MINISTRY
OF TRANSPORT,
MOBILITY AND THE
URBAN AGENDA

STATE SECRETARIAT
OF TRANSPORT, MOBILITY
AND THE URBAN AGENDA

SECRETARIAT-GENERAL
OF THE URBAN AGENDA
AND HOUSING

2020 ERESEE

2020 UPDATE

OF THE LONG-TERM STRATEGY FOR ENERGY RENOVATION IN THE BUILDING SECTOR IN SPAIN (ERESEE)

June 2020

Transposition

***Article 2a* Directive 2010/31/EU**

Long-term renovation strategy:

Each Member State shall establish a long-term renovation strategy to support the renovation of the national stock of residential and non-residential buildings, both public and private, into a highly energy efficient and decarbonised building stock by 2050, facilitating the cost-effective transformation of existing buildings into nearly zero-energy buildings.

Drafting of the ERESEE

Secretariat-General of the Urban Agenda and Housing
Directorate-General of the Urban Agenda and Architecture
Subdirectorate-General of Architecture and Construction
Secretariat-General of Urban Policy

Acknowledgements:

Interministerial Group Members:
Ministry of Territorial Policy and Civil Service
Ministry for the Ecological Transition and the Demographic Challenge
IDAE [Institute for Diversification and Saving of Energy] - Ministry for the Ecological Transition and the Demographic Challenge
Ministry of Health, Consumption and Social Welfare
Ministry of Finance
Ministry of Economic Affairs and Digital Transformation
ICO [Official Credit Institute] - Ministry of Economic Affairs and Digital Transformation
INE [National Statistics Institute] - Ministry of Economic Affairs and Digital Transformation
Ministry of Education and Vocational Training
Ministry of Labour and Social Economics
Ministry of Social Rights and the 2030 Agenda

Subdirectorate-General for Land, Information and Assessment. MINISTRY OF TRANSPORT, MOBILITY AND THE URBAN AGENDA (MITMA)
Participants in the public participation process and
especially the working group moderators

Contributors:
GBCe [Green Building Council España]
Cíclica [Space, Community, Ecology]
A3e
ATECYR [Spanish Technical Association for Air Conditioning and Cooling]
AMI
ADHAC [Association of Heating and Cooling Network Companies]
Instituto de Ciencias de la Construcción Eduardo Torroja [Eduardo Torroja Institute for Construction Science]. CSIC [Spanish National Research Council]
Technical University of Madrid
Tecnalia
BC3 Basque Centre for Climate Change

The 2015 Paris Agreement on climate change following the 21st Conference of the Parties to the United Nations Framework Convention on Climate Change (COP 21) boosts the Union's efforts to decarbonise its building stock. Taking into account that almost 50 % of Union's final energy consumption is used for heating and cooling, of which 80 % is used in buildings, the achievement of the Union's energy and climate goals is linked to the Union's efforts to renovate its building stock by giving priority to energy efficiency, making use of the 'energy efficiency first' principle as well as considering deployment of renewables.

The text reproduced above is an unabridged copy of recital 7 of Directive (EU) 2018/844 of the European Parliament and of the Council of 30 May 2018 amending Directive 2010/31/EU on the energy performance of buildings and Directive 2012/27/EU on energy efficiency.

Recital 8 of that Directive continues by stating that the provisions on long-term renovation strategies laid down to date in Directive 2012/27/EU on energy efficiency had to be moved to Directive 2010/31/EU on the energy performance of buildings, where they fit more coherently.

Spain complied with this order laid down in Directive 2012/27/EU through the drafting by the Ministry of Development (as it was called at the time) of the 'Long-Term Strategy for Energy Renovation in the Building Sector in Spain' hereinafter referred to as the 2014 ERESEE[1]. Article 4 of the Directive on energy efficiency established the obligation to review the Strategy every 3 years. This review was fulfilled through the drafting, again by the Ministry of Development, of the 2017 ERESEE[2], submitted to the European Commission as part of the National Energy Efficiency Action Plans (NEEAP), and which also coincided with the 2017 review of the 2014-2020 NEEAP.

These two strategies were very highly regarded by the Joint Research Centre (JRC) in its National Strategy Assessment Report commissioned by the European Commission DG Energy. The report on the first version of the strategy submitted by each Member State in 2014 was published in 2016[3], and awarded the Spanish strategy the highest score of the 31 strategies submitted. The Ministry of Development's second strategy, published in 2019[4], was once again given the highest score, though this time tied with the French strategy.

The European Commission's commitment to the energy renovation of the building stock in the Member States is growing stronger all the time. This is reflected in the *Green Deal* presented by the Commission at the start of the year, in which the "Renovation Wave" plays a leading role. This ambition is also reflected in the extension of the content and concrete detail that must now be included in the long-term renovation strategy, laid down, following the publication of Directive 2018/844/EU, in Article 2(a) of Directive 2010/31/EU.

Specifically, this extension of content now requires the previous strategies to be updated to include, among other things, the following issues: policies and actions to target all public buildings; a roadmap with measures and domestically established measurable progress indicators; a strategy to tackle the problem of energy poverty; and finally, a public participation process to gather an overview from the various sectors that play a decisive role so as to ensure that the energy renovation of buildings actually takes place at the intensity and rates desired.

Lastly, we must mention that, against the backdrop of this favourable context for promoting the energy renovation of the building stock, the COVID-19 pandemic has shaken the world, bringing long-term consequences that we cannot foresee at the time of drafting this document. Given that work on the strategy began before this devastating phenomenon occurred, we have not amended the consumption or investment forecasts because, as mentioned, it is difficult to determine what the consequences will be. This has been

[1] Accessible at: http://www.fomento.gob.es/MFOM/LANG_CASTELLANO/PLANES/ELPRESEEESP/

[2] Accessible at: https://www.mitma.gob.es/recursos_mfom/pdf/24003A4D-449E-4B93-8CA5-7217CFC61802/143398/20170524REVISIONESTRATEGIA.pdf

[3] Castellazzi, L: Zangheri P; Paci, D. (2016). *"Synthesis Report on the assessment of Member State's Building Renovation Strategies"*; EUR 27722 EN; doi 10.1790/052530 (2016).
Accessible at: https://ec.europa.eu/jrc/en/publication/eur-scientific-and-technical-research-reports/synthesisreportassessment-member-states-building-renovation-strategies

[4] Accessible at: https://publications.jrc.ec.europa.eu/repository/bitstream/JRC114200/kjna29605enn.pdf

reflected in the consideration of the importance of a home that meets adequate conditions, not only in terms of thermal comfort, but also sound and light, issues already highlighted in Directive 2018/844/EU.

Likewise, in the tertiary sector, we have also taken into consideration the possibility that hospitals will become a priority and strategic sector for action in the next decade, with a potential overhaul or update of their air conditioning and ventilation systems. This consideration is reflected in the design of the tertiary sector scenarios in which, taking this into account, the intervention rate has been increased compared with other uses of the tertiary stock.

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CHAPTER 1. ASSESSMENT: THE STOCK OF RESIDENTIAL AND TERTIARY BUILDINGS IN SPAIN.

1.1. ASSESSMENT OF THE RESIDENTIAL BUILDING STOCK IN SPAIN.

This assessment of the Spanish residential building stock comprises two separate parts:

The first involves an overview analysis of the Spanish residential building stock and covers the following aspects:

- analysis of the Spanish residential stock according to occupation: main and secondary dwellings;
- type analysis, by building age and size of the dwellings in Spain;
- analysis of the distribution of dwellings according to municipality size;
- analysis of the tenure status of households in Spain.

In the light of the above analysis, the second part segments this residential stock into typological clusters, which will be used throughout the ERESEE 2020 to propose renovation approaches within the clusters and to economically assess the different options, while at the same time taking into account the different climatic zones and energy consumption.

1.1.1. Data sources and hypotheses used

In the 2014 and 2017 versions of the ERESEE, the work conducted was primarily based on data from the 2011 Population and Housing Census (National Statistics Institute). Given that these data are now nine years old and the next census will not be conducted until 2021, alternative data sources have been used for this 2020 ERESEE update. Those sources were as follows:

The main source used was the latest available version (2018) of the Continuous Household Survey[5] conducted by the National Statistics Institute, which provides data on households (main dwellings) by type, year of construction, tenure status, floor area, etc.

The following additional sources were also used: the 2018 Household Budget Survey[6] (National Statistics Institute); the 2018 Living Conditions Survey[7] (National Statistics Institute); the 2018-2033 Household Projection[8] (National Statistics Institute); and the European Commission's Ageing Report[9].

Using the latest available data on households in 2018 according to the Continuous Household Survey (18 535 900), we developed a hypothesis to calculate the number of households in main dwellings in 2020,

5 https://www.ine.es/dyngs/INEbase/en/operacion.htm?c=Estadistica_C&cid=1254736176952&menu=resultados&idp=1254735572981

6 https://www.ine.es/dyngs/INEbase/en/operacion.htm?c=Estadistica_C&cid=1254736176806&menu=ultiDatos&idp=1254735976608

7 https://www.ine.es/dyngs/INEbase/en/operacion.htm?c=Estadistica_C&cid=1254736176807&menu=ultiDatos&idp=1254735976608

8 https://www.ine.es/dyngs/INEbase/en/operacion.htm?c=Estadistica_C&cid=1254736176954&menu=ultiDatos&idp=1254735572981

9 https://ec.europa.eu/economy_finance/publications/european_economy/ageing_report/index_en.htm

estimated at 18 771 653, of which 16 827 623 estimated with heating and 1 944 030 without. The estimated population is 47 051 507 inhabitants.

1.1.2. Analysis of the Spanish residential stock according to occupation: main, secondary and empty dwellings.

According to the Continuous Household Survey (ECH), there are an estimated 25.7 million dwellings in Spain in 2020, distributed as follows: 74.6% main dwellings (18 771 653) and 25.4% secondary and empty dwellings (6 375 471).

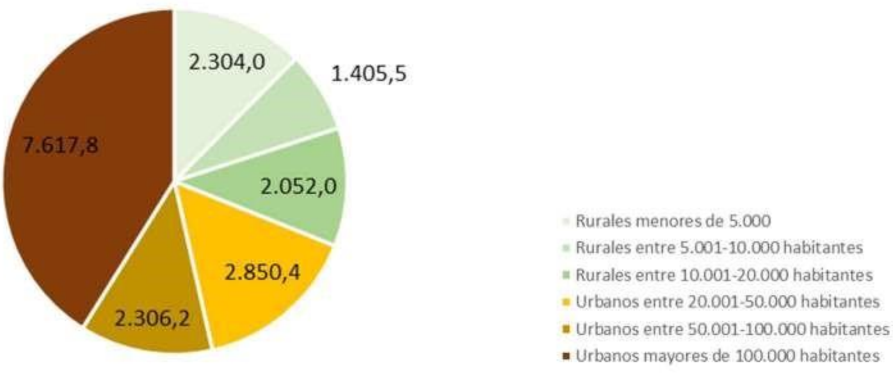
Those figures have not varied substantially compared with the most recent Population and Housing Survey available (2011), with main dwellings (17 528 518) representing 71.5% and the remaining 28.5% split between secondary (3 616 895, 14.8%), empty (3 374 291, 13.8%) and other dwellings, of a total stock that numbered 25.2 million at that time.

The data from the 2011 Census also allow us to qualify these data in different ways according to use. Thus, multi-family dwellings had greater weight among main dwellings (71.8% compared with 28.2% for single-family dwellings), while the situation is quite different in the secondary dwelling stock (where single-family dwellings total 46.9% compared to 53.1% of multi-family dwellings). In the case of empty dwellings, the distribution was largely similar to the overall distribution (68.4% multi-family and 31.6% single-family dwellings).

1.1.2.1. Analysis of the distribution of dwellings according to municipality size.

The data from the 2018 Continuous Household Survey show that 68.9% of Spanish main dwellings are situated in municipalities with over 20 000 inhabitants (hereinafter referred to as urban for ERESEE purposes) compared with 31.1% situated in municipalities with fewer than 20 000 inhabitants (referred to as rural for ERESEE purposes). It should be noted that, of the total stock, 7.6 million dwellings (41.1%) are concentrated in cities with over 100 000 inhabitants, and 3.1 million are located in the six cities with over 500 000 inhabitants (Madrid, Barcelona, Valencia, Seville, Zaragoza and Malaga).

Figure 1.1. Graph showing the distribution of main dwellings by municipality size.



	7 617.8
	2 304.0
	1 405.5
	2 052.0
	2 850.4
	2 306.2
	Rural with fewer than 5 000 inhabitants
	Rural with between 5 001 and 10 000 inhabitants
	Rural with between 10 001 and 20 000 inhabitants

	Urban with between 20 001 and 50 000 inhabitants
	Urban with between 50 001 and 100 000 inhabitants
	Urban with over 100 000 inhabitants

Source: MITMA based on the 2018 Continuous Household Survey (National Statistics Institute).

The distribution by building type shows that 60.3% of single-family dwellings are concentrated in municipalities with fewer than 20 000 inhabitants and that, conversely, multi-family dwellings are even more acutely concentrated in urban municipalities with over 20 000 inhabitants (82.6%). In this way, the breakdown by type differs greatly depending on the size of the municipality: single-family dwellings are predominant in rural municipalities, where they account for 61.8% compared with 38% in the case of multi-family dwellings, while in urban municipalities, these percentages are 18.3% for single-family and 81.4% for multi-family dwellings, respectively.

Figure 1.2. Distribution of main dwellings by size of municipality and type (thousands of dwellings)

	Total	%	Detached single-family dwelling	Terraced or semi-detached single-family dwelling	Single-family total	Building with two dwellings	Building with 3 to 9 dwellings	Building with 10 or more dwellings	Collective and Block total	Building used for other purposes
TOTAL Fewer than 20 000 inhabitants.	5 761.5	31.08	1 718.0	1 843.1	3 561.1	342.0	835.8	1 012.4	2 190.2	10.1
Fewer than 101 inhabitants	26.5	0.14	16.4	8.9	25.3	1.1	0.0	0.0	1.1	0.0
101-500 inhabitants	362.2	1.95	176.9	151.4	328.3	21.3	10.0	1.4	32.7	1.1
501-1 000 inhabitants	324.3	1.75	128.2	134.3	262.5	20.8	27.8	12.9	61.5	0.3
1 001-2 000 inhabitants	424.1	2.29	155.5	158.3	313.8	42.0	38.2	28.3	108.5	1.8
2 001-5 000 inhabitants	1 166.9	6.30	421.3	455.9	877.2	85.6	114.5	87.8	287.9	1.9
5 001-10 000 inhabitants	1 405.5	7.58	387.3	449.2	836.5	81.7	225.0	259.5	566.2	2.8
10 001-20 000 inhabitants	2 052.0	11.07	432.4	485.1	917.5	89.5	420.3	622.5	1 132.3	2.2
TOTAL Over 20 000 inhabitants.	12 774.4	68.92	858.2	1 482.7	2 340.9	254.6	2 406.8	7 741.6	10 403.0	30.4
20 001-50 000 inhabitants	2 850.4	15.38	397.7	602.8	1 000.5	110.7	591.7	1 141.6	1 844.0	6.0
50 001-100 000 inhabitants	2 306.2	12.44	197.3	346.5	543.8	53.7	438.7	1 265.1	1 757.5	4.9
100 001-500 000 inhabitants	4 450.5	24.01	218.5	430.2	648.7	72.5	858.5	2 860.9	3 791.9	9.8
500 001 or more inhabitants	3 167.3	17.09	44.7	103.2	147.9	17.7	517.9	2 474.0	3 009.6	9.7
		-			0.0				0.0	
TOTAL	18 535.9	100.00	2 576.2	3 325.8	5 902.0	596.5	3 242.6	8 754.1	12 593.2	40.7

Source: MITMA based on the 2018 Continuous Household Survey (National Statistics Institute).

1.1.2.2. Analysis of the type and floor area of dwellings in Spain.

By looking at the data from the 2018 Continuous Household Survey, we can see that almost half of Spain's main dwellings (45.5%) have a floor area of between 61 and 90 m^2: 17.6% between 61 and 75 m^2 and 27.9% between 75 and 90 m^2. Almost the other half (41.7%) are homes with a floor area of over 90 m^2 (broken down as 23.5% between 91 and 120 m^2, 8.1% between 121 and 150 m^2 and the other 10.2% over 150 m^2), while those smaller than 60 m^2, of which there are far fewer, account for just 12.7% of the main dwelling stock.

Figure 1.3. Distribution of main dwellings by floor area range and building age (thousands of dwellings)

	Total	Less than 60 m2	Between 61 and 90 m2	Between 61 and 75 m2	Between 76 and 90 m2	Over 90 m2	Between 91 and 120 m2	Between 121 and 150 m2	Over 150 m2
Before 1940	**1 312.0**	243.6	409.1	183.2	225.9	659.2	303.4	134.6	221.2
1941-1960	**1 777.0**	377.5	773.2	382.9	390.3	626.4	365.2	127.2	134.0
1961-1980	**6 370.2**	930.2	3 297.0	1 469.2	1 827.8	2 143.0	1 424.9	369.1	349.0
1981-2010	**8 851.8**	781.2	3 869.7	1 203.1	2 666.6	4 201.1	2 210.8	845.8	1 144.5
After 2010	**224.9**	28.6	87.9	31.5	56.4	108.6	44.8	23.2	40.6
Total	18 535.9	2 361.1	8 436.9	3 269.8	5 167.1	7 738.0	4 349.1	1 499.8	1 889.1

Source: MITMA based on the 2018 Continuous Household Survey (National Statistics Institute).

Looking at construction periods shows that the oldest dwellings, built prior to 1940, are larger, with more than half of them over 90 m^2. The most recent dwellings are also relatively large, both those built between 1981 and 2010 and those built after 2010, in which 47.5% and 48.3% are larger than 90 m^2. Dwellings built between 1941 and 1960 have the highest percentage smaller than 60 m^2 (21.2%), with a further 43.5% between 61 and 90 m^2 and 35.3% over 90 m^2. Lastly, approximately half of the dwellings built between 1961 and 1980 (51.8%) are between 61 and 90 m^2, with 14.6% smaller than 60 m^2 and 33.6% larger than 90 m^2.

Figure 1.4. Distribution of main dwellings by type and building age (thousands of dwellings)

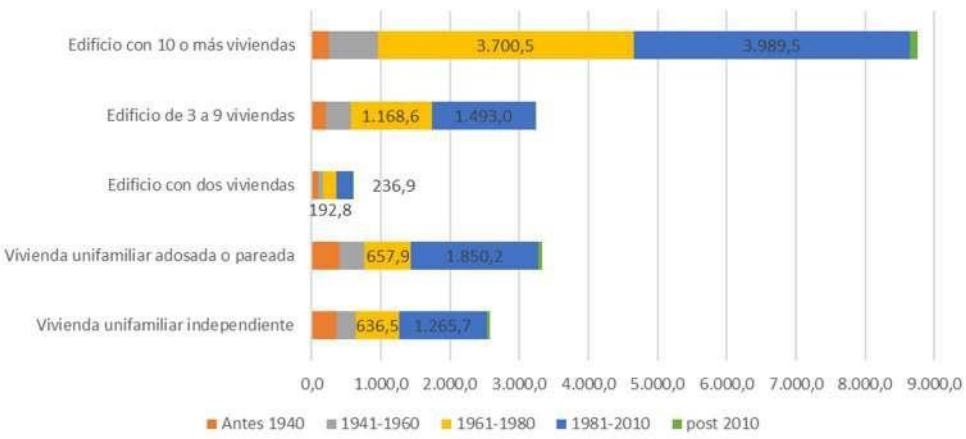
	Before 1940	1941-1960	1961-1980	1981-2010	After 2010	Total
Detached single-family dwelling	359.4	269.9	636.5	1 265.7	44.7	2 576.2
Terraced or semi-detached single-family dwelling	405.0	362.2	657.9	1 850.2	50.6	3 325.8
Building with two dwellings	94.8	67.8	192.8	236.9	4.2	596.5
Building with 3 to 9 dwellings	197.7	365.0	1 168.6	1 493.0	18.4	3 242.6
Building with 10 or more dwellings	250.3	706.7	3 700.5	3 989.5	107.0	8 754.1
Total	1 312.0	1 777.0	6 370.2	8 851.8	224.9	18 535.9

Source: MITMA based on the 2018 Continuous Household Survey (National Statistics Institute).

As regards type, according to the 2018 Continuous Household Survey, 67.9% of Spanish dwellings (8.7 million) are multi-family dwellings, compared with 31.8% single-family (5.9 million), which is further broken down into 2.5 million (13.9%) detached single-family dwellings and 3.3 million terraced or in blocks (17.9%).

The graphs below show main dwellings grouped by type and building age, clearly reflecting the prevalence of multi-family dwellings in buildings with over 10 dwellings (8.7 million, representing 47.2% of the total stock) and the big periods of construction in Spain (Francoist property cycle from the 1960s to 1975 and the property cycle at the end of the 20th century, approximately from 1997 to 2007).

Figure 1.5. Graph showing the distribution of main dwellings by type and building age (thousands of dwellings)

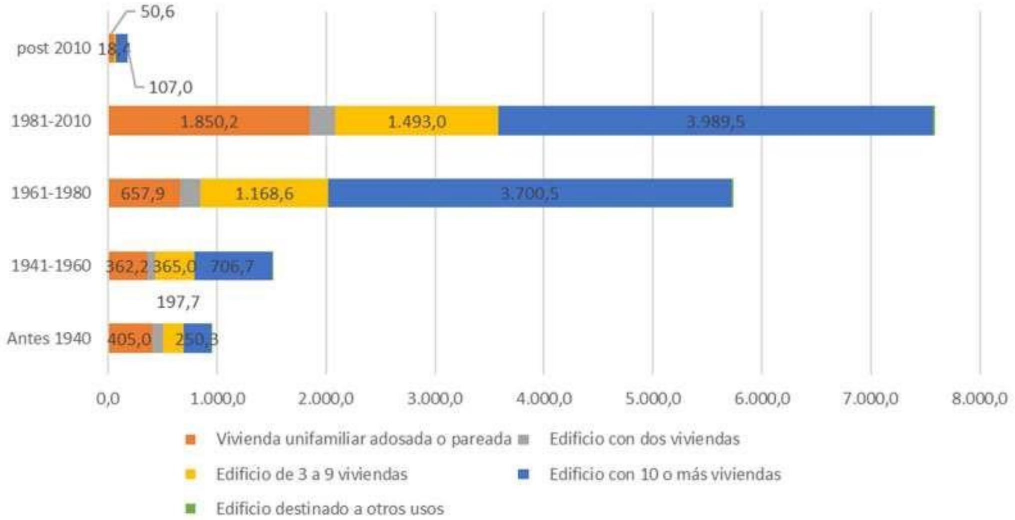


	Building with 10 or more dwellings
	3 700.5
	3 989.5
	Building with 3 to 9 dwellings
	1 168.6
	1 493.0
	Building with two dwellings
	192.8
	236.9
	Terraced or semi-detached single-family dwelling
	657.9
	1 850.2

	Detached single-family dwelling
	636.5
	1 265.7
	0.0
	1 000.0
	2 000.0
	3 000.0
	4 000.0
	5 000.0
	6 000.0
	7 000.0
	8 000.0
	9 000.0
	Before 1940
	1941-1960
	1961-1980
	1981-2010
	After 2010

Source: MITMA based on the 2018 Continuous Household Survey (National Statistics Institute).

Figure 1.6. Graph showing the distribution of main dwellings by building age and type (thousands of dwellings)



	After 2010
	1981-2010
	1961-1980
	1941-1960
	Before 1940
	50.6
	18.4
	107.0
	1 850.2
	1 493.0
	3 989.5
	657.9
	1 168.6
	3 700.5
	362.2
	365.0
	706.7

	197.7
	405.0
	250.3
	0.0
	1 000.0
	2 000.0
	3 000.0
	4 000.0
	5 000.0
	6 000.0
	7 000.0
	8 000.0
	Terraced or semi-detached single-family dwelling
	Building with two dwellings
	Building with 3 to 9 dwellings
	Building with 10 or more dwellings
	Building used for other purposes

Source: MITMA based on the 2018 Continuous Household Survey (National Statistics Institute).

1.1.2.3. analysis of the tenure status of households in Spain.

According to the data from the 2018 Continuous Household Survey, the tenure status of 76.7% of Spanish main dwellings is in ownership (14.2 million of a total of 18.5), compared with 17.8% in rental (3.3 million) and 5.5% under other forms of tenure (1.2 million; made available free of charge or for a price by another household, the company, etc.). Of the owned dwellings, 9.1 million (64%) no longer have ongoing mortgage payments, compared with 5.1 million (36%) that do.

Figure 1. 7. Distribution of dwellings by tenure status.

	27.6
	17.8
	5.5
	49.1
	% Owned through purchase, whether fully paid, inherited or donated
	% Owned with outstanding payments
	% Rented
	% Made available free of charge or for a price by another household, the company, etc.

Source: MITMA based on the 2018 Continuous Household Survey (National Statistics Institute).

1.1.3. Segmentation of the Spanish residential stock into clusters.

Since the goal of the present Strategy is renovation, the first task is to segment the existing dwelling stock into homogeneous groups – which we will call clusters – that present similar problems and therefore require sets of actions – which we will call intervention menus – that are also similar.

There are three types of problems that must be addressed by renovation in general and that should act as a guide for segmenting the dwelling stock:

- ‘Conservation’ defects in the building’s construction systems and installations. In accordance with the applicable legislation, these defects must be assumed – and therefore paid for up to the economic limit of the legal duty – by the owner, as a result of the duty of conservation inherent in the ownership
- Problems of physical accessibility to the dwelling, which, with regard to ‘reasonable accommodation’ in terms of accessibility, are also obligatory in nature.
- Improvements in the energy efficiency of the building, which are only voluntary.

Although these three types of problems may arise separately (though there may be a higher prevalence of problems among older buildings compared to newer ones) and it is therefore necessary to segment the stock differently depending in the different types of intervention required to solve the problems, it is a case of finding potential synergies, especially between conservation, which is obligatory, and energy efficiency, which is voluntary. In this sense, and as will be shown subsequently, the Building Assessment Report (IEE) or the Technical Building Inspection (ITE) may play a prominent role as catalysts or triggers for the energy efficiency improvement works.

1.1.3.1. Periodisation according to technical regulations

Considering that the main building characteristics of the stock fundamentally depend on the technical regulations in force at the time when the buildings were constructed, we have begun by identifying separate periods according to these regulations.

- The first period considered (prior to 1940) covers buildings constructed prior to the Spanish Civil War, among which those built prior to 1900 are considered to be historic buildings. These are all buildings primarily built using traditional construction systems in which the enclosing elements (load-bearing walls, built using stone, brick, mudbrick, etc.) also had a structural function. Although walls of this type do not have thermal insulation, they are often thick enough (from 1 ft) to offer considerable thermal inertia and good bioclimatic performance.
- The first technical standards that provided general regulations for the building sector in Spain during the second half of the 20th century were called ‘MV Standards’ and were approved by the Ministry of Housing, created in 1957. The majority of these standards in the MV series that were approved between 1961 and 1976 regulated structural safety, and none considered thermal insulation. The second period considered for the analysis covers dwellings built between 1940 and 1960.
- However, in 1969, the Provisional Ordinances approved by Order of the Ministry of Housing provided regulations governing certain characteristics of dwellings under the social housing system, including thermal insulation, set out in Ordinance 32. This was a straightforward regulation that divided Spain into two climatic zones according to the winter and summer isotherms, which were used to establish limits for the thermal transmittance (then called conductivity) of roofs and facades. The maximum limits were 1.2 and 1.6 kcal/m^{2}ºC, which meant that including an air gap was enough to achieve that transmittance. The standard enclosing facade element became a 6-inch brick wall, cavity and a thin or thick interior wall. The third period considered by the ERESEE covers the 1960s and 1970s.
- In 1977, the Government approved a unified framework for building regulations comprising the compulsory Basic Building Standards (*Normas Básicas de la Edificación*, NBE) and non-compulsory Technological Building Standards (*Normas Tecnológicas de la Edificación*, NTE), which were used as the operational development of the NBEs. The first of these basic standards, issued as a result of the second energy crisis of the 1970s, was NBE-CT 79 on thermal conditions in buildings, the first modern standard that required thermal insulation. It required an overall average insulation, characterised by a KG

coefficient that depended on the compactness of the building and on the climatic zone defined by day degrees, as well as maximum transmittances for the various enclosing elements to ensure a minimum thermal comfort and the absence of surface condensation. With these requirements, in force from 1980 until 2006, the 6-inch brick, cavity and thin-wall solutions were not enough, and thermal insulation in facade and roof gaps became standard.

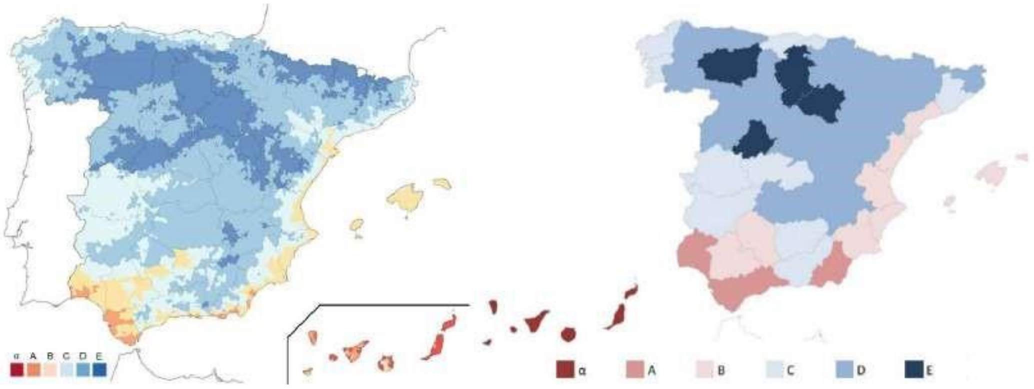
- Later, in 1999, Law 38/1999 of 5 November 1999 on Building Planning (LOE) was passed with the key aim of regulating the building sector in Spain. In terms of regulations, it was necessary to update the technical legislation, which had become profoundly obsolete, and therefore the law urged and authorised the Government to approve a Technical Building Code (*Código Técnico de la Edificación*, CTE) by means of a Royal Decree that set out the requirements to be met by buildings in relation to basic security and habitability requirements.
- The legislator drafted the LOE with the aim of responding to the demands of Spanish society, increasingly concerned about quality in buildings, safety, well-being, energy and protecting the environment. Hence, in the specifications, the Technical Building Code approved in 2006 came to reflect the objectives of the LOE and to translate these aspirations into technical language, which, in terms of energy efficiency, were set out in the Basic Document DB HE. At the same time, the Code was used to transpose certain obligations from European legislation. Pursuant to the basic requirement of the LOE regarding energy, this basic document DB HE set out requirements on limiting energy demand (which meant improving the passive aspects of the building), and also on improving the efficiency of the heating and lighting installations as well as a minimum provision from renewable energies (solar) to produce domestic hot water and electricity through solar collector panels and photovoltaic panels, respectively.
- With regard to the 1979 requirements, the new Code represented an important step forward, estimated to be an improvement in demand of between 25 and 35%, and therefore in insulation.
- The Technical Building Code has since been amended on various occasions, most recently in 2019 (see Chapter 4).

1.1.3.2. Summary of the process and methodology used to segment the Spanish residential stock into clusters.

In order to make use of the data taken from the various sources, a dynamic table was created to obtain the information by cross-checking the following data:

- Province where it is located, which makes it possible to consider the reference climatic zone in which the dwelling is situated (assimilating it to the capital of the province).

Figure 1.8. Climatic zones by municipalities (left) and result of the assimilation to the provincial capital zone (right).



Source: MITMA.

- Municipality size, which makes it possible to infer the dwelling's status as rural or urban and, thus, the types of energy to which it may have access or most preferred access, as well as its possible inclusion in larger action units.
- Year of construction within the specific periods listed above (before 1900, 1901-1940, 1941-1960, 1961-1980, 1981-2007, 2008-2020), which are significant due to technical or regulatory changes: before 1940 (traditional building), between 1940 and 1960 (first cycle of urban expansion with block types), between 1960 and 1980 (second cycle of urban expansion with changes in construction systems), between 1980 and 2007 (new technical changes and period of application of NBE-CT/79, which set a minimum level of thermal insulation in the enclosing elements), from 2008 onwards (implementation of the Technical Building Code (CTE), which requires energy efficiency conditions for the building). By assigning the dominant construction systems in each period in each cluster, this segmentation makes it possible to infer the level of insulation of the enclosing elements.
- Classification as single-family buildings, collective buildings (multi-family with up to three storeys) or blocks (multi-family with four or more storeys), which allows us to take into consideration the renovation management unit (individual or homeowners association), the accessibility requirements (lift) and the general construction and geometric characteristics.
- The heating system of the dwellings, which both indicates the presence or absence of any type of heating and identifies the source of the energy used and the main technologies for the residential sector defined by the National Integrated Energy and Climate Plan (PNIEC).

These data have been used to select the clusters that are significant from the perspective of energy efficiency, understanding that building types are separated into groups that may have common action menus with a view to improving their energy efficiency:

Figure 1.9. Matrix defining the dwelling clusters.

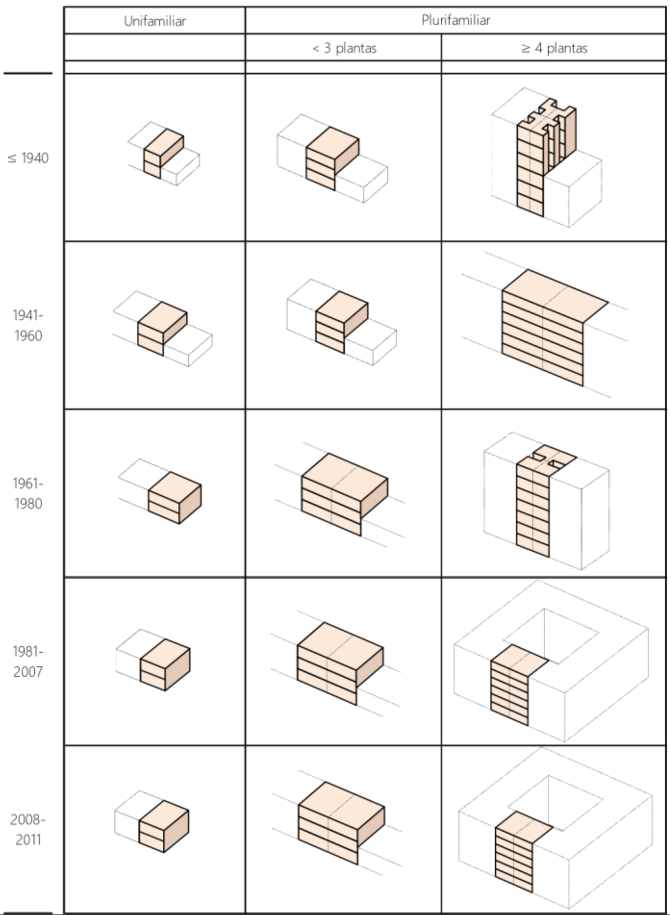
	Uu Single-family dwelling	Cc Dwelling in multi-family buildings with 2 or more dwellings and up to three storeys	Bb Dwelling in multi-family buildings with 2 or more dwellings and more than three storeys
Before 1940	Uu <40	Cc <40	Bb <40
1941-1960	Uu 41-60	Cc 41-60	Bb 41-60
1961-1980	Uu 61-80	Cc 61-80	Bb 61-80
1981-2007	Uu 81-07	Cc 81-07	Bb 81-07
2008-2011	Uu 08-11	Cc 08-11	Bb 08-11

Source: MITMA.

The nomenclature used for the clusters refers to the following:

- Letter U, C, B: U=Single-family dwellings; C=Dwellings in multi-family buildings (with 2 or more dwellings) and up to three storeys; B=Dwellings in multi-family buildings with (2 or more dwellings) and more than three storeys.
- Letter in upper or lower case: upper case indicates an urban setting (towns/cities with over 20 000 inhabitants) and lower case indicates a rural setting (towns/cities with fewer than 20 000 inhabitants). Where two letters are used, this refers to the complete cluster, i.e. both urban and rural settings.
- < 40, 41-60, 61-80, 81-07, 08-11: this refers to the age of the building.

Figure 1.10. Volumetric modelling matrix of the dwelling clusters included in the 2020 ERESEE.



	Single-family
	Multi-family

	< 3 storeys
	≥ 4 storeys
	≤ 1940
	1941-1960
	1961-1980
	1981-2007
	2008-2011

Source: MITMA. (2019) 'Segmentation of the residential stock in Spain into type clusters'. Study (01) for the 2020 ERESEE.

The dwellings for each of these clusters have been modelled on the basis of the following parameters, which define the geometry of each cluster:

- Average floor area of typical dwelling (m^2).
- No of storeys in building.
- No of dwellings per storey.
- Front/back ratio (typical building).
- Dwelling front/back ratio (typical dwelling).
- Front (typical building) (m).
- % of party walls in contact with exterior.
- Total area of facade (m2).
- Area of opaque facade (including party walls in contact with exterior) (m^2).
- Area of facade apertures (m^2).
- Area of party wall not in contact with exterior (considered adiabatic) (m^2).
- Area of floor (m^2).
- Area of roof (m^2).

These parameters were obtained from a specific study of the main types of dwellings in Spain[10], the results of which in terms of geometry for each of the clusters are given in the tables in Annex A.1.

Once the dwellings in the clusters have been geometrically modelled, the next stage is to technically characterise their enclosing elements (facades, roofs, ground floor framework, and apertures) given that we have assumed that each cluster has some similar building characteristics.

For each of the envelope elements (facades, roofs, ground floor framework, and apertures), we have a table that assigns the percentages of the various construction solutions that may arise for each cluster. For example, in the case of facades, the following are taken into consideration: Single-leaf thick solid wall (1 ft), Single-leaf thick solid wall (1.5 ft), Single-leaf wall without cavity or insulation, Double-leaf wall with cavity but without insulation, and Double-leaf wall with cavity and insulation CT79. The attached table illustrates the situation for the facades (and includes the table of solutions proposed for the intervention menus):

Figure 1.11. Hypothesis used to assign construction solutions for the enclosing facade elements to the clusters (Uu and Bb) (Original situation and intervention menus).

ORIGINAL SITUATION	U <40				U40-60				U60-80				U80-07			
	VW	X	Y	Z	VW	X	Y	Z	VW	X	Y	Z	VW	X	Y	Z
Facade																
Single-leaf thick solid wall (1 ft)	70	70	70	70	70	70	70	70	25	25	25	25				
Single-leaf thick solid wall (1.5 ft)	30	30	30	30												
Single-leaf wall without cavity or insulation					30	30	30	30	25	25	25	25				
Double-leaf wall with cavity but without insulation									50	50	50	50				
Double-leaf wall with cavity and insulation CT79													100	100	100	100

ORIGINAL SITUATION	B <40				B40-60				B60-80				B80-07			
	VW	X	Y	Z	VW	X	Y	Z	VW	X	Y	Z	VW	X	Y	Z
Facade																
Single-leaf thick solid wall (1 ft)	30	30	30	30												
Single-leaf thick solid wall (1.5 ft)	70	70	70	70	20	20	20	20								
Single-leaf wall without cavity or insulation					80	80	80	80								
Double-leaf wall with cavity but without insulation									100	100	100	100				
Double-leaf wall with cavity and insulation CT79													100	100	100	100

[10] MITMA. (2019) 'Segmentation of the residential stock in Spain into type clusters'. Study (01) for the 2020 ERESEE.

INTERVENTION MENUS	U<40						U40-60						U60-80						U80-07					
	a	A	B	C	D	E	a	A	B	C	D	E	a	A	B	C	D	E	a	A	B	C	D	E
Facade																								
Insulation applied internally (plasterboard panels)	100	100	100	100	100	100	20	20	20	20	20	20	15	15	15	15	15	15	10	10	10	10	10	10
Insulation applied internally with demolition																			10	10	10	10	10	10
External insulation (EIFS)							80	80	80	80	80	80	35	35	35	35	35	35	60	60	60	60	60	60
Insulation by filling the cavity													50	50	50	50	50	50	20	20	20	20	20	20

INTERVENTION MENUS	B<40						B40-60						B-60-80						B80-07					
	a	A	B	C	D	E	a	A	B	C	D	E	a	A	B	C	D	E	a	A	B	C	D	E
Facade																								
Insulation applied internally (plasterboard panels)	80	80	80	80	80	80	20	20	20	20	20	20												
Insulation applied internally with demolition																			10	10	10	10	10	10
External insulation (EIFS)	20	20	20	20	20	20	80	80	80	80	80	80							70	70	70	70	70	70
Insulation by filling the cavity													100	100	100	100	100	100	20	20	20	20	20	20

Source: CSIC-Instituto de Ciencias de la Construcción Eduardo Torroja [Eduardo Torroja Institute for Construction Science] (Construction Quality Unit) and MITMA.

Below is a very schematic outline of the building characteristics considered (the great range of combinations permitted by the matrices has not been taken into consideration):

- Single-family dwellings built before 1960 are assumed to have been built using traditional technical systems, thus with a predominance of solid masonry walls (primarily brick, stone or clay) whose thickness guarantees both structural strength and impermeability, while also providing both a certain thermal resistance and thermal inertia. The apertures in these walls are predominantly assumed to be closed off by wooden frames with low thermal resistance in the glazing and normally with high air permeability. There may be a great deal of variation in the type of roofs on these buildings, but a tiled roof over a ventilated attic has been considered to be the standard. Contact with the ground is generally the same across all dwellings, with the floor slab laid directly onto compacted earth.

- Single-family dwellings built after 1960 show changes in the construction systems compared with the proceeding clusters, with a predominance of double-leaf brick walls with intermediate air gap as the enclosure wall, in addition to the existence of a pitched tiled roof but without a ventilated attic or chamber due to the transformation of this into a habitable space. The frames continue to be mostly wooden or with metal profiles in some cases, which does not improve thermal conductivity or air-tightness. As regards the ground floors, these are a combination of floor slab laid on compacted earth either with a gravel sub-base or, in some cases some cases, suspended flooring.

- Dwellings built between 1980 (therefore after the NBE-CT/79) and 2007 (therefore before the compulsory application of the Technical Building Code) are considered to have thermal insulation in the walls that is integrated in the cavity of the enclosure wall, and insulation under the roof; this period also marks the start of the predominance of aluminium frames with thicker, double glazing with a cavity, improving their thermal insulation. Suspended floors with an air space separating the ground floor from the ground become widespread.

- The clusters that include dwellings in multi-family buildings follow the same construction patterns in terms of walls and apertures as single-family dwellings from the same periods, although there is considered to be a predominance of flat roofs (with insulation from 1980 onwards) and floor slab or party floor with arcades or commercial premises on the ground floor.

For each of these construction solutions, we have the corresponding parameters for thermal transmittance (W/m^2 K), which, when applied to the corresponding geometry, makes it possible to calculate the demand for the reference type.

Figure 1.12. Example matrix of thermal transmittance parameters (W/m^2 K) for walls by cluster and climatic zone.

MUROS	U <40	U40-60	U60-80	U80-07	C<40	C40-60	C60-80	C80-07	B <40	B40-60	B60-80	B80-07
A	2,12	2,12	1,85	1,50	2,12	2,08	1,50	1,50	1,94	1,81	1,68	1,50
B	2,03	2,12	1,85	1,40	2,12	2,08	1,40	1,40	1,94	1,81	1,68	1,40
C	1,98	2,12	1,85	1,30	2,12	2,08	1,30	1,30	1,94	1,81	1,68	1,30
D	1,98	2,12	1,85	1,30	2,12	2,08	1,30	1,30	1,94	1,81	1,68	1,30
E	1,94	2,12	1,85	1,30	2,12	2,08	1,30	1,30	1,94	1,81	1,68	1,30

	Wall
	U <40
	U40-60
	U60-80
	U80-07
	C<40

	C40-60
	C60-80
	C80-07
	B<40
	B40-60
	B60-80
	B80-07
	A
	2.12
	2.12
	1.85
	1.50
	2.12
	2.08
	1.50
	1.50
	1.94
	1.81
	1.68
	1.50
	B
	2.03
	2.12
	1.85
	1.40
	2.12
	2.08
	1.40
	1.40
	1.94
	1.81
	1.68
	1.40
	C
	1.98
	2.12
	1.85
	1.30
	2.12
	2.08
	1.30
	1.30
	1.94
	1.81
	1.68
	1.30
	D
	E

Source: CSIC-Instituto de Ciencias de la Construcción Eduardo Torroja [Eduardo Torroja Institute for Construction Science] (Construction Quality Unit) for MITMA.

1.1.3.3. Summary of the results of the segmentation by type clusters for the Spanish residential stock.

Having segmented the dwellings of the Spanish residential stock in accordance with the criteria above, some of the most the relevant results are summarised below.

Figure 1.13. Breakdown of total dwellings by cluster. Total number of dwellings by year of construction (rows) and type (columns).

	Uu Single-family dwelling	Cc Multi-family dwelling < 3 storeys	Bb Multi-family dwelling + 3 storeys	Total
Built before 1900	428 178 dwellings	97 273 dwellings	139 027 dwellings	664 479 dwellings
Built between 1901 and 1940	663 895 dwellings	168 783 dwellings	305 724 dwellings	1 138 402 dwellings
Built between 1941 and 1960	913 592 dwellings	452 219 dwellings	1 040 116 dwellings	2 405 926 dwellings
Built between 1961 and 1980	1 854 114 dwellings	1 123 298 dwellings	5 686 104 dwellings	8 663 516 dwellings
Built between 1981 and 2007	4 180 057 dwellings	2 049 477 dwellings	5 233 857 dwellings	11 463 392 dwellings
Built between 2008 and 2020	494 338 dwellings	203 258 dwellings	679 434 dwellings	1 377 030 dwellings
Total	8 534 174 dwellings	4 094 308 dwellings	13 084 261 dwellings	25 712 744 dwellings

Source: Cíclica [Space, Community, Ecology] for MITMA.

However, for ERESEE purposes, we will only look at main dwellings, as we assume these account for the majority of consumption and these are the dwelling on which any interventions will take place. The 6 178 dwellings in Ceuta and Melilla have been deducted from this group of main dwellings as the disaggregated information required to treat these in the same way as the rest of the fleet is not available.

Figure 1.14. Definition of Clusters. Number of Main Dwellings (excluding Ceuta and Melilla) by year of construction (rows) and type (columns).

	Uu Single-family dwelling	Cc Multi-family dwelling < 3 storeys	Bb Multi-family dwelling + 3 storeys	Total
Built before 1900	298 849 dwellings	70 497 dwellings	112 506 dwellings	481 852 dwellings
Built between 1901 and 1940	461 024 dwellings	121 315 dwellings	245 364 dwellings	827 703 dwellings
Built between 1941 and 1960	634 065 dwellings	324 348 dwellings	816 134 dwellings	1 774 547 dwellings
Built between 1961 and 1980	1 307 894 dwellings	794 646 dwellings	4 280 881 dwellings	6 383 421 dwellings
Built between 1981 and 2007	2 963 779 dwellings	1 470 720 dwellings	3 824 103 dwellings	8 258 602 dwellings
Built between 2008 and 2020	346 667 dwellings	146 218 dwellings	497 105 dwellings	989 990 dwellings
Total	6 012 278 dwellings	2 927 744 dwellings	9 776 093 dwellings	18 716 115 dwellings

Source: Cíclica [Space, Community, Ecology] for MITMA.

For the purposes of calculating and breaking down energy consumption, which comes later in the 2020 ERESEE, only dwellings with heating are taken into consideration, thereby excluding main dwellings on the Canary Islands (865 336; 4.6%) and all other main dwellings that do not have heating systems (1 029 334; 5.5%) and those with minority heating systems (223 318; 1.3%). The remaining group of dwellings totals 16 598 128, which is 88.4% of all main dwellings in Spain.

-

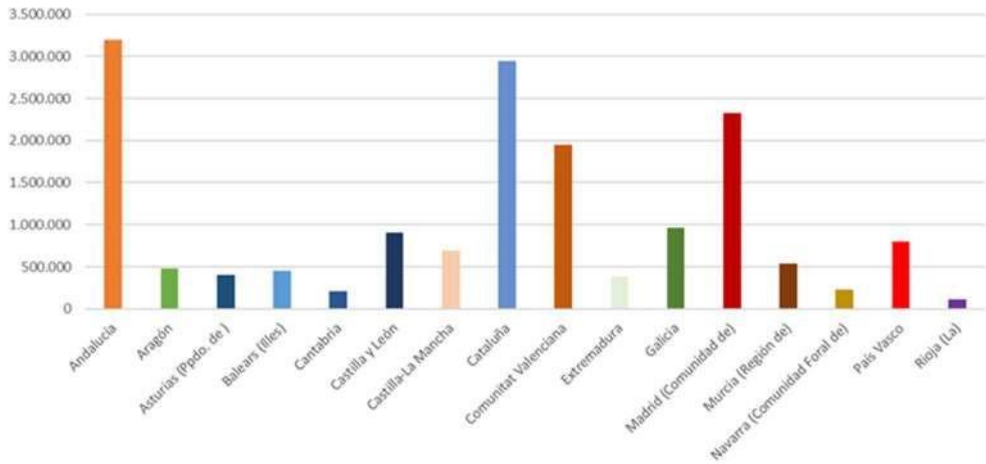
Figure 1.15. Definition of Clusters. Number of Main Dwellings with heating (excluding Ceuta, Melilla and the Canary Islands) by year of construction (rows) and type (columns)

	Single-family property	Multi-family property (collective)	Multi-family property (block)	Total
Built before 1900	273 905 dwellings	63 241 dwellings	101 568 dwellings	438 715 dwellings
Built between 1901 and 1940	422 679 dwellings	107 598 dwellings	220 957 dwellings	751 234 dwellings
Built between 1941 and 1960	580 599 dwellings	275 466 dwellings	723 717 dwellings	1 579 782 dwellings
Built between 1961 and 1980	1 171 956 dwellings	664 873 dwellings	3 829 955 dwellings	5 666 784 dwellings
Built between 1981 and 2007	2 696 261 dwellings	1 202 037 dwellings	3 382 411 dwellings	7 280 709 dwellings
Built between 2008 and 2020	322 419 dwellings	116 523 dwellings	441 961 dwellings	880 903 dwellings
Total	5 467 820 dwellings	2 429 738 dwellings	8 700 570 dwellings	16 598 128 dwellings

Source: Cíclica [Space, Community, Ecology] for MITMA.

The tables below show the results grouped by Autonomous Community and province.

Figure 1.16. Number of main dwellings with heating per Autonomous Community.

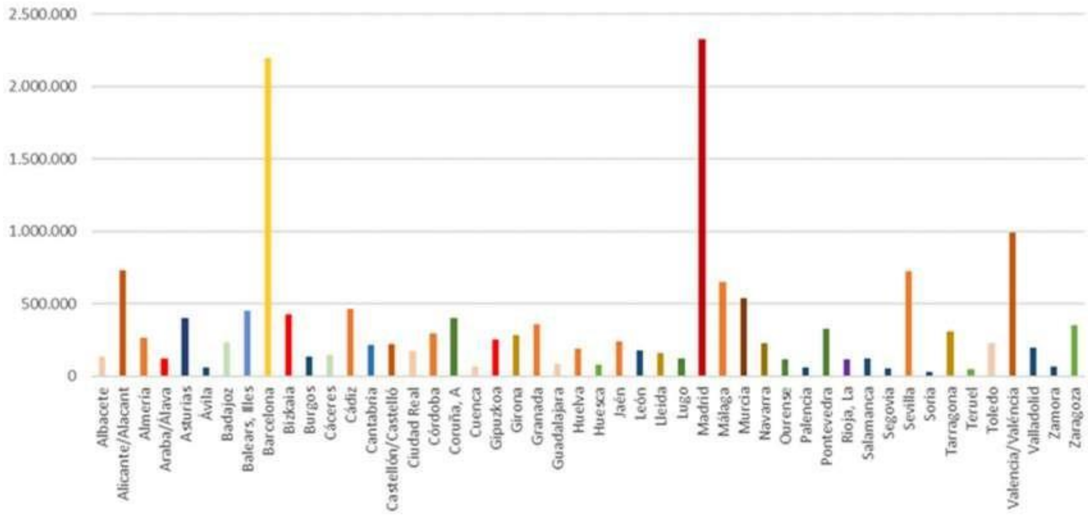


	3 500 000
	3 000 000
	2 500 000
	2 000 000
	1 500 000
	1 000 000
	500 000
	0
	Andalusia
	Aragon
	Asturias
	Balearic Islands
	Cantabria
	Castile and Leon
	Castile-La Mancha
	Catalonia
	Valencia

	Extremadura
	Galicia
	Madrid
	Murcia
	Navarre
	Basque Country
	Rioja

Source: GBCe based on Cíclica [Space, Community, Ecology] for MITMA.

Figure 1.17. Number of main dwellings with heating per province.



	Albacete
	Alicante/Alacant
	Almería
	Araba/Álava
	Asturias
	Ávila
	Badajoz
	Balearic Islands
	Barcelona
	Bizkaia
	Burgos
	Cáceres
	Cádiz
	Cantabria
	Castellón/Castelló
	Ciudad Real
	Córdoba
	A Coruña
	Cuenca
	Gipuzkoa
	Girona
	Granada
	Guadalajara
	Huelva
	Huesca
	Jaén
	León
	Lleida
	Lugo
	Madrid
	Malaga
	Murcia
	Navarre
	Ourense
	Palencia
	Pontevedra
	Rioja
	Salamanca
	Segovia
	Sevilla

	Soria
	Tarragona
	Teruel
	Toledo
	Valencia/Valéncia
	Valladolid
	Zamora
	Zaragoza

Source: GBCe based on Cíclica [Space, Community, Ecology] for MITMA.

The provincial analysis shows the unequal territorial distribution of households in Spain, which are predominantly situated in the large metropolitan areas (Madrid and Barcelona) and, to a lesser extent, in coastal areas, whereas the inland provinces (with the exception of Madrid) have a low number of households.

1.2. ASSESSMENT OF THE TERTIARY BUILDING STOCK IN SPAIN.

Characterising construction in the non-residential sector is much more complex than for the residential stock for several reasons, including the wide range of uses of the buildings in this sector and, within each of those uses, the enormous variety of building types, which makes it difficult to form clusters comprising meaningful groupings.

At the same time, the construction characteristics of the buildings are also highly variable due to the very different requirements necessitated by each type of use. Furthermore, the information available for this stock is sectoral and, in general, not very homogenous from one sector to another. The land register thus becomes the source of basic information for acquiring data on these kinds of properties. However, unlike the housing census and other surveys on quality of life and housing, the information it contains about the state of conservation or the characteristics of interest in defining this strategy is not very relevant.

Despite the fact that the administration is ultimately responsible for inspecting and checking the state of conservation of these buildings and that they accommodate uses where large numbers of people are present, for the majority of the buildings from this stock there are no policies related to their quality and services, as there are for housing (which must be decent and adequate, as stipulated by the Constitution). Therefore, in terms of these buildings, there is no framework of prior actions to support the approaches planned in the Strategy. Viewed in another way, this situation leaves energy efficiency as the fundamental objective to be addressed by the Renovation Strategy.

In order to approach the characterisation of the non-residential sector of the building stock, we considered it vital to establish the link between the energy needs of each type and the activities that those buildings accommodate. Since the types of activities are so variable, it is not easy to establish a common reference pattern, as can be identified among residential buildings (despite the undeniable variety that exists among dwellings) and therefore it was considered key to segment the non-residential building stock based on differentiation by types of use.

1.2.1 Distribution of number of properties and built area by tertiary use and decade of construction.

Table 1.18 shows the number of properties in the Spanish building stock (excluding the Basque Country and Navarre) grouped by uses given in the Land Register and disaggregated by construction period. Conversely, Table 1.19 uses the same grouping but shows the m² built on. Analysing both provides an overview of the Spanish building stock.

Figure 1.18. Number of properties per use and decade of construction in the Spanish building stock (excluding Basque Country and Navarre).

	NO OF PROPERTIES PER USE AND DECADE OF CONSTRUCTION												
	Before 1900	1900-1920	1921-1940	1941-1950	1951-1960	1961-1970	1971-1980	1981-1990	1991-2001	2002-2011	From 2012 onwards (*)	Other (**)	TOTAL
RESIDENTIAL													***23 523 517***
V - Residential	406 571	1 214 227	934 555	651 394	1 268 300	3 118 732	4 189 259	2 956 171	3 818 527	4 637 278	248 939	79 564	23 523 517
NON-RESIDENTIAL													***12 280 509***
TERTIARY, SERVICES AND EQUIPMENT													***2 058 779***
O - Offices	2 008	5 952	6 055	5 555	10 245	36 389	51 761	37 498	59 388	77 528	2 425	420	295 224
C - Commercial	13 425	37 120	36 769	26 593	60 462	215 842	285 456	218 621	243 339	190 728	7 732	1 498	1 337 585
K - Sport	153	673	589	799	1 703	5 836	13 097	15 948	19 025	22 423	3 076	1 191	84 513
T - Shows/performances	167	450	375	302	426	666	855	735	749	534	60	248	5 567
G - Leisure and Hospitality	1 768	5 180	3 536	2 352	4 742	17 363	44 303	65 108	27 978	26 684	1 447	3 644	204 105
Y - Health and Charity	420	1 253	1 227	994	1 616	3 629	6 526	6 523	7 051	7 191	895	315	37 640
E - Cultural	1 131	2 940	3 088	2 754	4 827	8 152	9 268	6 035	5 377	6 462	920	395	51 349
R - Religious	10 969	14 276	2 831	2 069	1 910	2 427	2 660	1 574	1 419	1 274	338	1 049	42 796
INDUSTRIAL													***1 715 782***
I - Industrial	93 334	263 470	111 099	75 893	86 173	145 931	226 813	208 613	236 711	207 869	19 917	39 959	1 715 782
STORAGE - PARKING													***8 302 552***
A - Storage - Parking	23 067	77 565	49 442	35 128	63 326	267 693	1 025 525	1 186 739	2 202 759	3 205 288	145 805	20 215	8 302 552
OTHER													***118 479***
M - Urbanisation works and gardening, not including building	3 565	8 767	2 449	1 579	1 516	3 083	4 067	5 477	11 040	32 839	3 332	18 813	96 527
P - Singular building	1 097	2 458	1 607	1 309	1 411	1 772	3 294	2 464	2 167	2 939	386	253	21 157
B - Agricultural storage	0	8	4	8	4	8	17	21	20	19	4	16	129
J - Agricultural industrial	15	24	23	23	30	70	131	131	91	76	10	42	666
Other	2 520	4 942	3 370	3 389	3 719	4 705	14 069	11 023	17 307	16 602	1 996	1 275	84 917

(*) Includes buildings constructed in 2012 or 2013.

(**) 'Other' is considered to be buildings whose year of construction is zero, or after 2013.

Source: Prepared by MITMA using the 2017 Land Register Database.

Figure 1.19. Total area of properties per use and decade of construction in the Spanish building stock (excluding Basque Country and Navarre).

	TOTAL AREA OF PROPERTIES PER USE AND DECADE OF CONSTRUCTION (in 1000 m2)												
	Before 1900	1900-1920	1921-1940	1941-1950	1951-1960	1961-1970	1971-1980	1981-1990	1991-2001	2002-2011	From 2012 onwards (*)	Other (**)	Total (in 1000 m2)
RESIDENTIAL													***3 424 424***
V - Residential	87 006	238 050	167 032	114 876	174 529	355 304	528 391	431 298	580 866	686 847	46 568	13 658	3 424 424
NON-RESIDENTIAL													***2 229 342***
TERTIARY, SERVICES AND EQUIPMENT													***998 555***
O - Offices	840	2 141	2 225	2 265	3 100	9 241	16 437	12 045	26 962	38 881	2 919	238	**117 293**
C - Commercial	1 717	5 058	5 011	3 823	7 712	26 187	37 971	31 546	50 226	60 724	7 957	1 169	**239 102**
K - Sport	417	1 652	1 511	2 140	7 945	15 981	25 909	31 156	61 665	68 214	7 650	1 193	**225 432**
T - Shows/performances	2 443	4 158	4 541	3 859	7 947	15 855	21 395	14 835	16 910	17 486	2 804	343	**112 574**
G - Leisure and Hospitality	1 115	2 531	1 964	1 311	3 951	12 816	15 335	17 213	22 971	23 446	2 064	2 139	**106 857**
Y - Health and Charity	642	1 541	1 628	1 753	2 954	4 239	8 477	5 648	8 756	16 989	2 893	445	**55 966**
E - Cultural	2 443	4 158	4 541	3 859	7 947	15 855	21 395	14 835	16 910	17 486	2 804	343	**112 574**
R - Religious	5 938	8 047	3 017	1 709	1 734	1 655	1 639	1 133	2 125	1 124	232	403	**28 755**
INDUSTRIAL													***753 540***
I - Industrial	13 598	36 341	22 257	20 720	33 628	71 855	123 055	91 066	145 361	174 139	15 112	6 409	753 540
STORAGE - PARKING	0	0	0	0	0	0	0	0	0	0	0	0	***358 297***
A - Storage - Parking	2 059	7 334	4 614	3 389	5 592	18 318	47 721	49 880	93 832	117 785	6 675	1 099	358 297
OTHER	0	0	0	0	0	0	0	0	0	0	0	0	***118 951***
M - Urbanisation works and gardening, not including building	1 099	2 197	1 116	545	1 158	3 778	2 011	2 617	5 122	8 097	1 213	2 350	31 303
P - Singular building	1 695	3 600	2 565	2 981	2 635	2 096	3 661	4 220	5 706	6 724	1 628	285	37 795
B - Agricultural storage	0	0	1	7	1	4	8	5	15	6	0	11	58
J - Agricultural industrial	1	10	6	8	58	56	164	124	148	107	29	56	766
Other	674	2 091	1 234	1 366	2 050	3 943	9 729	6 375	10 174	9 889	831	672	49 029

(*) Includes buildings constructed in 2012 or 2013.

(**) 'Other' is considered to be buildings whose year of construction is zero, or after 2013.

Source: Prepared by MITMA using the 2017 Land Register Database.

Within the 'non-residential' uses given in the Land Register, for the ERESEE, we chose to work with the subset of uses shown in the table below, which are uses specific to the services sector, excluding from the analysis only sport and show/performance uses. We decided not to cover these in this study due to their special air-conditioning and usage profile characteristics, and also because these uses are not disaggregated in the IDAE-MITERD real consumption balance that will be analysed in the sections below.

Figure 1.20. Number of properties per use and decade of construction in the Spanish tertiary building stock under study in this section (excluding Basque Country and Navarre).

	NUMBER OF PROPERTIES PER USE AND DECADE OF CONSTRUCTION												
USE_DESC	**Before 1900**	**1900-1920**	**1921-1940**	**1941-1950**	**1951-1960**	**1961-1970**	**1971-1980**	**1981-1990**	**1991-2001**	**2002-2011**	**From 2012 onwards (*)**	**Other (**)**	**TOTAL**
Offices	2 008	5 952	6 055	5 555	10 245	36 389	51 761	37 498	59 388	77 528	2 425	420	295 224
Commercial	13 425	37 120	36 769	26 593	60 462	215 842	285 456	218 621	243 339	190 728	7 732	1 498	1 337 585
Leisure and Hospitality	1 768	5 180	3 536	2 352	4 742	17 363	44 303	65 108	27 978	26 684	1 447	3 644	204 105
Health and Charity	420	1 253	1 227	994	1 616	3 629	6 526	6 523	7 051	7 191	895	315	37 640
Cultural	1 131	2 940	3 088	2 754	4 827	8 152	9 268	6 035	5 377	6 462	920	395	51 349
Religious	10 969	14 276	2 831	2 069	1 910	2 427	2 660	1 574	1 419	1 274	338	1 049	42 796
Singular building	1 097	2 458	1 607	1 309	1 411	1 772	3 294	2 464	2 167	2 939	386	253	21 157
SERVICES TOTAL	**30 818**	**69 179**	**55 113**	**41 626**	**85 213**	**285 574**	**403 268**	**337 823**	**346 719**	**312 806**	**14 143**	**7 574**	**1 989 856**

Source: Prepared by MITMA using the 2017 Land Register Database

Figure 1.21. Total area of properties per use and decade of construction in the Spanish tertiary building stock under study in this section (excluding Basque Country and Navarre).

	NUMBER OF PROPERTIES PER USE AND DECADE OF CONSTRUCTION												
USE_DESC	**Before 1900**	**1900-1920**	**1921-1940**	**1941-1950**	**1951-1960**	**1961-1970**	**1971-1980**	**1981-1990**	**1991-2001**	**2002-2011**	**From 2012 onwards (*)**	**Other (**)**	**TOTAL (m2)**
Offices	840	2 141	2 225	2 265	3 100	9 241	16 437	12 045	26 962	38 881	2 919	238	117 293
Commercial	1 717	5 058	5 011	3 823	7 712	26 187	37 971	31 546	50 226	60 724	7 957	1 169	239 102
Leisure and Hospitality	1 115	2 531	1 964	1 311	3 951	12 816	15 335	17 213	22 971	23 446	2 064	2 139	106 857
Health and Charity	642	1 541	1 628	1 753	2 954	4 239	8 477	5 648	8 756	16 989	2 893	445	55 966
Cultural	2 443	4 158	4 541	3 859	7 947	15 855	21 395	14 835	16 910	17 486	2 804	343	112 574
Religious	5 938	8 047	3 017	1 709	1 734	1 655	1 639	1 133	2 125	1 124	232	403	28 755
Singular building	1 695	3 600	2 565	2 981	2 635	2 096	3 661	4 220	5 706	6 724	1 628	285	37 795
SERVICES TOTAL	**14 390**	**27 076**	**20 952**	**17 701**	**30 031**	**72 088**	**104 915**	**86 640**	**133 655**	**165 375**	**20 497**	**5 022**	**698 343**

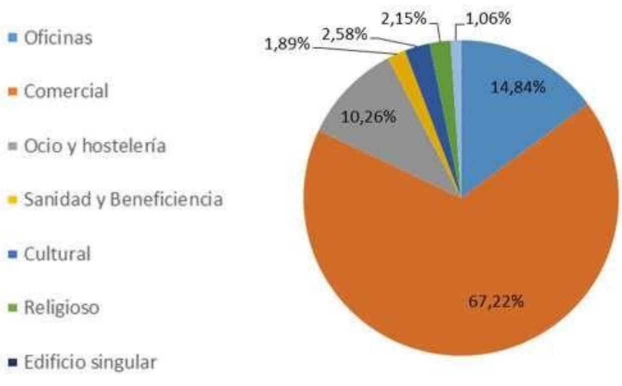
Source: Prepared by MITMA using the 2017 Land Register Database.

From the comparison of the m² built represented by the tertiary stock against the total, we can see that this represents 13% of the square metres built, although, as given in section 2 of the energy consumption assessment, this sector accounts for 42% of total consumption.

Furthermore, the breakdown of properties and square metres built by use is as follows:

Figure 1.22. Breakdown of properties per tertiary use (excluding Basque Country and Navarre).

USE:	**NO OF PROPERTIES PER USE**	**% PER USE**
Offices	295 224	14.8%
Commercial	1 337 585	67.2%
Leisure and Hospitality	204 105	10.3%
Health and Charity	37 640	1.9%
Cultural	51 349	2.6%
Religious	42 796	2.2%
Singular building	21 157	1.1%
SERVICES TOTAL	**1 989 856**	100.0%



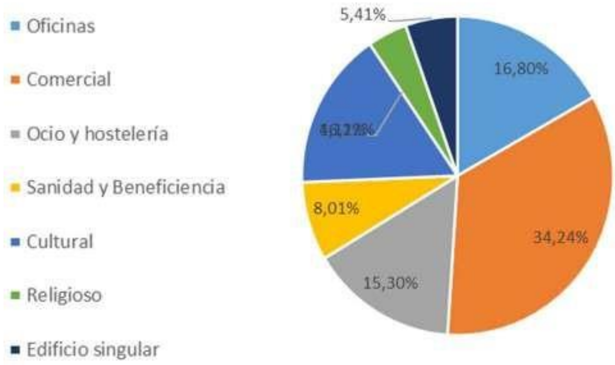
	Offices
	Commercial
	Leisure and Hospitality
	Health and Charity

	Cultural
	Religious
	Singular building
	1.89%
	2.58%
	2.15%
	1.06%
	10.26%
	14.84%
	67.22%

Source: Prepared by MITMA using the 2017 Land Register Database.

Figure 1.23. Percentage of built surface area for tertiary use per construction phase (excluding Basque Country and Navarre).

USE:	TOTAL AREA PER USE	% PER USE
Offices	117 293 219	16.8%
Commercial	239 101 621	34.2%
Leisure and Hospitality	106 856 717	15.3%
Health and Charity	55 966 495	8.0%
Cultural	112 574 460	16.1%
Religious	28 755 462	4.1%
Singular building	37 794 876	5.4%
SERVICES TOTAL	**698 342 850**	100.0%



	Offices
	Commercial
	Leisure and Hospitality
	Health and Charity
	Cultural
	Religious
	Singular building
	5.41%
	16.80%
	8.01%
	15.30%
	34.24%

Source: Prepared by MITMA using the 2017 Land Register Database.

Breakdown of uses per decade of construction

From the information in the Land Register, we can see the predominant construction phase for each use, which can provide information on the associated building characteristics, which in turn translates into a specific energy performance of the thermal envelopes. However, as mentioned previously, the wide variety of types with their many difference constraints prevents us from clearly identifying clusters, as is possible in the case of residential buildings.

Figure 1.24. No of properties per use and decade of construction

		NUMBER OF PROPERTIES PER USE AND DECADE OF CONSTRUCTION											
USE:	USE_DESC	Before 1900	1900-1920	1921-1940	1941-1950	1951-1960	1961-1970	1971-1980	1981-1990	1991-2001	2002-2011	From 2012 onwards (*)	* Other (**)
O	Offices	0.7%	2.0%	2.1%	1.9%	3.5%	12.3%	17.5%	12.7%	20.1%	26.3%	0.8%	0.1%
C	Commercial	1.0%	2.8%	2.7%	2.0%	4.5%	16.1%	21.3%	16.3%	18.2%	14.3%	0.6%	0.1%
G	Leisure and Hospitality	0.9%	2.5%	1.7%	1.2%	2.3%	8.5%	21.7%	31.9%	13.7%	13.1%	0.7%	1.8%
Y	Health and Charity	1.1%	3.3%	3.3%	2.6%	4.3%	9.6%	17.3%	17.3%	18.7%	19.1%	2.4%	0.8%

E	Cultural	2.2%	5.7%	6.0%	5.4%	9.4%	15.9%	18.0%	11.8%	10.5%	12.6%	1.8%	0.8%
R	Religious	25.6%	33.4%	6.6%	4.8%	4.5%	5.7%	6.2%	3.7%	3.3%	3.0%	0.8%	2.5%
P	Singular building	5.2%	11.6%	7.6%	6.2%	6.7%	8.4%	15.6%	11.6%	10.2%	13.9%	1.8%	1.2%

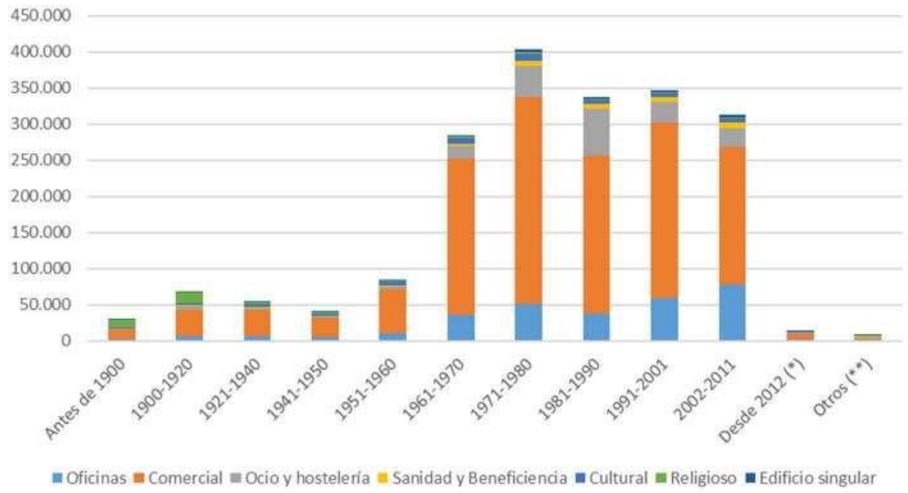
Source: Prepared by MITMA using the 2017 Land Register Database.

Figure 1.25. Percentage of built surface area for tertiary use per construction phase (excluding Basque Country and Navarre).

		TOTAL AREA OF PROPERTIES PER USE AND DECADE OF CONSTRUCTION											
USE:	USE_DESC	Before 1900	1900-1920	1921-1940	1941-1950	1951-1960	1961-1970	1971-1980	1981-1990	1991-2001	2002-2011	From 2012 onwards (*)	* Other (**)
O	Offices	0.7%	1.8%	1.9%	1.9%	2.6%	7.9%	14.0%	10.3%	23.0%	33.1%	2.5%	0.2%
C	Commercial	0.7%	2.1%	2.1%	1.6%	3.2%	11.0%	15.9%	13.2%	21.0%	25.4%	3.3%	0.5%
G	Leisure and Hospitality	1.0%	2.4%	1.8%	1.2%	3.7%	12.0%	14.4%	16.1%	21.5%	21.9%	1.9%	2.0%
Y	Health and Charity	1.1%	2.8%	2.9%	3.1%	5.3%	7.6%	15.1%	10.1%	15.6%	30.4%	5.2%	0.8%
E	Cultural	2.2%	3.7%	4.0%	3.4%	7.1%	14.1%	19.0%	13.2%	15.0%	15.5%	2.5%	0.3%
R	Religious	20.6%	28.0%	10.5%	5.9%	6.0%	5.8%	5.7%	3.9%	7.4%	3.9%	0.8%	1.4%
P	Singular building	4.5%	9.5%	6.8%	7.9%	7.0%	5.5%	9.7%	11.2%	15.1%	17.8%	4.3%	0.8%

Source: Prepared by MITMA using the 2017 Land Register Database.

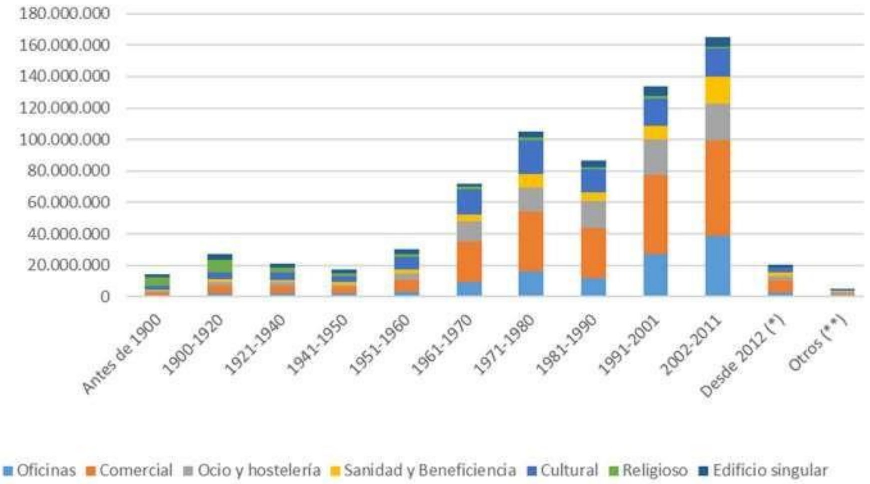
Figure 1.26. No of properties per use and decade of construction



	450 000
	400 000
	350 000
	300 000
	250 000
	200 000
	150 000
	100 000
	50 000
	0
	Before 1900
	1900-1920
	1921-1940
	1941-1950
	1951-1960
	1961-1970
	1971-1980
	1981-1990
	1991-2001
	2002-2011
	From 2012 onwards (*)
	Other (**)
	Offices
	Commercial
	Leisure and Hospitality
	Health and Charity
	Cultural
	Religious
	Singular building

Source: Prepared by MITMA using the 2017 Land Register Database.

Figure 1.27. Total area of properties per use and decade of construction



	180 000 000
	160 000 000
	140 000 000
	120 000 000
	100 000 000
	80 000
	60 000
	40 000
	20 000
	0
	Before 1900
	1900-1920
	1921-1940
	1941-1950
	1951-1960
	1961-1970
	1971-1980
	1981-1990
	1991-2001
	2002-2011
	From 2012 onwards (*)
	Other (**)
	Offices
	Commercial
	Leisure and Hospitality
	Health and Charity
	Cultural
	Religious
	Singular building

Source: Prepared by MITMA using the 2017 Land Register Database.

Land register/strategy types

The Land Register database offers a significant level of type disaggregation for some tertiary uses. These Land Register types were analysed to identify those that could be grouped together based on similar energy performance, as regards usage profile, activity and probable building characteristics. However, in other cases, we found that the disaggregation offered by the Land Register is not sufficient to identify types with different usage patterns, for example in the case of college faculties, which form one single type in the Land Register.

The Land Register types for the various tertiary uses are those given in the table below, in which the types considered in the analysis performed in this strategy are shaded. The same colour is used for the types deemed to have similar characteristics for the purposes of drawing up the Strategy.

Figure 1.28. Land Register Types

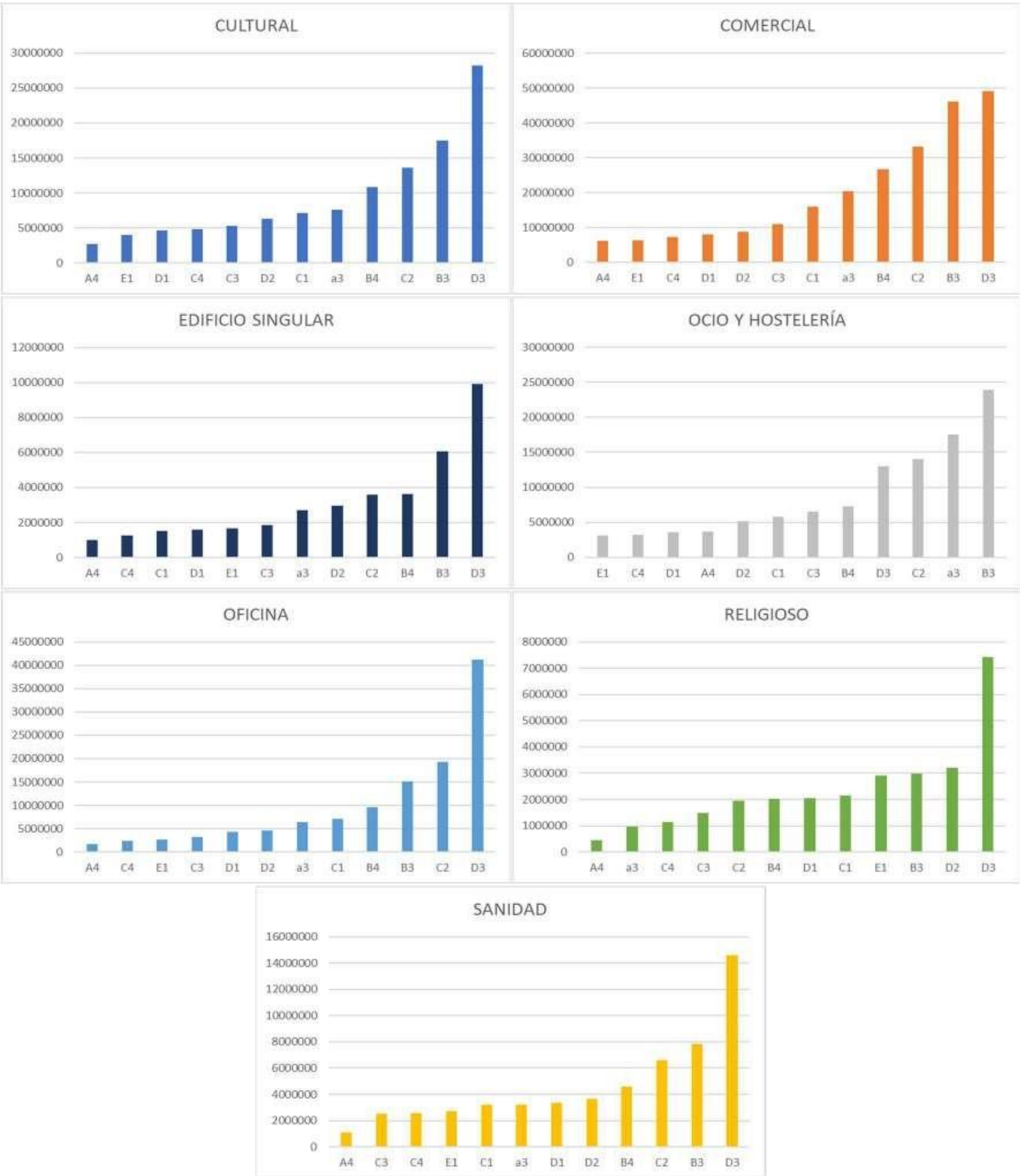
BUILDING TYPES		
USE:	CLASS:	CATEGORY
3 OFFICES	3.1. EXCLUSIVE-USE BUILDING	0311 MULTIPLE OFFICES
		0312 SINGLE OFFICES
	3.2. MIXED-USE BUILDING	0321 LINKED WITH HOUSING
		0322 LINKED WITH INDUSTRY
	3.3. BANKING AND INSURANCE	0331 IN EXCLUSIVE-USE BUILDING
		0332 IN MIXED-USE BUILDING
4 COMMERCIAL	4.1. BUSINESSES IN MIXED-USE BUILDING	0411 BUSINESS PREMISES AND WORKSHOPS
		0412 SHOPPING CENTRES
	4.2. BUSINESSES IN EXCLUSIVE-USE BUILDING	0421 ON ONE FLOOR
		0422 ON VARIOUS FLOORS
	4.3. MARKETS AND SUPERMARKETS	0431 MARKETS
		0432 HYPERMAREKTS AND SUPERMARKETS
7 LEISURE AND HOSPITALITY	7.1. WITH RESIDENCE	0711 HOTELS, HOSTELS
		0712 APARTHOTELS, HOLIDAY BUNGALOWS
	7.2. WITHOUT RESIDENCE	0721 RESTAURANT
		0722 BARS AND CAFES
	7.3. EXHIBITIONS AND MEETINGS	0731 CASINOS AND SOCIAL CLUBS
		0732 EXHIBITIONS AND CONFERENCES
8 HEALTH AND CHARITY	8.1. HEALTHCARE CENTRES WITH BEDS	0811 HEALTHCARE CENTRES AND CLINICS
		0812 HOSPITALS
	8.2. OTHER HEALTHCARE CENTRES	0821 OUTPATIENT CENTRES AND MEDICAL PRACTICES
		0822 SPAS, BATHHOUSES
	8.3. AID AND ASSISTANCE	0831 WITH RESIDENCE (homes, residential accommodation, etc)
		0832 WITHOUT RESIDENCE (canteens, clubs, nurseries, etc)
9 CULTURAL AND RELIGIOUS	9.1. CULTURAL WITH RESIDENCE	0911 BOARDING SCHOOLS
		0912 HALLS OF RESIDENCE
	9.2. CULTURAL WITHOUT RESIDENCE	0921 FACUTIES, COLLEGES, SCHOOLS
		0922 LIBRARIES AND MUSEUMS
	9.3. RELIGIOUS	0931 CONVENTS AND PARISH CENTRES
		0932 CHURCHES AND CHAPELS
10 SINGULAR BUILDINGS	10. HISTORIC-ARTISTIC	1011 MONUMENTS
		1012 ENVIRONMENTAL OR TYPICAL
	10.2. OFFICIAL	1021 ADMINISTRATIVE
		1022 REPRESENTATIVE
	10.3. SPECIAL	1031 PRISONS, MILITARY AND OTHER
		1032 INTERNAL DEVELOPMENT WORKS
		1033 CAMPSITES
		1034 GOLF COURSES
		1035 GARDENING
		1036 SILOS AND DEPOSITS FOR SOLID MATERIALS (M/3)
		1037 LIQUID DEPOSITS (M/3)
		1038 GAS DEPOSITS (M/3)

Source: Prepared by MITMA.

1.2.2. Breakdown of the number of properties and built area per province and climatic zone.

The Land Register information on the number of properties and on m^2 built per tertiary use can be disaggregated by province. Assigning each province the Technical Building Code climatic zone corresponding to its provincial capital makes it possible to create an approximate breakdown of uses by these climatic zones given in the regulations. The majority of uses are concentrated in climatic zone D3, which is Madrid, while the presence of leisure and hospitality use stands out in climatic zone B3, which corresponds to regions with a Mediterranean climate.

Figure 1.29. Breakdown of built surface area by uses and climatic zone.



	CULTURAL
	30000000
	25000000
	20000000
	15000000
	10000000
	5000000
	0
	A4
	E1
	D1
	C4
	C3
	D2

	C1
	a3
	B4
	C2
	B3
	D3
	SINGULAR BUILDING
	12000000
	10000000
	8000000
	6000000
	4000000
	2000000
	0
	A4
	C4
	C1
	D1
	E1
	C3
	a3
	D2
	C4
	B4
	B3
	D3
	OFFICE
	45000000
	40000000
	35000000
	30000000
	25000000
	20000000
	15000000
	10000000
	5000000
	0
	A4
	C4
	E1
	C3
	D1
	D2
	a3
	C1
	B4
	B3
	C2
	D3
	HEALTH
	16000000
	14000000
	12000000
	10000000
	8000000
	6000000
	4000000
	2000000

	0
	A4
	C3
	C4
	E1
	C1
	a3
	D1
	D2
	B4
	C2
	B3
	D3
	COMMERCIAL
	60000000
	50000000
	40000000
	30000000
	20000000
	10000000
	0
	A4
	E1
	C4
	D1
	D2
	C3
	C1
	a3
	B4
	C2
	B3
	D3
	LEISURE AND HOSPITALITY
	30000000
	25000000
	20000000
	15000000
	10000000
	5000000
	E1
	C4
	D1
	A4
	D2
	C1
	C3
	B4
	D3
	C2
	a3
	B3
	RELIGIOUS
	8000000
	7000000
	6000000
	5000000
	4000000

	3000000
	2000000
	1000000
	0
	A4
	a3
	C4
	C3
	C2
	B4
	D1
	C1
	E1
	B3
	D2
	D3

Source: Prepared by MITMA using the 2017 Land Register Database.

1.3. PUBLIC SECTOR

The Inventory of Central Government Buildings, drawn up by the IDAE - Ministry for the Ecological Transition and the Demographic Challenge, in compliance with Article 5 of Directive 2012/27/EU on energy efficiency, provides detailed information on the stock of Central Government buildings and their energy consumption. In relation to the inventory, it is important to note that this does not include the following buildings:

- Officially classified buildings
- Ministry of Defence buildings

- Large infrastructure buildings such as airports or train stations
- Religious buildings

However, it would be interesting to look at the renovation of some of these groups of buildings.

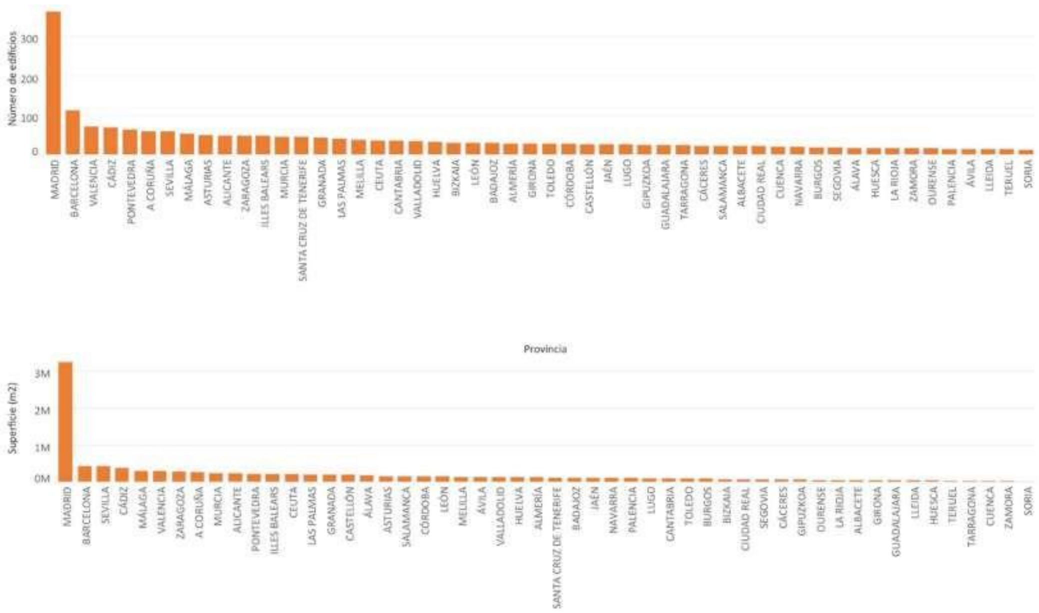
Below is a detailed analysis of the inventoried stock with data from 2018. Where consumption information was more complete for 2017, consumption data from that year have been used.

The total number of building in all of Spain (mainland, Balearic Islands, Canary Islands, Ceuta and Melilla) contained in the 2018 inventory is 2 126. Of these, there 60 buildings that are 'unused or with unrecorded consumption' in the 2018 inventory. The number of buildings without consumption data in the 2018 inventory was 92.

Conclusions regarding location:

The first studies are based on identifying the areas (geographical and climatic) with the most buildings and greatest floor areas. Madrid stands out in terms of both number of buildings and floor area, with over 15% of the inventory buildings and almost 30% of the total floor area. The graph below shows this big difference compared with the rest of the provinces.

Figure 1.30. Number of buildings and floor area by province (2018)



	Number of buildings
	0
	100
	200
	300
	MADRID
	BARCELONA
	VALENCIA
	CADIZ
	PONTEVEDRA
	A CORUÑA
	SEVILLE
	MALAGA
	ASTURIAS
	ALICANTE
	ZARAGOZA
	BALEARIC ISLANDS
	MURCIA

	SANTA CRUZ DE TENERIFE
	GRANADA
	LAS PALMAS
	MELILLA
	CEUTA
	CANTABRIA
	VALLADOLID
	HUELVA
	BIZKAIA
	LEÓN
	BADAJOZ
	ALMERÍA
	GIRONA
	TOLEDO
	CÓRDOBA
	CASTELLÓN
	JAÉN
	LUGO
	GIPUZKOA
	GUADALAJARA
	TARRAGONA
	CÁCERES
	SALAMANCA
	ALBACETE
	CIUDAD REAL
	CUENCA
	NAVARRE
	BURGOS
	SEGOVIA
	ÁLAVA
	HUESCA
	LA RIOJA
	ZAMORA
	OURENSE
	PALENCIA
	ÁVILA
	TERUEL
	SORIA
	Province
	Floor area (m2)
	MADRID
	BARCELONA
	SEVILLE
	CÁDIZ
	MALAGA
	VALENCIA
	ZARAGOZA
	A CORUÑA
	MURCIA
	ALICANTE
	PONTEVEDRA
	BALEARIC ISLANDS
	CEUTA
	LAS PALMAS
	GRANADA
	CASTELLÓN
	ÁLAVA
	ASTURIAS

	SALAMANCA
	CÓRDOBA
	LEÓN
	MELILLA
	ÁVILA
	VALLADOLID
	HUELVA
	ALMERÍA
	SANTA CRUZ DE TENERIFE
	BADAJOZ
	JAÉN
	NAVARRE
	PALENCIA
	LUGO
	CANTABRIA
	TOLEDO
	BURGOS
	BIZKAIA
	CIUDAD REAL
	SEGOVIA
	CÁCERES
	GIPUZKOA
	OURENSE
	LA RIOJA
	ALBACETE
	GIRONA
	GUADALAJARA
	LLEIDA
	HUESCA
	TERUEL
	TARRAGONA
	CUENCA
	ZAMORA
	SORIA
	3M
	2M
	1M
	0M

Source: PARAE (GBCe) programme based on the 2018 Energy Inventory.

1.3.1. Breakdown by climatic zone

Largely due to this high presence in Madrid, a significant number of buildings and significant floor area of the fleet is located in climatic zone D3.

Figure 1.31. Number of buildings and floor area by climatic zone.

	Climatic zone
	Number of buildings
	Area (m2)
	400
	200
	0
	D3
	B3
	D2
	C1
	D1
	A3
	B4
	C2
	C4
	E1
	a3
	C3
	A4
	A2
	B2
	4M
	3M
	2M
	1M
	0M

Source: Prepared by GBCe based on the 2018 Energy Inventory data

Analysis in relation to building use:

An analysis was conducted on the inventory so as to assign a use to each property, as this information is not included in the inventory. To do this, the use was assigned to each property based on its name, so as to see which types are the most common, as shown in the table below:

Figure 1.32. Number of buildings by main use (2017)

Main use	Number of buildings
Offices	1 404
Police station	282
Prison	97
Research centre	92
Barracks	60

Figure 1.33 Floor area of buildings by main use (2017)

Main use	Floor area (m^2)
Offices	4 484 405
Prison	3 685 338
Police station	1 424 404
Research centre	713 082
Care centre	219 950

Care centre	47
Classroom building	29
Garage	28
Test track	27
Warehouse	19
Records office	13
Residence	11
Data processing centres	5
Auditorium	4
Museum	4
Hangar	2
Hospital	1
Workshop	1

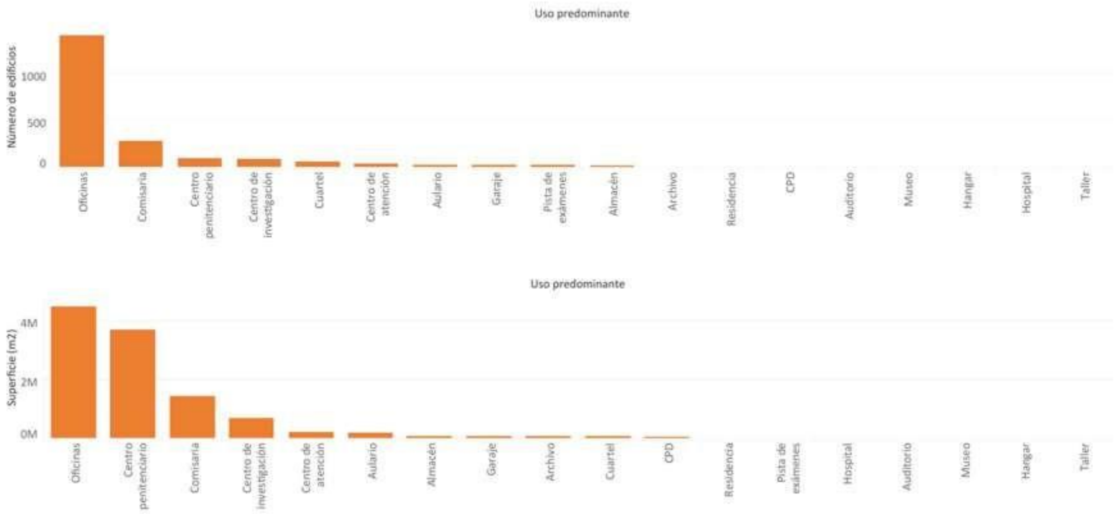
Classroom building	186 634
Warehouse	91 265
Garage	82 338
Records office	76 672
Barracks	70 746
Data processing centres	63 089
Residence	26 910
Test track	23 063
Hospital	14 760
Auditorium	13 369
Museum	7 370
Hangar	4 009
Workshop	2 652

The main type is office, both for number of buildings and floor area.

In relation to the number of buildings, this type is far ahead of the type in second place, police stations, which are spread throughout Spanish territory and which vary greatly in terms of size.

Conversely, the analysis by floor area shows that the second type in terms of m^2 built is prisons, which, despite being far fewer in number than offices, have a much larger floor area as a whole, as each of these facilities has very large dimensions.

Figure 1.34. Number of buildings and floor area by type of main use



	Main use
	Offices
	Police station
	Prison
	Research centre
	Barracks
	Care centre
	Classroom building
	Garage
	Test track
	Warehouse
	Records office
	Residence

	Data processing centres
	Auditorium
	Museum
	Hangar
	Hospital
	Workshop
	1000
	500
	0
	Area (m2)
	Offices
	Prison
	Police station
	Research centre
	Care centre
	Classroom building
	Warehouse
	Garage
	Records office
	Barracks
	Data processing centres
	Residence
	Test track
	Hospital
	Auditorium
	Museum
	Hangar
	Workshop
	4M
	2M
	0M

Source: PARAE (GBCe) programme based on the 2018 Energy Inventory.

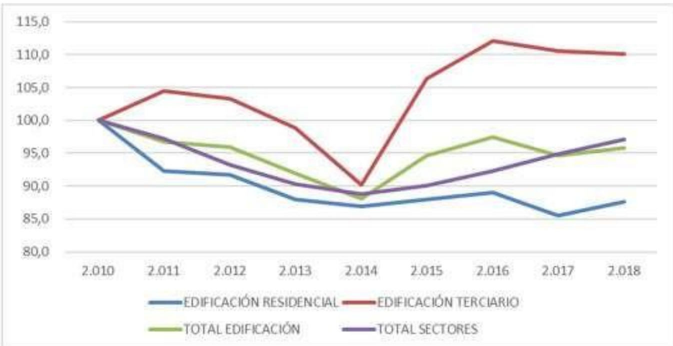
CHAPTER 2. ASSESSMENT: ENERGY CONSUMPTION IN THE BUILDING SECTOR AND ITS TREND FROM 2014-2020.

2.1. GENERAL ASSESSMENT OF ENERGY CONSUMPTION IN THE BUILDING SECTOR AS A WHOLE.

The building sector as a whole accounts for approximately 30% of energy consumption in Spain: in 2018, the most recent year for which data are available, the weight of the residential building sector was exactly 17.1% and that of the tertiary sector (trade, services and public administration) was 12.4%. Furthermore, this has remained more or less constant since 2010, with slight fluctuations in the percentages (reaching a peak of 31.6% in 2016 and falling to its lowest in 2018, at 29.5%).

The figures provided show the long-term (from 1990) and medium-term (from 2010) trend with base value of 100 across all sectors, the building sector, and its two constituent parts: residential and tertiary. Over the long term, we can see how the increase in energy consumption in the building sector has mirrored the growth in all sectors experienced during the period of intense economic expansion in the 1990s and early 2000s. The effect of the 2007-2008 global economic crisis was seen in consumption across all sectors before that of the building sector, which saw continued growth in residential building up to 2010 and in tertiary building up to 2011. These years were the respective turning points from which consumption began to fall, reversing the uninterrupted upward trend experienced since 1990. From that moment, the trend can been seen more clearly in the graph with base value 100 in 2010, which shows how consumption across all sectors and in the building sector continued to fall (possibly as a continued consequence of the drawn-out impact of the crisis) until 2014, from which point it began to rise again, gently in the residential sector and quite sharply in the tertiary sector (until 2016).

Figure 2.1. Trend with base value 100 from 1990 and from 2010 of energy consumption in the building sector (residential and tertiary) and across all sectors.



	350.0
	300.0
	250.0
	200.0
	150.0
	100.0
	50.0

	RESIDENTIAL
	TERTIARY
	BUILDING TOTAL
	SECTORS TOTAL
	1990
	1991
	1992
	1993
	1994
	1995
	1996
	1997
	1998
	1999
	2000
	2001
	2002
	2003
	2004
	2005
	2006
	2007
	2008
	2009
	2010
	2011
	2012
	2013
	2014
	2015
	2016
	2017
	2018
	115.0
	110.0
	100.0
	95.0
	90.0
	85.0
	80.0
	RESIDENTIAL BUILDING
	TERTIARY BUILDING
	BUILDING TOTAL
	SECTORS TOTAL
	2 010
	2 011
	2 012
	2 013
	2 014
	2 015
	2 016
	2 017
	2 018

Source: MITMA based on IDAE data: 'Final Energy Balances'. http://sieeweb.idae.es/consumofinal/

In recent years, the performance of the residential sector has been more positive than that seen across all sectors, such that the total absolute saving between 2010 and 2018 was 29 787 GWh. Of this, the building sector contributed a reduction of 12 871 GWh, the result of an even more favourable balance in the residential sector

(-24 391 GWh), compared with an increase of 11 541 GWh in the tertiary sector. This means that the building sector made a much greater contribution to the total savings (43.2%) than its weight (30%).

If we analyse the trend since 2015 (the latest reference date for the analysis presented in the 2017 ERESEE), we can see that energy consumption (which, as specified, goes back to 2014) has been increasing both across all sectors and in the building sector. However, recently, the latter seems to have performed better between 2015 and 2018 than all sectors combined, such that the building sector only accounted for 3 779 GWh (5.2%) of the total absolute growth over those years (73 074 GWh) and again as a result of a much more favourable balance in residential (net savings of 545 GWh) than in tertiary, with a notable increase of 4 341 GWh.

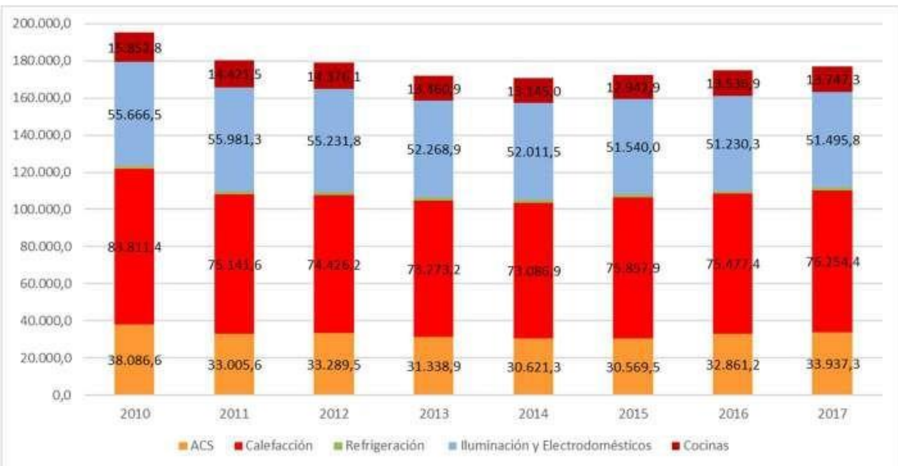
2.2. ENERGY CONSUMPTION IN THE RESIDENTIAL SECTOR.

As mentioned above, the detailed trend in the residential sector from 2010 was downward until 2014, when it began rising again until 2017, which is the last year for which disaggregated data are available. The 2017 ERESEE, which had data up to 2015, warned of the change in trend from 2014 onwards, but, with only one set of data after that date, it was not possible at the time to forecast whether or not that negative change would consolidate itself over time. Unfortunately, with the 2017 data, that trend appears to have been confirmed, such that both in 2015 and in 2016 and 2017, there were increases (which accelerated slightly each year) in energy consumption in the residential sector compared with the previous year. This growth amounted to 2 030.6, 2 185.7 and 2 337.4 GWh, which is approximately 1.3% per year.

If we observe the trend by use within the residential sector, we see that, during the period in which consumption fell (2010-2014), there was a drop of 24 664.6 GWh, and, between 2014 and 2017, an increase of 6 553.8 GWh, giving a net balance of -18 110.8 GWh between 2010 and 2017.

The 24 664.6 GWh drop seen between 2010 and 2014 breaks down as follows: 43.5% for heating usage, 30.3% for DHW, and much smaller percentages for the remaining uses (14.8% for lighting and household appliances, 11% for stoves and 0.5% for cooling). During the most recent period of net growth in energy consumption in the residential sector (2014-2017), the 6 553.8 GWh increase broke down as 48.3% for heating and 50.6% for DHW, with the fall in consumption (of electricity) for cooling and, especially, for lighting and household appliances continuing to fall over that period.

Figure 2.2. 2010-2017 trend in energy consumption in the residential sector broken down by uses (GWh).



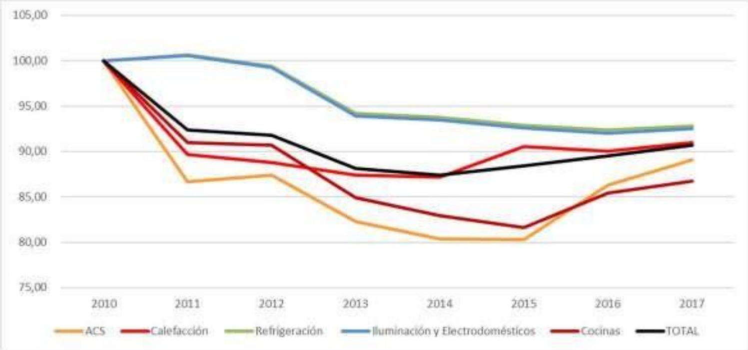
	200 000.0
	180 000.0
	160 000.0
	140 000.0
	120 000.0
	100 000.0
	80 000.0

	60 000.0
	40 000.0
	20 000.0
	0.0
	15 851.8
	14 421.5
	14 376.1
	13 860.9
	13 145.0
	12 942.9
	13 835.9
	13 747.3
	55 666.5
	55 981.3
	55 231.8
	52 268.9
	52 011.5
	51 540.0
	51 230.3
	51 495.8
	83 811.4
	75 141.6
	74 426.2
	78 223.2
	78 686.9
	75 852.9
	75 477.4
	76 254.4
	38 086.6
	33 005.6
	33 289.5
	31 338.9
	30 621.3
	30 569.5
	32 861.2
	33 937.3
	DHW
	Heating
	Cooling
	Lighting and Household Appliances
	Stoves

Source: MITMA based on IDAE data (2019). 'Annual Energy Consumption Report. Total Final Energy Consumption by Use: Residential Sector/Households.' 10th Edition. July 2019.

The graph showing the 2010-2017 trend with base value 100 in 2010 provides a good illustration of this unequal performance across the sectors, highlighting the sustained fall in consumption for cooling, lighting and household appliances (with the exception of the last year, 2017, in which is rebounds slightly), and the cycle (downward until 2014-2015 and then upward until 2017) in the other sectors (DHW, heating and stoves). The most recent inter-year data (2016-2017) show increases in consumption across all sectors, which, while reduced in absolute terms, show a clear change in the downward trend observed previously.

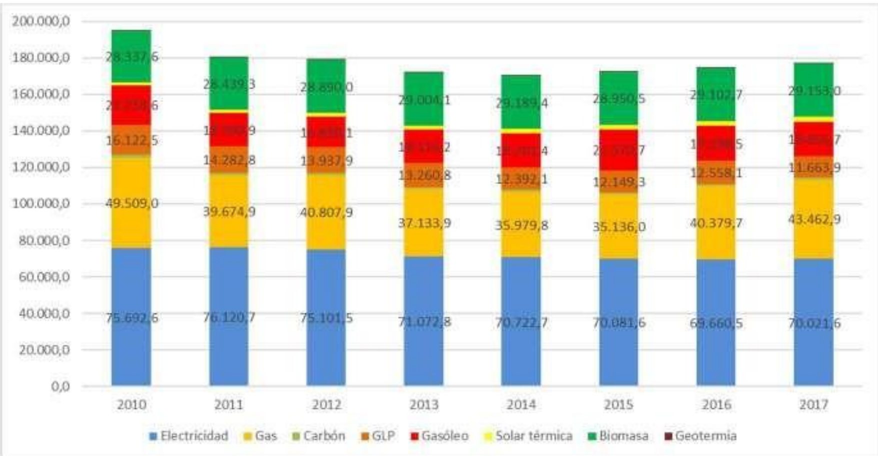
Figure 2.3. Trend with base value 100 from 2010 of energy consumption in the residential sector broken down by use.



	105.00
	100.00
	95.00
	90.00
	85.00
	80.00
	75.00
	DHW
	Heating
	Cooling
	Lighting and Household Appliances
	Stoves
	TOTAL

Source: MITMA based on IDAE data (2019). 'Annual Energy Consumption Report. Total Final Energy Consumption by Use: Residential Sector/Households.' 10th Edition. July 2019.

Figure 2.4. 2010-2017 trend in energy consumption in the residential sector broken down by energy source (GWh).



	200 000.0
	180 000.0
	160 000.0
	140 000.0
	120 000.0
	100 000.0
	80 000.0
	60 000.0
	40 000.0
	20 000.0
	0.0
	Electricity
	Gas
	Coal

	LPG
	Fuel oil
	Solar thermal
	Biomass
	Geothermal

Source: MITMA based on IDAE data (2019). 'Annual Energy Consumption Report. Total Final Energy Consumption by Use: Residential Sector/Households.' 10th Edition. July 2019.

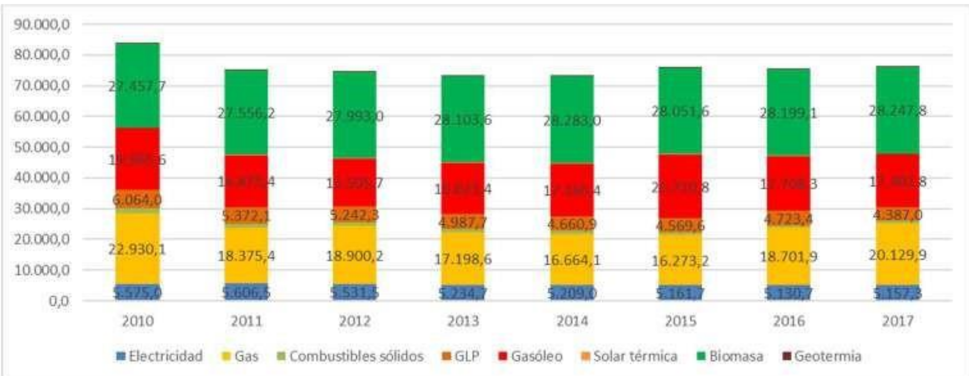
In terms of energy sources, the 24 664.6 GWh reduction seen in the residential sector between 2010 and 2014 was due primarily to the 13 529.1 GWh (54.9% of the total) drop in the consumption of Natural Gas, together with -4 969.9 GWh in Electricity, -3 730.4 GWh in LPG, -3 057.2 GWh in Fuel Oil and -943.2 GWh in Coal, more than compensating for minor increases in renewables: 694.6 GWh in Solar Thermal and 851.8 GWh in Biomass. In terms of percentage, between 2010 and 2014, the standout figures were a 73.1% increase in Solar Thermal compared with 2010 and a 54.1% decrease in Coal, which fell from 2 011.2 to 1 068.0 GWh. There were also significant drops in LPG (-27.7%) and Fuel Oil (-13.3%).

For its part, the 6 553.8 GWh increase between 2014 and 2017 was above all due to the increase in the consumption of Natural Gas (7 483.1 GWh), reversing the downward trend that had been seen for this fuel since 2010. The downward trend in Fuel Oil was also reversed, but to a much lesser extent. Solar Thermal energy continued its upward trend, which began back in 2010, with an increase of 526.8 GWh between 2014 and 2017; and Coal, Electricity and LPG continued to fall, although at much slower rates than in the previous period (from -46.9% to -14.1%; from -6.6% to -1%; and from -23.1% to -6%, respectively).

2.2.1. The trend in energy consumption for heating in households.

The graph below shows the trend in consumption of heating in the residential sector, which, as mentioned before, can be broken down into an initial phase between 2010 and 2014 with a reduction in consumption of 10 724.5 GWh (-12.85% compared with 2010) and a second, between 2014 and 2017, in which energy consumption experienced an upturn of 3 167.5 GWh (4.3% above 2014). However, we should point out that, although the overall trend between 2014 and 2017 shows this upturn, the inter-year variation fluctuated: increasing between 2014 and 2015 (3.8%), and falling between 2015 and 2016 (-0.5%), before growing again between 2016 and 2017 (1%).

Figure 2.5. 2010-2017 trend in energy consumption for heating in the residential sector broken down by energy source (GWh).



	90 000.0
	80 000.0
	70 000.0
	60 000.0
	50 000.0
	40 000.0
	30 000.0
	20 000.0

	10 000.0
	0.0
	Electricity
	Gas
	Solid fuels
	LPG
	Fuel oil
	Solar thermal
	Biomass
	Geothermal

Source: MITMA based on IDAE data (2019). 'Annual Energy Consumption Report. Total Final Energy Consumption by Use: Residential Sector/Households.' 10th Edition. July 2019.

In terms of energy sources, the majority of the 10 724.5 GWh fall between 2010 and 2014 came from Natural Gas (58.4%: -6 266.0 GWh), followed by Fuel Oil for heating (-2 805.3 GWh), LPG (-1 403.1 GWh), Coal (-770.3 GWh) and, to a lesser extent, electricity (-366.0 GWh). In relative terms, the standout figure were the 54.1% drop in consumption of Coal (falling from 1 642.5 to 872.2 GWh), although the relative decreases in consumption of Natural Gas, Fuel Oil and LPG were also significant (-27.3%, -14.1% and -23.1%). The only sources with a real increase were renewables: Biomass had a small increase of 3% (which in absolute figures amounted to 825.3 GWh), while Geothermal and, especially, Solar Thermal experienced significant percentage growth (18% and 41.6%, respectively) although not in absolute terms (9.5 and 51.4 GWh).

During the 2014-2017 phase, the net increase of 3 167.5 GWh (4.3% in relative terms) was due almost exclusively to Natural Gas, for which consumption grew by 3 465.8 GWh (20.8% compared with 2014). Coal (-119.0 GWh, -13.6%), LPG (-273.9 GWh,-5.9%) and Electricity (-51.6 GWh, -1%) all maintained their downward trend while Fuel Oil underwent an upturn of 4.5% (142.5 GWh). In terms of renewables, Solar Thermal continued its growth, although at a slower rate (22.3% in percentage terms and 39 GWh in absolute terms), while Biomass fell by 35.3 GWh.

As a result of the two phases, the overall balance for the 2010-2017 period (-7 557.0 GWh) shows a moderate fall in electricity consumption (7.5%: -417.7 GWh) together with a significant drop in fossil fuels: -2 800.2 GWh (-12.2%) in Natural Gas, -2 662.8 GWh (-13.3%) in Fuel Oil for heating, -1 677.0 GWh (-27.7%) in LPG and -889.3 (-54.1%) in Coal. For their part, renewables experienced net increases of 790.1 GWh for Biomass (2.9%), 90.4 GWh for Solar Thermal (73.1%) and 9.5 GWh for Geothermal (18%).

2.2.2. The trend in energy consumption for DHW in households.

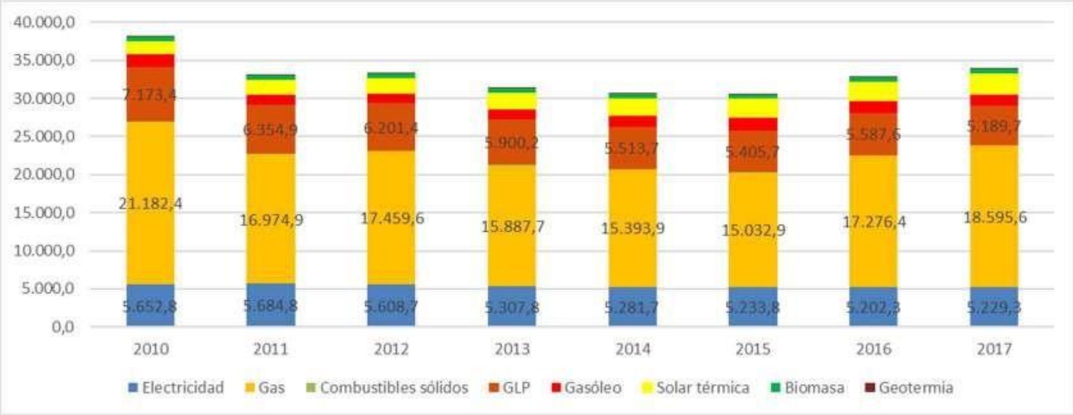
In the case of DHW, the first phase of reduction in consumption ran until 2015 and reached -7 517.1 GWh (-19.7%) while the recent upturn between 2015 and 2017 was even greater than that seen in heating (3 367.8 GWh, 11.0%) and has remained steady, without fluctuation, over the most recent inter-year periods (although with a downward trend: 1 076.1 GWh increase between 2016 and 2017, compared with 2 291.7 GWh for the year before).

As with heating, but once again more acutely, the 7 517.1 GWh fall in energy consumption for DHW between 2010 and 2015 was primarily due to Natural Gas (-6 149.5 GWh, -29% compared with 2010 consumption), followed, to a lesser extent, by LPG (-1 767.8 GWh, -24.6%), Electricity (-419.0 GWh, -7.4%) and Coal (-62.3 GWh), the latter experiencing the greatest drop expressed as a percentage (-48.8%). The biggest increase was in Solar Thermal energy for DHW (796.7 GWh, equating to 51.5% in relative terms), with much smaller increases in Fuel Oil (66.9 GWh, 3.7%), Biomass (12.6 GWh, 2.2%) and Geothermal (5.4 GWh, 18%).

The significant 3 367.8 GWh upturn (11%, higher even than that seen in heating) between 2015 and 2017 was also due almost exclusively to Natural Gas (3 562.7 GWh, also constituting a 23.7% increase in this consumption in 2015), which, from 2015 onwards, reversed the downward trajectory seen here since 2010. Moreover, the remaining sources have, over the last few years, maintained their trends from the previous period, with continued drops in consumption of LPG (-216 GWh, -4%), Coal (-6.8 GWh) and Electricity (-4.5 GWh) and increases in Solar Thermal (334 GWh, 14.3%) and Biomass (4.2 GWh, 0.7%). Along with Natural Gas, as mentioned above, the only other fuel for which the trend changed over the last few years was Fuel Oil: in this case, it changed favourably, with a reduction of 306 GWh (-16.5%) compared with the growth seen between 2010 and 2015.

Therefore, the overall balance for both phases shows a drop in the consumption of energy for DHW of 4 149.3 GWh (10.9%) between 2010 and 2017, of which 2 586.8 GWh was the result of Natural Gas alone (a reduction of 12.2% compared with consumption in 2010), 1 983.8 GWh in LPG (27.7%), 423.5 GWh (7.5%) in Electricity, 239.1 GWh (13.3%) in Fuel Oil and 69.2 GWh in Coal (62.3%). In terms of renewables, there were increases in the consumption of energy from Solar Thermal (1 131.1 GWh, 73.1%), Biomass (16.7 GWh, 2.9%) and Geothermal (5.4 GWh, 18%).

Figure 2.6. 2010-2017 trend in energy consumption for DHW in the residential sector broken down by energy source (GWh).



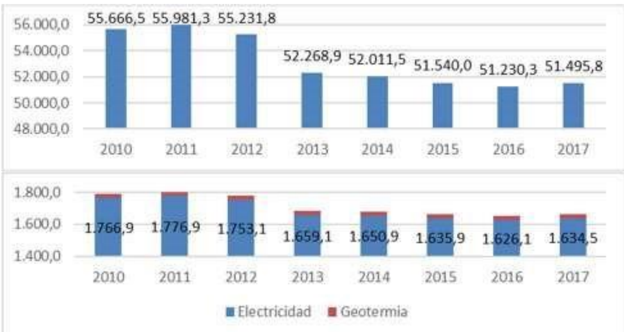
	40 000.0
	35 000.0
	30 000.0
	25 000.0
	20 000.0
	15 000.0
	10 000.0
	5 000.0
	0.0
	Electricity
	Gas
	Solid fuels
	LPG
	Fuel oil
	Solar thermal
	Biomass
	Geothermal

Source: MITMA based on IDAE data (2019). 'Annual Energy Consumption Report. Total Final Energy Consumption by Use: Residential Sector/Households.' 10th Edition. July 2019.

2.2.3. The trend in energy consumption for lighting, household appliances and cooling in households.

The consumption of electricity for lighting and household appliances, which represents approximately 30% of total household consumption, fell by 4 170.6 GWh (7.5%) between 2010 and 2017. This decrease was constant, except in the last period for which data are available (2016-2017), which saw a slight upturn of less than 1% (265.5 GWh).

Figure 2.7. 2010-2017 trend in consumption of electricity for Lighting and Household Appliances (left) and energy for Cooling (right) (GWh).



	56 000.0
	54 000.0
	52 000.0
	50 000.0
	48 000.0
	55 666.5
	55 981.3
	55 231.8
	52 268.9
	52 011.5
	51 540.0
	51 230.3
	51 495.8
	1 800.0
	1 600.0
	1 400.0
	1 766.9
	1 776.9
	1 753.1
	1 659.1
	1 650.9
	1 635.9
	1 626.1
	1 634.5
	Electricity
	Geothermal

Source: MITMA based on IDAE data (2019). 'Annual Energy Consumption Report. Total Final Energy Consumption by Use: Residential Sector/Households.' 10th Edition. July 2019.

The data on energy consumption for cooling show that this represents only around 1% of the total. As was also the case for electricity for lighting and household appliances, consumption of electricity for cooling fell by 7.5% (-132.4 GWh) between 2010 and 2017, with another slight upturn between 2016 and 2017, again of less than 1% (8.4 GWh).

Despite this reduced proportion represented by cooling in total household energy consumption, we must not forget the data from the study published by IDAE in 2016 on the stock of heat pumps in Spain[11], according to which the country has 11.3 million heat pump units: 8.5 million installed in homes[12], another 2.3 millions in the commercial-services sector and a further 1 million in industry (IDAE, ibid. p. 20), with almost 80% of them in the Mediterranean zone. According to the data from the survey conducted for that study, of the 11.3 million units, 5.4 million (48%) are only used for cooling, even though they also have a heating function.

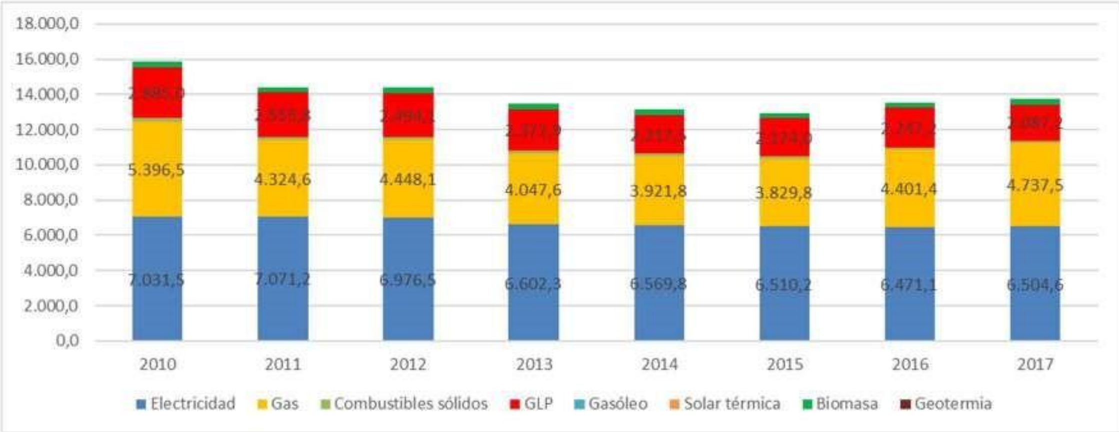
Given that the total installed power in heat pumps is estimated to be 77 673 MWt (IDAE, ibid, p. 24), there seems to be a clear disparity between the large size and power of the existing heat pump stock and the low impact on the consumption of electricity for cooling on the total energy consumed by households. Therefore, with a view to the future, we must bear in mind the possible increase in consumption that may arise if the factors (cultural, heat-adaptive comfort, etc.) that may explain this disparity were to change.

2.2.4. The trend in energy consumption for cooking in households.

Figure 2.8. 2010-2017 trend in energy consumption for cooking in the residential sector broken down by energy source (GWh).

[11] IDAE (2016) 'Estudios IDAE 001: Parque de Bombas de Calor en España. Síntesis del Estudio".
https://www.idae.es/publicaciones/sintesis-del-estudio-parque-de-bombas-de-calor-en-espana-estudios-idae-001

[12] According to the study data, of the total of 18 million households, approximately 5.8 million (i.e. approximately 32%) had a heat pump (IDAE, ibid, p. 20).



	18 000.0
	16 000.0
	14 000.0
	12 000.0
	10 000.0
	8 000.0
	6 000.0
	4 000.0
	2 000.0
	0.0
	Electricity
	Gas
	Solid fuels
	LPG
	Fuel oil
	Solar thermal
	Biomass
	Geothermal

Source: MITMA based on IDAE data (2019). 'Annual Energy Consumption Report. Total Final Energy Consumption by Use: Residential Sector/Households.' 10th Edition. July 2019.

Energy consumption for cooking in households also showed a cyclical pattern similar to that of DHW and heating: a first phase between 2010 and 2015 with a significant reduction (-2 909.9 GWh, -18.4% compared with 2010 consumption), followed by an upturn of 804.4 GWh (6.2%) between 2015 and 2017. In this case, the net balance resulting from the period shows a more homogeneous distribution of consumption reductions between the three main sources of energy used for cooking in households: -797.8 GWh (-27.7% compared with 2010) in the consumption of LPG, -659.0 GWh (-12.2%) in Natural Gas, -526.8 GWh (-7.5%) in Electricity, and -130.4 GWh in Coal (-54.1%). Again similarly to DHW and heating use, Natural Gas saw a significant reversal in the downward trend it had experienced between 2010 and 2015 (-1 566.7 GWh): its consumption only rose between 2015 and 2017 (by 907 GWh).

2.3. MODELLING OF SYSTEMS, EQUIPMENT AND SOURCES OF ENERGY FOR HEATING AND DHW IN SPANISH HOUSEHOLDS (2020).

a) Description of the model.

There are two sources of data on systems, equipment and energy consumed for heating and DHW in Spanish households: the model used by MITERD for drawing up the PNIEC (TIMES-Sinergia model [Integrated System for Studying Energy]) and the Studies into the SECH-SPAHOUSEC I and II Projects carried out by IDAE[13].

In order to analyse the energy system and its outlook in the PNIEC, we used the TIMES tool (The Integrated MARKAL-EFOM System), originally created by the International Energy Agency as part of the Energy Technology Systems Analysis Program (ETSAP) on energy and environmental analysis. This TIMES tool has been used to model the energy system in over 60 countries and is a tool widely used across Europe, for example in Italy, Portugal, Finland and Norway.

For Spain, the TIMES-Spain model was developed by the Energy,
Environment and Technology Research Centre (CIEMAT) using 2005 as the baseline. Using this TIMES-Spain model, the Directorate-General of Energy Policy and Mines (DGPEM), part of the MITERD State Secretariat for Energy, performed the work required to use the TIMES as an energy forward-planning and analysis tool to draw up the PNIEC and thereby created a new model which was given the name TIMES-SINERGIA (Integrated System for Studying Energy).

TIMES-SINERGIA is a generator of mathematical bottom-up models. This means that the model uses each of the components of the energy system to subsequently obtain data at aggregate level. The TIMES-SINERGIA model generator combines two complementary approaches, one technical and the other economic. It is based on the linear optimisation of the energy system and seeks a solution under the minimum cost principle.

It contains a detailed characterisation of the energy technologies and demand for energy services, which it uses for the various scenarios considered by the TIMES-SINERGIA model and to cover the demand for energy services by combining operational and investment decisions, thereby minimising the cost of the energy system over the time period under analysis.

Specifically, the methodology used to model the systems, equipment stocks and sources of energy used for heating and DHW in the residential sector is as follows:

1. It starts with the data on equipment stocks from the SECH-SPAHOUSEC 2011 Project, which contains the equipment numbers for various technologies broken down by single-family and multi-family dwellings and the three climatic zones (Atlantic, Mediterranean and Continental).

2. An initial correction to this equipment is then carried out, by either increasing or decreasing the number depending on the fuel consumption ratio between 2011, the first study date, and 2016. The SECH-SPAHOUSEC study (2019) also contains up-to-date information.

3. During the second correction phase, the system takes into consideration the increase in the number of households of each type from the reference date up to the present time.

4. The resulting equipment stocks are then rebalanced so that there are as many items of equipment as households, as the SECH-SPAHOUSEC Project is an inventory of the total equipment numbers and may therefore have more than one piece of equipment per household, while TIMES uses just one piece of equipment per household.

5. The equipment is then split into collective and individual thermal systems in proportion to the data available on the number of households with each type of system, as the SECH-SPAHOUSEC Project did not originally differentiate here.

6. Following this, the fuel distributions are then calculated: Where one type of demand (for example, heating in single-family households) has different equipment consuming the same fuel, the fraction of fuel that each type of equipment consumes to cover that demand (calculated beforehand based on the Eurostat Balance and the SPAHOUSEC breakdowns by end use) is calculated on the basis of the number of households (stock) with that equipment and weighted on the basis of the relative efficiency of the specific piece of equipment, on the assumption that all households have similar needs.

7. Consumption is distributed between pieces of equipment providing mixed services, as the SECH-SPAHOUSEC Project does not differentiate between simple pieces of equipment and those that cover DHW and heating

[13] https://www.idae.es/file/14704/download?token=vM743g7l

needs. In the case of equipment that covers two needs (DHW and heating), the totals are split between the two variants. This adjustment is carried out per iteration, monitoring to ensure that the stocks and consumption of DHW in collective and individual systems have parameters fully adjusted in line with the data available.

8. Lastly, the numbers of households that have some type of equipment are converted into capacity. This uses a factor known as AFA, which is a ratio of annual operation calculated using consumption and stock, and used to balance the consumption of the equipment and the stocks.

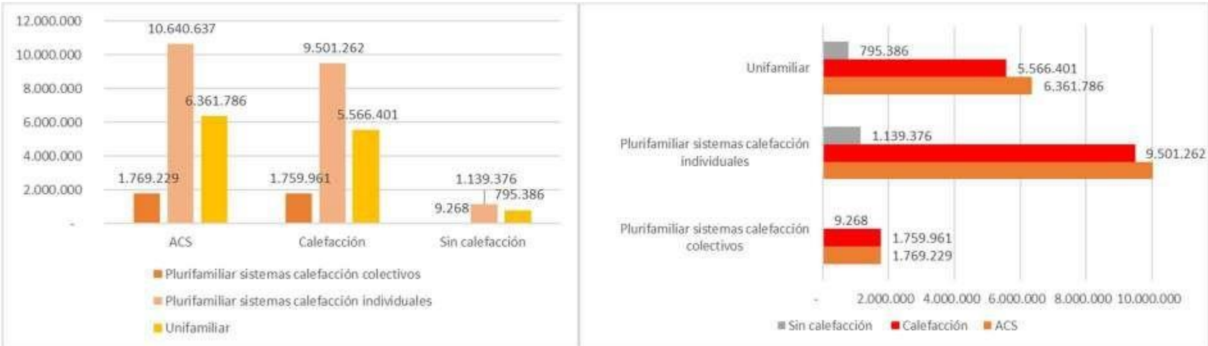
On the basis of the results obtained by applying this methodology developed by MITERD for the TIMES-SINERGIA model, which are used for the PNIEC, MITMA has made the corresponding adjustments to the total number of households estimated for the ERESEE in 2020 and developed the corresponding model of the residential stock, for which the data are shown below and are those ultimately used for the 2020 ERESEE calculation model.

b) Systems, equipment and average energy consumption for heating and DHW per household.

According to the model of the residential stock and its installations in 2020 created by MITMA using MITERD data and the SEC-SPAHOUSEC project from IDAE, 100% of the 18 771 653 households considered to be main dwellings have an installation providing DHW. In relation to heating, 89.6% of households (16 827 623 in total) have an installation or some means (fireplace, stove, appliance, etc.) providing this service, compared with 1 944 029 households without heating (10.4%).

Of the households with heating, approximately 33.1% are individual systems in single-family dwellings, 56.5% are individual systems in multi-family dwellings and 10.5% are centralised systems in multi-family dwellings.

Figure 2.9. Breakdown of heating and DHW equipment by household (single/multi-family) and system (individual or centralised).



	12 000 000
	10 000 000
	8 000 000
	6 000 000
	4 000 000
	2 000 000
	10 640 637
	9 501 262
	6 361 786
	5 566 401
	1 769 229
	1 759 961
	1 139 376
	9 268
	795 386
	DHW
	Heating
	No heating
	Multi-family, collective heating systems

	Multi-family, individual heating systems
	Single-family

Source: MITMA model based on MITERD (TIMES-SINERGIA model) and IDAE data.

This breakdown is very different when seen in terms of consumption, where the single-family:multi-family ratio reverses: single-family dwellings, which account for 33.1% of households, consume 60.9% of the energy used for domestic heating, while multi-family dwellings, which (individual and centralised systems combined) account for 66.9% of households, consume 39.1%. In terms of average consumption of energy for heating per dwelling, while the average Spanish dwelling consumes 4 647.6 kWh per year[14], single-family dwellings have an average consumption of 8 563.4 kWh, which is practically triple the average consumption of multi-family dwellings (at 2 301.1 kWh per year for those with collective heating systems and 2 788.2 kWh for those with individual systems)[15].

The same cannot be said for DHW, which has an average consumption of 1 426.3 kWh per year per dwelling, without any significant differences (less than 10%) between single-family and collective dwellings, as this consumption primarily depends on the number of inhabitants in each household and their habits, and not on the type or characteristics of the dwellings.

c) Characterisation of heating equipment.

For this characterisation, we have used the data from the recent study conducted by IDAE (2019) as part of the SPAHOUSEC II Study project, based on a survey carried out specifically for that study (subsequently increased to 16 504 809 households with heating).

According to these data, the majority of Spanish households have, to some extent, multiple pieces of heating system equipment, from one up to three types of system within one household, which explains why the availability of main and secondary heating systems in households is over 100%.

The most common equipment, present in almost half of Spanish households, is a conventional boiler (i.e. not condensing boilers, which involve much more modern technology and are only present in 4% of households). This is followed by electrical systems (radiators/convectors), present in 18.1% of households and heat pumps, in 11.3%. Finally, 'other' systems make up another 21.1%. These include fireplaces, stoves (wood, coal or LPG), braziers, gas convectors, geothermal heating, etc. Energy-based individual heating systems and underfloor heating make up less than 1%, accounting for 0.4% and 0.3% respectively.

Figure 2.10. Type of heating system in households (%) by climatic zone and dwelling type.

Heating system type	Total	Climatic zone					
		North Atlantic		Continental		Mediterranean	
	Dwelling type	Block	Single-family	Block	Single-family	Block	Single-family
Conventional boiler	49.3	53.1	63.1	85.9	80.2	27.7	23.1
Condensing boiler	4.0	14.3	4.0	5.9	4.0	1.0	1.9
Reversible heat pump	11.3	0.3	0.0	0.6	0.7	18.5	24.5
Electric radiator/convector	18.1	28.1	16.2	7.4	9.0	23.4	21.8
Solar panels	0.4	0.2	0.0	0.2	0.0	0.0	1.5
Underfloor heating	0.3	1.0	1.2	0.2	0.5	0.1	0.3
Other	21.1	4.7	20.4	13	12.0	33.1	33.6

[14] According to the SEC-SPAHOUSEC I study (2011), the average consumption at that time was 4 944 kWh per year for heating and 1 988 kWh for DHW.
[15] According to the SEC-SPAHOUSEC I study (2011), the average consumption at that time was 2 554 kWh per year for heating in collective dwellings and 10 870 kWh per year for single-family dwellings.

Basis: 16 504 809 households with individual heating system.

Source: Estudios IDAE 005: Estudio SPAHOUSEC II. Análisis estadístico del consumo de gas natural en las viviendas principales con calefacción individual. (2019). Figure 5.25.

In terms of climatic zone, conventional boilers are clearly predominant in the Continental zone, accounting for over 80% of installations, both in single-family and collective dwellings. Conversely, in the Mediterranean zone, the main types are installations covered in the 'others' category, which account for a third of the total, followed by conventional boilers, electric radiators/convectors and heat pumps, which are less common in single-family homes. Finally, the situation in the Atlantic zone lies somewhere between the above two with over half of households with a conventional boiler, followed by electric radiators/convectors at 16.2% and 28.1% (single-family and collective, respectively), and then other systems in single-family dwellings (20.4%) and condensing boilers in collective dwellings (14.3%). The Atlantic zone has the lowest rate of heat pumps.

Overall, over half of heat systems based on conventional boilers are concentrated in the Continental zone, while electrical appliances (heat pumps and radiators) and solar heating systems are more prevalent in the Mediterranean zone. The Atlantic zone, in turn, has a higher concentration of heating systems using underfloor heating and condensing boilers.

Figure 2.11. Distribution of heating systems (%) by climatic zone

	Conventional boiler
	Condensing boiler
	Reversible heat pump (cooling/heating)
	Electric radiator/convector
	Solar panels
	Underfloor heating
	Other
	North Atlantic
	Continental
	Mediterranean
	Basis: 16 504 809 households with individual heating system.
	24.5

Source: Estudios IDAE 005: Estudio SPAHOUSEC II. Análisis estadístico del consumo de gas natural en las viviendas principales con calefacción individual. (2019). Figure 5.25.

d) Breakdown of energy consumed for heating by type of dwelling and its systems (2020).

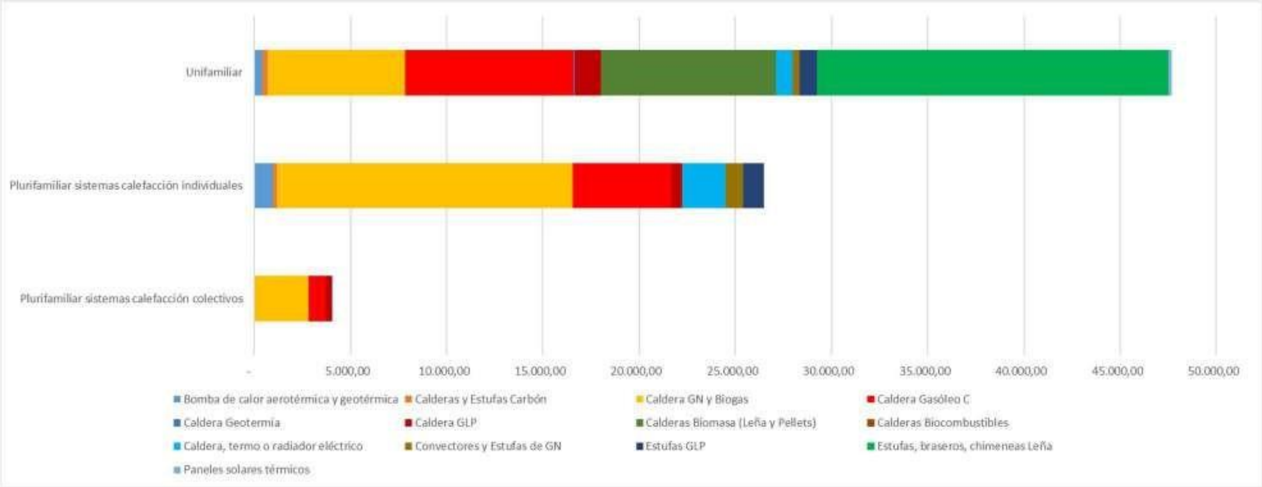
To analyse the breakdown of energy consumed, we used the model of the residential stock and its installations in 2020 drawn up by MITMA based on data from MITERD and the SEC-SPAHOUSEC project from IDAE. We grouped the results in line with the three types and systems analysed: single-family dwellings, multi-family dwellings with centralised or collective systems, and multi-family dwellings with individual systems.

In absolute terms, total consumption for the 5 566 401 single-family dwellings modelled is 47 667.4 GWh, with Biomass representing over half of this figure: 38.3% for stoves, braziers and fireplaces, in dwellings without specific heating installations, and 19.1% for Biomass boilers, in dwellings with installations (boiler, heating circuit and radiators)/ Adding consumption in dwellings with Fuel Oil boilers (18.3%) and Natural Gas (15%) accounts for almost 90% of total energy consumption in this type of dwelling, with the remaining 10% split between LPG boilers (2.8%), LPG stoves (2%), electric boilers or radiators (1.8%), heat pumps (0.9%) and other minority equipment.

Consumption in the 9 501 262 dwellings modelled as a multi-family with individual systems amounts to 26 491.3 GWh (i.e. approximately half the consumption in single-family dwellings), of which 58% comes from Natural Gas boilers, 19.4% from Fuel Oil boilers and 8.6% from electric boilers or radiators (Joule effect). Systems contributing less than 5% to consumption would be LPG stoves (4.2%), Natural Gas convectors and stoves (3.3%), electricity for heat pumps (3.7%), LPG boilers (2%) and coal (0.7%).

Finally, the 1 759 961 dwellings modelled as multi-family with collective heating systems would have total consumption of 4 049.8 GWh (which alone is barely 8% of single-family consumption and reaches 64% if we add that of multi-family dwellings with individual systems), broken down as 69.1% for Natural Gas central boilers, 21.8% for Fuel Oil boilers and 7.9% for LPG boilers, with heat pumps, solar thermal panels and coal boilers each representing less than 1%.

Figure 2.12. Distribution of energy consumed in 2020 for heating by equipment and fuel, broken down by dwelling type and system type (individual, collective). (GWh)



	Single-family
	Multi-family, individual heating systems
	Multi-family, collective heating systems
	5 000.00
	10 000.00
	15 000.00
	20 000.00
	25 000.00
	30 000.00
	35 000.00
	40 000.00
	45 000.00
	50 000.00
	Aerothermal and geothermal heat pump
	Geothermal boiler
	Boiler, electric water heater or radiator
	Solar thermal panels
	Coal boilers and stoves
	LPG boiler
	NG convectors and stoves
	NG and biogas boiler
	Biomass boilers (wood and pellets)
	LPG stoves
	Heating fuel oil boiler
	Biofuel boiler
	Wood stoves, braziers, fireplaces

Source: MITMA model based on MITERD (TIMES-SINERGIA model) and IDAE data.

e) Analysis of the most inefficient dwellings by system, equipment and fuel.

The table below shows the average consumption per dwelling according to the model used, differentiating between the types and systems. As can be seen, in addition to the variations in terms of the average consumption per each type of dwelling, which has been discussed above, the differences in terms of fuel are also very significant. In multi-family dwellings, those that use LPG, Coal and Fuel Oil to heat their homes consume more than average, while among single-family dwellings, the highest consumption is attributable to biomass boilers, which are almost double the average household consumption in Spain, and, above all, wood stoves, braziers and fireplaces, which are almost three times higher.

Conversely, the dwellings with consumption below average would be those with solar thermal panels, electric boilers or radiators and heat pumps. Consumption in dwellings with Natural Gas boilers, which is the most common fuel, is around average for each dwelling type.

Figure 2.13. Average heating consumption by dwelling by type, system and equipment. (MWh per year). (2020)

	SYSTEM AND EQUIPMENT	MWh/dwelling 2020
Multi-family, collective systems	Solar thermal panels	1 488.0
	NG boiler	2 171.4
	AVERAGE Multi-family Collective systems	**2 301.1**
	LPG boiler	2 363.2
	Coal boiler	2 981.0
	Heating fuel oil boiler	3 006.2
Multi-family, individual systems	Aerothermal heat pump	898.4
	Boiler, electric water heater or radiator	1 465.8
	NG convectors and heat pumps	2 692.6
	AVERAGE Multi-family Individual systems	**2 788.2**
	NG boiler	3 218.2
	LPG stoves	3 348.8
	Coal boilers and stoves	4 068.2
	Heating fuel oil boiler	4 126.0
	LPG boiler	4 553.0

	SYSTEM AND EQUIPMENT	MWh/dwelling 2020
Single-family	Aerothermal and geothermal heat pump	1 798.6
	Boiler, electric water heater or radiator	2 368.4
	Direct-use geothermal boiler	3 417.8
	Solar thermal panels	5 375.3
	NG boiler	6 537.7
	NG convectors and stoves	6 946.4
	LPG stoves	7 248.1
	Biofuel boilers	7 437.5
	Heating fuel oil boiler	7 550.6
	Coal boilers and stoves	7 569.5
	LPG boiler	7 580.1
	AVERAGE Single-family	**8 563.4**
	Biomass boilers (wood and pellets)	8 784.8
	Wood stoves, braziers, fireplaces	14 820.7

AVERAGE SPAIN	4 647.6

Source: MITMA model based on MITERD (TIMES-SINERGIA model) and IDAE data.

f) Characterisation of equipment for Domestic Hot Water (DHW)

For this characterisation, we used the data from the SPAHOUSEC II Study conducted by IDAE (2019), according to which almost all households in Spain (99.8%)[16] have DHW, and almost none with multiple pieces of DHW equipment.

The main systems are conventional boilers (54% of households), with electric water heaters (19%) and gas water heaters (20.7%) significantly further behind. The former are found mostly in dwellings in the Continental and Atlantic zones, and the latter in dwellings in the Mediterranean zone. Systems based on condensing boilers are present in less than 5% of households, with their presence more prominent in block dwellings in the Atlantic zone. Solar DHW systems, for their part, are found in only 1.3% of households, primarily in dwellings in the Mediterranean zone, especially single-family dwellings.

Figure 2.14. Type of DHW system in Spanish households (%) by climatic zone and dwelling type.

Heating system type	Total	Climatic zone					
		North Atlantic		Continental		Mediterranean	
	Dwelling type	Block	Single-family	Block	Single-family	Block	Single-family
Conventional boiler	54.0	54.1	65.1	82.7	69.4	35.3	26.7
Condensing boiler	4.7	14.5	3.4	6.1	3.9	1.4	1.9
Electric water heater	19.0	18.2	13.7	7.3	13.3	24.4	32.3
Gas water heater	20.7	10.7	12.4	3.7	10.3	37.0	31.5
Solar panels	1.3	0.3	0.5	0.1	1.4	0.4	6.3
Other	1.5	2.2	4.9	0.2	14	1.5	1.3

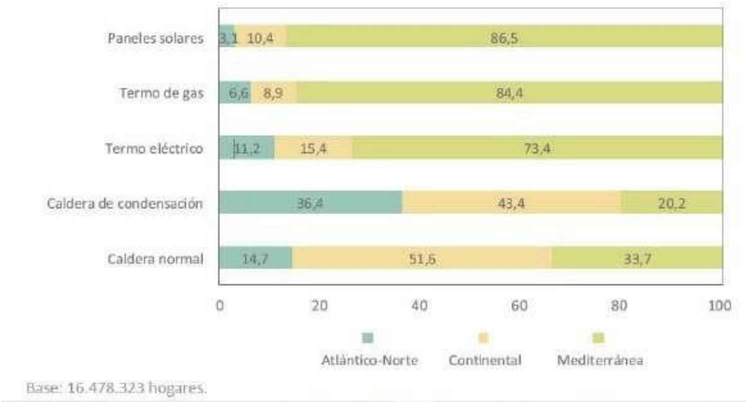
Basis: 16 478 373 households

Source: Estudios IDAE 005: Estudio SPAHOUSEC II. Análisis estadístico del consumo de gas natural en las viviendas principales con calefacción individual. (2019). Figure 5.26.

In terms of climatic zone, conventional boilers stand out in the Continental zone, accounting for 69.4% of installations in single-family dwellings and 82.7% in collective dwellings. In the Mediterranean zone, there is practically a three-way split between gas water heaters, electric water heaters and conventional boilers, such that water heaters (both electric and gas), together with solar panels in this Mediterranean zone, account for over 70% of all such installations in Spain. Lastly, the Atlantic zone sits somewhere between the two zones above, with conventional boilers accounting for 54.1% of installations in collective dwellings and 65.1% in single-family dwellings, followed by electric and gas water heaters and, in collective dwellings, condensing boilers.

[16] For the purposes of the ERESEE, according to the MITMA model, coverage is 100%.

Figure 2.15. Distribution of DHW systems (%) by climatic zone



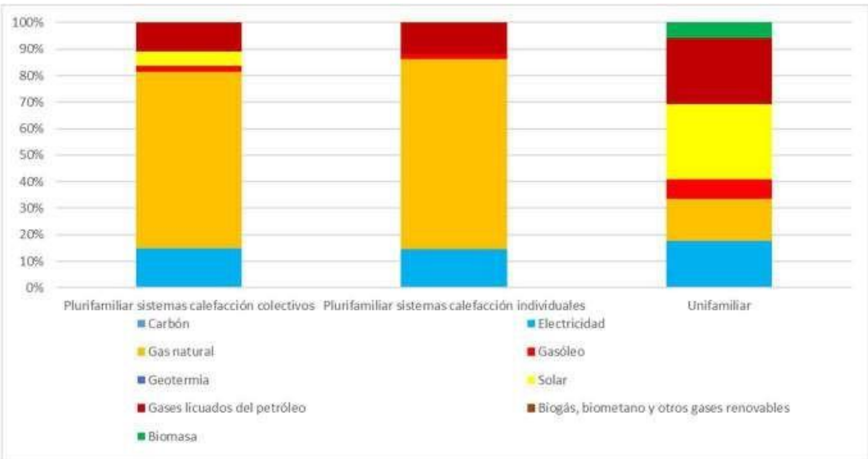
	Solar panels
	Gas water heater
	Electric water heater
	Condensing boiler
	Conventional boiler
	North Atlantic
	Continental
	Mediterranean
	Basis: 16 478 323 households.

Source: Estudios IDAE 005: Estudio SPAHOUSEC II. Análisis estadístico del consumo de gas natural en las viviendas principales con calefacción individual. (2019). Figure 5.27.

g) Breakdown of energy consumed for DHW by type of dwelling and its systems (2020).

As discussed, according to the model of the residential stock and its installations in 2020 created by MITMA using MITERD data and the SEC-SPAHOUSEC project from IDAE, although average consumption for DHW per household is very similar in single- and multi-family dwellings, its distribution by energy source shows a very different picture for each of these two types. According to the model used, in single-family dwellings, there is a broad split between various sources: 28.3% of consumption from Solar Energy, 25% from LPG, 17.6% from Electricity, 15.8% from Natural Gas, 7.3% from Fuel Oil and 5.8% from Biomass. Conversely, in multi-family dwellings, more than two thirds of consumption is attributable to Natural Gas (66.6% in multi-family dwellings with collective systems and 71.8% in multi-family dwellings with individual systems), followed by electricity (around 14%) and LPG (around 11%), Solar in multi-family dwellings with collective systems (5.3%) and some Fuel Oil (around 2%).

Figure 2.16. Percentage distribution of energy consumption for DHW by fuel, broken down by dwelling type and system type (individual, collective). (% of total)



	100%
	90%
	80%
	70%
	60%
	50%
	40%
	30%
	20%
	10%
	0%
	Multi-family, collective heating systems
	Multi-family, individual heating systems
	Single-family
	Coal
	Natural gas
	Geothermal
	LPG
	Biomass
	Electricity
	Fuel oil
	Solar
	Biogas, biomethane and other renewable gases

Source: MITMA model based on MITERD (TIMES-SINERGIA model) and IDAE data.

h) Characterisation of equipment for Cooling and frequency of use patterns.

According to the data from the SPAHOUSEC II study (IDAE, 2019), 30% of the Spanish households that have individual heating have some type of air conditioning system, or 5 669 927 households if we extrapolate the data from the survey.[17] The systems present in these households with cooling equipment are reversible heat pumps (76.1%), irreversible heat pumps (15.8%) and portable air conditioning units (8.2%).

In terms of dwelling type, we can see that single-family dwellings are generally better equipped than dwellings in blocks, although in absolute terms, around two thirds of cooling systems are found in these latter dwellings. Within single-family dwellings, we find a slightly higher prevalence of reversible heat pumps than of other types of systems.

As regards the geographic distribution, we can see significant differences between the number of households with cooling installations, with the Mediterranean zone standing out with over 50% of households equipped, compared with the Atlantic zone, where the number of households with these installations is barely over 1%.

Figure 2.17. Type of cooling system in households (%) by climatic zone and dwelling type.

Heating system type	Total	Climatic zone					
		North Atlantic		Continental		Mediterranean	
	Dwelling type	Block	Single-family	Block	Single-family	Block	Single-family
Portable air conditioning unit	8.2	50.0	40.0	10.9	7.7	7.1	8.2
Reversible heat pump (cooling/heating)	76.1	25.0	40.0	63.0	77.5	79.5	76.1
Irreversible heat pump (cooling)	15.8	25.0	20.0	26.1	14.8	13.4	15.8

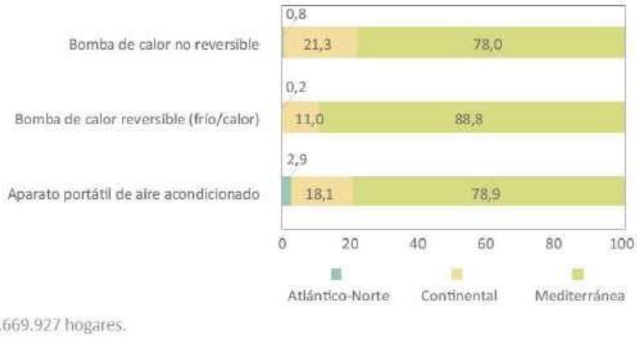
[17] These data are very similar to those from the afroementioned IDAE study (2016) entitled *Estudios IDAE 001: Parque de Bombas de Calor en España. According to the study data, of the total of 18 million households, approximately 5.8 million (i.e. approximately 32%) had a heat pump (IDAE, ibid, p. 20).*

Basis: 5 669 927 households.

Source: Estudios IDAE 005: Estudio SPAHOUSEC II. Análisis estadístico del consumo de gas natural en las viviendas principales con calefacción individual. (2019). Figure 5.27.

The distribution of cooling systems by climatic zone shows the predominance of the Mediterranean area, which accounts for almost all cooling equipment, from 78% of irreversible heat pumps up to 88.8% of reversible pumps. The presence of cooling equipment in the Atlantic zone is greatly reduced, with portable units constituting the most common type, although they do not even account for 3% of the total.

Figure 2.18. Distribution of cooling systems (%) by climatic zone.

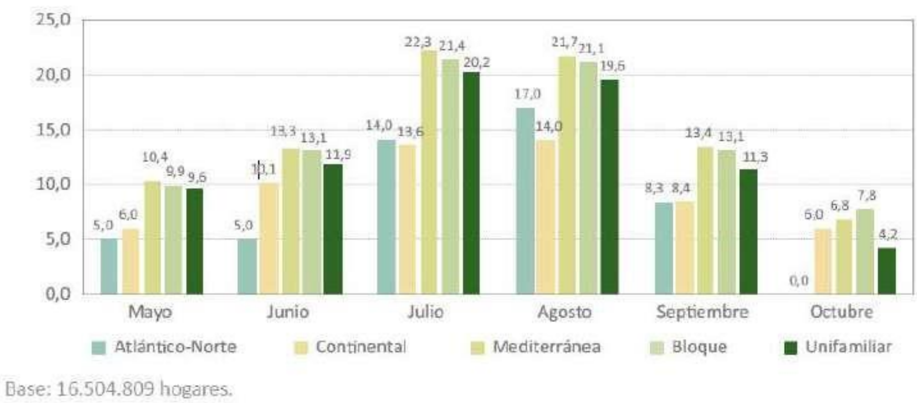


	Irreversible heat pump
	Reversible heat pump (cooling/heating)
	Portable air conditioning unit
	North Atlantic
	Continental
	Mediterranean
	Basis: 5 669 927 households.

Source: Estudios IDAE 005: Estudio SPAHOUSEC II. Análisis estadístico del consumo de gas natural en las viviendas principales con calefacción individual. (2019). Figure 5.29.

Finally, usage patterns are an important aspect in relation to air conditioning. The average number of days per month on which air conditioning is used is 13.9, with the Mediterranean zone using cooling systems to the greatest extent: 14.6 days per month, compared with the Atlantic zone, where usage is much lower (6 days fewer). In terms of the daily hours of use, the average is 3.9, increasing slightly for dwellings in the Mediterranean zone.

Figure 2.19. Frequency of use (no of days/month) of air conditioning by climatic zone and dwelling type.



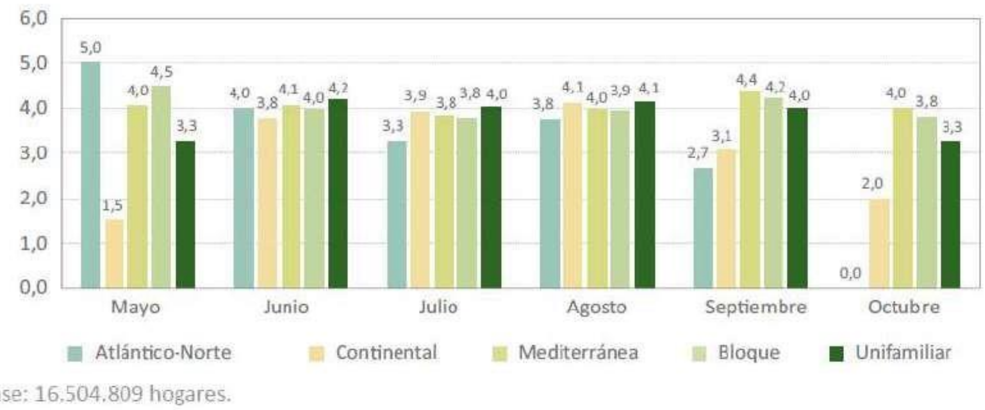
	25.0
	20.0
	15.0
	10.0
	5.0
	0.0
	May
	June
	July
	August
	September
	October
	North Atlantic
	Continental
	Mediterranean
	Block
	Single-family
	Basis: 16 504 809 households.

Source: Estudios IDAE 005: Estudio SPAHOUSEC II. Análisis estadístico del consumo de gas natural en las viviendas principales con calefacción individual. (2019). Figure 5.37.

In terms of dwelling type, there are no significant differences, with the data showing a slight increase in the use of this equipment in dwellings in blocks, which is more marked in October.

When considering dwellings by type and climatic zone, the greatest differences can be seen between dwellings in blocks in the Mediterranean zone, where average monthly use exceeds 15 days, and dwellings in blocks in the Atlantic zone, with less than 6 days' use. The pattern in terms of hours of use per day also shows the greatest difference between dwellings in blocks in the Mediterranean zone and the Atlantic zone, with a difference of three hours between the two. In the case of single-family dwellings, there are fewer differences across the geographic locations.

Figure 2.20. Frequency of use (no of hours/day) of air conditioning by climatic zone and dwelling type.



	6.0
	5.0
	4.0
	3.0
	2.0
	1.0
	0.0
	May

	June
	July
	August
	September
	October
	North Atlantic
	Continental
	Mediterranean
	Block
	Single-family
	Basis: 16 504 809 households.

Source: Estudios IDAE 005: Estudio SPAHOUSEC II. Análisis estadístico del consumo de gas natural en las viviendas principales con calefacción individual. (2019). Figure 5.38.

These usage patterns and the adaptive comfort may explain the difference (already discussed in the section on the analysis of energy consumption) between the high presence of air-conditioning equipment and its very low impact as reflected in the consumption data, as, overall, the energy consumed for cooling barely represents 2.4% of that consumed for heating or 7% of that consumed for DHW.

2.4. ENERGY CONSUMPTION TREND IN THE TERTIARY SECTOR.

Based on the Final Energy Balance data (1990-2018) from IDAE-MITERD, consumption in the tertiary or non-residential building sector (corresponding to the statistical series 'Trade, Services and Public Administrations') for the 2014-2018 period underwent a sustained increase, with a sharp rise in 2015 of 1 582 ktoe, softening softened over the following year, which recorded an increase of 565 ktoe, before undergoing slight drops of 146 ktoe in 2017 and 46 ktoe in 2018. The sharp rise in 2015 coincided with the change in methodology used to record consumption previously considered as 'Unspecified', which resulted in a significant increase in gas consumption. These data should therefore be treated with caution.

Nevertheless, given the trend in the 2010-2018 series, we must highlight that, in the tertiary sector, the consumption data experienced a 10.1% increase compared with 2010, a situation which was not seen either in the building sector overall or in the residential building sector, which saw reductions of 4.13% and 12.4%, respectively.

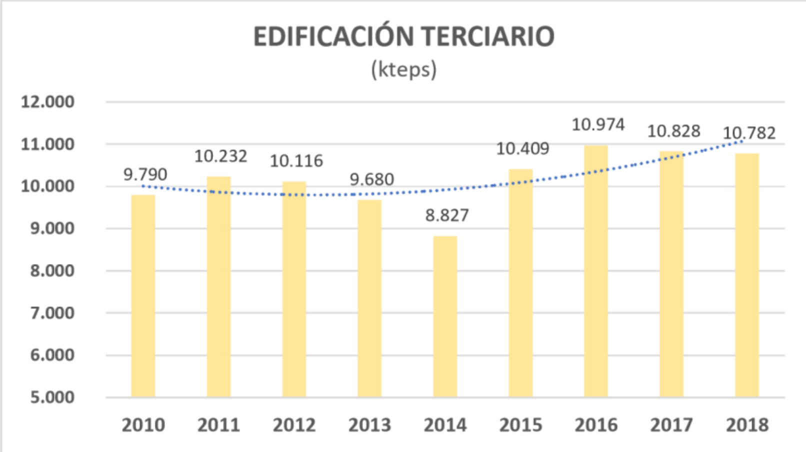
The analysis of these data shows that, in 2018, tertiary sector consumption accounted for more than 40% of total final energy consumption attributed to the building sector.

Figure 2.21. Total Final Energy Consumption 2010-2018

(ktoe)	SECTORS TOTAL	RESIDENTIAL BUILDING	TERTIARY BUILDING	BUILDING TOTAL
2010	89 444	16 965	9 790	26 755
2011	86 930	15 663	10 232	25 895
2012	83 414	15 560	10 116	25 676
2013	80 824	14 919	9 680	24 599
2014	79 419	14 744	8 827	23 571
2015	80 600	14 914	10 409	25 323
2016	82 520	15 106	10 974	26 080
2017	84 899	14 497	10 828	25 325
2018	86 883	14 867	10 782	25 649

Source: Prepared by MITMA based on the Final Energy Balance series (1990-2018). IDAE-MITERD

Figure 2.22. Final Energy Consumption Trend in the tertiary building sector 2010-2018.



Source: Prepared by the authors based on the Final Energy Balance series (1990-2018). IDAE-MITERD

If we use the same Final Energy Balance series to create a breakdown of consumption by energy source, we can see the annual trend in the data from 2010 in the following table:

Figure 2.23. Summary of final energy consumption 2010-2015 by energy sources. Tertiary Sector (ktoe)

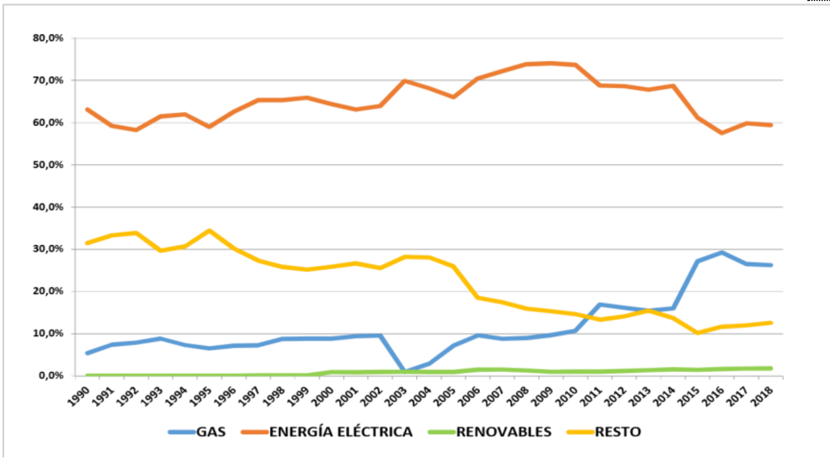
(ktoe)	PETROLEUM PRODUCTS TOTAL	GASES TOTAL	RENEWABLES TOTAL	ELECTRICITY TOTAL	OTHER	TOTAL
2010	1 429	1 049	99	7 213		9 790
2011	1 361	1 729	106	7 036		10 232
2012	1 424	1 631	118	6 943		10 116
2013	1 496	1 493	131	6 561		9 681
2014	1 212	1 409	138	6 067		8 826
2015	1 058	2 827	150	6 372	2	10 409
2016	1 273	3 210	176	6 310	6	10 975
2017	1 291	2 868	187	6 475	7	10 828
2018	1 350	2 831	190	6 407	4	10 782

Source: Prepared by the authors based on the Final Energy Balance series (1990-2018). IDAE-MITERD

In absolute terms, for the period 2010-2018, the total balance is +992 ktoe, with electricity experiencing the greatest drop -806 ktoe (11%), followed by petroleum products (fuel oil and LPG) at -79 ktoe (6%). Conversely, gas consumption experienced the greatest increase of the total of 1 782 ktoe (170%) and renewables saw an increase of 91 ktoe(92%) although these figures remain insignificant in terms of total consumption. The trend since 2015 shows the emergence of the 'Other' sources, although these are currently insignificant.

This long-term series shows how consumption has been redistributed in the tertiary sector since the 90s, when electricity accounted for approximately 60% of the total, petroleum products (fuel oil and LPG) 30% and gas a little less than 10%. This redistribution is as follows: electricity has maintained a similar percentage of 60% after having experienced an increase of up to 75% from 2005 the 2010; petroleum products ('Rest' in the graph) have maintained a downward trend to their current level of approximately 12%, while gas has benefited from this fall and gained a greater presence, rising to almost 30%; lastly, renewables have begun to emerge but still account for very residual percentages (less than 2%), and continue to experience very flat trends.

Figure 2.24. Graph showing the percentage change in final energy consumption in the tertiary sector by source (%)



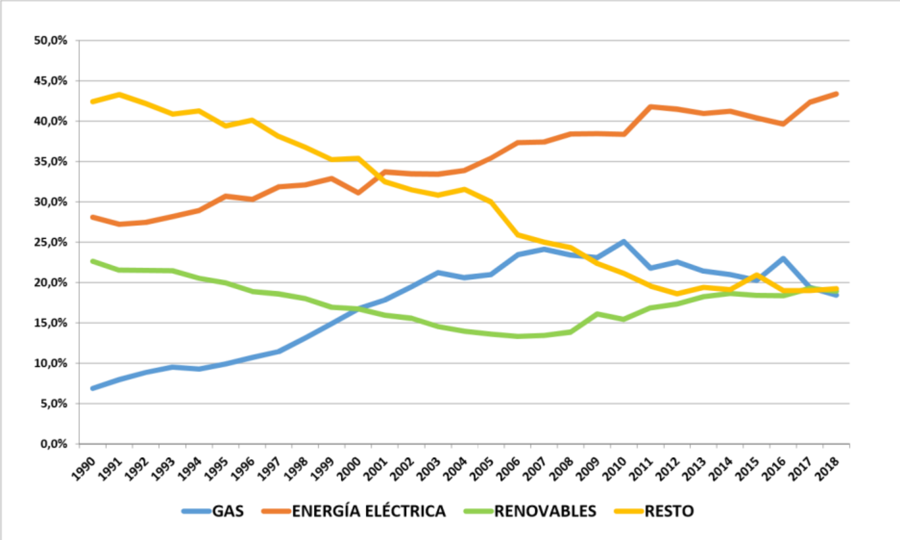
	0.0%
	10.0%
	20.0%
	30.0%
	40.0%
	50.0%
	60.0%
	70.0%
	80.0%
	Gas
	ELECTRIC POWER
	RENEWABLES
	REST

Source: Prepared by MITMA based on the Final Energy Balance series (1990-2018). IDAE-MITERD

This development follows the trend of the scenario forecast up to 2050, in which gas is the non-renewable source with the greatest presence, with progressive falls for the other non-renewable sources, and in which renewables must gain an ever increasing share.

However, if we compare this with the trend graph for the residential sector, we can see significant differences: electrification is the dominant source, currently at 40%, while petroleum products (fuel oil and LPG) experience a constant fall to approximately 20%, putting them at the same level as renewables and gas. This development seems to show a trend in which the gap left by the gradual demise of petroleum products (‘Rest’ in the graph) is filled by renewables.

Figure 2.25. Graph showing the percentage change in final energy consumption in the residential sector by source (%).



	0.0%
	5.0%
	10.0%
	15.0%
	20.0%
	25.0%
	30.0%
	35.0%
	40.0%
	45.0%
	50.0%
	Gas
	ELECTRIC POWER
	RENEWABLES
	REST

Source: Prepared by the authors based on the Final Energy Balance series (1990-2018). IDAE-MITERD

The IDAE series also make it possible to compare the analysis disaggregated by branches and energy sources. However, as the period for which disaggregated data are available on this scale only runs until 2017, a breakdown is provided for the trend period from 2010 to 2017. A summary of those tables is shown below:

Figure 2.26. Energy consumption (ktoe) for the services sector in Spain (2017, 2014 and 2010). Disaggregation by branches and energy sources. Not including non-energy uses.

2010	**Petroleum Products**	**Gases(*)**	**Electric Power**	**Renewables Total**	**TOTAL**	**%Branch**
Offices	501.4	230.8	2 431.4	74.9	3 238.6	33.0%
Hospitals	127.1	98.8	393.7	1.0	620.6	6.3%
Trade	370.8	494.4	2 435.2	13.4	3 313.8	33.8%
Hospitality	69.5	52.9	638.2	3.0	763.7	7.8%
Education	205.9	72.2	385.9	4.1	668.1	6.8%
Other Services	147.5	115.2	930.3	2.6	1 195.7	12.2%
SERVICES CONSUMPTION TOTAL	1 422.3	1 064.4	7 214.7	99.1	9 800.5	100.0%
2014	**Petroleum Products**	**Gases(*)**	**Electric Power**	**Renewables Total**	**TOTAL**	**%Branch**
Offices	411.5	310.3	2 047.8	39.5	2 809.0	31.7%
Hospitals	109.1	141.1	352.6	5.5	608.2	6.9%
Trade	307.4	686.8	2 066.0	3.8	3 064.0	34.6%
Hospitality	93.2	75.8	510.1	18.8	697.9	7.9%
Education	178.5	95.1	320.3	5.5	599.4	6.8%
Other Services	108.1	141.2	749.8	67.5	1 066.6	12.1%
SERVICES CONSUMPTION TOTAL	1 207.8	1 450.2	6 046.6	143.0	8 847.6	100.0%
2017	**Petroleum Products**	**Gases(*)**	**Electric Power**	**Renewables Total**	**TOTAL**	**%Branch**
Offices	378.0	600.0	2 208.0	12.8	3 241.0	32.0%
Hospitals	139.0	289.0	419.0	4.4	853.0	8.4%
Trade	481.0	1 028.0	1 810.0	1.9	3 325.0	32.8%
Hospitality	42.0	118.0	519.0	16.8	701.0	6.9%
Education	165.0	122.0	237.0	5.2	533.0	5.3%
Other Services	80.0	245.0	1 056.0	18.3	1 469.0	14.5%
SERVICES CONSUMPTION TOTAL	1 284.0	2 401.0	6 248.0	188.0	10 129.0	100.0%

Source: Prepared by the authors based on the Final Energy Balance series (1990-2018). IDAE-MITERD

We can see that, in 2017, the distribution of consumption between branches of activity in the tertiary sector breaks down approximately as follows: one third in offices (32%), one third in trade (32.8%) with the remaining third split between hospitals (8.4%), restaurants and accommodation (6.9%), education (5.3%) and other services (14.5%). This distribution has remained fairly stable since 2010, as shown by the data.

The distribution of the various energy sources in 2017 shows that petroleum products are most present in trade, accounting for 37%, offices (29%), and education (13%). The trade sector stands out particularly in terms of gas consumption, where it accounts for 43%, followed by offices, which consume 25%. The distribution of electricity consumption remained relatively stable during the period 2010-2014, breaking down into thirds in a similar way to that discussed for general consumption. However, in 2017, this balance began to change a little, with office consumption rising to 35%, followed by trade at 29%, and the final third split between restaurants and accommodation (8%), hospitals (7%), education (4%) and other services (17%).

Analysing each branch individually gives the following:

In trade, the branch with the highest consumption, totalling 3 325 ktoe (32.8% of the total), the energy source with the highest consumption is electricity, at 54%, followed by gas at 31% and petroleum products at 14%. Consumption in the trade sector has remained practically stable compared with 2010, although there has been an increase of 261 ktoe compared with 2014.

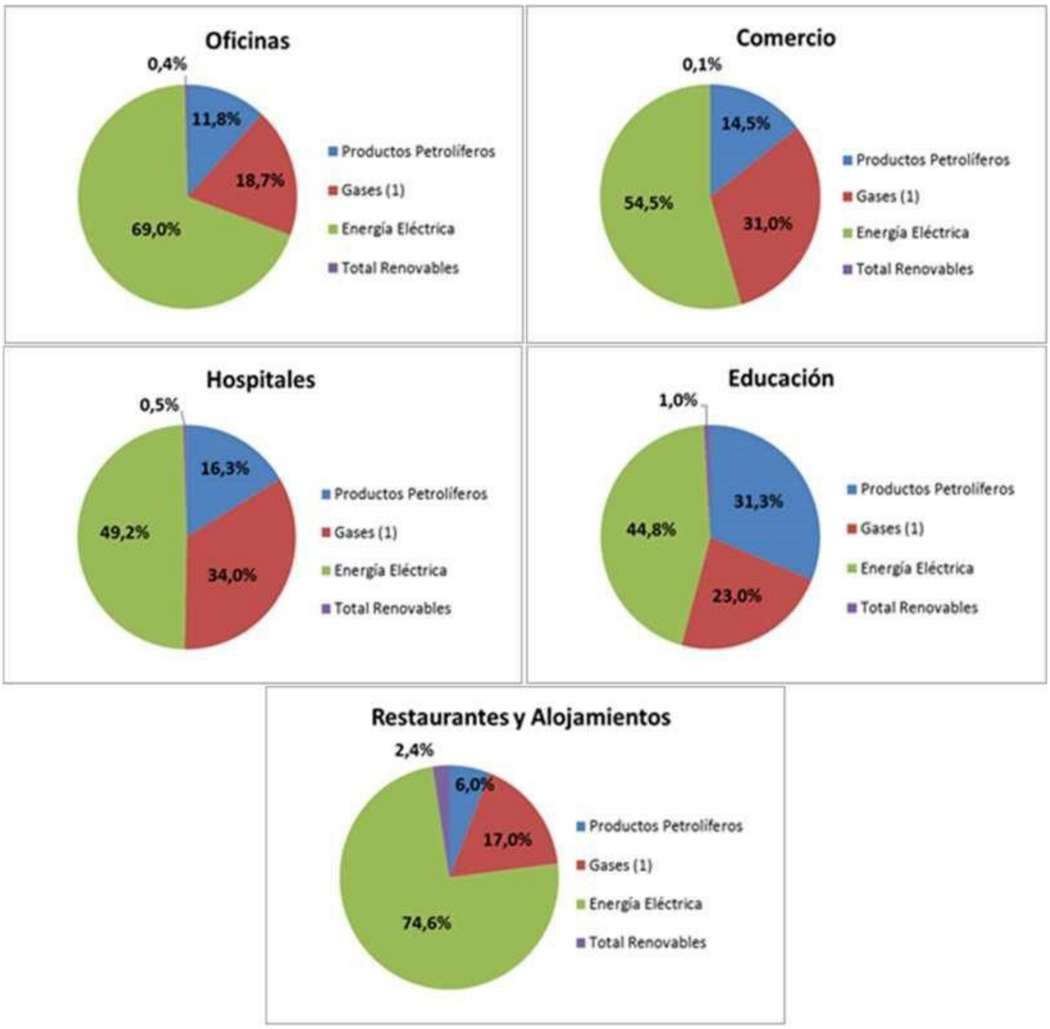
In offices, which account for a similar level of consumption to trade (3 241 ktoe, or 32%), the largest energy source used is by far electricity, which accounts for 68%, followed by gas at 19% and petroleum products at 12%. Consumption in this sector has also remained stable compared with 2010, although there has been an increase of 432 ktoe compared with 2014.

In hospitals, the greatest consumption remains electricity (49%), followed by gas (34%) and petroleum products (16%). Consumption in this sector has increased compared with both 2010 and 2014 by 245 ktoe (almost 40%).

In restaurants and accommodation, electricity accounts for the majority of consumption, at 74%, followed by gas (17%) and petroleum products (6%). Consumption in this sector has fallen compared with 2010, but has remained practically the same as 2014, increasing by just 4 ktoe.

Finally, consumption in buildings for educational use is more spread out, with electricity accounting for 44%, petroleum products 33% and gas is 23%. The weight of petroleum products stands out in this sector, where it is much higher than that of other branches (roughly double). Consumption in this sector has fallen constantly compared with both 2014 and 2010, with falls of approximately 10% over each period.

Figure 2.27. Graph showing the breakdown of energy sources in each branch of the tertiary building sector (%)



	Offices
	0.4%
	11.8%
	18.7%
	69.0%
	Petroleum Products
	Gases(1)
	Electric Power
	Renewables Total
	Trade
	Hospitals

	Education
	Restaurants and Accommodation

Source: Prepared by the authors based on the Tertiary Sector Consumption Data series (2017). IDAE-MITERD

Overall, some general conclusions can be drawn within this data breakdown:

On the one hand, the general trend shows two clearly distinct phases. Between 2010 and 2014, all consumption fell in all branches, which is directly related to the crisis period in the country and the fall in economic activity, while between 2015 and 2017 this trend reversed, with all consumption increasing, even exceeding the overall consumption figures for 2010.

On the other hand, this increase in consumption is not based on an increase in consumption of renewable sources which remained at insignificant levels of around 2% of total consumption.

Lastly, breaking down the data in Figure 2.24. Graph showing the percentage change in final energy consumption in the tertiary sector by source (%) for the period 2010-2017, the distribution of overall consumption shows different trends for the different energy sources: electricity fell by around 12 points to its current level of 62%, while the fall in petroleum products was just 2 points, to 13%. In conclusion, we can say that gases are the energy source absorbing this difference (given the negligible presence of renewables), increasing by 13 points to their current level of 24%.

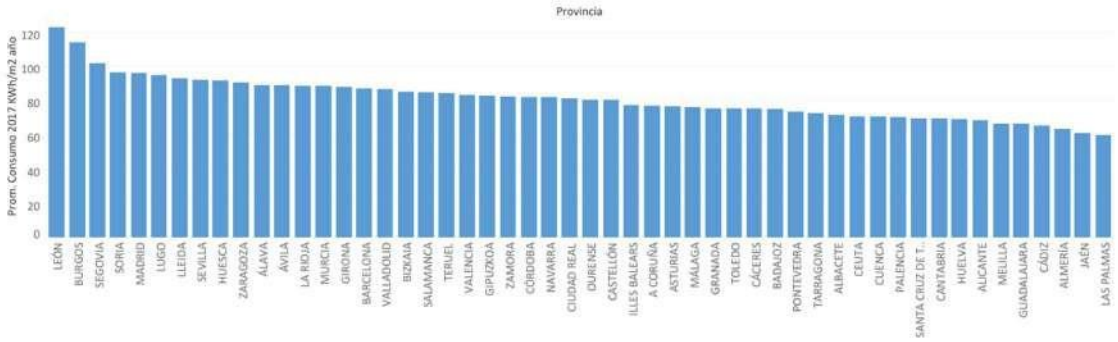
2.5. PUBLIC SECTOR

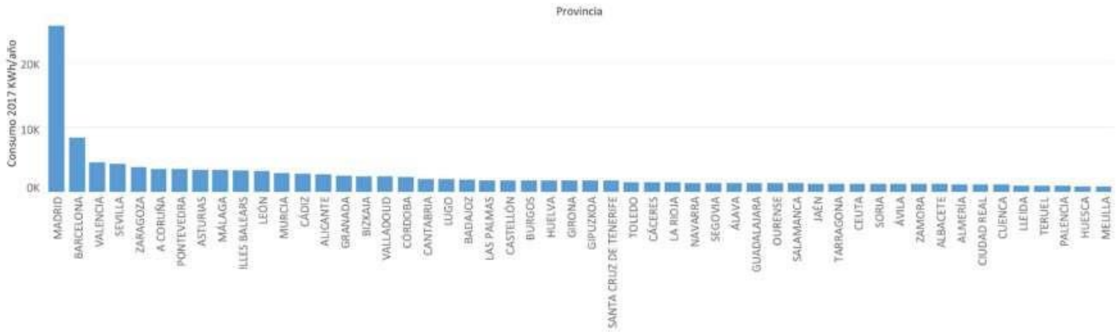
In the same way as in the section assessing the public stock, where the analysis was conducted using the Inventory of Central Government Buildings drawn up by the IDAE - MITERD so as to study the energy consumed by public administration buildings belonging to the Spanish State Administration, the same data source will be used here.

To avoid results that are inconsistent with that analysis, we have excluded from the statistics associated with consumption (with the exception of those in relation to Energy Certifications) buildings with consumption below 30 kWh/m^2 and above 300 kWh/m^2, as we believe these data may be errors or very specific cases that are not comparable to the general volume analysed. We analysed consumption for a total of 1 626 buildings.

The average consumption by floor area varies from 60 kWh/m^2 per year in Las Palmas to 123 kWh/m^2 per year in Leon. Burgos, Leon and Segovia stand out slightly above the rest, primarily because the buildings are situated in climatic zone E1. As regards total consumption, there is clearly a link with the number of buildings, with the figures for Madrid far above those for all other provinces, given that the capital has the highest number of Central Government properties.

Figure 2.28. Average consumption by floor area and total consumption by province (2017)





	Province
	Average consumption 2017 kWh/m2 per year
	120
	100
	80
	60
	40
	20
	0
	LEÓN
	BURGOS
	SEGOVIA
	SORIA
	MADRID
	LUGO
	LLEIDA
	SEVILLE
	HUESCA
	ZARAGOZA
	ÁLAVA
	ÁVILA
	LA RIOJA
	MURCIA
	GIRONA
	BARCELONA
	VALLADOLID
	BIZKAIA
	SALAMANCA
	TERUEL
	VALENCIA
	GIPUZKOA
	ZAMORA
	CÓRDOBA
	NAVARRE
	CIUDAD REAL

	OURENSE
	CASTELLÓN
	BALEARIC ISLANDS
	A CORUÑA
	ASTURIAS
	MALAGA
	GRANADA
	TOLEDO
	CÁCERES
	BADAJOZ
	PONTEVEDRA
	TARRAGONA
	ALBACETE
	CEUTA
	CUENCA
	PALENCIA
	SANTA CRUZ DE TENERIFE
	CANTABRIA
	HUELVA
	ALICANTE
	MELILLA
	GUADALAJARA
	CÁDIZ
	ALMERÍA
	JAÉN
	LAS PALMAS
	Province
	20k
	10k
	0k
	Consumption 2017 kWh/year
	MADRID
	BARCELONA
	VALENCIA
	SEVILLE
	ZARAGOZA
	A CORUÑA
	PONTEVEDRA
	ASTURIAS
	MALAGA
	BALEARIC ISLANDS
	LEÓN
	MURCIA
	CÁDIZ
	ALICANTE
	GRANADA
	BIZKAIA
	VALLADOLID
	CÓRDOBA
	CANTABRIA
	LUGO
	BADAJOZ
	LAS PALMAS
	CASTELLÓN
	BURGOS
	HUELVA
	GIRONA
	GIPUZKOA

	SANTA CRUZ DE TENERIFE
	TOLEDO
	CÁCERES
	LA RIOJA
	NAVARRE
	SEGOVIA
	ÁLAVA
	GUADALAJARA
	OURENSE
	SALAMANCA
	JAÉN
	TARRAGONA
	CEUTA
	SORIA
	ÁVILA
	ZAMORA
	ALBACETE
	ALMERÍA
	CIUDAD REAL
	CUENCA
	LLEIDA
	TERUEL
	PALENCIA
	HUESCA
	MELILLA

Source: PARAE (GBCe) programme based on the 2018 Energy Inventory

Analysis by use

In terms of the data on total consumption, prisons stand out due to their large size and intensity of use, along with data processing centres.

Figure 2.29. Total annual consumption by use (2017)

MAIN USE	CONSUMPTION (kWh/year)
Prison	360 596 704
Offices	291 297 284
Police station	108 204 220
Research centre	62 923 975
Care centre	16 729 620
Data processing centres	11 714 065
Classroom building	5 288 106
Records office	3 592 137
Residence	2 533 059
Barracks	2 340 947
Auditorium	516 551
Workshop	414 902
Museum	265 976
Garage	240 216
Warehouse	209 537
Test track	202 872
Hangar	140 542

Figure 2.30. Annual average per m² and use

MAIN USE	CONSUMPTION BY AREA (kWh/m²/year)
Data processing centres	246.1
Workshop*	156.4
Residence	152.5
Research centre	137.5
Prison	113.4
Records office	92.4
Care centre	88
Classroom building	85.8
Police station	83.4
Offices	78.5
Auditorium*	65.9
Museum*	57.4
Barracks	57.1
Hangar*	44.2
Garage	41.2
Test track	40.4
Warehouse	34.1

* Types with fewer than five buildings, as a result of which they are not considered representative.

Source: PARAE (GBCe) programme based on the 2018 Energy Inventory

Energy certifications

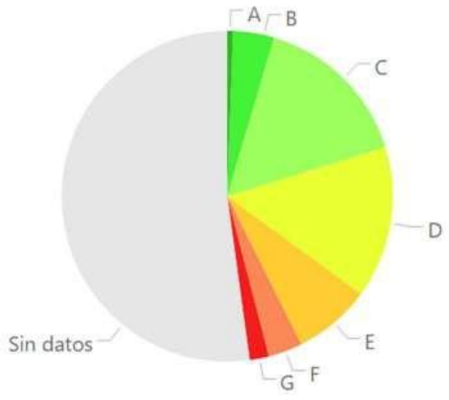
We analysed the energy certificates for all the buildings in the inventory. For this, we used the information from the latest inventory (2019).

From this information, we can conclude that less than half of buildings had an energy certificate at the end of 2018. Among the buildings that had a certificate, less than 5% have an A or B rating and a little more than 15% have a C rating.

Figure 2.31. Energy Performance Certificates (EPC) in line with primary energy consumption ratings (2018)

	ENERGY CERTIFICATE	PERCENTAGE OF TOTAL
Total	1055	49.62%
A	13	0.61%
B	89	4.19%
C	346	16.27%
D	321	15.10%
E	169	7.95%
F	76	3.57%
G	41	1.93%
None	1071	50.38%

Figure 2.32. Energy Performance Certificates (EPC) in line with primary energy consumption ratings (2018)



	No data
	A
	B
	C
	D
	E
	F
	G

Source: PARAE (GBCe) programme based on the 2019 Energy Inventory.

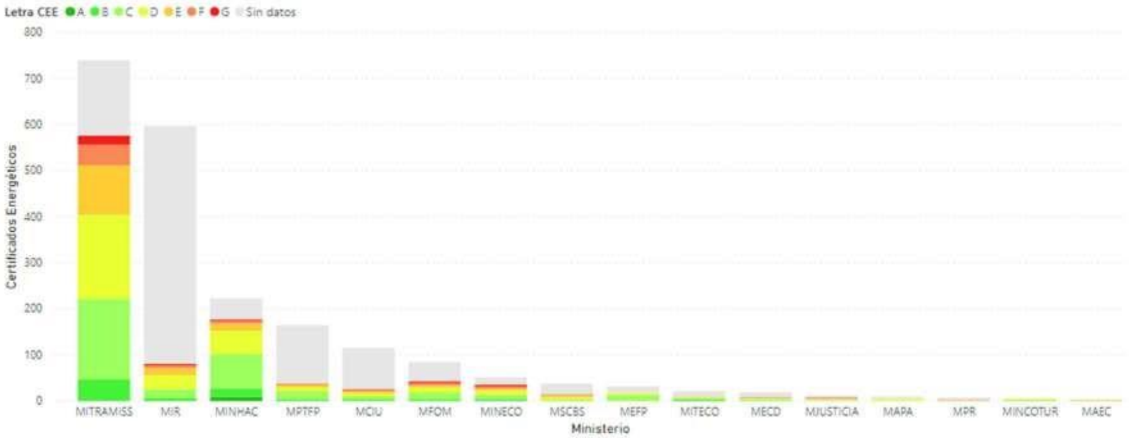
Figure 2.33. Energy Performance Certificates (EPC) by Ministry, in line with primary energy consumption ratings (2018).

	Total	%	Ministry	Ministry of Industry, Trade	Ministry of Foreign Affairs and	Ministry of Finance (MINHAC)	Ministry of Labour, Migration and	Ministry of Economy	Ministry of Justice (MJUSTICIA)	Ministry of Education and	Ministry of Development	Ministry of Agriculture,	Ministry of Education, Culture	Ministry for the Ecological	Ministry of Health, Consumer Affairs	Ministry of the Presidency (MPR)	Ministry of Territorial Policy	Ministry of Science and Innovation	Ministry of the Interior (MIR)
Buildings with EC	1050			5	3	178	577	36	8	18	43	5	9	10	15	3	38	26	81
%		49.50%		100%	100%	80%	78%	69%	67%	56%	51%	50%	47%	45%	39%	38%	23%	23%	14%
A	13	0.61%				9	2	2											
B	89	4.20%				18	46	3		1	3		1	4			4	3	6
C	343	16.17%		3		75	174	9	2	12	16	1	3	2	3		18	8	20
D	319	15.04%		2	2	50	182	9	2	5	11	4	2	1	6	1	8	6	30
E	169	7.97%				16	108	4	1		4		1	3	3	1	6	6	16
F	76	3.58%			1	7	45	5	2		5		1		2	1	1		6
G	41	1.93%				3	20	4	1		4		1		1		1	3	3

No data	1071	50.50%			45	163	16	4	14	42	5	10	12	23	5	127	89	516

Source: PARAE (GBCe) programme based on the 2019 Energy Inventory

Figure 2.34. Energy Performance Certificates by Ministry and primary energy consumption rating



	EPC rating
	A
	B
	C
	D
	E
	F
	G
	No data
	Energy Certificates
	800
	0
	Ministry of Labour, Migration and Social Security (MITRAMISS)
	Ministry of the Interior (MIR)
	Ministry of Finance (MINHAC)
	Ministry of Territorial Policy and Civil Service (MPTFP)
	Ministry of Science and Innovation (MCIU)
	Ministry of Development (MFOM)
	Ministry of Economy (MINECO)
	Ministry of Health, Consumer Affairs and Social Welfare (MSCBS)
	Ministry of Education and Vocational Training (MEFP)
	Ministry for the Ecological Transition and Demographic Challenge (MITECO)
	Ministry of Economy (MECO)
	Ministry of Justice (MJUSTICIA)
	Ministry of Agriculture, Fisheries and Food (MAPA)
	Ministry of the Presidency (MPR)
	Ministry of Industry, Trade and Tourism (MINCOTUR)
	Ministry of Foreign Affairs and Cooperation (MAEC)

	Ministry

Source: PARAE (GBCe) programme based on the 2019 Energy Inventory.

CHAPTER 3. ASSESSMENT: BUILDING RENOVATION IN SPAIN AND ITS TREND FROM 2014-2020.

3.1. ANALYSIS OF THE BUILDING RENOVATION TREND IN SPAIN.

The statistics from the works management approvals of the Technical Architects Associations (‘Building Works’) provided by the Ministry of Transport, Mobility and the Urban Agenda give very meaningful information on the trend in building renovation activity in Spain.

By analysing the general trend data on the number of renovation approvals, the number of buildings and dwellings subject to renovation works and the works implementation budget invested in those renovation works, we can see that there was significant growth in renovation activity between 2017 and 2019.

Specifically, the number of works management approvals for renovation works rose by 10.1% between 2017 and 2019. For its part, the number of buildings used for dwelling that underwent refurbishment or restoration rose from 25 996 in 2017 to 28 364 in 2019, which translates into a 9.1% increase. Conversely, we can see that the number of buildings intended for other uses that underwent renovation and restoration grew more slowly, from 6 317 in 2017 to 6 454 in 2019.

Furthermore, if we analyse the investment in renovation works, the increase is very significant. The implementation budget for the renovation works approved each year grew by 35.6% between 2017 and 2019, reaching 4 213 300 000 euro in the last year; this also included refurbishment and restoration works, extension and refurbishment of premises, and enhancement and reinforcement of buildings. Specifically, the implementation budget for refurbishment or restoration works in residential buildings reached 1 437 000 000 euro in 2019, which is a 25.2% increase compared with the figure for 2017 (1 148 200 000 euro).

Figure 3.1. Works management approvals: building refurbishment and/or restoration. Number of buildings and implementation budget by main purpose.

AÑO	TOTAL	OBRA NUEVA	A AMPLIAR	A REFORMAR Y/O RESTAURAR
2015	76.542	49.695	1.434	25.413
2016	92.135	64.038	2.003	26.094
2017	109.047	80.786	2.237	26.024
2018	128.799	100.733	2.049	26.017
2019	137.376	106.266	2.577	28.533

	YEAR
	2015
	TOTAL
	76 542
	109 047
	NEW BUILDING
	49 695
	100 733
	106 266
	EXTENSION
	1 434
	REFURBISHMENT AND/OR RESTORATION
	25 413

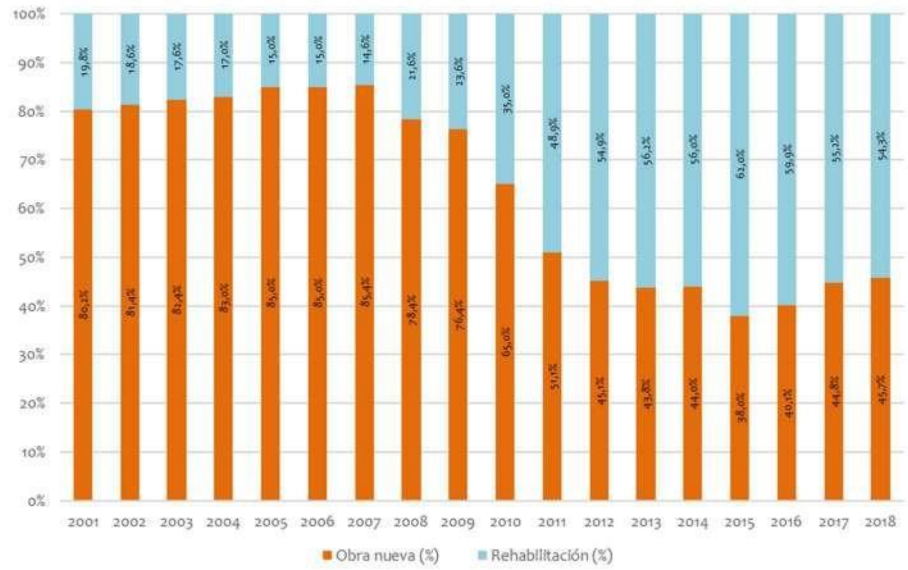
Source: Ministry of Transport, Mobility and the Urban Agenda. Building Works Series (Approvals from Master Builders and Technical Architects Associations).

This all provides a meaningful balance across the three years of the 2017-2019 period analysed: approvals were granted for refurbishment or restoration works on a total of 100 093 buildings, 80 323 of which intended for dwelling and 19 770 intended for other uses, amounting to a total investment (according to implementation budget data) of 7 261 000 000 euro (3 798 000 000 euro in residential buildings and 3 462 000 000 euro in buildings for other uses). This gives an average budget by building for 2019 of 47 286 euro for residential buildings and 175 134 euro for buildings for other uses.

According to the latest data from the Construction Industry Structure Survey[18], renovation activity achieved annual turnover in 2018 of 29 591 400 000 euro, which constitutes a 9.7% increase compared with the previous year, surpassing the turnover for new building for the third consecutive year. Therefore, renovation accounted for 55.7% of total turnover in the building sector, a rate significantly higher than that of 2007 (when it stood at 18.2%).

In terms of residential building, the graph below shows that, from 2012 onwards, renovation activity exceeded new construction in terms of turnover, achieving a 54.3% share in 2018.

Figure 3.2. Trend in residential building turnover: ratios between new building and renovation.



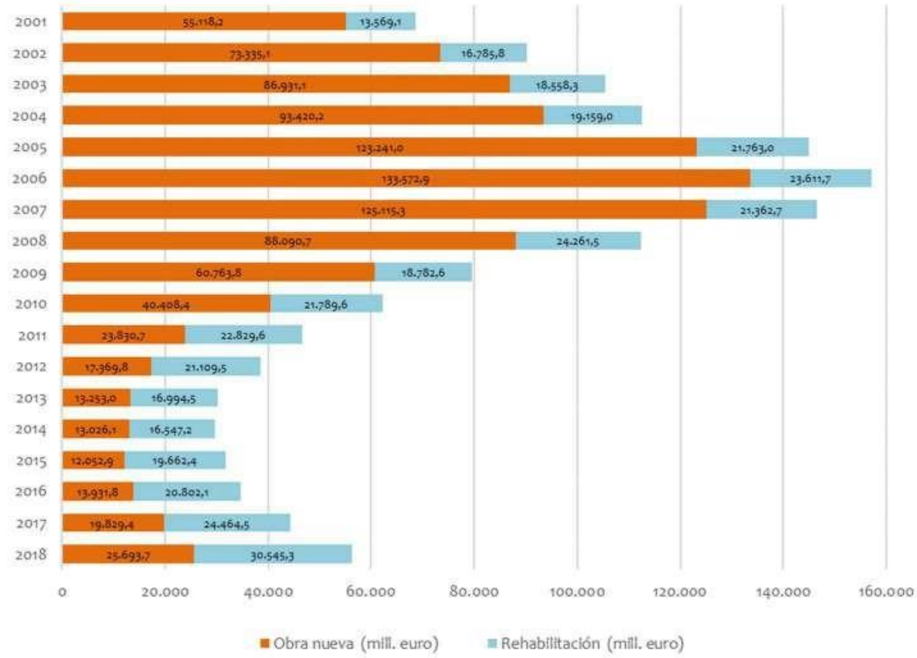
	100%
	19.8%
	80.2%
	New building (%)
	Renovation (%)

Source: Ministry of Transport, Mobility and the Urban Agenda. Construction Industry Structure Survey.

Likewise, if we analyse the total turnover, we can see that, in 2018, residential renovation activity reached an all-time high, at 30 545 300 000 euro, while new building achieved turnover of 25 693 700 000 euro, which, despite being the highest figure for the last eight years, constituted less than a fifth of the turnover achieved in 2006.

[18] Published by the Ministry of Transport, Mobility and the Urban Agenda.

Figure 3.3. Trend in residential building turnover: new building and renovation (please note: figures given in millions of euro).



	2001
	55 118.2
	20 000
	New building (figures in millions of euro)
	Renovation (figures in millions of euro)

Source: Ministry of Transport, Mobility and the Urban Agenda. Construction Industry Structure Survey.

In terms of the volumes of housing approvals, the total number of approvals to renovate dwellings across the 2017-2019 period accounted for over 30.4% of the total, including extensions, refurbishments and restorations, although we must take into account the fact that the recovery of new building approvals has had a significant impact on this percentage in recent years: in 2019, there were 106 266 dwellings in approvals for new building, 31.5% more than in 2017 (80 786). As the table below shows, the figures for dwellings subject to renovation have increased significantly in recent years.

Table 3.4. Works management approvals. new building, extension and/or refurbishment of buildings. Number of dwellings by type of works.

YEAR	TOTAL	NEW BUILDING	EXTENSION	REFURBISHMENT AND/OR RESTORATION
2015	76 542	49 695	1 434	25 413
2016	92 135	64 038	2 003	26 094
2017	109 047	80 786	2 237	26 024
2018	128 799	100 733	2 049	26 017
2019	137 376	106 266	2 577	28 533

	YEAR

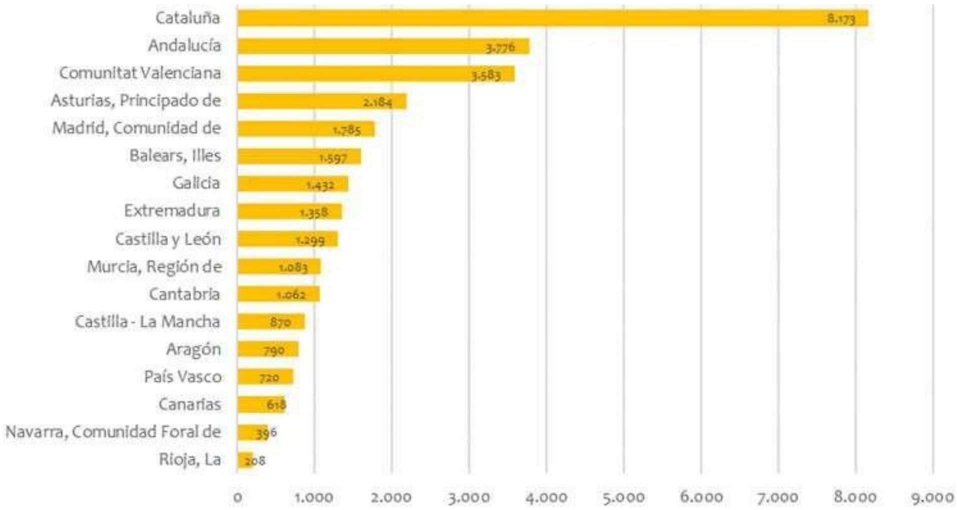
	2015
	TOTAL
	76 542
	109 047
	NEW BUILDING
	49 695
	100 733
	106 266
	EXTENSION
	1 434
	REFURBISHMENT AND/OR RESTORATION
	25 413

Source: Ministry of Transport, Mobility and the Urban Agenda. Building Works Series. (Approvals from Master Builders and Technical Architects Associations).

Regional distribution by Autonomous Community.

The latest data available (2019) show very unequal performance of this activity in the various Autonomous Communities, in terms of the number residential buildings subject to renovation, including extension, refurbishment or restoration works, according to the information from works management approvals. These figures show the highest levels in Catalonia, with 8 173 residential buildings for renovation, followed by Andalusia, with 3 776.

Figure 3.5 Number of residential buildings for renovation by use per Autonomous Community in 2019.

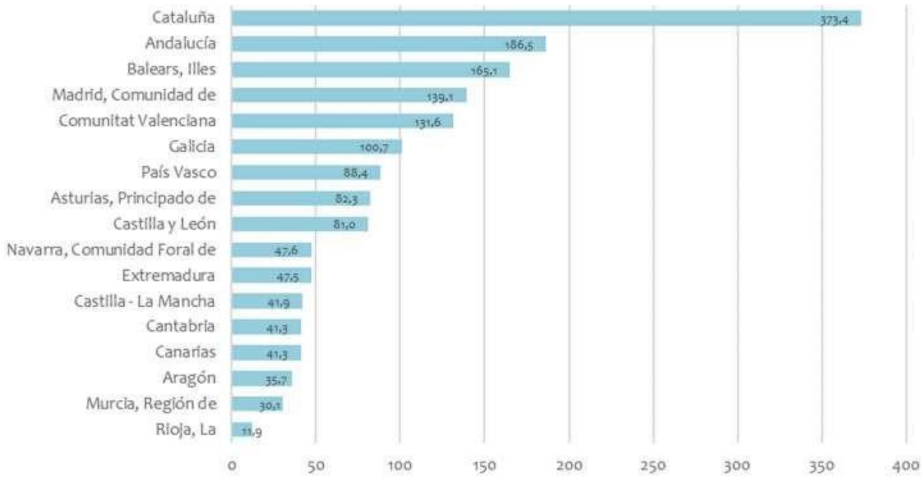


	Catalonia
	Andalusia
	Valencia
	Asturias
	Madrid
	Balearic Islands
	Galicia
	Extremadura
	Castile and Leon
	Murcia
	Cantabria
	Castile-La Mancha
	Aragon
	Basque Country
	Canary Islands
	Navarre
	Rioja
	1 000
	8 173

Source: Ministry of Transport, Mobility and the Urban Agenda. Building Works Series (Approvals from Master Builders and Technical Architects Associations)

If we analyse the investment in residential renovation works according to the information given in works management approvals, we can again see wide regional disparity. As the graph below shows, Catalonia once again stands out, with 373.4 million euro, followed by Andalusia, with 186.5 million euro in implementation budget.

Figure 3.6. Implementation budget for residential renovation by Autonomous Community in 2019 (millions of euro).

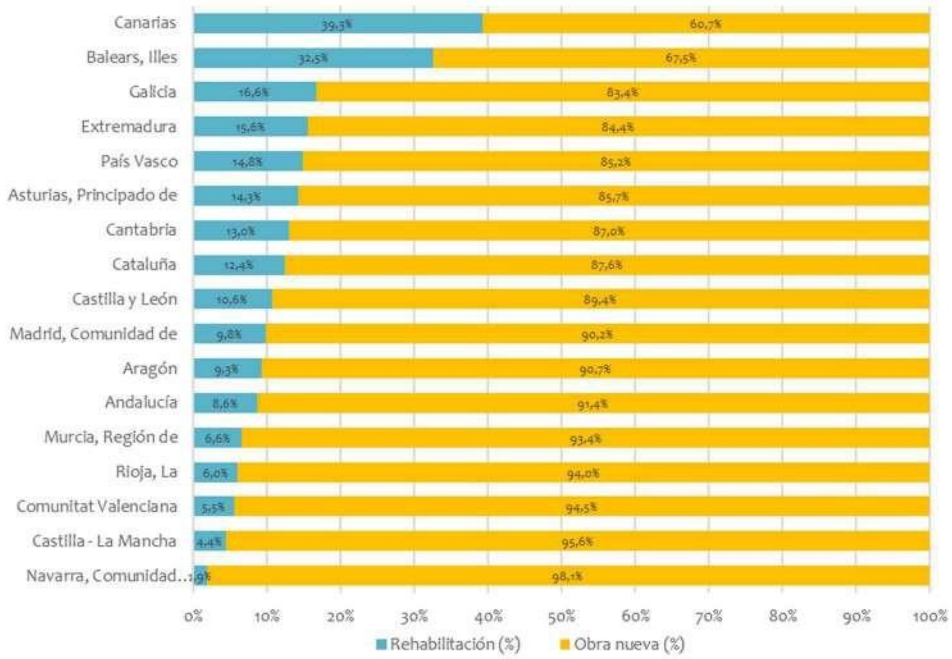


	Catalonia
	Andalusia
	Balearic Islands
	Madrid
	Valencia
	Galicia
	Basque Country
	Asturias
	Castile and Leon
	Navarre
	Extremadura
	Castile-La Mancha
	Cantabria
	Canary Islands
	Aragon
	Murcia
	Rioja
	373.4

Source: Ministry of Transport, Mobility and the Urban Agenda. Building Works Series (Approvals from Master Builders and Technical Architects Associations).

Finally, analysing the available information (2018) in the statistics on municipal building permits provided by the Ministry of Transport, Mobility and the Urban Agenda shows that the weight of residential renovation in the building sector as a whole is very different between the Autonomous Communities. The following graph shows that renovation has a higher weight in the Balearic and Canary Islands, with percentages above 30% in both cases.

Figure 3.7 Percentage of dwellings according to permits broken down by Autonomous Community in 2018: renovation and new building.



	Canary Islands
	Balearic Islands
	Galicia
	Extremadura
	Basque Country
	Asturias
	Cantabria
	Catalonia
	Castile and Leon
	Madrid
	Aragon
	Andalusia
	Murcia
	Rioja
	Valencia
	Castile-La Mancha
	Navarre
	Renovation (%)
	New building (%)
	39.7%
	0%
	50%

Source: Ministry of Transport, Mobility and the Urban Agenda. Statistics on municipal building permits.

Comparison with Europe.

Spain has experienced very positive performance in terms of renovation in recent years (the number of works management approvals for renovation works increased by 10.1% between 2017 in 2019), but there is still work to do to bring the sector closer to the European average. According to data from the European Commission[19], the figures for renovation of the residential stock in Spain are still low compared with other countries in the EU:

[19]Source: European Commission (2016). https://ec.europa.eu/energy/en/eu-buildings-factsheets

as at 2014 in Spain, approximately 0.8% of residential buildings were undergoing deep renovation each year, compared with 1.82% in Austria, 1.75% in France and 1.49% in Germany.

3.2. TERTIARY SECTOR.

In relation to the features that characterised the trend in buildings for tertiary use, an approximation can be obtained based on the buildings for commercial use (1.3 million according to the land register database), leisure/hospitality use (over 200 000 buildings) and office use (over 300 000 buildings).

As the table below shows, there is significant variation between these three uses when compared against the variation in the total number of buildings. In the case of buildings used as offices, there was a 40% rise over the 2006-2019 period, with approximately 86 000 new buildings used for this purpose. Furthermore, this increase was above the average both for the 2006-2019 period and the 2017-2019 period.

In relation to buildings for commercial use, the variation was also significant, with a 16.5% increase between 2006 and 2019. Nevertheless, this is below the average increase in the number of buildings in the same period. In any case, an can be seen in the final period (2017-2019), both in commercial use and in buildings intended for leisure/hospitality, with the number of buildings increasing at more than double the average rate for buildings over that period.

Figure 3.8. Variation in the number of buildings per period

	2006-2017 variation	2017-2019 variation	2006-2019 variation
Commercial	14.4%	1.9%	16.5%
Leisure/Hospitality	1.1%	5.5%	6.7%
Offices	36.6%	2.5%	40.0%
Total buildings	21.6%	0.8%	22.7%

Source: Directorate-General for the Land Register and authors' own work.

The analysis of the number of building entries in the land register building database for the three types of use mentioned based on the status of the owner is also significant. As the table below shows, the percentage of legal entities is very high in the case of buildings used as offices, representing 76.2% of database entries in the 2008-2018 period, much higher than the percentage of entries by legal entities for all buildings, at 52.1%.

In any case, the table shows that, for the three uses analysed, the proportion of building entries by legal entities is higher in the case of buildings for leisure/hospitality (65.3%) and for commercial use (54.0%) than the proportion of entries for all uses. Commercial use has the highest percentage for entries by natural persons, at 43.2%.

Figure 3.9. Entries of properties by status of owner.

	2008-2018 total	% Natural Persons	% Legal Entities	% Other
Commercial	176 817	43.2%	54.0%	2.9%
Leisure/Hospitality	27 710	29.2%	65.3%	5.5%
Offices	64 142	20.1%	76.2%	3.8%
Total buildings	7 665 373	41.8%	52.1%	6.1%

Source: Directorate-General for the Land Register and authors' own work.

Finally, if we analyse buildings used for the three most important tertiary purposes (commercial, leisure/hospitality, and offices) on the basis of municipality size, we can see from the table below but office-use buildings are concentrated very considerably in the larger municipalities. For example, the 49 municipalities with over 100 000 urban properties (urban units) according to the land register database account for 54.4% of properties for office use, far greater than the proportion of properties overall situated in this group of municipalities (32.6%). On the other hand, we can see that the 7 350 municipalities with fewer than 25 000 urban properties account for just 20.3% of buildings for office use. A similar although somewhat less pronounced situation also arises in the case of buildings for commercial use, 45.2% of which are concentrated in municipalities with over 100 000 urban properties.

Conversely, in the case of leisure/hospitality use, the situation is very different as the large municipalities account just 14.7% of buildings for this purpose, which are primarily concentrated in the 203 medium-sized municipalities (between 25 000 and 100 000 urban properties), with 46.8% of the total.

Figure 3.10. Percentage of properties for the main tertiary uses, by municipality size.

Municipalities by number of urban properties	Number of municipalities	Commercial	Leisure	Offices	Total buildings
More than 100 000	49	45.2%	14.7%	54.4%	32.6%
Between 25 000 and 100 000 urban units	203	28.0%	46.8%	25.3%	24.0%
Fewer than 25 000	7 358	26.8%	38.5%	20.3%	43.4%

Source: Directorate-General for the Land Register and authors' own work.

In terms of the growth dynamic in the number of properties for the three uses mentioned above, broken down by municipality size, the following table shows that growth was particularly strong for buildings intended for leisure/hospitality use in the 49 largest municipalities, growing by 27.5% in the 2017-2019 period. In any event, as was shown in the tables above, this table also shows that buildings intended for commercial, leisure/hospitality and office use grew at a higher rate than the growth dynamics for all buildings in the three municipality groups, thus forming a very general trend.

Figure 3.11. 2017-2019 variation in properties for the main tertiary uses, by municipality size.

Municipalities by number of urban properties	Number of municipalities	Commercial	Leisure	Offices	Total buildings
More than 100 000	49	2.0%	27.5%	2.0%	0.8%
Between 25 000 and 100 000 urban units	203	1.5%	1.7%	2.7%	0.7%
Fewer than 25 000	7 358	2.1%	3.5%	3.7%	1.0%

Source: Directorate-General for the Land Register and authors' own work.

In terms of the volume of renovation activity in non-residential uses, the latest Construction Sector Structure Survey (2018) showed a total of 14 947 900 000 euro, which is a 10.2% increase compared with the figure for the previous year (13 563 200 000 euro).

If we analyse the information on works management approvals provided by the Ministry of Transport, Mobility and the Urban Agenda, we can also see a very considerable increase in the renovation of non-residential buildings (including refurbishment and/or restoration activity), which reached an implementation budget of 1 351 600 000 euro in 2019, a 26.7% increase compared with the figure for the previous year (1 066 900 000 euro).

Finally, please note that the renovation of the public building stock will be addressed in chapter 4 on the follow-up on previous strategies and measures.

CHAPTER 4. ASSESSMENT: FOLLOW UP ON PREVIOUS STRATEGIES AND MEASURES.

Below, we will provide an assessment of the follow-up on the 2017 ERESEE, using the same order of measures as shown in that strategy, grouped into structuring areas.

At the end, we will also include the follow-up on the obligation laid down in Article 5 of Directive 2012/27/EU relating to energy efficiency in the buildings of public authorities.

4.1. STRUCTURING AREA (SECTORAL, VERTICAL AND HORIZONTAL COORDINATION).

The main aim of this area is to develop and promote the ERESEE at national and regional level, arranging the necessary coordination as follows: vertically, between the various administrations (State, Autonomous Community, municipalities); sectorally, between the various ministerial departments involved; and horizontally, taking into account the key players in the renovation sector and bringing together other existing initiatives. The following actions have been carried out for this purpose:

- Creation of an interministerial working group led by MITMA and composed of the ministerial departments and corresponding bodies (IDAE, ICO, INE) with competence in this area, with the dual aim of updating the ERESEE and of promoting renovation and energy efficiency in the building sector.
- Permanent interministerial coordination at technical level to ensure alignment between the PNIEC, the Decarbonisation Strategy and the ERESEE.
- Implementation of a public participation process for the development of the 2020 ERESEE, as the constituent basis for a future permanent dialogue platform at national level, bringing together the key players in the Spanish renovation sector, with thematic working groups.

BOX 1. PUBLIC PARTICIPATION PROCESS TO UPDATE THE ERESEE.

The public participation process to review the 2020 ERESEE was led by the Ministry of Transport, Mobility and the Urban Agenda (MITMA), the coordinator for drafting the strategy, and took place between September and December 2019, with GBCe acting as session coordinator and facilitator.

The process used the working methodology developed as part of the European BUILD UPON project, also coordinated by GBCe, and aimed to coordinate and support the drafting of the revisions to the 2017 Long-Term Renovation Strategies in 13 European countries. The starting point of this process was the results already obtained by that project.

Firstly, the actors involved in renovation in Spain were identified in a map of actors, and the resulting knowledge and initiatives that could enhance the strategy revision were set out.

Subsequently, a debate and collective design process was launched through a series of dynamic discussion roundtables in which all participants could share and compare their opinions. Six sessions were held on the topics identified as being key to the success of the strategy and the final results presentation session took place as part of the COP25.

In total, more than 200 agents representing the entire renovation value chain participated in these debates, which were also attended by representatives of the public authorities involved in drafting and implementing the strategy.

This process went beyond simply collecting opinions from civil organisations and served as a meeting point for the various renovation actors, with a view to seeking joint solutions and creating a dialogue community, which offered to continue working to facilitate the implementation of the strategy.

In this way, a dual objective was achieved: gathering the knowledge and opinion of the sector so as to review the strategy and boosting the synergies between the various actors involved so as to improve collaboration. All this took place with the ultimate objective of reviewing, improving and adapting the strategy to the reality of the Spanish building stock.

The results obtained and suggestions made as part of this process were compiled into the Observations and Suggestions Document and were submitted to the Ministry of Transport, Mobility and the Urban Agenda for consideration in the Strategy.

The participation process and the methodology used are described in detail in the Public participation process report and the rest of the resources generated (video summarising the sessions, map of actors, map of initiatives, etc.) have been published on the GBCe website: https://gbce.es/eresee-2020/

	PROJECT LAUNCH
	PREPARATION FOR THE SESSIONS
	11-OCT OPENING SESSION
	24-OCT THE ENERGY VECTOR IN THE BUILDING STOCK
	30-OCT COMMUNICATION, UPSKILLING AND PROFESSIONALISATION
	DRAFTING OF CONCLUSIONS
	18-OCT FUNDING AND BUSINESS MODEL
	28-OCT MUNICIPAL COUNCILS AND RENOVATION MANAGEMENT
	10-DEC PRESENTATION OF CONCLUSIONS

- Based on the new data characterising the residential stock (2018 Continuous Household Survey) and the SPAHOUSEC energy consumption data and those used to draft the PNIEC, the calculations on the breakdown of energy consumption at regional level in Spain were reworked, to form a basis for drafting the 2020 ERESEE.

- The following additional work was also conducted to update the 2020 ERESEE[20]:

[20] Accessible at: https://www.mitma.gob.es/el-ministerio/planes-estrategicos/estrategia-a-largo-plazo-para-la-rehabilitacion-energetica-en-el-sector-de-la-edificacion-en-espana

(01) Segmentation into type clusters and geometric characterisation of the residential housing stock in Spain

(02) Alignment with residential energy needs for heating in Spain

(03) Hypothesis on the distribution of residential energy consumption for heating in Spain 2020

(04) Outlook and future development of air conditioning and DHW systems in residential buildings

(05) Characterisation of the type clusters in terms of construction features

(06) Solar thermal and photovoltaic energy generation potential in Spanish residential buildings in their urban setting

(07) Macroeconomic impact and benefits of renovation

(08) Recent innovative practices in terms of renovation in Spain

(09) Outlook and future development of heating and cooling and DHW systems in tertiary buildings

(10) Report on types, consumption, improvement initiatives and potential savings in the tertiary sector building stock

4.1.1. Other initiatives to coordinate dialogue between agents within the sector at national level.

As a continuation of the European BUILD UPON project and once again with participation from various European Green Building Councils (including Spain's, GBC España - GBCe), a new project, BUILD UPON 2, was launched with the intention of addressing one of the main barriers preventing suitable public management and the subsequent improvement of energy renovation interventions: the lack of a suitable and widely shared Impact Monitoring Framework. The aim of the framework is to explore and find meaningful and achievable common indicators, firstly to measure and then to develop strategies at the various levels, with local level being the most sought after. Both in Spain and in the other countries, the project has a Monitoring Committee made up of national experts and experts from cities following the project (Valladolid, Zaragoza).

Furthermore, the efforts being made in some Autonomous Communities to create or strengthen a cluster of agents and institutions to promote renovation are also worthy of note. For example, the Regional Government of the Autonomous Community of Castile and Leon maintains close collaboration with the Castile and Leon Construction Institute (Instituto de la Construcción de Castilla y León, ICCL), the Construction Labour Foundation (Fundación laboral de la Construcción) and the AEICE Efficient Housing Cluster (Clúster AEICE Hábitat Eficiente).

BOX 2. Collaboration between the Autonomous Community of Castile and Leon and other agents to promote renovation and sustainable building.

The Castile and Leon Construction Institute (ICCL) is a private non-profit scientific-cultural foundation that aims to contribute to all technical aspects involved in the construction process, whether civil engineering, building or renovation.

Through this foundation, the administration of the Autonomous Community maintains a fluid relationship with universities and professional associations in the building sector, which has resulted in significant advances in training in the area of renovation and in the application of the Technical Building Inspection (ITE) within Castile and Leon.

The Construction Labour Foundation is a private non-profit entity, with origins in the General Agreement on the Building Sector, which arose at the initiative of the most representative organisations in the sector. Since 1992, the Foundation has been working to offer companies and employees the best training and resources in all areas of construction, including prevention of workplace risks, sustainability and innovation, and always promotes best practices.

Various training initiatives have been conducted with the Foundation, with the aim of advancing knowledge of the various renovation interventions and the management of the new BIM methodology.

For its part, the AEICE Cluster is a private non-profit association whose mission is to develop the competitiveness of companies in the housing sector through innovation, collaboration, training, internationalisation and communication.

In this way, dialogue and collaboration with all these actors enables the cluster to understand first-hand the needs of the housing sector so as to develop a more sustainable and healthy construction sector for citizens.

4.2. INFORMATION AND SOCIETY AREA.

The aim of this area is to foster a cultural change among the public, arousing greater social awareness of energy saving, building maintenance and renovation, as well as the dissemination, at a more technical level, of any pioneering or innovative experiences in terms of renovation and urban regeneration, for the purpose of fostering their exchange. Various initiatives have been carried out within these two main strands:

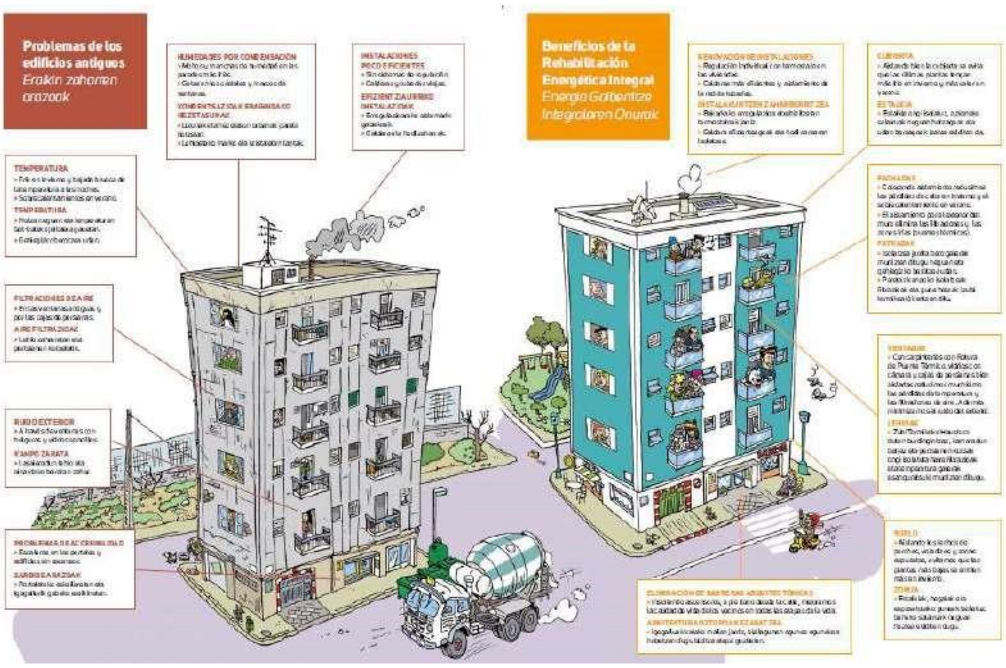
4.2.1. Public information and dissemination initiatives.

Work has continued on the public information and dissemination campaigns in relation to the funding measures in force during this period.

BOX 3 EXAMPLES OF INFORMATIVE GUIDES: NAVARRE.

The Government of Navarre submitted various thematic guides[21], published by Nasuvinsa as part of the European SustaiNAVility project[22], aimed at informing and training consumers and energy management company staff regarding the opportunities and benefits of the measures for achieving energy efficiency in buildings, the use of renewables or self-consumption.

These guides, which Nasuvinsa tasked to the company Kisar and which are available on the project website, are: Integral Energy Building Rehabilitation Guide, aimed at the public; Energy efficiency guide in residential buildings, for property administrators and residents' associations; Photovoltaic solar energy guide for self-consumption, for people producing and consuming energy; and lastly, the Energy guide in local entities, aimed at local councillors and authorities (council staff). An accompanying booklet on district heating has also been published.



21 https://www.sustainavility.eu/en/home/

22 SustaiNAVility comprises a total of eight work packages, including: Efficient management of energy in municipalities, Total energy renovation in public buildings, Full energy modernisation of private buildings, Efficient management of energy in industry.
https://www.sustainavility.eu/en/home/

4.2.2. knowledge exchange and disseminate initiatives at technical level.

The following should be highlighted:

- Numerous technical training and dissemination sessions were held, as were informative sessions aimed primarily at technical staff, as well as users, housing managers and residents' associations. Some of these sessions were led by public authorities[23], some by the professional sectors (Master Builders and Technical Architects Associations, etc.[24]) and others by private businesses (such as the ANERR (National Association of Renovation and Refurbishment Companies) Renovation Forum[25]) or universities[26].

- IDAE guides.

IDAE has published a range of guides that can be downloaded at: https://www.idae.es/en/publicaciones.

- The drafting and dissemination of Explanatory guides has continued.

	**BOX 4. EXPLANATORY GUIDE EXAMPLE: 'Express renovation for vulnerable homes. Low-cost solutions'.** *Authors: Margarita de Luxán García De Diego, Carmen Sánchez-Guevara Sánchez, Emilia Román López, María del Mar Barbero Barrera, Gloria Gómez Muñoz.* *The objective of this study, promoted by the Naturgy Foundation, is to make progress towards possible improvements in the conditions of thermal well-being and in the evaluation of energy consumption in the heating and cooling of homes inhabited by families in situations of energy poverty or vulnerability in Spain, as well as to provide low-cost solutions, which can be applied quickly and simply, and that improve the comfort conditions of these people.* https://www.fundacionnaturgy.org/en/product/re-habilitacion-expres-hogares-vulnerables-soluciones-coste/

	Express renovation for vulnerable homes

[23] For example, the ITE+3R conferences (Burgos 2018 and León 2019) in Castile and Leon, or the 2017 'Urban regeneration: Land management and recovery of degraded areas' conference in the Basque Country.
The AVS association of technical staff working in Public Housing and Land Authorities created a 3R group (Getafe, Nov. 2018) and held two 'AVS conferences on Urban Renovation, Regeneration and Renewal' http://www.sestaoberri.eus/cita-en-bilbao-ii-congreso-de-avs-sobre-rehabilitacion-regeneracion-y-renovacion-urbana/

[24] For example: Urban Regeneration and Renovation Sessions held by the Official Architects Association of Albacete (26 and 27 April 2018); Sessions on Tools for the Comprehensive Renovation of Urban Fabrics held by the Official Architects Association of Cádiz (18 May 2018); CONTART Conference (Zaragoza, June 2018) held by the Technical Architects Association; Sessions on innovation in energy renovation and urban renewal (COAC and INTEMAC) in Cáceres (Sept 2018); 'RE-URBANISMO' [re-urbanism] course by the Architects' Association of Cantabria (9 sessions between 8 Oct and 10 Dec 2019: https://www.coacan.es/profesion/actividad/formacion/formacion-coacan/9524-iii-curso-de-urbanismo-re-urbanismo), etc.

[25] https://www.anerr.es/category/campus-de-la-rehabilitacion/actividades/foros-de-rehabilitacion/
Also, for example, *Ciudad Sostenible* magazine promoted the *Foro de las Ciudades* cities forum (Madrid 13-15 June 2018).

[26] For example, the *Cátedra Zaragoza Vivienda* partnership for Urban Regeneration Strategies (April 2019): https://catedrazaragozavivienda.wordpress.com/2019/07/01/videos-de-la-vi-jornada-de-la-catedra-zaragoza-viviendasobre-estrategias-locales-de-regeneracion-urbana/

- Various research papers, doctoral theses and reports have been conducted in the field of renovation[27].
- New web portals were set up specifically to disseminate information on renovation, including, in particular, the Observatorio Ciudad 3R observatory, the page 'Ni Un Hogar Sin Energía'[28] or the Construible sustainable building portal[29].

BOX 5. WEBSITE EXAMPLE: 'Observatorio Ciudad 3R'.

The Observatorio Ciudad 3R ([3Rs City Observatory], in which the 3 Rs stand for urban Renovation, Regeneration and Renewal) was created in November 2017 as part of the CONAMA LOCAL conference held in Valencia, sponsored by 13 national entities and various sectors (academic, professional, etc.) and supported by 17 Antennas or Collaborators in each of the 17 Autonomous Communities. It is an open and collaborative project and forms part of the strategic line of work of the ECODES foundation, which aims to contribute to the Sustainable Development Goal (SDG) on 'Sustainable cities and communities'. The webpage compiles and broadcasts News, Events, a Library and Video Library on 3R City subjects together with regulations and standards classified by topic, type of action and administrative area. Its primary objective is to collaborate to establish a culture of assessing public policies and private initiatives in the field of promoting renovation.

http://www.observatoriociudad3r.com/

	Observatorio Ciudad 3R
	RENOVATION, REGENERATION, RENEWAL
	Introduction
	What's happening?

[27] For example: *Informe GTR Ciudades: Por un cambio en las políticas públicas de fomento de la rehabilitación residencial: Los municipios, pieza clave en un marco de cooperación institucional.*
http://www.conama2018.org/download/bancorecursos/C2018/Informe%20GTR%20Ciudades.pdf
Nuevos enfoques en la rehabilitación energética de la vivienda hacia la convergencia europea La vivienda social en Zaragoza, 1939-1979. Belinda López-Mesa (coord.).2018
http://www.observatoriociudad3r.com/biblioteca_category/b1-rehabilitacion-edificatoria/
Informe de evaluación sobre políticas públicas de rehabilitación residencial en España (2013 - 2017). Reflexiones sobre el desafío 2020 / 2030. Published by the Observatorio Ciudad 3R observatory (28 November 2019)
http://www.observatoriociudad3r.com/informes/informe-de-evaluacion-sobre-politicas-publicas-de-rehabilitacion-residencial-en-espana-2013-2017-reflexiones-sobre-el-desafio-2020-2030/
Other reports can be found at: http://www.observatoriociudad3r.com/biblioteca_category/b1-rehabilitacion-edificatoria/

[28] 'Ni Un Hogar Sin Energía' [No home without energy'] is a project run by the Ecology and Development Foundation (Fundación Ecología y Desarrollo, ECODES). ECODES is a non-profit, independent organisation that forms part of the EU Energy Poverty Observatory and works to ensure the wellbeing of all people within the limits of the planet. To that end, it is seeking associates from among the public, civil society organisations, businesses and public authorities to accelerate the transition to a green, inclusive and responsible economy, within a framework of new governance, through innovation and the building of bridges and alliances. It is a line of direct action in the fight against Energy Poverty in Spanish households. Since 2013, it has intervened in over 4 427 households throughout Spain.
https://niunhogarsinenergia.org/

[29] The CONSTRUIBLE site is the main webpage of the Grupo Tecma Red group, which is responsible for numerous initiatives in the building sector, with a particular focus on renovation:
https://www.construible.es/rehabilitacion-edificios
- CASADOMO - All about Smart Buildings
- CONSTRUIBLE - All about Sustainable Building
- ESEFICIENCIA - All about Energy Efficiency
- ESMARTCITY - All About Smart Cities
- SMARTGRIDSINFO - All about Smart Electricity Networks

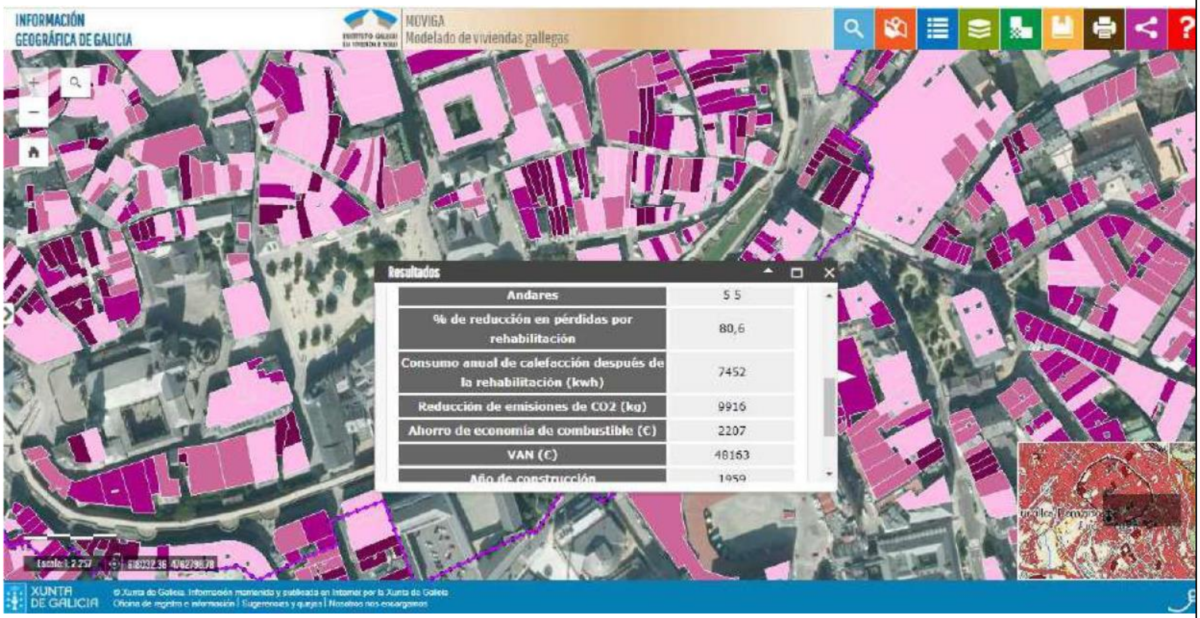
Grupo Tecma Red also organises various annual and biannual conferences on these topics, including, for example, the *Edificios de Consumo de Energía Casi Nulo* conference [nearly zero-energy buildings].

4.2.3. Public tools to simulate renovation consumption, savings and costs.

And lastly, we must highlight the importance of information, both for the authorities themselves for the planning of policies and for technicians and users. Reconciling information on the current building stock situation and on the benefits that energy renovation entails, with the help of the aid available, forms a strong pillar for raising awareness and promoting this type of renovation. Initiatives seeking to provide the public with tools to simulate renovation consumption, savings and costs, such as the MOVIGA example in Galicia, explained below, are of great interest.

BOX 6. MOVIGA DWELLINGS MODEL IN GALICIA.

The Regional Government of Galicia has provided the public with access to a public tool called MOVIGA (model of dwellings in Galicia), which any citizen can use to obtain approximate data on the consumption savings and estimated cost of the energy renovation of any building in Galicia.



Source and link: http://mapas.xunta.gal/visores/moviga/

	GEOGRAPHIC INFORMATION FOR GALICIA
	MOVIGA:
	Model of Galician dwellings
	Results
	Storeys
	% of loss reduction with renovation
	80.6
	Annual heating consumption after renovation (kWh)
	7452
	Reduction in CO2 emissions (kg)
	Fuel savings (€)
	NPV (€)
	REGIONAL GOVERNMENT OF GALICIA

4.3. TECHNICAL, PROFESSIONAL AND BUSINESS AREA.

The aim of this area is to develop the technical (not strictly regulatory) aspects associated with renovation, with particular attention on promoting the existing tools, such as the Building Assessment Report (IEE) and Energy Certification of Buildings.

4.3.1. The Building Assessment Report is an informative tool and catalyst for synergistic energy renovation initiatives.

In Spain, Law 8/2013 introduced the Building Assessment Report (IEE) at national level as a report on conservation status, compliance with basic accessibility conditions and energy efficiency, which is obligatory for collective residential buildings that are over 50 years old. The idea was to convert this into a key component for promoting energy renovation. In Spain, conservation of buildings and compliance with basic accessibility conditions from parts of the legal obligations inherent in ownership, such that owners must carry out the necessary conservation works and make any reasonable adjustments in terms of accessibility that result from the Building Assessment Report. Although energy efficiency improvements are not obligatory, the requirement to have an Energy Performance Certificate (which must include recommendations on voluntary energy efficiency improvements) as an integral part of the Building Assessment Report aims to lead to synergies between obligatory conservation works on facades and roofs and voluntary energy efficiency improvements.

At the end of 2017, Constitutional Court Ruling 143/2017 of 14 December 2017 ruled that a large part of the regulation on the Building Assessment Report in state legislation was unconstitutional. As a result, as of that Ruling, the detailed regulation of the procedure and contents of the Building Assessment Report has been the exclusive responsibility of the Autonomous Communities.

Although the current situation in the different Autonomous Communities is very unequal, various studies[30] have shown that, in the majority of cases (although not all), regional regulations have adopted the basic content laid down in the State legislation at that time.

4.3.2. Improving the Energy Performance Certificate (EPC)31.

The requirements regarding the energy certification of buildings laid down in Directive 2002/91/EC of the European Parliament and of the Council of 16 December 2002 were transposed into Spanish law by means of Royal Decree 47/2007 of 19 January 2007, which approved the basic procedure for the energy performance certification of newly constructed buildings, pending regulation, by means of additional complementary provisions, of the energy performance certification of existing buildings.

The amendment of Directive 2002/91/EC by means of Directive 2010/31/EU of the European Parliament and of the Council of 19 May 2010 on the energy performance of buildings required the amendments introduced by that new Directive to be transposed into Spanish law. In relation to certification, that transposition took place by means of Royal Decree 235/2013 of 5 April 2013, which also incorporated the basic procedure for the energy performance certification of existing buildings and also drew on the experience gained from its application over the five years during which the previous regulation was in force.

Therefore, as of the date of this document, the basic procedure with which the methodology used to calculate the energy performance rating must comply, taking into consideration the factors that have the greatest impact on energy consumption, and the technical and administrative conditions for building energy performance certifications are laid down in the aforementioned Royal Decree 235/2013 of 5 April 2013.

That Royal Decree establishes the obligation to provide the buyers or users of buildings with an energy performance certificate that includes objective information on the energy performance of a building and

[30] For example: de Santiago Rodríguez, Eduardo; Jiménez Renedo, María Consuelo. Estudio comparado de la regulación del Informe de Evaluación de Edificios (IEE) en la normativa autonómica vigente. Ciudad y Territorio Estudios Territoriales (CyTET), [S.l.], p. 335-356, Nov. 2019. ISSN 2659-3254. Available at: https://recyt.fecyt.es/index.php/CyTET/article/view/76666. Date of access: 18 March 2020

[31] https://energia.gob.es/desarrollo/EficienciaEnergetica/CertificacionEnergetica/Paginas/certificacion.aspx

reference values, such as minimum energy performance requirements, so that the owners or tenants of the building or of a unit within it can compare and evaluate its energy performance.

Furthermore, it regulates the use of the common distinctive symbol throughout national territory, known as the energy performance label, and guarantees in all cases the specific requirements in the various Autonomous Communities. In the case of buildings that provide public services to a significant number of people and which are therefore routinely visited by those people, the Decree requires that this symbol be prominently displayed.

The technical considerations regarding the procedures for assessing the energy performance of buildings are compiled in the recognised document for the energy certification, known as the *Technical conditions governing the procedures for assessing energy performance*.

Changes to the Energy Certification since 2017.

Royal Decree 564/2017 of 2 June 2017 amended Royal Decree 235/2013 of 5 April 2013 on the energy performance certification of buildings, with the aim of excluding buildings with official protection due to architectural or historic value and places of worship, among others, from the scope of application.

As of the date of this document, a new Royal Decree approving the basic procedure for the energy performance certification of buildings is being processed, which, once approved, will replace Royal Decree 235/2013 of 5 April 2013. The public consultation for this draft Royal Decree was held between 31 July and 16 September 2019. This draft Royal Decree, which is being processed jointly by the Ministry for the Ecological Transition and the Demographic Challenge and the Ministry of Transport, Mobility and the Urban Agenda, is currently in the final processing phase. The aim of this Royal Decree is to partially transpose some of the issues covered in Directive (EU) 2018/844 of the European Parliament and of the Council of 30 May 2018 amending Directive 2010/31/EU on the energy performance of buildings and Directive 2012/27/EU on energy efficiency, and to introduce improvements into the procedure. The amendments introduced are summarised below (this is not an exhaustive list):

Definitions have been updated: Technical building system, and new ones have been added: Building control and automation systems.

A new article has been added establishing a requirement for financial incentives to improve energy performance in the refurbishment of buildings to be linked to an actual improvement.

Scope of application has been broadened. With the aim of encouraging a greater number of buildings to improve their performance level, the scope of application of the Royal Decree has been broadened to include:

- Buildings in which a public authority occupies a total useful floor area of more than 250 m^2, irrespective of whether this is frequently visited by the public.
- Privately owned buildings with a total useful floor area of more than 500 m^2 used for specific purposes.
- Buildings undergoing relevant renovations (renovation of thermal installation requiring a RITE project (Regulation on Thermal Installations in Buildings) or intervention on more than 25% of the building envelope) or extensions that increase by more than 10% the floor area or built volume of the unit(s) of use undergoing extension, where the total extended useful floor area exceeds 50 m^2.
- Buildings for which the Technical Building Inspection is obligatory.

Some improvements have been introduced into the procedure to increase certificate quality:

- The obligation for the competent technician to visit the building (as a minimum).
- Obligation to include improvement measures on the certificates with an investment payback period estimate.
- The improvement measures may also include estimates regarding improvements in comfort, health and well-being conditions.

- The obligation for private individuals and companies to show the energy rating on the sale or rental advert.
- Creation of a centralised certificate register at the Ministry with the aim of obtaining statistical information on the energy rating status of the building stock.

4.3.3. First steps towards the Energy Passport in Spain.

Article 2a(1)(c) of Directive 2010/31 refers to the introduction of an optional scheme for building renovation passports in the Member States.

In Spain, two unofficial reports have been drawn up on the possibilities of introducing this new instrument:

- *'El reto de la rehabilitación: El Pasaporte Energético y otras propuestas para dinamizar el sector'*[31] [The renovation challenge: the Energy Passport and other suggestions to boost the sector], a document drawn up by Garrigues y G-advisory for the House That Saves Foundation (Fundación La Casa Que Ahorra) in 2018.

  According to this report, the main aim of the Passport would be to facilitate, foster and fund activities for the gradual renovation of residential buildings of a minimum age, by means of phased activities over a minimum period of four years. This would prevent the timeframes for completing the works from constituting a problem, based on a specific aid programme over an extended period of time. This passport would consider improvements to the thermal insulation of the facade, the thermal insulation of the roof and ground, and the building enclosure elements to be activities eligible for funding. Furthermore, the improvement or replacement of systems for heating, cooling, domestic hot water and ventilation for thermal conditioning could be eligible for aid.

  The funding formula would be that 80% of the aid would be paid at the end of each phase and the remaining 20% would remain unpaid until full project completion, making the Energy Passport an agreement between owners and the authorities. The authorities would offer this aid as renovations are completed each year.

  In order for the activities to be considered eligible, the report suggests that they should jointly bring about a reduction in the annual overall energy needed to heat and cool the building, specified in the energy certification as a minimum of 60% for buildings located in climatic zones D and E under the Technical Building Code and 50% for buildings in climatic zone C.

  The eligible costs would be those incurred to implement the renovation activities, installation, any associated civil works and additional installations required, renovation work project management, project preparation, and prior diagnostics and studies for drawing up the project. Together with the Energy Passport, this study also suggests two additional packages of measures, one tax-related and the other administrative.

- The *PAS-E, Pasaporte del edificio*[32] [Building Passport] instrument, developed by the Cíclica architecture cooperative and Green Building Council España (GBCe), covers the steps to be followed to facilitate the deep renovation of buildings and help communities implement these renovations. The plan translates into a roadmap setting out a sequence of interventions to be performed based on the needs of the people and includes information for addressing legal, operational, financial and social issues.

4.3.4. Inclusion of renovation and energy efficiency in university educational programmes.

Education on urban renovation, regeneration and renewal is gradually being included in post-graduate university education, for example[33]: in the RERU Master's (Building Renovation and Urban Regeneration) offered by the

[31] https://www.lacasaqueahorra.org/ficheros/esp/Documentos/A396A757-1796-F325-D485-688F86720C8D.pdf/

[32] http://www.pas-e.es/#/en

[33] http://www.observatoriociudad3r.com/event_category/master-postgrados/

University of Valencia and the Valencian Building Institute (Instituto Valenciano de la Edificación, IVE), the Master's on Urbanism and Territorial Studies offered by the National Institute of Public Administration (Instituto Nacional de la Administración Pública, INAP) or the Master's in Urban and Regional Planning offered by the Polytechnic University of Madrid.

4.3.5. Updates on the heating and cooling networks in Spain and the Local Energy Communities.

Heating and cooling networks are a key tool in implementing a policy based on efficiency as they establish synergies between centralised energy production and use of local energy resources as sources of renewable energy or residual heat. However, despite their undeniable benefits, the presence of heating and cooling networks in Spain is still minor. According to statistics communicated under Article 24(6) of Directive 2012/27/EU, final energy consumption in heating and cooling networks in Spain in 2017 was 1 777.29 TJ (approximately 42.5 ktoe), which represents a 0.15% share of the total consumption in the heating and cooling sector (i.e. well below the 2% specified in Article 24(10)(a) of Directive 2018/2001 on the promotion of the use of energy from renewable sources).

However, heating and cooling networks in Spain have grown in recent years, both in terms of the number of networks and installed capacity. Since 2011, the ADHAC association (Association of Heating and Cooling Network Companies) has published an annual report on the development of heating and cooling networks in Spain, as a result of a collaboration agreement with IDAE. In 2011, ADHAC identified 46 operational networks, a number that had risen to 414 in the most recent report submitted in 2019.

Whilst these figures are low in comparison with neighbouring countries, the growth in the development of heating and cooling networks in Spain has been relentless, especially in rural settings and with the use of renewable energy, primarily biomass.

The most recently published census provides the following general data:

- More than 5 000 buildings supplied with power.
- More than 740 km in length.
- Savings in excess of 300 million tonnes of CO_2 per year.
- 1 189 MW of heating installed.
- 386 MW of cooling installed.
- 80% of networks use renewable energy in their energy mix. This is logical given the late development of these networks in Spain.

Looking at the geographical distribution, Catalonia stands out with almost a third of Spain's existing networks, while Castile and Leon has a large number of rural networks supplying biomass.

Figure 4.1. Percentage distribution of heating and cooling networks in Spain (2019).

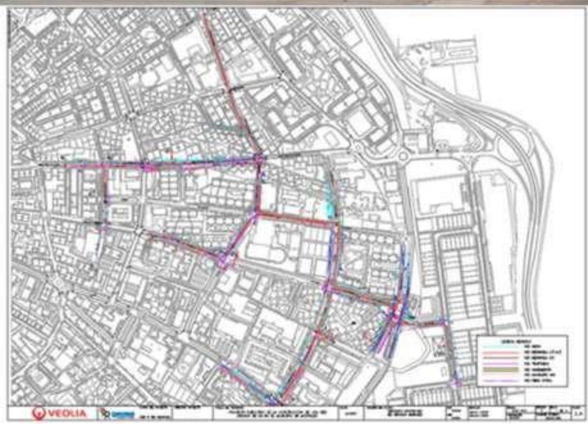
Source: Association of Heating and Cooling Network Companies Census. ADHAC, 2019.

In terms of capacity, Catalonia retains top position, but Madrid, with barely 8% of existing networks, accounts for up to 25% of installed capacity. The reason for this difference comes from the location of large district networks in Spain, which are primarily found in Catalonia and Madrid.

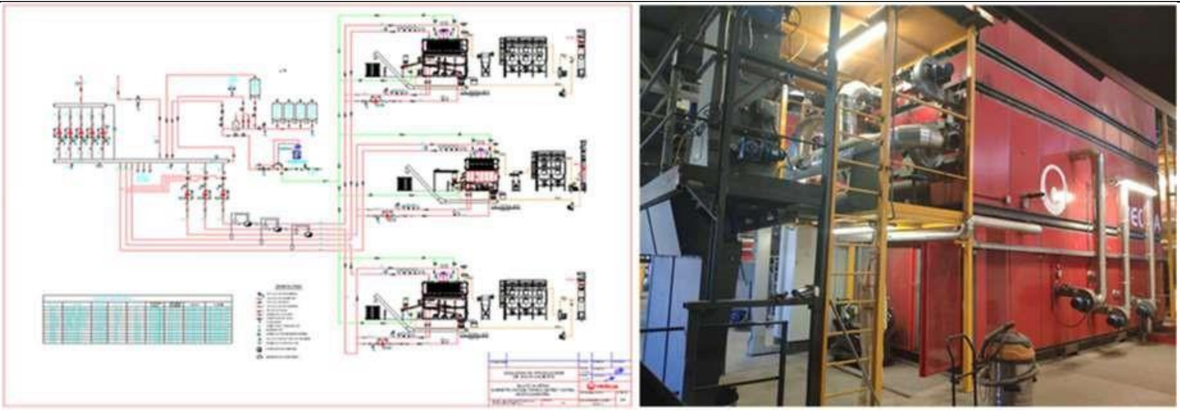
As regards the type of networks, the majority are heating networks (over 370), although the 36 combined heating and cooling networks have greater installed capacity and are longer. In terms of ownership, there is a high level of similarity between the number of public networks and private networks, and only 3% are in mixed public-private ownership; however, these mixed networks (normally franchises) account for almost a third of the installed capacity as they include the existing large district networks.

The development of these networks shows enormous growth in rural settings, where micro-networks have been built to generate heat both for public buildings and for the residential and tertiary sector. In recent years, we have also seen the construction and launch of new networks in urban settings, which are set to become a trend in Spain so as to significantly increase savings and speed up the replacement of inefficient individual installations with highly efficient urban network installations. Despite this trend, the district heating and cooling market is still very concentrated in 15 networks representing 51% of the total installed capacity.

BOX 6: EXAMPLE OF AN URBAN HEATING AND COOLING NETWORK: THE MÓSTOLES ECONENERGÍA NETWORK.



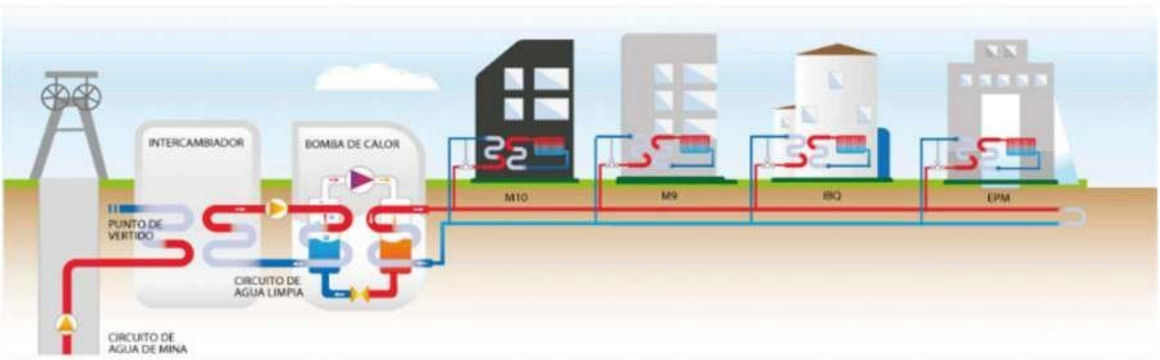
One established example of a new urban network is the Móstoles Ecoenergía biomass network, which provides heating and domestic hot water to 3 600 dwellings grouped into 20 homeowners' associations. This network, which is 4 km long and has a capacity of 12 MW, has reduced the cost of hot water and heating for the residents of Móstoles that it serves by 15%. For this, it uses forest biomass chips that come from clearing operations in Spanish forests. In addition to the economic improvements, it also cuts CO2 emissions into the atmosphere by approximately 7 000 t. The company that owns the network commissioned VEOLIA with operating the heating network generation plant, the energy supply and 24/7 monitoring. This is possible thanks to the energy management centre, which makes it possible to monitor and operate the installations remotely in real time. The investment totalled around 8 million euro, all funded privately with the exception of a PAREER (aid programme for the energy renovation of existing buildings) repayable loan of 2.1 million euro provided by IDAE. The business plan is to supply 5 275 dwellings and achieve 13 million euro in investment by 2023.



Móstoles Network plant. Image source: Association of Heating and Cooling Network Companies. ADHAC.

BOX 7 GEOTHEMAL NETWORK IN MIERES, ASTURIAS.

Another interesting example of the many possibilities offered by district heating and cooling networks within the context of the current energy transition is the geothermal district heating network recently established by Hunosa in Mieres (Asturias). This project is of particular interest not only due to its use of an abundant local resource that would otherwise go to waste, but also due to the significant economic and social impact that it has had on a municipality with a long mining tradition, for which the closure of the coal mines created great difficulty. This was the view taken by the International Energy Agency, which, in 2019, rewarded the project with the Global District Energy Climate Award in the emerging market category. This network, financed with ERDF funds, uses the energy from the water in the former Barredo mine, which, with the aid of heat pumps, is consumed in the form of heating and DHW in two public buildings and numerous dwellings. For Mieres, this project also means a significant source of wealth generation, a 653 t reduction in CO2 emissions and the preservation of its industrial heritage.



Mieres Network. Source: Association of Heating and Cooling Network Companies. ADHAC.

	EXCHANGER
	HEAT PUMP
	DISCHARGE POINT
	CLEAN WATER CIRCUIT
	MINE WATER CIRCUIT
	M10
	Mieres Polytechnic School
	Bernaldo de Quirós Institute

BOX 8 NETWORK IN A RURAL MUNICIPALITY: RIBES DE FRESSER (GIRONA).

Within the rural context, the Ribes de Fresser (Girona) biomass network provides heating and domestic hot water to 10 buildings in this municipality in the Ripollès district. This network, which is 1.11 km long and has a capacity of 0.72 MW, has reduced the cost of hot water and heating in the buildings that it serves. In addition to the economic improvements, it is also of significant environmental benefit as it cuts CO_2 emissions into the atmosphere by approximately 480 t each year.

The network is managed by a private company responsible for operating the heating network generation plant and the energy supply.

Ribes de Fresser network. Source: Association of Heating and Cooling Network Companies. ADHAC.

Finally, it should be noted that there have been significant developments in the regulations to promote heating and cooling networks and the development of Local Energy Communities, which are analysed in the section below.

4.4. REGULATORY DEVELOPMENT AND ADMINISTRATIVE MEASURES AREA.

4.4.1. Regulatory developments and initiatives at State level in the areas of energy and building.

In 2013, Law 8/2013 of 26 June 2013 on Urban Renovation, Regeneration and Renewal (Official State Gazette of 27 June 2013) was approved as the basis for a new state regulatory framework for promoting urban renovation, regeneration and renewal as strategic tools for transforming the Spanish real estate model, which has historically been focussed on creating new urban developments and building new housing, and redirecting it towards a more sustainable approach focused on urban regeneration of the country's towns and cities and on the renovation of the existing building stock. This text has now been recast with the basic land legislation by means of Royal Legislative Decree 7/2015 of 30 October 2015, approving the Recast Text of the Land and Urban Renovation Act (Official State Gazette of 31 October 2015).

This basic state legislation remains valid to date; the challenge now, as we will see, lies in its incorporation, transposition and implementation in regional regulations.

In the area of building and technical regulations, the regulatory framework in force is also relatively recent, with its latest developments being: Royal Decree 235/2013 of 5 April 2013 approving the basic procedure for the energy performance certification of buildings (Official State Gazette of 13 April 2013); Royal Decree 238/2013 of 5 April 2013 amending certain articles and technical instructions in the Regulations on Building Heating Installations (RITE) of 20 July 2007 to set out stricter requirements concerning the energy performance of heating and cooling equipment, as well as equipment used to move and transport fluids (Official State Gazette of 13 April 2013); and the recent Royal Decree 732/2019 of 20 December 2019 (Official State Gazette of 27 December 2019) amending the Technical Building Code approved by means of Royal Decree 314/2006 of 17 March 2006.

a) Recent developments in the Technical Building Code in terms of energy performance and renovation works.

The Basic Document on Energy Savings (DBHE) is the section of the Technical Building Code that lays down the requirements on energy performance that buildings must meet to guarantee that occupant comfort is achieved with rational energy usage, reducing consumption to sustainable limits and at the same time ensuring that part of this consumption comes from renewable energy sources.

The DBHE was originally published by means of Royal Decree 314/2006 approving the Technical Building Code. That Royal Decree repealed Basic Building Standard NBE-CT 79, which established the thermal conditions in buildings, a document that, at the time, constituted the first regulatory approach to defining minimum insulation requirements for buildings in Spain.

With the approval of the DBHE in 2006, the requirements on buildings established in Directive 2002/91/EC of the European Parliament and of the Council of 16 December 2002 were transposed into Spanish law, establishing the obligation to periodically review and, where necessary, update those requirements, with the aim of bringing them into line with technical advances in the construction sector.

This obligation to periodically review the document, together with the approval of Directive 2009/28/EC of the European Parliament and of the Council of 23 April 2009 on the promotion of the use of energy from renewable sources and Directive 2010/31/EU of the European Parliament and of the Council of 19 May 2010 on the energy performance of buildings and amending Directive 2002/91/EC, led to the amendment of the DBHE in 2013. That amendment was approved by Ministerial Order FOM/1635/2013 of 10 September 2013. In addition to partially transposing both Directives, that DBHE revision constituted the first approach to achieving 'nearly zero-energy buildings', a concept explicitly outlined in Directive 2010/31/EU. That Directive established the obligation to set minimum energy performance requirements on buildings with the aim that, by 31 December 2020, all new buildings would be nearly zero-energy buildings and that, by the end of 2018, all buildings occupied and owned by a public authority would have achieved that same objective.

Changes to the DBHE of the Technical Building Code since 2017.

In 2017, by means of Ministerial Order FOM/588/2017 of 15 June 2017, the DBHE was once again revised, both so as to complete the periodic review of requirements as laid down in Directive 2010/31/EU and to bring it into line with the new procedure for the energy certification of buildings defined in the Recognised Document

'Technical conditions governing the procedures for assessing energy performance'. This review set out a regulatory definition of a 'Nearly Zero-Energy Building', specifically defining it as a building that fulfils the regulatory requirements established for new buildings in the various sections of DBHE.

On 27 December 2019, Royal Decree 732/2019 of 20 December 2019 was published amending the Technical Building Code.

Changes in relation to the DBHE.

That Royal Decree included a new DBHE document, which transposed into Spanish law the requirement to carry out a review and update every five years under Directive 2010/31/EU of the European Parliament and of the Council of 19 May 2010 on the energy performance of buildings, and incorporated the provisions of Regulation 244/2012 and standard UNE-EN-ISO 52000-1: 2017, which lay down the rules for conducting the building energy assessment (for example the need to take energy obtained from the environment into consideration).

The 2019 DBHE finally defines a 'Nearly Zero-Energy Building' (NZEB) as a new or existing building that fulfils the regulatory requirements laid down in that 'Basic Document on Energy Savings' as regards the limit on energy consumption for newly constructed buildings. I.e., all new buildings built in accordance with the DBHE 2019 will be NZEBs, as will existing buildings that comply with the levels established for new buildings in the primary energy consumption indicators.

Therefore, the two key indicators that establish maximum consumption based on building use and climatic zone are:

- The building's total energy needs: total primary energy consumption ($\mathbf{C_{pe,tot}}$) (a new indicator compared with the previous version)
- Primary energy consumption from non-renewable sources ($\mathbf{C_{pe,nren}}$)

These consumption values are defined using different calculations depending on whether the situation relates to new buildings or refurbishments in existing buildings, on which interventions are carried out at different levels of intensity.

Existing buildings must comply with the limits established for those consumption indicators where the intervention relates to over 25% of the envelope and to the thermal generation systems or relates to extensions or changes of use of floor areas of over 50 m^2. As stated previously, compliance with those limits established for existing buildings would constitute regulatory compliance; however, if the objective is to make that existing building a nearly zero-energy building, it must comply with the values set out for new buildings in the primary energy consumption indicators mentioned above.

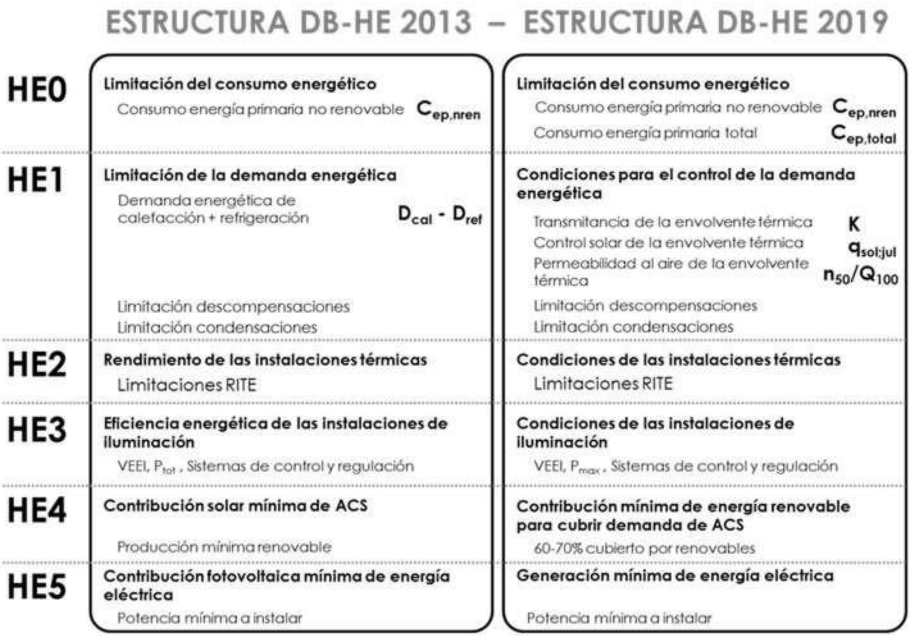
Additionally, the DBHE establishes other obligations for both new buildings and interventions on existing buildings:

1. Design and construction of a building that requires little energy to achieve comfort conditions in line with its use and the climate conditions of its environment. The building design phase is key to achieving this objective and must address aspects such as orientation, compactness, proportion of apertures, sunscreens and shade. This requires:
   - At least a minimum level of overall thermal insulation (**K**), which is once again different for new and existing buildings.
   - At least a minimum level of insulation for elements in contact with the exterior ($\mathbf{U_{lim}}$), including thermal bridges; in this case, there are single levels for both new buildings and elements that are modified in existing buildings.
   - Monitoring of the air permeability of the elements ($\mathbf{Q_{100}}$ for all new apertures or those on which interventions are taking place and n_{50} for new residential buildings over 120 m^2).
   - Limiting surplus solar gains in summer ($\mathbf{q_{sol;jul}}$).

- Preventing the loss of heat from dwellings and business premises through internal partitions (**U_{lim}**).
- Ensuring the performance of these features over time by limiting imbalances.

2. Use of efficient thermal and lighting installations that guarantee comfort and adequate air quality. This requires:
   - Highly efficient heating/cooling equipment.
   - Efficient ventilation that guarantees air quality.
   - The use of natural light and limitation on the consumption of lighting systems.
   - Installation design that guarantees user comfort and performance over time.
3. Use of renewable energy to prevent greenhouse gas emissions and limit the buildings' environmental footprint. This requires:
   - Production of domestic hot water using renewable energy sources.
   - Generation of electric power, on the plot or in its vicinity, from renewable sources.

Figure 4.2. Development of the DBHE structure and indicators



	DBHE STRUCTURE 2013 – DBHE STRUCTURE 2019
	HE0
	HE1
	HE2
	HE4
	HE5
	Limit on energy consumption
	Non-renewable primary energy consumption
	$C_{pe,nren}$
	Limit on energy need
	Energy demand for heating + cooling
	D_{heat} - D_{cool}
	Limit on imbalances
	Limit on condensation
	Performance of thermal installations
	RITE limits

	Energy performance of lighting installations
	Installation Energy Performance Value, total capacity (C_{tot}), control and regulation systems
	Minimum solar contribution to DHW
	Minimum production from renewables
	Minimum photovoltaic contribution to electric power
	Minimum capacity to be installed
	Limit on energy consumption
	Non-renewable primary energy consumption
	$C_{pe,nren}$
	Total renewable primary energy consumption
	$C_{pe,total}$
	Conditions for controlling energy demand
	Transmittance of thermal envelope
	K
	Solar control of thermal envelope
	$q_{sol;jul}$
	Air permeability of thermal envelope
	n_{50}/Q_{100}
	Limit on imbalances
	Limit on condensation
	Thermal installation conditions
	RITE limits
	Lighting installation conditions
	Installation Energy Performance Value, maximum capacity (C_{max}), control and regulation systems
	Minimum contribution from renewable energy to cover DHW demand
	60-70% covered by renewables
	Minimum electric power generation
	Minimum capacity to be installed

Source: MITMA.

Changes in relation to interventions in existing buildings.

The recent approval of the Amendment to the Technical Building Code (Royal Decree 732/2019 of 20 December 2019 (Official State Gazette of 27 December 2019) amending the Technical Building Code, approved by means of Royal Decree 314/2006 of 17 March 2006) introduces general criteria and specifically, a flexibility criterion, when carry out interventions on buildings, taking into consideration the range of potential situations (historic buildings, buildings of architectural interest or buildings for which application of certain measures is difficult). Section IV of the DBHE sets out the following:

'IV. Application criteria for existing buildings

Criterion 1: No deterioration: Except in cases where a Basic Document establishes other criteria, any pre-existing conditions that may be less strict than those set out in any Basic Document may not be reduced, and those that are more strict may only be reduced to the level established in the corresponding Basic Document.

Criterion 2: Flexibility: In cases where it is not possible to achieve the performance level generally established in this Basic Document, solutions may be adopted that give the highest possible level of suitability, (with identification of that level), provided that one of the following situations exists:

a) *in buildings of recognised historic or architectural value, where other solutions may unacceptably alter the building's appearance or nature, or;*

b) *the application of other solution would not bring about an effective improvement in performance associated with the basic 'Energy Saving' requirement, or;*

c) *other solutions are not technically or economically viable, or;*

d) *other solutions involve substantial changes to elements of the thermal envelope or the thermal generation installations that were not originally subject to intervention.*

The project must include the reason for applying this flexibility criterion.

The final works documentation must record the performance level achieved and the factors conditioning use and maintenance, if any.

Criterion 3: Damage repair: The elements of the existing part not affected by any of the conditions established in this Basic Document may be left in their current state provided that, prior to the intervention, there is no damage that has significantly impaired their original performance. If the building has damage associated with the basic 'Energy saving' requirement, the intervention must include specific measures to rectify this.'

In addition, a number of clarifications were introduced to the terms for the application of the Technical Building Code to new building works and to interventions on existing buildings that involve the Limit on energy consumption as given in Section HE0. According to the approved amendment, the scope of application is now as follows:

- Extensions that increase by more than 10% the floor area or built volume of the unit(s) of use undergoing extension, where the total extended useful floor area exceeds 50 m^2.
- Changes of use, where the total useful floor area exceeds 50 m^2.
- Refurbishments involving renovation to both the thermal generation installations and more than 25% of the total area of the building's final thermal envelope.

This last condition would include all interventions on the entire envelope of existing buildings, thereby matching the conditions required for newly constructed buildings.

b) Recent developments in the Regulations on Building Heating Installations (RITE).

The Regulations on Building Heating Installations (RITE) establishes the conditions to be fulfilled by installations intended to meet thermal well-being and hygiene needs via heating, air conditioning and domestic hot water installations, in order to achieve a rational use of energy. These regulations are implemented through an approach based on performance or objectives, by expressing the requirements to be met by thermal installations without stipulating the use of a specific technology or material nor preventing the incorporation of new technologies and concepts in the design.

The Council of Ministers meeting held on 20 July 2007 approved Royal Decree 1027/2007 approving the Regulations on Building Heating Installations. The Royal Decree was drawn up jointly by the Ministry of Industry, Tourism and Commerce and the Ministry of Housing.

The Regulations on Building Heating Installations were amended in 2013 by means of Royal Decree 238/2013 of 5 April 2013. The aim of the amendments laid down was to incorporate the obligations deriving from Directive 2010/31/EU in terms of the thermal installations of buildings, to update the regulations, adjusting them to the new energy saving and performance requirements, and to comply with the requirement laid down in the second final provision of Royal Decree 1027/2007 approving the RITE to periodically review the energy performance requirement at intervals not exceeding 5 years.

Currently, the recent approval of various European regulations on energy performance, promotion of the use of energy from renewable sources and developments in technology in various areas require the RITE to be adapted.

This new adaptation is being undertaken in two phases.

The aim of Phase 1 to promptly transpose the substantive obligations laid down in the following Directives in terms of building thermal installations: Directive (EU) 2018/844 of the European Parliament and of the Council of 30 May 2018 amending Directive 2010/31/EU on the energy performance of buildings and Directive 2012/27/EU on energy efficiency; Directive (EU) 2018/2002 of the European Parliament and of the Council of 11 December 2018 amending Directive 2012/27/EU on energy efficiency; and Directive (EU) 2018/2001 of the European Parliament and of the Council of 11 December 2018 on the promotion of the use of energy from renewable sources.

The public consultation and information process for this was held between 5 August 16 September 2019. As of the date of this document, the procedure is continuing towards the final approval by the Council of Ministers and publication in the Official State Gazette.

The main amendments introduced are:

- Update to the requirements for the approval of professionals and companies.
- Addition of automation and control systems that are obligatory for non-residential installations (over 290 kW) but not obligatory for residential installations. Furthermore, inclusion of an additional provision establishing the obligation for existing non-residential buildings with over 290 kW from 2025 onwards.
- Definition of the 'General energy performance of the thermal installation'.
- Inclusion of requirements to be met by heat pumps in order to be considered renewable energy.
- Removal of energy performance requirements for products regulated by European eco-design regulations, with explicit reference to the fact that compliance with those regulations is obligatory.
- Establishment of temperatures used when calculating internal conditions to avoid oversized equipment (IT 1.1.4.1.).
- Establishment of the maximum inlet temperature for heaters of 60ºC (instead of average temperature).
- Addition of an instruction regarding consumption information.
- Amendment of instruction on inspections.
- Update and addition of definitions.

Phase 2, which is currently being drafted, relates to technical modifications needed to ensure the Regulations on Building Heating Installations remain in line with technical progress and other EU regulations. Specifically, these include:

- Incorporation of requirements regarding new terms and definitions.
- Revision of requirements to prioritise the use renewable energy and the increased use of residual energy.
- Promotion of introduction of more efficient equipment and more advanced technology.
- Consideration of the technical requirements of thermal installations in all areas associated with these: design, size, installation, maintenance and use, as well as documentation and procedures to guarantee correct application.

c) Urban regeneration, renovation and energy performance within the framework of the Spanish Urban Agenda.

The Spanish Urban Agenda is a strategic, non-binding National Urban Policy, which, in compliance with international commitments, aims to establish criteria to guide the adoption of public policies affecting towns and cities in Spain, so as to ensure socially inclusive, environmentally sustainable and economically competitive development. This is based on a holistic and integrated view of cities that goes beyond sectoral expertise and is based on collaboration between all parties involved.

To that end, the Urban Agenda comprises a series of 10 strategic goals[34] and 30 specific goals and suggests a series of lines of action, which, together with a system of control and monitoring indicators and a procedure guideline, will enable other Public Authorities and parties involved to draw up their respective action plans. It is

[34] Strategic Goal 1: Regulate the land, ensure rational land use, preserve and protect the land; Strategic Goal 2: Prevent urban sprawl and revitalise existing cities; Strategic Goal 3: Prevent and reduce the effects of climate change and increase resilience; Strategic Goal 4: Sustainably manage resources and promote a circular economy; Strategic Goal 5: Promote a local approach and sustainable mobility; Strategic Goal 6: Promote social cohesion and equality; Strategic Goal 7: Encourage and promote the Urban Economy; Strategic Goal 8: Guarantee access to housing; Strategic Goal 9: Lead and promote digital innovation; and Strategic Goal 10: Improve intervention tools and governance.

also an Action Plan that covers all the regulatory, planning, funding, governance improvement and knowledge sharing measures that the Spanish Central State Administration can carry out to achieve its goals.

The Spanish Urban Agenda finds its legal basis in the principle of sustainable regional and urban development as regulated in Article 3 of the Recast Text of the Land and Urban Renovation Act, which, among other requirements, requires public authorities to enable residential use of dwellings constituting primary residences '*in a safe, clean, universally accessible and socially integrated urban environment of sufficient quality, fitted with equipment, services, materials and products that prevent or, in any case, minimise, by application of the most advanced technology available on the market at a reasonable price, pollutant and greenhouse gas emissions, water and energy consumption, and waste generation, while also improving its management*' (Article 3).

Given that the building sector is of crucial importance from an environmental perspective as a key element in boosting the Circular Economy and due to its contribution to fulfilling the right to housing, the Spanish Urban Agenda affords it particular attention, even including a specific goal aimed at 'Improving the quality and sustainability of buildings (Strategic Goal 2.6)'.

This Urban Agenda is not aimed at achieving partial renovation, but at bringing about a transformation seeking comprehensive building improvements, increasing their habitability and energy performance, such that, in residential buildings, this translates into an improved quality of life and significant savings in household energy bills. This 'sustainable building' must also guarantee habitability, in other words, universal access to decent and adequate accommodation.

The action suggested by the Spanish Urban Agenda to achieve the renovation goals (Strategic Goals 2, 3, 4 and 8) include:

- Promoting and encouraging building renovation and urban regeneration to reach a suitable balance between this activity and new urban generation.
- Prioritising, by Public Authorities, the funding and viability of urban renovation, regeneration and renewal initiatives, including by promoting collaboration with the private sector.
- Driving improvements in the energy performance of the existing building stock through all available and possible measures: tax measures, streamlining and simplifying administrative procedures and launching educational campaigns.
- Promoting Technical Building Inspections or Building Assessment Reports to foster the introduction of preventive measures that encourage preventive maintenance, rather than merely corrective or palliative maintenance in buildings.
- Setting up mechanisms to bring about synergies between the different types of building interventions: maintenance, accessibility, energy performance, etc. This is a question of boosting comprehensive action.
- Using efficient building techniques that guarantee the use of suitable materials for buildings and dwellings and facilitate re-use. This would form part of a 'build to last' approach.
- Boosting the use of and updating the Building Log during the building's service life.

Likewise, the planning activities established in the Action Plan of the Central State Administration include:

- Drawing up a State Short- and Medium-Term Housing and Urban Renewal Strategy. (Action 2.1).
- Drawing up and implementing this 'Long-Term Strategy for Energy Renovation in the Building Sector in Spain' (2020 ERESEE) in line with the provisions of Directives 2012/27/EU and 2010/31/EU.

BOX 9. AN INTEGRATED PRACTICE BASED ON THE URBAN AGENDA: REHABITA EXTREMADURA.

The Spanish Urban Agenda establishes 10 Strategic Goals including the following: (...)

2. Prevent urban sprawl and revitalise existing cities.

3. Prevent and reduce the effects of climate change and increase resilience.

4. Sustainably manage resources and promote a circular economy.

5. Promote a local approach and sustainable mobility.

6. Promote social cohesion and equality.

8. Guarantee access to housing.

REHABITA
Extremadura

Under the Action Plan to implement this Urban Agenda in Extremadura, various strategies are being used to promote urban renovation, regeneration and renewal. These include Rehabita Extremadura. This initiative consists in transferring ownership of a dwelling to the Regional Government of Extremadura for a period of time in exchange for the Regional Administration renovating and leasing it. The income generated through this lease must, as far as possible, cover the renovation costs.

The aim of this is to recover some of the empty dwellings in the municipalities of this Autonomous Community, promoting renovation based on energy performance criteria. The renovated dwellings will be offered on a rental basis, guaranteeing promotion of social cohesion.

Irrespective of whether the implementation of this action will universally contribute to achieving the strategic goals mentioned above, the aims of this proposal are essentially:

1. To maintain the population in the region (re-inhabit)

2. To promote the renovation of buildings in the region's municipalities, while seeking to prevent the population moving from centres to suburbs or other local areas (renovate)

The task of implementing this action has been given to the public company URVIPEXSA and the variables taken into account are the cost of the works to be carried out and the minimum period for transfer of ownership based on the above parameter with the aim of making the strategy sustainable.

The project will be rolled out by means of the following specific initiatives: Rehabita Guareña, Rehabita Olivenza, Rehabita Valverde de Burguillos, Rehabita Torrejoncillo, and Rehabita Madroñera.

BOX 10. ANOTHER INTEGRATED PRACTICE IN HOUSING, SOCIAL RENTAL AND URBAN REGENERATION: THE REHABITARE PROGRAMME IN CASTILE AND LEON.

The REHABITARE programme aims to increase the public social rental stock in the Autonomous Community and maintain the population in rural areas, by recovering disused buildings under municipal ownership. Its priority is to meet the housing needs of groups under special protection as defined in Article 5 of Law 9/2010 of 30 August 2010 on the right to housing in the Autonomous Community of Castile and Leon, particularly young people.

In sum, this housing renovation programme serves to recover buildings that may then be used for social rental so as to optimise municipal resources, restore buildings with heritage value, revitalise traditional areas of the municipal urban fabric, and, above all, maintain the population in rural areas by providing renovated housing, under a social rental scheme, for groups under special protection.

It is also designed as a tool to revive the economy and create jobs in the municipalities, through the involvement of local companies in the renovation works carried out under the scheme.

The mechanism behind the administrative activity carried out to implement this programme is simple: once the Municipal Council has transferred the disused dwelling or building to the Regional Ministry of Development and the Environment, the Directorate-General for Housing, Architecture and Urbanism puts the necessary renovation works out to contract. Once those works have been completed, it returns the buildings to the Municipal Council, which will offer them under the social rental scheme to families or other groups under special protection as specified in Law 9/2010.

The joint action between the municipal and provincial authorities and the Administration of the Autonomous Community of Castile and Leon is key.

d) Updates on regulating self-consumption and Local Energy Communities.

d.1 Regulatory developments in relation to self-consumption in Spain.

Law 24/2013 of 26 December 2013 on the Electricity Sector defined self-consumption in article 9, and identified various types. Subsequently, that article was amended by means of Royal Decree-Law 15/2018 of 5 October 2018 on urgent measures for the energy transition and consumer protection.

Self-consumption is defined as consumption by one or more consumers of electricity from production facilities that are located in close proximity to the installations consuming that electricity and associated with that/those consumer(s).

The regulations laid down in Law 24/2013 of 26 December 2013 on self-consumption aim to guarantee an orderly roll-out of this activity, compatible with the need to guarantee the technical and economic sustainability of the electricity system as a whole.

This basic legislation was subsequently subject to regulatory development via Royal Decree-Law 15/2018 and Royal Decree 244/2019, regulating the administrative, technical and financial conditions of electricity self-consumption, which aim to make it easier for consumers to obtain cleaner energy more cheaply.

Royal Decree 244/2019 provides for installations without surpluses (which never export energy to the grid) and installations with surpluses, and, in the latter case, also allows the installations to take part in the simplified compensation system, to offset their production surpluses with their consumption or sell the surplus energy to the market.

Royal Decree 244/2019 also regulates self-consumption connections over the public distribution network, which makes it possible for consumption and generation to be located in different nearby buildings.

Furthermore, Royal Decree 244/2019 provides for collective self-consumption, whereby consumers in a single building or in nearby buildings can share the energy generated by a single self-consumption installation, with the energy being distributed on whatever basis the consumers agree.

In order to evaluate the real capacity for self-consumption in Spain, the PNIEC envisages carrying out a study on the potential of self-consumption as part of Measure 1.4 of the plan, which will determine the real potential of photovoltaic installations for self-consumption in the residential, service and industrial sectors. The initial estimates situate that potential between 4GW and 10.5GW in the period 2020-2030, meaning that the overall outlook for self-consumption in buildings is attractive.

d.2. Regulatory developments on Local Energy Communities.

The publication of the European Directives that form the legislative 'Clean Energy Package' encouraged the inclusion of district heating and cooling networks in the PNIEC, as one of the tools that will make it possible to increase the share of renewable energy in heating and cooling consumption by 1.3% each year, based on the figure achieved in 2020. This document contains the amendments made following the European Commission's rating of the first draft sent last year and includes Measure 1.6 'Framework for the development of thermal renewable energy', which provides for specific action, both in terms of regulation and economic support, to enable heating and cooling networks using renewable fuels to play a much more significant role in 2030. This action includes the annual collection of the information required to meet the statistical obligations on networks, the setting up of mechanisms to guarantee the provision, to end consumers, of information on energy performance and the share of renewable energy in the heating networks to which those consumers are connected, the assessment of the potential of those networks in new urban developments, the regulatory analysis and implementation of possible measures aimed at potential users, support lines for the renewal and construction of highly efficient heating and cooling networks, and the development of renewable energy communities associated with heating and cooling networks.

According to the PNIEC, the last point is relevant due to the potential for this to promote energy efficiency, increase the share of renewables, and empower the consumer, as depicted in the 'Guide on the development of instruments to promote Local Energy Communities' published by IDAE[35].

The development of Local Energy Communities, which then manage their own electricity and thermal energy, is one of the high hopes for the development of district networks in Spain's municipalities. This development will start with the 'aggregator', which will normally develop the ways in which energy is 'self-supplied' to the various components that form the Energy Communities.

Likewise, the Ministry for the Ecological Transition and Demographic Challenge recently launched phase II of the works to modify the Regulations on Building Heating Installations (RITE) via the creation of various subgroups, among which District Heating and Cooling Systems. This subgroup will provide the Ministry with an analysis and information on any issues of particular relevance to the sector and which are likely to be included in the RITE. This work is a great opportunity to transpose into Spanish law some of the rules associated with district heating and cooling networks laid down in Directive 2018/2001 of 11 December 2018 on the promotion of the use of energy from renewable sources and in Directive 2018/2002 of 11 December 2018 amending Directive 2012/27/EU on energy efficiency.

Another important development is the recent publication by the Spanish standards body, UNE, of standard UNE 216701 'Classification of Energy Services Providers', which provides professional and independent certification to make it easier to identify companies that provide energy services, including services for heating and cooling networks. The classification provides clarity and trust in the market regarding the different existing types of companies or providers, based on their actions; it also recognises the special nature of groups of companies, joint ventures or enterprise groups when it comes to providing energy services.

In this sector, the main barriers to the development of the district heating and cooling networks specified by ADHAC are the lack of a specific regulation on the authorisation, certification and licencing procedures applicable to this type of installation, and the lack of a regulation similar to that of other European countries, which establishes obligations for connection to networks where these are available, giving priority to overall rather than particular needs.

The sector also shows the fear of certain municipal councils to address the development of networks in consolidated urban areas, despite existing good examples in Spain and other countries.

e) Developments in terms of Energy Poverty and vulnerable consumers.

This sectors covers the most important developments in the area of Energy Poverty and vulnerable consumers: the approval of the 2019-2024 National Strategy to combat Energy Poverty and the Social Electricity and Thermal Payments regulation.

[35] https://www.idae.es/sites/default/files/documentos/publicaciones_idae/guia_para-desarrollo-instrumentos-fomento_comunidades_energeticas_locales_20032019_0.pdf

e.1. The 2019-2024 National Strategy to combat Energy Poverty.

Energy poverty is another example of the general phenomenon of poverty and social exclusion. It is a problem that is gaining in public awareness, not only in Spain, but also in the European Union and globally.

The current political climate surrounding energy, where the aim is to achieve a new, sustainable and fully decarbonised energy model, aimed at consumers, and in which access to energy is considered to be a right for all citizens, makes the development and implementation of the 2019-2024 National Strategy to combat Energy Poverty, approved by the government on 5 April 2019, a necessity. The drafting and approval of the strategy was carried out in compliance with Royal Decree-Law 15/2018 of 5 October 2018 on urgent measures for the energy transition and consumer protection.

The Strategy includes all the ongoing and planned initiatives in the various public policies to combat energy poverty and guarantee the effective exercising of this right to energy by all citizens.

e.1.1. Assessment of Energy Poverty in Spain.

The Strategy gives the following definitions:

'Energy poverty is the situation in which a household cannot meets its basic energy supply needs, as a result of an insufficient level of income. This situation may be exacerbated by an energy-inefficient dwelling.'

'A vulnerable consumer is a consumer of electric power or heat who finds themselves in energy poverty, making them eligible for the support measures established by the authorities.'

To assess and suitably monitor the various types of energy poverty and compare them with the characterisation variables, we have used the four official indicators created by the EU Energy Poverty Observatory (EPOV):

- High share of energy expenditure in income (2M): proportion of households whose share of energy expenditure in income is more than twice the national median share (Disproportionate Expenditure).
- Low absolute energy expenditure (M/2): share of households whose absolute energy expenditure is below half the national median (Hidden Energy Poverty, HEP).
- Inability to keep home adequately warm: share of population not able to keep their home adequately warm.
- Arrears on utility bills: share of population having arrears on household utility bills.

Information on the situation regarding the indicators in Spain can be obtained from the statistical instruments used by the National Statistics Institute, specifically:

- Household Budget Survey (EPF) (2017): provides information for the Disproportionate expenditure and Hidden energy poverty indicators.
- Living Conditions Survey (ECV) (2017): provides information for the Inability to keep home adequately warm and Arrears on utility bills indicators.

The indicators above provide the following energy situation in Spain, updated in October 2019[36]:

Figure 4.3. Official Energy Poverty Indicators in Spain 2015-2018 (% of households).

[36] https://www.miteco.gob.es/es/ministerio/planes-estrategias/estrategia-pobrezaenergetica/actualizaciondeindicadorespobrezaenergetica2019_tcm30-502983.pdf

Indicador primario	2015	2016	2017	2018
Gasto desproporcionado 2M[1] (% hogares)	16,6	16,7	17,3	16,9
Pobreza energética escondida HEP[2] (% hogares)	10,8	11,3	10,7	11,0
Temperatura inadecuada en la vivienda en invierno[3] (% población)	10,6	10,1	8,0	9,1
Retraso en pago de facturas de suministros de la vivienda[4] (% población)	8,8	7,8	7,4	7,2

	Primary indicator
	2015
	Disproportionate expenditure 2M[1] (% households)
	16.6
	7.2
	Hidden energy poverty HEP[2] (% households)
	Inadequate temperature in the home in winter[3] (% population)
	Arrears on household utility bills[4] (% population)

Source: MITERD 'Update of indicators in the National Strategy to combat Energy Poverty Measure 2. 15 October 2019'.

Therefore, depending on the indicator used, between 3.5 and 8.1 million people in Spain are in some Energy Poverty situation.

e.1.2. Energy Poverty reduction goals as part of the Strategy (2019-2024).

For each of the EPOV indicators, the Strategy target is to achieve a minimum reduction of 25% by 2025, with a desired goal to go beyond that and reach 50% of current values

Figure 4.4. Summary of the Goals to combat Energy Poverty 2019-2024.

INDICADOR (%)	2017	OBJETIVO MÍNIMO PARA 2025	OBJETIVO BUSCADO PARA 2025
GASTO DESPROPORCIONADO	17,3	**12,9**	8,6
POBREZA ENERGÉTICA ESCONDIDA	11,5	**8,6**	5,7
TEMPERATURA INADECUADA DE LA VIVIENDA	8,0	**6**	4,0
RETRASO EN EL PAGO DE LAS FACTURAS	7,4	**5,5**	3,7

	INDICATOR (%)
	2017
	MINIMUM GOAL FOR 2025
	DESIRED GOAL FOR 2025
	DISPROPORTIONATE EXPENDITURE
	17.3
	8.6
	HIDDEN ENERGY POVERTY
	INADEQUATE TEMPERATURE IN THE HOME
	ARREARS ON BILLS

Source: 2019-2024 National Strategy to combat Energy Poverty.

e.1.3. Action Areas and Measures suggested in the Strategy.

The Strategy is divided into 4 areas, 9 lines and 19 measures, which are summarised below:

Area I. To improve knowledge of energy poverty

Line 1: To establish a robust system for regularly calculating the indicators and to designate responsible bodies.

Measure 1. Updating and regular calculation of energy poverty indicators. This consists in an annual update of the indicators. This must be performed by 1 October each year at the latest.

Line 2: To make the indicator publication system transparent

Measure 2. Regular publication of the indicators by the Ministry for the Ecological Transition. The development of the indicators must be published by 15 October each year at the latest.

Line 3: To deepen knowledge of required energy expenditure

Measure 3. Performance of a more complete study on consumer energy expenditure according to the climatic zone in which they live. For this, a panel of vulnerable homes will be analysed on a permanent basis.

Area II. To improve the response to the current energy poverty situation

Line 4: To improve the subsidy mechanisms used to tackle energy poverty.

Measure 4. Creation of a new social energy payment, which will be characterised by three elements: universality of supply sources, automation and coordinated management with other public authorities.

Measure 5. Establishment of a vital minimum supply. In the case of non-payment of energy supply by vulnerable consumers, once the 4-month period mentioned in Royal Decree 897/2017 has elapsed, power will be reduced to a vital minimum supply for a further 4 months. Once this period has elapsed without the situation having been settled, the supply may be cut.

Line 5: Protection for consumers in extreme meteorological situations

Measure 6. Ban on cutting energy supply in extreme meteorological situations for vulnerable consumers.

Area III. To create a structural change to reduce energy poverty

Line 6: Reduction in the number of people living in energy poverty. We will first highlight the importance of energy efficiency within the framework of EU-Spain governance and emphasise the multiplicity of actors and the most significant actions in terms of energy efficiency:

- **Ministry for the Ecological Transition and Demographic Challenge:** the Energy Renovation of Buildings programme and sustainable urban development projects are noteworthy.
- **Ministry of Transport, Mobility and the Urban Agenda:** Long-term strategy for energy renovation in the building sector in Spain and State Housing Plans

This also includes an analysis of the building stock in Spain.

Measure 7. Express renovation in dwellings, with specific low-cost and rapid-implementation measures, specifically in relation to exchanging thermal equipment and modifying certain elements of the dwelling envelope.

Measure 8. Promotion of the public dwelling stock under the social rental scheme with subsidies for energy supply expenses for particularly vulnerable groups.

Measure 9. Replacement of equipment with other more energy-efficient equipment, including fridges/freezers, thermal equipment, washing machines, electric ovens/hobs, or boilers.

Measure 10. Comprehensive renovation of buildings, seeks to promote measures aimed at buildings in urban regeneration and renewal areas or in rural areas with vulnerable consumers.

Measure 11. Other measures derived from the analysis of the 'Long-term Strategy for Energy Renovation in the Building Sector in Spain (ERESEE) of the Ministry of Development'.

Area IV. Measures to protect consumers and raise social awareness

Line 7: Professional action in the fight against energy poverty.

Measure 12. Development of a protocol to enable primary health care professionals to identify situations of energy poverty.

Measure 13. Standardisation of information management. A study will be conducted into the drive to create a database to standardise information arising from the management of the various public economic benefits resulting from the implementation of this Strategy. The aim of this will be to include the benefits in the *Tarjeta Social Universal* (Universal Social Card).

Line 8: Improvement in information and training for consumers.

Measure 14. Establishment of mechanisms to raise awareness and collective consciousness of the problem of energy poverty in Spain.

Measure 15. Webpage as a general point of access for information on energy poverty.

Measure 16. Implementation of communication activities on the use of smart meters. The Government will promote citizen awareness of the use and possibilities of smart meters.

Measure 17. Information on consumption habits, energy saving and improving energy performance. The Government will promote constant communication and information for citizens to encourage the improvement of responsible consumption habits.

Measure 18. Setup of a permanent communication channel for news and developments on energy poverty for stakeholders and interested groups.

Line 9: Regulatory improvements for consumer protection.

Measure 19. Inclusion of the energy poverty outlook in regulations on energy consumers. Consistency between regulatory amendments in this area and the Strategy.

e.1.4. Strategy Governance.

The Strategy provides a brief explanation of the drafting process and a summary of the contributions made during the public consultation periods. A prior public consultation and a public consultation on the draft Strategy were held.

The drafting of operational plans is also considered for the implementation of the Strategy.

A proposal is given for the creation of an interministerial working group. This would be a continuation of the group formed for the drafting of the Strategy, a social roundtable with social entities, and the use of specific bodies for cooperation and coordination with Autonomous Communities and Local Entities.

The Institute for Energy Diversification and Saving (IDAE), a public business entity attached to the State Secretariat for Energy, has been designated as the monitoring body.

Periodic evaluations and a final evaluation of both the Strategy and the operational plan(s) will be carried out.

e.2. The Social Payment[37].

The Social Payment is a mechanism set up on 1 July 2009. It was created by the Government to protect vulnerable consumers in accordance with Article 45 of Law 24/2013 of 26 December 2013 on the Electricity Sector.

Royal Decree 897/2017 of 6 October 2017 on vulnerable consumers, the social payment and other protection measures for domestic consumers of electricity, and Order ETU/943/2017 of 6 October 2017, which builds on

[37] https://energia.gob.es/bono-social/Paginas/bono-social.aspx

the former, were published on 7 October and 9 October 2017, respectively. These rules include the new requirements that must be met to benefit from the social payment.

Royal Decree-Law 15/2018 of 5 October 2018 on urgent measures for the energy transition and consumer protection was recently approved and expands the scope of this payment.

There are two payments:

The Social Electricity Payment[38], which provides a discount on electricity bills:

- Of 25% for vulnerable consumers who meet the established requirements.
- Of 40% for severely vulnerable consumers who meet the established requirements.
- Furthermore, if the consumer is a consumer at risk of social exclusion, because they are receiving assistance from the social services of a regional or local administration paying at least 50% of the bill, they will not need to pay the electricity bill and, if they are temporarily unable to pay the bill, their electricity supply will not be cut off.
- COVID-19: New beneficiaries. The following will be considered vulnerable consumers and may be granted a 25% discount on their electricity bill:
    - Self-employed workers whose activities have ceased due to COVID-19 and who meet the established conditions.
    - Self-employed workers who, due to COVID-19, have experienced a drop in their turnover of 75% compared with the previous 6 months and who meet the established conditions.

The Social Thermal Payment[39], which is an aid programme providing compensation for thermal expenses incurred by the most vulnerable consumers for heating, hot water or cooking.

The Social Thermal Payment was created under Article 5 of Royal Decree-Law 15/2018 of 5 October 2018 on urgent measures for the energy transition and consumer protection with the aim of supplementing the aid received by vulnerable consumers under the Social Electricity Payment, for energy used for heating, domestic hot water, or cooking, irrespective of the source used.

Beneficiaries of the Social Electricity Payment as at 31 December 2018 are considered beneficiaries of the Social Thermal Payment without the need to go through any procedures or application process, as are those who had submitted a complete application prior to that date and had received a favourable result. In 2019, the aid granted was between 25 and 123.94 euro and could be combined with any other type of aid granted for the same purpose. The beneficiary's aid will be paid in a single annual payment into the beneficiary's current account from which the electricity bill is paid, and the amount of the aid varies depending on their level of vulnerability and the climatic zone in which their usual residence is located. If the consumer is severely vulnerable or at risk of social exclusion, the aid increases by 60% compared with the aid they are entitled to based on their climatic zone.

The budget allocated for this aid in 2019 was 75 million euro.

Figure 4.5. Webpages of the Social Electricity Payment and Social Thermal Payment.

	Social Electricity Payment
	Social Thermal Payment

[38] https://www.bonosocial.gob.es/

[39] http://www.bonotermico.gob.es/#inicio

Sources: https://www.bonosocial.gob.es/ and http://www.bonotermico.gob.es/#inicio.

4.4.2. Amendments and new regulations in the Autonomous Communities to adapt and develop state legislation on urban renovation, regeneration and renewal.

As mentioned above, Law 8/2013 introduced important developments in terms of Urban Renovation, Regeneration and Renewal at state level, which have now been recast with the basic land legislation in Royal Legislative Decree 7/2015 of 30 October 2015, approving the Recast Text of the Land and Urban Renovation Act.

However, in Spain, beyond basic state regulations and given that the Autonomous Communities are responsible for urbanism and housing, it is fundamental that the basic state legislation be incorporated and developed in each Autonomous Community. The way in which this incorporation and development has taken place has been very variable: some Autonomous Communities have introduced only some partial aspects, such as the Building Assessment Report (prior to the Ruling of the Constitutional Court), while very few (for example Galicia) have fully adopted the developments of Law 8/2013 and have developed them beyond the basic state legislation, adapting them to their regions. The table below shows the regulations on Urban Renovation, Regeneration and Renewal in force in each Autonomous Community, with the amendments corresponding to the period 2017-2020 shown in green.

AUTONOMOUS COMMUNITY	**Amendments and New Regulations in the Autonomous Communities to adapt to state legislation on Urban Renovation, Regeneration and Renewal.**
ANDALUSIA	No information on amendments after Law 8/2013 or Royal Legislative Decree 7/2015 to include developments in terms of renovation.
ARAGON	Legislative Decree 1/2014 of 8 July 2014 approves the Recast Text of the Law on Urbanism.
ASTURIAS	No information on amendments after Law 8/2013 or Royal Legislative Decree 7/2015 to include developments in terms of renovation.
BALEARICS	Law 2/2014 of 25 March 2014 on Planning and Land Use.
CANARY ISLANDS	Canary Islands Law 4/2017 of 13 July 2017 on Land and Nature Protection Areas in the Canary Islands (LSENPC), the Sixth Title of which regulates activities in the urban environment.
CANTABRIA	Law 7/2014 of 26 December 2014 on Fiscal and Administrative Measures amends Law 2/2001 (through the addition to Article 102 bis: Activities in the urban environment).
CASTILE-LA MANCHA	Law 3/2016 of 5 May 2016 on Administrative and Tax Measures amends the Law on Land Management and Urban Activity (LOTAU) (Article 138: Building Assessment Report).
CASTILE AND LEON	Law 7/2014 of 12 September 2014 on measures for urban renovation, regeneration and renewal and for sustainability, coordination and simplification in urbanism. Decree 6/2016 of 3 March 2016 amending the Castille and Leon Regulation on Urbanism to bring it in line with Law 7/2014 of 12 September 2014 on measures for urban renovation, regeneration and renewal and for sustainability, coordination and simplification in urbanism.
CATALONIA	Article 10 of Decree Law 5/2019 of 5 March 2019 on urgent measures to improve access to housing includes a new Fifth Additional Provision to the Recast Text of the Law on Urbanism (Legislative Decree 1/2010 of 3 August 2010) as a measure *'to facilitate the implementation of building renovation initiatives in the urban environment'*. That Fifth Additional Provision states that *'the scope of activity may be determined by means of urban planning, the conservation and renovation area declaration referred to in Article 36 of Law 18/2007 of 28 December 2007 on the right to housing, or by the processing procedure for urban management tools referred to in Article 119'*.
VALENCIA	Law 5/2014 of 25 July 2014 on Land Management, Urbanism and Landscape of the Autonomous Community of Valencia.
EXTREMADURA	Extremaduran Law 11/2018 of 21 December 2018 on Sustainable Land and Urban Management (LOTUSEx). That law includes various measures seeking to promote Urban Renovation, Regeneration and Renewal. The sixth section of the preamble to that law states that *'transverse criteria are established to promote urban regeneration and renovation, prioritising initiatives that highlight the value of the built heritage of Extremadura and renovate urban centres with empty buildings as opposed to new development processes'*. The Fifth Additional Provision of Extremaduran Law 11/2019 of 11 April 2019 on the promotion of and access to housing in Extremadura established the *Creation of the Extremadura Guarantee Fund for Energy Efficiency in Housing* with the aim of implementing a regional financial instrument to overcome the current financing barriers.
GALICIA	Galician Law 1/2019 of 22 April 2019 on Urban Renovation, Regeneration and Renewal (L3RG). Of all the new regulatory frameworks, this is the one that has incorporated and built on the developments outlined at national level by Law 8/2013 to the greatest extent, by introducing into Galician urban legislation specific new provisions seeking to address financing as the key problem of urban renovation, regeneration and renewal.
LA RIOJA	Law 13/2013 of 23 December 2013 on Fiscal and Administrative Measures for 2014, which amends Law 5/2006 of 2 May 2006 on Land Management and Urbanism.
MADRID	Decree 103/2016 of 24 October 2016 governs the Building Assessment Report and creates the Building Assessment Report Single Integrated Register for the Autonomous Community of Madrid.
MURCIA	Law 13/2015 of 30 March 2015 on Land and Urban Planning.
NAVARRE	Regional Legislative Decree 1/2017 of 26 July 2017 approving the Recast Text of the Regional Law on Land Planning and Urbanism (repealing Regional Law 35/2002 of 20 December 2002 on Land Planning and Urbanism, previously amended by Regional Law 5/2015 of 5 March 2015 on measures to promote sustainable urbanism, urban renewal and urban activity).
BASQUE COUNTRY	Law 3/2015 of 18 June 2015 on housing in the Basque Country primarily aims to regulate the constitutional right to enjoy decent and adequate housing within the Autonomous Community of the Basque Country. That right is recognised not only in relation to access to a first home, but also in relation to the conditions of the residential stock, the right to a decent and adequate urban or rural environment, in compliance with the commitments made under the Social Housing Pact of the Basque Country. The Renovation of buildings and improvement of the building stock with the aim of achieving energy and functional adequacy and comprehensive Urban Regeneration, which involves the reclassification of urban spaces and the economic and social revival of neighbourhoods, as well as promoting more streamlined land use and fostering more sustainable, homogeneous and harmonised growth under the compact-city model, are at the heart of the new vision emanating from the aforementioned pact and implemented via the Law.

4.4.3. Regulatory development at regional level to promote financing.

Various initiatives have recently come about to complement classic financing for renovation by means of non-repayable subsidies, with other innovative mechanisms such as guarantee funds (Extremadura, Basque Country), the loans of the Catalan Institute of Finance (Institut Català de Finances, ICF) and the Catalan Housing Agency (Agència de l'Habitatge de Catalunya, AHC), and the subsidised renovation loans of the Galician Institute of Housing and Land (Instituto Galego da Vivenda e Solo). These examples are explained in greater detail in section 5.4 below.

4.4.4. Renovation Strategies and Plans at regional level.

For the first time in Spain, the 2013-2016 State Housing Plan (Royal Decree 233/2013 of 5 April 2013) required, in Article 3(3)(d), partnership agreements signed by the Autonomous Communities and the cities of Ceuta and Melilla with the Ministry of Development for the implementation of the plan to include *'the global strategic plan proposed by the Autonomous Community or cities of Ceuta and Melilla regarding the implementation of the different programmes in the plan, with an estimate of the number of actions to be financed annually'*.

Beyond formal compliance with this requirement, which varies between the Autonomous Communities, some Autonomous Communities implemented real Regional Renovation Plans or Strategies. Below is an update to the information provided in the 2017 ERESEE on this aspect:

Castile and Leon.

In 2016, Castile and Leon approved the Strategy for Urban Regeneration in Castile and Leon (ERUrCyL[40]) so as to have a guide document for urban renovation, regeneration and renewal processes implemented within the Autonomous Community, whether via private initiatives or the various public authorities. While the ERUrCyL is not regulatory in nature nor a planning document, it seeks to act as a guide or tool to enable or facilitate the transition from the abstract concept behind regulatory provisions to the concrete action across the region for the group of (primarily public) agents involved in urban renovation and regeneration. In this sense, the Strategy aims to become a reference work that enables Municipal Councils in Castile and Leon to develop their own Municipal registers of vulnerable areas and Municipal renovation strategies. This will be possible based on the analysis on the homogeneous residential groups established in the City Files annexed to the document, and in line with the methodology contained therein. The ERUrCyL includes several Urban Regeneration indices calculated using homogeneous parameters, which will also make it possible to prioritise urban renovation, regeneration and renewal initiatives at municipal level and, at the same time, to comparatively assess and monitor these initiatives at Autonomous Community level.

Furthermore, within this Autonomous Community, the AEICE[41] (Innovative Business Group for Efficient Building) Efficient Housing and Building Cluster of Castile and Leon implemented the 3R Action Plan or Sustainable Rehabilitation Plan for Castile and Leon 2016-2020[42]. This 3R Action Plan is implemented in line with both the 2014 ERESEE and the ERUrCyL and is formed of a strategic plan and an operational plan to implement specific measures for action, with specific information on timetable, resources, investment and indicators. The 3R Action Plan is structured around five major strategic areas, for which a roadmap focused on citizens, owners and users as stakeholders has been drawn up to lay out their implementation through programmes and measures for each Area.

[40] http://www.jcyl.es/junta/cp/ERUCyL.pdf
[41] https://www.aeice.org/?lang=en
[42] http://planaccion3r.org/plan-a3r/tenemos-un-plan/

Figure 4.6. Areas of the 3R Action Plan or Sustainable Rehabilitation Plan for Castile and Leon 2016-2020.

	Area 1
	Training agents and strengthening the sector
	Read more
	Area 2
	Activating and boosting demand
	Area 3
	Obtaining financial sources and resources
	Area 4
	Creating models and guarantees
	Area 5
	Integrating and innovating Creating networks

Source: https://planaccion3r.org/ejes/

Catalonia.

In the case of Catalonia, the Regional Government approved the Catalan Strategy for Energy Renovation of Buildings (Estratègia Catalana de Renovació Energètica d'Edificis, ECREE)[43] in February 2014, i.e. prior to the publication of the ERESEE 2014. The ECREE builds on the previous work performed under the European MARIE project and contains an Action Plan with the executive description for each of the agreed actions, covering six areas (IT system; Communication and awareness-raising; Training and employment; Products and services; Organisational model and regulation; and Investment programme and financial mechanisms). There is also a Forum for Entities for the implementation of the Catalan Strategy for the Energy Renovation of Buildings.

Valencia.

In the Autonomous Community of Valencia, the Valencian Building Institute (Instituto Valenciano de la Edificación, IVE) published a *'Study of the Potential for Energy Saving and Reduction of CO2 Emissions in the Autonomous Community of Valencia'*[44], in 2015, in relation to the EPISCOPE project[45] *(Energy Performance Indicator Tracking Schemes for the Continuous Optimisation of Refurbishment Processes in European Housing Stocks),* financed by the EU with the aim of boosting energy renovation processes and constituting a continuation of the TABULA project, which identified residential types and characterised the building stock in participating countries[46]. Subsequently, the RENHATA[47] website was set up, on which an Action Plan for the Renovation and Renewal of Housing in the Autonomous Community of Valencia was announced, the aim of which is to plan the primary long-term actions to transform the building sector towards a sustainable, intelligent and inclusive growth model, based on the comprehensive renovation of residential buildings, with four areas of work: Financing and management; Training and employment; Information and awareness raising; and Innovation and development. The Bureau on Renovation of the Autonomous Community of Valencia was also set up as the coordinating and managing body for the Action Plan, with the aim of developing a cooperation, momentum and exchange platform

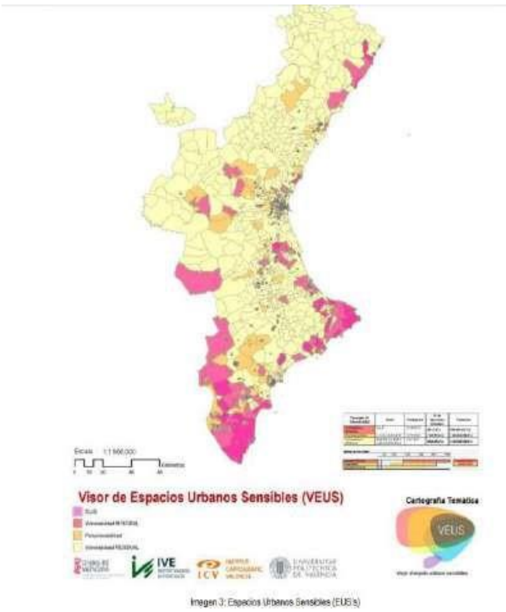
[43] http://icaen.gencat.cat/ca/plans_programes/ecree/
[44] http://episcope.eu/fileadmin/episcope/public/docs/pilot_actions/ES_EPISCOPE_RegionalCaseStudy_IVE.pdf
[45] http://episcope.eu/welcome/
[46] http://episcope.eu/building-typology/country/es/
[47] https://renhata.es/es

to give the agents involved a suitable framework to discuss their problems, concerns, needs and experience, and to promote and carry out common interest projects that foster and facilitate the building stock renovation and renewal process.

In terms of urban regeneration, Law 2/2017 of 3 February 2017 of the Valencian Government on the Social Function of Housing in Valencia, provides, in the Third Additional Provision, for the creation of the 'Housing and Urban Segregation Observatory' (Observatorio del Hábitat y la Segregación Urbana) with the aim of understanding, for example, the general and, in particular, public housing situation in quantitative and qualitative terms, the territorial distribution of housing and the indicators identified in the Valencian Government's public policies on housing and urban regeneration. The Observatory is attached to the Regional Ministry responsible for housing.

In this sense, the Valencian Government has also drawn up a series of Guidelines for the Development of Urban Regeneration Strategies in the Municipalities of the Autonomous Community of Valencia[48] (version 2, July 2018), and a Sensitive Urban Space Viewer (VEUS[49]) to identify the priority areas within each municipality that should undergo urban regeneration, in relation to the funds for the Urban Regeneration Initiatives given in the 2018-2021 State Housing Plan in the Autonomous Community of Valencia[50].

Figure 4.7. Sensitive Urban Space Viewer for the Autonomous Community of Valencia.



	Sensitive Urban Space Viewer (VEUS).
	Image 3: Sensitive Urban Spaces (EUS).

Source: https://visor.gva.es/visor/index.html?idioma=es&capasids=VEUS;4,3,2,1,0

Andalusia.

[48] http://www.habitatge.gva.es/documents/20558636/166160274/DIRECTRICES_ERU_V2_Julio_2018.pdf/72ef21b7-702e4151-99a8-f6e3c0b182a8
[49] https://visor.gva.es/visor/index.html?idioma=es&capasids=VEUS;4,3,2,1,0

[50] http://www.habitatge.gva.es/es/web/vivienda-y-calidad-en-la-edificacion/areas-de-regeneracio-y-renovacion-urbana

In Andalusia, the 'Andalusian Regional Strategy for social cohesion and inclusion. Intervention in less-favoured areas (ERACIS)'[51] was implemented with the aim of improving the quality of life of people living in less-favoured areas through the design, organisation and assessment of policies and regional and local public management, all with the active participation of citizens, the various authorities, and the public and private entities involved. The initiative is part of the Andalusian 2014-2020 ESF Operational Programme and the 'Design and Implementation of Local Strategies for Employability and Social Integration of People Experiencing or at Risk of Social Exclusion' (Regional Ministry of Equality and Social Policy) to tackle these situations. The ERACIS has four areas: sustainable economic and community development; public policies for well-being and social cohesion; improving housing and living conditions; networking and innovation in community social intervention.

To develop this, tools are proposed in the form of Local Intervention Plans for Less-Favoured Areas (PLIZD)[52]. These Local Intervention Plans for Less-Favoured Areas, coordinated by local authorities and developed and implemented jointly between the competent public authorities, neighbourhood social agents and residents, aim to implement measures in specific neighbourhoods. Calls for grants are in place to aid with the drafting and development of these Local Intervention Plans.

Basque Country.

By Order of the Regional Ministry for the Environment, Land Planning and Housing in November 2019, the 'Basque Urban Agenda - Bultzatu 2050'[53] was approved. It was drafted based on the UN New Urban Agenda and aligned with Sustainable Development Goal No 11, which aims to make cities inclusive, safe, resilient and sustainable, with nobody and no place left behind. The document contains eight strategic priorities and five cross-cutting principles, formulated into 33 intervention areas and 104 lines of action to be implemented over the next 30 years.

The new BULTZATU 2050 is a continuation of and update to the previous BULTZATU 2025, which targeted sustainable building and established objectives and indicators associated with reducing energy poverty and improving accessibility conditions, energy performance, living conditions, employment, innovation, etc. Within the framework of that agenda, an 'Assessment of intervention needs in the renovation of the building stock in the Autonomous Community of the Basque Country'[54] was drawn up in 2011, containing an inventory and assessment, broken down by each census section, of the residential buildings built before 1980 and their urban environment, with the aim of determining the actual situation of built-up physical space. The aim of the inventory was to enable renovation strategies to be identified and intervention priorities and strategies to be developed.

Finally, on the basis of the powers of the Autonomous Community of the Basque Country in terms of Housing, Land Planning and Urbanism, the assessment was drawn up in order to draft the *'Long-Term Renovation Strategy for the Building Stock in the Basque Country'*[55], with the aim of completing it over 2020. Through this work, the indicators for the architectural, energy and economic characterisation were identified, determining the performance and efficiency of the potential necessary interventions to guarantee minimum health conditions, minimum comfort conditions, conditions for being in or at risk of energy poverty and the performance and efficiency parameters of the intervention, so as to include these in the set of urban vulnerability indicators, which has been updated.

Navarre.

In Navarre, work is currently under way on a residential map of the Autonomous Community based on criteria of building age, state, and socio-economic characteristics of its residents, so as to identify vulnerable zones or

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51 https://www.juntadeandalucia.es/organismos/igualdadpoliticassocialesyconciliacion/areas/inclusion/zonastransformacion/paginas/planes-zonastransformacion.html
https://www.juntadeandalucia.es/export/drupaljda/Estrategia_Regional__Cohesion_Social-web.pdf

52 https://www.juntadeandalucia.es/export/drupaljda/Zonas_desfavorecida s_provincias_2018.pdf
53 https://www.euskadi.eus/informacion/bultzatu-2050-basque-urban-agenda/web01-a2lurral/es/
54 http://www.etxebide.euskadi.eus/x39-ovad03/es/contenidos/informacion/ovv_direcc_vivienda/es_ovv_sevi/ovv_sectorvivienda245_es.html
http://www.etxebide.euskadi.eus/contenidos/nota_prensa/npetxe120307_inventario_parque/es_npetxe/adjuntos/informe.pdf
55 https://www.euskadi.eus/informacion/regeneracion-urbana/web01-a2lurral/es/#5832

those with the greatest need for urgent renovation and to serve as a tool for planning future protected renovation activities.

Aragon.

Finally, in other Autonomous Communities, despite there being no specific strategy at regional level, a sort of network or cluster has been formed to promote renovation, for example, the creation of the 'Bureau for Building Renovation and Urban Regeneration' in Aragon in 2016[56].

4.4.5. Regional roll-out of One-Stop Shops and networks of Renovation Offices.

As in other European counties, the One-Stop Shops can be seen as simple web portals offering information and advisory services on renovation and improving energy performance in buildings. As this type of web portal is common is the various Autonomous Communities in terms of regional renovation programmes, below are some of the notable physical one-stop shop initiatives, set up in the form of Offices to promote renovation deployed across Spanish territory (covering a neighbourhood, a city or a district, in rural areas) which offer comprehensive citizen advice services:

Navarre.

In addition to a One-Stop Shop in the form of a web portal providing information on renovation[57], the Autonomous Community of Navarre also has a long tradition of District Renovation Offices, which were created in 1986-87. In 1988, regulations were introduced governing the granting of aid to finance these offices, by means of Regional Decree 289 of 14 December 1988. Since then, the District Offices have gathered long and fruitful experience in the Autonomous Community, with some, such as the majority of those located in District and Region capitals, having celebrated 25th anniversaries (Estella, Tudela, Sanguesa, Elizondo, Alsasua, for example). Today, these are known as Housing and Building Renovation Offices (Oficinas de Rehabilitación de Viviendas y Edificios, ORVE[58]) and are regulated by means of Regional Decree 363/1997 of 9 December 1997 governing the functions of the Municipal and District Renovation Offices and the granting of aid to finance these offices (Official Gazette of Navarre of 24 December 1997). Each year, aid is provided to finance six of these Offices, with an annual total of approximately 1 100 000 euro.

Furthermore, Navarre has a public land and housing company, NASUVINSA, which is also very active in the field of renovation, offering consultancy, support and management equipment to private individuals, residents' associations, private promoters or municipal councils and local entities for housing and building renovation projects as well as overall projects at neighbourhood level. This company has implemented the projects in the neighbourhood of Txantrea and the Lourdes neighbourhood in Tudela, with a view to expanding this strategy to other districts of Pamplona-Iruña or other municipalities of Navarre. A further three offices are attached to NASUVINSA, thereby completing the Navarre network of nine Renovation Offices.

OIR Network in the Autonomous Community of Valencia.

The OIR Network[59] (Oficinas de Información para la Rehabilitación - Renovation Information Offices) is an initiative set up by the Valencian Government that aims to establish, through local entities, a culture of renovation among the public, so that they are aware of the importance of maintaining their buildings and understand how to properly approach a renovation project, benefiting from the economic assistance offered by the authorities. This network is also aimed at professionals in the construction sector, through training and information, as these are key players in the planning and implementation of maintenance or renovation work and essential partners in guiding users in these areas.

[56] https://www.cepymearagon.es/?p=2364
[57] https://www.navarra.es/home_es/Temas/Vivienda/Ciudadanos/Rehabilitacion/

[58] https://www.navarra.es/home_es/Temas/Vivienda/Ciudadanos/Rehabilitacion/Tramitacion/ORVE/

[59] https://renhata.es/es/ciutadania/red-oir

The Municipalities that are part of the OIR Network provide their citizens and professionals with an information point, bringing together up-to-date information on aid, applicable regulations and good renovation practices, and also work actively together with the regional administration both in collecting data on the conditions of the existing building stock or the urban quality of neighbourhoods/areas and on interventions being carried out in these areas, as well as in identifying and rolling out the most suitable strategies for urban renovation, regeneration and renewal.

Figure 4.8. List of member municipalities of the OIR Network in the province of Alicante (updated as at 20 April 2018).

(Actualizado el 20-04-2018)

Provincia de ALICANTE			
MUNICIPIO	WEB	MUNICIPIO	WEB
ALACANT/ALICANTE	http://www.alicante.es	ALFAFARA	http://www.alfafara.es
ASPE	http://aspe.es/	ALTEA	http://www.altea.es
BENFERRI	http://www.benferri.es	BENIARBEIG	http://www.beniarbeig.org/
BENIDORM	https://benidorm.org/es	BENISSA	http://www.ayto-benissa.es
CALP	http://www.calp.es	CALLOSA D'EN SARRIÀ	http://www.callosa.es
DÉNIA	http://www.denia.es	ELDA	http://www.elda.es
ELX	http://www.elche.es	FINESTRAT	http://www.finestrat.es
MANCOMUNITAT LÁLCOIÀ I EL COMTAT	http://lamancomunitat.org/	ORBA	http://orba.spotlio.com/home
PEGO	http://www.pego.org	RELLEU	http://www.relleu.org
SANT JOAN D'ALACANT	http://www.santjoandalacant.es	SANT VICENT DEL RASPEIG	http://www.raspeig.es
SANTA POLA	http://www.santapola.es	TORRE MAÇANES	http://www.torremanzanas.es/
TORREVIEJA	http://www.torrevieja.es	VILA JOIOSA	http://www.villajoyosa.com
VILLENA	http://www.villena.es	XIXONA	http://www.xixona.es/

	INFORMATION AND AWARENESS RAISING
	Information and Renovation office
	(Updated on 20 April 2018)
	Province of ALICANTE
	MUNICIPALITY
	WEB
	ALACANT/ALICANTE
	http://www.alicante.es
	ASPE
	http://www.aspe.es/
	BENFERRI
	http://www.benferri.es
	BENIDORM
	https://benidorm.org/en
	CALP
	http://www.calp.es
	DÉNIA
	http://www.denia.es
	ELX
	http://www.elche.es
	MANCOMUNITAT LÁLCOIÁ I EL COMTAT
	http://www.lamancomunitat.org/
	PEGO
	http://www.pego.org/en/
	SANT JOAN D'ALACANT

	http://www.santjoandaiacant.es
	SANTA POLA
	https://www.santapola.es/?lang=en
	TORREVIEJA
	http://www.torrevieja.es
	VILLENA
	http://www.villena.es
	ALFAFARA
	https://www.alfafara.es/en/
	ALTEA
	http://www.altea.es
	BENIARBEIG
	http://www.beniarbeig.org/
	BENISSA
	http://www.ayto-benissa.es
	CALLOSA D'EN SARRIÁ
	http://www.callosa.es
	ELDA
	http://www.elda.es
	FINESTRAT
	http://www.finestrat.es
	ORBA
	http://www.orba.spotlio.com/home
	RELLEU
	http://www.relleu.org
	SANT VICENT DEL RASPEIG
	http://www.raspeig.es
	TORRE MAÇANES
	http://www.torremanzanas.es/
	VILA JOIOSA
	http://www.villajoyosa.com
	XIXONA
	http://www.xixona.es

Source: *https://renhata.es/es/ciutadania/red-oir*

Galicia: Network of Renovation Offices, Rexurbe Centres and Forum of Historic Urban Centres for Renovation Offices.

In Galicia, work has been under way on this line of action for several years and was consolidated with the creation of the Network of Renovation Offices and the Rexurbe Centres provided for under Law 1/2019 of 22 April 2019 on urban renovation, regeneration and renewal in Galicia.

In Galicia, the Forum of Renovation Offices[60] has the objective, firstly, of exchanging information between the Renovation Offices of Historic Urban Centres and, secondly, of publishing information for the public on the different initiatives being carried out under the various renovation tasks.

OPENGELA Network in the Basque Country.

The Autonomous Community of the Basque Country has extensive experience in management via local offices. The approval of Decree 278/1983 of 5 December 1983 on the renovation of built and urbanised heritage brought with it an obligation to form an Urban Renovation Society (Sociedad Urbanística de Rehabilitación, SUR) created for the purposes of the Integral Rehabilitation Area declaration (Área de Rehabilitación Integral, ARI). Over time, that regulation evolved to include Degraded Areas (Áreas Degradadas, AD).

With this framework, which has been in place for almost 40 years, over 120 ARI or AD declarations have been processed; however, there are only 17 Urban Renovation Societies, which do not cover all the areas for which

[60] http://igvs.xunta.gal/web/paraquen/40

that declaration has been issued. As is usual, the regulation included an exception to the formation of these entities, which, over time, has become the norm.

This has led to poor installation and coverage of assistance and support services for local management in the areas with the greatest need. Furthermore, with the urban vulnerability register, we were able to verify that all the areas under an ARI or AD declaration still exhibit conditions of vulnerability, after almost 40 years of action by public authorities with very notable levels of investment.

For this reason, the aim of the OpenGela programme (which builds on the European HIROSS4all project) is to design a business model that will enable the rollout of a management model with local offices across the entire Autonomous Community of the Basque Country, which includes both support and technical, legal and administrative assistance services and the financial/economic aspects.

The proposal consists in creating a Managing Body to collaborate on, promote and develop public policy on building renovation and urban regeneration at regional level and support and coordinate the network of one-stop shops that will be set up at municipal level.

BOX 11. OPENGELA: RENOVATION OFFICES IN THE BASQUE COUNTRY.

Opengela [61] *is a project seeking to extend urban regeneration in the Basque Country by using an innovative tool: 'the creation of neighbourhood offices acting as one-stop shops to serve residents'.*

*Each neighbourhood office (**Opengela**) is centrally responsible for the management tasks associated with the comprehensive building renovation process: from administrative paperwork to managing the relationship with the professionals involved in the works or providing financial aid.*

The programme is aimed at private individuals and homeowners' associations wanting to renovate their buildings and also seeks to involve them in the renovation process and support them from the outset.

During the initial phase, Opengela launched two pilot projects in the neighbourhoods of Otxarkoaga (Bilbao) and Txonta (Eibar). The objective is to replicate this model in other places within the Basque Country and Europe.

It is a matter of improving the quality of life for residents in their neighbourhoods, making buildings more energy efficient, providing universal accessibility (lifts, etc.) and installing minimum protection and fire safety systems. Throughout the project, the residents are the focus; they become part of the process.

This project funded by the European Commission's Horizon 2020 programme started with a pilot test in two neighbourhoods: Otxarkoaga (Bilbao) and Txonta (Eibar).

The project has aid funding of 1.7 million euro from the European Commission's Horizon 2020 programme for the 2019-2022 period.

	¿WHY
	SHOULD I FULLY RENOVATE MY BUILDING?
	BECAUSE IT WILL IMPROVE QUALITY OF LIFE IN YOUR HOME:
	A safer, more accessible home.
	Because I will have a healthier home, without dampness, with less risk of illness: asthma, rheumatism.
	Cooler in summer and warmer in winter.
	Better insulated against outside noise.
	WILL I
	RECEIVE FINANCIAL SUPPORT?
	Yes, the Basque Government and Municipal Council have aid for:
	A Technical Building Inspection, if not already done.
	Fire safety.
	Universal accessibility (installation of a lift, etc.).

[61] http://opengela.eus/

	Improvements in the energy performance of the facades, roof insulation and installation.
	Yes, I will receive aid if my homeowners' association agrees to support these measures.
	Yes, there is additional aid available for households with fewer resources.
	Yes, there will be financing facilities.
	WHERE
	CAN I GO FOR MORE INFORMATION?
	OTXAR OPEN**GELA**
	TO THE OTXAR OPENGELA OFFICE
	Avenida Pau Casals, 16 (Otxarkoaga, Bilbao). Frente a plaza Kepa Enbeita.
	94 685 19 32
	otxaropengela@vvmm.bilbao.eus
	www.opengela.eus
	Bilbao Etxebizitzak

OSIR (Oficina de Servicios Integrales para la rehabilitación energética de viviendas - Comprehensive Service Office for the energy renovation of housing) in Extremadura.

The 'Comprehensive Service Office for the energy renovation of housing' is an initiative launched by the Extremaduran Energy Agency (AGENEX) and the Extremaduran Government, co-financed with European H2020+CA funds.

The objective is to perform comprehensive energy renovation on blocks of dwellings and single-family houses in the region. To achieve this, the office provides technical, financial and legal advice and assistance throughout the renovation process. This assistance is free of charge for homeowners for the duration of the project.

The OSIR's activities are:

1. Technical feasibility studies.
2. Economic feasibility studies.
3. Possibility of access to a specific financing fund with advantageous conditions and to other aid and grants.
4. Advice for homeowners' associations.
5. Advice when selecting companies to carry out the renovation work.
6. Advice on the aid available for the renovation project.

4.4.6. Innovations and advances in the planning, management and financing of renovation at municipal level.

Municipal involvement is fundamental to the roll-out of renovation, as, ultimately, all activities must be implemented across the region. The section below provides an analysis of some of the most important elements for this roll-out, such as the Renovation plans or strategies at municipal level, the Municipal renovation funding programmes and the Development of management tools: urban planning, one-stop shops/renovation offices, etc. Furthermore, there must be a good level of coordination between these three elements in order to deploy renovation at municipal level.

Renovation Strategies or Plans at municipal level. The first key element in the planning of renovation activities at municipal level, identifying priority action areas and planning, for each of those areas, the schedule, financial scheme and urban planning and management tools required for implementation.

Here, we can mention the following examples: for a medium-sized city, the 'Master Plan for Urban Regeneration and Renovation Plan in Albacete'; for a small municipality, the 'Master Plan for the Comprehensive Urban Regeneration of the Historic and Artistic Centre of Alcalá del Júcar', also in the province of Albacete.

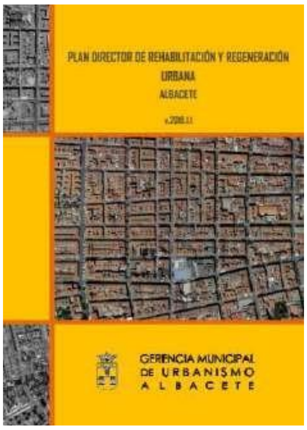
BOX 12. EXAMPLE RENOVATION STRATEGY OR PLAN IN A MEDIUM-SIZED CITY: ALBACETE (POPULATION: 390 337).

In November 2018, Albacete City Council released the 'Master Plan for Urban Regeneration and Renovation Plan in Albacete'. According to that document, 'the main objective of this Master Plan is to establish a unified regeneration and renovation strategy for the city of Albacete, as an alternative to the approach involving large developments of surrounding land and returning the focus to the built city. To achieve this, the Master Plan establishes and analyses bases for action focussed on the urban renovation of areas given priority in the Executive Council Agreement (those for which action is required first) and on providing a description of the action required to implement the suggestions, with the likely level of detail of a Master Plan. The initial areas identified are: La Milagrosa area; Ensanche area (Fátima-Franciscanos); Santa Teresa area; Hermanos Falcó area ('500 Viviendas' [500 homes]); Calle Burgos area. Likewise, the Plan also aims to provide the elements required, where applicable, to enable people to apply for the renovation and regeneration aid laid down in the State and regional housing plans.

[…]This plan in not intended as an exhaustive, all-encompassing document, but simply seeks to lay the foundations for developing urban renovation and regeneration action in Albacete, while at the same time providing an initial analysis and proposals for action in the areas identified initially, which may be eligible for public aid for short-term renovation and regeneration'.

The document begins by considering how this could be coordinated with other initiatives in the city, such as the Integrated Sustainable Urban Development Strategy (ISUDS), the General Town Planning Plan or the Municipal Order on the

Conservation and Periodic Inspection of Buildings and Structures. The measures envisaged are summarised in the table below and are coordinated on the basis of the establishment of a Technical Urban Regeneration and Renovation Office, as the first basic element for the subsequent roll-out, as part of a second phase, of the various actions proposed for each of the priority areas identified, some of which require the drafting or amendment of the urban plan.



MEDIDAS PLAN DIRECTOR REHABILITACIÓN Y REGENERACIÓN URBANA

Medida	Actuaciones que comprende	Medios para la ejecución	Repercusión económica	Plazo estimado ejecución
1	Oficina Técnica de Rehabilitación y Regeneración urbana.			
	Constitución Oficina.	GMUyV	12.000 €/año	2018
	Adaptación de la normativa municipal a criterios del TRLSyRU15.	GMUyV - Ayto	Fondos EDUSI	2018
	Reactivación convenio ITEs con el COACM y COAAT.	GMUyV - COAB	A determinar (convenio)	2018
	Modernización bases de datos como apoyo a la regeneración.	GMUyV	Fondos EDUSI	2019
2	Modificación de planeamiento en la zona de Santa Teresa, calle Burgos y Hnos. Falcó.			
3	Área de Regeneración y Renovación Urbana (ARRU) en Santa Teresa – Hermanos Falcó – Calle Burgos – "Viviendas de RENFE"			
	Reurbanización de espacios públicos.	URVIAL (gestión ayudas)	A determinar en memoria ARRU	2018-2021
	Rehabilitación integral de edificios.	URVIAL (gestión ayudas)	A determinar en memoria ARRU	2018-2021
4	Mejora urbanística de la Zona de Ensanche Fátima-Franciscanos.			
	Estudio previo dotaciones.	GMUyV	Fondos EDUSI	2019
	Redacción instrumento planeamiento.	GMUyV	Personal propio	2019-2020
5	Programación de la reforma interior de la Zona "La Milagrosa".			
	Redacción PERI.	GMUyV	Personal propio/encomienda URVIAL	2019
	Redacción Proyecto urbanización/reparcelación.	GMUyV	Personal propio	2020
	Ejecución PAU (gestión directa s/convenio JCCM-Ayto.).	A determinar	A determinar	2020-2022
6	Reforma interior de ámbito de suelo no consolidado en La Estrella.			
	Delimitación y remisión a Reforma Interior en La Estrella.	GMUyV	Personal propio/encomienda URVIAL	2019
	Fijación condiciones para programación.	GMUyV	Personal propio	2020

Source: Albacete Town Planning Authority 'Master Plan for Urban Regeneration and Renovation Plan in Albacete'.

http://www.albacete.es/es/por-temas/urbanismo-y-obras/documentos/plan-director-rr.2018.1.1

	MASTER PLAN FOR URBAN REGENERATION AND RENOVATION
	ALBACETE
	TOWN PLANNING AUTHORITY
	ALBACETE
	MEASURES IN THE MASTER PLAN FOR URBAN REGENERATION AND RENOVATION
	Measure
	Actions involved
	Resources for implementation
	Economic impact
	Estimate time frame for implementation
	Technical Urban Regeneration and Renovation Office.
	Creation of the Office.
	Adaptation of municipal regulations to TRLSyRU15 (2015 Recast Text of the Land and Urban Renovation Act) criteria.

	Reactivation of Technical Building Inspection agreement with COACM and COAAT.
	Modernisation of databases to support regeneration.
	GMUyV
	GMUyV - Council
	GMUyV - COAB
	GMUyV
	€12 000/year
	ISUDS funds
	Tbd (agreement)
	ISUDS funds
	2018
	Plan amendment for the Santa Teresa, Calle Burgos and Hermanos Falcó areas.
	Urban Renewal and Regeneration Area (ARRU) in Santa Teresa – Hermanos Falcó – Calle Burgos – 'Viviendas de RENFE' [RENFE housing]
	Reurbanisation of public spaces.
	Comprehensive building renovation.
	URVIAL (aid management)
	TBD in ARRU report
	2018-2019
	Urban improvements in Ensancho Fátima-Franciscanos area.
	Study prior to funding.
	Drafting of planning tool.
	ISUDS funds
	Own HR
	Scheduling of internal refurbishment of 'La Milagrosa' area
	Drafting of the Special Internal Refurbishment Plan (PERI).
	Drafting of urbanisation/reparcelling project.
	Urbanisation Action Plan (PAU) implementation (direct management under agreement between the Regional Government of Castile-La Mancha and the Council).
	Tbd
	Own HR/URVIAL assignment
	Own HR
	Internal refurbishment of non-consolidated land in La Estrella.
	Scope and referral for Internal Refurbishment in La Estrella.
	Specification of conditions for scheduling.

BOX 13. EXAMPLE RENOVATION STRATEGY OR PLAN IN A SMALL MUNICIPALITY: ALCALÁ DEL JÚCAR (POPULATION: 1 199)

Responding to the competitive call for proposals held in 2016 by the Regional Government of Castile-La Mancha for the pilot programme 'to Promote Sustainable and Competitive Cities' as regulated in Chapter IX of the State Plan, the Municipal Council of Alcalá del Júcar submitted a proposal and received funding to draw up a Master Plan for Comprehensive Urban Regeneration of the Historic and Artistic Centre of Alcalá del Júcar. In line with the provisions of the call for proposals, the contents of that master plan are integrated and are very similar to the elements required for the Integrated Sustainable Urban Development

Strategies (ISUDS): an Assessment, a SWOT analysis, an Implementation Plan for the Strategy laid down in the comprehensive urban regeneration action plan, etc. This is therefore an interesting example of the integrated methodology proposed for the ISUDS being applied to a small municipality. As this is an integrated proposal, the Investment Programme in the Master Plan includes 67 projects, broken down into 47 lines grouped into four broad chapters: Promotion and Preservation of Heritage, Sustainable Regional Competitiveness, Family Reconciliation and Social Cohesion, and Economic Promotion. For each of these, the source of the funding required for implementation is identified (specifying whether the funds would come from the State, the Autonomous Community, the Provincial Council or the Municipal Council), a priority level is established and an estimated budget allocated. The total amount for the proposed measures is 7.8 million euro. The projects requiring larger sums are: the removal of negative impacts in building (0.525 million euro); converting the Historic and Artistic Centre into a sustainable urban environment (0.54 million euro); the Urban Renewal and Regeneration Areas (2.97 million euro) and two social cohesion programmes (0.36 million euro).

In 2018, the Alcalá del Júcar Urban Renewal and Regeneration Area received 1 332 624 euro during the call for proposals held by the Regional Government of Castile-La Mancha to select new Urban Renewal and Regeneration Areas as part of the extension of the State Plan.

PROGRAMA DE INVERSIONES DEL PLAN DIRECTOR DE REGENERACIÓN URBANA INTEGRAL DEL CONJUNTO HISTÓRICO ARTÍSTICO DE ALCALÁ DEL JÚCAR (ALBACETE)

EJE SECTORIAL	OBJETIVO SECTORIAL	Nº Proy.	ORIGEN FINANCIACIÓN					RANGO DE PRIORIDAD			PRESUPUESTO ASIGNADO
			Estado	CC.AA.	Dip. AB	Ayto.	Privados	P-1	P-2	P-3	
I	Promoción y preservación del patrimonio	31									2.983.200 €
I-1	Identificación y comprensión del Patrimonio	9									242.500 €
I-1.1	Elaboración de material divulgativo del patrimonio cultural.	1				X	X	1			25.000 €
I-1.2	Recopilación, ordenación y catalogación del patrimonio cultural.	1			X				2		12.000 €
I-1.3	Aplicación de nuevas tecnologías para la documentación del patrimonio cultural.	3	X	X	X	X		1	2	3	42.000 €
I-1.4	Elaboración de estudios sobre el Patrimonio Cultural.	1			X					3	6.000 €
I-1.5	Soporte divulgativo del Conjunto Histórico Artístico y su contexto territorial	1	X	X	X	X			2		47.500 €
I-1.6	Herramientas de monitorización del Patrimonio Cultural.	1		X		X			2		25.000 €
I-1.7	Órganos de gestión y asesoramiento del Patrimonio Cultural.	1		X	X	X	X	1			85.000 €
I-2	Protección y conservación del Patrimonio	4									1.709.000 €
I-2.1	Catalogación del Patrimonio Cultural	1		X	X					3	15.000 €
I-2.2	Protección frente a riesgos, del Patrimonio Cultural	1	X	X	X			1			1.590.000 €
I-2.3	Incentivos para la conservación del Conjunto Histórico Artístico	1				X		1			90.000 €
I-2.4	Racionalización de la gestión del Patrimonio Cultural	1		X	X	X			2		14.000 €
I-3	Rehabilitación y valorización del Patrimonio	14									978.000 €
I-3.1	Incentivación de la rehabilitación edilicia (pública y privada)	1	X	X		X		1			68.000 €
I-3.2	Eliminación de impactos negativos en la edificación	4	X	X		X	X	1			525.000 €
I-3.3	Actuaciones de regeneración del tejido urbano	2				X	X	1			40.000 €
I-3.4	Recuperación funcional de bienes patrimoniales	1				X				3	40.000 €
I-3.5	Implantación de nuevas dotaciones y servicios	2		X	X	X		1	2		175.000 €
I-3.6	Regeneración y recualificación del espacio público	2		X	X	X		1	2		50.000 €
I-3.7	Puesta en valor de los yacimientos arqueológicos	1	X	X					2		30.000 €
I-3.8	Puesta en valor del sistema museístico local	1				X	X		2		50.000 €
I-4	Transmisión y difusión del Patrimonio	4									53.700 €
I-4.1	Posicionamiento del municipio en la red	1				X		1			7.200 €
I-4.2	Promoción y difusión de buenas prácticas en la intervención del patrimonio	1				X		1			6.500 €
I-4.3	Desarrollo de modelos innovadores de difusión patrimonial, apoyados en TICs	2			X	X			2		40.000 €

	MASTER PLAN FOR COMPREHENSIVE URBAN REGENERATION OF THE HISTORIC AND ARTISTIC CENTRE OF ALCALÁ DEL JÚCAR (ALBACETE)
	INVESTMENT PROGRAMME LAID DOWN IN THE MASTER PLAN FOR COMPREHENSIVE URBAN REGENERATION OF THE HISTORIC AND ARTISTIC CENTRE OF ALCALÁ DEL JÚCAR (ALBACETE)
	SECTORAL AREA
	SECTORAL OBJECTIVE
	No of Projects
	FINANCING SOURCE
	State
	Autonomous Community
	Provincial Council
	Municipal Council
	Private parties
	PRIORITY LEVEL
	P-1
	ALLOCATED BUDGET
	Promotion and Preservation of Heritage
	€2 983 200
	I-1
	Identification and understanding of heritage
	€242 500
	€6 000

	Drafting of information material on cultural heritage
	Compilation, sorting and cataloguing of cultural heritage
	Application of new technologies to document cultural heritage
	Development of emblems for cultural heritage
	Information medium for the Historic and Artistic Centre and territorial context
	Tools for monitoring cultural heritage
	Management and consultancy bodies for cultural heritage
	Protection and Conservation of Heritage
	Cataloguing of cultural heritage
	Protection of cultural heritage from risks
	Incentives for the conservation of the Historic and Artistic Centre
	Streamlining of management of cultural heritage
	Renovation and Development of Heritage
	Incentivisation for building renovation (public and private)
	Removal of negative impacts of building
	Action for urban fabric regeneration
	Functional recovery of assets
	Setup of new funding and services
	Regeneration and reclassification of public spaces
	Allocation of value to archaeological sites
	Allocation of value to local museum structures
	Transmission and Broadcasting of Heritage
	Positioning of the municipality in the network
	Promotion and distribution of good practices in interventions involving heritage
	Development of innovative models to disseminate heritage, underpinned by IT systems

Municipal renovation financing programmes.

The implementation of a Renovation Strategy or Plan at municipal level involves developing an approach for the corresponding financing schemes for each of the actions proposed. Along with the various financing sources (public: European, State or regional, or private), some municipal councils also contribute their own resources, usually in the form of subsidies.

BOX 14. EXAMPLE OF COMPREHENSIVE INTEGRATED APPROACH AT MUNICIPAL LEVEL: MADRID CITY COUNCIL (POPULATION 3 266 126).

Although it does not have a specific Renovation Strategy or Plan, Madrid City Council does have a map showing the Preferential Areas for Urban Renovation (Áreas Preferentes para la Intervención de Rehabilitación Urbana, APIRUs)[62]*, identified on the basis of a study of urban vulnerability indicators in the city. The purpose of identifying these preferential areas (APIRUs) is to designate the priority urban areas within the region for implementing an Urban Regeneration and Territorial Rebalancing Strategy as part of sustainable urban development.*

Furthermore, Madrid City Council has launched its own financing and management programme, to run alongside other existing financing lines. This is known as the Madrid Recupera [Madrid Recovers] Plan or Mad-Re Plan[63]*. The map of the*

[62] https://www.madrid.es/UnidadesDescentralizadas/UrbanismoyVivienda/Urbanismo/Destacamos/PlanMAD-RE/PlanMADRERecuperaCasa%20Recupera%20tu%20barrioRecuperaCiudad/Ficheros/ANEXO1MapaAPIRU2018.pdf
[63]http://www.madrid.es/portales/munimadrid/es/Inicio/Vivienda-y-urbanismo/Plan-MAD-

APIRUs has been used as a reference guide for applying the various public calls for proposals for the granting of subsidies for the implementation of measures of accessibility, conservation and energy efficiency of existing residential buildings within the council's remit. The aid (details of which can be seen in the box below) covers conservation, accessibility and efficiency of buildings and is provided in the form of subsidies, capped at a maximum amount per dwelling or a maximum percentage of the measure.

Finally, the Mad-Re Plan, which focuses exclusively on building renovation, falls within a broader urban regeneration strategy at city level known as the 'Madrid Recupera Plan. Urban Regeneration Strategy'[64]. This Urban Regeneration Strategy is based on the commitments made in the New Urban Agenda adopted at the United Nations Conference held in Quito in 2016 and the objectives of the 2030 Agenda for Sustainable Development, which, based on an ecological and social perspective, prioritises public policies targeting the existing city with a view to developing a smarter, more sustainable and more socially inclusive model. The Strategy is an action framework and a tool for municipal administrative coordination for urban regeneration, and includes a programme of 375 measures: 37% associated with public space projects; 27% with urban mobility projects; 4% with environmental projects; 13% measures for comprehensive neighbourhood regeneration; and 19% planning proposals for new urban centres. It covers the period 2019-2030 and has a budget of 730 million euro.

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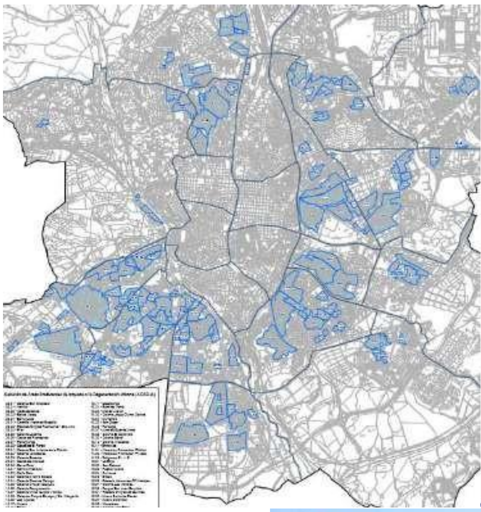
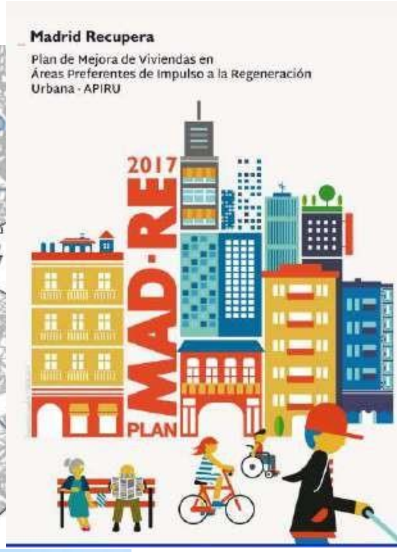
[64] https://transparencia.madrid.es/portales/transparencia/es/Organizacion/Planes-y-memorias/Planes/Plan-MadridRecupera-Estrategia-de-Regeneracion-Urbana/?vgnextfmt=default&vgnextoid=251b21a54bf68610VgnVCM1000001d4a900aRCRD&vgnextchannel=d869508929a56510VgnVCM1000008a4a900aRCRD





	Madrid Recupera
	Plan to Improve Housing in Preferential Areas for Urban Renovation (APIRUs)
	What form does the aid take and what subsidy percentage would apply per project?
	ACCESSIBILITY
	Installation of lift, stair-lift, ramps, etc.
	70%
	€10 000/dwelling
	ENERGY PERFORMANCE

	Thermal insulation, window replacement, heating and cooling equipment replacement, renewable energy and green roofs, etc.
	maximum
	€8 000/dwelling
	CONSERVATION
	Repair of deteriorated shared elements
	minimum
	General installations and specific repairs to roofs/facades.
	OTHER EXPENSES
	Fees, taxes, etc.
	€15 000/building
	In groups of 5 or more communities within the same APIRU.
	When will I receive aid under the MAD-RE plan?
	Half at the start
	Half at the end
	Aid under the MAD-RE plan includes VAT
	and is non-repayable
	Who is it intended for?
	Homeowners' associations
	Owners of single-family dwellings
	Minimum investment
	€30 000/building
	€ 20 000/building for accessibility
	What do I need in order to apply for aid?
	Agreement of homeowners' association
	Permit application or equivalent
	Aid application
	Three quotes for the works
	Works plan (if necessary)
	Building Assessment Report (including Technical Building Assessment)
	The basis for this call for proposals will be published in due course.
	Practical examples
	'We do not have a lift and pay very high energy bills because we do not have insulation'
	Community of 20 residents within an APIRU.
	We install a lift
	70%
	€160 800
	We conduct energy performance works to improve the energy rating by two letters (50% saving)
	We install a life and conduct energy performance works to improve the energy rating by two letters (50% saving)
	These examples are guides only.

Development of management tools: urban planning, One-Stop Shops/Renovation Offices, etc.

In addition to financing, the implementation of a Renovation Strategy or Plan at municipal level also involves developing the tools required for its management.

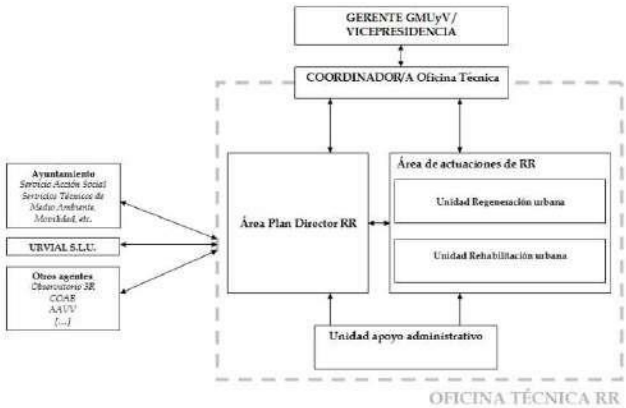
In some cases, it may be necessary to develop urban planning tools to enable the measures to be implemented. These tools may range from conventional Special Internal Refurbishment Plans (PERIs) to identifying areas of action as specified in Law 8/2013. In this sense, the innovations made by some Autonomous Communities to bring flexibility to the identification of these areas are noteworthy, such as the Catalan example mentioned below.

BOX 15. EXAMPLE OF HOW TO BRING FLEXIBILITY TO THE IDENTIFIATION OF AREAS OF ACTION.

In Catalonia, Decree Law 5/2019 of 5 March 2019 on urgent measures to improve access to housing introduced a new Fifth Additional Provision to the Recast Text of the Law on Urbanism (Legislative Decree 1/2010 of 3 August 2010) according to which 'the area of action may be determined by means of urban planning, the conservation and renovation area declaration referred to in Article 36 of Law 18/2007 of 28 December 2007 on the right to housing, or by the processing procedure for urban management tools referred to in Article 119'.

The existence of One-Stop Shops and/or Renovation Offices is also important, whether at municipal lever or decentralised in the areas of action, depending on the size of the municipality. In this particular area, Spain has a long tradition, from the regional networks mentioned above to the offices at municipal level. It is important to highlight that the current 2018-2021 State Housing Plan (Royal Decree 106/2018) has a facility, established in its Programme to Promote Urban and Rural Renewal and Regeneration (Article 51), to provide funding for *'expenses for preparing projects and works management, planning teams and offices, information (one-stop shop), management and social support for measures eligible for funding'*, up to 1 000 euro/dwelling.

Figure 4.9. Proposed Structure for the Albacete Technical Regeneration and Renovation Office.



	GMUyV MANAGER/VICE-PRESIDENCY
	Technical Office COORDINATOR
	Regeneration and Renovation Action Areas
	Urban Regeneration Unit
	Urban Renovation Unit
	Regeneration and Renovation Master Plan Area
	URVIAL S.L.U.
	Other agents
	COAB
	Residents' Associations
	(…)
	Administrative Support Unit
	Technical Regeneration and Renovation Office

Source: Albacete Town Planning Authority 'Master Plan for Urban Regeneration and Renovation Plan in Albacete'.

In the example already mentioned for the Basque Country, the OpenGela programme network, extended throughout the Autonomous Community of the Basque Country, proposes creating management offices at municipal level (One-Stop Shops) but coordinated at Autonomous Community level by the Managing Body. These One-Stop Shops will be formed in collaboration with the Municipal Councils. Their objective will be to intervene at municipal level by implementing Building Renovation and Urban Regeneration policies in that municipal district.

Furthermore, and given that, in Spain, homes in homeowners' associations in collective dwelling buildings form the majority, and that many of those buildings dating from the 1940s-1980s are located in homogeneous neighbourhoods that may include thousands of dwellings and hundreds of buildings, it is important that, where these are renovated individually, there is a holistic unitary plan, for example the Comprehensive Intervention Projects in Navarre and the Coordination Documents in Zaragoza.

BOX 16. EXAMPLE OF ACTION MANAGEMENT COORDINATION IN LARGE URBAN COMPLEXES.

In Navarre, regulations have been laid down to govern the 'Comprehensive Intervention Projects'[65], which provide a road map of the measures to be implemented on a building or group of buildings, irrespective of whether those measures are performed in phases. In the specific case of Pamplona City Council, this authority subsidises the preparation of a Comprehensive Intervention Project covering a specific area by means of a public call for proposals[66]. To date (April 2020), 18 of these 'Comprehensive Intervention Projects' have been given administrative approval, affecting 4 244 dwellings and amassing a total estimated private investment of almost 82 million euro.

With a similar aim, in Zaragoza, the Zaragoza General City Management Plan (PGOUZ) has been amended via Specific Amendment No 154, which states that 'In homogenous groups [...], any project that amends the external appearance of one of the buildings must be preceded [...] by successive Detailed Studies that regulate minor built units and establish, with a level of definition similar to that of the basic project, the external processing of all the buildings included, provided that the first Detailed Study includes a Coordination Document for the entire group or original homogeneous unit that contains criteria and assessments common to all future partial measures, so as to achieve overall harmony. […]. Detailed Studies and basic projects, if any, in which the guarantee of homogeneous external processing shall apply to less than one continuous block or building, shall not be admitted. Some of these Coordination Documents have already been submitted such as the Balsas de Ebro Viejo Urban Group in Zaragoza (1 260 dwellings).

4.5. FINANCING AREA.

4.5.1. Public financing programmes at State level.

4.5.1.1. 2018-2021 State Housing Plan.

Royal Decree 106/2018 of 9 March 2018 constitutes the regulatory framework regulating the 2018-2021 State Housing Plan[67,68], in force until 31 December 2021 and currently being implemented.

The framework of powers on housing grants responsibility for managing the State Housing Plan to the Autonomous Communities and the cities of Ceuta and Melilla, with the exception of the Basque Country and Navarre, where the State Housing Plan does not apply due to their specific chartered regime in terms of financing. In 2018, the then Ministry of Development (now the Ministry of Transport, Mobility and the Urban Agenda) signed the corresponding collaboration agreements for the implementation of the State Housing Plan with each Autonomous Community and City.

The State Housing Plan makes state financing conditional on a certain level of co-financing by the Autonomous Communities and Cities. The budgetary commitments made by the then Ministry of Development and the Autonomous Communities and Cities to implement the State Housing Plan are shown in the table below.

[65] Article 56. *Preferential Renovation Areas and Comprehensive Intervention Projects* in Regional Decree 61/2013 of 18 September 2013, laying down regulations for eligible measures in the area of housing. http://www.lexnavarra.navarra.es/detalle.asp?r=32564
Article 83. *Comprehensive Intervention Projects* in Regional Decree 2/2016 of 27 January 2016 amending Regional Decree 61/2013. http://www.gobiernoabierto.navarra.es/sites/default/files/decreto_foral_9.pdf

[66] Public Call for Proposals for the contract for the Preparation of the Comprehensive Intervention Project. 6. https://www.boe.es/boe/dias/2004/05/14/pdfs/B04240-04240.pdf

[67] https://www.boe.es/buscar/doc.php?id=BOE-A-2018-3358

[68] Order TMA/336/2020 of 9 April 2020 incorporates, replaces and amends the aid programmes of the 2018-2021 State Housing Plan, in accordance with the provisions of Articles 10, 11 and 12 of Royal Decree-Law 11/2020 of 31 March 2020 adopting additional urgent social and economic measures to tackle COVID-19.

Figure 4.10. State and Regional Financing in the 2018-2021 State Housing Plan. *Amounts in euro.*

COMUNIDAD AUTÓNOMA	FINANCIACION ESTATAL + AUTONÓMICA				
	2018	2019	2020	2021	TOTAL
ANDALUCIA	77.805.000,00	79.361.100,00	80.917.200,00	82.695.600,00	320.778.900,00
ARAGON	17.290.000,00	17.635.800,00	17.981.600,00	18.376.800,00	71.284.200,00
ASTURIAS	15.015.000,00	15.315.300,00	15.615.600,00	15.958.800,00	61.904.700,00
BALEARES	13.646.398,00	19.417.087,00	11.356.800,00	11.606.400,00	56.026.685,00
CANARIAS	24.115.000,00	24.597.300,00	25.079.600,00	25.630.800,00	99.422.700,00
CANTABRIA	8.645.000,00	8.817.900,00	8.990.800,00	9.188.400,00	35.642.100,00
CASTILLA Y LEÓN	24.873.600,00	25.278.000,00	25.656.000,00	26.114.400,00	101.922.000,00
CASTILLA LA MANCHA	18.200.000,00	18.564.000,00	18.928.000,00	19.344.000,00	75.036.000,00
CATALUÑA	65.975.000,00	67.294.500,00	68.614.000,00	70.122.000,00	272.005.500,00
COMUNIDAD VALENCIANA	51.870.000,00	52.907.400,00	53.944.800,00	55.130.400,00	213.852.600,00
EXTREMADURA	7.350.000,00	13.923.000,00	14.196.000,00	14.508.000,00	49.977.000,00
GALICIA	25.935.000,00	26.453.700,00	26.972.400,00	27.565.200,00	106.926.300,00
MADRID	46.955.000,00	45.410.400,00	46.300.800,00	47.318.400,00	185.984.600,00
MURCIA	17.241.516,00	20.420.400,00	20.820.800,00	21.278.400,00	79.761.116,00
RIOJA (LA)	7.735.000,00	7.889.700,00	8.044.400,00	8.221.200,00	31.890.300,00
CEUTA	455.000,00	464.100,00	473.200,00	483.600,00	1.875.900,00
MELILLA	1.475.000,00	1.487.000,00	1.494.000,00	1.507.000,00	5.963.000,00
TOTAL	**424.581.514,00**	**445.236.687,00**	**445.386.000,00**	**455.049.400,00**	**1.770.253.601,00**

	AUTONOMOUS COMMUNITY
	STATE + REGIONAL FINANCING
	2018
	77 805 000.00
	ANDALUSIA
	ARAGON
	ASTURIAS
	BALEARIC ISLANDS
	CANARY ISLANDS
	CANTABRIA
	CASTILE AND LEON
	CASTILE-LA MANCHA
	CATALONIA
	VALENCIA
	EXTREMADURA
	GALICIA
	MADRID
	MURCIA
	RIOJA
	CEUTA
	MELILLA
	TOTAL

Source: MITMA.

The State Housing Plan governs nine housing aid programmes, specifically:

- Agreed loan subsidisation programme.
- Home rental aid programme.

- Aid programme for people who have been evicted from their usual home or whose usual home has been repossessed.
- Programme to promote the stock of rental housing.
- Programme to promote improvements in energy performance and sustainability in homes.
- Programme to promote conservation, improvement in safety in use and accessibility in homes.
- Programme to promote urban and rural regeneration and renewal.
- Youth aid programme. Programme to promote homes for senior citizens and disabled people.

Of these nine programmes, three are directly linked to renovation: programmes 5, 6 and 7. And of the two that relate to improving the energy performance of the building stock, programmes 5 on promoting improvements in energy performance and sustainability in homes, and 7 on promoting urban and rural regeneration and renewal, will be analysed below:

Programme (No 5) to promote improvements in energy performance and sustainability in homes

The aim of this programme, both in rural and urban settings, is to fund works to improve energy performance and sustainability, with particular attention on the building envelope in collective residential buildings, including their dwellings, and in single-family dwellings.

Of the measures eligible for aid, the following are directly associated with energy aspects:

- Improving the thermal envelope to reduce energy demand through measures to improve thermal insulation, replacement of frames and glazing in apertures, or others, including the installation of bioclimatic or shading systems.
- Installing heating, cooling, domestic hot water production and ventilation systems for thermal conditioning, or increasing the energy efficiency of those systems already in place, through measures such as: replacing the heating or cooling systems; installing control, regulation and energy management systems; thermal insulation of distribution and transport installations or replacing systems used to move heat-transporting fluids; installing residual energy recovery systems; installing free cooling systems that use outside air and air exchange heat recovery; and connecting homes to existing heating and cooling networks, among others.
- Installing energy generation systems or systems that enable the use of renewable energy such as photovoltaic solar, biomass or geothermal energy to reduce traditional thermal or electric energy consumption in homes. This will include installation of any renewable energy technology, system or equipment, such as solar thermal panels and complete aerothermal solutions for heating/cooling and domestic hot water, so as to contribute to the production of domestic hot water required by the home or the production of hot water for heating installations.
- Improving the energy efficiency of communal lift and lighting installations, the building or plot, through measures such as replacing bulbs and lights with more efficient ones (generally LED lights, for example) installing systems that control switching on, regulate the lighting level and make the most of natural light.
- Measures promoting sustainable mobility in the communal services and installations of the buildings or developments, such as installing electric vehicle charging stations in parking garages or adapting parking areas and installations for bikes.
- Installing plant roofing and facades.
- Installing home automation and/or sensors.

The aid is conditional on the measures under a), b) and c) achieving a reduction in overall annual energy demand for heating and cooling specified on the energy certification, as compared with the situation prior to the measures, of at least:

- Climatic zones D and E: 35%.
- Climatic Zone C: 25%.
- Climatic zones: α, A and B, 20% or, alternatively, a reduction in consumption of non-renewable primary energy, as specified on the energy certification, of at least 30%.

According to the climatic classification given in the Building Technical Code.

The maximum subsidy quantity is between 8 000 and 12 000 euro/dwelling (which may increase if the building is declared a Property of Cultural Interest or if it houses disabled people) and may not exceed 40% of the eligible investment (which may rise to 75% depending on family income).

Programme (No 7) to promote urban and rural regeneration and renewal.

The aim of this programme is to finance the joint implementation of renovation works in buildings and dwellings, urbanisation or reurbanisation works in public spaces or, if applicable, building renewal, within the areas of action known as Urban or Rural Renewal and Regeneration Areas (ARRUs) specified above.

The energy measures eligible for aid under this programme are: improving energy performance in buildings and urban services, rolling out renewable energy and centralised or district heating/cooling systems (considered efficient under Directive 2012/27/EU), promoting sustainable mobility and, in general, any other measures aimed at reducing energy demand, reducing emissions of polluting gases and increasing the use of renewable energies.

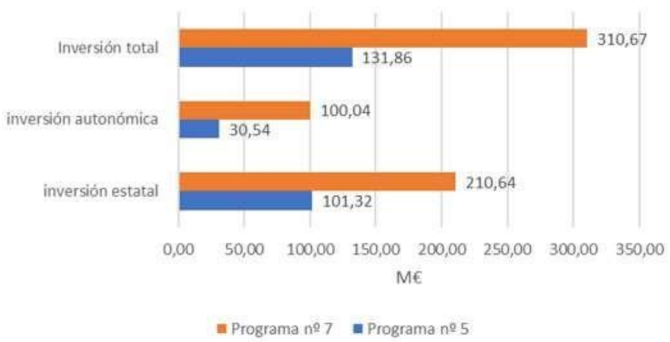
This programme includes maximum unitary aid of 12 000 euro/dwelling undergoing renovation (which may increase if the building is declared a Property of Cultural Interest) or 30 000 euro for each dwelling built to replace a demolished building, as well as an additional 2 000 euro per renovated dwelling and/or dwelling built to replace a demolished building for measures to improve the quality and sustainability of the urban environment. In addition to the foregoing, a further 4 000 euro may be added per year per family unit for rehousing occupants for the duration of the works, for up to 3 years, and up to 500 euro per dwelling for the cost of planning, information, management and social support teams and offices.

The maximum amount of this aid may likewise not exceed 40% of the eligible cost of the measure (which may rise to 75% depending on family income or if the dwellings house disabled people).

The funding detailed in the tables below is for all these State Housing Plan aid programmes, with the exception of the agreed loan subsidisation programme, which is financed separately.

The funds are distributed between the various aid programmes by agreement between the Autonomous Community or City and the Ministry. This distribution may be amended as many times as agreed during the term of the State Housing Plan. The quantities initially assigned to programmes 5 and 7 described above are those given in the table below:

Figure 4.11. Investments for Programmes 5 and 7 of the 2018-2021 State Housing (figures in millions of euro):



	Total investment
	310.67
	Investment from Autonomous Community
	State investment

	0.00
	50.00
	100.00
	Millions of euro
	Programme No 7
	Programme No 5

Source: MITMA.

BOX 17. EXAMPLE OF AN URBAN RENOVATION AREA DEVELOPED AS PART OF THE STATE PLAN: LOS BLOQUES URBAN RENOVATION AREA IN THE MUNICIPALITY OF ZAMORA (AUTONOMOUS COMMUNITY OF CASTILE AND LEON).

The area occupied by the two groups of dwellings measures 14 096 m^2 and is home to 578 residents. The analysis of the population pyramid shows an ageing population, with 28.72% over 65 years old. The residents showed great willingness to renovate.

The priorities were:

- To guarantee retention of the resident population, which is characterised by a high level of ageing and dependency, as well as low purchasing power.

- To place value on the architectural heritage of both groups of dwellings, which are catalogued in the urban plan and included in the DOCOMOMO foundation inventory.

- To regenerate the urban space so as to incentivise neighbourly relations, resident participation and use of underused private free spaces.

- The priorities were established by the Municipal Council and the Regional Government based on the prior demographic and socio-economic analysis of the area, which showed a high urban vulnerability index.

The results achieved led to the renovation of all the buildings forming the declared unit: 330 dwellings, 25 premises and one building housing the head office of the residents' association. This involved:

- Work to bring the building in line with its classification: the original apertures in the dwellings were restored, new apertures were removed, balcony and terrace enclosure elements were removed (which, in some cases, meant a reduction in the useful floor area of the dwellings). Original cuts and colours were returned to facades, clotheslines were hidden, additions, external splays and cabling for the installations that run through the facades were removed.

- The improvements in terms of savings and energy performance in the buildings: frames were replaced, which eliminated the problems of surface condensation and improved (together with the external facade cladding, which included insulating material) the hygrothermal conditions of the complex. In the same vein, work was also performed on the roofs, including insulation, restoring their original slopes and replacing all elements forming the rain water discharge system.

- Improvement in accessibility conditions: new electric lifts were installed without encroaching on any public thoroughfares, by seeking the most favourable layout; with access from within vestibule or from the block courtyards.

- Improvement in the quality of the urban space: public spaces and internal block courtyards were re-urbanised (where functional degradation prevented use) to house both recreation areas and vehicle parking.

Fundamental aspects and lessons learned:

- Financial and Institutional: The resources used for the measures are primarily from public funds.

- Social: The socio-economic aspect of the measures is shown in the intervention in a degraded neighbourhood, as is the case for 'Los Bloques' in Zamora.

- Cultural: The recovery of Architectural Heritage is considered to be one of the priority objectives within the Autonomous Community. In this case, a firm decision was taken to recover a Modern Movement rationalist complex that brings together Central European experiences of collective housing from the 1920s. The necessary recovery of this complex became a collective claim, from the Zamora Architecture Guide to the DOCOMOMO Iberian inventory.

- Environmental: The measures implemented on the buildings improved the quality of life of the citizens. The quality and sustainability improvement measures increased the thermal insulation capacity of the whole building by more than 100% compared with the pre-intervention level and equipped its enclosing elements with a thermal inertia enabling them to conserve the temperature of the heated spaces for longer. The improvements may lead to an estimated energy bill reduction of 50% and a substantial drop in polluting gas emissions, with the improvement in air quality that this entails. We also cannot overlook the fact that the works implemented have increased the level of sound insulation against airborne noises in the building and thereby the comfort level of the dwellings within.

The implementation of the measure highlighted the risk of owners of the dwellings refraining from complying with their duty to conserve their properties. The practice is an example of transferability.

4.5.1.2. PAREER, PAREER-CRECE and PAREER II Programmes.

Named PAREER, this programme was initially provided with 125 million euro with the aim of incentivising and promoting the implementation of comprehensive measures to foster energy savings, improvements in energy performance and the use of renewable energy in existing residential buildings (dwellings and hotels). The programme was implemented by the former Ministry of Industry, Energy and Tourism (now the Ministry for the Ecological Transition and the Demographic Challenge) through IDAE in September 2013.

Once more than a year had elapsed, and in the light of the experience gained, it was deemed appropriate to expand the target of the PAREER Programme to include the greatest possible number of existing buildings throughout Spain, in conformity with the objectives of Directive 2012/27/EU, extending its term, introducing certain amendments to help facilitate management and broadening its scope.

Within this context, the Plan of Measures for Growth, Competitiveness and Efficiency (CRECE), approved by the Council of Ministers on 6 June 2014, included measures to be implemented on buildings to bring about an energy reform in the existing building stock. As part of this plan, Law 36/2014 of 26 December 2014 on the General State Budget for 2015 included a budget allocation of 75 million euro to strengthen and boost the measures set out in the PAREER Programme and to address the broadening of its objective.

As a result, the name of the programme was changed to the PAREER-CRECE Programme (Aid Programme for the Energy Renovation of Existing Buildings), which brought with it an expansion to include comprehensive measures in existing buildings used for any purpose (dwelling, administrative, commercial, healthcare, educational, etc.) to foster energy savings, improvements in energy performance, reduction in CO2 emissions and the use of renewable energy, and expressly excluding new construction. The aid for this programme was co-financed by the European Regional Development Fund (ERDF) under the 2014-2020 Sustainable Growth Operational Programme.

These measures fell within one or more of the following action types:

- Improving the energy efficiency of the thermal envelope.
- Improving the energy efficiency of thermal and lighting installations.
- Replacing traditional energy with biomass in thermal installations.
- Replacing traditional energy with geothermal energy in thermal installations.

The measures eligible for aid, selected via a basic competitive process, had to improve the building's overall energy rating by at least one letter, measured on the CO2 emissions scale (kg CO2/m^2 per year) compared with the building's initial energy rating. This improvement in energy rating had to be achieved by implementing one type of action or a combination of types.

The aid consisted of the provision of funds without consideration for the eligible cost of the measure, which could be increased with additional aid based on the following three criteria, up to a maximum aid amount:

- Social criterion: measures implemented in buildings that had been classed as State-Subsidised Housing and Housing Protected under the Special Scheme by the competent body of the corresponding Autonomous Community or measures implemented in residential buildings situated in Urban Regeneration and Renewal Areas, in accordance with the 2013-2016 State Plan to Promote Rental Housing, Building Renovation and Urban Regeneration and Renewal.
- Energy performance: measures that raise the building's energy rating to attain energy class 'A' or 'B' on the CO2 scale or that increase the initial energy rating by two letters.
- Integrated action: measures that include a combination of two or more types of action at the same time.

In addition, an application could also be submitted for a repayable loan for up to 90% of the eligible costs, for the portion not covered by the direct aid.

The types of beneficiaries envisaged by this aid programme were as follows:

- The owners of existing buildings used for any purpose, whether natural persons or private or public legal persons.
- Homeowners' associations or groupings of homeowners' associations
- from residential buildings for dwelling use, officially established as commonhold property.
- Owners who as a group are building owners and had not signed a deed establishing commonhold property.
- Building-operating, tenant or concessionaire companies.
- Energy service companies.

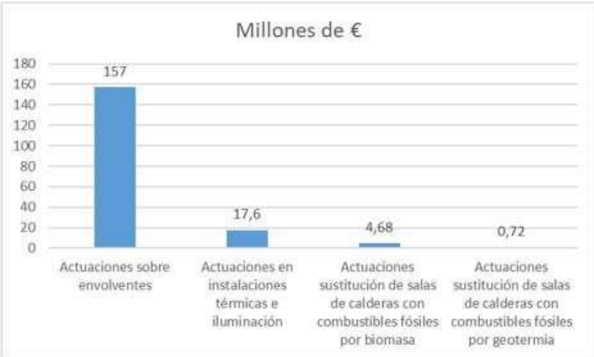
The programme closed on 5 May 2016 as applications for aid exceeded the 200 million euro allocated to the programme by 35%. The PAREER-CRECE Programme reached 2 488 applications submitted, representing

269 million euro in requested aid, exceeding the planned budget by 35%. 1 513 applications were assessed favourably, accounting for €180 million euro in aid and representing an investment of 303 million euro.

The 1 513 applications assessed favourably led to an improvement in the energy performance of 42 358 dwellings, 8 398 rooms in 41 hotels and 15 residences and 4 500 000 m^2 of total conditioned area.

The average investment ratio per application submitted was 200 000 euro and the average aid was 120 000 euro per application. In terms of the type of aid granted, 48% of the aid related to direct aid and the remaining 52% to repayable loans. As regards the type of action carried out, of the four types included in the programme, the thermal envelope measure received the most economic support, with 87% of the aid, followed by measures to change boiler rooms using fossil fuels to natural gas with condensing boilers (10%), measures to change boiler rooms using fossil fuels to biomass (2.6%) and geothermal (0.4%). The following graph shows this distribution of the amount of aid granted by type of action:

Figure 4.12. Aid granted by type of action under PAREER-CRECE (millions of €).



	Millions of €
	17.6
	Measures on envelopes
	Measures on thermal and lighting installations
	Measures to replace change boiler rooms using fossil fuels to biomass
	Measures to replace change boiler rooms using fossil fuels to geothermal

Source: IDAE

In terms of the type of beneficiary, residents' associations were the beneficiaries that received the most aid, with 89.1%, followed by hoteliers with 3.3% and energy service companies with 2.8%.

Figure 4.13. Aid granted by type of beneficiary under PAREER-CRECE.

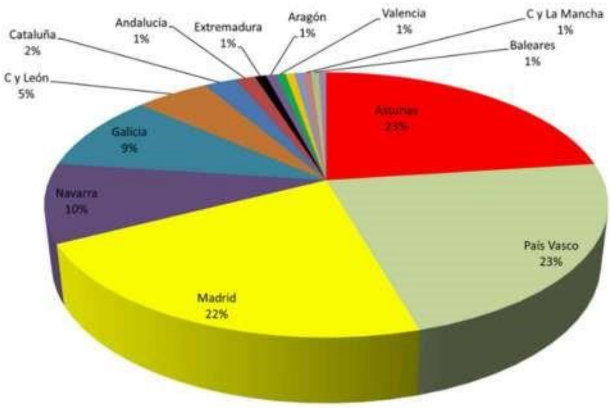
	€120 000 000
	€2 621 492

	€0
	Single-family
	Sole owner
	Homeowners' association
	Company
	ESCOs
	Hotelier

Source: IDAE

In terms of the aid granted final approval by Autonomous Communities, the Basque Country, Asturias and Madrid stand out.

Figure 4.14. Financial aid approved by Autonomous Community.



	Catalonia 2%
	Castile and Leon 5%
	Andalusia 1%
	Extremadura 1%
	Aragon 1%
	Valencia 1%
	Castile-La Mancha 1%
	Balearic Islands 1%
	Basque Country 23%
	Madrid 22%
	Navarre 10%
	Galicia 9%

Source: IDAE

Continuing with the analysis of the 1 513 favourable applications approved, the 180 million euro in aid allocated was distributed as follows: 44% basic aid, 4% additional aid and 52% pertaining to the repayable loan. Of the additional aid granted in the favourable applications, 52% relates to the social criterion, 43% to integrated measures and the remaining 5% to the energy performance criterion. 58% of the approved files led to an improvement in rating: 38% improved by two letters and 4% by three letters.

The energy and environmental impacts of the PAREER-CRECE programme can be summarised as:

- Final energy saved: 33 661 toe/year.
- Emissions prevented: 96 204 t CO2/year

As a continuation of the PAREER and PAREER-CRECE programmes, the Second Call for Applications for the Aid Programme for the Energy Renovation of Existing Buildings (PAREER II) was launched on 21 December 2017. It had an application period that ran between January and December 2018, a budget of 204 million euro and was very successful, receiving applications for 261 million euro (28% above budget).

This new aid line included the following eligible measures:

- Improving the energy efficiency of the thermal envelope.
- Improving the energy efficiency of thermal and lighting installations.
- Replacing traditional energy with solar thermal energy.
- Replacing traditional energy with geothermal.

The most significant results obtained as at 31 March 2020 were:

- 1 566 applications have been submitted, of which 950 have been reviewed with 800 approved to date.
- With approved aid currently at 144 million euro, this represented an investment of 224 million euro.
- The average investment ratio is 280 000 euro per file and the average aid ratio is 180 000 euro per application.
- 52% of the aid provided relates to direct aid and 48% to loans.
- The type of action that has received the most financial aid to date relates to measures involving the envelope, with 98% of the aid provided.
- The type of beneficiary that has received the most financial aid to date are residents' associations, with 98%.
- The 800 files assessed favourably represent an improvement in the energy performance of:
    - 29 600 dwellings.
    - 1 800 000 m^2 in conditioned floor area.
    - Final energy saved: 12 800 toe/year.
    - Emissions prevented: 40 800 t CO2/year

4.5.1.3. Financing of local energy community pilot projects (IDAE).

In its capacity as the driver behind the change in the energy model, IDAE's lines of action include investing in and funding energy projects that contribute to fast-tracking the energy transition process and that show the viability of new technology, solutions or strategies.

The impetus behind our strategies or forms of action includes local energy communities for which there is a drive to afford special attention to provide support for pilot projects that meet technical and economic solvency requirements during this initial phase.

As a result, there now exists the possibility for the promoters of these local energy communities to submit their project proposals to IDAE for assessment, in line with the terms and conditions given on the IDAE website: Participation in innovative investment projects.

Participation in Local Energy Community projects will be analysed by IDAE on an individual basis in line with the needs of the project and its promoters[69].

4.5.1.4. ICO Financing Facility.

For nearly a decade, individuals and homeowners' associations have also been able to apply for financing through the Spanish Official Credit Institute's [Instituto de Crédito Oficial – ICO] Enterprises and Entrepreneurs Facility[70],

[69] Proposals can be sent to: tuproyecto@idae.es
https://www.idae.es/ayudas-y-financiacion/financiacion-del-idae/comunidades-energeticas-locales
[70] https://www.ico.es/web/ico/ico-empresas-y-emprendedores/-/lineasICO/view?tab=general

exclusively for renovating dwellings and buildings. Any items that involve renovation works in dwellings and/or buildings and/or the refurbishment of their shared elements, are eligible for financing; this can also include labour, professional fees, VAT or similar taxes.

The financing may take the form of a loan, lease, rent or credit line. The maximum amount per client and year is 12.5 million euro, in one or more transactions. The main characteristics of the products are the following:

- Repayment and grace period:
    - 1 to 6 years with a 0 or 1-year grace period for the principal.
    - 7 to 9 years with a 0, 1 or 2-year grace period.
    - 10, 12, 15 and 20 years with a 0, 1, 2 or 3-year grace period.
- Loan interest rate:
    - The customer may choose a fixed or variable interest rate.
    - If the variable interest rate is selected for the transaction, this will be reviewed on a six-monthly basis by the Credit Institution in line with the provisions of the finance contract.
- Transaction APR

  The Annual Percentage Rate (APR) applicable to the transaction will be formed of the cost of the upfront fee that the Credit Institution may apply, plus the interest rate.

  The APR may not exceed the following limits:
    - For transactions with a term of 1 year: fixed or variable rate plus up to 2.30%.
    - For transactions with term of 2, 3 or 4 years: fixed or variable rate plus up to 4.00%.
    - For transactions with a term of 5 years or more: fixed or variable rate plus up to 4.30%.

  This APR is updated fortnightly. At the time at which this document was drawn up, it was 4.46 over 5 years and 4.64 over 10 years.

The results of recent years, including the number of transactions and the amounts, and their regional breakdown by Autonomous Community are given in the table below:

Figure 4.15. Transactions for Dwelling Renovations (Enterprises and Entrepreneurs) 2017-2019. Distribution by Autonomous Community.

Autonomous	2017		2018		2019		Loan amount (euro)	No of operations
	Loan amount (euro)	No of operations	Loan amount (euro)	No of operations	Loan amount (euro)	No of operations		
MADRID	11 888 783	184	13 173 874	213	16 112 916	220	41 175 573	617
GALICIA	3 187 149	89	3 746 827	133	3 130 675	83	10 064 650	305
ARAGON	1 930 513	47	1 745 248	47	2 388 872	41	6 064 633	135
ANDALUSIA	800 744	30	2 962 415	78	1 962 229	47	5 725 388	155
VALENCIA	737 625	31	1 346 562	39	1 070 647	25	3 154 834	95
CATALONIA	805 878	21	1 298 025	37	804 681	16	2 908 584	74
CASTILE AND LEON	533 285	13	762 321	21	1 073 412	25	2 369 018	59
CANARY ISLANDS	301 000	12	400 800	11	165 534	5	867 334	28
MELILLA			232 773	2	464 300	3	697 073	5
BALEARIC ISLANDS	187 000	5	379 500	14	30 000	1	596 500	20
MURCIA	184 721	7	223 000	5	117 746	6	525 467	18
BASQUE COUNTRY	168 000	5	309 721	6	6 280	1	484 001	12
CASTILE-LA MANCHA	137 643	3	95 000	3	239 100	2	471 743	8
ASTURIAS	75 000	2	137 567	5	201 237	2	413 804	9
EXTREMADURA	48 719	2	220 429	8			269 148	10
CANTABRIA	12 000	1	81 678	3	87 463	2	181 141	6
NAVARRE	64 600	2	30 000	1			94 600	3
TOTAL	21 062 659	454	27 145 740	626	27 855 093	479	76 063 492	1 559

Source: ICO

4.5.1.5. European Funds for energy performance in buildings, public infrastructure and dwellings and for integrated sustainable urban development.

The ERDF measures for the 2014-2020 period for energy performance in buildings, public infrastructure and dwellings fall into two areas: Area 4: Low-Carbon Economy and Area 12: Integrated Sustainable Urban Development.

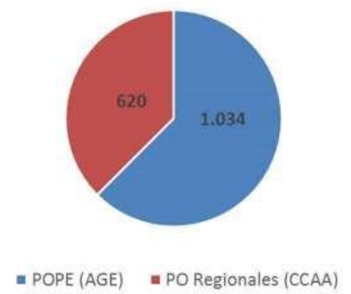
The most relevant measures and the expected results of each are described below.

a) ERDF support for energy performance in buildings, public infrastructure and dwellings within the Low-Carbon Economy area.

For the 2014-2020 period, a total of 1.654 billion euro has been allocated as ERDF aid (2.391 billion euro in total expenditure) for investment priority IP 4c: supporting energy efficiency, smart energy management and renewable energy use in public infrastructure, including in public buildings and in the housing sector under Area 4: Low-Carbon Economy.

Of this amount, 1.034 billion euro (63%) is under the management of the General State Administration via IDAE and 620 million euro (the remaining 37%) is under the management of the Autonomous Communities, as Intermediate Bodies for their respective Regional Operational Programmes.

Figure 4.16. ERDF aid (millions of euro) planned for IP 4c by the General State Administration and Autonomous Communities.



	1 034
	Spanish Pluriregional Operational Programme (POPE) – General State Administration
	Regional Operational Programmes – Autonomous Communities

Source: 2020 Fund IT application

Of the part managed by the General State Administration, the Sustainable Urban Development (SUD[71]) projects stand out, with EAFD aid for investment priority 4c of 865 million euro. The beneficiaries of these SUD programmes are Local Entities, which are dedicating a significant portion of the aid to energy performance in public infrastructure, primarily municipal lighting, and to the renewal of public buildings in their ownership.

Another interesting programme, due to its driving and exemplary nature, is the energy renovation of buildings of the General State Administration, granted ERDF aid of 95 million euro.

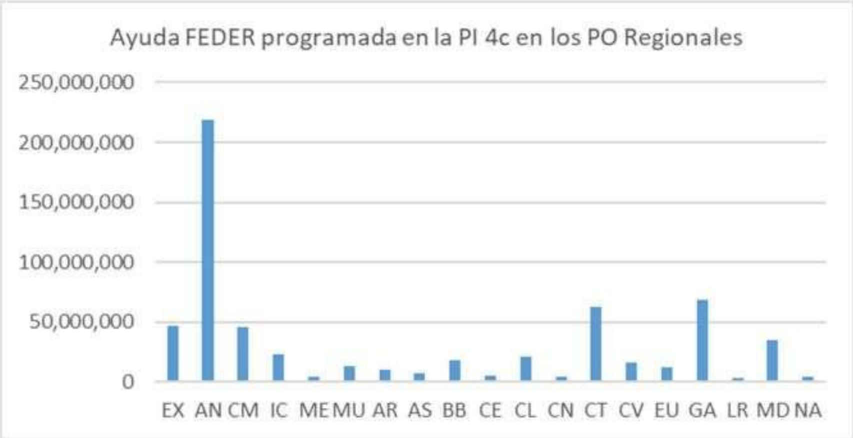
The remaining part of the General State Administration part, 74 million euro, has been allocated for the energy renovation of housing.

Of the part managed by the Autonomous Communities, the noteworthy fund allocations within investment priority 4c are those of Andalusia, with ERDF aid of 219 million euro, Galicia (68 million euro), Catalonia

[71] Not to be confused with ISUD (Integrated Sustainable Urban Development) Strategies mentioned above. The SUD projects provide funding for measures for Local Entities exclusively in the area of the Low-Carbon Economy, while the ISUD strategies take an integrated approach to addressing urban needs in all areas.

(63 million euro), Extremadura (47 million euro), Castile-La Mancha (46 million euro) and Madrid (35 million euro), these six Autonomous Communities accounting for 77% of the regional part for this investment priority.

Figure 4.17. ERDF aid (millions of euro) planned for IP 4c in the Regional Operational Programmes.



	ERDF aid planned for IP 4c in the Regional Operational Programmes.
	250 000 000
	Extremadura
	Andalusia
	Castile-La Mancha
	Canary Islands
	Melilla
	Murcia
	Aragon
	Asturias
	Balearic Islands
	Ceuta
	Castile and Leon
	Cantabria
	Catalonia
	Valencia
	Basque Country
	Galicia
	Rioja
	Madrid
	Navarre

Source: 2020 Fund IT application

The energy renovation of buildings is financed under both parts of the ERDF and includes measures covering, for example, improving the thermal envelope, renewal of heating, air conditioning or domestic hot water installations, and funding nearly zero-energy building pilot projects.

The results expected to be achieved at the end of the ERDF aid programme period (for both parts: General State Administration and Autonomous Communities) for the energy renovation of buildings within Area 4 translate into the following productivity indicators:

- CO31: number of homes with better energy consumption, with a target of 33 000.
- CO32: reduction in annual primary energy consumption in public buildings, with a savings target of 1 085 000 MWh/year.

b) ERDF aid to improve energy efficiency in urban areas within Area 12 on Integrated Sustainable Urban Development (ISUD).

In addition to the above, via the General State Administration ERDF section, under Area 12 on Integrated Sustainable Urban Development (ISUD), support is being provided for ISUD Strategies managed by (groups of) municipalities with over 20 000 inhabitants.

These ISUD Strategies were selected via three competitive calls for applications: the first published on 17 November 2015, the second on 7 October 2016 and the third on 13 November 2017. Following these calls for applications, ERDF aid amounting to 1.366 billion euro was granted to a total of 173 ISUD Strategies submitted by Local Entities.

The action lines to be financed under Area 12 (ISUD) managed by the General State Administration via the Subdirectorate-General of Urban Development (Ministry of Finance) and the Subdirectorate-General of Local Cooperation (Ministry of Territorial Policy and Civil Service) must fall within one of the following four Thematic Objectives (TOs):

- TO2, Improve access, use and quality of ICTs
- TO4, Favour the transition to a low-carbon economy in all sectors
- TO6, Conserve and protect the environment and promote resource efficiency
- TO9, Promote social inclusion and the fight against poverty

In accordance with the terms of the calls, an indicative investment percentage of around 20-30% must be allocated in each of the ISUD Strategies to financing measures under Thematic Objective 4 on the low-carbon economy.

Specifically, within TO4 of Area 12 (ISUD), ERDF aid of 140 million euro (200 million euro in expenditure) was granted with the aim of achieving Specific Objective 4.5.3. Improving energy efficiency and increasing renewable energy in urban areas.

The measures under this Specific Objective may be aimed at energy efficiency in public infrastructure, installing renewable energy and energy renovation in buildings, including measures in the thermal envelope, heating, air conditioning or domestic hot water installations, and funding nearly zero-energy building pilot projects.

As a result of the ERDF measures under the ISUD area, the result expected at the end of the programme period for this area is reflected in the following productivity indicator:

- CO32: reduction in annual primary energy consumption in public buildings, with a savings target of 50 570 MWh/year.

4.5.2. Public financing programmes at Autonomous Community level.

4.5.2.1. Navarre.

Through the approval of Regional Law 22/2016 of 21 December 2016 adopting housing support measures for citizens, work was undertaken to attempt to adapt the legal framework in place in the Autonomous Community of Navarre into a new framework providing more support and promotion for protected renovation and placing more value on the built city.

Some of the new principles of the text were:

- Reduce the minimum works budget from 6 000 to 2 000 euro so as to take protectable action into consideration.

- Increase in the subsidy percentages for certain groups (large families, victims of terrorism, victims of gender-based violence, people with severe disabilities) and significant increase in subsidies for under 35s.

- Approval of new eligible measures to promote energy efficiency:

    - Possibility of accessing subsidies for measures involving the thermal envelope for buildings built between 1980 and 2006 (NBE CT 79 and Technical Building Code DBHE) once they reach a minimum age of 25.

    - Improving energy efficiency through improvements to centralised thermal installations in buildings. District heating networks providing thermal energy to multiple buildings are also considered centralised installations provided that at least 50% of the network demand is for residential purposes. This includes the ring circuit of the internal installation.

- Subsidies for local entities to renovate buildings for rental purposes.

- Improving subsidies for accessibility measures and measures to remove barriers for 'Comprehensive Intervention Projects'.

Figure 4.18. Current Navarre housing aid framework.

RESIDENTS' ASSOCIATIONS: Removal of barriers supported by the association: Building age =>	**More than 25**
- Total removal of barriers, buildings without lift: (Maximum €8 000/dwelling, 10 000 if fewer than 11 dwellings)	**45%**
- Total removal of barriers, buildings with lift: (Maximum €5 000/dwelling)	**30%**
- Buildings without lift, without total adjustment in line with barrier regulations: (Maximum €5 000/dwelling)	**25%**
- Buildings with lift, without total adjustment in line with barrier regulations: (Maximum €3 000/dwelling)	**20%**
- In Comprehensive Intervention Projects, an additional subsidy will be granted of:	**5%**
RESIDENTS' ASSOCIATIONS: Improvements to thermal envelope supported by the association (Max. €6 000/dwelling)	**40%**
- Improvements to the thermal envelope in Comprehensive Intervention Projects (Max. €7.500/dwelling)	**50%**
- Improvements in efficiency of centralised thermal installations adjusting them in line with Technical Building Code DB-HE-2	**40%**
(Maximum €6.000/dwelling)	**20%**
EXCEPTIONAL SUBSIDIES FOR NATURAL PERSONS (Maximum €12 000 or €25 000 in single-family dwellings or Preferential Renovation Areas)	
- **Adaption of dwelling** of person with disability of no less than 40% and income of less than 2.5 times the SARA (Sufficient	**50%**
Income to Purchase Essentials): Promoters with income between 2.5 and 3.5 times the SARA	**40%**
- **Promoters or spouses over 65 or under 35**, with income of less than 2.5 times the SARA: Promoters with income	**45%**
between 2.5 and 3.5 times the SARA	**30%**
- **Preferential Renovation Areas**: (Promoter-users with income of less than 2.5 times the SARA) Promoter-users	**45%**
with income between 2.5 and 3.5 times the SARA	**30%**
- **Large families.** If these fall into the general category, they will receive an additional subsidy of (3):	**5%**
If these fall into the special category, they will receive an additional subsidy of (3):	**10%**
- **Victim** of terrorism, gender-based violence or recipients of the *Renta de Inserción Social* (minimum jobseekers allowance),	**5%**

PROMOTERS FOR RENTAL PURPOSES: (Maximum €12 000/dwelling) The dwellings must be used for rental purposes for at least 5 years			
from the final rating date.	Building age =>	**More than**	**More than**
- In Preferential Renovation Area with monthly income of less than €5.62 or €5.31 per m².		**40%**	**11%**
	Maximum subsidy, per m² of useful floor area, up to a maximum of 120 m²:	€329.18	€88.62
- In buildings with monthly income of less than €5.62 or €5.31 per m².		**22%**	**11%**
	Maximum subsidy, per m² of useful floor area, up to a maximum of 120 m²:	€177.25	€88.62
TABLE OF WEIGHTED INCOME (€) General part of taxable income plus income below tax threshold			

2018 SARA	Personal income tax declaration (€) for 2018 as a multiple of the SARA	
€8 266.16	2.5 SARA	3.5 SARA
Building	**ORDINARY SUBSIDIES BY INCOME**	
Over 50 years old	20%	10%
Between 25 and 50 years old	10%	5%

Source: Housing Department of the Government of Navarre.

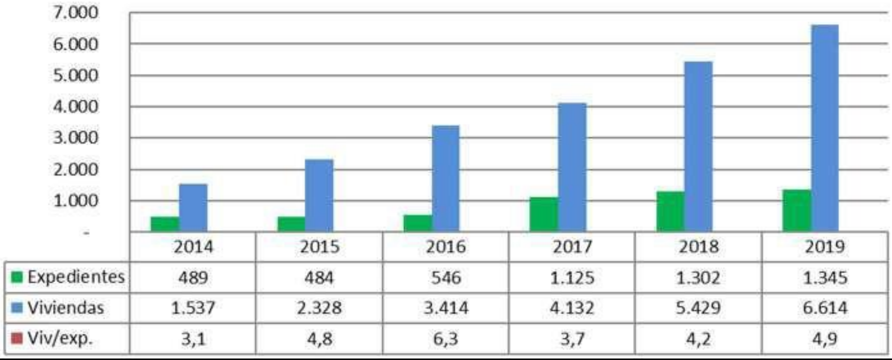
Another particular feature of the Renovation Programmes of the Government of Navarre is that they are not subject to annual calls for applications for subsidies; instead, the aid is granted through the individual assessment system, in line with basic principles laid down in the regulations, and without budgetary limits.

BOX 18: GRANTING OF SUBSIDIES FOR PROTECTED RENOVATION WITHOUT CALL FOR APPLICATIONS

The system in Navarre has the particular feature that there are no annual calls for applications for subsidies for protected renovation; instead, the aid is granted through the individual assessment system, in line with basic principles laid down in the regulations, and without budgetary limits. The facility enabling the submission of applications between 1 January and 31 December of each year and the guarantee that the proposed measure will be approved provided it meets the technical requirements (with no reliance on the existence of a budget balance) prevents peaks and troughs and bottlenecks in terms of files as a result of specific dates for calls for applications and enables the renovation works to be carried out more fluidly and continuously over time.

The programme data are summarised in the graphs below:

Figure 4.19. Graph showing the results of the Renovation Programmes of the Autonomous Community of Navarre for the 2014-2019 period (number of files and dwellings).



	7 000
	Files
	Dwellings
	Dwellings/file
	1 537
	3.1

Source: Housing Department of the Government of Navarre.

Figure 4.20. Table summarising the results of the Renovation Programmes of the Autonomous Community of Navarre for the 2014-2019 period.

	FILES	DWELLINGS	BUDGET	ELIGIBLE BUDGET	SUBSIDY	BUDGET/DW	DWELLINGS/FI	SUBSIDY/DWE
2014	489	1 537	€25 933 667	€23 964 015	€8 356 390	€16 873	3.1	€5 436.82

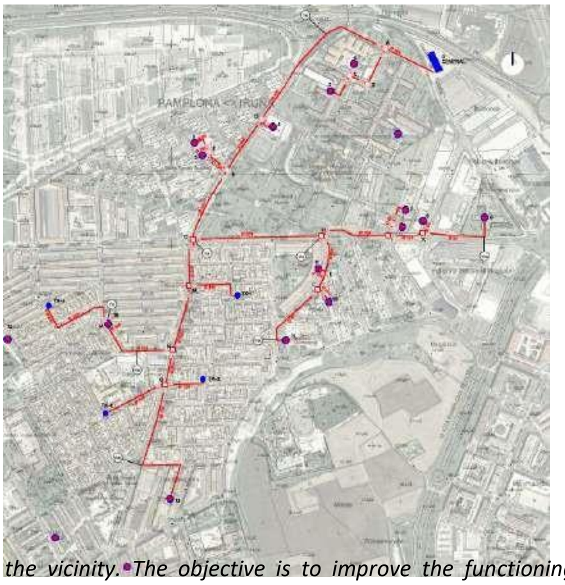
2015	484	2 328	€28 714 079	€27 094 387	€9 614 447	€12 334	4.8	€4 129.92
2016	546	3 414	€48 186 528	€46 213 016	€16 433 376	€14 114	6.3	€4 813.53
2017	1 125	4 132	€52 541 192	€49 856 095	€18 179 514	€12 716	3.7	€4 399.69
2018	1 302	5 429	€65 305 752	€62 121 476	€22 686 112	€12 029	4.2	€4 178.69
2019	1 345	6 614	€74 323 481	€70 673 476	€24 629 901	€11 237	4.9	€3 723.90

Includes: number of files, dwellings, budget, eligible budget, budget per dwelling, number of dwellings per file and subsidy per dwelling. Source: Housing Department of the Government of Navarre.

BOX 19. LA CHANTREA/TXANTREA NEIGHBOURHOOD, PAMPLONA[72].

The La Chantrea neighbourhood is located in the north of the city of Pamplona, on the border between the city and the municipalities of Burlada and Ansoáin. It borders the neighbourhoods of Casco Antiguo de Pamplona (the historical city centre), Excazaba and Rochapea.

The Efidistrict Fwd de Chantrea project aims to achieve the Comprehensive Energy Regeneration of this neighbourhood by implementing energy saving measures in the buildings and using renewable energy in the heating systems. The project covers three types of action:



- The comprehensive energy renovation of the neighbourhood's buildings, including the thermal envelopes; both service buildings and residential buildings built between the 1950s and the 1980s, which have inefficient construction systems.

- The creation of a New (District Heating) Thermal Network powered by over 90% renewable energy of local origin (forest biomass) to supply the entire neighbourhood. This New Thermal Network would basically consist of a new thermal power plant and a distribution network that would supply the public and private buildings. Altogether, the aim of the Efidistrict Power Plant is to supply heating and DHW to over 4 500 dwellings and a large number of service buildings. In addition to heating and DHW, there are plans in place to produce and distribute cooling via a small network to supply the service and assistance buildings situated in the vicinity of the power plant.

- The renovation of the Old District Heating Systems present in the vicinity. The objective is to improve the functioning of these heating systems, focusing on the renovation and improvement of the distribution networks by introducing energy saving measures, supported by the incorporation of regulation and control systems to reduce consumption and improve functioning.

One very important element of this was the opening of an office in the neighbourhood itself to serve as a point of contact with residents and as a one-stop shop for all the intervention management work. This office assesses the building condition, defines any technical preliminaries, conducts a search for collective funds, coordinates the work with the public authorities,

72 https://www.efidistrict.eu/
https://www.mitma.gob.es/arquitectura-vivienda-y-suelo/urbanismo-y-politica-de-suelo/observatorio-de-la-vulnerabilidad-urbana/informe-formulas-innovadoras-gestion-financiacion-actuaciones-regeneracion-barrios

draws up technical and financial proposals for each type of project, activates the public participation plan, advises the residents, manages public aid, clarifies doubts, and supervises and certifies public and private investment. It supports the residents throughout the project. During the second phase, driven by the residents' interest in carrying out renovations within the residents' associations, an agreement was signed between public company Nasuvinsa (attached to the Government of Navarre) and Pamplona City Council to continue promoting the renovation in the neighbourhood.

This action has the following funding sources:

- *The Efidistrict project, financed by the European Union as part of the Intelligent Energy Europe programme.*
- *Aid in the form of subsidies from the Government of Navarre: on the one hand, the Directorate-General of Industry, Energy and Innovation, with aid intended to support the renovation of old district heating systems and promote the renovation of distribution networks; on the other, subsidies from the Department of Social Rights for housing renovation, in accordance with Regional Housing Law 22/2016.*
- *In addition to these subsidies, a framework agreement has also been drawn up with the financial institution Caja Rural de Navarra to offer finance for up to 100% of the amount not covered by the subsidies to the homeowners' associations, as the parties responsible for the loan (which means that there is no need for the provision of individual or personal guarantees). Two types of credit were established here: credit as an advance on the subsidies (this covers the amount of the subsidy and is cancelled upon receipt of the subsidy) and credit for the unsubsidised part with a maximum term of 12 years.*

4.5.2.2. Basque Country. 2018-2020 Master State Housing Plan[73].

The Plan, the approach of which includes the spirit of the 2015 Law for the first time, aims to guarantee the social function of housing and the subjective right of the public to housing through the preferential promotion of rental housing, boosting of renovation, urban regeneration or the use of empty flats. Likewise, it includes measures to promote social cohesion and greater links between housing policies and other social policies and to afford special attention to the needs of young people in their process of empowerment and to improving the quality of life of senior citizens, via the accessibility and energy performance of buildings.

67% of houses in the Autonomous Community of the Basque Country were built before 1980 and the first regulations that included parameters on energy efficiency date from 1979, which means that the majority of buildings built prior to that date, with the exception of those on which interventions in this area have been carried out, run the risk of having insufficient insulation to guarantee adequate energy performance.

As regards accessibility, we are seeing the proportion of dwellings without a lift gradually falling. However, almost a third of the stock in the Autonomous Community of the Basque Country still has no lift.

Nevertheless, the lack of lift is not the only problem in terms of accessibility, given that, in some cases, the lift does not serve level zero and residents are required to overcome obstacles, such as stairs, to reach the lift. This, coupled with the gradual ageing of the population, means that guaranteeing accessibility is becoming a priority for housing policies.

Promoting and supporting renovation measures has traditionally been a priority of the Deputy Regional Ministry of Housing of the Government of the Basque Country. To that end, the Deputy Regional Ministry has five aid programmes that form part of the Renove Plan.

As regards the first of these programmes, which relates to aid aimed at private individuals and homeowners' associations for works on their buildings and dwellings, a sum of 15.8 million euro was granted in 2016 to a total of 12 655 dwellings.

There has been a downward trend in the granting of this aid since the 2009 financial year, although, in the last 2 years, it has remained stable. The reason behind this drop lies in the fall in the number of applications, meaning that the budget allocated to this programme has not been exhausted.

The crisis also had an impact here, as the economic difficulties discouraged people from renovating buildings, except in cases where this was absolutely necessary. Furthermore, during the years of the crisis, we also saw an increase in the default rate in homeowners' associations, a factor that led to a greater reluctance to begin renovation measures of a certain size.

[73] https://www.etxebide.euskadi.eus/x39-ovad01/es/contenidos/informacion/ovv_pdv_2018_2020/es_def/index.shtml

A not insignificant portion of the aid granted was aimed at structural adjustments to buildings, amounting to 54% of the subsidies granted in 2016 (8.5 million euro). Works to improve accessibility accounted for a quarter of all aid (approximately 4 million euro, 25%). Renovation measures performed on the envelope to improve energy performance made up 18% of subsidies granted (2.8 million euro in 2016).

4.5.3. Financing programmes at municipal level.

In addition to the State and Regional Programmes to fund urban regeneration and renovation measures, there are a large number of municipalities in Spain that have provided additional funds from their own budgets to supplement this financing. Below are some examples, highlighting two important aspects that these programmes should, in general, take into consideration:

- The long-term nature and inclusion of this aspect in a global municipal urban regeneration strategy or model with a certain degree of continuity over time that transcends political fluctuations.
- Paying special attention to providing finance to the most vulnerable groups with lower rents, coordinating mechanisms specifically for that purpose.

BOX 20. EXAMPLE OF LONG-TERM MUNICIPAL FINANCING PROGRAMMES[74].

Via the Zaragoza Vivienda municipal company, Zaragoza City Council has a long history and great deal of experience in urban renovation strategies and policies, which date back to 1989. For over 30 years, the City Council has been promoting activity to update and improve the oldest housing in the city of Zaragoza, by managing public funds allocated for this purpose, participating in European projects and developing the necessary regulations to promote and improve the opportunities to renovate the city. A summary of the results is shown in the table below:

AÑOS	CONVOCATORIA	Nº PORTALES	Nº VIV.	INVERSIÓN PÚBLICA/AÑO	INVERSIÓN	SUBV. TOTAL	% AYUDAS MEDIA	COSTE RH/VIV (MEDIA)
1989 2011	ORDENANZA	3.612	41.791	2.630.491 €	172.900.000 €	60.501.286 €	34,99 %	4.137 €
2006 2016	PLANES DE VIVIENDA	66	602	1.616.071 €	15.177.270 €	10.836.940 €	71,40 %	25.211 €
2013 2015	ECOEFICIENTES	15	147	485.560 €	3.079.813 €	1.942.238	63,06 %	20.951 €
2016 2017	ETAPA ACTUAL	47	671	2.426.863 €	11.675.345 €	4.853.725 €	41,57 %	17.400 €
		3.740	43.211		205 M €	78,5 M €	42,21 %	13.539,94 €

Etapas de gestión del fomento de la rehabilitación por Zaragoza Vivienda (1989-2017)

	YEARS
	CALL FOR APPLICATIONS
	No VESTIBULES
	No DWELLINGS
	PUBLIC INVESTMENT/YEAR
	INVESTMENT
	TOTAL SUBSIDY
	% AVERAGE AID
	RENOV/DWELLING COST (AVERAGE)
	ORDINANCE
	HOUSING PLANS
	ECOEFFICIENCY
	CURRENT STAGE
	3 612
	€2 426 863
	€15 177 270
	€205 000 000
	€78 500 000
	Zaragoza Vivienda stages of renovation promotion

[74] http://www.zaragozavivienda.es/

	management (1989-2017)

Initially, policies focused on the historic centre; however, as of 2001, these were broadened to include the rest of the city (specifically the peripheral neighbourhoods built during the Franco years), firstly via the application of the Municipal Ordinance for the Promotion of Private Renovation (aid for which was stopped in 2011) and, in later years, through the management of aid from other Institutions, such as the Government of Aragon, the Spanish Government and European funds.

Although no Renovation Strategy or Plan has ever been drawn up at city level, it can certainly be said that Zaragoza was one of the first cities to have a global city overview of renovation. Key features of this include the publication of the study 'Nuevas propuestas de rehabilitación urbana en Zaragoza: Estudio de los 21 conjuntos urbanos de interés' [New urban renovation proposal in Zaragoza: a study of the 21 urban complexes of interest] and the performance of various socio-urban studies and proposals for the urban regeneration of specific neighbourhoods: San Pablo, Balsas de Ebro Viejo, Barrio Oliver, San José, Las Fuentes (http://www.zaragozavivienda.es/M07_REHABILITACION-URBANA/03estudiosypublicaciones.asp).

The most recent municipal aid was structured around the following six lines:

Line 1. Energy performance in buildings built before 1980.

Line 2. Additional aid (on top of Line 1) for low-income family units.

Line 3. Works on buildings for homeowners' associations or owners of single-family dwellings with low incomes or which provide housing for the municipal rental stock.

Line 4. Works inside dwellings for low-income family units.

Line 5. Works inside dwellings for transfer to the municipal rental stock. Line 6. Works to install electric vehicle charging points in privately owned buildings.

	Zaragoza VIVIENDA
	Google
	Personal search
	ZARAGOZA VIVIENDA
	ZARAGOZA CITY COUNCIL
	SOCIAL MANAGEMENT
	PROMOTING HOUSING
	PROMOTING BUILDINGS

	URBAN RENOVATION
	Renovation Aid Measures and Results Studies and Publications
	EUROPEAN PROJECTS
	AID AND SUBSIDIES
	TRANSPARENCY
	SOCIAL RESPONSIBILITY
	CONTRACTOR PROFILE
	JOBS
	NEWS
	AID AND SUBSIDIES » RENOVATION AID » CALL FOR APPLICATIONS
	RENOVATION AID LINE 1.
	ENERGY PERFORMANCE IN BUILDINGS BUILT BEFORE 1980.
	[illegible]
	Aid to perform works to improve the energy performance of buildings completed before 1980 with the possibility of including accessibility and conservation works. The financial envelope for this line is 2 200 030 euro.
	APPLICATION SUBMISSION PERIOD CLOSED
	LINES OF ACTION
	- LINE 1-
	APPLICATION SUBMISSION PERIOD CLOSED
	WHAT TYPE OF WORK?
	ENERGY PERFORMANCE, which may include CONSERVATION + FULL ACCESSIBILITY (at level zero)
	HOMEOWNERS' ASSOCIATIONS (exceptions for sole owner in the conditions).
	WHO?
	WHERE?
	BUILDINGS BUILT BEFORE 1980

As regards the link to the financing of measures in neighbourhoods with low rents and/or little or no capacity to coordinate the work themselves, some municipal councils have established repayable renovation aid for certain socio-economic profiles, guarantee recovery through entry of the expense in the Property Register. This is the case, for example, at Barcelona City Council and Santa Coloma de Gramenet Municipal Council.

BOX 21. CARRER PIRINEUS. SANTA COLOMA DE GRAMENET[75].

The action involved the renovation of an area containing 32 buildings (26 multifamily dwellings and 6 single-family dwellings) which, in turn, accommodate 360 homes and 26 business premises. The structures were built mainly in the years between 1968 and 1974. Furthermore, this area is in a part of the Barcelona Metropolitan Area with one of the most vulnerable populations and where the building types are of low quality. In view of that situation, the Santa Coloma municipal council decided to lead the renovation process, demarcating various sectors and declaring a Conservation and Renovation Area, with the municipal council as its acting administration, thereby imposing an obligation on the owners to bear the cost of renovation work resulting from defects in the buildings.

[75] http://www.observatoriociudad3r.com/wp-content/uploads/2018/03/Jordi-Mas-Presentaci%C3%B3n_Pirineos_zgz.pdf https://www.mitma.gob.es/arquitectura-vivienda-y-suelo/urbanismo-y-politica-de-suelo/observatorio-de-lavulnerabilidad-urbana/informe-formulas-innovadoras-gestion-financiacion-actuaciones-regeneracion-barrios

The municipal council led the entire process: it contacted the residents of the area involved; it arranged and defrayed the cost of the inspections and plans (agreed with each homeowners' association); it handled the application for subsidies; it signed development agreements with the homeowners' associations; it activated the sector by means of the above-mentioned planning instrument, the Conservation and Renovation Area, assuming the role of acting administration; it established (by regulation) three different modalities for payment of the development fee; it invited tenders for all of the work, jointly, as a public project (which meant significant savings); and it dealt with collecting payments from the residents.

Given that the income level of the resident population was low, the financing and systems for payment were divided into three modalities, adapted to the different economic profiles of the owners. The first payment modality involved 50-50 payment (50% of the value at the start of the work and 50% on completion of the work on the building), applied to legal entities or those residents with sufficient financial resources to make the payments and who did not want to make use of other payment arrangements. The second modality involved payment in 60 monthly instalments, interest-free, with the amounts to be paid by standing order over a period of five years. And, lastly, the third modality involved the municipal council making the payment initially, with the amount being registered as a charge at the Land Registry – to be paid when ownership of the property is transferred in the future, whether by sale or inheritance – applicable to resident owners with an annual income of less than €20 000.

	Renovation cost, after deducting subsidy, per entity (in €)
	0.81%
	53.12%
	UP TO 3 000
	7 000-9 000
	MORE THAN 11 000
	Amount for payments in 60 monthly instalments
	60.00%
	LESS THAN €60
	FROM 60 TO 90
	FROM 90 TO 120
	FROM 120 TO 150

	FROM 150 TO 180
	FROM 180 TO 220
	Uptake of payment modality, by profile
	Owner-occupiers
	Non-occupying owners
	Financial institutions
	Non-occupying owners
	50%
	50-50%
	Registration
	Pending
	Municipal Council of Santa Coloma de Gramenet

4.5.4. Complementary financing measures at local or regional level.

As already noted in section 4.3 of this chapter, various initiatives have recently come about to complement classic financing for renovation by means of non-refundable subsidies, with other innovative mechanisms such as guarantee funds (Extremadura, the Basque Country), the loans of the Catalan Institute of Finance (Institut Català de Finances: ICF) and the Catalan Housing Agency (Agència de l'Habitatge de Catalunya: AHC), and the subsidised renovation loans of the Galician Institute of Housing and Land (Instituto Galego da Vivenda e Solo).

BOX 22. EXTREMADURA GUARANTEE FUND FOR ENERGY EFFICIENCY IN HOUSING[76].

The Fifth Additional Provision of Law 11/2019, of 11 April, on the promotion of and access to housing in Extremadura, provides for the creation of the Extremadura Guarantee Fund for Energy Efficiency in Housing, as a fund without legal personality, as provided for in Article 2.1 bis of Law 5/2007, on public funds in Extremadura. Its purpose is to implement a regional financial instrument that deals with the current barriers to financing the energy renovation of existing buildings.

The main aim of the Guarantee Fund is to support the homeowners' associations of residential buildings subject to commonhold property rules and individual homeowners, to carry out comprehensive building renovation projects relating to energy efficiency and renewable energy. The end recipients will be homeowners' associations and individual homeowners carrying out fundable projects which help to achieve greater energy efficiency, energy saving, a reduction in greenhouse gas emissions and greater comfort for the owners and their homes.

It is a financial instrument intended to guarantee loans provided by private financial institutions for the renovation of residential buildings where improvements in energy efficiency are involved.

- *Public guarantee fund provided with €5 million, which expects to mobilise an investment of up to €35 million in the area of the energy renovation of housing.*
- *Fundable projects must take account of financial sustainability and be able to demonstrate the capacity to repay the loan by guaranteeing the anticipated savings; they must achieve a reduction in pollutant emissions and greenhouse gases (TCO2/year); they must achieve a reduction in final energy consumption through energy efficiency actions (kWh/year); and they must promote greater energy saving, greater energy efficiency and savings in relation to final energy consumption.*
- *Projects must verify the energy savings and reductions in greenhouse gas emissions; in that regard, they will be linked to actions aimed at reducing the energy demand of the building, including the comprehensive renovation of the building envelope, as well as actions to reduce energy consumption and CO2 emissions, involving the comprehensive renovation of the building's installations.*

The initial implementation period is expected to run from 1 September 2019 to 1 September 2021.

BOX 23. SPECIAL FINANCIAL INSTRUMENT FOR RENOVATION IN THE BASQUE COUNTRY.

At the end of 2019, the Basque Government approved Decree 210/2019, of 26 December, on financial collaboration between credit institutions and the Government of the Autonomous Community of Euskadi (the Basque Country) in relation to housing and land and amending regulatory provisions in relation to housing[77]. This Decree regulates the conditions for financial collaboration with credit institutions for eligible actions relating to housing and land in the years 2019 and 2020, and, in particular, in relation to renovation, it establishes the 'Special Financial Instrument for Renovation' for the period 2019 to 2023. The new measure expands the range of financial instruments and financing modalities, with advantageous conditions as regards rates and terms for individuals undertaking the very wide range of eligible actions relating to housing.

The Special Financial Instrument for Renovation defines collaboration between the Department for Housing, the Basque Institute of Finance and the signatory credit institutions, to finance actions relating to the renovation of housing and buildings, universal accessibility and the improvement of energy efficiency. The instrument provides for a guarantee fund, provided by the Department for Housing, which will cover 16% of each bad loan. The operational management of the fund, which will be provided with €30 million, will be carried out by the Basque Institute of Finance.

[76] http://doe.gobex.es/pdfs/doe/2019/750o/19010011.pdf

[77] https://www.euskadi.eus/gobierno-vasco/-/decreto/decreto-2102019-de-26-de-diciembre-de-colaboracion-financiera-entre-las-entidades-de-credito-y-la-administracion-de-la-comunidad-autonoma-de-euskadi-en-materia-de-vivienda-y-suelo-y-de-modificacion-de-disposiciones-reglamentarias-en-materia-de-vivienda/

BOX 24. LOANS OF THE CATALAN INSTITUTE OF FINANCE AND THE CATALAN HOUSING AGENCY[78].

In the first half of 2019, the Catalan Institute of Finance (ICF) and the Catalan Housing Agency (AHC) opened up a new line of funding to finance investments in renovation, energy efficiency and accessibility made by homeowners' associations. Accordingly, homeowners' associations that need to carry out building work will have access to finance on preferential terms, allowing them to cover the total amount of the investment. This agreement between the ICF and the AHC represents an important change with regard to access to finance for investments made by owners' associations and fills a gap in a manner which the whole sector has been demanding for some time. Financing by homeowners' associations and not by owners individually has been a constant obstacle for associations that wanted to obtain credit to pay for renovation work. Until now, the only way they could cover the cost of the investments was to save over a number of years and apply for the existing subsidies, which only allowed for 30-40% of the cost to be covered, once the work had already been completed. That meant that, in many cases, by the time the associations had saved enough to cover the cost of the work required, the problems had got worse.

The new line of funding has been provided with €100 million and the loans will have a fixed interest rate, discounted by the AHC, of 2%. The maximum repayment period will be 15 years. Furthermore, the AHC will assume a degree of risk in the transactions. It is calculated that these loans will make it possible to finance the renovation of up to 10 000 homes, for a minimum amount per owners' association of €30 000.

BOX 25. SUBSIDISED RENOVATION LOANS OF THE GALICIAN INSTITUTE OF HOUSING AND LAND[79].

The Galician Institute of Housing and Land (Instituto Galego da Vivenda e Solo: IGVS) has established a programme to incentivise renovation by providing financing to the promoters of such renovation actions, whether they be individuals or homeowners' associations.

Support for renovation actions may consist of:

- *Qualified loans provided by credit institutions within the scope of the agreements entered into with the IGVS. The maximum amount of the loans will be €30 000 or €60 000, depending on whether they are secured by a personal guarantee or by a mortgage, respectively. In any event, the amount of the loan cannot be greater than the cost of the work. The financial support provided by the Xunta (Galicia's regional government) may cover up to 100% of the interest on the loan for a period of 48 months, with the extent of the support varying according to the income of the applicants. The loan may be used for both individuals' homes and the common elements of the owners' associations.*
- *Direct financial assistance, involving subsidising the interest on the qualified loans, such that the IGVS would subsidise the interest, by income bands, for up to 4 years.*

Characteristics of the loans

Both individuals and homeowners' associations can apply for the loans from Abanca, Caixabank, Caixa Rural and Banco Sabadell.

The loans agreed will have the following minimum characteristics:

- *Loan amount: The lesser of the following amounts:*
  - *Total cost of the work up to the maximum eligible budget.*
  - *€30 000 (personal loans) or €60 000 (mortgage loans).*
- *Repayment period: Between 6 months and 15 years.*
- *Guarantees: mortgage or personal guarantee.*
- *Grace period: An initial grace period of up to 2 years may be established in relation to repayment of the capital.*
- *In the case of actions organised by homeowners' associations, the loans will be calculated for each home according to its percentage share of the eligible budget for the work.*

[78] http://www.icf.cat/es/sala-de-premsa/El-ICF-y-la-AHC-abren-una-linea-de-prestamos-para-financiar-las-inversiones-de-las-comunidades-de-propietarios
[79] http://igvs.es/web/actuamos/10

- *No commissions.*

Eligible budget

The maximum amount applied for may include the cost of the renovation/work that is going to be carried out and the following costs, provided they are properly justified:

- *Fees of the professionals involved in planning and/or carrying out the work.*
- *Technical reports.*

Costs resulting from taxes of any kind will not be included and nor will costs relating to valuation, notaries and registers.

Subsidisation

The percentage subsidisation of the interest on the loan and its duration will depend on the income level of the borrower's family unit, in accordance with the following table:

IPREM	Subsidiación máxima	Duración máxima
Menor o igual a 4	100% de los intereses	48 meses
Mayor de 4 y menor de 5,5	80% de los Intereses	36 meses
Mayor de 5,5 y menor de 6,5	Sin subsidiación	Duración del préstamo

In the case of actions organised by homeowners' associations, the subsidisation of the loans will be calculated for each family unit according to its percentage share of the eligible budget for the work and the income of the household in question, provided that the other requirements laid down in the order of 19 September 2016 are satisfied. In the event that eligible actions are carried out in the homes within the building at the same time as the work on the common elements, the total subsidisation that would be due to each home cannot exceed the maximum percentages established in the above table.

The annual amount of the subsidisation will be deducted in advance by the financial institution from the amounts that would be due by way of capital repayment and interest, where applicable, calculated on a pro rata basis for each due date.

	IPREM
	Maximum subsidisation
	Maximum duration
	Less than or equal to 4
	100% of the interest
	48 months
	Greater than 4 and less than 5.5
	80% of the interest
	36 months
	Greater than 5.5 and less than 6.5
	No subsidisation
	Duration of the loan

4.5.5. Tax measures.

From the point of view of removing existing tax barriers, one of the obstacles that is referred to most often is the negative collateral impact which receiving subsidies for renovation has on the families with the lowest incomes, as it has a negative effect on their personal income tax (*Impuesto sobre la Renta de las Personas Físicas*: IRPF). In that regard, the Autonomous Community of Navarre has led the way in eliminating this effect by amending the legislation regulating personal income tax, initially declaring exempt those subsidies granted to homeowners' associations for accessibility and energy efficiency actions and, from 2020, all subsidies received for any eligible action relating to renovation, regardless of the entity granting the subsidy, and linking it to an upper limit (€30 000) on the income of the taxpayer.

BOX 26. AMENDMENT IN NAVARRE OF THE RECAST TEXT OF THE REGIONAL INCOME TAX ACT.

In Navarre, Regional Law 29/2019, of 23 December, on changes to various taxes and other tax measures, has added a Fifty-fifth Additional Provision, with effect from 1 January 2020, to the Recast Text of the Regional Income Tax Act, approved by Regional Legislative Decree 4/2008, of 2 June, with the following wording:

‘Fifty-fifth additional provision. Protected renovation work.

Public subsidies granted by the Government of the Autonomous Community of Navarre for protected renovation work shall be exempt, in accordance with Regional Decree 61/2013, of 18 September, regulating housing actions eligible for protection, provided that the subsidies are received by taxpayers who do not have an income, excluding exempt sources of income, of more than €30 000 in the relevant tax period.

Subsidies which, on the same basis, are received from other public authorities shall also be exempt.’

From a perspective complementary to the removal of barriers, that is, relating to the design of new tax frameworks that are favourable to renovation, the adjustment of the VAT applicable to renovation is still pending. Some Autonomous Communities have introduced tax relief on the relevant part of the gross tax liability due to the Autonomous Community.

BOX 27. TAX RELIEF FOR RENOVATION IN GALICIA.

In Galicia, as an initiative to facilitate financing, there is a tax measure that has already been approved by means of Law 7/2019, of 23 December, on tax and administrative measures relating to tax deductions at the regional level, which makes it possible to deduct sums invested to improve the energy rating of residential buildings or single-family dwellings.

Finally, it is also worth highlighting how some municipal councils have made progress in changing the regulation of the tax on immovable property (*Impuesto de Bienes Inmuebles*: IBI) to encourage renovation work or the installation of renewable energy.

BOX 28. BY-LAW OF GUADALAJARA MUNICIPAL COUNCIL REGULATING THE TAX ON IMMOVABLE PROPERTY. (ART. 12.4).

'4. Taxpayers who install in their homes heating or electricity systems making use of solar energy shall be entitled to a discount of 30% on their total tax liability, for the five tax periods following completion of the installation.

The application of this discount shall be conditional on the installations for heat generation including collectors having the relevant authorisation by the competent authority.

... The above discount shall not be given where the installation of such systems making use of solar energy is mandatory under the relevant specific regulations.'

4.5.6. Innovations, measures and remaining barriers in relation to the model for the provision of energy services by ESCOs.

From the regulatory perspective, both European and domestic, energy services are defined as: *'the physical benefit, the use or the good derived from the combination of an energy source with an efficient energy technology, or with an action, which may include the operations, maintenance and control necessary to provide the service, which is provided in accordance with a contract and which, under normal circumstances, has been shown to achieve an improvement in energy efficiency or a verifiable and measurable or estimable primary energy saving.'*

From a practical perspective, it is a model in which an Energy Service Company (ESCO) invests in the modernisation of a customer's energy-consuming installations, recouping the cost in full or in part on the basis of the energy savings achieved. The ESCO thus not only makes the initial investment in the new equipment, it also assumes the risk in the installation covered by the contract for the entire duration of that contract, generating energy (and also financial) savings from day one and allowing the owner to carry out the necessary renovation without being faced with the investment it entails.

Figure 4.21. Diagram of the typical involvement of an Energy Service Company (ESCO).

	ENERGY COST (€)
	Energy cost
	Electricity
	Fuel
	Q&M:
	Investment
	Direct saving
	ESCO payment:
	Investment
	Comfort increase
	O&M:
	Risk assumption
	Energy cost
	Electricity
	Fuel
	Guaranteed saving
	Saving
	O&M:
	Energy cost
	Electricity
	Fuel
	INITIAL SITUATION
	CONTRACT PERFORMANCE
	TIEMPO:
	AFTER THE CONTRACT

Source: AMI. Association of Comprehensive Maintenance and Energy Services Companies.

The different European directives related to the Green Deal establish a clear commitment to promoting the energy services market, emphasising the decisive role of Energy Service Companies (ESCOs) in the renovation of buildings belonging to public authorities, urging the Member States to encourage *public bodies to 'make use, where appropriate, of energy services companies and energy performance contracts in order to finance the renovation work and implement plans to maintain or improve energy efficiency in the long term.'*

Focusing on the most recent Spanish regulations, energy services are a cross-cutting element of the Integrated National Energy and Climate Plan 2021-2030 (*Plan Nacional Integrado de Energía y Clima*: PNIEC), as they play a decisive role in the implementation of the measures related to self-consumption (Measure 1.4), local energy communities (Measure 1.13) as well as the measures related to improvements in industrial management technology and systems (Measure 2.5), among others. The plan also includes a measure related to the promotion of energy services (Measure 2.11), which urges regional authorities to promote new contract models adapted to the recommendations of Eurostat and in accordance with the new Public Sector Contracts Act (*Ley de Contratos del Sector Público*). Of particular relevance to the sector is Measure 2.12, which proposes specific actions for the stock of buildings owned by the Central State Administration, such as the promotion of self-consumption, renewable energy and contracting with ESCOs.

The paradigm shift in the energy management of installations in the public sector highlights the need to remove barriers which, despite the obligations established in current legislation, continue to limit the growth of the energy services market in Spain.

Looking in greater detail at the existing barriers and the measures that are being taken to remove them, on the supply side, it is customary to criticise an absence of mechanisms which ensure the quality of the services offered.

But, in recent times, the sector has succeeded in removing that barrier and thus the Spanish standards body, UNE, drafted and, in 2018, published the standard UNE 216701 'Classification of Energy Services Providers', which provides professional and independent certification to make it easier to identify companies that provide energy services and create a more transparent energy services market. The classification establishes clarity and trust in the market regarding the existing different types of companies or providers, based on their actions; it also recognises the special nature of groups of companies, joint ventures or agreements between companies when it comes to providing energy services. The classification also aims to make it possible to compare the different providers of energy services, intending them to be described accurately, establishing a classification by type of provider and, in turn, within each type, establishing the parameters that make possible to compare them. The standard also allows companies with no experience to be included in the classification.

That standard represents a qualitative complement to the regulations laid down in Royal Decree 56/2016, of 12 February, transposing Directive 2012/27/EU, on energy efficiency, as regards energy audits, accreditation of service providers and energy auditors and promoting efficiency in the supply of energy. Article 7 of Royal Decree 56/2016 sets out the requirements to be satisfied by energy services providers in order to carry out their professional activity; Article 8 deals with authorisation and the declaration of compliance relating to the requirements for carrying out their activity; and Article 10 deals with matters relating to the public listing of providers of energy services. The requirements to be satisfied in order to be included in the list of energy services providers are limited to a declaration of compliance, in which the owner of the company or its legal representative declares that it complies with the applicable requirements, that it has the documentation to prove such compliance and that it undertakes to continue such compliance for the duration of the activity. The standard UNE 216701 provides independent accreditation recognising compliance with those minimum requirements, as well as higher levels of service.

The UNE standard is the result of consensus within the sector, centred around National Technical Committee 216, taking into account all of the suggestions made both by the Spanish Institute for Energy Diversification and Saving (Instituto para la Diversificación y Ahorro de la Energía: IDAE) and by other bodies, and it has been used as an example in various European Commission documents[80].

One more step in the necessary standardisation of rules is the work that is being done at the European level in the working group CEN/CLC/JTC 14/WG4, which includes representatives of UNE on the part of Spain. The group's work is aimed at achieving a European standard for a model Energy Performance Contract.

Furthermore, as detailed in another section of this ERESEE, in May 2018, Eurostat and the European Investment Bank published their new practical guide to the statistical treatment of energy performance contracts. That guide has removed the main obstacle that prevented may public authorities putting energy services in their buildings out to tender, as it offers the authorities (and market operators) a solution when it comes to inviting tenders for energy performance contracts in which the investments made by the ESCOs under the relevant contract are not included in the balance sheet of the contracting authority. The guide provides all of the elements that an energy performance contract must contain. Moreover, it allows the authorities to prepare and finance projects by mobilising private capital and consider different alternatives for drawing up an energy services contract.

The guide is the result of the work done by the sector in recent years to make the European institutions aware of the negative impact of the statistical treatment of the above-mentioned investments in the energy services market of some EU Member States and it has enjoyed the backing of the Spanish government.

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[80] See Commission Recommendation (EU) 2019/1019 of 7 June 2019 on building modernisation https://www.boe.es/doue/2019/165/L00070-00128.pdf

From a legislative perspective, the new Public Sector Contracts Act, Law 9/2017, offers authorities a range of options for tender processes tailored to deal with the problems posed by energy services, such as the Contract for Services with Investment, the Service Concession Contract and the Mixed Supply and Service Contract.

Those contract types offer extensive possibilities for putting energy services out to tender and remove one of the main obstacles that existed with the earlier public contracts legislation. In particular, they all provide for the possibility of tendering for long-term contracts, lasting as long as is necessary to recoup the investments that have to be made, and they also make it possible to set different prices for each year of the contracts, although the rules on the de-indexation of prices are, at present, one of the major existing barriers.

These changes have, in the opinion of the sector itself, put an end to the regulatory and trust-related barriers which existed in relation to the development of energy services in the public sector and have made it possible for various organisations and public institutions to publish model documents that are in accordance both with the regulations of Eurostat and with the new Public Sector Contracts Act, most notably those published by the IDAE[81] and the Catalan Energy Institute (Institut Català d'Energia: ICAEN)[82], among other organisations. The first contracts using those models have recently been put out to tender[83].

In conclusion, in recent years, in the public sector, there have been significant advances in relation to the energy services market in Spain. The European directives recognise the essential role of ESCOs in the implementation of the energy efficiency measures required of the Member States and public authorities have the tools to commit to this service model, thanks to the work done to promote the sector in both the public and private spheres.

On the demand side, in the public sector, the main barrier is the limited promotion of tendering for such services on the part of public authorities and the lack of awareness of the new rules referred to above, both as regards the impact of the statistical treatment of investments made by ESCOs in publicly-owned assets and as regards the Public Sector Contracts Act and the UNE standards. That is to say, the current barriers are of more of an operational nature, such as the absence of incentives or instructions for procuring bodies to commit definitively to energy efficiency in their buildings; that would require measures such as those put in place with Plan AGE-330 and Plan 2000-ESEs to be reintroduced, so that there is political impetus behind the managing and contracting bodies.

According to the ESCO sector itself, the main obstacle would be the current price review rules relating to public contracts, which, on account of the law on the de-indexation of the economy, would make it difficult to publish review formulas and also to put in place long-term contracts.

With regard to the private sector, the barrier of lack of trust/quality has been removed by the above-mentioned standard UNE 216701 on Energy Services Providers and the upcoming regulation of energy communities, which should mark the beginning of energy services being launched in the residential and commercial sphere.

4.5.7. Innovative initiatives in the private finance sphere.

4.5.7.1. The application of the ESCO model and the capitalisation of energy savings in large-scale projects.

Capitalisation of energy savings is one of the most important ways of helping to finance renovation and urban regeneration actions, beyond the owners' own resources and public funds. Two examples are set out below: the application of the ESCO model on a small scale in a residential building and an example of application on a large scale in the Torrelago district of the town of Laguna de Duero, in the province of Valladolid.

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[81] https://www.idae.es/tecnologias/eficiencia-energetica/edificacion/edificios-publicosconsulta-publica-sobre-losborradores-de-modelos-de-pliegos-de-clausulas-administrativas-y-tecnicas
[82] http://icaen.gencat.cat/web/.content/10_ICAEN/17_publicacions_informes/04_coleccio_QuadernPractic/quadern_practic/arxius/12_contractesRendimentEnergetics_pdf.pdf
[83] https://contractaciopublica.gencat.cat/ecofin_pscp/AppJava/es_ES/notice.pscp?idDoc=47186214&reqCode=viewCn&idCap=203469&

BOX 29. FINANCING THE RENOVATION OF HOMES THROUGH ENERGY SERVICE COMPANIES. THE EXAMPLE OF EOS ENERGY.

As an energy services company, EOS Energy offers a contract with includes the complete renovation work, the maintenance service and the energy supply for a period of 10 or 15 years, as well as the financing (Euribor +3%) of the whole project for that period. As a result of the renovation work, the energy saving is approximately 66%; that saving is guaranteed for the 10 years of the contract and helps to repay the financing. The company also handles applications for assistance from schemes such as PAREER (a programme of support for the energy renovation of existing buildings), the National Housing Plan, etc. If such assistance is received, it is used to pay down the debt, by way of partial repayment. Its services apply to both commercial buildings and multi-family residential property.

The financing comes from two sources: 30% from the European Institute of Innovation and Technology (EIT), through its investment arm, the company INNOENERGY, and 70% from own funds and recourse financing, with recourse to the balance sheet, from the various credit institutions operating in our country. In other words, the entire financing of the project is structured so that the customer pays 120 instalments, if the financing is over 10 years. Once the work has been paid for, the customer has the new building and a third of the energy consumption.

Example of a residential building in Guadalajara:

Source: EOS Energy.

	FUEL
	FACADE INSULATION
	ROOFING INSULATION
	CONSUMPTION STRUCTURE
	RENEWABLE ENERGY SUPPORT
	ALTERATION IN BOILER ROOM
	LIGHTING
	ARCHITECTURAL BARRIERS
	OIL
	NO
	CENTRALISED

	NO
	TRADITIONAL
	NO
	NATURAL GAS
	ETIS
	YES
	COST ALLOCATORS
	SOLAR PV-T
	LED
	'The model that makes it possible to improve users' quality of life, increase the value of their homes and care for the environment'
	ENERGY DEMAND
	EFFICIENCY OF THE EQUIPMENT
	FUEL SAVING
	EMISSIONS AVOIDED (CO_2 t/year)
	[illegible]
	ENERGY RATING PROPERTY VALUE
	PROPERTY TAX
	100%
	€124 000
	€329
	[illegible]
	INVESTMENT
	€1 302 635.81
	AID
	EOS FINANCING
	€268 435.59 (30% EU)
	EXTERNAL FINANCING
	ENERGY SAVING
	€626 349.71 (70%)
	TOTAL PER OWNER
	MONTHLY COST OVERRUN
	€0.47
	Current
	(Energy + Maintenance)
	During EOS contract
	(Energy + Maint. + Repayment)
	After EOS contract
	(Energy + Maintenance)
	INCREASE IN PROPERTY VALUE
	ADVANTAGES FOR THE OWNERS' ASSOCIATION / OWNER
	Average market price per property (90m^2)
	€124 000.00
	Increase
	20%
	Increased price of the property
	Gain per property
	€71.87
	ADVANTAGES FOR THE OWNERS' ASSOCIATION
	Investment to be made
	Life-cycle savings
	Current
	During EOS contract

	After EOS contract
	Without Subsidy
	Current
	During EOS contract
	After EOS contract
	State Plan

BOX 30. TORRELAGO. LAGUNA DE DUERO, VALLADOLID[84].

The action formed part of the European project CityFied, within the call for proposals for the FP7- ENERGY programme, coordinated by the Cartiff Foundation. The intervention in Torrelago is one of the project's three demonstration sites (along with Soma, in Turkey, and Lund, in Sweden). The work was carried out between 2014 and 2018 and basically consisted of actions of two kinds:

- *Improving the thermal envelope of the buildings by installing insulation in the façades with an external thermal insulation system (ETIS), achieving a 38.72% energy saving. The work involved 1 488 homes in 31 tower block-type buildings. This ETIS installation was the largest of its kind in Europe in a single intervention: it included 140 000m^2 of façade and a building footprint of 174 600m^2.*

- *Installation of a shared district heating system, taking advantage of the need to renovate the existing system. There were two boiler plants in the area, for the two homeowners' associations into which the buildings were grouped. Taking advantage of the need to renovate one of the two boiler plants, a completely new biomass plant, consisting of 3 boilers, was installed, requiring the construction of a new underground boiler room. The boiler room of the second owners' association and the heat exchanger rooms in the blocks, which had been built more recently, were retained and incorporated into the new system. The systems of the two homeowners' associations were connected, new heat exchanger rooms were built in each block of the first homeowners' association and individual control cabinets were made for every home in both homeowners' associations. As a complementary action, the project included a small co-generator, which uses the heat produced by the operation of the boilers themselves to generate part of the electricity that runs them.*

The financing was mixed public-private. The work was financed without extraordinary contributions by the residents, with the amount they paid for their homeowners' association bills remaining the same as before the intervention during the repayment period for the work. Individual billing for energy consumption, independent of the bill of the owners' association, was introduced for each home, with a considerable reduction in the expenditure on heating per home. The difference between the real cost of the owners' association's bill and the price that residents had been paying prior to the intervention made it possible to pay for each resident's contribution to the work. The residents did not, therefore, have to apply for finance from financial institutions or pay up front for the cost of the renovation and it was the construction company (3iA) and the energy services company (Veolia) that financed the work; they received the European subsidies directly and also the instalments paid by the owners' associations during the repayment period.

4.5.7.2. Development of innovation business strategies.

Set out below, merely by way of illustration and without implying any kind of assessment on the part of the public authorities, are some business initiative related to renovation which aim to introduce models that have worked in other countries in Spain.

[84] http://es.cityfied.eu/
https://www.mitma.gob.es/arquitectura-vivienda-y-suelo/urbanismo-y-politica-de-suelo/observatorio-de-la-vulnerabilidad-urbana/informe-formulas-innovadoras-gestion-financiacion-actuaciones-regeneracion-barrios
www.construible.es/comunicaciones/comunicacion-modelos-negocio-impulsar-rehabilitacion-edificios-distritos-residenciales

BOX 31. EUROPACE PROJECT.

This instrument has been introduced in Spain by the GNE Finance initiative. It has received European funding for its implementation through the project H2020 EuroPACE. Its aim is to offer technical and administrative guidance and financing to members of the public for the energy renovation of their homes. As in the case of PACE in the USA, it is a public-private collaboration instrument that offers the public technical and administrative guidance and financing for the energy renovation of their homes, through a one-stop-shop service.

So far, it has been introduced in the municipality of Olot, in the Basque Country (the municipalities of Bilbao and Eibar have joined the project) and it is in the process of being introduced in the Balearic Islands and the Autonomous Community of Valencia.

Key features of EuroPACE:

- *Using the one-stop-shop service, members of the public receive information and advice on the whole process of renovating their home, including administrative processes, applying for consents, technical advice, and also access to finance for the work.*
- *The loans are long-term loans (currently 15 years) with a low rate of interest (5%). They cover all of the costs associated with renovation, including technical plans and consents, etc., up to €1 000 000.*
- *It is based on a public-private collaboration model in which 3 main actors are involved. The municipal councils that join the programme. To that end, they sign a collaboration agreement with the rest of the parties involved. The contribute:*
  - *Communication with the public.*
  - *The involvement of the different municipal departments with the consents, social services, etc.*
  - *Administrative support in the event of incidents relating to payments. In such cases, the municipal council, through social services, steps in to avoid the social impact on vulnerable populations, such as cases of energy poverty.*
- *GNE Finance. This is the company responsible for designing the programme, implementing the one-stop shop, its integration with the municipal council and management of the finance facility. Furthermore, it provides specific software for managing the programme, as well as other technical support resources.*
- *The managing entity. An entity in which both the public and private parties are involved. It is non-profit-making, but it operates on a financially independent basis.*
- *To mobilise funds, there are two financial vehicles:*
  - *An investment fund, which seeks contributions from both private and public (EIB) investors, in order to be able to offer loans to the property owners.*
  - *A social guarantee fund, which guarantees the above fund in cases of non-payment by vulnerable populations.*
- *Collection of the payments relating to the debt, in the absence of a change to the legislative framework allowing this loan to be recognised as 'public revenue' (whether as a municipal tax, public provision or special contribution), is carried out by a third party, such as a bank.*
- *Given the difficulties encountered up to now in attempting to change the national legislative framework to authorise a public revenue to facilitate loans for energy efficiency, a model renovation agreement has been developed, which is to be signed by the participating municipal councils and which is protected, legally, by the Housing Act (Ley de Vivienda) of each Autonomous Community that decides to join the programme. This legal-contractual construct allows the parties involved to organise accessible financing, which can also cover vulnerable groups within the population.*
- *To date, it has mobilised €1.2 million of investment, making it possible to renovate 46 homes, particularly single-family dwellings, although the instrument is designed for homes of all kinds.*

BOX 32. PROGRAMME FOR THE ACTIVATION OF ECOLOGICAL CAPITAL (PACE).

This voluntary financial mechanism seeks public-private collaboration to promote renovation, specifically to finance energy-efficiency work on residential or commercial buildings. A private fund is set up, organised by Greenward Partners, to provide long-term financing (between 20 and 25 years) at a fixed interest rate for energy-efficiency work on residential or commercial buildings.

The mechanism presented by Greenward Partners in February 2020 has the following characteristics:

- *It offers financing with private funds.*
- *The security for the loan is the property itself and it is transferred with the property in the event of sale or seizure.*
- *The loan is repaid through the local public authorities, by means of a local contribution (PACE contribution), which is paid out by the municipal council, with the benefit of the tacit mortgage on the building.*
- *Use of the instrument is voluntary for any municipal council wishing to participate.*
- *The financing offered is long-term (between 20 and 25 years) with a fixed rate of interest. The financing covers 100% of the project costs, including technical plans, consents, etc., up to a limit of 20% of the value of the property.*
- *The long-term financing and the attachment of the debt to the property make it possible to [text missing].*

The full implementation of the PACE system would require a new legal framework for its introduction, including the amendment of the following instruments:

- *Recast Text of the Local Revenue Authorities Act (Texto Refundido de la Ley de Regulación de las Haciendas Locales: TRLRHL) to create a specific contribution, or a surcharge on the immovable property tax, to allow municipal councils to make the loan repayments.*
- *General Taxation Act, to regard the repayment of the PACE financing as a tacit legal mortgage.*
- *Specific collaboration agreements with each participating local authority, to create a special form of PACE financing agreement, beyond the strict public procurement framework.*

4.5.8. Strategies for demand aggregation.

BOX 33. PROJECT AGREE FOR THE AGGREGATION OF DEMAND[85]

The aim of the project HORIZON 2020 'Aggregation and improvement of governance to harness the potential for residential energy efficiency in the Basque Country - AGREE' is to promote investment in the energy-efficient renovation of private residential buildings in the Basque Country, through the development and deployment of innovative mechanisms for the activation and aggregation of demand, better governance of the processes and personalised financing solutions. The Basque Government's Department of Housing, in close collaboration with three Basque cities (Donostia-San Sebastián, Vitoria-Gasteiz and Basauri), the public company Ihobe (Technical Secretariat of the Basque Network of Sustainable Municipalities, Udalsarea 2030) and Tecnalia, will co-design and implement innovative solutions for the renovation of residential buildings built between 1940 and 1980, from the perspectives of both energy efficiency (façade and roofing) and accessibility (lift installation), in three pilot projects, mobilising an investment of approximately €8.5 million and achieving a reduction of 250 tonnes of CO_2 equivalent/year between now and 2022.

[85] https://agree-basquecountry.eu/es/proyecto-agree/

4.5.9. Creation of national forums for dialogue and sharing experiences in relation to financing.

BOX 34. THE AÚNA FORUM FOR SUSTAINABLE FINANCE IN RELATION TO THE SMART FINANCE FOR SMART BUILDINGS INITIATIVE.

AÚNA is an H2020 project coordinated by GBCe, which has recently been approved and which, in the next few years, will create a FORUM in Spain for permanent, multi-level and multilateral debate, entirely focused on the sustainable financing of buildings, for the effective and extensive implementation of the European initiative Smart Finance for Smart Buildings.

Its principal objectives are:

- *To promote understanding between all actors involved in financing the energy renovation of buildings.*
- *To develop and strengthen permanent platforms for interested parties, to include the principal actors of the entire construction sector.*
- *To involve interested parties from the whole of Spain in permanent multilateral debates about energy-efficiency investments in existing buildings.*
- *To identify, analyse and establish the bases for expanding the existing initiatives relating to best practice (at the Spanish and European level) in energy-efficiency financing.*
- *To monitor and evaluate the financial measures implemented in the different national, regional and local policies aimed at promoting the renovation of buildings.*
- *To give recommendations to the politicians responsible for creating appropriate mechanisms to support the mobilisation of investment in the energy-efficient renovation of buildings. Those mechanisms will be particularly focused on:*
  - *the aggregation of projects to make them accessible to investors, as well as integrated solutions for potential customers;*
  - *reducing the perceived risk in energy-efficiency transactions for investors and the private sector;*
  - *using public funds to take advantage of the additional investment from the private sector or tackle specific market failures;*
  - *directing investment towards a stock of energy-efficient public buildings, in accordance with the guidance of Eurostat;*
  - *accessible and transparent advisory tools, such as one-stop shops for consumers and energy advice services, relating to energy-efficient renovation and relevant financial instruments.*
- *To publicise the results and products of the project, in order to reach other interested parties that do not participate directly in the round table discussions.*

4.6. MONITORING OF THE OBLIGATION UNDER ARTICLE 5 OF DIRECTIVE 2012/27/EU RELATING TO ENERGY EFFICIENY IN THE BUILDINGS OF PUBLIC AUTHORITIES.

Directive 2012/27/EU of 25 October 2012 on energy efficiency provides, in Article 5 (Exemplary role of public bodies' buildings), that, by 31 December 2013, Member States are to establish and make publicly available an energy inventory of central government buildings with a total useful floor area over 500 m^2 and, as of 9 July 2015, over 250 m^2.

On the basis of the inventory taken, as of 1 January 2014, 3% of the floor area of those buildings must be renovated annually, so that they at least comply with the minimum energy performance requirements set in application of Article 4 of Directive 2010/31/EU.

In compliance with Article 5 of Directive 2012/27/EU, since 2013, the energy inventory of the buildings belonging to the Central State Administration has been published on the website of the Ministry for the Ecological Transition and the Demographic Challenge, containing the energy data for the previous year.

Based on the energy inventory, a document is published each year establishing the renovation target for government buildings for the following year. That document includes the area renovated in the previous year of the buildings that formed part of the inventory that year, indicating the criteria that were taken into account to obtain it and the working methodology used.

In accordance with the above, in preparing the inventory, the following were taken into account [86]:

- All those public bodies referred to as being part of the Central State Administration by Law 40/2015, of 1 October, on the legal regime applicable to the public sector, were considered to be 'central government', as defined in Article 2(9) of the Directive.

  The criteria set out in the interpretative notes produced at the Joint Meeting Energy Demand Management Committee ('Energy Services' Formation - Directive 2006/32/EC) and Committee on Cogeneration (Directive 2004/8/EC)' and in Annex 4 to Directive 2004/18/EC were also followed.

- Only buildings with a heating and/or cooling system and a total floor area of more than 250 m^2 were included in the inventory.

- The buildings selected belong to the Central State Administration and were occupied on the date on which the inventory was taken.

- Article 5(2) of the Directive provides for the possibility of excluding from the inventory 'buildings officially protected as part of a designated environment, or because of their special architectural or historical merit, in so far as compliance with certain minimum energy performance requirements would unacceptably alter their character or appearance' (Article 5(2) of Directive 2012/27/EU).

  In view of the above, those buildings which enjoy some degree of protection provided by the different planning regulations of the local authorities, or by the bodies of the Autonomous Communities and the Central State Administration having responsibility for architectural or historical heritage, are not included in the inventory.

  Those protected buildings, although they are not included in this public inventory, also underwent an energy inventory using the same methodology and may be included in specific programmes of action to improve energy efficiency, taking their particular architectural characteristics into consideration.

- Also in accordance with the Directive, the inventory excludes 'buildings owned by the armed forces or central government and serving national defence purposes, apart from single living quarters or office buildings for the armed forces and other staff employed by national defence authorities' (Article 5(2) of Directive 2012/27/EU).

[86] https://energia.gob.es/desarrollo/EficienciaEnergetica/directiva2012/Inventario2018/00_Inventario%20Doc%202%20-%2020200207%20INVENTARIO%202019%20ARTICULO_5.pdf

Nevertheless, the Ministry of Defence has developed its own system of property and energy management, known as SINFRADEF, which contains information on the energy consumption and efficiency of all of its buildings. Accordingly, although, for security reasons, the information relating to that ministry is not included in this inventory, there is a system for Ministry of Defence buildings which has similar objectives to those established by Article 5 of the Directive.

For the present purposes, the buildings of the Directorate-General of the Civil Guard were regarded as buildings serving national defence purposes and, therefore, have not been included in this inventory. They did, however, undergo an energy inventory using the same methodology and may be included in specific programmes of action to improve energy efficiency, taking their special characteristics into consideration.

- Lastly, ‘buildings used as places of worship and for religious activities’ (Article 5(2) of Directive 2012/27/EU) have not been included in the inventory, as the Directive also excludes them from that obligation. Although, no buildings with those characteristics were identified among the building stock of the Central State Administration.

4.6.1. Carrying out the inventory.

To carry out the inventory, the Institute for Energy Diversification and Saving (IDAE), a body attached, to the Ministry for the Ecological Transition and the Demographic Challenge through the State Secretariat for Energy, used the IT system for the energy management of Central State Administration buildings (Sistema Informático de Gestión Energética de Edificios de la Administración General del Estado: SIGEE-AGE), the main purpose of which is to centralise and make use of energy-related and physical information about buildings belonging to the Central State Administration and its dependent public bodies.

Since 2013, in collaboration with all of the ministries concerned, the inventory has been carried out using the SIGEE-AGE application. The selection of the buildings and the energy-related and physical details it contains were provided by the ministries through the energy managers of each ministry and the energy managers of each building. The SIGEE-AGE application allows the inventory to be kept constantly up to date, with buildings being added or removed, as well as their energy consumption, provided by the energy managers of each building.

With regard to the first energy inventory carried out in December 2013, in the years since then a great deal of work has been done to update the data uploaded to the SIGEE-AGE platform.

The energy inventory provided includes the following information:

- PaeeAge code: identifies each building on the SIGEE-AGE IT platform with a code.
- Name: building name.
- Road type: indicates whether it is a street, a road, an avenue, etc.
- Road name: name of the street.
- Number: number on the street where the building is located.
- Municipality.
- Province.
- Floor area: total floor area of the building.
- Energy consumption: electricity, natural gas, oil, propane and total energy consumption in the year 2018, expressed in kWh.
- Energy rating.
- Consumption of non-renewable primary energy and CO_2 emissions: energy rating of the building, expressed by means of a letter indicating the energy efficiency of the building. The rating scale goes from ‘A’ to ‘G’, with A being used for the most efficient buildings and G for the least efficient.

As a result, 2 126 buildings were identified with a floor area of more than 11 million square metres, which complies with the scope established in section 2.1. The main characteristics of those buildings are summarised in the following table:

The inventory is published on the website of the Ministry for the Ecological Transition:

https://energia.gob.es/desarrollo/EficienciaEnergetica/directiva2012/Paginas/actuaciones-transposicion.aspx

4.6.2 Monitoring of the 3% aggregated renovation target.

Figure 4.22. Energy inventory of the buildings of the Central State Administration grouped by ministry.

Ministerio	Nº de Edificios	Superficie (m²)	Electricidad 2018 (kWh)	Gas Natural 2018 (kWh)	Gasóleo 2018 (kWh)	Propano 2018 (kWh)	Consumo Total 2018 (kWh)
MAEC	3	6.743					
MAPA	10	63.767	4.352.310	774.955	498.098		5.625.363
MCD	19	189.914	4.480.029	1.627.841	545.313		6.653.183
MCIU	115	838.656	115.503.372	26.068.068	7.557.295	74.457	149.203.193
MEFP	32	166.351	5.353.914	1.589.080			6.942.994
MFOM	85	208.927	6.692.507	348.504	1.365.762	6.758	8.413.530
MINCOTUR	5	307.032	18.918.396	3.210.339	309.144		22.437.879
MINECO	52	135.518	2.533.737	768.802	80.255		3.382.795
MINHAC	223	898.115	48.740.361	5.099.157	7.893.073	34.622	61.905.714
MIR	597	5.600.245	255.723.478	138.207.357	124.111.069	9.709.682	527.751.586
MITECO	22	40.885	1.487.558	64.599	460.060	39.159	2.656.293
MITRAMISS	740	1.924.505	120.445.459	18.710.417	7.765.921	20.893	146.942.689
MJUSTICIA	12	41.114	5.839.512	337.905	107.313		6.284.730
MPR	8	121.082	14.828.513	151.313	1.598.117		16.577.943
MPTFP	165	352.392	9.553.104	3.013.844	2.897.893		15.464.840
MSCBS	38	336.871	22.977.991	5.368.426	13.987.200	363.141	43.998.953
TOTAL	**2.126**	**11.232.118**	**637.430.241**	**205.340.606**	**169.176.512**	**10.248.712**	**1.024.241.683**

	Ministry
	Nr of Buildings
	Floor area (m²)
	Electricity 2018 (kWh)
	Natural Gas 2018 (kWh)
	Oil 2018 (kWh)
	Propane 2018 (kWh)
	Total Consumption 2018 (kWh)
	Ministry of Foreign Affairs and Cooperation (MAEC)
	6 743
	169 176 512
	1 024 241 683
	Ministry of Agriculture, Fisheries and Food (MAPA)
	Ministry of Culture and Sport (MCD)
	Ministry of Science and Innovation (MCIU)
	Ministry of Education and Vocational Training (MEFP)
	Ministry of Development (MFOM)
	Ministry of Industry, Trade and Tourism (MINCOTUR)
	Ministry of Economy (MINECO)
	Ministry of Finance (MINHAC)
	Ministry of the Interior (MIR)

	Ministry for the Ecological Transition and Demographic Challenge (MITECO)
	Ministry of Labour, Migration and Social Security (MITRAMISS)
	Ministry of Justice (MJUSTICIA)
	Ministry of the Presidency (MPR)
	Ministry of Territorial Policy and Civil Service (MPTFP)
	Ministry of Health, Consumer Affairs and Social Welfare (MSCBS)
	TOTAL

Source: Energy inventory of the buildings of the Central State Administration.

The following table shows the individual figure per year and the aggregated figure for the renovation actions carried out between 2014 and 2019.

Figure 4.23. Actions in the 2014-2019 period.

3% Renovation Actions	2014 Floor Area (m²)	2015 Floor Area (m²)	2016 Floor Area (m²)	2017 Floor Area (m²)	2018 Floor Area (m²)	2019 Floor Area (m²)	Total 2014-2019 Floor Area (m²)
Annual renovation target	318 833	295 523	289 116	275 094	278 509	279 902	1 736 977
New build	700	4 800	23 026	0	8 063	3 409	39 997
Refurbishment	32 872	270 990	158 681	274 715	129 832	156 420	1 023 510
Sale, demolition and disuse	272 979	106 791	66 988	27 494	74 676	13 779	562 707
Total renovated floor area	306 550	382 581	248 695	302 209	212 571	173 608	1 626 214
Level of compliance	**96%**	**129%**	**86%**	**110%**	**76%**	**62%**	**94%**

In the years 2015 and 2017, the renovated floor area recorded exceeded the renovation target, which could be used to justify the amount achieved in the previous year or in the three following years, according to Article 5(3) of Directive 2012/27/EU.

Taking into account the total renovated floor area between the years 2014 and 2019, more than 94% of the renovation target was achieved, with a shortfall in renovated floor area of 110 763 m², which could be offset by exceeding the renovation target in the following years.

CHAPTER 5. ASSESSMENT. ANALYSIS OF THE MAIN STRUCTURAL CHALLENGES.

Set out below are a number of structural challenges for the implementation of energy renovation in Spain, which were identified in the assessment carried out for the 2014 ERESEE and the 2017 ERESEE and still exist or which have become apparent in their subsequent implementation. The aim of this section is not only to highlight them, but also to arrive at some conclusions that make it possible to design optimal measures for tackling them.

5.1. COMPLEXITY OF THE PROBLEMS AFFECTING THE SPANISH RESIDENTIAL BUILDING STOCK.

As noted in the 2017 ERESEE, there are various instruments in Spain for analysing the residential building stock, which have made it possible, both at national level and at the level of the Autonomous Communities and even provinces, to carry out an exhaustive analysis of the characteristics of residential buildings and an assessment of their renovation requirements[87]. A large part of that information is also available at census subdivision level, which even makes it possible to produce thematic maps at a very detailed level[88].

In the different analyses carried out, substandard housing (dwellings smaller than 30 m^2 and/or without a bathroom, running water, waster water evacuation, etc.) are regarded as the most serious problem, qualitatively, although - as already noted in the 2017 ERESEE - it is very limited problem quantitatively, as it affects less than 1% of the total Spanish building stock and, moreover, significant progress has been made in that regard in recent years[89].

With regard to the state of repair of residential buildings, the situation in Spain is a little below the EU average: as can be seen in the following graph, according to European Commission data for 2013, in Spain, 16.7% of the population lived in housing with repair problems, compared to an average for the EU28 of 15.7%. In absolute terms, according to the last census in 2011, there were 1.8 million homes in Spain that were in a dilapidated, poor or deficient state of repair (with important differences between those three states), which represented approximately 7% of the total.

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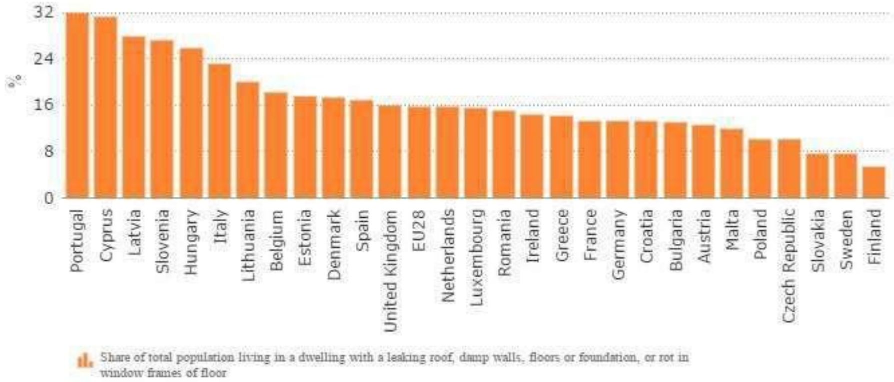
[87] The *'Analysis of the characteristics of residential buildings in Spain':*
http://www.fomento.gob.es/MFOM/LANG_CASTELLANO/DIRECCIONES_GENERALES/ARQ_VIVIENDA/SUELO_Y_POLITICAS/OBSERVATORIO/ANALISIS_CARAC_EDIF_RES/

These reports present the main characteristics of the Spanish residential building stock, at national level, by Autonomous Community and province, analysing various variables related to residential buildings (type, age, floor area of the dwellings, state of repair, accessibility, etc.), based on data from the population and housing censuses of the Spanish National Statistical Institute (Instituto Nacional de Estadística: INE) for the years 2001 and 2011. They provide data making it possible to describe the housing stock on each of the reference dates, they identify the building stock in most urgent need of intervention (deficiencies in the state of repair or in relation to accessibility, substandard housing) and they analyse its development between 2001 and 2011.

[88] The *"Atlas of Residential Buildings"* in Spain 2001-2011 is a web application, produced using the data form the 2001 and 2011 population and housing censuses, which offers statistical information and makes it possible to analyse - at census subdivision level and in every municipality in Spain - various variables relating to buildings and, in particular, those used predominantly for housing, generating thematic maps of different indicators, organised into four domains: basic characteristics of the buildings and homes; characteristics relating to use, ownership and tenure; state of repair and availability of installations; and urban development characteristics.
http://www.fomento.gob.es/MFOM/LANG_CASTELLANO/DIRECCIONES_GENERALES/ARQ_VIVIENDA/SUELO_Y_POLITICAS/OBSERVATORIO/AtlEdiResEsp/

[89] Ministry of Development (2014) *'Analysis of the characteristics of residential buildings in Spain in 2011. Volume I'*, pp. 42 *et seq.*
Significant progress has also been in the eradication of shanty towns and in improving the housing conditions of specific groups, such as the gypsy community. In that regard, see: Ministry of Health, Social Services and Equality. *'Mapping Study on Gypsy Housing and Population. Executive Summary'* (September 2016).
http://www.eapn.es/ARCHIVO/documentos/recursos/4/1473319238_resumen_ejecutivo_estudio_vivienda_-_pob__gitana_2015.pdf

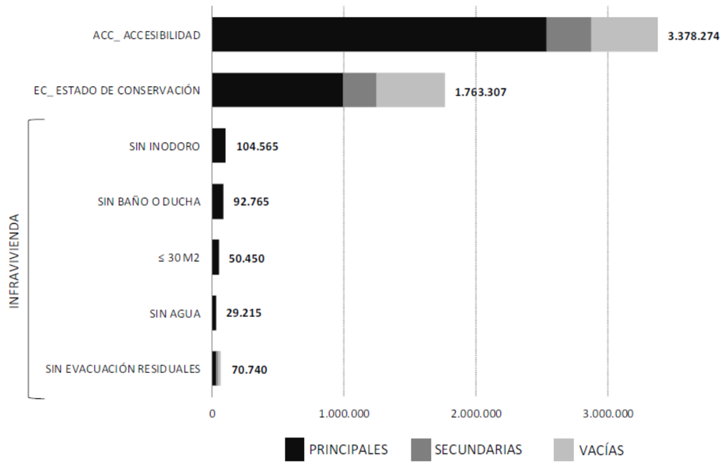
Figure 5.1. EU countries according to population percentage in housing with repair problems (leaks, damp in walls, floors or foundations, joinery in poor condition, etc.). (2013).



Source: European Commission (2016). https://ec.europa.eu/energy/en/eu-buildings-factsheets

With regard to accessibility, it has to be borne in mind that Spain is one of the countries with the highest population percentage living in multi-family residential buildings with more than four floors and that, despite - according to Credit Suisse - being the country with the most lifts per inhabitant in the world, according to the data from the 2011 census, there were then 3.4 million homes located in buildings with four or more floors and no lift, affecting approximately 13.5% of the building stock. As can be seen in the following graph, from the quantitative perspective, this is the most significant of all of the problems analysed, as it affects almost 3.4 million homes:

Figure 5.2. Main problems with the residential building stock in Spain (2011).



	ACC_ACCESSIBILITY
	3 378 274
	SR_STATE OF REPAIR
	NO LAVATORY
	NO BATH OR SHOWER
	≤ 30M2
	NO WATER
	NO WASTE EVACUATION
	SUBSTANDARD
	MAIN
	SECOND
	EMPTY

Source: Ministry of Development.

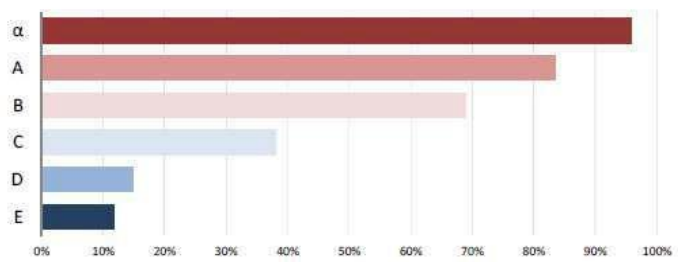
From the qualitative point of view, this problem is also particularly serious for people with disabilities and the elderly and, no doubt for that reason, emerges as the issue that most concerns Spaniards with regard to the building in which their home is situated, according to the last major survey carried out nationally on housing conditions in Spain (the Housing Barometer, of the Centre for Sociological Research, conducted in 2018, updating the previous survey carried out in 2014, which was discussed in the 2017 ERESEE), with 50.4% of those surveyed saying they were fairly (25.6%) or entirely (24.8%) dissatisfied with the accessibility conditions of their building[90].

With regard to the energy performance of the Spanish residential building stock, it should be stressed that - as recorded in the 2014 and 2017 ERESEEs on the basis of the data from the 2011 census - almost 60% of Spanish homes (that is, some 13.8 million, of which 9.8 million are main residences and another 4 million are second or empty homes) pre-date the first Spanish legislation requiring minimum levels of energy efficiency, which - in our country, as in many other European states - was passed after the oil crisis at the end of the 1970s (Standard NBE CT 79). Regarding the remaining homes built prior to the 2007 Technical Building Code (*Código Técnico de la Edificación:* CTE), it should be borne in mind that, although they had to comply strictly with the minimum levels established by Standard CT 79, they were built in a context of rising family incomes and continuously falling energy prices, which meant that little attention was paid to energy efficiency and there was little social awareness of the issue.

With regard to heating installations, the most recent data available (2018 Housing Barometer) indicate that 71.8% of Spanish homes have heating (64.3% with individual heating and 7.5% with communal or district heating), compared to 20.9% which, although they do not strictly speaking have a heating system, do have some appliance making it possible to heat some rooms[91] and 7.1% that have neither.

Unfortunately, the only source that allows the data on heating to be broken down by region is the population and housing census, the last one being from 2011, and the next one is not planned until 2021. According to the 2011 data, of the total of 17.5 million main residences that there then were in Spain, some 9.9 million homes (56.7%) had a heating installation, almost 5.2 million did not have a heating system or installation as such, although they did at least have some form of heating appliance, and almost 2.4 million homes had neither. What matters is that, as can be seen in the graph below, there are major differences as regards the presence of heating systems depending on the climatic zone, with it being a more concerning issue - albeit with a proportionally much lower incidence - in areas with more severe winters.

Figure 5.3. Percentage of homes without a heating system in each climatic zone.



Source: Ministry of Development-Juan de Herrera Institute. 'Analysis of the characteristics of residential buildings in Spain according to the 2011 census. Volume II', p. 13.

http://www.fomento.gob.es/NR/rdonlyres/BDE3A416-114C-498B-9F1A-0286545535E0/135889/TomoII_Fichasestatalyautonomicas.pdf

[90] In 2014, these percentages were 43.9% of those surveyed (fairly dissatisfied, 26.5%; and entirely dissatisfied, 17.4%).

[91] The data from the 2014 Housing Barometer indicated the following: 67.9% of homes surveyed responded that they had a heating system, 25.6% said that they did not have a heating system, but did have appliances to heat some rooms, and only 6.4% said that they had neither.

With regard to energy efficiency being considered a problem by society, according to the 2018 Housing Barometer[92], 34% of Spaniards said that they were fairly (25.7%) or entirely (8.3%) dissatisfied with their home's insulation against cold and heat, which indicates greater concern with thermal comfort than with state of repair (regarding which only 17.7% said that they were fairly or entirely dissatisfied), but a very similar level to that for concern with noise (35.8%) or security against burglary (30.5%) and well below that for accessibility, which - as mentioned above - is the most significant concern (50.4%).

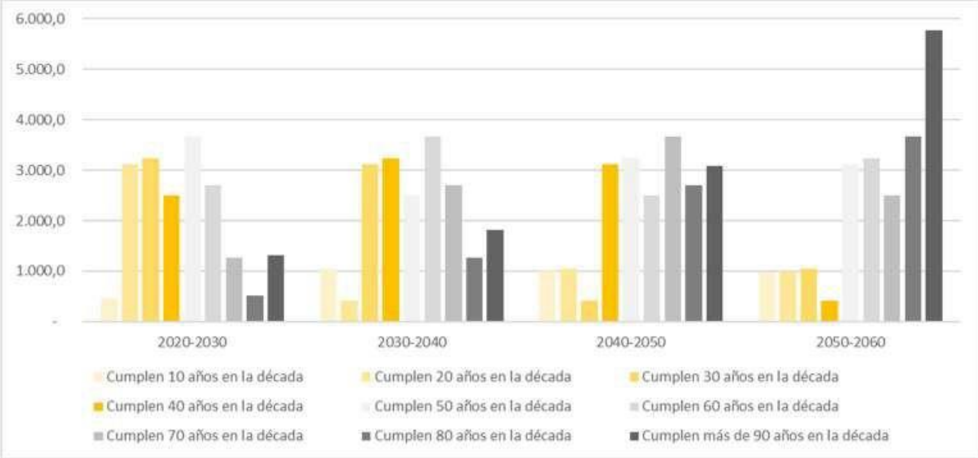
In conclusion, the Spanish residential building stock has problems of very different kinds, which can be grouped according to three aspects: state of repair, universal accessibility and energy efficiency. Although energy efficiency is one of the most significant deficits in relation to the challenges and demands of today's society - in particular as regards tackling the challenge of climate change - there is not the same level of concern about it, or the same level of social awareness of it, as there is for other problems. Hence, the outlook of renovation must go beyond partial or sectoral approaches and be envisaged as an integrated set of actions, intended to improve the habitability, quality and comfort of the building stock as a whole. That implies, on the one had, that the policies designed to address those problems must try to establish interrelationships between them and achieve synergistic solutions and, on the other, that the available public resources must be appropriately distributed, in order to deal with such diverse problems, prioritising those which are most serious.

In this regard, it is important emphasise - as will be discussed further on - the great potential, in Spain, of instruments such as the Building Assessment Report or the Building Technical Inspection (or other equivalent instruments that may exist currently or be introduced in the future, such as the 'energy passport') to generate synergies between mandatory repair work, or reasonable adjustments relating to accessibility, and voluntary work to improve energy efficiency.

The graphs below show the change over the next four decades in the age of buildings serving as main residences in Spain. The first conclusion to emerge is that, due to the different cycles that construction in Spain has been through, in the decade 2040-2050 and, above all, 2050-2060, there will be a significant number of homes that are more than 70, 80 and 90 years old, which were built during the Franco era. While there is currently a clear consensus - both academically and socially - regarding the need to maintain and preserve historic centres (where homes pre-dating 1940 are concentrated), there has not been a similar process of reflection - either academically or socially - on the long-term future of homes built during the period of rapid development in the 1950s and 60s, many of them located in free-standing blocks of flats on the outskirts of towns and cities, which pose serious problems, both in terms of urban development and in terms of the buildings themselves. And nor has there been such a process regarding the future of the small rural centres in what has been termed 'abandoned Spain' (*España vaciada*). Given that some of these problems are intrinsic in nature (poor urban configuration, small size of the homes, inadequate ceiling heights, etc.), meaning that they cannot be solved by renovation, or making it extremely difficult to do so, it is necessary to begin a debate and reach a consensus, technically and socially, on whether their future should be renovation by means of demolition or whether renovation of the homes and urban regeneration are possible, bearing in mind the undoubted advantages of this second option from the point of view of sustainability, the embodied energy in the buildings and the circular economy.

Figure 5.3. Change in the age of buildings (main residences, single- and multi-family dwellings) in each decade (2020-2060): number of homes by age in each decade (millions of homes).

[92] In 2014, the figures were very similar: 32.8% of Spaniards said that they were fairly (25.2%) or entirely (7,6%) dissatisfied with their home's insulation against cold and heat, 18.9% with its state of repair, 36.3% with noise and 34.3% with security against burglary.

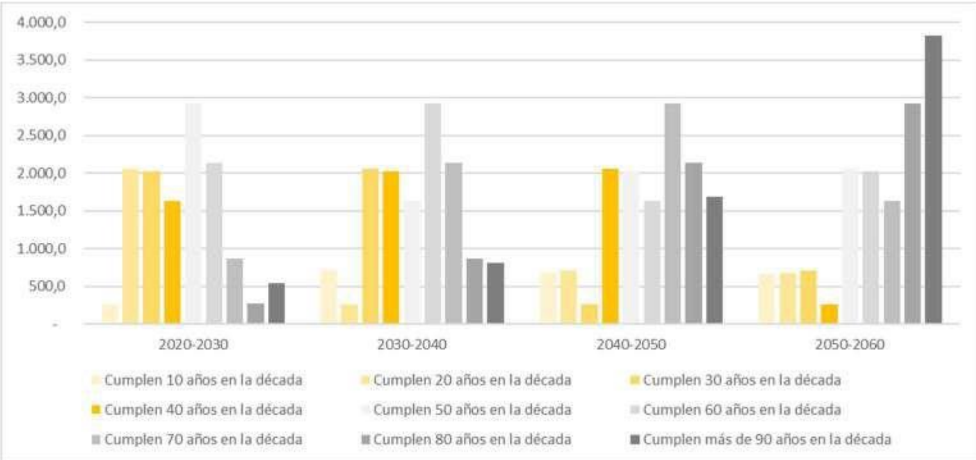


	6 000.0
	2020-2030
	Reach 10 years old in the decade
	Reach 40 years old in the decade
	Reach 70 years old in the decade
	Reach 20 years old in the decade
	Reach 50 years old in the decade
	Reach 80 years old in the decade
	Reach 30 years old in the decade
	Reach 60 years old in the decade
	Reach more than 90 years old in the decade

Source: MITMA.

Furthermore, given that the Building Assessment Report or Building Technical Inspection (or equivalent instruments) are usually required for multi-family residential buildings, for the first time, when they reach 50 years old (and to be renewed every 10 years from then on), the graphs below show an estimate of the number of homes in which those circumstances would arise and for which, therefore, those instruments would be required.

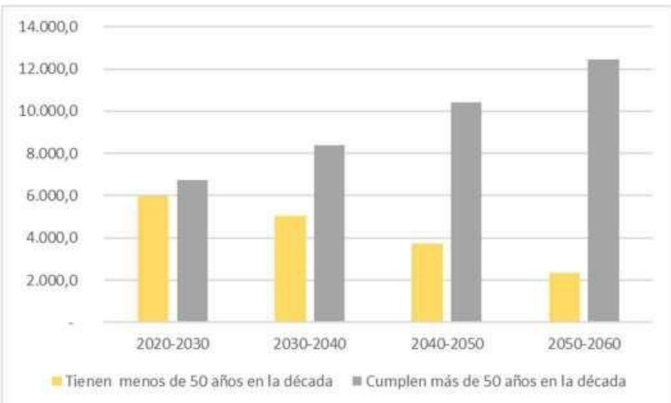
Figure 5.4. Change in the age of buildings (main residences in multi-family buildings) in each decade (2020-2060): number of multi-family homes by age in each decade (millions of homes).



	4 000.0
	2020-2030
	Reach 10 years old in the decade
	Reach 40 years old in the decade
	Reach 70 years old in the decade
	Reach 20 years old in the decade
	Reach 50 years old in the decade
	Reach 80 years old in the decade
	Reach 30 years old in the decade
	Reach 60 years old in the decade
	Reach more than 90 years old in the decade

Source: MITMA.

Figure 5.5. Main residences more and less than 50 years old in each decade (2020-2060) (millions of homes).



	14 000.0
	2020-2030
	Less than 50 years old in the decade
	Reach more than 50 years old in the decade

Source: Prepared in-house by MITMA.

The last of the above graphs is particularly illustrative, as it shows that the number of homes reaching more than 50 years old in the decade 2020-2030 (and, therefore, theoretically subject to the obligation to carry out the Building Assessment Report (BAR) for the first time or subsequently have it renewed every 10 years) reaches 6.7 million. Obviously, in the following decades the volume rises: almost 8.4 million in the decade 2030-2040, 10.4 million in 2040-2050 and 12.4 million between 2050 and 2060.

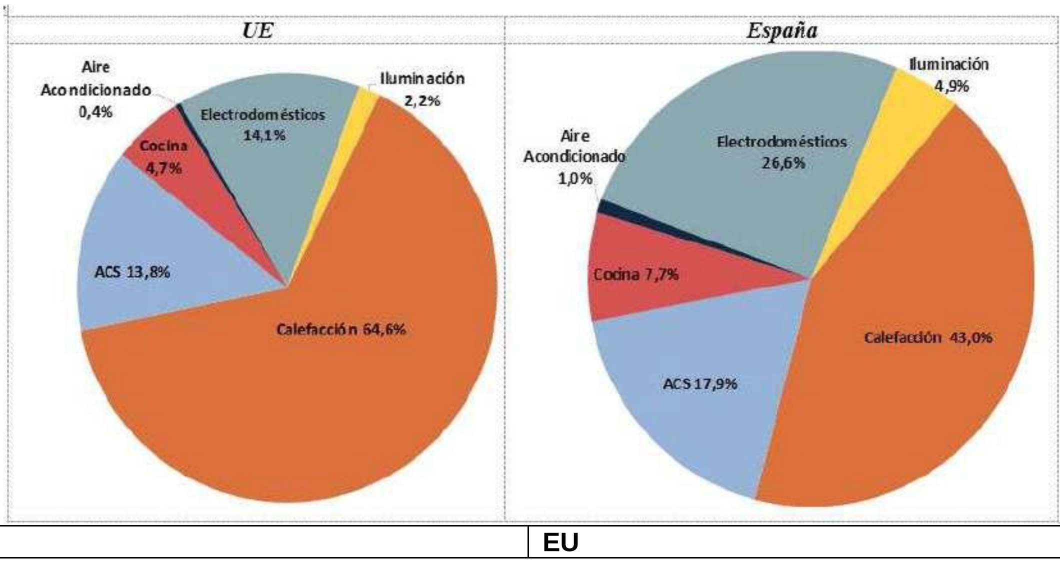
5.2. FACTORS RELATED TO CLIMATE

Paragraph 1(b) of Article 2a of Directive 2010/31/EU, as amended, provides for the inclusion in national strategies of 'the identification of cost-effective approaches to renovation relevant to the building type and climatic zone'. Implicit in both that requirement for cost-effectiveness and the optimum cost methodology is the hypothesis that energy renovation can be financed through the long-term capitalisation of the energy savings obtained. In accordance with Article 4 of Directive 2012/27/EU, which then applied, that hypothesis was employed in the 2014 ERESEE, in which, on the basis of certain fixed data and the value of certain input variables, 'the calculation model determines the point from which it is cost-effective to renovate a dwelling from a particular cluster and band, insofar as the costs of its intervention menu are economically viable due to being lower than the future energy savings that can be achieved' (2014 ERESEE, p. 56).

However, for that hypothesis to function adequately, scenarios involving high energy prices are required and high levels of energy consumption for heating and cooling, making it possible to achieve savings which, when capitalised over time, result in a significant amount. In that regard, Spain, together with other Mediterranean countries, forms part of the group of countries with the lowest energy consumption in the residential sector in the whole of the UE and, in particular, with the energy used for heating and cooling representing a smaller proportion of total household consumption.

Thus, for example, according to figures from the National Energy Efficiency Action Plan (Plan Nacional de Acción de Eficiencia Energética: PNAEE) 2017-2020, both relating to the year 2014, the buildings sector in Spain represented only 29.7% of the total demand for final energy, compared to an EU average of 38.5%, while heating as a proportion of total consumption in the residential sector was only 43%, compared to an EU average of 64.4%[93].

Figure 5.6. Structure of Energy Consumption by Use in the Residential Sector in Spain and the EU, 2014.



	EU

[93] Conversely, this makes the proportion of energy consumed for cooking, electrical appliances and lighting much larger in Spain (7.7%, 26.6% and 4.9%, respectively) than in the EU (4.7%, 14.1% and 2.2%).

	Air Conditioning 0.4%
	Electrical Appliances 14.1%
	Lighting 2.2%
	Cooking 4.7%
	DHW 13.8%
	Heating 64.6%
	Spain
	Air Conditioning 1.0%
	Electrical Appliances 26.6%
	Lighting 4.9%
	Cooking 7.7%
	DHW 17.9%
	Heating 43.0%

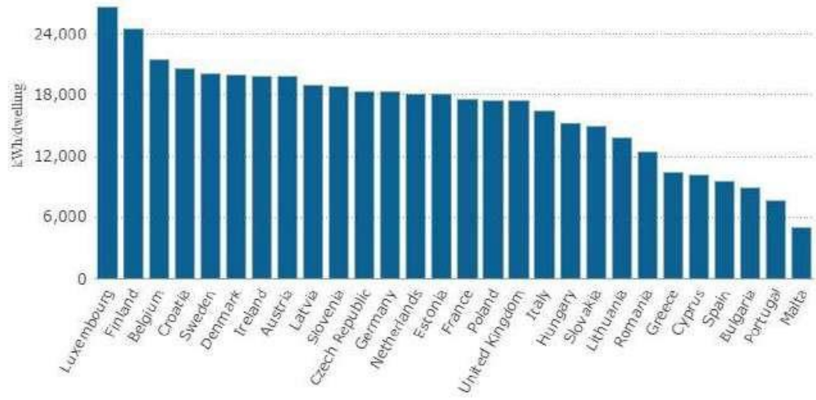
Source: IDAE-CE. Note: The consumption by use has been modelled on the basis of the SECH-SPAHOUSEC I study and the Manual of Household Energy Consumption Statistics (Manual de estadísticas de consumo energético en los hogares: MESH).

According to the estimate used in this 2020 ERESEE (see figure 6.6 in chapter 6), the distribution in 2020 would be 45.4% for heating, 26.3% for electrical appliances and white goods, 15.5% for DHW, 7.9% for cooking, 3.8% for lighting and 1.09% for cooling.

When compared with Europe, it should be noted that the differences in annual unit consumption per household between countries are significant and Spain, specifically, is among those with the lowest consumption, since - as can be seen in the following graph, based on European Commission data (2016) - the annual average consumption of a household in Spain was 9 422.1 kWh/dwelling[94], compared to 26 568.1 kWh/dwelling for Luxembourg.

[94] Value very similar to that estimated in this Strategy for 2020: 9 185.1 kWh/year.

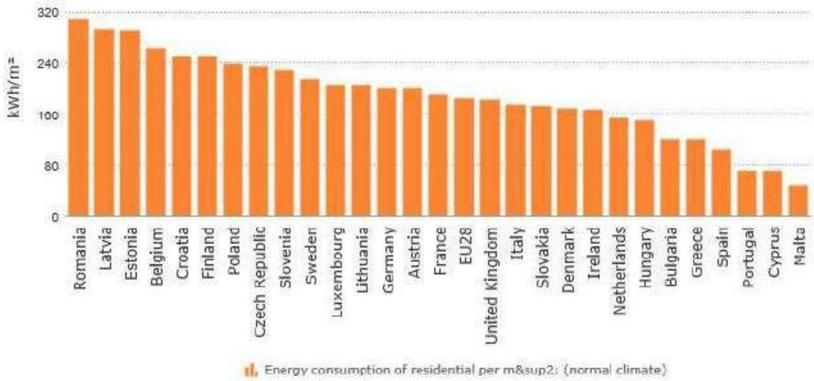
Figure 5.7. EU countries according to energy consumption in residential buildings by dwelling (standardised climatic conditions).



Source: European Commission (2016). https://ec.europa.eu/energy/en/eu-buildings-factsheets

The same occurs in terms of unit energy consumption in residential buildings per m2, where the consumption in Spain (103.04 kWh/m2) is among the lowest in Europe, compared to an average for the EU28 of 184.14 kWh/m2 or 308.09 kWh/m2 in Romania.

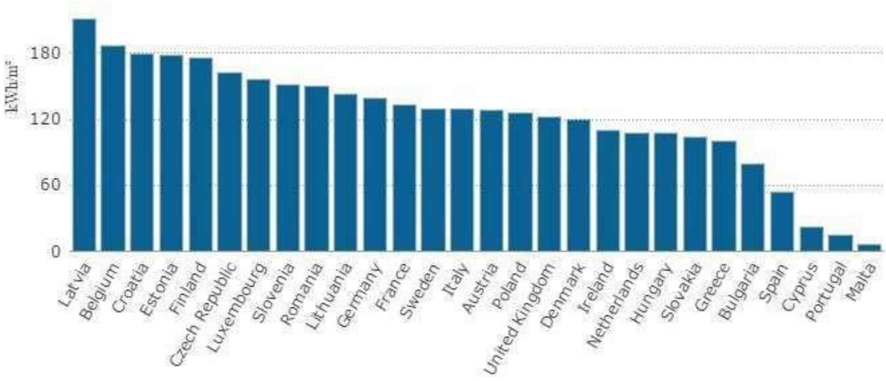
Figure 5.8. EU countries according to energy consumption in residential buildings per square metre.



Source: European Commission (2016). https://ec.europa.eu/energy/en/eu-buildings-factsheets

Similarly, the unit consumption per m^2 for heating in Spain is also much lower than in other European countries: 53.6 kWh/m^2 compared to 209.09 kWh/m^2 in Latvia.

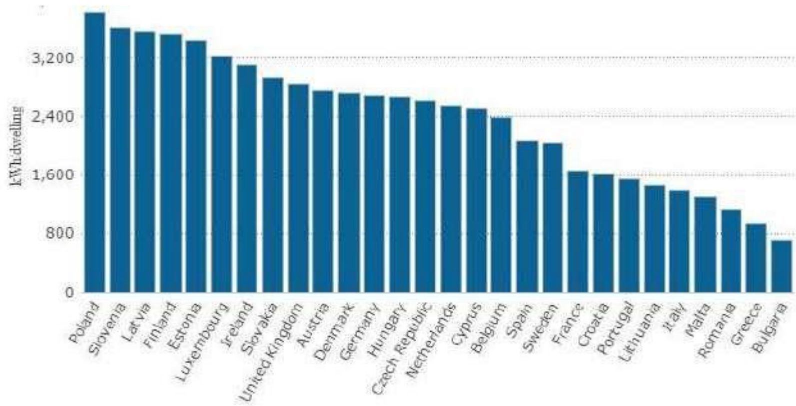
Figure 5.9. EU countries according to unit energy consumption per m² for heating in residential buildings.



Source: European Commission (2016). https://ec.europa.eu/energy/en/eu-buildings-factsheets

As regards DHW, according to the data from the graph below, Spain's annual consumption also places it in the third of countries with the lowest consumption in absolute terms: 2 054.3 kWh per dwelling compared to 3 814.5 for Poland.

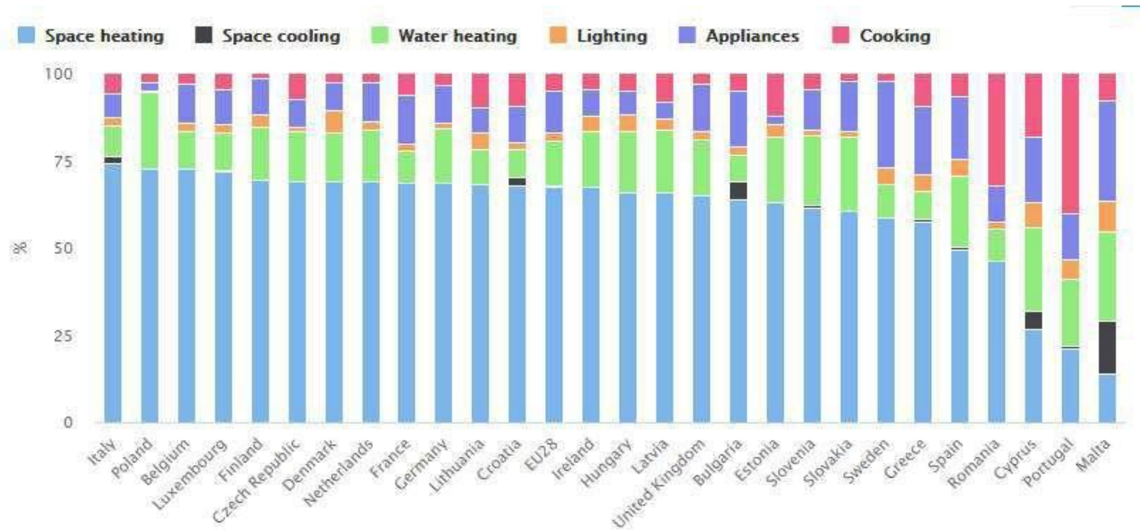
Figure 5.10. EU countries according to energy consumption for DHW per dwelling.



Source: European Commission (2016). https://ec.europa.eu/energy/en/eu-buildings-factsheets

As a result of the above, there are notable differences in the consumption structures in the households of different countries, as can be seen in the following graph, where Spain is among those with the lowest percentage of energy used for heating (around 49.3% in 2013, compared to 74.51% in Italy).

Figure 5.11. EU countries according to energy consumption by use (2013).



Source: European Commission (2016). https://ec.europa.eu/energy/en/eu-buildings-factsheets

In short, given that Spain, as a result of its climate, is among the countries with the lowest household energy consumption, especially as regards heating (both in absolute terms and in relation to total domestic consumption), the potential saving that can be achieved is much less than in other EU countries and, therefore, it is also less feasible - or much more difficult - to finance the cost of the initial work that needs to be done by means of the long-term capitalisation of those energy savings.

On the other hand, those climatic conditions suggest that there would be significant potential in Spain to save energy on cooling in summer. However, the available data contradict that idea, indicating that consumption for cooling is barely 1% of the household total, and therefore, once again, there is little potential for significant savings on cooling and, consequently, little to be gained by capitalising those savings.

Another factor to consider is the existence of a tariff structure (for example, with electricity), where the fixed costs of bills (billing for an amount of power contracted for) have a very large impact on the variable cost relating to billing for energy actually consumed, which, together with the climatic factors described, contributes to making the capitalisation of energy savings difficult within a reasonable period of time.

It therefore seems logical that, in Spain and in other Mediterranean countries, the hypothesis of the economic returns on investment in energy efficiency should not be the only one used in national strategies and that, for it to achieve the required impetus, energy renovation must be aligned with other objectives.

In this regard, this 2020 ERESEE incorporates the macroeconomic perspective of the overall returns on public investment in renovation through taxes, savings on healthcare, reductions in unemployment, etc. Also, as triggers for renovation work, it incorporates not just the financial return on the capitalisation of energy savings (to which a partial role is assigned), but also synergies with other mandatory work, the improvement of habitability and the comfort of residents, etc.

5.2.1. Initial estimates of the impact of climate change on demand for cooling and heating 2020-2050.

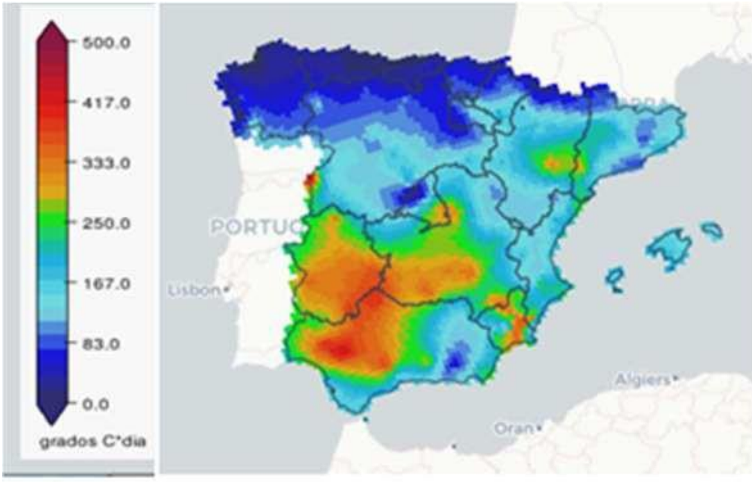
There can be no doubt that one of the most important long-term issues - and, therefore, a subject for reflection in a strategy such as this - is the analysis of the impact of climate change on demand for the cooling and heating of buildings.

Given the complexity of the matter, the Spanish National Research Council's Eduardo Torroja Institute for Construction Sciences (Construction Quality Unit) was tasked by MITMA with carrying out an initial analysis on the basis of climate microdata from the forecasts contained in the Climate Change Scenarios Viewer (AdapteCCA.es[95]) developed by MITERD (Spanish Office for Climate Change (Oficina Española de Cambio Climático: OECC), Spanish Meteorological Agency (Agencia Estatal de Meteorología: AEMET) and Spanish National Research Council (Consejo Superior de Investigaciones Científicas: CSIC))[96].

To that end, the following two indicators were considered: heating degree days and cooling degree days, the former with a base temperature of 18º and the latter with a base temperature of 26º.

The study considered the situation of altered buildings where the level of intervention was extensive, such as those proposed in this ERESEE.

Figure 5.12. Change in cooling degree days.



500.0	**500.0**
degree C° days	**degree C° days**

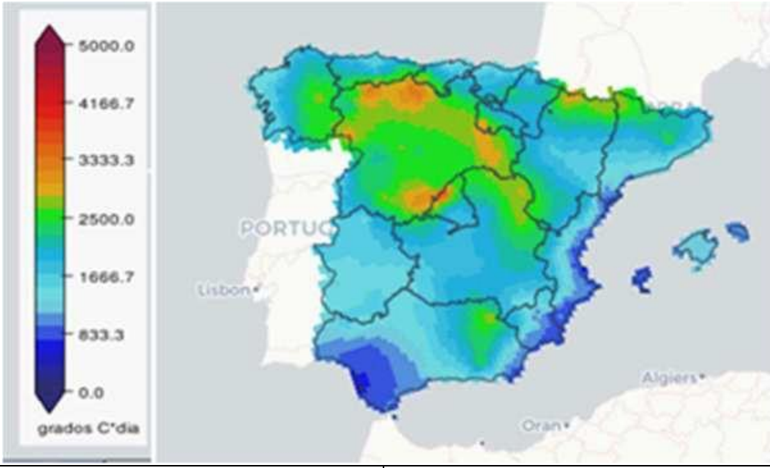
Source: AdapteCCA.es Climate Change Scenarios Viewer. MITERD

This graph shows how the change in cooling degree days is more pronounced in the area of the Guadalquivir Valley, the Monegros region of Aragon, the south of the Madrid Autonomous Community and the region of Murcia than in the Atlantic and Cantabrian zones and even the Mediterranean coastal strip, where the expected impact is less.

[95] https://escenarios.adaptecca.es/

[96] The viewer provides access to regionalised climate change projections for Spain, made on the basis of the global projections from the Fifth Assessment Report of the IPCC (Intergovernmental Panel on Climate Change) in the context of the National Plan for Adaptation to Climate Change (Plan Nacional de Adaptación al Cambio Climático: PNACC) Scenarios initiative and, specifically, the 2017 collection of PNACC Scenarios.
The data available are drawn from two main sources: specific projections by the Spanish Meteorological Agency (AEMET) and grid projections from the international initiative Euro-CORDEX.

Figure 5.13. Change in heating degree days.



	500.0
	degree C° days

Source: AdapteCCA.es Climate Change Scenarios Viewer. MITERD

This graph shows how the expected change in heating degree days is more pronounced in the northern part of Castile and Leon, the Pyrenees and the Sistema Central and Sistema Ibérico mountain ranges and much less noticeable in the coastal areas of the Mediterranean coast, the Guadalquivir Valley and the southern Atlantic arc.

Estimate of the change in cooling and heating degree days 2020-2050.

The following table shows the percentage increase in cooling degree days compared to the year 2020, up to the time horizon of 2050, according to the summer climatic zones established in the CTE.

Figure 5.14. Percentage increase in cooling degree days by summer climatic zone (% compared to 2020).

Incremento de GDR (%)	2030	2040	2050
1	16	32	48
2	16	31	47
3	12	24	36
4	10	19	29

	Increase in CDDs (%)

Source: CSIC-Instituto de Ciencias de la Construcción Eduardo Torroja [Eduardo Torroja Institute for Construction Science] (Construction Quality Unit) for MITMA.

The following table shows the percentage reduction in heating degree days compared to the year 2020, up to the time horizon of 2050, according to the winter climatic zones established in the CTE.

Figure 5.15. Percentage reduction in heating degree days by winter climatic zone (% compared to 2020).

Decremento de GDC (%)	2030	2040	2050
ZONA A	-5	-10	-14
ZONA B	-4	-9	-13
ZONA C	-3	-7	-10
ZONA D	-3	-6	-9
ZONA E	-3	-6	-9

	Decrease in HDDs (%)
	ZONE A
	ZONE B
	ZONE C
	ZONE D
	ZONE E
	-5

Source: CSIC-Instituto de Ciencias de la Construcción Eduardo Torroja [Eduardo Torroja Institute for Construction Science] (Construction Quality Unit) for MITMA.

Estimate of the change in demand for cooling and heating 2020-2050.

On the basis of the above data, an estimate was made of their impact on demand in kW/m^2/year, which was subsequently reflected in the tables in a homogeneous manner, with a base figure of 100 in 2020.

The table shows the possible increase that would occur in demand for cooling up to the year 2050, in relation to 2020.

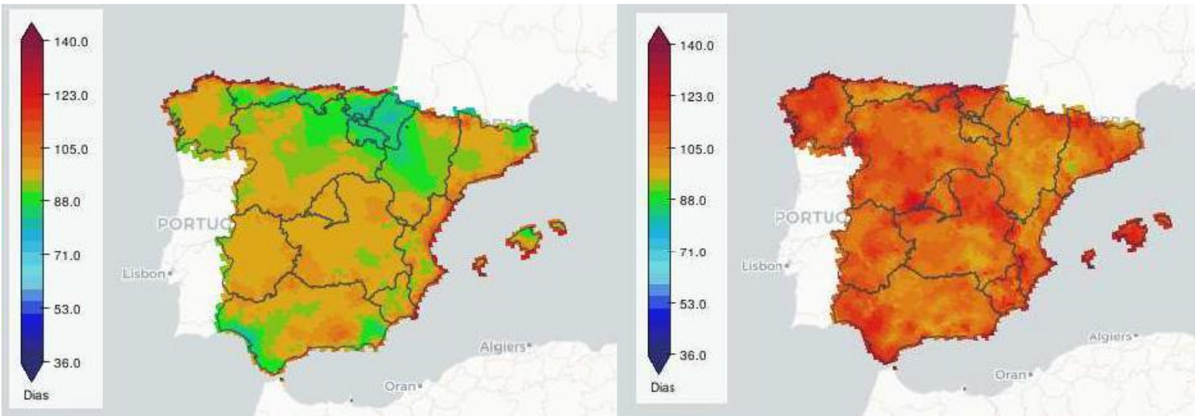
Figure 5.16. Change in demand for cooling by summer climatic zone (base 100=2020 demand).

	2020	2030	2040	2050
1	100.0	121.4	135.7	150.0
2	100.0	115.7	131.4	147.1
3	100.0	111.7	123.4	135.7
4	100.0	109.9	119.9	129.3

Source: CSIC-Instituto de Ciencias de la Construcción Eduardo Torroja [Eduardo Torroja Institute for Construction Science] (Construction Quality Unit) for MITMA.

The results indicate a differentiated impact that is less significant in the warmest zones and fairly considerable (with an increase of 1.5 times the demand for cooling in 2020) in the mildest summer zones, which would become considerably hotter.

Figure 5.17. Hot days (left) and tropical nights (right) in climate change scenarios.



	140.0
	Days

Source: AdapteCCA.es Climate Change Scenarios Viewer. MITERD Distant future. RCP 8.5 scenario.

Applying the results of the table for the reduction in heating degree days, shown below is the estimated change in demand for heating up to the year 2050, in relation to 2020.

Figure 5.18. Change in demand for heating by winter climatic zone (base 100=2020 demand).

	2020	2030	2040	2050
A	100.0	96.2	90.4	86.5
B	100.0	95.8	91.5	87.3
C	100.0	96.4	92.8	89.9
D	100.0	96.7	93.9	90.7
E	100.0	97.0	94.0	91.2

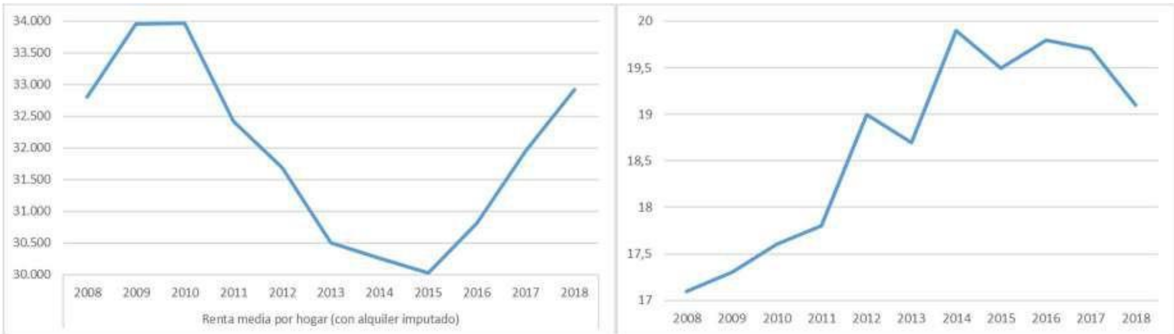
Source: CSIC-Instituto de Ciencias de la Construcción Eduardo Torroja [Eduardo Torroja Institute for Construction Science] (Construction Quality Unit) for MITMA.

According to the results obtained, the reduction in heating demand will be much less pronounced than the increase in cooling demand, ranging between a reduction to 86.5% of 2020 demand in climatic zone A and a reduction to 91.2% in the coldest zone, E.

5.3. CONSIDERATIONS REGARDING THE AVAILABILITY OF FINANCING TO HOUSEHOLDS.

Another factor that must also be very much taken into account is the difficult economic context that some Spanish families have experienced in recent years and the uncertainty about the future resulting from the current Covid-19 pandemic. As shown in the Living Conditions Survey, although average net income (with imputed rent) per household had fallen 11.6% between the years 2010 and 2015 (from €33 965 to €30 031, respectively), at the same time as the at-risk-of-poverty rate (with imputed rent) increased from 17.1% in 2008 to 19.9% in 2014, between 2015 and the spring of 2020 both indicators improved. Thus, average household income had recovered by 9.7% in just three years (2015-2018), while poverty had decreased more slowly, falling from 19.9% in 2014 to 19.1% in 2018.

Figure 5.19. Left: Change in average household income (with imputed rent) (€). Right: Change in at-risk-of-poverty rate (with imputed rent[97]) (%) (rent for the year prior to the interview).



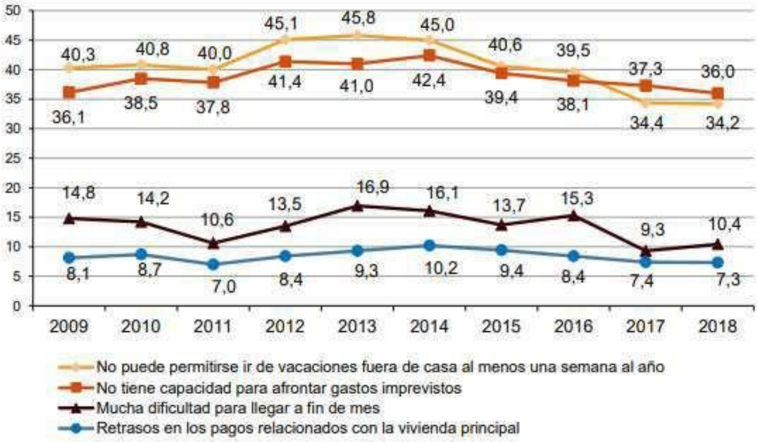
	34.000
	2008
	Average income per household (with imputed rent)
	20
	19.5

Source: MITMA based on the Living Conditions Survey (2018).

As can be seen in the graph below, according to the Living Conditions Survey (LCS 2018, with 2017 data), households' financial difficulties have also be decreasing since the years 2013-2014, when they reached their worst level. For example, the proportion of households struggling to make ends meet has fell from 16.9% in 2013 to 10.4% in 2018.

[97] In the Living Conditions Survey, the figures used in the calculation of variables such as income and at-risk-of-poverty rate always relate to the previous year. Poverty threshold: this is 60% of the median annual income per consumption unit (modified OECD scale), based on the distribution for individuals. The income per consumption unit is obtained by dividing total household income by the number of consumption units. The definition of household income includes imputed rent. Imputed rent applies to households that do not pay a full rent, either because they are owners or because they occupy a dwelling rented for less than the market price or free of charge. The imputed value is the equivalent of the rent that would be paid in the market for a dwelling similar to that occupied, minus any rent actually paid. The interest on loans taken out to purchase the main home is also deducted from the household's total income.

Figure 5.20. Change in household financial difficulties 2009-2018.



	50
	40.3
	2009
	Cannot afford to go away on holiday at least one week a year
	Not able to cope with unforeseen expenses
	Great difficulty making ends meet
	Delays in payments relating to main residence

Source: Living Conditions Survey, 2018.

Nevertheless, despite this relative improvement on average, also according to the LCS 2018, more than half of Spanish households (53.7%) continue to have some degree of difficulty making ends meet: 10.4% have a great deal of difficulty, 15.9% have difficulty and 27.4% have a certain amount of difficulty. Conversely, 31.4% say that they makes ends meet relatively easily, 13.7% easily and 1.2% very easily. The 2018 Housing Barometer[98] offers similar data, showing that 50.2% of Spanish households only just make ends meet and 13.8% have difficulty doing so (with 8.5% having had to draw on savings and 5.3% having taken on debt), compared to 33.1% who said that they could save something at the end of the month.

In any event, the positive trajectory of the last five years was abruptly interrupted in the spring of 2020, with the irruption of a new crisis triggered by the coronavirus pandemic. According to IMF forecasts from April 2020, the Spanish economy could plunge 8% this year and unemployment could shoot up to 20.8%. Therefore, in the immediate future, we are likely to witness a deterioration in average family incomes and possibly an increase in the difficulties of households with the lowest incomes.

On the other hand, independently of the above, in order to talk about the availability of financing to owners, it is necessary to put the cost of the measures proposed by the intervention menus considered in the ERESEE into context with the financial conditions of households. If the cost range for the interventions of an extensive nature[99] proposed in the ERESEE - which require an investment ranging from approximately €5 000 to €10 000, just for the envelope, and from €12 000 to €40 000 for the full intervention (with a complete change in heating and cooling and DHW installations) - is compared with the average monthly income of households in the Family Budget Survey, it can be seen that (despite their positive trajectory between 2015 and 2018) these kinds of interventions are not accessible to a great many households, unless they have prior savings or there is supplementary public aid.

[98] Response 15.
[99] These interventions always involve reductions in heating demand of between 60% and 90% and covering 50% of the DHW demand with renewable energy.

Figure 5.21. Distribution of households (as a percentage) according to the household's level of regular net monthly income (2015 and 2018).

	2015	2018
Up to €499	4.6	3.4
From €500 to €999	19.2	16.3
From €1 000 to €1 499	21.9	19.4
From €1 500 to €1 999	17.0	16.0
From €2 000 to €2 499	13.4	14.2
From €2 500 to €2 999	9.8	11.8
From €3 000 to €4 999	11.5	15.0
€5 000 or more	2.7	3.9
Total	100.0	100.0

Source: INE Family Budget Survey (FBS), 2018.

It is also worth emphasising the enormous gap between what the actual amount for the interventions proposed in the ERESEE would be and the initial idea the public have (according to the 2018 Household Barometer) of the cost of the work to renovate their building, which also indicates the need to provide them with better information in that regard. Indeed, when those surveyed were asked what they expected the cost of the interventions[100] to be, 19.5% expected to spend less than €1 000, 17.1% between €1 000 and €2 500, 14% between €2 500 and €5 000, 17.4% between €5 000 and €10 000 and only 9.1% more than €10 000. In multi-family buildings[101], the response regarding the expected impact per dwelling was as follows: 45% did not know/answer; 24.2% estimated it to be less than €1 000; 13.7% between €1 000 and €2 500; 5% between €2 500 and €5 000; 2.3% between €5 000 and €10 000; and only 7.8% more than €10 000.

Given these data and the range of approximate amounts indicated above as the initial outlay necessary to carry out energy renovation work, at least three segments can be identified: one with sufficient financial resources to take on the work (for which the long-term capitalisation of energy savings could work), another for which a certain level of public support would be necessary (subsidies or loans), covering a percentage of the costs and thus making it possible to cope with the initial outlay required, and, finally, a third segment that already has problems coping with ordinary household expenses and which would, therefore, find it difficult to carry out work of this kind, unless there was sufficient public support to make it possible.

The data yielded by the 2018 Housing Barometer regarding the manner in which households planning to make alterations to their building in the next 12 months planned to finance the work are also significant, as they indicate a lack of trust in external financing sources beyond the household's own resources. Thus, 66.7% planned (multiple response) to finance it through an extra contribution to the homeowners' association fees; 26.5% using the savings of each association or owner; 4.1% by accessing public subsidies or grants; and 1.4% through tax relief. A further 2.3% planned to borrow money and just 0.9% considered the possibility of financing it through energy savings[102].

With regard to the way in which those surveyed think government should encourage the renovation of residential buildings (up to two responses), 62.2% believe it should do so through subsidies, 38.3% by providing cheap loans, 29.6% through tax relief and 33.1% by directly organising the work required[103].

In short, it has to be borne in mind that there is a segment of Spanish households for which it would be difficult to take on energy renovation work, without having external financing or receiving public support directly. It therefore seems necessary to include social criteria in the design of public support, to take account of less-favoured families in particular, for whom the current partial subsidy schemes - for example, those in the current state plan that cover 35 % of the cost of the work - do not solve the problem of the remaining percentage that is not covered by the subsidy. This solution would also prevent the personal situation of certain owners from being a burden to the other owners of the building in question. Hence, it seems advisable either to increase the subsidised percentage in certain specific cases, or to provide access to supplementary financing mechanisms that

[100] Response 18b. Almost 23% did not know/answer.
[101] Response 19b.
[102] Response 19a. In 2014, the percentages were similar: 58.7% through extra contributions; 9.9% using own savings; 6.8% with subsidies; 3.4% with loans; and 0.5% by capitalising energy savings.
[103] Response 20. The percentages in 2014 were, respectively: 58.7%; 32.7%; 22.5%; and 22.5%.

cover a greater percentage of the costs.

Figure 5.22. Diagram illustrating the variety of schemes and financing scenarios to be taken into account.

	MAXIMISE AS FAR AS POSSIBLE
	HIGHER INCOMES
	LOWER INCOMES
	URBAN DEVELOPMENT ADDED VALUE
	CAPITALISATION OF ENERGY SAVINGS
	OWN RESOURCES
	TAX RELIEF
	LOAN
	SUBSIDY
	CASE 1
	CASES IN ENERGY POVERTY

Source: MITMA.

5.4. CONSIDERATIONS REGARDING VULNERABLE CONSUMERS AND ENERGY POVERTY.

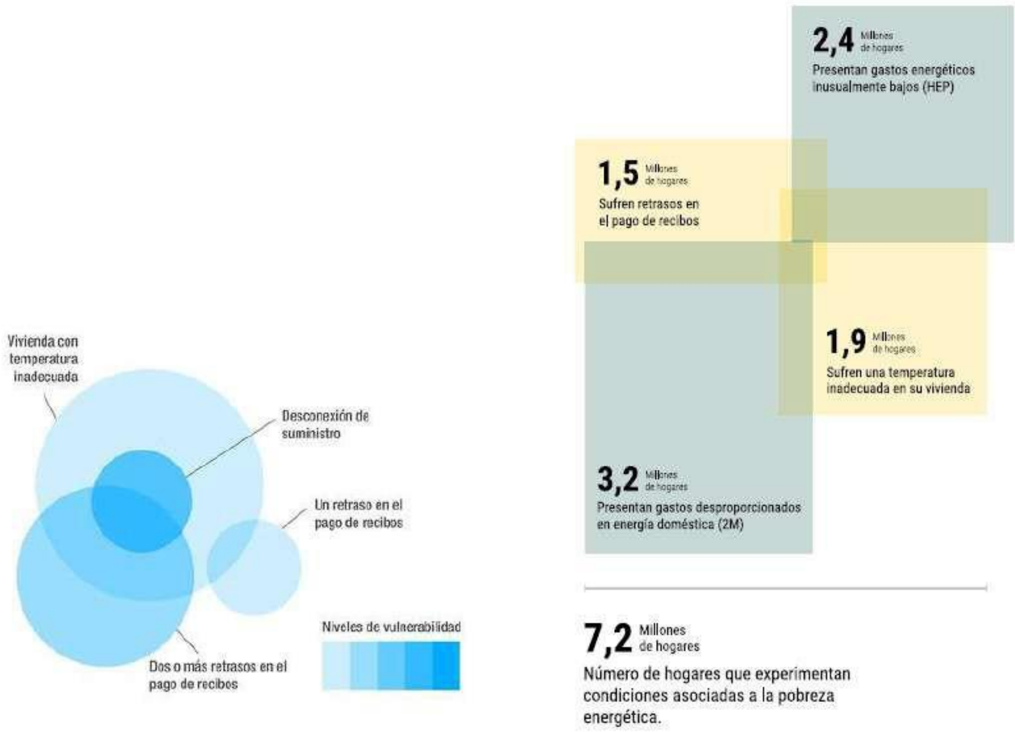
Even with what has been explained in the previous section, it will be difficult for certain mechanisms to work in the third segment, identified as the group of households that already have problems coping with ordinary household expenses. This population is going to need specific social support and a special approach to the problem, not from the perspective of the financial return on capitalising energy savings (even where assisted partially), but instead from the social perspective of reducing energy poverty and/or protecting vulnerable consumers.

The section on the National Strategy on Energy Poverty 2019-2024 explains how energy poverty is defined on the basis of different indicators - inadequate temperature in the home in winter, late payment of utility bills, disproportionate expenditure (2M) and hidden energy poverty (HEP) - each of which reflects an aspect of this problem.

5.4.1. Indicators for the regional characterisation by homogeneous groups of households in energy poverty in Spain.

Given that, in every section of this 2020 ERESEE, there is a regional breakdown at provincial level at a minimum, a regional characterisation of energy poverty indicators is required, which, for various reasons, is not easy. The first is the different origins of the sources of the four indicators mentioned above, since it is very complicated to work with two sources as different as the FBS and the LCS. Another difficulty is the superimposition of the indicators, given that each of the different subgroups defined by such overlaps (see the images below) identifies different aspects and angles of the problem.

Figure 5.23. Overlaps between energy poverty indicators.



	Dwelling with inadequate temperature
	Disconnection of supply
	One delay in the payment of bills
	Two or more delays in the payment of bills
	Levels of vulnerability
	1.5 million homes
	Experience delays in the payment of bills
	Show unusually low energy expenditure (HFP)
	Show disproportionate expenditure on domestic energy (2M)
	Experience an inadequate temperature in their home
	Number of households experiencing conditions associated with energy poverty.

Left: Visual representation of the overlap between LCS indicators according to the number of people affected. Source: ACA: Report 'Energy Poverty in Spain 2018'.

Right: Overlap in the number of households experiencing conditions associated with energy poverty.

Given that in the 2020 ERESEE there are ultimately three aspects of interest - the possibility of regionalisation, the possibility of relating (through expenditure) the chosen indicator(s) with a reduction in consumption and the possibility of a relationship with household income level - the ENPEn indicators finally selected were disproportionate expenditure (2M) and hidden energy poverty (HEP), related to a lack of inner well-being due to insufficient spending on heating and cooling. For this last type of energy poverty, the ENPEn uses HEP (equivalent to M/2) as an indicator; however, for the ERESEE, another hidden energy poverty indicator (Pobreza Energética

Escondida: PEE) is going to be used, which, in turn, makes it possible to factor in household income. This indicator was developed during the research carried out on the matter by Sánchez-Guevara Sánchez, Sanz Fernández and Hernández Aja, 2015[104]. By analysing the data from the FBS specifically conducted for this document, the indicators PEE and HEP were compared and it was found that PEE includes cases of hidden energy poverty that do not appear if only HEP is used.

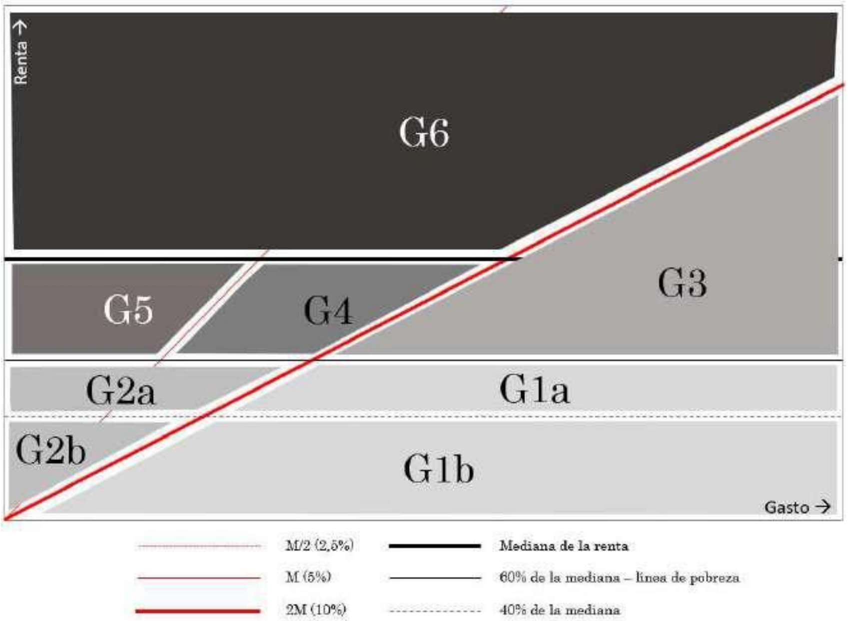
As well as incorporating income level in order to identify cases of hidden energy poverty (PEE) more accurately in the division of the groups of households according to their relationship energy poverty related to disproportionate expenditure (2M), divisions by income level are also used, which makes it possible to incorporate into the analysis a key factor according to the ENPEn itself. That analysis results in the division of households into the groups that can be seen in the

diagram, having the following description:

- **Group 1 (G1):** households below the energy poverty (2M) and monetary (60% of the median income) indicators.
  - Group 1a (G1a): those between 40% of the median and the poverty line (60% of the median).
  - Group 1b (G1b): those below 40% of the median.
- **Group 2 (G2):** households experiencing monetary poverty and spending less than 2M on heating and cooling —hidden energy poverty (PEE)—.
  - Group 2a (G2a): those between 40% of the median and the poverty line (60% of the median).
  - Group 2b (G2b): those below 40% of the median.
- **Group 3 (G3):** households in energy poverty (according to the 2M indicator), but without experiencing monetary poverty (above 60% of the median income).
- **Group 4 (G4):** households vulnerable due to energy poverty (according to the 2M indicator and the PEE indicator) and due to monetary poverty (according to the indicator of 60% of the median income).
- **Group 5 (G5):** households vulnerable due to energy poverty (according to the PEE indicator) and due to monetary poverty (according to the indicator of 60% of the median income).
- **Group 6 (G6):** households that are not vulnerable financially or with regard to energy.

Figure 5.24: Division of groups of households according to their relationship with income and energy expenditure.

[104] *C. Sánchez-Guevara, A. Sanz Fernández, A. Hernández Aja (2014), 'Income, energy expenditure and housing in Madrid: retrofitting policy implications'*, Building Research & Information. 3218 (2014) 1e13, https://doi.org/10.1080/09613218.2014.984573



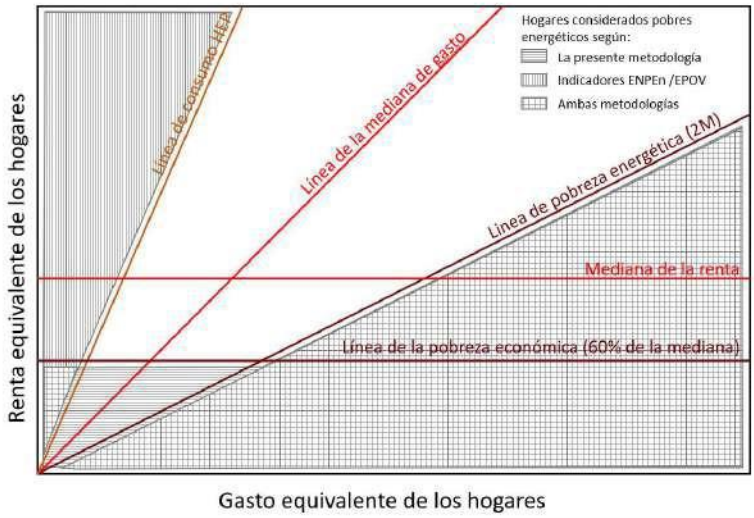
	Income
	G6
	Expenditure
	M/2 (2.5%)
	M (5%)
	2M (10%)
	Median income
	60% of the median - poverty line
	40% of the median

Source: C. Sánchez-Guevara & A. Sanz Fernández (Polytechnic University of Madrid) (2020) using the methodology developed in Sánchez-Guevara Sánchez, Sanz Fernández & Hernández Aja, 2015.

The relationship between these groups and the ENPE energy poverty indicators is as follows:

- Disproportionate expenditure (2M): Households whose expenditure on energy supplies represents 10% of their income. It includes group G1a (in monetary poverty), group G1b (in severe monetary poverty) and group G3 (households without monetary poverty).
- Hidden energy poverty (HEP): Households whose expenditure on energy supplies is abnormally low in relation to their income. It could not be transposed literally, since, as can be seen in the **Error! The origin of the reference cannot be found.** the methodology set out in this document and the methodology that considers HEP as an indicator regard households with different characteristics as experiencing energy poverty. From the point of view of this methodology, groups G2a and G2b could be thought to be in hidden energy poverty and groups G4 and G5 (which, as can be seen in the diagram, partially overlap with the HEP indicator) could be thought to be vulnerable to being in that situation.
- Without energy poverty. Households not included in the 2M and HEP indicators. There are three groups, distinguished by income level: group G4, group G5 and group G6.

Figure 5.25. Differences and similarities between the present methodology and the indicators proposed by the ENPEn.



	Equivalent household income
	Households in energy poverty according to:
	The present methodology
	ENPEn/EPOV indicators
	Both methodologies
	HEP consumption line
	Median expenditure line
	Energy poverty line (2M)
	Median income
	Financial poverty line (60% of the median)
	Equivalent household expenditure

Source: C. Sánchez-Guevara & A. Sanz Fernández (Polytechnic University of Madrid) (2020).

5.4.2. Methodology and general results.

The analysis of the indicators defined above and the segmentation into homogeneous groups was done by mining the microdata from the 2017 Family Budget Survey (FBS).

The results at national level are shown in figure 5.26, where it can be seen that, out of a total of 17 485 692 households for which data relating to income and domestic energy expenditure are available, almost 25% are in a situation of energy and/or monetary poverty. A further 7% are in both types of poverty (G1A and G1B added together), while 6% experience energy poverty due to their expenditure being more than double the median (G3). Finally, 11% of the population (G2A and G2B added together), is in a situation of monetary poverty and probably with cases of hidden energy poverty due to the conditions of their building and the absence of appropriate and efficient installations (Sánchez-Guevara Sánchez et al., 2015).

Figure 5.26. Spanish households (excluding the Canary Islands, Ceuta and Melilla) grouped according to their relationship with energy poverty.

GRUPOS	ESTATAL (1)	
	Hogares	%
G1A	593.519	3,39%
G1B	636.355	3,64%
G2A	1.400.740	8,01%
G2B	564.526	3,23%
G3	1.115.873	6,38%
G4	2.717.005	15,54%
G5	1.774.819	10,15%
G6	8.682.855	49,66%
Total	**17.485.692**	**100%**

	ESTATAL (1)	
	Hogares	%
G1+G2+G3	4.311.013	24,65%

	GRUPOS:
	NATIONAL(1)
	Households
	%
	G1A
	593 519
	3.39%
	G3
	Total
	17 458 692
	100%
	NATIONAL(1)
	Households
	%
	G1+G2+G3
	4 311 013
	24.65%

(1) Excluding the Canary Islands, Ceuta and Melilla.

Source: C. Sánchez-Guevara & A. Sanz Fernández (Polytechnic University of Madrid) (2020) for MITMA based on the data from the 2017 FBS.

In order to better characterise the households in the different types of energy poverty, these groups and indicators are analysed below according to the following characteristics:

- Analysis of households segmented according to situations of energy poverty and by the size of the municipality.
- Analysis of households segmented according to situations of energy poverty and by dwelling type.
- Analysis of households segmented according to situations of energy poverty and by climatic zone.
- Analysis of households segmented according to situations of energy poverty and by Autonomous Community.
- Analysis of energy poverty indicators according to financial vulnerability and their relationship with monetary poverty.

a) Analysis of households segmented according to situations of energy poverty and by the size of the municipality.

As can be seen in the table below, of the almost 25% of Spanish households that are in some form of energy poverty, a little more than 9% live in rural municipalities (with less than 20 000 inhabitants) and the remaining 15% are in municipalities with more than 20 000 inhabitants.

That means that 62% of the cases arise in urban areas (slightly less than the total proportion of such municipalities, which contain nearly 70% of Spanish households). Looking at municipalities with 20 000 inhabitants, we see that 30% of households are affected by some form of energy poverty, while, in urban areas, 22% of households are affected (compared to a national average of 25%). It may be inferred that, although, proportionally, there is a greater incidence in small municipalities, given their lower overall demographic weight, the majority of households in energy poverty are concentrated in municipalities with more than 20 000 inhabitants.

Figure 5.27. Spanish households (excluding the Canary Islands, Ceuta and Melilla) grouped according to energy poverty level and the size of the municipality in which they are located.

GRUPOS	TAMAÑO POBLACIÓN			
	< 20.000		>20.000	
G1A	264.267	1,51%	329.252	1,88%
G1B	210.820	1,21%	425.535	2,43%
G2A	489.972	2,80%	910.768	5,21%
G2B	153.841	0,88%	410.685	2,35%
G3	515.664	2,95%	600.209	3,43%
G4	960.639	5,49%	1.756.366	10,04%
G5	543.862	3,11%	1.230.957	7,04%
G6	2.225.740	12,73%	6.457.115	36,93%
Total	**5.364.804**	**30,68%**	**12.120.887**	**69,32%**

	INCIDENCIA DE LA POBREZA ENERGÉTICA							
	<20.000				<20.000			
	Hogares	% (1)	% (2)	% (3)	Hogares	% (1)	% (2)	% (3)
G1+G2+G3	1.634.564	9,35%	37,92%	30,47%	2.676.449	15,31%	62,08%	22,08%

	GROUPS
	POPULATION SIZE
	< 20 000
	G1A
	264 267
	1.51%
	329 252
	1.88%
	Total
	5 364 804
	30.68%
	12 120 887
	69.32%
	INCIDENCE OF ENERGY POVERTY
	Households
	%(1)
	G1+G2+G3
	1 634 564
	9.35%

Notes: (1) Percentage of households in energy poverty in municipalities of that size in relation to the total number of Spanish households. (2) Percentage of households in energy poverty in municipalities of that size in relation to the total number of households in energy poverty. (3) Percentage of households in energy poverty in relation to the total number of households in municipalities of the same size.

Source: C. Sánchez-Guevara & A. Sanz Fernández (Polytechnic University of Madrid) (2020) for MITMA based on the data from the 2017 FBS.

b) Analysis of households segmented according to situations of energy poverty and by dwelling type.

The situation seen in households according to the size of the municipality is repeated in their characterisation according to dwelling type. Of the 25% of households in some form of energy poverty, almost 10% reside in single-family dwellings and a little under 15% live in residential blocks. Even though less than 32% of Spanish households live in single-family dwellings, almost 40% of energy-poor households reside in dwellings of that kind and, out of the total number of households residing in single-family dwellings, almost 30% experience some form of energy poverty (compared to the national average of 25%). Once again, the incidence of the phenomenon is found to be greater, proportionally, in those households living in single-family dwellings; more than 60% of cases of energy poverty appear in multi-family residential buildings fundamentally because they are the most common type in the Spanish building stock.

Figure 5.28. Spanish households (excluding the Canary Islands, Ceuta and Melilla) grouped according to energy poverty level and the type of building lived in.

GRUPOS	TIPO DE VIVIENDA			
	Unifamiliar		Plurifamiliar	
G1A	284.532	1,63%	308.766	1,77%
G1B	208.732	1,19%	424.707	2,43%
G2A	495.564	2,83%	900.575	5,15%
G2B	166.764	0,95%	393.084	2,25%
G3	533.354	3,05%	582.518	3,33%
G4	951.752	5,44%	1.763.403	10,08%
G5	551.344	3,15%	1.222.149	6,99%
G6	2.386.961	13,65%	6.291.410	35,98%
Total	**5.579.003**	**31,91%**	**11.886.612**	**67,98%**

	INCIDENCIA DE LA POBREZA ENERGÉTICA							
	Unifamiliar				Plurifamiliar			
	Hogares	% (1)	% (2)	% (3)	Hogares	% (1)	% (2)	% (3)
G1+G2+G3	1.688.947	9,66%	39,18%	30,27%	2.609.650	14,92%	60,53%	21,95%

	GROUPS
	DWELLING TYPE
	Single-family
	Multi-family
	G1A
	284 532
	1.63%
	Total
	5 579 003
	31.91%
	11 888 612
	67.98%
	INCIDENCE OF ENERGY POVERTY
	Households
	%(1)
	G1+G2+G3
	1 688 947
	9.66%

Notes: (1) Percentage of households in energy poverty in that type of dwelling in relation to the total number of Spanish households. (2) Percentage of households in energy poverty in that type of dwelling in relation to the total number of households in energy poverty. (3) Percentage of households in energy poverty in relation to the total number of households in the same type of dwelling.

Source: C. Sánchez-Guevara & A. Sanz Fernández (Polytechnic University of Madrid) (2020) for MITMA based on the data from the 2017 FBS.

c) Analysis of households segmented according to situations of energy poverty and by climatic zone.

Even though the level of disaggregation of the Family Budget Survey (FBS) does not allow for analysis by province, in this document the Autonomous Communities have been grouped together according to climatic zone in a manner similar to that seen in the document 'SEC-SPAHOUSEC II' (see the illustration below)[105].

Figure 5.29. SEC-SPAHOUSEC distribution of provinces according to climatic zone.

[105] In order to adapt it to fit the Autonomous Communities, the whole of Galicia and the Basque Country have been included in the climatic zone 'Atlantic-North' and the whole of Catalonia in 'Mediterranean'.

	Climatic zones
	Atlantic-North
	Continental
	Mediterranean

Source: Proyecto SEC-SPAHOUSEC II. Análisis estadístico del consumo de gas natural en las viviendas principales con calefacción individual.

That aggregation makes it possible to analyse the incidence of energy poverty by climatic zone, throughout the country. Of the 25% of households in energy poverty in Spain, only 3% are in the climatic zone 'Atlantic-North', while almost 9% are in the 'Continental' zone and a little over 13% are in the 'Mediterranean' zone.

The least affected zone, proportionally, is 'Atlantic-North'. That lower incidence can be seen both in the fact that it includes 12% of the total number of households experiencing energy poverty in Spain (even though 15% of the total number of Spanish households are concentrated in that area) and because only 19% of households in that climatic zone experience some form of energy poverty (compared to an average of almost 25% for the whole country). Conversely, in the 'Continental' climatic zone, there is a greater proportion of households in energy poverty, slightly above the national average (a little over 26% compared to the above-mentioned figure of 25%) and with a higher concentration of households in energy poverty compared to the national total (35% of households in energy poverty are concentrated in that area, while only 33% of Spanish households live in that climatic zone).

Figure 5.30: Spanish households (excluding the Canary Islands, Ceuta and Melilla) grouped according to energy poverty level and their climatic zone (similar to that determined in SEC-SPAHOUSEC II).

GRUPOS	ZONA CLIMÁTICA					
	ATLÁNTICO NORTE		CONTINENTAL		MEDITERRÁNEO	
G1A	69.626	0,40%	246.714	1,41%	277.179	1,59%
G1B	63.229	0,36%	199.463	1,14%	373.663	2,14%
G2A	158.229	0,90%	364.849	2,09%	877.661	5,02%
G2B	69.978	0,40%	153.510	0,88%	341.038	1,95%
G3	149.140	0,85%	525.295	3,00%	441.438	2,52%
G4	416.919	2,38%	773.612	4,42%	1.526.473	8,73%
G5	286.080	1,64%	520.099	2,97%	968.640	5,54%
G6	1.458.372	8,34%	2.925.799	16,73%	4.298.683	24,58%
Total	**2.671.574**	**15,28%**	**5.709.342**	**32,65%**	**9.104.775**	**52,07%**

	GROUPS
	CLIMATIC ZONE
	ATLANTIC-NORTH
	CONTINENTAL
	MEDITERRANEAN
	G1A
	69 626
	0.40%
	Total

	2 671 574
	15.28%
	G1+G2+G3
	Households
	510 203
	% (1)
	2.92%

	ATLÁNTICO NORTE			
	Hogares	% (1)	% (2)	% (3)
G1+G2+G3	510.203	2,92%	11,83%	19,10%
	CONTINENTAL			
	Hogares	% (1)	% (2)	% (3)
G1+G2+G3	1.489.831	8,52%	34,56%	26,09%
	MEDITERRÁNEO			
	Hogares	% (1)	% (2)	% (3)
G1+G2+G3	2.310.979	13,22%	53,61%	25,38%

	ATLANTIC-NORTH
	Households
	% (1)
	G1+G2+G3
	510 203
	2.92%
	11.83%
	19.10%
	CONTINENTAL
	1 489 831
	MEDITERRANEAN
	2 310 979
	13.22%
	53.61%

Notes: (1) Percentage of households in energy poverty in relation to the total number of Spanish households. (2) Percentage of households in energy poverty in that climatic zone in relation to the total number of households in energy poverty. (3) Percentage of households in energy poverty in relation to the total number of households in the same climatic zone.

Source: C. Sánchez-Guevara & A. Sanz Fernández (Polytechnic University of Madrid) (2020) for MITMA based on the data from the 2017 FBS.

d) Analysis of households segmented according to situations of energy poverty and by Autonomous Community.

If the analysis carried out at the national level is done at the level of the Autonomous Communities, we can see how the incidence of the phenomenon of energy poverty varies in the different regions analysed. We find Autonomous Communities in which energy poverty affects more than 30% of the population (as in the case of Andalusia, Castile-La Mancha, Extremadura and Murcia), Autonomous Communities where the average is close to the national average (such as Aragon, Castile and Leon, Valencia, Galicia, Navarre and La Rioja) and others where the incidence of the phenomenon is lower (such as Asturias, the Balearic Islands, Cantabria, Catalonia, Madrid and the Basque Country).

In more detailed analyses - which do not need to be expanded on here - it would also be possible, using the table shown, to identify different types of poverty. For example: the Autonomous Communities in which energy poverty due to excess expenditure (the 2M indicator or groups G1 and G3) is most pressing, which could be Aragon, Castile-La Mancha, Castile and Leon, Extremadura, Galicia, Madrid, Navarre or La Rioja; and those Autonomous Communities where the most significant problem is linked to hidden energy poverty (identified as group G2), such as, for example, Castile-La Mancha (assuming that high values for this group in warmer climates, such as that of Murcia, Extremadura or Andalusia, could partially reflect lower energy requirements).

Table 5.31. Spanish households (excluding the Canary Islands, Ceuta and Melilla) grouped according to homogeneous groups in relation to energy poverty and by Autonomous Community. Groups in some form of energy poverty (G1, G2, G3).

	G1A		G1B		G2A		G2B		G3		G1+G2+G3	
Comunidad Autónoma	Hogares	%	Hogares	%	Hogares	%	Hogares	%	Hogares	%	Hogares	%
ANDALUCÍA	112.775	3,56%	174.263	5,49%	429.860	13,55%	171.847	5,42%	91.003	2,87%	979.748	30,89%
ARAGÓN	21.737	4,08%	17.229	3,23%	28.884	5,42%	11.328	2,12%	59.111	11,08%	138.289	25,93%
ASTURIAS	12.692	2,79%	8.909	1,96%	28.732	6,32%	13.571	2,98%	24.079	5,29%	87.983	19,34%
BALEARS	10.555	2,36%	8.916	2,00%	20.483	4,59%	6.828	1,53%	24.002	5,38%	70.784	15,86%
CANARIAS	7.677	0,94%	37.492	4,59%	134.149	16,44%	65.322	8,00%	10.810	1,32%	255.450	31,30%
CANTABRIA	6.627	2,80%	11.018	4,66%	14.650	6,20%	6.430	2,72%	11.825	5,00%	50.550	21,38%
CASTILLA-LA MANCHA	69.173	8,92%	36.302	4,68%	81.466	10,51%	26.113	3,37%	89.418	11,53%	302.472	39,01%
CASTILLA Y LEÓN	46.434	4,54%	35.886	3,51%	44.334	4,33%	34.706	3,39%	117.972	11,53%	279.331	27,30%
CATALUÑA	83.670	2,82%	82.568	2,78%	169.627	5,72%	58.358	1,97%	207.846	7,00%	602.068	20,29%
CEUTA	421	1,57%	1.604	6,00%	2.517	9,42%	4.781	17,89%	141	0,53%	9.463	35,42%
COM. VALENCIANA	51.272	2,59%	82.559	4,16%	192.260	9,70%	70.528	3,56%	94.776	4,78%	491.395	24,78%
EXTREMADURA	16.478	3,91%	24.585	5,83%	60.092	14,26%	19.525	4,63%	32.110	7,62%	152.790	36,24%
GALICIA	31.366	2,90%	33.954	3,14%	80.967	7,48%	38.717	3,58%	77.232	7,14%	262.237	24,23%
MADRID	79.584	3,09%	77.260	3,00%	131.838	5,12%	53.808	2,09%	184.908	7,18%	527.398	20,49%
MELILLA	285	1,07%	1.973	7,44%	3.505	13,21%	4.510	17,00%	-	0,00%	10.274	38,72%
MURCIA	18.908	3,53%	25.357	4,73%	65.431	12,22%	33.477	6,25%	23.812	4,45%	166.984	31,18%
NAVARRA	8.291	3,27%	5.037	1,99%	11.438	4,51%	5.366	2,11%	26.837	10,58%	56.970	22,45%
PAÍS VASCO	18.941	2,11%	9.348	1,04%	33.879	3,77%	11.260	1,25%	36.004	4,01%	109.433	12,19%
LA RIOJA	5.017	3,92%	3.163	2,47%	6.798	5,32%	2.665	2,08%	14.939	11,69%	32.582	25,49%

	G1A
	G1+G2+G3
	Autonomous Community
	Households %
	ANDALUSIA
	ARAGON:
	ASTURIAS
	BALEARIC ISLANDS
	CANARY ISLANDS
	CANTABRIA
	CASTILE-LA MANCHA
	CASTILE AND LEON
	CATALONIA
	CEUTA
	VALENCIA
	EXTREMADURA
	GALICIA
	MADRID
	MELILLA
	MURCIA
	NAVARRE
	BASQUE COUNTRY
	LA RIOJA
	112 775
	3.56%

Source: C. Sánchez-Guevara & A. Sanz Fernández (Polytechnic University of Madrid) (2020) for MITMA based on the data from the 2017 FBS.

Table 5.32. Spanish households (excluding the Canary Islands, Ceuta and Melilla) grouped according to homogeneous groups in relation to energy poverty and by Autonomous Community. Groups not in some form of energy poverty (G4, G5, G6).

	G4		G5		G6	
Comunidad Autónoma	Hogares	%	Hogares	%	Hogares	%
ANDALUCÍA	577.094	18,19%	411.913	12,99%	1.203.062	37,93%
ARAGÓN	70.893	13,29%	43.866	8,22%	280.342	52,56%
ASTURIAS	57.817	12,71%	71.000	15,61%	238.123	52,34%
BALEARS	64.517	14,45%	41.028	9,19%	270.085	60,50%
CANARIAS	165.013	20,22%	81.545	9,99%	314.169	38,49%
CANTABRIA	32.979	13,95%	21.334	9,02%	131.528	55,64%
CASTILLA-LA MANCHA	145.588	18,78%	62.714	8,09%	264.500	34,12%
CASTILLA Y LEÓN	114.198	11,16%	113.141	11,06%	516.522	50,48%
CATALUÑA	410.984	13,85%	265.808	8,96%	1.689.028	56,91%
CEUTA	3.672	13,74%	2.056	7,70%	11.526	43,14%
COM. VALENCIANA	383.743	19,35%	193.227	9,74%	914.687	46,13%
EXTREMADURA	100.743	23,90%	45.020	10,68%	122.997	29,18%
GALICIA	228.257	21,09%	119.222	11,02%	472.616	43,67%
MADRID	290.655	11,29%	216.667	8,42%	1.539.618	59,81%
MELILLA	2.602	9,81%	1.342	5,06%	12.316	46,42%
MURCIA	90.136	16,83%	56.664	10,58%	221.823	41,42%
NAVARRA	33.871	13,35%	25.834	10,18%	137.098	54,02%
PAÍS VASCO	97.867	10,90%	74.525	8,30%	616.104	68,61%
LA RIOJA	17.665	13,82%	12.858	10,06%	64.721	50,63%

	G4
	Autonomous Community
	Households %
	ANDALUSIA
	ARAGON
	ASTURIAS
	BALEARIC ISLANDS
	CANARY ISLANDS
	CANTABRIA
	CASTILE-LA MANCHA
	CASTILE AND LEON
	CATALONIA
	CEUTA
	VALENCIA
	EXTREMADURA
	GALICIA
	MADRID
	MELILLA
	MURCIA
	NAVARRE
	BASQUE COUNTRY
	LA RIOJA
	577 094
	18.19%

Source: C. Sánchez-Guevara & A. Sanz Fernández (Polytechnic University of Madrid) (2020) for MITMA based on the data from the 2017 FBS.

5.4.1. Interrelationship between energy poverty and financial vulnerability.

In relation to this 2020 ERESEE, it is useful to explore the relationships between household energy poverty and financial vulnerability, it being understood that - in the majority of cases and, especially, those where public support is most suitable - there is a direct correlation between the two, such that energy poverty is usually one more aspect of monetary poverty.

In order to be able to approximate the segmented amount of public support that it would be necessary to allocate in order to deal with the different cases of energy poverty and financial vulnerability, the Polytechnic University of Madrid performed a mining operation, tailored to the requirements of MITMA, on the microdata from the 2017 Family Budget Survey.

In that mining process, the income levels used are levels of equivalent income (calculated using the methodology for measuring relative poverty used by Eurostat and which is obtained by dividing the household income by the number of consumption units[106]). Therefore, a relatively low level of equivalent income need not, necessarily, imply a low income level for the purposes of granting aid (which usually takes into account the total household income, without adjustments).

Given that, in the design of public policies, it is customary to use the Multi-purpose Public Income Indicator (Indicador Público de Renta a Efectos Múltiples: IPREM) as an objective indicator of household income, the segmentation of households according to energy poverty situation (groups G1 to G6) has been related to the levels of the IPREM[107].

The table below contains the results of that mining process, showing the number and percentage of households in each of the groups, according to their situation in relation to energy poverty and their income level measured in relation to the IPREM.

[106] The consumption units represent the number of individuals, on an adjusted basis, making up a household and they reflect the existence of economies of scale within households.
[107] For the sake of consistency, the IPREM for 2017 was used, which was €6 454.03.

Figure 5.33: Spanish households (excluding the Canary Islands, Ceuta and Melilla) grouped according to energy poverty level and their income level measured in relation to the IPREM for 2017 (€6 454.03).

GROUPS	FINANCIAL VULNERABILITY											
	Under 1xIPREM			Between 1 and 2xIPREM			Between 2 and 3xIPREM			Under 3xIPREM		Total
	Households	% of group	% of total	Households	% of group	% of total	Households	% of group	% of total	Households	% of group	Households
G1A	30 102	5.0%	4.1%	386 770	64.3%	11.4%	177 954	29.6%	4.5%	594 826	98.8%	601 902
G1B	427 382	63.1%	57.8%	243 270	35.9%	7.2%	6 773	1.0%	0.2%	677 425	100.0%	677 425
G2A	25 639	1.7%	3.5%	724 515	47.0%	21.4%	690 985	44.8%	17.5%	1 441 140	93.5%	1 540 910
G2B	256 060	40.1%	34.6%	326 824	51.1%	9.6%	53 750	8.4%	1.4%	636 633	99.6%	639 139
G3	0	0.0%	0.0%	449 293	39.9%	13.3%	397 641	35.3%	10.1%	846 934	75.2%	1 126 824
G4	0	0.0%	0.0%	991 825	34.3%	29.3%	1 065 106	36.9%	27.0%	2 056 931	71.2%	2 888 291
G5	0	0.0%	0.0%	264 474	14.2%	7.8%	399 004	21.5%	10.1%	663 478	35.7%	1 859 762
G6	0	0.0%	0.0%	0	0.0%	0.0%	1 154 450	12.8%	29.3%	1 154 450	12.8%	9 020 865
G1+G3	457 484	19.0%	61.9%	1 079 333	44.9%	31.9%	582 367	24.2%	14.8%	2 119 185	88.1%	2 406 150
Total with data	**739 184**	4.0%	100.0%	**3 386 971**	18.5%	100.0%	**3 945 663**	21.5%	100.0%	**8 071 817**	44.0%	**18 355 118**
Absolute total	**896 602**			**3 386 971**			**3 945 663**			**8 229 236**		**18 512 537**

	Under 1 x IPREM			
	Households	% (1)	% (2)	% (3)
G1+G2+G3	739 184	4.03%	16.12%	100.00%
	Under 2 x IPREM			
	Households	% (1)	% (2)	% (3)
G1+G2+G3	2 869 856	15.64%	62.58%	69.55%
	Under 3 x IPREM			
	Households	% (1)	% (2)	% (3)
G1+G2+G3	4 196 958	22.87%	91.51%	52.00%

(1) Percentage of households in energy poverty under the stated IPREM threshold in relation to the total number of Spanish households. (2) Percentage of households in energy poverty under the stated IPREM threshold in relation to the total number of households in energy poverty. (3) Percentage of households in energy poverty in relation to the total number of households under the stated IPREM threshold.

Source: C. Sánchez-Guevara & A. Sanz Fernández (Polytechnic University of Madrid) (2020) for MITMA based on the data from the 2017 FBS.

The table below makes it possible to relate energy poverty to financial vulnerability, expressed by means of income level in relation to the IPREM. That correlation is seen to be very clear in the households most financially vulnerable in terms of income, with 61.9% of those with an equivalent income of less than 1 x IPREM being in energy poverty, or 31.9% of those with an equivalent income of between 1 and 2 x IPREM. Similarly, it is possible, in a fairly approximate manner, to identify the majority of the households in energy poverty exclusively by means of income, as 63.9% of them are below 2 x IPREM and 88.1% are below 3 x IPREM. With a view to intervention, it is much more complicated to identify households in energy poverty than it is to identify them by means of income (for which there are regionalised data that are disaggregated spatially for every Spanish municipality). This conclusion is important, because it means that, if there is an intervention - for example, regeneration at district level - based on the identification of vulnerable areas by income (less than 2 or 3 x IPREM), it would, at the same, include a large number of the households in energy poverty.

Figure 5.34. Relationship between households in energy poverty (G1+G3) and IPREM levels.

Households	Under 1xIPREM	Between 1 and	Between 2 and 3xIPREM	Under 3xIPREM	Over 3xIPREM	TOTAL
G1+G3	457 484	1 079 333	582 367	2 119 185	286 966	2 406 150
Other Groups	281 699	2 307 638	3 363 296	5 952 633	9 996 335	15 948 967
Total	739 184	3 386 971	3 945 663	8 071 817	10 283 300	18 355 118
% vertical	Under 1xIPREM	Between 1 and	Between 2 and 3xIPREM	Under 3xIPREM	Over 3xIPREM	TOTAL
G1+G3	61.9	31.9	14.8	26.3	2.8	13.1
Other Groups	38.1	68.1	85.2	73.7	97.2	86.9
Total	100.0	100.0	100.0	100.0	100.0	100.0
% horizontal	Under 1xIPREM	Between 1 and	Between 2 and 3xIPREM	Under 3xIPREM	Over 3xIPREM	TOTAL
G1+G3	19.0	44.9	24.2	88.1	11.9	100.0
Other Groups	1.8	14.5	21.1	37.3	62.7	100.0
Total	4.0	18.5	21.5	44.0	56.0	100.0

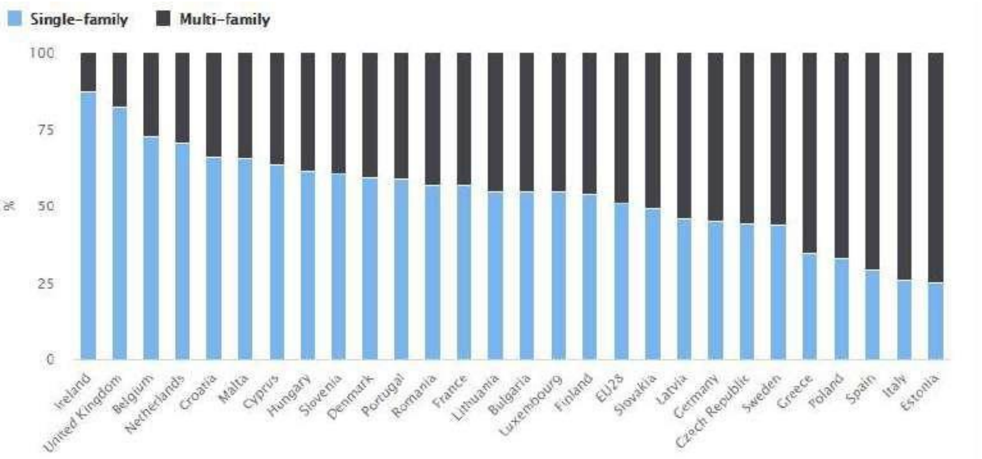
Source: C. Sánchez-Guevara & A. Sanz Fernández (Polytechnic University of Madrid) (2020) for MITMA based on the data from the 2017 FBS.

5.5. FACTORS RELATED TO OWNERSHIP STRUCTURE.

In addition to the economic barriers referred to above, there are also others related to ownership structure. As has already been discussed, the most recent data available on tenure (from the 2018 Continuous Household Survey) show that the distribution of homes in Spain according to tenure type is as follows: 76.7% of homes are owned (14.2 million of a total of 18.5 million), 17.8% are rented (3.3 million) and 5.5% are held under other forms of tenure (1.2 million; made available free of charge or for a low price by another household, the company, etc.).

Moreover, unlike the majority of the European countries represented in the graph below, in Spain there is an absolute predominance of multi-family dwellings (71.8%) compared to single-family dwellings (28.2%), which, as a whole, means that the majority of Spanish homes are owned dwellings located in multi-family residential buildings, established as homeowners' associations governed by Law 49/1960, the Commonhold Property Act.

Figure 5.35. Countries according to the division of the residential building stock between single-family and multi-family properties.



Source: European Commission (2016). <u>*https://ec.europa.eu/energy/en/eu-buildings-factsheets*</u>

This assertion can be examined in greater detail by looking at the 2001 census data (assuming this variable has not changed significantly since then), as the published results of the 2011 census do not make it possible to distinguish between types of owner. According to those data, at that time, single-family dwellings (which accounted for approximately one-third of the total) were in 98.7% of cases owned by one person, while dwellings in multi-family properties (67% of the total) were mostly (in 69.4% of cases) part of homeowners' associations (and thus subject to commonhold property rules), with 29.1 % being owned by single owners. Thus, out of the total number of dwellings in Spain in 2001, 46.5% were in multi-family properties organised into homeowners' associations, 32.5% were single-family dwellings owned by one person and 19.5 % were in multi-family properties with a single owner.

This predominance of commonhold property means that in Spain, unlike what occurs in other European countries, decision-making regarding carrying out work generally has to be a collective process, in which the different owners of the property – each of them, furthermore, with their own financial circumstances – must come to an agreement, which is much more complicated than in the case of other countries with a predominance of single-family dwellings, where the decision exclusively lies with the owner, or of publicly-owned or part publicly-owned social housing, where the decision is also made by a single body. That collective decision-making process is subject to certain rules, including a system of majorities according to the type of work to be undertaken, established, as already mentioned by the Commonhold Property Act. This complexity also affects applications for and the granting of public aid or loans for renovation in multi-family residential buildings, as such homeowners' associations lack their own legal personality.

Consequently, and despite the fact the Commonhold Property Act, which dates from 1960, has been amended on several occasions to facilitate renovation work (the last time by means of Law 8/2013), there is still room to make adjustments that make it possible to respond fully to the demands of today's society. Furthermore, beyond these strictly legislative aspects, a particular effort must also be made in terms of communication with homeowners' associations, in which property managers and other professionals who usually deal with the associations can play an important role.

5.6. CULTURAL BARRIERS AND RELUCTANCE TO CARRY OUT WORK ON THE COMMON ELEMENTS OF BUILDINGS.

There are also significant challenges from the cultural point of view, such as encouraging a culture of maintenance and preventive conservation, especially with regard to the common elements of multi-family residential buildings.

The latest data from a large survey conducted at national level on housing conditions in Spain (the above-mentioned 2018 Housing Barometer), provide information on the willingness and expectations of Spanish households with regard to carrying out renovation work. The results[108] indicate that the vast majority of Spaniards (87%) do not anticipate making improvements or alterations in their home in the next 12 months (64.6% because they believe the property does not need them and 20.6% because they do not have the financial resources to do so), compared to the 11.9% who say they are considering it[109]. Although very slight, these data indicate an improvement in the situation compared to the previous Barometer from 2014, discussed in the 2017 ERESEE, where the percentage that did not plan to carry out work was practically the same[110], but - at the expense of the undecideds - the percentage who do intend to do so has increased from 9.1% to 11.9%, while the percentage who do not do so for financial reasons has fallen from 26.3% to 20.6%. Regarding the type of improvements planned (multiple response), as in 2014[111], work of a merely decorative nature or simply to update the property stands out: 48.8% plan to paint, 38.6% plan to renovate bathrooms or kitchens and 20.1% plan to change flooring, compared to the much lower weight of improvements in some way related to energy efficiency (just 24.6% plan to change doors or windows, 7.8% to repair water, electricity or gas installations, and 7.2% to mend heating or DHW installations).

With regard to those living in multi-family buildings (with more than two dwellings), the results of the survey[112] also indicate a lack of willingness to undertake work on the common elements of the building, although a clear improvement can be seen compared to 2014: the percentage saying that they were not considering carrying out renovation work on the building fell from 81.8% to 70%, compared to an increase from 8.3% to 14.5% for those saying that they did intend to carry out work. With regard to the type of work expected to be carried on the building (multiple response), an important piece of data to take into account is the fact that the planned actions are mainly focused on the envelope (27.9% plan to do work on the façade and 22.8% on the roof), compared to other interventions involving common elements of the building[113].

In view of all of the above, it is advisable, on the one hand, to promote a culture of maintenance and preventive conservation, especially among homeowners' associations, and, on the other, to reorientate the message to be conveyed, stressing not only the financial case (returns on savings) for energy renovation, but also the comfort, the improvement in health and quality of life, the increase in property values, insulation against noise, etc., that may be obtained.

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[108] Response 18a. 'Housing Barometer' of the Centre for Sociological Research (CSR), 2018.

[109] Although, in 2014, the percentage that did not plan to do work was practically the same: at 87%, 65.9% because they did not think the property needed it and 26.3% because they lacked the financial resources to do so.

[110] At 87%: 65.9% because they did not think the property needed it and 26.3% because they lacked the financial resources to do so.

[111] In 2014, these percentages were as follows: 46.4% planned to renovate bathrooms or kitchens; 18.3% planned to change flooring; 24.1% planned to change doors or windows; 13.4% planned to repair water, electricity or gas installations; and 8.5% planned to mend heating or DHW installations.

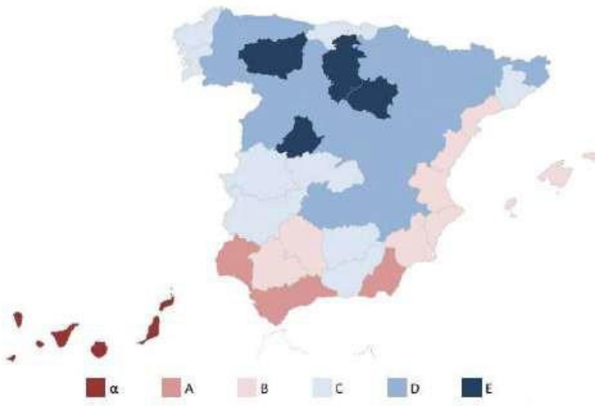
[112] Response 19a.

[113] Thus, 12.3% plan to do work on the stairs, 14.6% on the lift, 8.2% on the plumbing, 5.9% on the electrical installation, 3% on the structure or foundations, and only 1.8% on the heating systems. In 2014, these percentages were, respectively, 19.4%,16%, 13.1%, 12.1%, 10.7% and 2.4%. The most notable change can be seen in relation to the intention to carry out work on the façade, which was 44.2% in 2014 and fell to 27.9% in 2018.

5.7. DIVERSITY OF DOMESTIC CLIMATIC CONDITIONS AND THE NEED TO CONSIDER THEM IN THE REGIONAL IMPLEMENTATION OF THE STRATEGY.

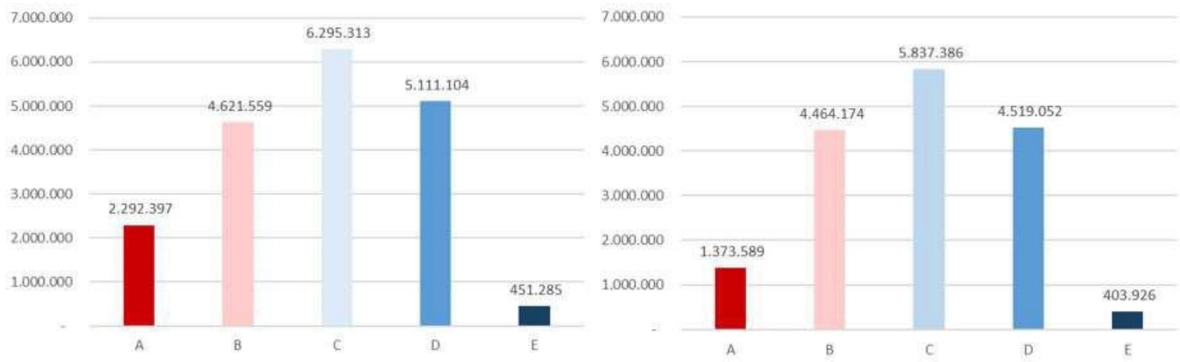
In addition to the reflections outlined in section 5.2, resulting from the comparison of the climatic conditions in Spain with those of other EU countries, it must also be taken into account that domestically, Spain is a country of contrasts and very diverse climates. The Building Technical Code (*Código Técnico de la Edificación*: CTE) defines six winter climatic zones and four summer climatic zones, which can be seen on the map below:

Figure 5.36. Winter climatic zones in Spain according to the CTE, by province, with each province being assigned the climatic zone of its capital.



Source: MITMA.

Figure 5.37. Total number of main residences per climatic zone (left) and main residences with heating (right).



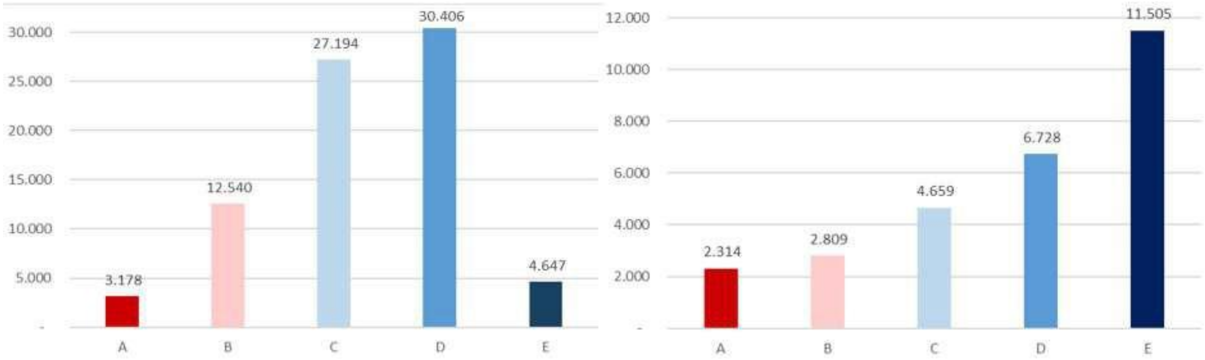
Source: MITMA.

The differences between the climatic conditions of these zones are very significant. Thus, while zones E and D - continental climatic zones located in the interior of the country - have a high number of degree days (approximately, more than 2 750 degree days and between 2 200 and 2 750 degree days, respectively), zones A and B are clearly Mediterranean (up to 850 and 1 100 degree days), while zone C reflects intermediate conditions (up to 1 650 degree days) and the alpha zone, in the Canary Islands, is between 0 and 150 degree days.

Given these differences, it is significant to analyse the distribution of homes in each of these climatic zones, which, as can be seen in the graph and table below, can be summarised by grouping, approximately, a third of the total number of main residences in zones D and E, another third in the zones with the mildest climate (alpha, A and B), and the remaining third in the intermediate temperate climatic zone (C). In terms of consumption, according to the consumption distribution model used for this 2020 ERESEE, 80% of the energy used for heating in the residential sector is concentrated in zones C, D and E, even though those zones only contain 65% of homes. The indicator that best reflects these differences is annual unit consumption per home: thus, if the average consumption per home is 4 697.3 kWh/year, in the colds zones, D and E, it reaches 6 728.5 and 11 504.6 kWh/year, respectively; in the warm zones, it is 2 313.8 kWh/year in zone A and 2 809.1 kWh/year in zone B;

while, in zone C, it is very similar to the average (4 658.7 kWh/year).

Figure 5.38. Distribution of total consumption (GWh) in the stock of main residences with heating (left) and unit consumption per home (kWh) according to the climatic zones of the CTE.



Source: MINISTRY OF TRANSPORT, MOBILITY AND THE URBAN AGENDA (MITMA)

As set out in Annex A.2, the breakdown of the climatic zones at provincial level also yields notable differences in the number of homes located in each of them and in their respective consumption - associated with the climatic zone assigned to each province according to the climate of its capital.

This all leads to an initial conclusion: the difficulty of financing work through the capitalisation of energy savings - discussed earlier in relation to the country as a whole in comparison with the other EU Member States - is also relevant in several Spanish climatic zones (containing, at least, more than half of the existing housing), where the relatively benign climate means that the savings that can be made on heating are small and, therefore, there is little likelihood that the owners will find such investments attractive or that the returns obtained on such savings could finance the cost of the work.

The second conclusion derives from the fact that the hypothesis of capitalising energy savings only works clearly in the climatic zones with the coldest winters (such as zones E and D[114]). That means that those would be the zones where it would be most cost-effective to act in financial terms and in terms of impact on aggregate consumption at national level, at the clear expense of other zones, where, according to that criterion, intervention would not be a priority.

Without losing sight of achieving the national energy saving targets, for which it is unquestionably necessary to begin, as a matter of priority, actions in the climatic zones and on the property types with the greatest heating consumption (which are significantly concentrated in the provinces of the climatic zones with the harshest winters, which have been precisely identified by carrying out a detailed study of the national distribution of consumption), it seems necessary to introduce other supplementary criteria that allow for greater regional balance in the actions to be carried out. There needs to be effective coordination of the different policies for intervention in the existing building stock, both support aimed at the strict renovation of buildings ('bricks-and-mortar support') and support that is more social in nature ('support for households'), or, as the case may be, whatever support may be considered in order to redistribute the returns from the macroeconomic benefits of renovation.

[114] Of the total of 6.56 million homes in provinces with climatic zones D and E, the province of Madrid alone contains 38%, in contrast to the other 24 provinces of the Spanish interior, of which only Asturias and Zaragoza have a volume that exceeds 5% of that total.

5.8. ABSENCE OF REGIONAL STRATEGIC FRAMEWORKS FOR PLANNING RENOVATION AND URBAN REGENERATION.

In relation to the above considerations, it should be noted that, the general reference framework at national level for the energy renovation of buildings having been established by Law 8/2013 the 2014 ERESEE, and since, in Spain, competences for urban development and housing are part of the exclusive powers of the Autonomous Communities and therefore the state does not have the ability to implement renovation and urban regeneration planning regionally, it is necessary for such regional implementation to take place at the level of the Autonomous Communities.

As regards regulation, within the framework of its competences, in 2015, the state approved the Recast Text of the Land and Urban Renovation Act, adding the important changes and reforms introduced in relation to renovation in Law 8/2013. As has been seen, some Autonomous Communities have recently incorporated these changes into their own legal systems, and it is important for the rest to do so as quickly as possible.

From the strategic point of view, the 2013-2017 National Plan stated, in Article 3, that any partnership agreements signed with the Autonomous Communities had to include a global strategic plan proposed by each of them regarding the implementation of the different programmes in the plan, with at least with an estimate of the number of actions to be financed annually. The development of such strategic plans and the importance the Autonomous Communities have attached to it as an opportunity to provide themselves with a strategic document has been very inconsistent, and, moreover, few have had the initiative to develop a real strategic plan for renovation and urban regeneration in their regions (see chapter 4).

Furthermore, as outlined in the document entitled 'Diagnóstico de la Rehabilitación en las Comunidades Autónomas' (Assessment of Renovation in the Autonomous Communities)[115], the implementation of renovation policies by the Autonomous Communities, as regards volumes of dwellings renovated, total investment made, unit amount of the aid provided, percentages subsidised, etc., is also very different in each Autonomous Community.

The 'Analysis of the characteristics of residential buildings in Spain' also shows the different characteristics of the residential building stock in each Autonomous Community as regards age, state of repair or distribution according to municipality size, since there are some Autonomous Communities that are mostly urban, while others have a predominance of single-family dwellings in rural municipalities[116], for which it would be advisable to propose specific menus of renovation actions, on a differentiated basis.

In view of the above, it would seem very important to urge the Autonomous Communities, in the framework of their competences, to develop strategic renovation and urban regeneration planning tools, based on the assessment of the status of the building stock in each of them. Regarding that assessment, which could be done on the basis of the existing work and tools mentioned above, each Autonomous Community could plan, regionalise and develop its own targets.

5.9. POTENTIAL OF RENEWABLE ENERGY IN BUILDINGS IN SPAIN.

Spain is one of the EU countries with the most potential for using renewable energy in buildings, particularly solar energy, thanks to the hours of sunlight and the considerable development of this business and industrial sector in Spain. Furthermore, there is great and growing potential for other sources of renewable energy, such as aerothermal and geothermal energy and biomass.

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115 http://www.gbce.es/archivos/ckfinder/51files/Informe%20Rehabilitaci%C3%B3n%20CCAA.pdf

116 In Spain as a whole, of the total of 25.2 million dwellings in Spain, nearly half (47.6%: 11 987 675) are in urban municipalities with more than 50 000 inhabitants, with the remaining half being distributed as follows: 15.7% in municipalities with between 20 001 and 50 000 inhabitants (3 969 298 dwellings); 20% in municipalities with between 5 001 and 20 000 inhabitants (5 029 342 dwellings); and another 16.7% in municipalities with fewer than 5 000 inhabitants (4 222 297 dwellings).

As an example of the differences between the Autonomous Communities, in the Autonomous Community of Madrid, 82.7% of dwellings are in municipalities with more than 50 000 inhabitants and only 3.7% are in municipalities with fewer than 5 000 inhabitants, compared to Extremadura, where 44.8% of dwellings are in rural municipalities with fewer than 5 000 inhabitants.

For that reason, Spain has led the way in adopting measures that make it mandatory to introduce renewable energy into buildings. Twenty years have passed since the first solar by-laws entered into force in major cities, such as the Barcelona by-law in the year 2000, followed by the entry into force of requirements HE4 and HE5 of the CTE building regulations in 2006, which included requirements relating to contributions to be made by renewable energy in satisfying part of the demand for DHW and electricity in buildings. During that time, experience has been gained which can only result in renewable energy being incorporated better and more effectively into existing buildings. That experience will make it possible to bring about nearly zero-energy buildings, in an effective manner, such that 100% of the consumption in those buildings can be renewable energy and, therefore, their use can be completely decarbonised.

The targets of the Integrated National Energy and Climate Plan (PNIEC) are ambitious and, in order to achieve them, it is necessary to strengthen and promote actions in every area - regulatory, financial and fiscal - to increase the use of renewable energy in existing buildings. Measure 1.6 of the PNIEC 'Framework for the development of thermal renewable energy' establishes mechanisms that combine actions in all of those areas and that will make it possible to achieve those targets.

Despite the experience gained, there are still barriers as regards awareness on the part of developers, who, when it comes to making the relevant decisions, at times opt for conventional heating and cooling solutions for their buildings, without giving sufficient thought to the inclusion of renewable energy. Moreover, the aid that, until recently, was available for replacing fossil fuel-powered generators with others that also used fossil fuels took away opportunities for integrating renewable energy into buildings.

The regulatory measures established in the CTE and RITE building regulations have been effective in increasing the use of such energy in existing buildings, although they need to be strengthened and combined with other more effective financial support measures that improve this situation.

The electrification of the thermal requirements of the residential building stock, included in the PNIEC package of measures, will make it possible for large-scale renewable energy generation to supply buildings with off-site renewable energy, but it is also essential to examine, in depth, the potential for using on-site renewable energy, such as solar energy, aerothermal energy, geothermal energy, etc.

Furthermore, increasing the use of renewable energy for heating and cooling in existing buildings will go a long way towards complying with the provisions of Article 23 'Mainstreaming renewable energy in heating and cooling' of Directive (EU) 2018/2001 on the promotion and use of energy from renewable sources, which sets a highly ambitious growth path of up to 1.1% per year. In that regard, Measure 1.6 of the above-mentioned PNIEC envisages mechanisms that guarantee a minimum quota of renewable energy in the thermal applications sector, for which the individuals affected and obliged to comply will be determined, as well as the projects eligible and how energy contributions are to be accounted for.

The correct selection from the different options available will be key to a fast and effective transition, taking into account how those options may complement one another and provide service to one or more buildings by means of district heating and cooling systems and/or energy communities.

It will be necessary to analyse how certain variables such as the capacity for electricity distribution to some rural settings, the availability of solar radiation and the available space, the availability of biomass, geothermal resources, the intensity of the thermal demand to be supplied, etc., influence the selection.

The potential penetration of renewable energy in buildings is immense and there is a wide range of economically viable technical solutions which, by themselves or in combination, can meet the demands of renovated buildings. These solutions are particularly interesting if they are combined with actions that involve a significant reduction in the heating and cooling demand of the buildings, as they make it possible to incorporate optimised systems.

However, measures to reduce heating and cooling demand do not affect DHW demand, which will remain constant over time despite the intensification of regulatory measures to promote the construction of nearly zero-energy buildings or the renovation of buildings to that end. The only way to achieve the drastic decarbonisation of DHW is to incorporate renewable energy systems that involve zero or minimal consumption of non-renewable primary energy and that allow the available energy to be used locally.

The solutions, both for producing DHW and for heating and/or cooling, could be single solutions, such as biomass boilers, solar thermal energy, seasonal high-efficiency heat pumps, heat pumps powered by solar photovoltaic or thermal energy, or electricity storage powered by photovoltaic energy, or they could be hybrid solutions combining those technologies.

5.9.1. Solar energy and self-consumption.

Spain is in a privileged position relative to other European countries with regard to the availability of solar radiation and, therefore, the renewable energy requirements established in the CTE building regulations have traditionally referred to the solar resource. However, given the improvement in other technologies as regards the renewable aspect and the increasing electrification of the thermal demand, the renewable component that is required for buildings can be satisfied with any renewable technology.

The increase in the use of renewable electrical installations for self-consumption will have a direct effect in reducing part of the non-renewable primary energy consumption of the buildings to which they supply energy, as they will also be able supply part of the thermal consumption (heat pumps, Joule effect, etc.).

That contribution is envisaged in the energy performance certification of buildings and accounting for it correctly is key, along with the renovation of building envelopes, improving the energy efficiency of heat generators and incorporating renewable energy for thermal uses, in order to be able to comply with the requirements laid down in the Building Technical Code (CTE) and so that existing buildings can effectively be converted into nearly zero-energy buildings.

Furthermore, the Integrated National Energy and Climate Plan (PNIEC) promotes the use of distributed generation, which is closely related to buildings.

With the development of electricity self-consumption and distributed generation, the PNIEC promotes the active role of the public in decarbonisation, as well as promoting the use of urban space for renewable energy generation, greater energy and climate awareness in society and the emergence of new business models.

In that regard, the potential offered by the energy renovation of buildings, the use of renewable energy for thermal applications on-site and electricity self-consumption systems - especially collective self-consumption - stand out as ways to mitigate situations of energy vulnerability and poverty.

Through the National Strategy on Energy Poverty 2019-2024 (Measure 4.11), the PNIEC also envisages self-consumption systems as a tool for mitigating energy poverty. In that regard, the government's actions relating to the promotion of social housing stock, access to housing and the work of social services should take into account the potential of self-consumption to reduce electricity bills and the energy dependence of families and vulnerable groups. Moreover, measures to promote self-consumption should be designed to be accessible to society as a whole and in particular to vulnerable consumers who are excluded from self-consumption in market conditions without specific measures.

The policy of promoting renewable energy exploits and strengthens synergies with other approved measures, such as Royal Decree-Law 15/2018 and Royal Decree 244/2019, regulating the administrative, technical and financial conditions of electricity self-consumption, which aim to make it easier for consumers to obtain cleaner energy and more cheaply.

Royal Decree 244/2019 provides for installations without surpluses (which never export energy to the grid) and installations with surpluses, and, in the latter case, also allows the installations to take part in the simplified compensation system, to offset their production surpluses with their consumption or sell the surplus energy to the market.

Royal Decree 244/2019 also regulates self-consumption connections over the public distribution network, which makes it possible for consumption and generation to be located in different nearby buildings.

Furthermore, Royal Decree 244/2019 provides for collective self-consumption, whereby consumers in a single building or in nearby buildings can share the energy generated by a single self-consumption installation, with the energy being distributed on whatever basis the consumers agree.

In order to evaluate the real capacity for self-consumption in Spain, the PNIEC envisages carrying out a study on the potential of self-consumption as part of Measure 1.4 of the plan, which will determine the real potential of photovoltaic installations for self-consumption in the residential, service and industrial sectors. The initial estimates situate that potential between 4GW and 10.5GW in the period 2020-2030, meaning that the overall outlook for self-consumption in buildings is attractive.

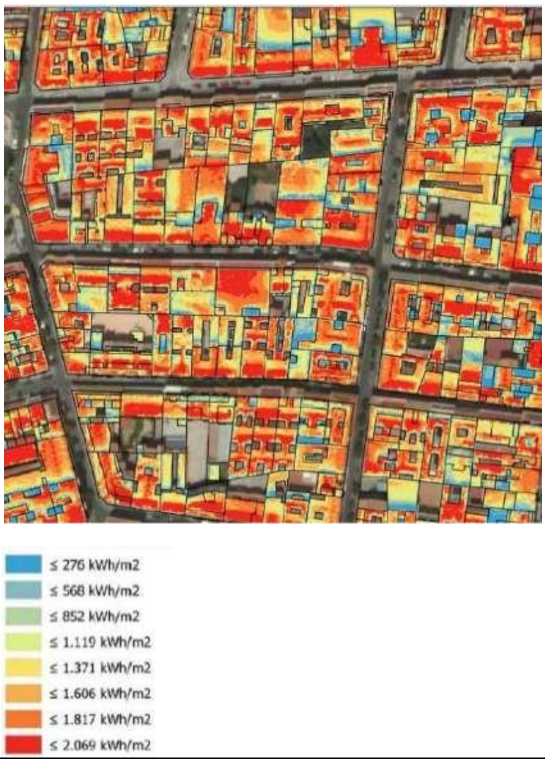
5.9.2. Study on the potential for generating solar thermal and photovoltaic energy in Spanish residential buildings in their urban setting.

Independently of the above study, MITMA has commissioned a multidisciplinary team from the Polytechnic University of Madrid to carry out a 'Study on the potential for generating solar thermal and photovoltaic energy in Spanish residential buildings in their urban setting.'[117]

The research methodology for that work was divided into three major phases: an initial phase in which the available solar resource and the unit generating capacity by province and autonomous city, throughout Spain, was assessed. In the second phase, a number of urban areas that are characteristic of the Spanish residential building stock were demarcated in order to assess their real capacity for capturing and, therefore, generating energy. For that purpose, the city of Madrid was used as a case study, on account of the great diversity of representative types of urban fabric it contains. Lastly, in the third phase, the production capacity of residential buildings was examined according to their urban setting and the demand structure of Spanish households as regards heating, cooling, DHW and other applications.

Figure 5.39. Orientation of Roofs – Urban Fabric: Sprawl

Figure 5.40. Annual Irradiation – Urban fabric: Sprawl



	Sloping North (315° - 45°)
	Sloping East (45° - 135°)
	Sloping South (135° - 225°)
	West (225° - 315°)
	Flat
	≤ 276 kWh/ m2
	≤ 1 119 kWh/ m2

Source: Prepared by Román E., Caamaño E., Romanillos G., Sánchez-Guevara C., 2019, using data from the National Geographic Institute and the Virtual Cadastre.

The main general conclusions of this study on the possibility of using the solar energy received annually by the roofs of residential buildings in order to meet the energy needs of Spanish households are as follows:

[117] Román E., Caamaño E., Romanillos G., Sánchez-Guevara C. (2019).

- It is evident that there is an excellent solar resource in Spain and there is clearly a case for making use of flat and sloping roofs, including, in the latter case, roofs with orientations other than south-facing, which increases the potential for exploiting solar energy, given the diversity of the existing residential building stock.

- Although the study in question was carried out exclusively in relation to the roofs of residential buildings, it is worth stressing that there is greater potential if other surfaces of the building envelope, such as the façades, are taken into consideration, as well as building types other than those studied, such as those used for urban facilities and installations or industrial buildings.

- The level of annual irradiation on the roofs of buildings differs according to the type of urban fabric, with variations of up to 20%.

- Of the types of urban fabric studied, those having the highest annual irradiation values were single-family dwellings, H-shaped blocks and linear blocks. One of the common characteristics of these fabric types is that they are made up of buildings of similar heights, which minimises the shadows they cast on each other, and, in general, the roofs have fewer protruding elements. The fabric types with the lowest values, however, are urban expansion areas, sprawl and modern blocks; these fabric types have roofs with a great deal of volumetric complexity and abundant protruding elements (cabins for lifts or other installations, chimneys, attics, roof structures or small terraces or parapets), which increase the surface area over which shadows are cast during the course of the day and, therefore, reduce the potential for capturing solar radiation. Added to which, there is also the difference in the heights of the different roofs, which means that some buildings cast a shadow over others.

- Integrating the results of the analysis of solar radiation at the urban level, carried out in the city of Madrid, with those for energy demand coverage for the different building types reveals a reduction in demand coverage and generation of surpluses of around 5% in single-family dwellings, 8-12% in residential buildings with up to three floors and around 5-15% in residential buildings with four or more floors.

- The solar energy captured per square metre of plot also differs according to the type of urban fabric.

- A comparative analysis of the variation in average solar irradiation on roofs per area of plot produces much more differentiated results than the preceding analysis, with a difference between the highest and lowest values obtained of 380%. That arises because, in this case, the irradiation values per area of roof are modified by a factor that depends on the proportion of the area of plot occupied by buildings. In this case, the types of urban fabric analysed having the highest average solar irradiation values on roofs per square metre of plot are linear blocks, H-shaped blocks and the old town, where the buildings frequently occupy the total area of the plots, while the urban fabric types with the lowest average solar irradiation values on roofs per area of plot are single-family dwellings and terraced houses, followed, at some distance by, modern blocks. In these cases, the area of the plots occupied by buildings is small in relation to the total area.

Finally, the study analysed the potential for generating solar thermal and photovoltaic energy in residential buildings, for which it outlined three different scenarios, using the total potential of the roofs and analysing demand and consumption in annual terms, according to the on-site use made of the energy generated:

- SCENARIO 1: This scenario considers the use of part of the roof to produce domestic hot water using a solar thermal installation. The remaining part of the roof is used to generate electricity to cover the demand for lighting and electrical appliances.

It was found that the annual electricity demand of single-family dwellings and residential buildings with up to three floors could be covered in its entirety (100%). In taller buildings, the coverage would be over 60%. Furthermore (figure 5.42), surpluses would be produced in excess of the on-site electricity demand for lighting and electrical appliances in single-family dwellings (between 2 and 3.5 times) and in residential buildings with up to three floors (between 0.75 and 1.5 times); in taller buildings, the surpluses would be less than 15% of the demand.

Figure 5.41. Scenario 1: coverage of the annual electricity demand for lighting and electrical appliances.

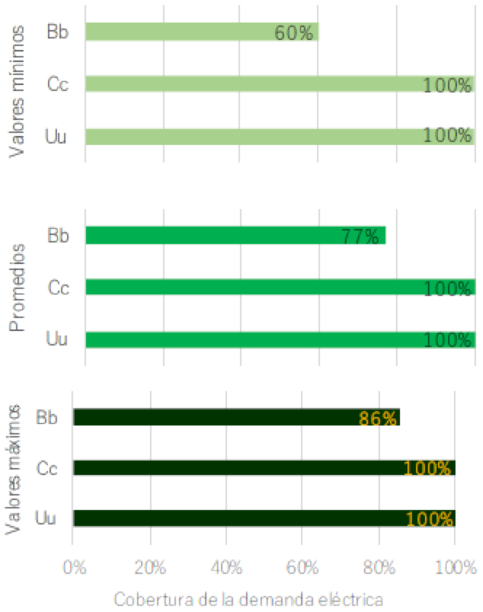
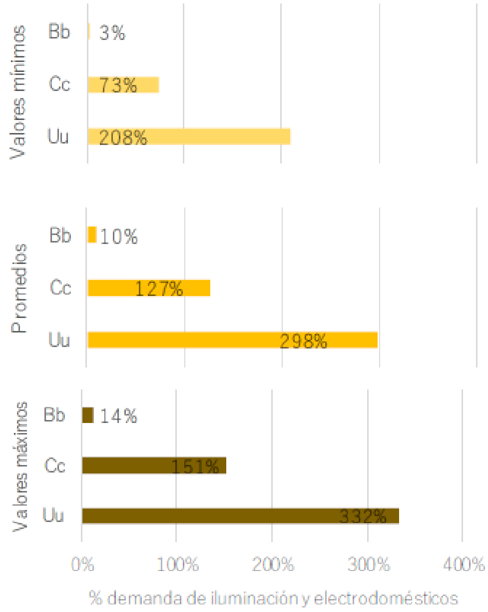


Figure 5.42. Scenario 1: generation of annual surpluses, expressed as a percentage of the electricity demand.



	Minimum values
	Averages
	Maximum values
	Bb
	60%
	Cc
	Uu
	Coverage of electricity demand
	% demand for lighting and appliances

Bb: Dwellings in blocks with more than three floors; Cc: dwellings in blocks with up to three floors; Uu: single-family dwellings.
Source: Román E., Caamaño E., Romanillos G., Sánchez-Guevara C. (2019).

- SCENARIO 2: This scenario considers the generation of electricity for lighting and electrical appliances, as well as for the production of domestic hot water using a storage electric boiler or its equivalent.

In this case, enough electricity would be produced to cover the demand for lighting and electrical appliances shown in figure 5.43, as well the surpluses shown in figure 5.44.

Figure 5.43. Scenario 2: coverage of the annual electricity demand for DHW, lighting and electrical appliances.

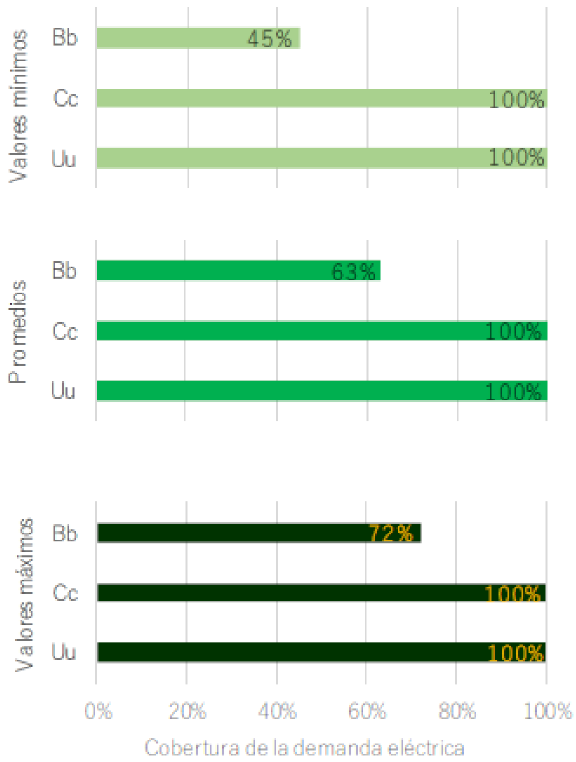
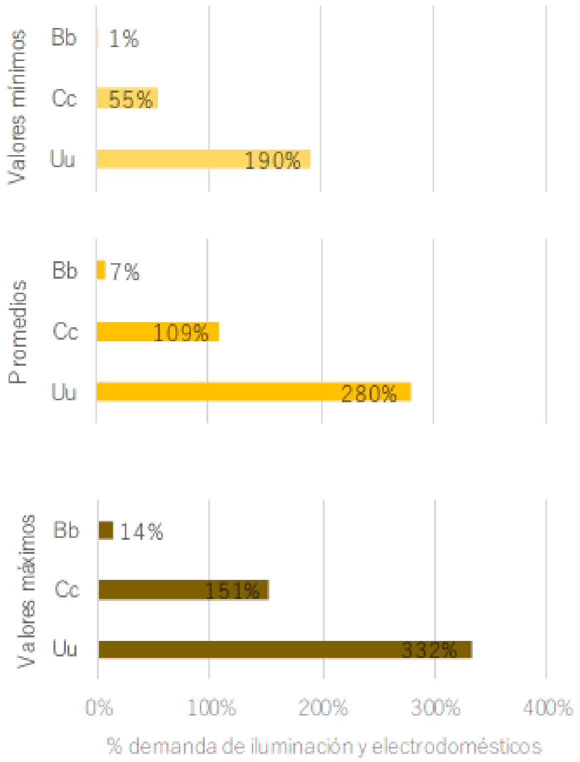


Figure 5.44. Scenario 2: generation of annual surpluses, expressed as a percentage of the electricity demand.



	Minimum values
	Averages
	Maximum values
	Bb
	Cc
	Uu
	Coverage of electricity demand
	% demand for lighting and appliances

Bb: Dwellings in blocks with more than three floors; Cc: dwellings in blocks with up to three floors; Uu: single-family dwellings.

Source: Román E., Caamaño E., Romanillos G., Sánchez-Guevara C. (2019).

Due to the production of domestic hot water by means of electric heating, the coverage figures and surpluses obtained are slightly smaller than those in Scenario 1. Nevertheless, the electricity demand in single-family dwellings and residential buildings with up to three floors is still covered in its entirety and more than 45% of the demand is covered in taller buildings.

Furthermore, the surpluses would continue to be greater than the electricity demand for lighting and electrical appliances in single-family dwellings (between 2 and 3.5 times that demand) and in buildings with up to three floors (between 0.5 and 1.5 times); in taller buildings, the surpluses would not be more than 10% of the demand in question.

- SCENARIO 3: This scenario considers the generation of electricity for heating and for the production of domestic hot water (using an electrically operated heat pump), as well as for lighting and electrical appliances.

The results show that, in single-family dwellings, between 66% and 100% of the energy demand would be covered during the heating period (figure 5.45) and 100% the rest of the year (figure 5.46). Moreover, the annual surpluses would continue to exceed between 1 and 3 times the demand for lighting and electrical appliances (figure 5.47).

In residential buildings with up to three floors, the coverage would be slightly lower during the heating period (55%-100%) and the surpluses would also be smaller (0.5 to 1.5 times the demand for lighting and electrical appliances). In taller buildings, the coverage in the heating period would be between 25% and 85% and between 77% and 100% the rest of the year. The surpluses generated would be less than 15% of the annual demand for lighting and electrical appliances.

Figure 5.45. Scenario 3: coverage of the energy demand during the heating period.

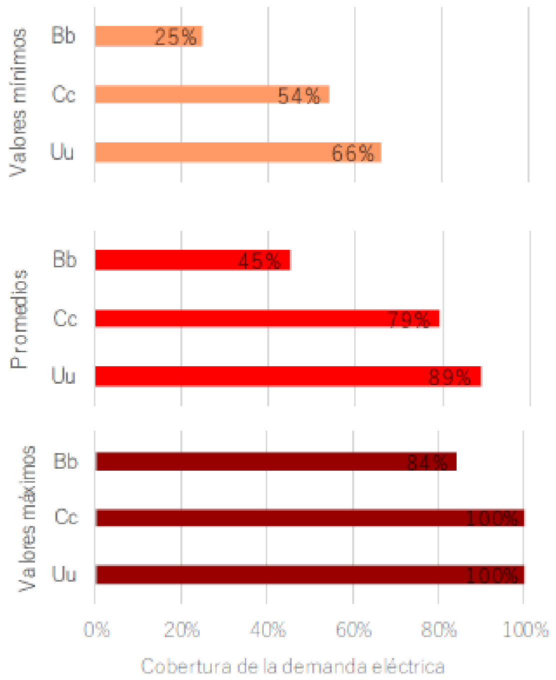
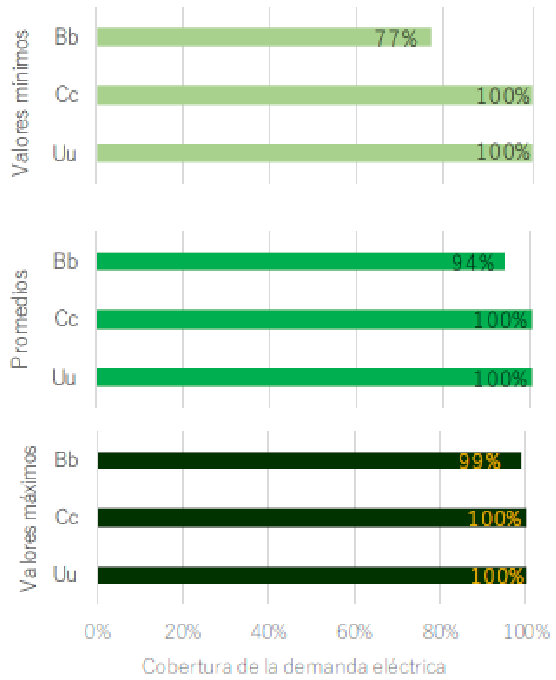
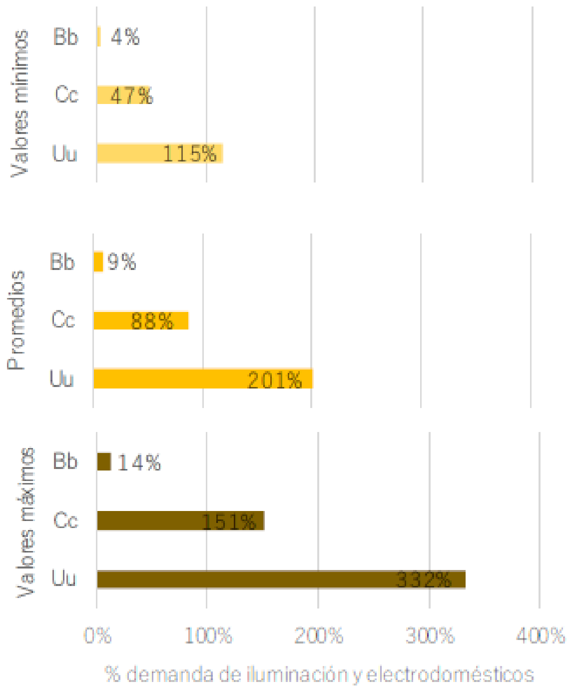


Figure 5.46. Scenario 3: coverage of the energy demand for the rest of the year.



	Minimum values
	Averages
	Maximum values
	Bb
	Cc
	Uu
	Coverage of electricity demand

Figure 5.47. Scenario 3: generation of annual surpluses, expressed as a percentage of the electricity demand for lighting and electrical appliances.



	Minimum values
	Averages
	Maximum values
	Bb
	Cc
	Uu
	% demand for lighting and appliances

Source: Román E., Caamaño E., Romanillos G., Sánchez-Guevara C. (2019).

Taking this work as a starting point and given the wide variety of situations in urban settings in Spain, it is advisable to carry out detailed studies, at city or district level, which make it possible to determine the solar potential of the buildings in greater detail. The methodology that was used in this study can be extended to other urban and geographical contexts, adapting it to the particular characteristics of each case analysed.

5.10. IMPROVEMENT IN THE CURRENT ACCOUNTING RULES FOR ENERGY PERFORMANCE CONRACTS.

When the previous 2017 ERESEE was drawn up, the accounting rules for energy performance contracts (EPCs) in the public sector required the whole of the investment in energy renovation to be counted as public expenditure, even if that investment was made and financed - in full or in part - by the private sector, unless the investment amounted to 50% of the value of the asset following the action. That fact acted as a decisive brake on energy efficiency actions on the part of the public sector and, consequently, made developing the market for energy services in countries that, like Spain, are subject to strict fiscal discipline significantly more difficult.

In May 2018, the statistical office of the European Union (Eurostat), in collaboration with the European Investment Bank (EIB), published a Guide to the Statistical Treatment of Energy Performance Contracts. That guide was endorsed by the 'Eurostat Manual on Government Deficit and Debt (Implementation of ESA 2010 - 2019 edition)', which regulates the accounting and statistical treatment of the different public sector contracts.

The guide is the result of the work done on the basis of the note published by Eurostat in September 2017 and allows investments (in work or installations) intended to save energy through an EPC to be accounted for in a new way, such that the amount of the investments, when they are made by a private company, is not counted as debt in the accounts of the public authorities.

How investments in an EPC are recorded in public accounts is a very important matter for authorities with high levels of debt, since, if an asset is accounted for within the balance sheet or accounts of the public authority, it then counts for debt and deficit purposes, whereas, if the assets remain off the balance sheet, then only the regular payments over time to the company awarded the contract (the Energy Service Company or ESCO) count towards debt and deficit.

The guide also represented a fundamental step forwards in developing and launching EPCs with investment in installations or work for the purpose of saving energy, since, up to that point, such investments could only be accounted for in accordance with the established rules for either public-private partnerships (PPPs) or concession contracts. With the publication of that guide, then, three possible ways of accounting for such investments in public accounts were established:

- As a concession. In general terms, in the case of concessions, investments in energy efficiency do not form part of the public accounts. It applies, for example, to the majority of tender processes for district heating and cooling networks and to some exterior street lighting contracts, but it is not generally applicable to public buildings.

- As a PPP. In this case, the whole of the investment in energy renovation, even if that investment is made and financed, in full or in part, by the private sector, forms part of the public accounts (and, therefore, debt and deficit levels) <u>unless the investment amounts to 50% of the value of the asset following the action</u>. In general terms, this rule can be applied to most exterior street lighting and also to new investments in installations that are capable of being dealt with on an individual basis, but it gave rise to interpretation problems in relation to energy efficiency actions by the public sector and relating to the renovation of buildings. In fact, it acted as a brake on energy efficiency actions in public buildings.

- As an EPC. This option is applicable to the majority of contracts affecting public buildings. For investments not to be included in the public accounts, the above-referenced guide carries out a comprehensive analysis of what an EPC involves and establishes the situations that have to arise in the contract for the investments to remain off the public balance sheet. The guide also contains a detailed annex so that the assessment can be made by each contracting body.

The three accounting options have a number of points in common:

- The investment must be made by the company awarded the contract, that is, the ESCO.

- The risk (as defined by Eurostat) must be borne by the ESCO.

- The contracts must be long-term contracts.

With regard to the innovations contained in the guide, it is worth highlighting the following significant points:

- The scope of the guide is limited exclusively to EPCs with investment.

- Special provision is made in the case of an ESCO that is a special purpose vehicle (SPV).

- Every aspect of an EPC is analysed and criteria are established to determine that they do not affect the accounting treatment, that they do affect it and mean that the amount of the investments counts towards debt and deficit or that they involve a moderate, high or very high risk.

- There are no limits on the amount of the investment, unless it relates to installations that make it possible to produce energy for self-consumption or that could involve the sale of energy to third parties, where a limit of 50% of the investment is established; although, in that case, accounting under the PPP rules could apply.

- The minimum duration must be 8 years.

- The investments can be transferred to the public authority, either at the end of the EPC or at some other earlier point.

- The ESCO must bear all of the construction risks (except authorisations and consents), both in relation to cost overruns or delays and in relation to the savings.

- The ESCO must bear the risk relating to the design, operation and management of the installations.

- The ESCO must carry out the maintenance. There must maintenance standards that allow the assets to function correctly and allow for penalties to be applied if those standards are not complied with.

- The amount of the savings (to which savings on taxes and energy generation must be added) must be greater than the operational payments made to the ESCO by the authority, with operational payments being understood to be the routine payments made to the ESCO by the authority and relating to the performance of the EPC assets. Neither the energy supply nor payments for other activities unrelated to the EPC assets form part of the calculation (they are not included in the payments). The guide allows for offsetting between buildings, as well as a grace period.

- There must be plans to measure and verify the savings, at least once a year.

- Payments may be index-linked.

- There can be no limit on the penalties imposed on the ESCO for failing to achieve the savings guaranteed in the contract, but nor can any limit be placed on the profits made by the ESCO as a result of achieving excess savings. It may, however, be agreed that up to a third of such profits can be transferred to the contracting authority.

- Assets may be transferred to the public authority, with or without payment.

- Public financing is possible, although special rules are established for accounting for it. It should be stressed that financing by the EU, the EIB or other international bodies is not considered public financing.

There are already various public authorities which have put in place model contracts that conform to these characteristics, both at national level (IDEA) and at the level of the Autonomous Communities (ICAEN or the regional government of Extremadura).

5.11. ARCHITECTURAL AND URBAN PLANNING CHALLENGES.

Energy efficiency is just one of many aspects which come together in buildings. Renovation cannot be considered only from the perspective of improving energy efficiency, but rather - as seen in section 5.1 of this chapter - it must look for synergies with conservation and accessibility. In this section, the challenges facing renovation in relation to architecture and habitability are also analysed, as well as the need to widen the focus from the level of the building to the level of urban planning, framing renovation actions within actions aimed at urban regeneration and transformation of the city. The relationship between renovation, architecture and the financing of actions by achieving added value in terms of urban development and other complementary mechanisms is analysed as well.

Figure 5.48. The building envelope as an outward image of housing's problems with habitability, energy efficiency, noise, etc.

Source: E. de Santiago.

5.11.1. Challenges and opportunities in architectural elements: architecture, energy efficiency and habitability.

The façade as outer skin.

The façade - as the element that usually represents the largest surface area of the building envelope - is the architectural element with the most potential from the point of view of improving energy efficiency, by installing insulation (internally or, better still - as it allows thermal bridging to be dealt with - externally) and renovating the joinery and glass of the openings or installing secondary glazing (which involves less work if it is done internally and significantly improves acoustic conditions). Its possibilities from an architectural point of view should also be taken into account, as it makes it possible to renovate and unify the outward appearance of a building, which has often deteriorated with the passage of time and the combined effect of disorderly individual actions. It should be borne in mind that the cheapest solutions (such as the external insulated façade system (EIFS) and others of that kind) may involve a loss of architectural richness and the qualities of the materials that existed previously (for example, exposed brick and - of course - stone). Other systems, such as ventilated façades, allow for greater versatility and richness in terms of finishes, but they involve considerably more cost, which would have to be assessed in each specific case. Particular consideration should also be given to the performance in relation to fire risk of new façade systems intended to improve energy efficiency.

Figure 5.49. Examples of improvement in the architectural quality and appearance of façades in renovation projects including improving the energy performance of the building envelope.

Sources: Top: Zaragoza Housing. Bottom: WWW.PUERTOCHICOSEMUEVE.BLOGSPOT.COM Puerto Chico Residents' Association, Q-21 Architects.

Roofing and flat roofs.

Roofing and flat roofs - as integral parts of the building envelope - not only offer the possibility of improving energy efficiency, they can also be converted into spaces for installing new heating and cooling systems (for example, heat pumps) and/or introducing renewable energy (solar panels, photovoltaic pergolas, etc.), either for on-site use (solar panels for DHW, solar photovoltaic energy for self-consumption, etc.) or even to make a profit by renting out or allowing the use of the space or selling the energy generated. From the architectural point of view, they also offer various possibilities that are not generally explored: spaces for community recreational or other uses (bicycle storage, community room, etc.), gardens, etc.

Figure 5.50. Illa Eficient plan for a city block with various proposals for the use of flat roofs, roofs and the interior courtyard.

Source: Habitat Futura and the Regional Government of Catalonia.

Of course, where urban planning rules allow it, they may also be used to increase the size of the building (by means of additional floors), which may allow financial benefits to be generated to finance the renovation actions.

In the case of blocks with interior courtyards, such as that shown in the image - a type of urban fabric typical of urban expansion areas - the interior of the block is a space that can be treated as a whole, where different proposals can be carried out.

Ground floors.

At times the ground floors of buildings are underutilised, as in the case of unoccupied commercial premises or arcades. Where urban planning rules allow it, such spaces can be enclosed and/or fitted out for use as dwellings, workplaces, community spaces or for caring for the elderly or young children, or even for small installations in places where there is a shortage of land.

In the case of multi-family residential blocks where there are already dwellings on the ground floor, those dwellings do not usually have independent access from the outside. Renovation could be an excellent opportunity to reconsider such access, improving not only the functionality of the dwellings that benefit directly, but also the security of the building by controlling the space adjacent to it, encouraging its use and avoiding it becoming degraded.

Balconies.

Even though enclosing balconies is, in general, specifically prohibited under urban planning rules, the reality is that, throughout Spain, such irregular actions have proliferated over many years, resulting in a very poor-quality urban landscape.

Figure 5.51. Examples of disorderly and irregular balcony enclosures. In the right-hand example, the percentage of enclosed balconies is such that it has become the norm, forming a central body of miscellaneous glazed galleries.

Source: E. de Santiago.

The majority of such actions are carried out on modest dwellings in order to increase a habitable area that was originally small and they may also serve as a thermal buffer zone or gallery in winter[118]. Proposing that they be dismantled, therefore, does not seem very realistic. Article 24.5 of the Recast Text of the Land and Urban Renovation Act (Royal Legislative Decree 7/2015, of 30 October 2015) allows 'the enclosure or glazing of balconies or terraces which already have a roof' where, by doing so, a reduction of at least 30 per cent in the building's annual energy demand for heating or cooling is achieved. That provision opens up the possibility of carrying out unitary interventions on façades, proposing treatments that unify them and improve the architectural quality of the building. Exclusively from the perspective of the urban scene, there are already some municipal councils that allow such enclosures, if they are done in a unitary manner as part of a joint project.

Figure 5.52. View of two buildings with balconies, which were originally symmetrical. The building on the right shows the result of the disorderly enclosure of balconies and the proliferation of heat pumps; the building on the left shows a unitary intervention to renovate the façade.

Source: Eduardo de Santiago.

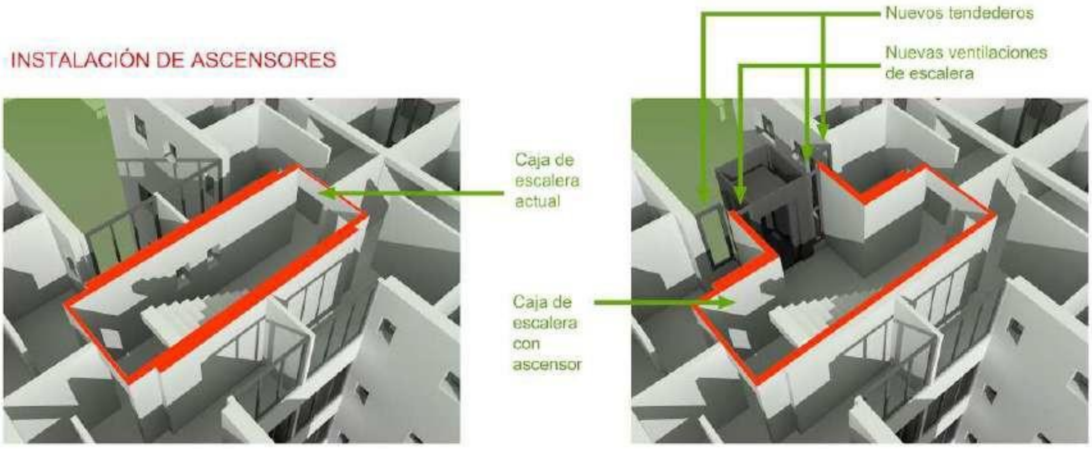
[118] In summer, on the other hand, if they are not appropriately protected, they may cause an overheating problem.

Increasing the useful floor area and improving the habitability of dwellings.

The data for the Spanish residential building stock indicate that dwellings built between the 1940s and the 1960s and the 1960s and the 1980s (more than 8 million, which is almost half of the total) have a fairly small average size: only a third of them is over 90 m^2 and almost half of all the dwellings is between 61 m^2 and 90 m^2. It is in these homes where, for the most part, the enclosure of balconies has occurred.

With the appropriate necessary changes to the urban planning rules, architectural renovation can contribute to a significant improvement in the habitability of these homes and to increasing their useful floor area: small increases in absolute terms - as occurs with the enclosed balconies - of the order of 6 m^2 to 10 m^2, can mean a significant improvement in relative terms. Such enlargements can occur in various different ways, for example, as illustrated in the image, taking advantage of the installation of the lift in the interior courtyard to reorganise kitchens and clothes lines, enlarging the former.

Figure 5.53. Top: Plan for the installation of a new lift in the interior courtyard, creating more space for the kitchen and making it possible to reorganise the kitchen and clothes line. Bottom: View of the kitchen before and after the renovation intervention.



	INSTALLATION OF LIFTS
	Current stairwell
	Stairwell with lift
	New clothes lines
	New staircase ventilation

Source: WWW.PUERTOCHICOSEMUEVE.BLOGSPOT.COM Puerto Chico Residents' Association, Q-21 Architects.

In other cases, such as the award-winning example of Lacaton and Vassal in France, the enlargement of a tower block all the way round its perimeter, using a prefabricated system, has been proposed. On a smaller scale, in the case of Lourdes Renove in Tudela, a smaller enlargement was carried out by extending the existing balconies. In the example of Puertochicosemueve in Madrid, the proposal was to demolish the existing enclosure all the way round its perimeter, incorporating the area of the balcony into the interior of the dwellings and adding a prefabricated exterior module.

Figure 5. 54. Transformation of 530 flats, buildings G, H and I, Grand Parc district - Lacaton & Vassal, Druot, Hutin. Top: Images of the exterior before and after the proposal. Bottom: Images of the space added to the existing volume.

Source: https://www.lacatonvassal.com/index.php?idp=80

Figure 5.55. Proposal to incorporate the existing continuous balcony into the interior and add a prefabricated exterior module with different possible uses.

	SPACE OF THE FORMER BALCONY INCORPORATED INTO THE DWELLING
	REMOVAL OF THE FORMER FACADE WALL
	SPACE ADDED TO THE DWELLINGS 1.2 m wide
	INTERCHANGEABLE CABINS hanging from a new structure attached to the building.
	Possible uses AT THE DISCRETION OF EACH USER.
	kitchen
	lavatory
	viewpoint
	balcony
	vertical garden
	Renovation with high-quality enclosures:
	INCORPORATION OF TERMAL INSULATION
	Renovation of installations
	Industrial construction systems:
	HIGH QUALITY AND FAST ASSEMBLY

Source: WWW.PUERTOCHICOSEMUEVE.BLOGSPOT.COM Puerto Chico Residents' Association, Q-21 Architects.

Figure 5.56. Enlargement of homes using the balcony space in the Lourdes Renove Tudela project. (Before and after.)

Source: NASUVINSA.

These small increases in floor area can lead to significant improvements in the habitability of many smaller dwellings or provide them with new spaces, such as a balcony or a terrace, and, therefore, can be very attractive incentives for the owners to renovate.

Layout of floors/uses[119].

The demand in terms of uses and the ways in which homes are now occupied are not the same as they were when they were built, such that, at times, the layout of the floors and the original dwelling type have become obsolete and barely functional. At times, urban planning legislation and, above all, the Commonhold Property Act, make the functional transformation of existing dwellings difficult, including processes such as division, combination, etc.

Figure 5.57. Prefabricated building in Rimavská Sobota (Slovakia) with the floor layout completely transformed - GutGut architects.

Source: https://www.plataformaarquitectura.cl

Accessibility.

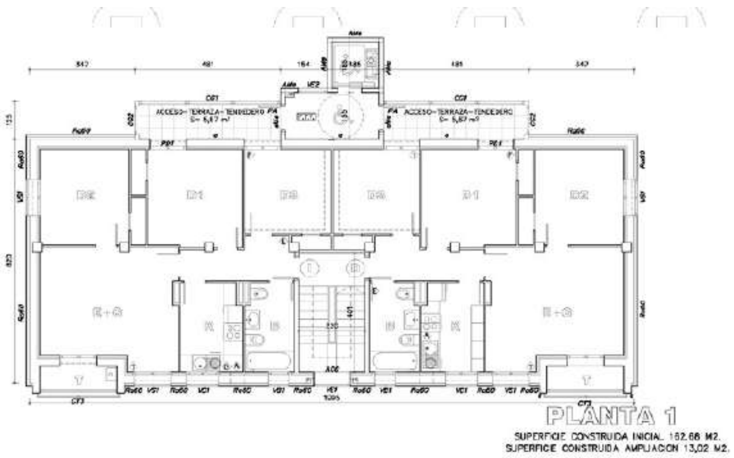
As discussed earlier, accessibility is the most important problem referred to by Spaniards in the Housing

[119] See, in this regard, the series of books ‘ReHabitar en nueve episodios’, published by the Directorate-General for Architecture, Housing and Land. Publications Centre, Ministry of Development. (2010)

Barometer of the Centre for Sociological Research (CSR). Very often, the installation of lifts is only possible on the outside of buildings and involves using public space, requiring the application of the relevant planning provisions. Article 24.4 of the Recast Text of the Land and Urban Renovation Act 2015 (Royal Legislative Decree 7/2015, of 30 October) already provides that ‘such areas of open or public space as are indispensable for the installation of lifts or other elements that ensure universal accessibility, as well as common areas for private use, such as lobbies, landings, roof space, projections and porches, whether they are located on the ground, below the ground or projecting from the building, may be occupied, when no other solution is technically or financially viable and provided that the functionality of the open spaces, facilities and other elements in the public domain is ensured’ and that, to that end, ‘land-use planning instruments shall ensure the application of [that] basic rule ... either by allowing those areas not to count for the purposes of the permitted building size or for the purposes of minimum distances to boundaries, other buildings or the public highway or building boundaries relative to the public highway, or by applying any other technique which, in accordance with the applicable legislation, achieves the same end’.

From the point of view of habitability, depending on whether or not the existing staircase is demolished, actions to improve accessibility can entail reconsidering how the dwellings are accessed, which can also offer new possibilities from the architectural perspective (galleries, extensions, etc.).

Figure 5.58. Renovation of a building with the installation of a lift on the outside (without demolishing the staircase) and reorganising access to the homes (double access and gallery). Alférez Rojas Group. C/ Enrique Ossó.



	BALCONY ACCESS
	1ST FLOOR
	INITIAL GROSS FLOOR AREA 162.66 M2
	ENLARGEMENT OF GROSS FLOOR AREA 13.02 M2

Source: Zaragoza Housing.

Figure 5.59. Renovation of a building with the installation of a lift on the outside (with the staircase being demolished) and reorganising the clothes drying area. Francisco Franco Group.

Source: Zaragoza Housing.

In any event, the installation of lifts offers an important lesson to be borne in mind in order to promote energy renovation work: with all of the financial difficulties that they usual entail and their considerable cost per home - well above that of energy renovation - such work is usually thought to be justified in itself on the basis of the improvement in accessibility, without it being necessary to find any additional justification in terms of financial returns or direct profitability for the owners to decide to undertake it.

Architectural integration of heat pumps.

As a simple stroll through any Spanish city will confirm, as well as the irregular enclosure of balconies, another element that has contributed significantly to the deterioration in the appearance of the urban environment is the disorderly installation of numerous heat pumps on the façades of buildings, even in contravention of the municipal by-laws that prohibit or regulate it. The anticipated future deployment of a large number of new heat pumps implies the need to propose, in advance, viable and realistic solutions to mitigate the problem of their architectural integration into the buildings.

Figure 5.60. Top: Example of the proliferation of heat pumps on a historic façade. Bottom: Example of the grouping of heat pumps on the roof of a historic building, removing them from the façade.

Source: E. de Santiago.

Figure 5.61. Examples of poor integration of heat pumps on residential blocks built between 1960 and 1980.

Source: E. de Santiago.

Architectural integration of bioclimatic devices.

Bioclimatic devices (shading devices, canopies, pergolas, glazed galleries, etc.) can also play a very important role in the architectural appearance of buildings.

Figure 5.62. Example of correct architectural integration of bioclimatic devices (canopies).

Source: E. de Santiago.

Architectural integration of renewable energy.

As in the case of heat pumps, the anticipated deployment of solar energy must be accompanied by the correct architectural integration of the installations.

Figure 5.63. Image illustrating the problems relating to the architectural integration of self-consumption equipment in existing multi-family residential buildings.

Source: E. de Santiago.

5.11.2. Beyond remodelling public spaces: the potential for urban regeneration to transform cities.

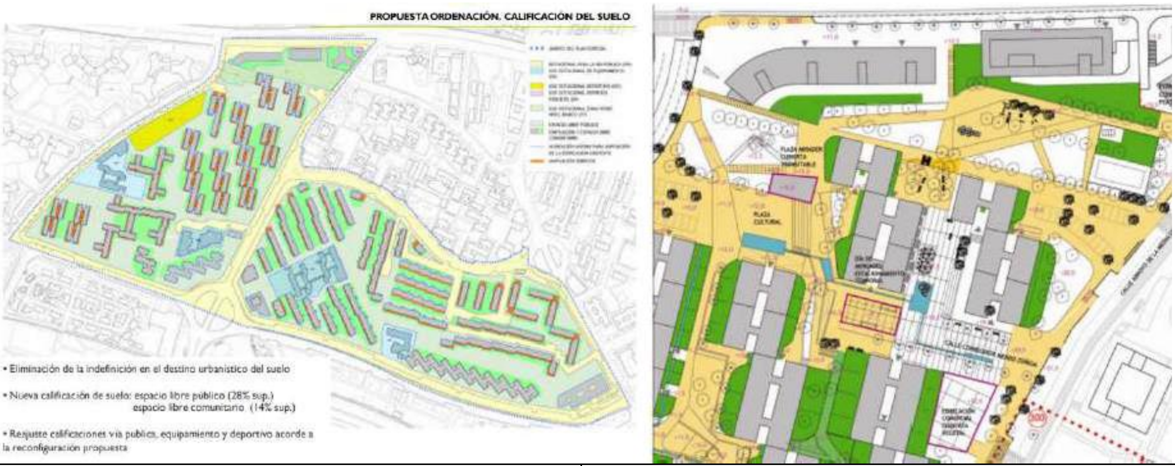
Much of the urban fabric that is formed of free-standing blocks constructed in the second half of the 20th century continues to pose problems in relation to urban development. It is true that most of the original shortcomings in terms of urban planning (lack of paving, insufficient provision of infrastructure and urban services) were corrected by the first democratic municipal councils and also that in the 1980s and 90s a significant effort was made to provide those outlying districts with basic facilities (green areas, sports facilities, schools, etc.), but, in many of them, some of their original deficiencies still remain.

Figure 5.64. Problems with public spaces between blocks: shortcomings in urban planning, occupation by cars, lack of vegetation.

Source: E. de Santiago.

One problem that is typical of urban fabric formed of free-standing blocks is the lack of definition of the spaces between the blocks, which makes it difficult to use, maintain and control them correctly. In many cases, such spaces were conceived, following the theoretical principles of the Modern Movement, as a '*tapis vert*' (green carpet) without a clear function and their current use is residual or is limited merely to parking vehicles. There are some innovative projects that propose urban regeneration actions including the remodelling and reorganisation of such spaces between blocks, reducing the amount of space dedicated to cars and enlarging the pedestrian areas, increasing or rationalising the landscaped areas, or fencing off part of the spaces for community uses such as vegetable gardens or play areas, sports fields, etc.

Figure 5.65. Proposals for reorganising public spaces in the Moratalaz district of Madrid.



	PLANNING PROPOSAL. CLASSIFICATION OF THE LAND.
	Eliminating the lack of definition in the planned use of the land.
	New classification of land as public open space (plus 28%) and community open space (plus 14%).
	Adjustment of classifications as public highway, installations and sports facilities, according to the proposed reconfiguration.

Source: J. Pozueta, P. Lamíquiz, E. Higueras.

There are also examples in which the remodelling of public space is liked to the management of flows of materials and energy, such as the installation of photovoltaic pergolas in public spaces or the introduction of district networks that produce energy in the local area itself.

Figure 5.66. Photovoltaic pergolas in the Morvedre garden, Valencia.

Another fundamental aspect to take into account is the adaptation of streets and public spaces to climate change scenarios, given their potential for improvement in relation to microclimatic environmental conditions using mitigation strategies such as the use of bioclimatic shading techniques (trees, canopies, etc.), improving evapotranspiration (presence of water, vegetation) or making use of permeable paving.

In short, the most important thing is to bear in mind that it seems necessary to go beyond interventions at the house-by-house or building-by-building level, planning urban regeneration actions which, moreover, as defined by Article 2 of the Recast Text of the Land and Urban Renovation Act, 'when they draw together social, environmental or economic measures framed within a comprehensive and unitary administrative strategy, shall also be of an integrated nature'. To that end, therefore, it is necessary to frame area-level actions within broader strategies at the municipal level - appropriately coordinated with urban planning, since such planning needs to change its approach to think more in terms of the consolidated city - and go beyond strict partial approaches focused exclusively on buildings, responding to the many social, environmental and economic challenges that face neighbourhoods, especially the most disadvantaged, where action and public leadership will, without doubt, be essential.

5.11.3. Increasing floor area ratios to contribute to the financing of actions.

Increasing floor area ratios in the consolidated city as a means of generating added value in terms of urban development has been used - with varying degrees of success - on many occasions: in some cases, working within the floor area ratio and number of stories permitted by the planning rules, and in others, increasing those parameters by means of an ad hoc amendment in order to generate added value. Since the second half of the 20th century, actions of this kind have been carried out in the historic centres and expansion areas of Spanish cities, but they have frequently been carried out from a purely speculative perspective, without the added value generated having benefited the community in any way[120]; thus, in many cases, the end result has been isolated increases in urban density or changes in use that have directly benefited only the promoters of the actions.

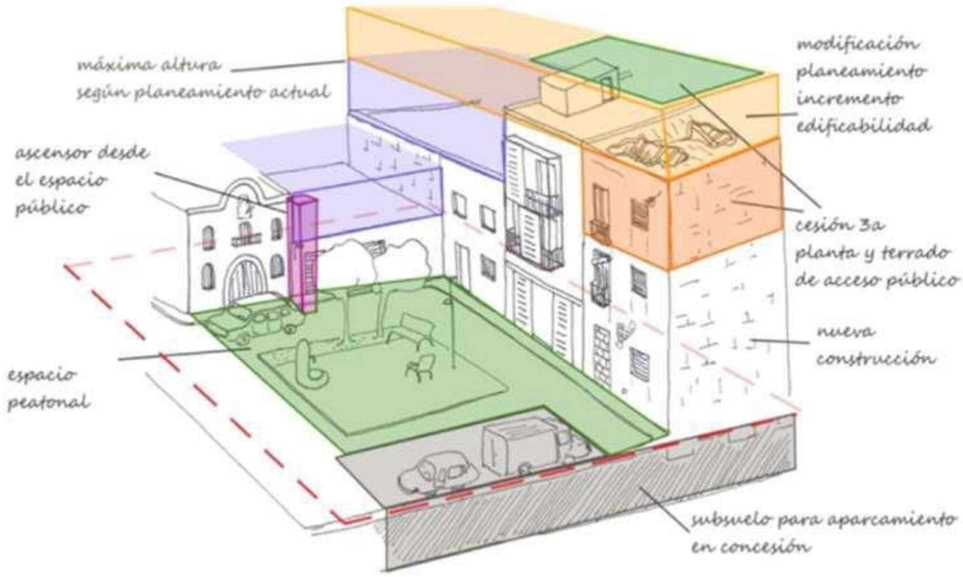
[120] Remember that this requirement arises from Article 47 of the Spanish Constitution of 1978 and that, prior to that, it dis not apply.

Figure 5.66. Example of a conventional increase in floor area ratio in a historic area.

Source: E. de Santiago.

Law 8/2013, on urban restoration, regeneration and renovation, made an attempt at regulating this complex tool of the mechanisms for generating urban development added value in urban regeneration operations (in particular, in outlying districts and areas where the urban fabric is formed of free-standing blocks, where the financial viability of the actions is usually complicated, unless they are carried out with the owners' resources), seeking the reinvestment of such added value in the actions themselves and for the benefit of those living in the area concerned. To that end, in Article 11, it introduced the concept of a Financial Viability Report, with the aim of 'paying closer attention to financial equilibrium, to the profitability of the operation and to not exceeding the limits of the legal duty of conservation' by means of the analysis of the 'changes proposed with regard to increasing floor area ratios or density, or the introduction of new uses, as well as the possible use of the land, above and below ground, including projections from buildings, in a differentiated manner'.

Figure 5.67. Interpretative diagram of the possibilities opened up by Law 8/2013 with regard to urban development added value in order to self-finance actions.



	maximum height under current planning rules
	lift from public space
	pedestrian space
	planning amendment to increase floor area ratio
	permission for 3rd floor and public roof terrace

	new build
	underground parking run as a concession

Source: Anna Fabregat.

Constitutional Court Judgment 143/2017, of 14 December, declared the content of that Financial Viability Report null and void - for encroaching upon the competences of the Autonomous Communities - but not the basic provisions regulating it, which remain in effect in the current Article 22.5 of the Recast Text of the Land and Urban Renovation Act (Royal Legislative Decree 7/2015, of 30 October), which states that 'the planning and execution of actions in the urban environment, whether or not they involve urban transformation, shall require the preparation of a report ensuring their financial viability, in terms of profitability, compliance with the limits of the legal duty of conservation and an adequate balance been the benefits and burdens of the action in question, for the owners included in its operational scope'.

Figure 5.68. Examples of energy renovation with a floor added to a flat roof using a light wooden structure, to contribute to the financing. Rakuunantie, Helsinki.

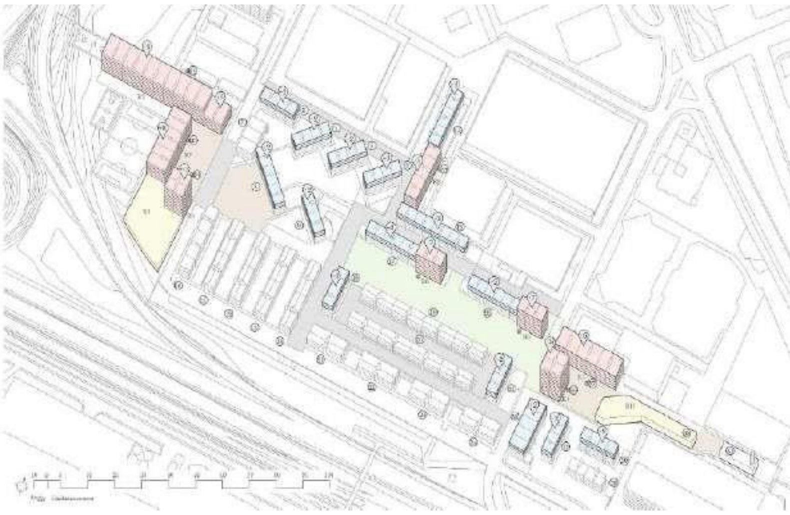
Source: Koskisen, Finland.

At the present time and in the absence of an innovative approach to this issue by the Autonomous Communities - which, according to the above-mentioned judgment have competence in the matter - beyond the basic provisions referred to above, there is a vacuum which, in practice, makes them difficult to apply for municipal councils interested in proposing actions including such mechanisms.

Figure 5.59. Proposal (unrealised) for urban regeneration action with increases in floor area ratio contributing to the financing of the operation. Urban area of interest in the Alférez Rojas district of Zaragoza.

Source: ACXT-IDOM and Zaragoza Housing.

Figure 5.60. Proposal (unrealised) for urban regeneration with financing through increases in floor area ratio relating to existing buildings (blue) and new-build projects (pink) for the Barrio del Aeropuerto (airport) district of Madrid.



Source: F.J González, S. Moreno Soriano, J. M. Márquez Martinón (2019)[121].

As can be seen in the images, this approach has also been explored in other countries as a possible complementary mechanism for financing building renovation actions, and also in combination with increases in the floor area ratio of the existing dwellings for the benefit of the occupants.

[121] F.J González González, S. Moreno Soriano, J. M. Márquez Martinón (2019) *'Re-densification and cooperativism as instruments for the sustainable urban regeneration of vulnerable districts of Madrid.'* Minutes of the 3rd ISUF-H International Congress, 18-20 September 2019, Guadalajara (Mexico).

Figure 5.61. Examples of building renovation proposals with increases in the floor area ratio on the façades of the existing dwellings ('parasite' modules added to the existing building volumes) and the occupation of roofs to generate added value, helping to finance the operation.

Right: Gammenlbacka, Porvoo, Finland. (Image source: Sara Pietilä). Left: Source Architecture Péllegrin and http://www.planete-surelevation.com/comment-surelever/

5.11.4. Regulatory and urban planning aspects.

The introduction of innovative solutions such as those described above, on many occasions, clashes with the existing legislation. In addition to what has been said regarding urban development added value, some of the barriers identified are as follows:

The Commonhold Property Act, conceived in 1960 in a context very different from the present one, makes it difficult to change the existing distributions of building types, or to make them more flexible, and it also makes it difficult to reach agreements regarding common elements (alterations to adjoining dwellings, the sale or letting of the caretaker's accommodation, occupation of flat roofs, etc.)

Traditionally, urban planning legislation prevented or significantly complicated - requiring ad hoc amendment - some of the actions described, such as the installation of lifts or insulation externally. However, following Law 8/2013 (currently Article 24.5 of the Recast Text of the Land and Urban Renovation Act, Royal Legislative Decree 7/2015, of 30 October 2015), it is permissible to carry out certain types of work on buildings[122], making the application of the planning parameters more flexible (for example, official building boundaries or the calculation of floor area ratios), where 'a reduction of at least 30 per cent in the building's annual energy demand for heating or cooling is achieved', for example:

'a) the installation of thermal insulation or ventilated façades on the outside of the building, or the enclosure or glazing of balconies or terraces which already have a roof.

b) the installation of bioclimatic devices attached to façades or roofs.

c) carrying out the work and putting in the installations necessary for centralisation or to provide common energy installations and solar collectors or other sources of renewable energy, on façades or roofs...'.

Finally, actions relating to the spaces between blocks are also complicated, in many cases because the ownership of those spaces is not even clear and, in others, because - being publicly owned - it is difficult to come up with simple formulas for their temporary transfer or self-management by the residents (vegetable gardens, community areas, etc.).

[122] *'Land-use planning instruments shall ensure the application of the basic rule established in the preceding paragraph, either by allowing those areas not to count for the purposes of the permitted building size or for the purposes of minimum distances to boundaries, other buildings or the public highway or building boundaries relative to the public highway, or by applying any other technique which, in accordance with the applicable legislation, achieves the same end.'*

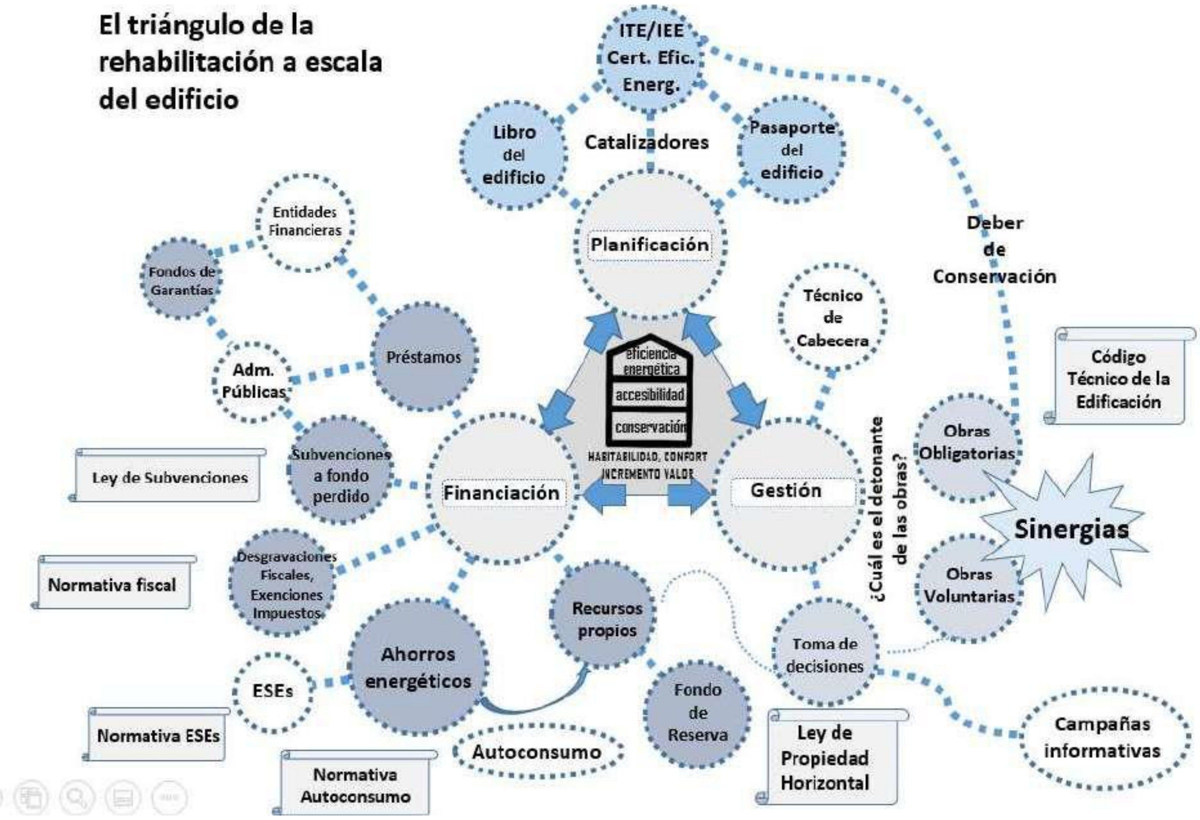
Figure 5.62. The Can Cadenes urban vegetable garden, Barcelona.

Source: Jordi Soteras. El Mundo (left). Barcelona City Council (right).

5.12. THE NEED TO TAKCLE ALL OF THE CHALLENGES FROM AN INTEGRATED PERSPECTIVE.

All of the above challenges must be tackled from an integrated perspective. The diagrams below propose a reading of the interrelationships between the main factors influencing renovation at the level of the building, from the municipal perspective and from the perspective of the Autonomous Communities, based on three key elements - planning, management and financing - which make up the renovation 'triangle'.

Figure 5.63. The renovation triangle at the level of the building.

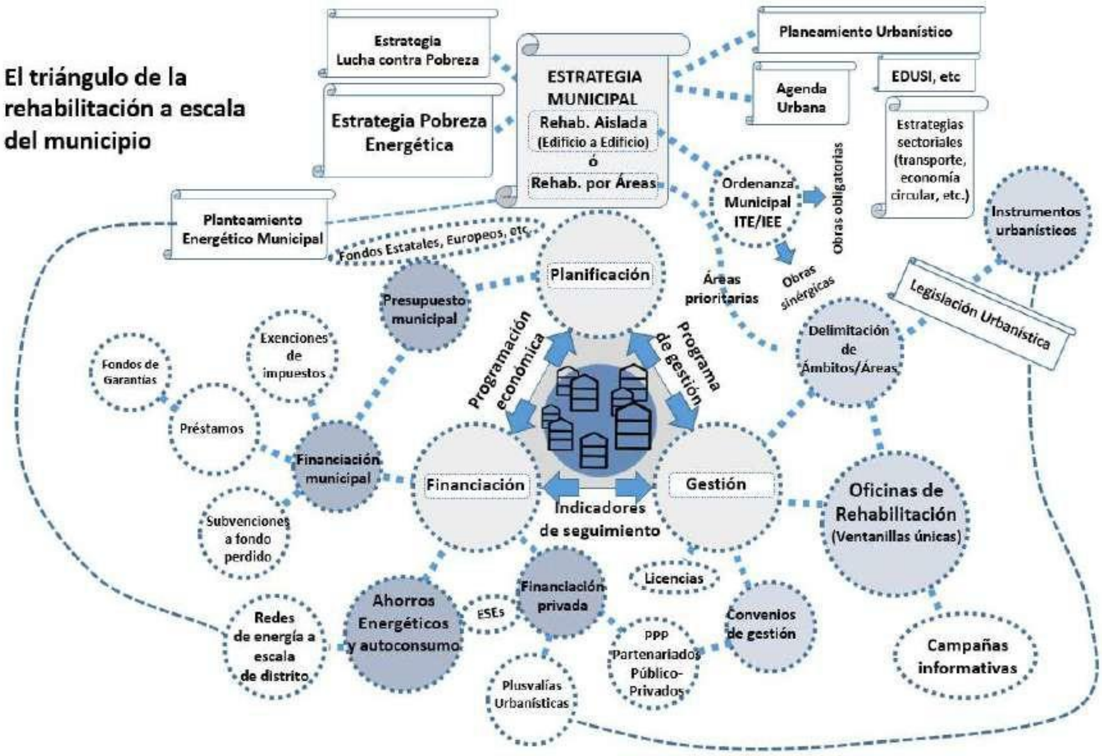


	The renovation triangle at the level of the building
	ITE/IEE Energy Perf. Cert.
	Building manual
	Catalysts

	Building passport
	Planning
	Financial institutions
	Guarantee funds
	Public Auth.
	Loans
	Non-refundable subsidies
	Tax relief, tax exemptions
	ESCOs
	Energy savings
	Subsidies Act
	Tax rules
	Rules on ESCOs
	Rules on self-consumption
	Own resources
	Self-consumption
	Reserve fund
	energy efficiency
	accessibility
	conservation
	HABITABILITY, COMFORT, INCREASE IN VALUE
	Technical advisor
	Duty of conservation
	Management
	What is the trigger for the work?
	Mandatory work
	Voluntary work
	Synergies
	Building Technical Code
	Information campaigns

Source: MITMA.

Figure 5.64. The renovation triangle at the municipal level.

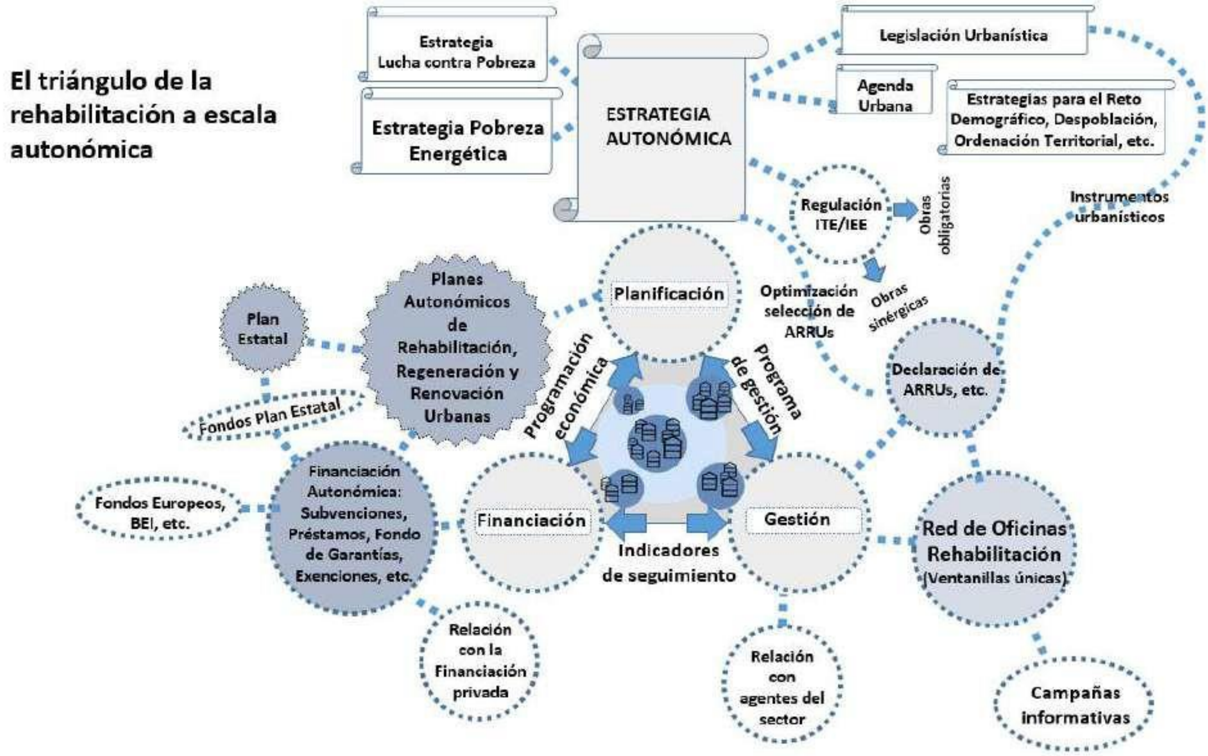


	The renovation triangle at the municipal level
	Strategy to Combat Poverty
	Energy Poverty Strategy
	MUNICIPAL STRATEGY
	Isolated Renov.
	(Building by Building)
	or
	Area Renov.
	Urban Planning
	Urban Agenda
	EDUSI, etc.
	Sectoral strategies (transport, circular economy, etc.)
	ITE/IEE municipal by-law
	Mandatory work
	Planning instruments
	Priority areas
	Synergistic work
	Urban Planning Legislation
	Demarcation of scope/areas
	Management programme
	Planning
	Municipal budget
	Financial programme
	State funds, European funds, etc.
	Municipal budget
	Municipal Energy Plan
	Tax exemptions
	Guarantee funds
	Loans
	Municipal financing
	Non-refundable subsidies
	District energy networks
	Financing

	Indicators for monitoring
	Management
	Consents
	ESCOs
	Private financing
	PPP public-private partnerships
	Management agreements
	Renovation offices (one-stop shops)
	Information campaigns
	Urban development added value

Source: MITMA.

Figure 5.65. The renovation triangle at the level of the Autonomous Communities.



	The renovation triangle at the level of the Autonomous Communities.
	Strategy to Combat Poverty
	Energy Poverty Strategy
	REGIONAL STRATEGY
	Urban Planning Legislation
	Urban Agenda
	Strategies for the Demographic Challenge, Depopulation, Regional Planning, etc.
	ITE/IEE regulation
	Mandatory work
	Planning instruments
	Synergistic work
	Optimisation of URRA selection
	Demarcation of URRAs, etc.
	Management programme
	Planning
	Regional Plans for Urban Restoration, Regeneration and Renovation
	Financial programme
	State Plan

	State plan funds
	Guarantee funds
	Municipal Energy Plan
	Tax exemptions
	European funds, EIB, etc.
	Regional Financing: Subsidies, Loans, Guarantee Funds, Exemptions, etc.
	Financing
	Non-refundable subsidies
	Indicators for monitoring
	Management
	Relationship with sector actors
	Information campaigns
	Network of renovation offices (one-stop shops)

Source: MITMA.

CHAPTER 6. STRATEGIC VISION AND OBJECTIVES FOR 2030, 2040 AND 2050.

6.1. OBJECTIVES IN THE RESIDENTIAL SECTOR.

6.1.1. Hypothesis and general objectives relating to energy saving and emissions in the residential sector.

The modelling of the residential building stock carried out by MITMA takes as its starting point the latest population[123] and household[124] data available at the time of drafting this ERESEE, to which the demographic changes considered by the European Commission in the Ageing Report[125] and the household projection produced by the INE[126] were applied.

The result of the population change estimates indicates an increase of 572 157 inhabitants by 2030 and 2 705 113 in the entire 2020-2050 period, which - together with the corresponding estimates of future changes in household size[127] - implies the formation of 1 245 852 households by the year 2030 and 3 221 690 by 2050.

Using this data, a model of the development of the residential building sector has been constructed, in which the increase in population and the reduction in the average household size result in the formation of a certain number of new households annually, with the consequent demand for housing, which is satisfied either by building new homes or by using existing (second or empty) homes as main residences. Taking into account - as well as these flows - the number of homes demolished annually, a general model of annual flows of homes added and removed has been developed, which is represented in summary form in the graph below.

[123] 2018 figure: INE official population figures resulting from the review of the municipal register of inhabitants as at 1 January. 2019 figure: INE population recorded in the municipal register as at 1 January 2019 (provisional figure).

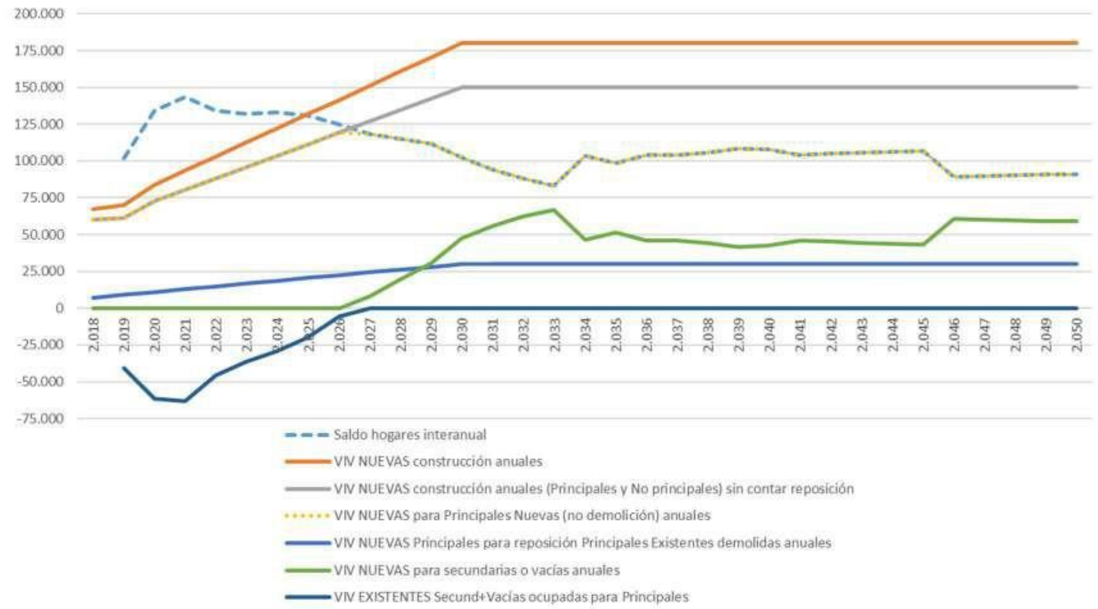
[124] Figure: 2018 Continuous Household Survey (INE).

[125] The increases in population per five-year period are obtained using the data for 2020, 2025, 2030, 2035, 2040, 2045 and 2050 from the Annual Ageing Report of the European Commission. Those increases are added to the latest population data available from the INE, which are those from the municipal register for 2018 and 2019. For 2019-2020, the increment provided by the Ageing Report for the decade 2020-2030 is used.

[126] The household data are based on the latest figures available from the Continuous Household Survey (2018). The data for the 2019-2033 series are those from the INE's 2018-2033 series of household projections. Between 2033 and 2050, the household figure is calculated by extrapolating the average annual rate of reduction in household size recorded over the five years prior to each year.

[127] See previous note.

Figure 6.1. Model of changes in the residential building sector and housing flows.



	200 000
	-25 000
	Year-on-year household balance
	NEW DWELLINGS annual construction
	NEW DWELLINGS annual construction (main and non-main) excluding replacement
	NEW DWELLINGS for new main dwellings (no demolition) per year
	NEW main DWELLINGS to replace existing main dwellings demolished per year
	NEW secondary or empty DWELLINGS per year
	EXISTING secondary and empty DWELLINGS occupied as main dwellings

	2 020	2 021-2 030	2 030	2031-2040	2 040	2041-2050	2 050	2021-2050
POPULATION	47 051 507	572 157	47 623 664	1 155 000	48 778 664	977 956	49 756 620	2 705 113
HOUSEHOLDS	18 771 653	1 245 852	20 017 505	996 895	21 014 400	978 943	21 993 343	3 221 690
HOUSEHOLD SIZE	2.51		2.38		2.32		2.26	
TOTAL DWELLINGS	25 147 124	1 152 529	26 299 653	1 500 000	27 799 653	1 500 000	29 299 653	4 152 529
TOTAL SECOND + EMPTY DWELLINGS	6 375 471	-93 323	6 282 148	503 105	6 785 253	521 057	7 306 310	930 839
% SECOND + EMPTY DWELLINGS	25.35	-8.10	23.89	33.54	24.41	34.74	24.94	
TOTAL MAIN DWELLINGS	18 771 653	1 245 852	20 017 505	996 895	21 014 400	978 943	21 993 343	3 221 690

Sources: MITMA based on statistics from MITMA, INE, European Commission Ageing Report, PNIEC.

On the basis of the current figures for the production of new homes (around 70 000 per year), it is estimated that there will be progressive growth in the annual production volume until the sector stabilises at around 180 000 units/year from 2030[128]. It is considered that these new dwellings would be mainly used to cover the needs derived from the balance of households (around 100 000), that another significant portion would be used as secondary dwellings (around 50 000[129]) and a further 30 000 would correspond to the replacement of existing

[128]As will be seen below, in combination with the hypothesis of stabilisation of renovation from 2050 onwards at around 150 000 dwellings per year, the ratio between new housing production and renovation would be close to a balance similar to the European average.

[129]This volume of newly built secondary dwellings is not relevant for the purposes of the ERESEE (since, on the one hand, from 2020 onwards, new dwellings would already be Nearly Zero Energy Buildings and, on the other hand, it has been assumed that heating consumption is concentrated in main dwellings), with secondary dwellings being shown in the graph for reference only.

main dwellings due to demolition[130].

Finally, this modelling of the total figures is also broken down by region on the basis of the hypothesis relating to households at the provincial level from the INE[131] projections, which makes it possible to have a regionalised model of the changes in the residential building stock and the flows of homes added to and removed from it. In that regard, it should be noted that, although no regionalised estimate has been produced of the possible flows with a net-zero result relating to households leaving certain current main residences (as would result, for example, from the current process of depopulation in the Spanish interior) to occupy second or empty homes in other areas, the regionalisation of the newly built homes, extrapolating the available trend data, is sufficiently comprehensive to be able to absorb this phenomenon without its dynamic affecting the numbers of renovated homes, with are the subject of this strategy.

6.1.2. General objectives relating to energy saving and emissions in the residential sector.

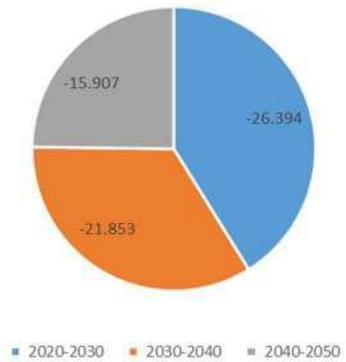
The Long-term Strategy (LTS) for a Modern, Competitive and Climate-Neutral Spanish Economy in 2050 is the strategic planning instrument that, in Spain, establishes the energy-saving and emissions targets for all economic activities, including the buildings sector.

Once adapted in line with the household trajectory considered by MITMA for the 2020 ERESEE, the estimated energy consumption data in the residential sector and the corresponding saving targets are as follows:

Figure 6.2. Final energy consumption and savings in the residential sector (excluding non-energy uses) for the LTS 2050 target scenario (GWh).

Final energy consumption in the residential sector (excluding non-energy uses) for the LTS target scenario (GWh)				
	2020	2030	2040	2050
Fossil fuels	72 448	47 465	21 995	-
Electricity	68 823	64 403	78 561	88 110
Renewable energy	31 148	34 157	23 627	20 155
Total	**172 419**	**146 025**	**124 172**	**108 264**

Final energy savings in the residential sector (excluding non-energy uses) for the LTS target scenario (GWh)				
	2020-2030	2030-2040	2040-2050	2020-2050
Fossil fuels	- 24 983	- 25 470	- 21 995	- 72 448
Electricity	- 4 420	14 159	9 548	19 287
Renewable energy	3 009	- 10 530	- 3 472	- 10 993
Total	**- 26 394**	**- 21 853**	**- 15 907**	**- 64 154**



Source: MITMA, based on the LTS 2050 (Long-term Strategy for a Modern, Competitive and Climate-Neutral Spanish Economy in 2050).

The cumulative target for 2050 (-64 154 GWh) is equivalent to a reduction of 37.3% compared to consumption in 2020 and, as can be seen in the graph above, the savings accumulate significantly in the first part of the period, with 41.1% occurring between 2020 and 2030 (-26 394 GWh), 34.1% between 2030 and 2040 and, finally, 24.8% between 2040 and 2050. Nevertheless, the percentage saving in each decade in relation to its starting point is

According to the estimates made, until 2026 the needs relating to the formation of new households will be in excess of the production of new homes, such that it would be necessary to occupy second homes (either empty ones or reducing the stock) as main residences. From that date onwards, the estimates indicate a surplus in the production of new homes in relation to the needs relating to the formation of households, which are those regarded as new second homes.

[130] On the basis of the current demolition figures (under 10 000), it is hypothesised that the replacement of homes will increase to around 30 000 a year between 2030 and 2050, assuming the obsolescence of a percentage of the residential building stock each year equivalent to 1.2 homes per 1 000 existing homes.
In total, this hypothesis would involve the renovation of around 3 million homes up to 2050, which, for the purposes of the ERESEE (given the requirements of the CTE building regulations for new homes) would also be nearly zero-energy buildings from the moment they were built.

[131] Supplemented with the relevant hypotheses relating to the percentage distribution of single-family and multi-family dwellings and floor areas, based on the available historical series produced by MITMA.

similar: the saving target of -26 394 GWh for the decade 2020-2030 implies a reduction of 15.7% compared to consumption in 2020; for the decade 2030-2040 it is -15.0% compared to 2030; and for 2040-2050 it is -12.5% compared to 2040.

As regards emissions, the data from the LTS 2050, once adapted in line with the household trajectory considered by MITMA, are those in the table below, showing a reduction in emissions of 98.8% compared to 2020 or, in other words, practically full decarbonisation by the target year.

Figure 6.3. Projected CO2 emissions in the LTS 2050 target scenario.

Projected emissions in the LTS scenario				
(Units: thousands of tonnes of CO2 equivalent)	2020	2030	2040	2050
Residential	17 044	10 725	4 854	201

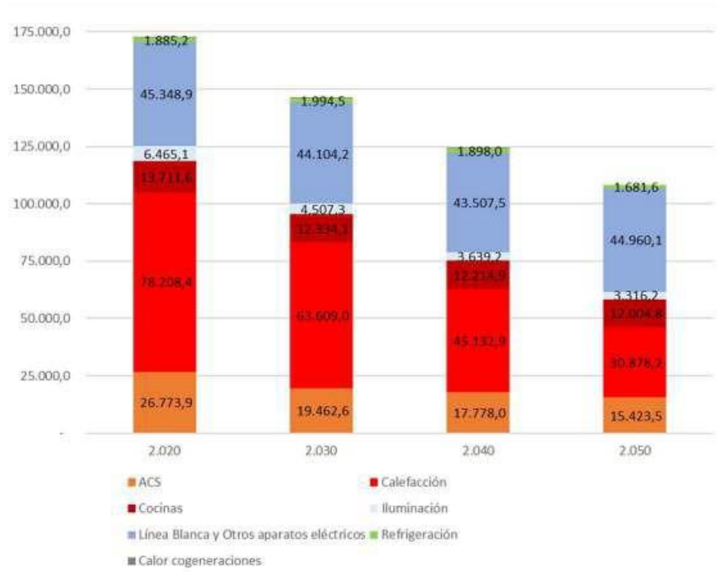
Source: MITMA, based on the LTS 2050 (Long-term Strategy for a Modern, Competitive and Climate-Neutral Spanish Economy in 2050).

This yields targets of -6 319 thousand tonnes of CO2 for the period 2020-2030, -5 871 for 2030-2040, -4 653 for 2040-2050, and, finally, -16 843 thousand tonnes of CO2 for the whole 2020-2050 period. The distribution of the total target by decade is even more homogeneous than in the case of energy savings: by 2030, 37.5% of the total saving target for 2050 should be achieved; between 2030 and 2040, 34.9% should be achieved; and, finally, for the last decade there would be 27.6% remaining.

6.1.3. Energy-saving targets according to use in the residential sector.

The TIMES-Sinergia modelling used for the LTS 2050 allows the general objectives for the residential buildings sector to be disaggregated, differentiating between the targets relating to heating, DHW, cooling, electrical appliances, stoves and lighting. An indication of the changes in consumption according to use is shown in the following graphs:

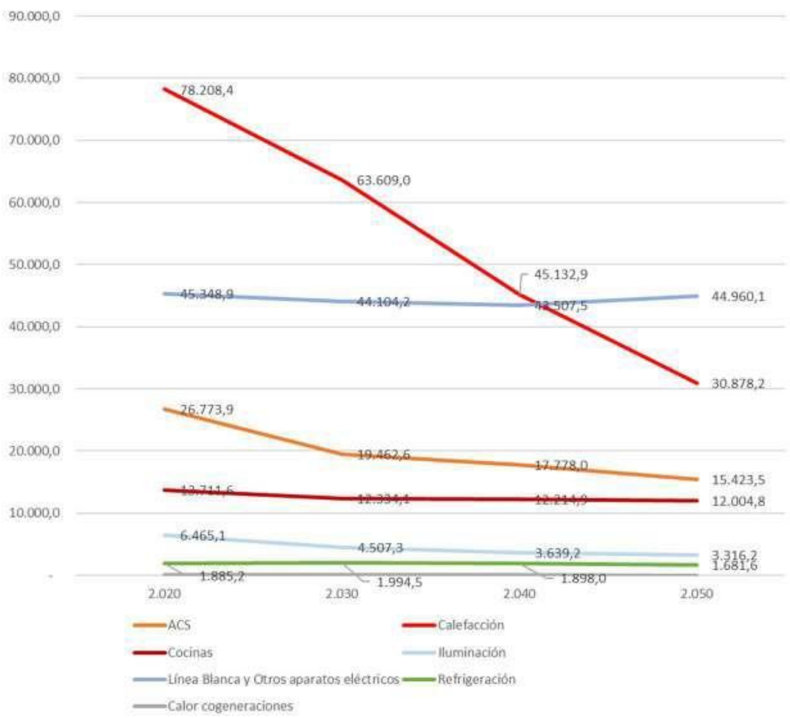
Figure 6.4. Model of the changes in energy consumption in the residential sector (GWh) in the period 2020-2050 and its distribution by decade.



	175 000.0
	1 885.2
	DHW
	Stoves
	White goods and other electrical appliances
	Heat cogeneration
	Heating
	Lighting
	Cooling

Source: MITMA, based on MITERD (TIMES-SINERGIA model for LTS 2050).

Figure 6.5. Changes in energy consumption for each use in the residential sector (2020-2050). (GWh).



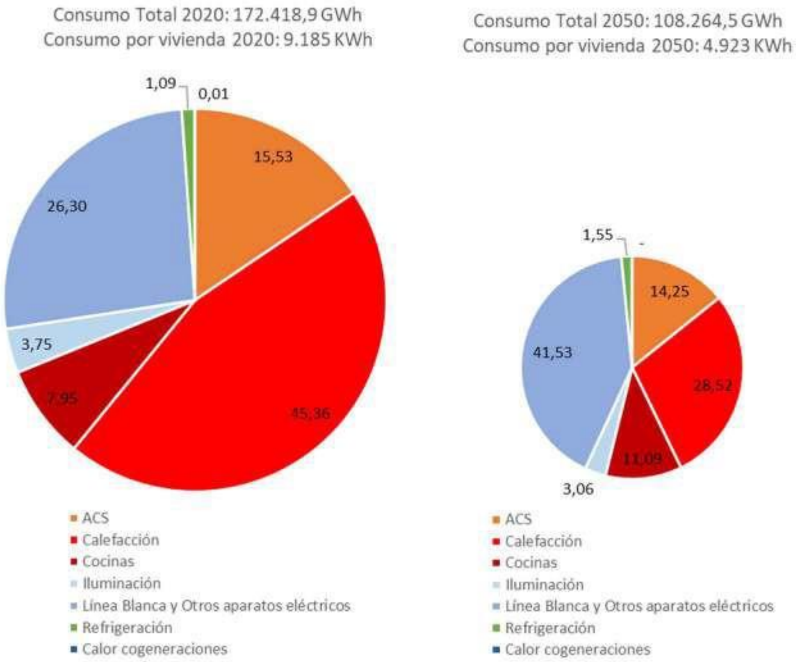
	DHW
	Stoves
	White goods and other electrical appliances
	Heat cogeneration
	Heating
	Lighting
	Cooling

Source: MITMA, based on MITERD (TIMES-SINERGIA model for LTS 2050).

As can be seen, the most significant conclusion from the above graphs is that estimated consumption relating to cooling, stoves and electrical appliances remains practically constant over time (with slight reductions of 10.8%, 12.4% and 0.9%, respectively), since it is thought that the savings resulting from more efficient equipment in the future will be offset by the larger amount of domestic equipment that there is expected to be for those uses (penetration in a larger number of households and an increase in the number of pieces of equipment or electrical appliances). Consequently, the anticipated savings are concentrated, to a limited extent, in lighting (where estimated consumption in 2050 is approximately half that of 2020) and, above all, in the uses of heating and DHW, with those three uses making up 96.4% of the total savings.

In particular, heating would go from 78 208.4 GWh in 2020 to 30 878.2 GWh in 2050, meaning a saving of 47.330,2 GWh (that is, a reduction in consumption of 48.7% compared to 2020), which represents as much as 73.8% of the total 2020-2050 saving target (64 154 GWh) for the residential sector. For its part, DHW would produce savings between 2020 and 2050 of 11.350.5 GWh, which would mean a decrease of 42.4% in relation to the consumption for DHW in 2020 or 17.7% of the total saving target for all uses.

Figure 6.6: Percentage distribution by use of the energy consumed in the residential sector (2020 and 2050). (%)



	Total consumption 2020: 172 418.9 GWh
	Consumption per dwelling 2020: 9 185 kWh
	Total consumption 2050:108 264.5 GWh
	Consumption per dwelling 2050: 4 923 kWh
	DHW
	Heating
	Stoves
	Lighting
	White goods and other electrical appliances
	Cooling
	Heat cogeneration

Source: MITMA, based on the TIMES-Sinergia modelling of MITERD for LTS 2050.

The above graph illustrates the change in the relative weight of each use in relation to total consumption in the residential sector and unit consumption per dwelling. As can be seen, the most significant[132] changes occur in the notable reduction in the weight of heating, which goes from representing almost half of domestic consumption in 2020 (45.4%) to 28.5% in 2050; and, conversely, in the increase in the weight of white goods and other electrical appliances (for which, as we have seen, absolute consumption is assumed to be stable over time), which goes from representing 26.3% in 2020 to 41.5% in 2050.

Consequently, the 'EPBD uses' (heating and DHW) would go from representing 60.9% in 2020 to just 42.8% in 2050, when lighting, white goods, electrical appliances and cooling would make up 46.1% of total consumption.

6.1.4. Saving targets in the residential sector by energy source.

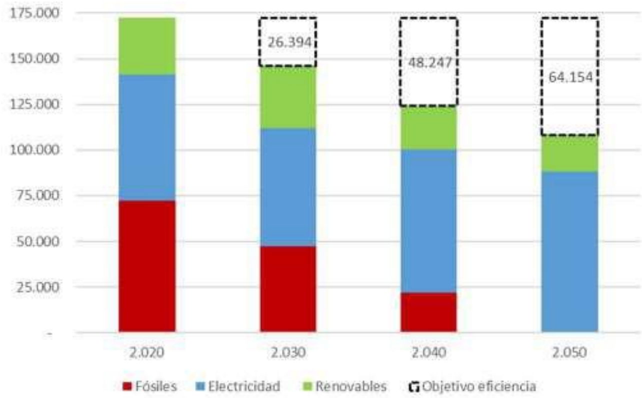
The TIMES-Sinergia modelling also makes it possible to differentiate between consumption from the different energy sources and the changes in such consumption during the course of the period 2020-2050. When the results are grouped into renewable sources, fossil fuels and electricity, the distribution is seen to go from 18.1%, 42.0% and 39.9% in 2020 to an electrification figure of 81.6% in 2050, supplemented by 18.4% renewables.

In absolute terms, the most important feature is the disappearance by 2050 of the 78 448 GWh of fossil energy seen in 2020, which occurs as the result of a major effort to save energy by increasing efficiency (-64 154 GWh) and an increase in electrification of approximately 28%, while renewable energy also sees a reduction of 35.3%.

[132] In the rest of the uses there are no significant relative changes: DHW goes from 15.5% to 14.2%, stoves from 7.9% to 11.1%, lighting from 3.7% to 3.1% and cooling from 1.1% to 1.5%.

The relative changes once gain show the disappearance of fossil fuels in parallel with electrification, while renewables grow slightly up to 2030 (from 18.1% to 23.4%), before falling off again by the end date of 2050 to a weight similar to that of 2020 (18.4%).

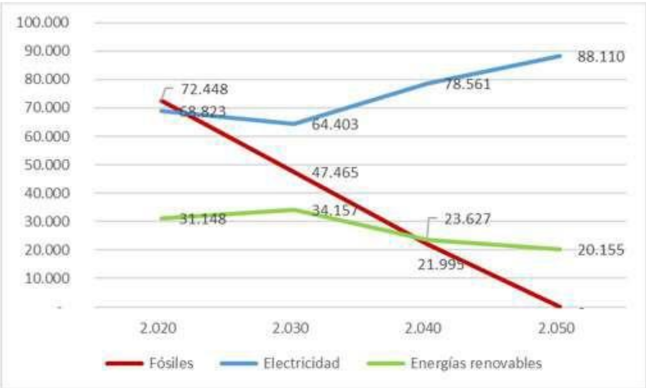
Figure 6.7. Changes in energy consumption in residential buildings (GWh) in the period 2020-2050 (by decade).



	Fossil fuels
	Electricity
	Renewables
	Efficiency target

Source: MITMA, based on the TIMES-Sinergia modelling of MITERD for LTS 2050.

Figure 6.8. Changes in consumption in residential buildings (GWh) in the period 2020-2050 (by energy type).



	Fossil fuels
	Electricity
	Renewable energy

Source: MITMA, based on the TIMES-Sinergia modelling of MITERD for LTS 2050.

6.2. OBJECTIVES IN THE TERTIARY SECTOR.

6.2.1. General objectives relating to energy saving and emissions in the tertiary sector.

The National Energy and Climate Plan (PNIEC) targets a cumulative saving for the tertiary sector, in terms of final energy, of 4 729 ktoe (for the period 2020-2030) compared to the base scenario.

Figure 6.9. Final energy consumption in the service sector and other sectors (excluding non-energy uses) for the base scenario (ktoe).

(ktoe)	2015	2020	2025	2030
Coal	29	39	40	40

Oil and its derivatives	1 111	1 042	714	447
Natural gas	2 819	3 544	3 661	3 552
Electricity	6 406	6 469	6 505	6 600
Renewable energy	156	242	212	192
Other non-renewables	2	7	6	4
TOTAL	**10 523**	**11 343**	**11 138**	**10 835**

Figure 6.10. Final energy consumption in the service sector and other sectors (excluding non-energy uses) for the target scenario (ktoe).

(ktoe)	2015	2020	2025	2030
Coal	29	30	15	0
Oil and its derivatives	1 111	1 096	807	527
Natural gas	2 819	3 485	3 132	2 636
Electricity	6 406	6 481	6 328	6 229
Renewable energy	156	241	337	435
Other non-renewables	2	7	6	4
TOTAL	**10 523**	**11 340**	**10 625**	**9 831**

The measures in the PNIEC intended to achieve the proposed reduction in consumption for the service sector, in relation to the base scenario, are:

Measure 2.8. Energy efficiency in buildings in the tertiary sector.

The measure aims to reduce the energy consumption of existing buildings used in the tertiary sector, whether they are publicly or privately owned, by means of energy renovation actions to improve their energy rating. The measure includes two different mechanisms:

- Extension of the obligation of the Central State Administration (CSA) to renovate public buildings (contained in Article 5 of Directive 2012/27/EU) to local and regional governments and, at the same time, requiring an additional 3% of the building stock of the Central State Administration to be renovated.
- Energy renovation of buildings by means of public support and financing schemes, similar to the support scheme for the energy renovation of existing buildings (*Programa de ayudas para la rehabilitación energética de edificios existentes*: PAREER), in effect since October 2013.

The first refers, on the one hand, to extending the obligation contained in Article 5 of Directive 2012/27/EU to all regional and local governments, ensuring that the public sector plays a proactive and responsible role and resulting in lower energy bills for public authorities, and, on the other hand, to establishing the requirement to renovate a further 3% of the building stock of the Central State Administration on top of the 3% provided for in the above directive.

The second refers to the continuation of the public support and financing schemes for the energy renovation of buildings used in the tertiary sector (similar to the PAREER scheme):

The aim of the measure is to achieve a cumulative final energy saving of 1 378.8 ktoe in the period 2021-2030. Those savings would be the result of the energy renovation of 5 million m^2/year of the building stock, both publicly and privately owned.

Eligible actions in relation to the renovation of buildings will be those achieving a reduction in CO2 emissions and final energy consumption by improving the services making up the greatest proportion of the buildings' energy consumption, such as heating, cooling and the production of domestic hot water.

Meanwhile, Measure 2.9 - 'Energy efficiency in cooling equipment and major heating and cooling installations in the tertiary sector and public infrastructure' - aims to reduce electricity consumption in the tertiary sector and can be subdivided into two:

- Measures for the renovation of major heating and cooling installations, the renovation of cooling equipment and storage and freezing units.
- Measures to improve energy efficiency in publicly-owned infrastructure, principally, in street lighting installations and in installations for the treatment and desalination of water and for making water drinkable.

The measure aims to achieve a cumulative final energy saving of 3 350.4 ktoe in the period 2021– 2030.

Figure 6.11. Breakdown of measures 2.8 and 2.9 relating to the tertiary sector.

PUBLIC SECTOR	CUMULATIVE saving 2021-2030 (ktoe)	ANNUAL EQUIVALENT saving (ktoe/year)
Total measure. Measure 2.8	**1 378.8**	**25.1**
Improvement in energy efficiency of CSA buildings (> 3%)	60.3	1.1
Improvement in energy efficiency of regional and local gov. buildings (3%)	681.3	12.4
Buildings used in the tertiary sector: Renovation of thermal envelope	6.1	0.1
Buildings used in the tertiary sector: heating and cooling installations	37.1	0.7
Buildings used in the tertiary sector: lighting installations	594.0	10.8
Measure 2.9. Total measure	**3 350.4**	**24.0**
Improvement in energy efficiency of street lighting systems	1 168.3	21.2
Improvement in energy efficiency of the water cycle	153.5	2.8
Renovation of storage and freezing units	1 181.6	21.5
Renovation of industrial and tertiary sector cooling equipment	847.0	15.4
Total	**4 729.2**	**49.1**

6.2.1.1 Public tertiary sector.

It is estimated that the obligation, under Article 5 of Directive 2012/27/EU on energy efficiency, to renovate the building stock of the Central State Administration (CSA) amounts to a total of 2 220 000 m^2 for the period between 2020 and 2030. That estimate takes into account not only the area inventoried, but also the changes resulting from the energy renovations carried out up to 2018 and the consequent reduction in the non-energy-efficient floor area of the Central State Administration.

The PNIEC also proposes that public authorities should be examples with regard to energy saving and energy efficiency. Thus, it proposes initiatives for achieving the target for renovating the public building stock set in the Energy Efficiency Directive (3%) and evaluates and promotes the savings that could be obtained with the renovation of an additional 300 000 m^2/year by the Central State Administration. The plan, in accordance with the Energy Efficiency Directive, encourages the Autonomous Communities and local authorities to adopt, at least, the mandatory renovation target for the Central State Administration of 3% of the gross floor area of heated and/or cooled buildings in the public building stock, since, by doing so, a much more ambitious energy saving target would be achieved.

Furthermore, consideration must be given to the potential reduction in energy consumption that could be achieved by renovating public buildings that are exempt from complying with the above-mentioned Article 5 of the Energy Efficiency Directive or those which belong to a public authority but which are not occupied by that authority.

The following table shows that the effort with regard to the renovation of the public building stock envisaged in Measure 2.8 is greater than that envisaged for the private building stock, with the public building stock also representing a much smaller area than that represented by the private tertiary sector building stock.

Figure 6.12. Breakdown of Measure 2.8 into public and private building stock.

SERVICE SECTOR. MEDIDA 2.8. PENIEC: DISTRIBUTION PUBLIC/PRIVATE SECTOR STOCK	CUMULATIVE saving 2021-2030 (ktoe) envisaged in Measure 2.8	% relative to total for the measure
Public sector building stock	741.5	53.8%

Private sector building stock	637.2	46.2%
Total	**1 378.8**	**100.0%**

6.2.2. Tertiary sector targets for 2050.

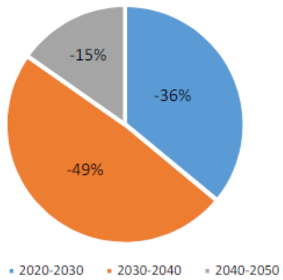
The Long-term Strategy for a Modern, Competitive and Climate-Neutral Spanish Economy in 2050 (LTS 2050) is the strategic planning instrument that, in Spain, establishes the energy-saving and emissions targets for all economic activities, including the buildings sector, up to the year 2050. The targets it contains for the period 2020-2030 are the same as those of the PNIEC.

The estimated data for energy consumption in the tertiary sector and the corresponding saving targets are as follows:

Figure 6.13. Final energy consumption and reduction in consumption in the tertiary sector for the LTS 2050 target scenario (GWh).

(GWh)	2020	2030	2040	2050
Fossil fuels	53 763	37 572	8 385	0
Electricity	75 379	72 201	76 987	77 306
Renewable energy	2 715	5 016	6 331	7 157
TOTAL	**131 858**	**114 788**	**91 703**	**84 463**

(GWh)	2020-2030	2030-2040	2040-2050	2020-2050
Fossil fuels	-16 192	-29 186	-8 385	-53 763
Electricity	-3 179	4 786	319	1 926
Renewable energy	2 301	1 315	826	4 442
TOTAL	**-17 069**	**-23 085**	**-7 240**	**-47 395**



Source: MITMA, based on the LTS 2050 (Long-term Strategy for a Modern, Competitive and Climate-Neutral Spanish Economy in 2050).

The final energy consumption target established for 2050 (-47 395 GWh) is equivalent to a reduction of 36% compared to consumption in 2020 and, as can be seen in the graph above, the fall in consumption is intense in the first and, especially, the second part of the period, with 36% occurring between 2020 and 2030 (-17 069 GWh), 49% between 2030 and 2040 (-23.085 GWh) and, finally, 15% between 2040 and 2050.

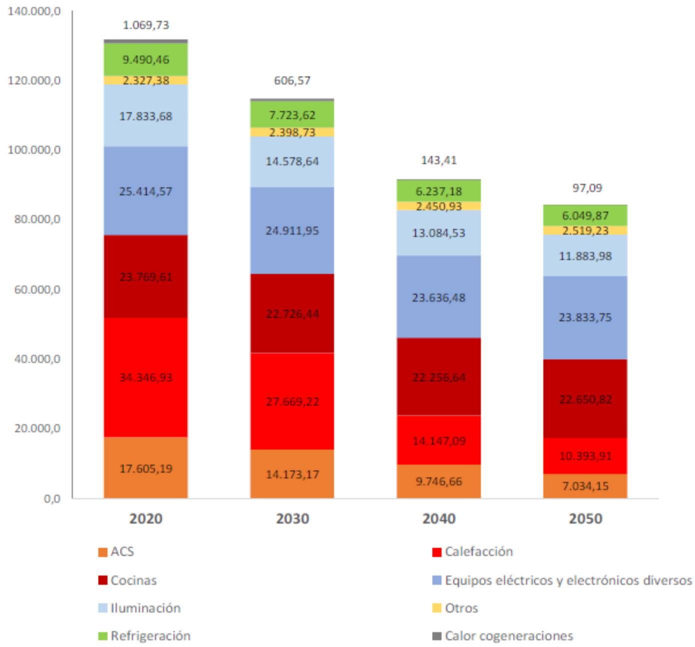
The reduction in consumption of 17 069 GWh for the decade 2020-2030 implies a reduction of 13.05% compared to consumption in 2020; for the decade 2030-2040 it is -20.22% compared to 2030; and for 2040-2050 it is -7.9% compared to 2040.

Energy-saving targets according to use in the tertiary sector.

With the TIMES-Sinergia modelling used for the LTS 2050, we can differentiate between the relevant targets according to use: heating, DHW, cooling, electrical appliances and equipment, stoves, lighting, cogeneration and others.

An indication of the changes in consumption according to use is shown in the following graphs:

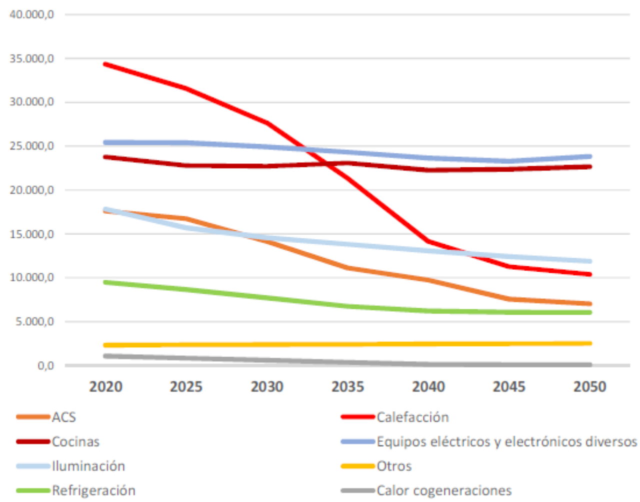
Figure 6.14. Model of the changes in energy consumption in the tertiary sector (GWh) in the period 2020-2050 and its distribution by decade.



	DHW
	Stoves
	Lighting
	Cooling
	Heating
	Other
	Electrical equipment and various electronics
	Other
	Heat cogeneration

Source: MITMA, based on MITERD (TIMES-SINERGIA model for LTS 2050).

Figure 6.15. Changes in energy consumption for each use in the tertiary sector (2020-2050). (GWh).



	DHW
	Stoves

	Lighting
	Cooling
	Heating
	Electrical equipment and various electronics
	Other
	Heat cogeneration

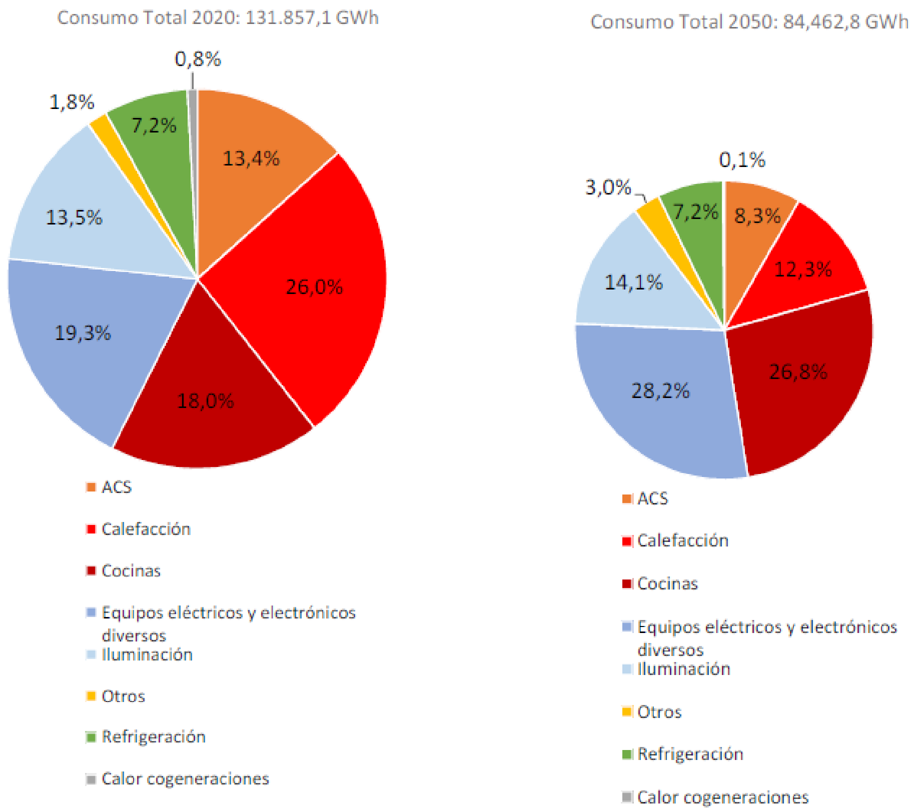
Source: MITMA, based on MITERD (TIMES-SINERGIA model for LTS 2050).

As can be seen, the most significant conclusion from the above graphs is that it is the estimated consumption relating to heating and DHW that sees the largest falls, making up a total of 72.8% of the total savings; that is, almost 3 out of every 4 GWh of reductions relates to those services. Lighting also reduces its consumption and represents 12.55% of the total savings, while cooling sees a smaller fall and represents 7.26% of the total.

It can also be seen that both the use of electronic equipment and electrical applies and the use of stoves remains practically constant throughout the three decades.

In particular, heating would go from 34 347 GWh in 2020 to 10 394 GWh in 2050, meaning a saving of 23 953 GWh (that is, a reduction in consumption of 69.74% compared to 2020), which represents as much as 50.54% of the total 2020-2050 saving target (47 395 GWh) for the tertiary sector. For its part, DHW would produce savings between 2020 and 2050 of 10.571 GWh, which would mean a decrease of 60% in relation to the consumption for DHW in 2020 or 22,3% of the total saving target for all uses.

Figure 6.16. Percentage distribution by use of the energy consumed in the tertiary sector (2020 and 2050). (%)



	DHW
	Heating
	Stoves
	Electrical equipment and various electronics

	Lighting
	Other
	Cooling
	Heat cogeneration
	DHW
	Heating
	Stoves
	Electrical equipment and various electronics
	Lighting
	Other
	Cooling
	Heat cogeneration

Source: MITMA, based on the TIMES-Sinergia modelling of MITERD for LTS 2050.

The above graph illustrates the change in the relative weight of each use in relation to total consumption in the tertiary sector. As can be seen, the most significant changes occur in the notable reduction, on the one hand, in the weight of heating, which goes from representing a quarter of domestic consumption in 2020 (26%), and, on the other, in DHW, which falls from 13.4% to 8.3% in 2050. Conversely, there is an increase in relation to stoves (from 18% to 26.4%) and, especially, the weight of electrical equipment and various electronics and other electrical appliances (for which, as we have seen, absolute consumption is assumed to be stable over time), which goes from representing 19.3% in 2020 to 28.2% in 2050.

Consequently, the ‘EPBD uses’ (heating, cooling, DHW and lighting) would go from representing 60.1% in 2020 to 41.9% in 2050. As has been noted, almost 20% of the consumption relates exclusively to electrical equipment and various electronics, which provides scope for a more detailed examination of the need for self-consumption and also the need to promote the installation of renewables.

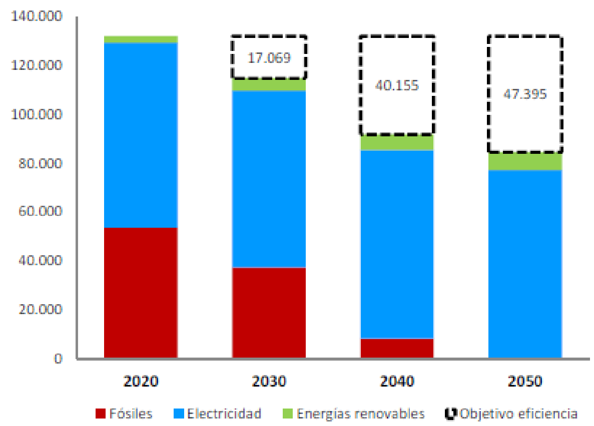
Saving targets in the tertiary sector by energy source.

The TIMES-Sinergia modelling also makes it possible to differentiate between consumption from the different energy sources and the changes in such consumption during the course of the period 2020-2030. When the results are grouped into renewable sources, electricity and fossil fuels, the distribution is seen to go from 2.1%, 57.2% and 40.8% in 2020 to an electrification figure of 91.5% in 2050, supplemented by 8.5% renewables.

In absolute terms, the most important feature is the disappearance by 2050 of the 53 763 GWh of fossil energy seen in 2020, which occurs, fundamentally, as the result of a major effort to save energy by increasing efficiency (-47 395 GWh) and a slight increase in electrification and renewable energy.

The relative change once again shows the disappearance of fossil fuels, while renewables grow slightly throughout the period (from 2.1% to 8.5%) and electricity sees a very large increase as a percentage of total consumption (from 57.2% to 91.5%), although, in absolute terms, it only represents an increase of 2.5%.

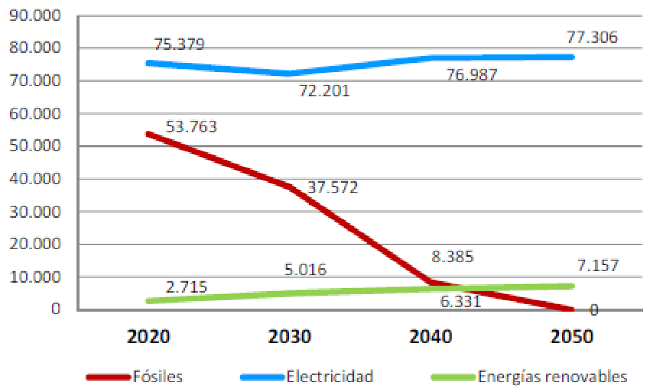
Figure 6.17. Changes in energy consumption in tertiary sector buildings (GWh) in the period 2020-2050 (by decade).



	Fossil fuels
	Electricity
	Renewable energy
	Efficiency target

Source: MITMA, based on the TIMES-Sinergia modelling of MITERD for LTS 2050.

Figure 6.18. Changes in consumption in tertiary sector buildings (GWh) in the period 2020-2050 (by energy type).

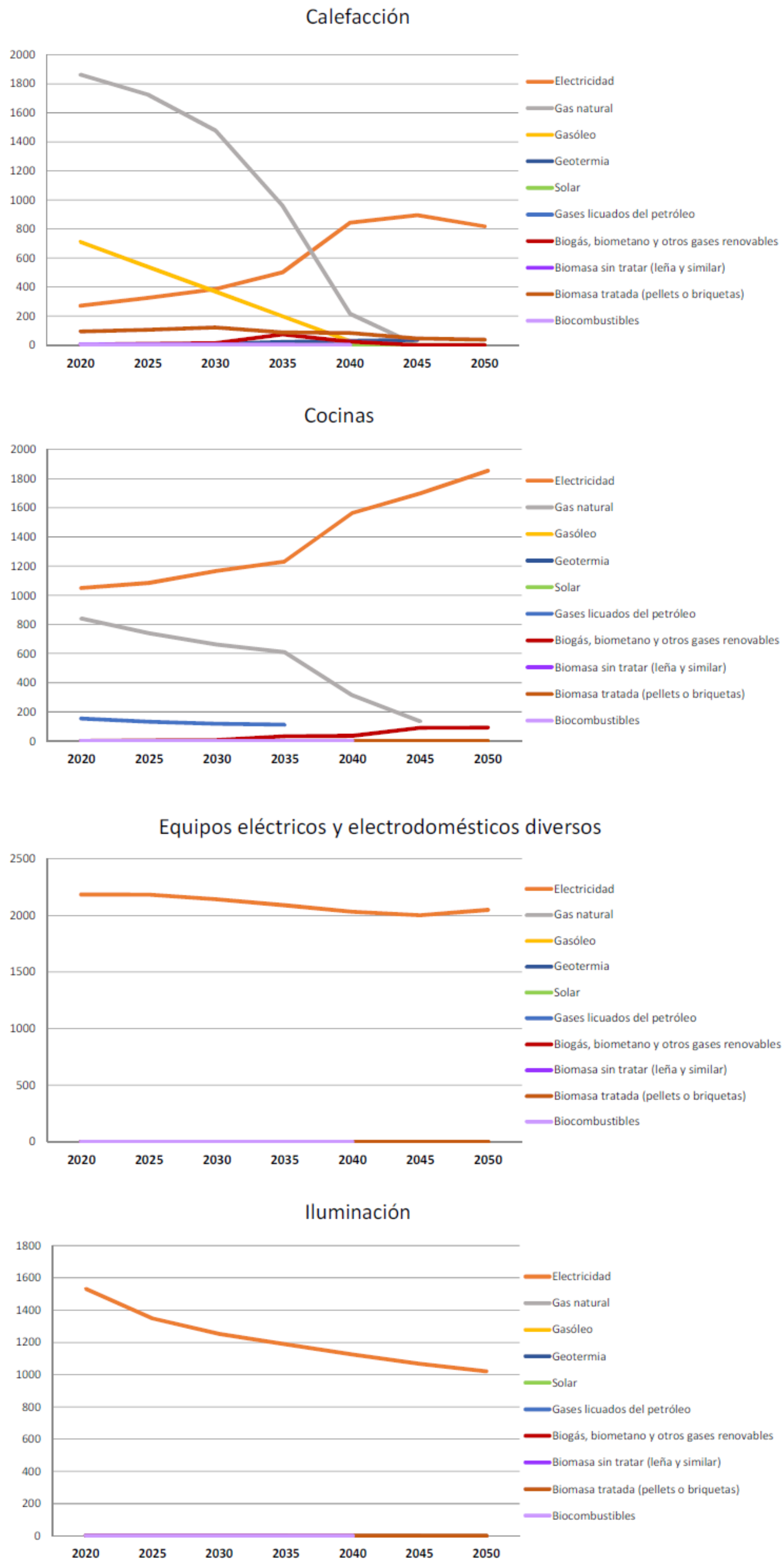


	Fossil fuels
	Electricity
	Renewable energy

Source: MITMA, based on the TIMES-Sinergia modelling of MITERD for LTS 2050.

By carefully matching types of energy source with the uses or services they supply, the following figures regarding the principal uses in the tertiary sector (heating, cooking, electrical equipment and various electrical appliances and lighting) are obtained, showing that both natural gas and oil are in constant decline as fossil fuels, especially for heating and cooking, and that the treatment of electricity varies according to the use, as it increases for both heating and cooking, while it falls in relation to lighting and remains constant for electrical equipment. The different forms of renewable energy are merely incidental in relation to these uses.

Figure 6.19. Changes in consumption in tertiary sector buildings (GWh) in the period 2020-2050 (by energy source and service).



	Heating
	Electricity

	Natural gas
	Fuel oil
	Geothermal
	Solar
	Liquefied petroleum gases
	Biogas, biomethane and other renewable gases
	Untreated biomass (firewood and similar)
	Treated biomass (pellets or briquettes)
	Biofuels
	Stoves
	Electricity
	Natural gas
	Fuel oil
	Geothermal
	Solar
	Liquefied petroleum gases
	Biogas, biomethane and other renewable gases
	Untreated biomass (firewood and similar)
	Treated biomass (pellets or briquettes)
	Biofuels
	Electrical equipment and various electrical appliances
	Electricity
	Natural gas
	Fuel oil
	Geothermal
	Solar
	Liquefied petroleum gases
	Biogas, biomethane and other renewable gases
	Untreated biomass (firewood and similar)
	Treated biomass (pellets or briquettes)
	Biofuels
	Lighting
	Electricity
	Natural gas
	Fuel oil
	Geothermal
	Solar
	Liquefied petroleum gases
	Biogas, biomethane and other renewable gases
	Untreated biomass (firewood and similar)
	Treated biomass (pellets or briquettes)
	Biofuels

Source: MITMA, based on the TIMES-Sinergia modelling of MITERD for LTS 2050.

7. CRITERIA AND PROPOSALS FOR MENUS, PROFITABLE APPROAHCES AND ECONOMIC ASSESSMENT OF THE RENOVATION OF THE RESIDENTAIL BUILDING SOTCK (ENVELOPE AND INSTALLATIONS).

7.1. GENERAL CRITERIA AND CONSIDERATIONS TO GUIDE RENOVATION INTERVNENTIONS IN THE RESIDENTIAL SECTOR.

In order to achieve the targeted reduction in domestic energy consumption for heating and cooling and DHW, it is necessary to recognise the functional logic of the factors that determine that energy consumption, which are:

- The use and management of the building and of its elements and systems.
- Energy demand, considering - where required - energy lost through transmission and energy lost through ventilation separately.
- The efficiency of the air conditioning installations that satisfy the demand for comfort.
- The energy source supplied to the buildings.

And the rational order of intervention in the case actions that are separated in time is precisely the order in which they are presented in the list:

- The rationalisation of the use and management of the building.
- The reduction of the building's energy demand by means of interventions involving the envelope (losses through transmission) and the ventilation.
- Improving the energy efficiency of the installations.
- The use of renewable energy.

These factors are examined below, one by one. The actions listed within each factor are intended, in general, to be alternatives to each other, forming a range from which the most suitable can be chosen according to the characteristics of each dwelling.

7.1.1. Rationalisation of the use and management of residential buildings.

The rationalisation of the use and management of the building is the first factor to consider in a comprehensive intervention to reduce consumption intended to achieve efficient performance in the use of energy and in the emissions associated with it, since the rest of the systems are just defined for a specific use and form of management. For example, it does not make sense to invest in an efficient boiler and subsequently improve the use and management, causing an appreciable reduction in demand such that the new boiler has excess capacity and, consequently, become less efficient.

This rationalisation of the use and management is a key factor in the energy demand, insofar as the former is decisive in determining the latter, and, therefore, the efficiency of any reduction in any of the other factors is also conditional on subsequent reductions provided by improving the use and management. Marginalised by most legislation - with the exception of the RITE building regulations - which always assume a standard and efficient use and management of the building and its installations, respectively, this factor does not affect construction-related aspects of the building or its installations. Therefore, the instruments for acting in relation to use and management - with the exception of 'intelligent' management systems - are not specific technical applications. Its reduction must be produced by stimuli that lead to efficiency on the part of the user, and training and awareness-raising actions can be combined with actions relating to the cost of the energy which heavily and exponentially penalise excessive consumption. They must involve pushing the user's management towards maximum efficiency at the moment when the rest of the measures are introduced and, therefore, their aim must be that, for each segment of the building stock, users align themselves with the lowest possible consumption and that those who do not do so pay the additional costs in terms of energy and emissions that make it possible to repay public investments in efficiency or those intended to rectify cases of energy poverty, etc.

In addition, efficient strategies should be developed for the use of buildings, such as, for example, the restoration of strategies for the use and management of historic buildings, provided that it is possible to adapt them to current needs. One factor to take particular account of in our country is that of adaptive comfort in those periods of the year when natural ventilation is possible, which results in a wider range of comfort temperatures and steep reduction in the demand for cooling in the warmer months.

The intervention menus proposed in this 2020 ERESEE do not take into account systems for the intelligent management of installations and construction-related elements - relating to ventilation, heating and cooling equipment, blinds, etc. - due to their high initial costs, although, when the cost of energy reaches a certain level, their installation could be considered as an additional action that could be carried out whenever it becomes profitable, replacing conscious action on the part of the user or making it easier.

The importance of metering consumption and checking performance.

In practice, the great majority of users are unaware of how much their installations consume. And yet, in conversations, opinions such as ‘my heating uses “a lot” of energy’, ‘they’ve charged me a “fortune” this month’ are heard, but without any analysis of whether the dwellings concerned are 70 m^2 or 200 m^2, or whether the family is made up of 2 people or 8 people; similarly, users usually know whether they spend €75 or €175, but they do not usually discriminate between different times of year and, certainly, they are unaware of whether their consumption was 2 000 kWh or 6 000 kWh.

A first step should be to promote education that makes people aware of what a reasonable order of magnitude of consumption is depending on the size of the dwelling, the services, the climatic zone and the associated emissions of pollutants.

It is also essential to require the installation of meters when refurbishing installations and their prior installation should even be advised, so that it is possible to have reliable data for the improvements achieved with the installations. Furthermore, users should always be advised that meters can be read remotely, which makes it easier to monitor the installations.

Evidently, there are two clearly differentiated situations in relation to metering: individual installations and collective installations.

- Individual Installations

  In the case of individual installations, the aim of the metering is to determine their performance, as the expenditure is determined by each user’s billing meters.

  Meters of this kind are very uncommon. When the fuel is used exclusively for thermal installations, the consumption figure is taken from the relevant bills; however, the heat provided is unknown and, therefore, the performance cannot be determined accurately.

  The incorporation of meters that make it possible to obtain such data should be promoted. At a minimum, electricity meters should be required on heat generating equipment, as the billing meter includes all of the electricity consumption for the dwelling: electrical appliances, lighting, heat generation, etc.

- Centralised Installations

  Installations of this kind need metering, on the one hand, in order to know how much they are consuming and thereby determine their performance. But, equally, it is also necessary to know the individual consumption of each dwelling in order to share out the costs.

The RITE building regulations establish a minimum number of compulsory meters, with which it is possible to determine performance and the division of costs; such meters are compulsory when installations are refurbished.

Metering exclusively of energy is recommended with central thermal installations, always in compliance with the current regulations, both for the heating service and for DHW and cooling services.

It must be possible to read meters for heating and cost allocators remotely, to ensure that useful and frequent information is provided regarding consumption, without the need to enter each dwelling to read them.

7.1.2. Reducing demand by means of actions involving the building envelope.

After efficient use and management, the next factor that determines energy consumption is the building demand; that is, the energy requirements - heating or cooling - that must be satisfied to provide comfort, depending on the use for which it is occupied. The demand depends on the climate, the orientation, the relationship between the surface area and the volume of the building - all of which are given factors - but also on the enclosing elements of the building, the quality of which is susceptible of intervention. Here we consider interventions involving the elements that make up the building envelope, improving its thermal insulation.

Action can be taken in the following areas:

a) Vertical enclosing elements - walls that separate the interior of the building from the exterior - where thermal insulation should be increased to the maximum possible efficiency (that is, when the increase in insulation no longer has an appreciable effect on overall losses), with two initial options:

-Internal insulation, maintaining the external appearance of the façade:

- By cavity filling, when, inside the enclosing element, there is a void that can be filled with an insulating material. There are different filling procedures and techniques that are amply viable.
- By internal application with an interior finish layer, ‘doubling’ the enclosing element to attach an insulating layer to it.

-External insulation, acting on the external face of the wall and transforming its initial appearance in order to provide it with permanent insulation and, necessarily, new waterproofing, by means of insulation applied externally and an exterior mortar finish. This external doubling - compared to internal doubling - easily allows for a significant improvement in the performance of the thermal bridging (casing for blinds, slab edges and supports, jambs, etc.).

b) External joinery, where the thermal insulation should be improved, as well as improving the sealing to prevent infiltration and providing the openings with better protection from the sun. The existing windows should be replaced with double-glazed joinery with a thermal break or a new window with double glazing and a thermal break should be added to the opening of the existing window. The addition of secondary glazing - which is not always possible - is a preferable action to replacement, as it allows the thermal resistance and the acoustic performance of the opening to be increased considerably, while, at the same time, avoiding work internally, which can be more irritating for the occupant of the property. Finally, the addition - if there is not one already - of a practicable solar protection system (blind, canopy, shutters, etc.) should also be considered.

c) Roofs, where thermal insulation should be increased to the maximum possible efficiency (that is, when the increase in the thickness of the insulation no longer has an appreciable effect on overall losses), with two initial options:

With pitched roofs:

c.1- if there is no ventilated cavity below the waterproofing, by replacing the existing waterproofing - most likely tiles - and applying thermal insulation and a new waterproofing layer on top;

c.2- if there is a ventilated cavity and it is accessible, by adding thermal insulation to the layer separating the habitable space from the ventilated cavity.

With flat roofs, by adding a layer of thermal insulation and a protective layer on top that can be walked on.

d) Plinths, where the thermal insulation should be increased to the maximum possible efficiency by:

d.1 Applying thermal insulation to the existing paving and adding a new layer of light paving with a total thickness of less than 7 cm.

d.2. For floor slabs, by placing thermal insulation in the cavity.

d.3. For slabs at ground floor level (arcades), by placing insulation on the underside.

As we will see further on, in relation to installations, an extensive renovation of the building envelope, such as that which would result from the actions proposed, would achieve a considerable reduction in the thermal energy needed for heating; such a reduction would make it possible to work with lower water distribution temperatures and, therefore, renovating the envelope could make it possible to incorporate a heat pump to replace an existing boiler, directly, without modifying the water distribution subsystem and radiators.

7.1.3. Reducing demand by controlling ventilation.

Once a suitable use and management has been achieved and the enclosing elements have been insulated and sealed as much as possible, ventilation becomes the deciding factor in relation to the building's energy demand. When there is an appreciable thermal gap between the temperature of the outside air and the temperature of the inside air, controlling the ventilation using a mechanical system is an action that significantly limits energy consumption.

The obligatory nature of controlled mechanical ventilation (CMV) systems, pursuant to basic document DB HS3 of the CTE building regulations, affects new-build projects, but is not a legal requirement when renovating buildings and more often than not existing buildings do not have systems of this kind.

A mechanical system ensures that a certain ventilation flow enters each premises, allowing energy to be recovered, with the consequent reduction in energy consumption; although, to do that, it must be a double-flow system with two ventilators (impulsion and extraction). Integrating such a system into single-family dwellings is very easy, but it is more complex in multi-family blocks.

Where the building envelope has been renovated beforehand, the consumption relating to ventilation becomes a larger proportion of total consumption and, therefore, it is very important to analyse the suitability of including systems of this kind in the renovation actions; in that regard, such mechanical ventilation must always have systems that recover energy from the extracted air and transfer that recovered heat to the incoming air.

For the purposes of the 2020 ERESEE, since it is not obligatory when renovating buildings (HS3), it is recommended to include mechanical ventilation with heat recovery in climatic zone E and it is, at a minimum, advisable in zone D. In those cases, there should be a controlled ventilation system that acts automatically when the CO2 concentration of the interior air exceeds a specific quantity. In that way, the air is renewed strictly according to the quality requirement of the interior air - the CO2 acts as an indicator of that quality - and unnecessary ventilation when the building is unoccupied is avoided.

In areas with milder winters, however, mechanical ventilation should be considered on a case-by-case basis. It should always be borne in mind that in many of our country's climatic zones and for a large part of the year, the exterior air temperature - even if at certain times it is above or below the comfort temperature we require for the interior - together with the thermal inertia of building elements and adequate natural ventilation achieved by opening windows, can allow for adequate interior air conditions, without the use of complex heating and cooling systems, and that, therefore, mechanically controlled ventilation systems - the concept of the 'submarine' or airtight home, typical of very cold climates - may clash with the culture of the users and with bioclimatic techniques.

7.1.4. Improving the efficiency of thermal installations.

It only makes sense to go about improving the efficiency of the installations that collect, transport, conduct and deliver the heat and cooling necessary at any given time and in any given place in order to satisfy demand when that demand has previously been rationalised as far as possible by combining the above measures.

a) The importance of the Energy Performance Certificate and energy audits.

It is common practice to undertake the refurbishment of installations only when the system breaks down, keeping obsolete and inefficient technologies in use; most consumers find that information on the advantages of alternative systems, or data to compare the costs of the different solutions, is not easily available.

In order to ensure that financial measures relating to energy efficiency in the renovation of buildings are applied in the best way possible, the support should be linked to the quality of the renovation work in proportion to the energy saving achievable or set, quantifiable objectively, for example, by means of the certification or qualification level of the installer or an energy audit. Alternatively, it should be linked to the improvement achieved as a result of the renovation, which should be assessed by comparing the Energy Performance Certificates issued before and after the work, using standard values, or by some other transparent and proportionate method.

Energy renovation work must be encouraged to follow the recommendations of energy audits and Energy Performance Certificates.

When a technical installation of a building is put in, replaced or improved, the overall energy efficiency of the modified part and, where appropriate, the entire modified installation should be assessed. It would be a good idea for the results of that assessment to be documented and provided to the building owner, so that they can be consulted and used to verify compliance with the minimum requirements laid down in the Spanish regulations and to issue the relevant Energy Performance Certificates.

Any equipment replaced must comply with the regulations resulting from the energy labelling (2010/30/EU) and ecodesign (2009/125/EC) directives applicable to energy-related products, which apply according to their power.

In order to guarantee the projected energy savings when carrying out an energy renovation, the use of energy performance contracts as defined in Article 2(27) of Directive 2012/27/EU must be promoted.

b) General measures for thermal installations.

When refurbishing water-based heating systems, the following common measures should be applied to every kind of refurbishment:

- If the terminal units are radiators, with both individual and collective installations, if the terminal units do not have valves with a thermostatic head, such valves should be installed so that the air temperature of each room can be controlled independently.
- Hydraulic balancing. Hydraulic balancing of the hydraulic installation should be carried out. In the case of radiators, they usually have a lockshield valve located at one end at the bottom. The circuit is balanced by adjusting these valves so that water enters all of the radiators at a similar temperature and so that, with all of them, there is temperature difference of 10 ºC or more between the upper and lower parts. The lockshield valve is left open on radiators that are further away from the boiler and closed on radiators that are nearer to it.

o In the case of central installations, as well as adding thermostatic valves to the radiators, when the interior distribution in the dwellings is in the form of a ring, it is recommended to install two-way control valves with dynamic balancing; the valves should be associated with variable displacement pumps and balancing of the general distribution, using differential pressure values or equivalent solutions.

o If the distribution is through risers, the pumps must also be variable displacement pumps and the accessories necessary to balance the risers must be planned.

o When circulation pumps are replaced, they must be installed with a speed controller that adjusts the flow of water passing through the distribution network in line with actual demand, being careful to install it in the optimum position on the pump.

o The temperature of the water sent to the terminal units must be controlled according to the outside temperature (outside temperature sensor), acting on the production temperature of the boilers up to a limit compatible with the existing equipment and services.

o With any collective thermal installation, the pipes and accessories of the installations, as well as the equipment, appliances and tanks, must be thermally insulated and, therefore, all accessible pipes must be insulated with at least the thicknesses indicated in the RITE building regulations. Losses during distribution can have a very significant impact, above all in the case of DHW recirculation and collective heating systems; it is, therefore, very important that such losses are specifically taken into account when planning the renovation.

c) Regarding the replacement of existing equipment.

With any existing thermal installations that are going to be renovated, the simplest change is simply replacing the existing equipment with other equipment that works with the existing installation, but has better seasonal energy performance and, therefore, consumes less energy for the same output.

Work to renovate the building stock must be done prioritising energy efficiency, applying the 'energy efficiency first' principle and studying the use of renewable energy as a source of final energy. That is especially true when a 1% increase in energy saving makes it possible to reduce imports of primary energy by 2.6%[133].

In any renovation project, it must always be established whether any periodic inspection of the energy efficiency of the thermal installation has been carried out and, if so, it must be confirmed that the report contains the following:

- Assessment of the scale of the heat production; in general, installations usually have excess capacity, which implies higher energy consumption, since the heat generators will spend more time working at less than their full capacity and will stop and start more, as well as there being larger volumes of thermal fluids being circulated. If this study has not been done, it should be done prior to renovating any dwelling.
- If energy efficiency improvements have already been proposed, checking whether they have been implemented.

7.1.5. Introduction of renewable and residual energy.

Even though any form of renewable or residual energy is very beneficial when renovating a building, the following are described in particular on account of their more established use in the residential renovation sector:

a) Biomass

[133] EU average. Directive 2010/31/EU.

Biomass is recommended for domestic heating if its emissions comply with strict emissions limits and it is used appropriately.

In cities, appropriate technologies must be used to ensure, by means of automated devices, that it burns properly and relatively non-polluting fuels must be chosen. In large biomass installations, flue gas cleaning equipment must be used to reduce emissions to acceptable levels and monitor the emissions, ensuring, at all times, that the outside air quality of the environment where they are located is not altered.

In any event, use must be made of locally produced biomass, principally in rural population centres, by means of the sustainable mobilisation of wood and the existing agricultural resources and the development of new sustainable systems of forestry and agricultural production. It is essential to ensure that the agricultural raw materials do not come from areas rich in biodiversity or from areas designated for the purpose of nature conservation or the protection of rare, threatened or endangered species or ecosystems.

Biomass must always be regarded as biomass capable of being supplied sustainably and must take due account of the principles of the circular economy and the waste hierarchy established in Directive 2008/98/EC.

b) Solar energy

Evidently, whenever it is possible to integrate solar energy and it is technically and financially feasible to do so, it should be done.

Prior to renovating a building, it is necessary to check whether there is already a solar thermal installation for DHW; many buildings have such installations, but they do not work, either because they were installed and set up incorrectly or because they have not been properly maintained.

The solar thermal installation for DWH is integrated into the building’s thermal installation, such that the solar installation preheats the water, up to the temperature it can achieve at any given time, and the thermal installation takes the water to the temperature set by the users. The conventional energy consumption reduces in proportion to the amount supplied by the solar installation. But if that installation does not work correctly (poor installation or set up or inadequate maintenance), as the set-point temperature is achieved by the thermal installation, the user is unaware of the fault in the solar installation, since the DHW service is unaffected. Such a fault can only be detected if the consumption recorded is analysed, as it increases when there are no solar contributions. If the installation does not have meters or the meters are not read periodically, the installation will not make efficient use of solar energy - a situation which is unfortunately very common.

When renovating a building, it is essential to check whether such an installation exists and, if it does, to get it working, stressing that a minimum amount of maintenance must be carried out to allow adequate use to be made of it; the financial return on repairing an existing installation is very favourable.

In renovated homes in which the thermal envelope is improved, as the demand for heating is reduced significantly, DHW will play a more important role and may come to represent more than 50% of the final energy required by EPBD consumption (heating, cooling and DHW). In homes built before 2006, that consumption sits at around 30% and, in areas with milder winters, may be higher; therefore, it is fundamental to ensure that the solar installation for this service works correctly.

The integration of solar thermal energy for DHW must always be considered and its use should be proposed when it is financial and technically feasible. If the DHW is produced with Joule effect electric water heaters, solar energy is even more important and is recommended whenever it is able to cover 70% of this service.

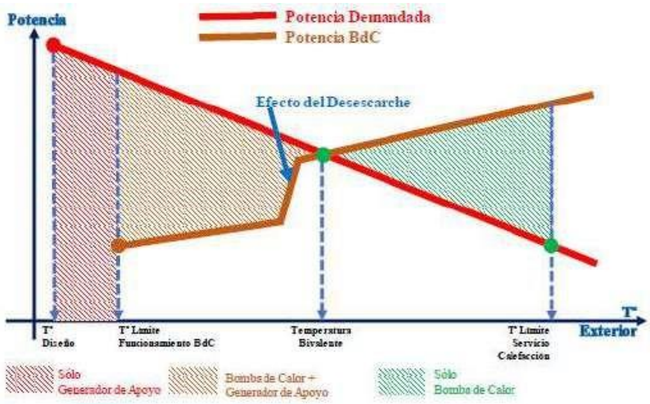
c) Heat pumps and their relationship with outdoor climatic conditions.

It is well known that heat pumps, as well as improving energy efficiency on account of their excellent performance, have the advantage that a percentage of the energy delivered is regarded as renewable, due to the fact that they extract it from natural sources: air (aerothermal), water (hydrothermal) or the ground (geothermal). Another advantage is that, in areas with a very severe summer climate (hot summers), the reversible heat pump can be used to cover demands for both cooling and heating.

However, heat pumps have some technical operational characteristics which, in the short term (2021-2030), make them difficult to incorporate in all climatic zones, due to the limits on the temperature they can reach - in general, a maximum of 60 ºC - and because their efficiency decreases with the outside temperature, above all when it falls below 7 ºC, due to defrost cycles, and back-up energy may be required.

The figure below shows the operating conditions of a heat pump, with the heating demand curve and the outside temperatures. As can be seen, there is a minimum outside temperature below which heat pumps do not work; above that temperature, their power and efficiency increases as the outside temperature increases. At around 0 ºC to 7 ºC, the effect of defrosting requirements sharply alters their performance and above that temperature their performance gradually improves again as the outside temperature rises.

Figure 7.1. Curves showing the operation of a heat pump and heating demand according to outside conditions.



	Power
	Power Required
	Heat Pump Power
	Effect of Defrosting
	T* Design
	T* Heat Pump Operating Limit
	Bivalent Temperature
	T* Heating Service Limit
	Outside
	Only Back-up Generator
	Heat Pump + Only Back-up Generator
	Only Heat Pump

Source: Spanish Technical Association for Climate Control and Refrigeration, for MITMA. ATECYR (2019) 'Report on the prospects and future development of heating and cooling and DHW systems in residential buildings'.

As a general rule and bearing the above characteristics in mind, up to 2030, the option of heat pumps is only advised in the areas with the mildest winders (up to climatic zone C), while, for the coldest areas, changing to heat pumps is not envisaged on a general basis, but rather it will be conditional on a detailed study of the planned renovation and the specific conditions in each case.

d) Heat pumps in renovations as a replacement for existing boilers.

Given the advantages as regards the efficiency of heat pumps and the long-term trend towards the electrification of the residential sector, it is necessary to analyse the potential of the heat pump as an alternative system, replacing the current systems which are mainly based on boilers (using fossil fuels) with a water-based distribution system and radiators and which usually have operating temperatures (flow and return) between 90-70 ºC and 80-60 ºC.

Obviously, an initial solution could be to dismantle the existing circuit and radiators and use an air-to-air heat pump (split). However, if the aim is just to replace the boiler with an air-to-air heat pump, retaining the radiators[134], it will be necessary to check that the existing distribution and emission subsystem can deliver the necessary power with the new service temperatures allowed by the heat pump, which will be lower than those of the original boiler.

Given that this analysis has to be carried out, in detail, in each particular case, MITMA commissioned the Spanish Technical Association for Climate Control and Refrigeration (Asociación Técnica Española de la Climatización y la Refrigeración: ATECYR) to carry out a preliminary study of the matter, which can serve as a general guide to the possible operating temperatures, analysing the different possibilities according to whether the building complies with the requirements of rule NBE CT-79 or whether it lacks thermal insulation on account of pre-dating that rule.

The main conclusions of that study are set out below[135]:

The power necessary to meet the needs of the heating demand in an existing building undergoing an extensive renovation of the building envelope was modelled, differentiating between whether or not the building complied with standard NBE CT-79 and considering different degrees of compactness and different climatic zones.

Figure 7.2. Power necessary (% of the initial amount) for heating after renovating the envelope of a building compliant with rule NBE CT-79.

POTENCIA (%) NECESARIA DEPUÉS DE LA REHABILITACIÓN						
%	COMPACIDAD	ZONA CLIMÁTICA				
POTENCIA	V/A (m)	A	B	C	D	E
TOTAL	≤ 1	78%	96%	99%	94%	84%
	≥ 4	48%	60%	63%	60%	55%

	POWER (%) NECESSARY AFTER RENOVATION
	COMPACTNESS
	CLIMATIC ZONE
	POWER
	TOTAL

Source: Spanish Technical Association for Climate Control and Refrigeration, for MITMA. ATECYR (2019) 'Report on the prospects and future development of heating and cooling and DHW systems in residential buildings'.

Figure 7.3. Power necessary (% of the initial amount) for heating after renovating the envelope of a building NOT compliant with rule NBE CT-79.

POTENCIA (%) NECESARIA DEPUÉS DE LA REHABILITACIÓN						
%	COMPACIDAD	ZONA CLIMÁTICA				
POTENCIA	V/A (m)	A	B	C	D	E
TOTAL	< 1	44%	42%	30%	26%	23%
	> 4	47%	45%	34%	29%	26%

	POWER (%) NECESSARY AFTER RENOVATION
	COMPACTNESS

[134] An optimal solution for an air-to-water heat pump is a low-temperature radiant floor; however, given the scale of the work required to install it, its scope will be limited to very extensive renovations.

[135] Spanish Technical Association for Climate Control and Refrigeration, for MITMA. ATECYR (2019) 'Report on the prospects and future development of heating and cooling and DHW systems in residential buildings'.

	CLIMATIC ZONE
	POWER
	TOTAL

Source: Spanish Technical Association for Climate Control and Refrigeration, for MITMA. ATECYR (2019) 'Report on the prospects and future development of heating and cooling and DHW systems in residential buildings'.

The aim is to determine whether or not the reduction in demand on account of the renovation can allow the new flow temperature that the radiators work with, once the boiler has been replaced with the heat pump, to be lowered and, therefore, allow the radiators (initially designed with a flow temperature of 90 ºC and a return temperature of 70 ºC or a flow temperature of 80 ºC and a return temperature of 60 ºC - design temperatures since 1998) to be able to offer similar comfort conditions to the original ones, operating at the new flow temperature of 60 ºC and return temperature of 50 ºC, that smaller thermal gap being offset by the lower thermal loads resulting from the renovation of the envelope.

It is important to point that, when such changes are made, as the power of the generators is reduced and, with it, on account of working at a lower temperature, the power that can be transferred by the radiators, the conditions of use should be modified as well. In general, users usually associate 'heating' with 'radiator temperature'. Given that the temperature of the radiators is going to be lower after the change and that that could bring about a sensation of lack of heating, users must be made aware of the fact that these solutions may require longer hours of heating than they were used to previously.

The following general considerations may be drawn from the analysis carried out by ATECYR:

- In buildings that are not very compact and which comply with rule NBE CT-79, generally, improving the envelope is not going to be sufficient to reduce the thermal load to the point where it is possible to use the existing radiators directly in order to be able work at temperatures of 60 ºC/50 ºC (acceptable for heat pumps). In such cases, if the option of installing heat pumps is ultimate chosen, it will most likely be necessary to replace the radiators with other larger ones.
- In compact buildings that comply with rule NBE CT-79, improving the envelope can make it possible to reuse the radiators that are already installed with the new working temperatures, allowing the heat pump to be incorporated directly, without the need to make changes to the rest of the installation or the radiators.
- As a general rule, in any uninsulated building (pre-dating rule NBE CT-79) which undergoes an extensive renovation in compliance with basic document DB HE of the CTE building regulations (whether voluntarily or on a mandatory basis, because it affects more than 25% of the building envelope) and which has radiator-based heating, it will - in principle - be possible to incorporate heat pumps reusing the existing distribution by radiators, as the reduction in power achieved with the renovation will be sufficient to make it possible to provide the necessary comfort conditions operating at a low temperature.

Finally, in any event, prior to replacing the boilers with heat pumps, it is also necessary to check that there is sufficient electrical power or that it is going to be possible to increase the supply. Furthermore, the heat pumps must be installed on the roof or in any suitably prepared outside area that ensures the necessary flows of outside air.

e) Energy networks and residual energy.

Whenever there is a local energy network in the vicinity of the building, or the opportunity to make use of residual energy, it must be used if it is technically and financially feasible.

There are many municipalities that are close to industries whose activity generates residual thermal energy that can be exploited for domestic thermal installations. To that end, additional infrastructure is required to connect the buildings - the building generating the by-product (industry) and the buildings where there is the demand (homes) - which normally does not exist. It is important to point it out in studies relating to renovation, so that, if it was not already, the local authority is aware of its potential, and its viability must be analysed in future plans relating to urban and regional planning.

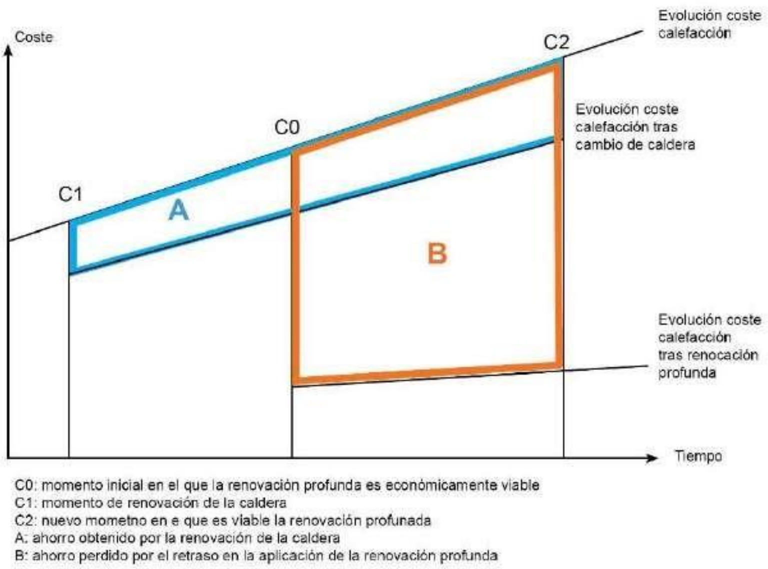
7.1.6. Regarding the order of intervention with regard to buildings: the correct sequencing of actions involving the installations and the building envelope.

In the case of an energy renovation intervention, the order in which the actions are carried out has a major impact on the results, especially on the savings achieved and, therefore, the profitability of the investments made.

In the useful life of a building, there is a point at which energy costs - and likely future changes in those costs - make the extensive renovation of the building profitable, achieving a reduction in consumption which may be up to 80% of the initial consumption. At that point, it is assumed that - at least in theory - the renovation would be initiated simply on account of its profitability. However, that does not imply that no other intervention should be carried out up to that point. On the contrary, the identification of that critical moment should be the starting point for thinking about the opportunity to ‘bring forward’ certain actions to improve energy efficiency and for assessing their consequences, as well as taking advantage of the opportunities and synergies offered by other interventions, such as, for example, ordinary conservation or the work resulting from the ITE building technical inspection or the IEE building assessment report, which is mandatory in nature.

The most important dilemmas arising in this regard are those around determining the optimum moment for changing a heating boiler (whether by simply replacing it with another more efficient one when it reaches the end of its useful life, as well as changing the fuel used, or, in more complex cases, even changing the system, for example, to an air/water heat pump), at the same time bearing in mind its relationship with the energy renovation of the building envelope.

Figure 7.4. Influence of the order of the intervention on the savings achieved.



	Cost
	Change in heating cost
	Change in heating cost after changing the boiler
	Change in heating cost after extensive renovation
	Time

	C0: initial point at which extensive renovation is financially viable
	C1: point at which the boiler is replaced
	C2: new point at which extensive renovation is viable
	A: saving achieved by replacing the boiler
	B: saving lost by delaying extensive renovation

Source: Albert Cuchí (Technical University of Catalonia).

The above graph shows the point at which, theoretically, it would be profitable to carry out an extensive energy renovation of the building envelope (point C0) and the savings (area B) that could be achieved by doing so.

However, if previously (at point C1) the boiler had been replaced (for example, simply renewing it on account of it reaching the end of its useful life) with another more efficient one (generating a certain amount of savings: A), that lower consumption after the renewal of the boiler would lead to a delay in the point at which the renovation of the building envelope would become profitable (point C2).

If point C1 were very close to C0 and point C2 fell within the boiler's amortisation period, we should include part of the price of the boiler in the cost of the intervention, while also taking into account the fact that the power of the boiler would be inappropriate. Obviously, it is positive to change to a more efficient boiler before point C0 if the financial saving obtained on account of energy saving A, produced by changing the boiler, is greater that the financial saving obtained by energy saving B, now lost by moving the extensive renovation from C0 to C2. But that is not true when the opposite is the case.

So, when a boiler change is necessary, it is important to do a complete analysis of the options for improving the building, such that those possibilities as a whole are not lost or delayed, bringing forward, where appropriate, other measures that are a priori less profitable, such as improving the building envelope.

This analysis of simply changing a boiler by replacing it with a new one can also be extended to changing the fuel used or the air conditioning system, operations which - like the boiler - have their own logic, which is also linked to the lifespan of the available technical equipment or its amortisation. Like changing the boiler, those changes must also be considered and properly evaluated in the model in order to determine their overall financial viability.

This exercise should also be carried out when taking advantage of opportunities, such as the need to remodel a façade and/or roof for reasons of conservation or maintenance, when the opportunity arises to bring forward investment in insulation and/or improving windows, or even to undertake a full extensive energy renovation operation. In such cases, the need for remodelling may also imply significant savings in the work involved in an extensive energy renovation (cost of scaffolding and other auxiliary resources), even if the financial return it offers as regards the energy savings obtained is - as in the case of thermal insulation - lower than that obtained by changing installations. In such cases, various scenarios should be evaluated:

Work on the façade for reasons of maintenance or conservation:

- Bring forward insulating walls.
- Bring forward improving windows.
- Bring forward insulating walls and improving windows.
- Bring forward the entire extensive energy renovation.

Work on the roof for reasons of maintenance or conservation:

- Bring forward insulating the roof.
- Bring forward the entire extensive energy renovation.

Similarly, if resolving the building's accessibility problems involves interventions that present opportunities to bring forward, in an efficient manner, investments in an extensive energy renovation, the relevant scenarios will also have to be assessed.

A potential improvement in habitability on account of the possibility of increasing the floor area of the dwelling due to a relevant amendment of the urban planning rules could also be the trigger for an energy renovation.

In any of these cases, the concept of the building manual or renovation passport could make it easier to analyse each case and identify the opportunities for improving each building, not only in terms of energy, and also to establish the correct order in order to achieve the best possible result, both in terms of savings and in terms of improving the habitability and resilience of the buildings.

7.1.7. Impact of energy efficiency interventions on safety in the event of fire and safety in the event of earthquakes.

Interventions aimed at improving the energy efficiency of buildings by carrying out work on their building envelope are passive strategies that result in improved energy performance for those buildings and lower consumption of energy of any kind, whether renewable or otherwise.

It must be borne in mind that altering the exterior envelope of the buildings not only alters their energy performance, but also affects other aspects of their functioning that cannot be disregarded. Aspects of their functioning that may be affected are those related to the performance of the building in the event of fire or in the event of earthquakes.

Point 7 of Article 1(2) of Directive (EU) 2018/844 of the European Parliament and of the Council amending Directive 2010/31/EU on the energy performance of buildings and Directive 2012/27/EU on energy efficiency, states that 'Each Member State may use its long-term renovation strategy to address fire safety and risks related to intense seismic activity affecting energy efficiency renovations and the lifetime of buildings'. Based on this indication, the following considerations are made.

a) Impact on earthquake safety

The fire performance of a building façade is determined by the ability of the façade to limit the external spread of a fire. This capacity is influenced by the characteristics of the construction systems that make up the façade as well as the distribution of openings in the façade and its volumetric characteristics. With regard to the characteristics of the materials and construction systems that make up the façades, the parameter that characterises their behaviour in the event of fire is their reaction to fire. Pursuant to Council Directive 89/106/EEC of 21 December 1988 on the approximation of laws, regulations and administrative provisions of the Member States relating to construction products, the Commission has established, by means of corresponding decisions, a common framework for classifying the reaction and resistance to fire performance of construction products and construction elements, the so-called Euroclass system. Reaction properties are those that limit the occurrence and spread of fire and smoke in the event of a fire. Thus, construction products and construction systems are classified according to their reaction to fire based on certain parameters that describe the temperature increase in a fire, the loss of mass, the speed of fire propagation, the emission of heat, the production of smoke or the fall of flaming droplets and particles. Construction products are classified according to a scale and assigned classes A1, A2, B, C, D, E and F, depending on their better or worse reaction to fire. There are certain materials that are considered to be classified in class A, the class of materials that do not contribute to fire, the so-called 'non-combustible' materials, without the need for testing. These materials include, for example, concrete, baked clay bricks, cement, lime, plaster, plastering mortars, natural stone and mineral wool.

The trend for the composition of façades in Spain, especially in residential use, has gone from the predominance of solid masonry walls, mostly of brick, stone or earth in buildings constructed before 1960, to the appearance of double-leaf cavity walls, which after the publication of the NBE -CT/79 (Basic standard on thermal conditions in buildings), improved their thermal performance by incorporating insulation in the cavity between the two leaves. In the composition of these façades, in any of the previously described construction types, traditional materials such as brick, in brickwork finishes or plastered with mortar or stone cladding, have played a very important role. These solutions have good fire performance and, as indicated above, these materials are among those that are class A materials without the need for testing.

For the first time in Spanish regulations, a specific reaction to fire class has been required for façade materials since the approval of the Technical Building Code in 2006, the documents of which include the Basic Fire Safety Document. Of course, the class required refers to the Euroclass classification system. The reaction to fire requirements for façade materials are set according to the height of the façade, as this is the parameter that determines the need to ensure a certain performance of the material. It is buildings with higher evacuation heights, with a greater need for means of evacuation (especially stairs) and a greater requirement for protection of and dependence on these means, that need to prevent the façade from contributing to the spread of fire. In 2006, Spanish regulations established the requirement of a class B rating for the façade materials of buildings with a height of more than 18 metres and for the first section of the façade of buildings easily accessible from the public road and susceptible to fire as a result. In addition, it also required a class B rating for insulation materials in ventilated wall cavities. In establishing these requirements, Spanish regulations took a first step towards the classification of façades in respect of fire. However, the reality of the composition of façades in the vast majority of buildings in Spain up to the time of the approval of the Technical Building Code, and therefore the predominance of façades with materials with good intrinsic fire performance and which complied with the regulatory requirements without difficulty, should be taken into account.

This reality has evolved over time, driven by technical innovations in construction materials and systems, by the advance of industrialisation and standardisation and by the process of globalisation of construction solutions. Over time, new façade solutions have been incorporated into the Spanish market, which were initially intended for tertiary sector uses, other than residential, but which have gradually become popular in residential use as well. The development of lightweight façades, ventilated façades and the evolution of their insulation materials and cladded façades, with the proliferation of EIFSs (Exterior Insulation and Finish Systems) have altered the usual façade types in Spain in recent years. In addition, the energy efficiency requirements for buildings have increased considerably in recent years and many of the new façade materials more than meet the requirements of the energy-saving regulations. The incorporation of new façade solutions has of course taken place in new construction, but it has also occurred in the field of renovation. Intervention solutions on the external envelope involving cladding the existing façade with a new material are easy to implement and provide significant and long-lasting improvements in the energy performance of the building. It should be noted, however, that these construction materials and solutions have a more complex behaviour in the event of a fire than traditional materials. These construction products are often made of multiple materials, using materials other than the traditional ones used until now or construction solutions anchored in lightweight structures, the behaviour of which in the event of fire is also relevant and which sometimes use physical barrier solutions in the ventilated cavities.

In Spain, it has been considered that this evolution in the composition of façades required an adaptation of the regulations to the new reality, an adaptation that has also gone hand in hand with the gradual incorporation of greater energy efficiency requirements for the building envelope. The most recently approved amendment of the Technical Building Code, published in December 2019, which also transposed the requirements of Directive 2010/31/EU on the energy performance of buildings, included an amendment of the Basic Fire Safety Document, focusing on external propagation through the façade. In this amendment, the required reaction to fire classes for façade construction systems and insulation systems in cavities have been tightened, both for low-rise buildings, where the regulations had no previous requirements, and for high-rise buildings with a façade height of more than 28 metres. A new requirement has also been introduced in relation to the parameter measuring the release of flaming droplets and particles in fires, given the evidence of the importance of this phenomenon in the evolution of fires. This tightening of the requirements will be applicable in Spain both for new-build offices and for interventions on existing buildings. In the case of the energy renovation of buildings, it is essential to take into account not only the required classes but also the so-called ‘no-worsening’ criterion, which is a basic principle of renovation in Spanish building regulations. This criterion means that an intervention on an existing building cannot worsen the pre-existing safety conditions of the building prior to the intervention. This criterion is particularly relevant in the case of interventions on existing buildings precisely because of the remarkable evolution in the materials present on the façades.

Fire safety in a building is defined by the overall characteristics of the building. It is not only the performance of the façade that determines the fire safety level of a building. This level of risk is determined by a combination of passive and active means of protection against fire, a combination of means in which the sectioning of the building, the means of evacuation available, the protection of these means which can guarantee that in the event of fire they will be sufficiently sectioned off from the rest of the building and will not be affected by smoke or the fire protection installations available in the building play their role. Other issues, such as the management of the building or the correct definition and implementation of a self-protection plan, also play a role. In many cases, existing buildings have different fire protection conditions than buildings with the same floor area, use, location or height would have under current regulations. It is common that they are not sectioned off in the same way as a new building of the same surface area or height, or that their evacuation elements, exits or stairs are not present in the same number or with the same protection conditions as in a new building. At the same time, as has been indicated, until recently in Spain the façade types that were mostly used employed materials and construction techniques that, although they had their shortcomings from the point of view of saving energy, had excellent fire performance. When intervening in existing buildings, it is necessary to determine whether or not changing the characteristics of the external envelope of buildings that do not have the same sectioning off, stair protection or fire brigade access conditions as a new building with the same characteristics - use, floor area, height, etc. - undermines the overall safety level of the building. An intervention on the envelope may require, and an assessment should always be carried out by competent technicians, the installation of additional fire protection measures in order to maintain the overall level of safety or it may be necessary to consider a higher requirement for the reaction to fire class of a façade material in an existing building than would be required in a new building if the existing building is deficient in its level of safety.

Finally, with regard to the development of fire protection in façades, it should be noted that work is ongoing at European level to harmonise a large-scale façade testing system. The problem with the description of façade construction systems in terms of fire resistance using Euroclass system stems from the fact that this classification system describes products on the basis of laboratory tests, which do not faithfully reproduce the stresses to which the products would actually be subjected in a full-size façade. The large-scale façade tests are intended to reproduce the actual behaviour of building systems on façades of a certain height more reliably.

b) Impact on earthquake safety

Spain is not a country with a high risk of seismic activity, but it does have some areas with a higher seismic hazard, mainly part of its Mediterranean coast, due to its proximity to the boundary of two convergent tectonic plates. The seismic hazard in the national territory is reflected in the Seismic Hazard Map of the Earthquake Resistant Construction Standard NCSE-2002, approved by Royal Decree 977/2002. The area in Spain with the highest probability of earthquakes is located between the provinces of Granada, Almeria, Murcia and Alicante, and also affects the cities of Ceuta and Melilla. This is the area where the largest earthquakes have occurred, including the Lorca earthquake in 2011, which killed 9 people and affected 80% of the dwellings in the town. Other regions such as the north of Girona and Huesca, the province of Huelva, or the provinces of Lugo and Orense are also at risk of earthquakes, though their occurrence is less likely.

A similar thought process can be used in relation to the impact of energy renovation on the increased risk in case of earthquakes as used for the impact on fire safety. As mentioned above, lightweight façade solutions, ventilated cavities and cladding solutions are increasingly being introduced on the market. Many of these solutions are based on the installation of substructures and panel systems anchored to the original façade. The Earthquake Resistant Construction Standard has a general criterion regarding its application in refurbishments and renovations, which states that earthquake safety may only be increased. It also establishes criteria for the non-structural elements of the building, giving the specific example of façade panels, stating that they should be properly connected to the structural elements in order to prevent detachment of parts during earthquakes, especially where the ductility of the structure is assumed to be high or very high. The Standard establishes other requirements, such as the special care that must be taken to avoid the danger of detachment of any construction systems, façades or other aspects, that could compromise the building's evacuation routes. While these criteria must be taken into account in all new buildings, they are particularly relevant in interventions on existing buildings where work is carried out on a building with a number of preconditions and possible shortcomings at the outset.

c) Energy renovation as a trigger for upgrading other building services

While intervention on the building envelope, which is generally aimed at improving its energy performance, should always be carried out bearing in mind the building's initial conditions, in order to prevent its safety level against hazards such as fire or earthquakes from being worsened, this should not be seen as a hindrance to this type of action. These actions can be the trigger for interventions that not only improve energy performance, but also serve to improve the overall safety of the building. The sufficiently detailed study of the current state of a building at the time of undertaking its renovation is an opportunity to analyse its weaknesses and design the most effective possible solution for them, a solution that might not be carried out if global renovations to the building envelope were not undertaken. To this end, it is important that all the parties involved in the renovation process are properly trained and that such training takes into account all the features that a building must fulfil in order to ensure the greatest possible suitability for all of them.

7.2. COST-EFFECTIVE APPROACHES TO RENOVATING AND IMPROVING THE ENERGY PERFORMANCE OF THE ENVELOPE IN THE RESIDENTIAL SECTOR.

7.2.1. Model of the distribution of heating consumption in dwellings at province level.

a) Advance study: Alignment with residential energy needs for heating.

Among the advance studies for the update of the Long-Term Strategy for Energy Renovation in the Building Sector in Spain (ERESEE), a specific study has been carried out entitled *Aproximación a la demanda energética residencial para calefacción en España*[136] covering the entire national territory, although it uses the province as the unit of analysis, which subsequently allows for aggregate analyses by climatic zones or by Autonomous Communities.

The classification of the residential building stock has been carried out on the basis of the 15 clusters described previously in Chapter 1 and formed from the cross-referencing of 3 variables: type of dwelling, number of floors and construction period. In this way, a breakdown of demand is obtained in 750 cases: type of dwelling (2), province (50), number of floors (2) and construction period (5).

With regard to the orientation of residential buildings, 2 simplified hypotheses have been developed: North-South and East-West. However, in order to summarise these two hypotheses, the results are presented as the average value of both hypotheses.

The study has used a static calculation method applied on a month-by-month basis based on the calculation of the energy balance. This system consists of a simplified calculation procedure that allows the assessment of the energy demand for heating of a dwelling, taking into consideration the main factors affecting the exchange of energy with the outside. The application of the above method is entirely appropriate given the size of the study and the precision of the input data. This is all the more true since the interest of the study for the rest of the ERESEE is essentially based on the relative relationships between the 750 case studies.

b) Consumption segmentation methodology.

[136] https://www.mitma.gob.es/el-ministerio/planes-estrategicos/estrategia-a-largo-plazo-para-la-rehabilitacion-energetica-en-el-sector-de-la-edificacion-en-espana

Based on the segmentation prior to calculation of demand, this theoretical demand for the Spanish housing stock as a whole has been adjusted using the real energy consumption data from MITERD, through its adjustment using the TIMES-SINERGIA model, which is itself consistent with the aggregate energy consumption data published by MITERD-IDAE in the Annual Balance Sheets.

Firstly, the data from the TIMES-SINERGIA model reworked by MITMA are processed, relating to the number of dwellings and energy consumption, broken down by type of dwelling (2), energy source (11) and heating system (7). From the cross-referencing and study of the available information, a set of the 9 most representative technologies (energy source + heating system) is established, which account for 99.0% of the heating energy consumption and 98.8% of the main dwellings with heating.

At the same time, the INE 2018-2033 household projection data is analysed. On this data set, a series of operations are performed in order to achieve a database comparable to the one extracted from the TIMES-SINERGIA model. Firstly, from the total number of 18 771 653 existing main dwellings, dwellings without heating systems (1 944 030) are discarded, followed by dwellings in Ceuta and Melilla (6 178), and finally dwellings with non-significant technologies (223 318). The result is 16 598 127, which turns out to be the set of main dwellings with heating that can be cross-referenced with the TIMES-SINERGIA model set (called the 'Modellable' Package).

Once the number of main dwellings with heating systems and significant technologies and their associated consumption has been defined, the data is broken down to the lowest scale of the study: the individual case.

In this regard, firstly, the heating energy consumption values from the SPAHOUSEC 2011 are used, broken down by climatic zone (3) and energy source (4). In this way, an initial breakdown of the consumption in 27 cases is obtained: climatic zone (3) and technology (9).

This consumption of the 'Modellable' Package is then broken down by type of dwelling. In this respect, the demand data from the aforementioned prior study *Aproximación a la demanda energética residencial para calefacción en España* is used together with the data already available from the SPAHOUSEC, which is segmented only by 2 dwelling types. In this way, a second breakdown of the consumption in 81 cases is obtained: climatic zone (3), technology (9) and type of dwelling (3).

The next step is to segment the new distribution according to province (50) and construction period (7). In this sense, the study of demand that presents values broken down at this level is again used; it is considered that the initial distribution of energy demand for heating is similar to the distribution of consumption. In this way, a third breakdown of the consumption in 9 450 cases is obtained: climatic zone (3), technology (9), type of dwelling (3), province (50) and construction period (7).

The next step is to segment the new distribution according to size of municipality (2). In this case, the previously created household breakdown that has this segmentation is used. In this way, a fourth breakdown of the consumption in 18 900 cases is obtained: climatic zone (3), technology (9), type of dwelling (3), province (50), construction period (7) and size of municipality (2).

Finally, the last step is to segment the new distribution according to energy poverty situation (2). In this case, the ACA study entitled *Pobreza, vulnerabilidad y desigualdad energética. Nuevos enfoques de análisis. España 2006-2016* is used. In this way, a final breakdown of the consumption in 37 800 cases is obtained: climatic zone (3), technology (9), type of dwelling (3), province (50), construction period (7), size of municipality (2) and energy poverty (2).

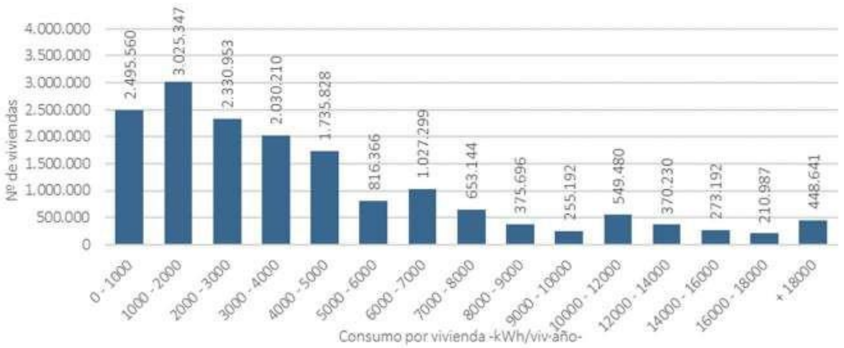
c) Distribution of main dwellings by initial heating consumption

Based on the segmentation methodology, the initial heating consumption is established for each of the 37 800 cases representing the set of 16 598 127 main dwellings with heating and significant technologies (the 'Modellable' Package).

This first set of 37 800 cases is established by cross-referencing the following variables:

- Type of dwelling (3): single-family; collective; block.
- Construction period (7): up to 1900; 1901 to 1940; 1941 to 1960; 1961 to 1980; 1981 to 2007; 2008 to 2020; after 2021.
- Size of the municipality (2): rural (<20 000), urban (>20 000).
- Province (50): P01 to P50.
- Heating technology (9): LPG boiler or heater; LPG stoves, braziers, fireplaces; Fuel oil boiler or heater; Natural gas boiler or heater; Natural gas convector; Biomass boiler or heater; Biomass stoves, braziers, fireplaces; Electrical aerothermal heat pump; Electrical boiler or heater.
- Energy Poverty situation (2): yes; no.

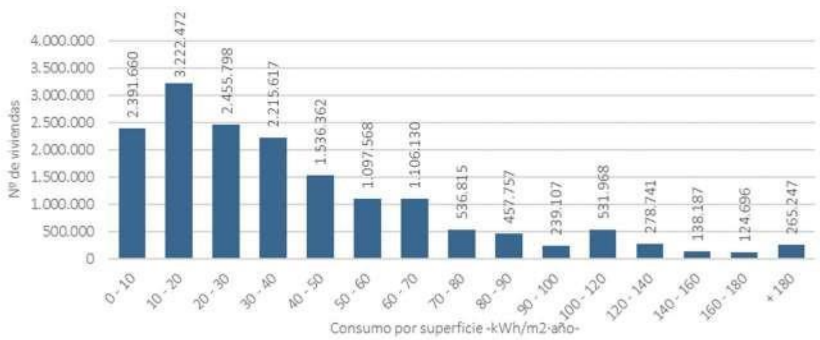
Figure 7.5. Distribution of the 16 598 127 dwellings by initial consumption per dwelling (kWh/dwelling per year)



	No of dwellings
	Consumption per dwelling (kWh/dwelling per year)

Source: Cíclica [Space, Community, Ecology] for MITMA.

Figure 7.5. Distribution of the 16 598 127 dwellings by initial consumption by floor area (kWh/m² per year)



	No of dwellings
	Consumption by floor area (kWh/dwelling per year)

Source: Cíclica [Space, Community, Ecology] for MITMA.

d) Distribution of the dwellings to be renovated by initial heating consumption

From the aforementioned set of 37 800 cases, an initial filtering is carried out in order to focus the intervention on the dwellings that can be renovated through common mechanisms, resulting in the subset or 'Common

Renovation Package’, consisting of 10 402 cases and 13 280 250 dwellings. As part of this filtering, the following dwellings are discarded from this Package:

- Dwellings in a situation of energy poverty: 2 572 361 dwellings.

  This Package, named the ‘Energy Poverty’ Package is analysed separately and has a specific heading in this chapter.

- Dwellings built between 2008 and 2020: 745 516 dwellings.

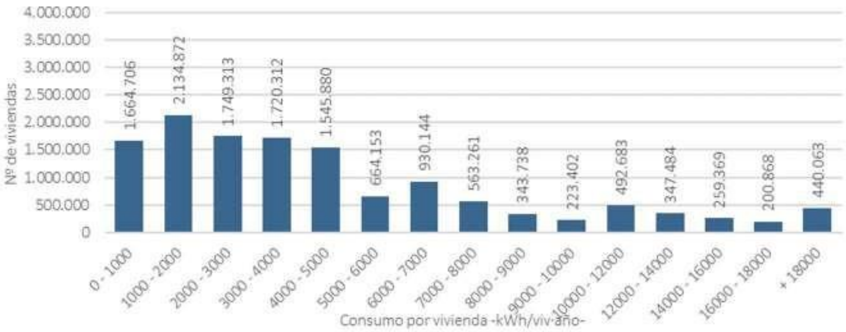
  It is assumed that these dwellings, named the ‘Dwellings built 2008-2020’ Package, built to the standards of the Technical Building Code, do not need a deep envelope renovation in the medium term, and are therefore left out of the envelope renovation analysis.

Figure 7.6. Distribution of the 13 280 250 dwellings by initial consumption per dwelling (kWh/dwelling per year)

Consumption ranges (kWh/dwelling per year)	**0 - 4 000**	**4 000 - 8 000**	**8 000 - 12 000**	**12 000. - 16 000**	**+ 16 000**	**Total**
‘Common Renovation’ Package	7 269 205	3 703 438	1 059 823	606 853	640 931	13 280 250
‘Energy Poverty’ and ‘Dwellings built 2008-2020’ Packages	2 612 867	529 199	120 545	36 569	18 697	3 317 877
‘Modellable’ Package	9 882 070	4 232 637	1 180 368	643 422	659 628	16 598 127

Source: Cíclica [Space, Community, Ecology] for MITMA.

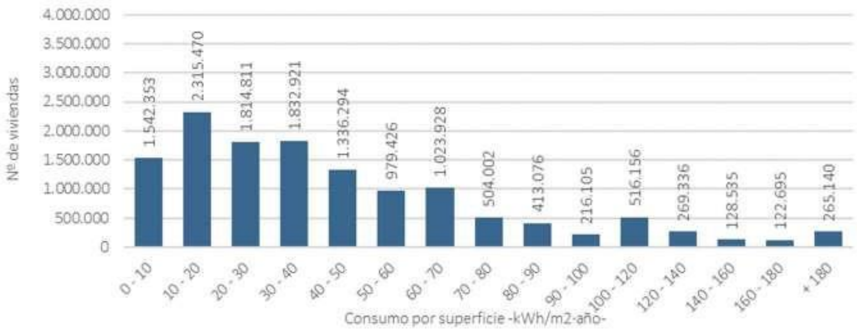
Figure 7.7. Distribution of the 13 280 250 dwellings by initial consumption per dwelling (kWh/dwelling per year)



	No of dwellings
	Consumption per dwelling (kWh/dwelling per year)

Source: Cíclica [Space, Community, Ecology] for MITMA.

Figure 7.8. Distribution of the 13 280 250 dwellings by initial consumption by floor area (kWh/m2 per year)



	No of dwellings
	Consumption per dwelling (kWh/dwelling per year)

Source: Cíclica [Space, Community, Ecology] for MITMA.

7.2.2. Definition of the envelope renovation menus

Once the subset of the 10 402 cases and 13 280 250 dwellings of the ‘Common Renovation Package’ has been established, we define the intervention menus that define the post-intervention scenario, according to their belonging to each of the 21 clusters considered (see Chapter 1). These data are mainly linked to the thermal transmittance and thermal capacity of each of the surfaces of the external envelope of the building and are based on the study carried out by CSIC-Eduardo Torroja Institute for Construction Science (Construction Quality Unit).

Table 7.9. Summary of transmittance values by cluster and building scenario - W/m²-K-

	Escenario actual				Escenario post-intervención				Variación entre escenarios			
Clúster	Muro	Cubierta	Solera	Ventana	Muro	Cubierta	Solera	Ventana	Muro	Cubierta	Solera	Ventana
Uu <1900	2,12	3,00	1,45	4,24	0,50	0,44	0,64	1,81	-76%	-85%	-56%	-57%
Uu 01-40	2,12	3,00	1,45	4,24	0,50	0,44	0,64	1,81	-76%	-85%	-56%	-57%
Uu 41-60	2,12	2,47	1,45	4,24	0,50	0,44	0,64	1,81	-76%	-82%	-56%	-57%
Uu 61-80	1,85	2,03	1,52	4,24	0,50	0,44	0,57	1,81	-73%	-78%	-62%	-57%
Uu 81-07	1,40	1,13	1,20	4,04	0,50	0,44	0,55	1,81	-64%	-61%	-54%	-55%
Uu 08-20	0,83	0,47	1,39	3,37	0,83	0,47	1,39	3,37	0%	0%	0%	0%
Uu >2021	-	-	-	-	-	-	-	-	-	-	-	-
Cc <1900	2,12	2,21	1,15	4,24	0,60	0,50	0,76	1,81	-72%	-77%	-34%	-57%
Cc 01-40	2,12	2,21	1,15	4,24	0,60	0,50	0,76	1,81	-72%	-77%	-34%	-57%
Cc 41-60	2,08	2,21	1,15	4,24	0,60	0,50	0,76	1,81	-71%	-78%	-34%	-57%
Cc 61-80	1,40	1,70	1,15	4,24	0,54	0,50	0,71	1,81	-61%	-71%	-38%	-57%
Cc 81-07	1,40	1,13	1,00	4,04	0,52	0,51	0,60	1,81	-63%	-55%	-40%	-55%
Cc 08-20	0,83	0,47	1,39	3,37	0,83	0,47	1,39	3,37	0%	0%	0%	0%
Cc >2021	-	-	-	-	-	-	-	-	-	-	-	-
Bb <1900	1,94	2,06	1,15	4,24	0,60	0,50	0,76	1,81	-69%	-76%	-34%	-57%
Bb 01-40	1,94	2,06	1,15	4,24	0,60	0,50	0,76	1,81	-69%	-76%	-34%	-57%
Bb 41-60	1,81	1,74	1,14	4,24	0,60	0,50	0,78	1,81	-67%	-71%	-31%	-57%
Bb 61-80	1,68	1,74	1,14	4,24	0,52	0,50	0,62	1,81	-69%	-71%	-45%	-57%
Bb 81-07	1,40	1,13	1,00	4,04	0,58	0,51	0,79	1,81	-59%	-55%	-21%	-55%
Bb 08-20	0,83	0,47	1,39	3,37	0,83	0,47	1,39	3,37	0%	0%	0%	0%
Bb >2021	-	-	-	-	-	-	-	-	-	-	-	-

	Cluster
	Current scenario
	Wall
	Roof
	Floor
	Window
	Post-intervention scenario
	Wall

	Roof
	Floor
	Window
	Variation between scenarios
	Wall
	Roof
	Floor
	Window

Source: CSIC-Instituto de Ciencias de la Construcción Eduardo Torroja [Eduardo Torroja Institute for Construction Science] (Construction Quality Unit) and MITMA.

In all cases, these are deep envelope renovations, in which savings of more than 60% are achieved[137].

Based on the constructive definition of the envelope of each case, together with a series of assumptions and input data (setpoint temperatures, internal loads by occupancy, lighting and appliances, ventilation airflow, solar radiation), a double energy simulation is carried out for each case, for its characteristics in the current scenario and in the post-intervention scenario.

Since the purpose of this section is to identify the improvements due to renovation actions on the building envelope, the energy simulation is carried out based on the concept of energy demand; this consideration allows reducing the number of cases to be simulated from 10 402 to 2 100 cases, by eliminating the 'Heating technologies' variable.

Once the simulation has been carried out for each of the 2 100 cases, the percentage reduction in demand obtained is applied to the set of 10 402 similar cases, obtaining the new heating energy consumption values after the envelope improvement actions.

Table 7.10. Summary of results by cluster for the envelope renovation menus

Clúster	Nº viviendas	Consumo inicial		Ahorro energético			Coste económico	
		Total GWh/año	Vivienda kWh/viv·año	Total GWh/año	Vivienda kWh/viv·año	Total -%-	Total -M€-	Vivienda -€/viv-
Uu <1900	215.462	3.145	14.597	2.484	11.528	79%	3.058	14.192
Uu 01-40	332.726	4.368	13.129	3.461	10.403	79%	4.381	13.167
Uu 41-60	461.697	4.944	10.709	3.853	8.345	78%	7.194	15.582
Uu 61-80	941.372	10.779	11.450	8.053	8.555	75%	14.945	15.875
Uu 81-07	2.207.191	17.924	8.121	11.965	5.421	67%	45.529	20.628
Cc <1900	53.643	349	6.508	253	4.710	72%	557	10.386
Cc 01-40	91.689	541	5.898	393	4.289	73%	900	9.819
Cc 41-60	234.364	1.220	5.204	881	3.760	72%	2.473	10.553
Cc 61-80	559.767	2.068	3.694	1.352	2.416	65%	4.817	8.606
Cc 81-07	1.018.342	2.789	2.738	1.739	1.707	62%	10.248	10.063
Bb <1900	88.872	398	4.477	277	3.120	70%	638	7.181
Bb 01-40	192.968	846	4.382	590	3.059	70%	1.359	7.043
Bb 41-60	629.578	2.469	3.921	1.682	2.671	68%	5.203	8.264
Bb 61-80	3.310.277	10.815	3.267	7.462	2.254	69%	19.734	5.962
Bb 81-07	2.942.302	5.959	2.025	3.604	1.225	60%	22.368	7.602
TOTAL	13.280.250	68.612	5.167	48.050	3.618	70%	143.405	10.798

	Initial consumption
	Energy saving
	Financial cost
	Cluster
	No of dwellings
	Total
	Dwelling

[137] According to the Staff Working Document accompanying the Commission's 2013 report entitled Financial support for energy efficiency in buildings (9), 'deep renovation' can be understood as a renovation that generates significant efficiency improvements (typically of more than 60%).

	GWh/year
	kWh/dwelling per year
	- In millions of €-
	- €/dwelling -

Source: Cíclica [Space, Community, Ecology] for MITMA.

Table 7.11. Results by cluster and Technical Building Code climatic zone for the envelope renovation menus

Clúster	Nº viviendas	Consumo inicial		Ahorro energético			Coste económico	
		Total GWh/año	Vivienda kWh/viv·año	Total GWh/año	Vivienda kWh/viv·año	Total -%-	Total -M€-	Vivienda -€/viv-
Uu <1900	10.357	70	6.771	62	6.010	89%	122	11.788
Uu 01-40	25.528	167	6.548	148	5.799	89%	290	11.376
Uu 41-60	58.716	329	5.603	285	4.851	87%	820	13.958
Uu 61-80	121.007	715	5.909	585	4.834	82%	1.746	14.428
Uu 81-07	298.924	1.009	3.374	757	2.533	75%	5.341	17.868
Cc <1900	3.568	9	2.434	7	2.035	84%	33	9.178
Cc 01-40	5.951	13	2.247	11	1.872	83%	51	8.629
Cc 41-60	19.440	39	1.986	32	1.646	83%	186	9.587
Cc 61-80	48.997	62	1.262	48	979	78%	404	8.254
Cc 81-07	103.018	84	812	66	643	79%	941	9.139
Bb <1900	1.634	3	1.545	2	1.280	83%	10	6.252
Bb 01-40	4.712	8	1.643	6	1.360	83%	30	6.435
Bb 41-60	22.821	28	1.208	22	968	80%	170	7.445
Bb 61-80	195.957	220	1.122	170	869	77%	1.137	5.801
Bb 81-07	192.740	94	489	74	382	78%	1.391	7.217
ZONA A	1.113.370	2.848	2.558	2.276	2.045	80%	12.674	11.383
Uu <1900	52.702	495	9.399	425	8.061	86%	687	13.039
Uu 01-40	97.879	868	8.871	741	7.576	85%	1.214	12.405
Uu 41-60	161.260	1.191	7.386	987	6.118	83%	2.368	14.685
Uu 61-80	317.015	2.368	7.470	1.858	5.860	78%	4.532	14.296
Uu 81-07	680.123	3.098	4.555	2.224	3.270	72%	12.018	17.671
Cc <1900	13.489	50	3.675	39	2.890	79%	129	9.600
Cc 01-40	32.295	111	3.428	87	2.703	79%	299	9.254
Cc 41-60	77.105	229	2.974	180	2.330	78%	767	9.948
Cc 61-80	184.885	356	1.924	255	1.377	72%	1.472	7.960
Cc 81-07	332.625	417	1.253	304	913	73%	2.978	8.953
Bb <1900	10.899	26	2.399	20	1.878	78%	76	6.968
Bb 01-40	26.771	63	2.340	49	1.826	78%	182	6.794
Bb 41-60	114.828	210	1.827	158	1.378	75%	894	7.782
Bb 61-80	763.270	1.226	1.607	902	1.182	74%	4.347	5.695
Bb 81-07	809.880	639	789	462	570	72%	5.601	6.916
ZONA B	3.675.026	11.347	3.088	8.691	2.365	77%	37.564	10.221

	Initial consumption
	Energy saving
	Financial cost
	Cluster
	No of dwellings
	Total
	Dwelling
	GWh/year
	kWh/dwelling per year
	- In millions of €-
	- €/dwelling -
	ZONE A
	ZONE B
	ZONE C
	ZONE D
	ZONE E

Uu <1900	103.623	1.474	14.225	1.156	11.157	78%	1.493	14.411
Uu 01-40	144.135	1.900	13.179	1.483	10.291	78%	1.909	13.241
Uu 41-60	160.283	1.861	11.612	1.420	8.858	76%	2.572	16.044
Uu 61-80	317.039	3.983	12.562	2.923	9.220	73%	5.276	16.643
Uu 81-07	664.826	5.805	8.732	3.947	5.937	68%	14.339	21.567
Cc <1900	24.503	143	5.839	102	4.168	71%	255	10.418
Cc 01-40	33.003	191	5.780	136	4.115	71%	331	10.022
Cc 41-60	82.616	429	5.198	303	3.673	71%	891	10.789
Cc 61-80	191.626	730	3.809	471	2.456	64%	1.709	8.920
Cc 81-07	333.904	955	2.859	626	1.874	66%	3.570	10.692
Bb <1900	43.656	157	3.585	108	2.479	69%	314	7.194
Bb 01-40	86.670	306	3.526	211	2.434	69%	609	7.023
Bb 41-60	245.107	771	3.145	516	2.107	67%	1.994	8.137
Bb 61-80	1.264.686	3.615	2.859	2.456	1.942	68%	7.528	5.953
Bb 81-07	998.802	1.814	1.816	1.196	1.197	66%	7.774	7.784
ZONA C	4.694.479	24.132	5.141	17.054	3.633	71%	50.565	10.771

Uu <1900	42.574	954	22.415	729	17.131	76%	671	15.750
Uu 01-40	55.384	1.194	21.564	913	16.483	76%	834	15.055
Uu 41-60	65.771	1.214	18.463	910	13.831	75%	1.165	17.720
Uu 61-80	154.527	2.981	19.291	2.171	14.051	73%	2.853	18.460
Uu 81-07	471.611	6.506	13.794	4.122	8.740	63%	11.795	25.009
Cc <1900	11.277	135	12.008	96	8.496	71%	131	11.600
Cc 01-40	19.384	211	10.861	149	7.665	71%	208	10.755
Cc 41-60	52.956	494	9.324	347	6.550	70%	604	11.413
Cc 61-80	125.758	838	6.667	530	4.216	63%	1.156	9.189
Cc 81-07	228.525	1.192	5.214	671	2.935	56%	2.552	11.168
Bb <1900	32.048	207	6.449	143	4.449	69%	234	7.299
Bb 01-40	73.723	460	6.233	317	4.306	69%	531	7.209
Bb 41-60	243.372	1.432	5.883	967	3.972	68%	2.119	8.706
Bb 61-80	1.049.222	5.468	5.212	3.746	3.571	69%	6.508	6.203
Bb 81-07	886.313	3.134	3.536	1.735	1.958	55%	7.217	8.143
ZONA D	3.512.445	26.420	7.522	17.546	4.995	66%	38.578	10.983

Uu <1900	6.206	151	24.394	111	17.911	73%	85	13.656
Uu 01-40	9.800	239	24.395	176	17.915	73%	134	13.661
Uu 41-60	15.667	349	22.265	252	16.099	72%	270	17.204
Uu 61-80	31.784	733	23.053	516	16.240	70%	538	16.915
Uu 81-07	91.707	1.507	16.428	915	9.981	61%	2.036	22.206
Cc <1900	806	12	15.349	8	10.493	68%	9	10.903
Cc 01-40	1.056	15	14.587	10	9.918	68%	11	10.336
Cc 41-60	2.247	28	12.650	19	8.511	67%	24	10.773
Cc 61-80	8.501	82	9.601	49	5.764	60%	77	9.009
Cc 81-07	20.270	142	7.001	72	3.558	51%	206	10.175
Bb <1900	633	6	9.475	4	6.221	66%	4	6.356
Bb 01-40	1.092	10	9.190	7	6.010	65%	7	6.156
Bb 41-60	3.450	29	8.391	18	5.342	64%	26	7.590
Bb 61-80	37.142	285	7.665	187	5.029	66%	215	5.778
Bb 81-07	54.567	277	5.083	138	2.524	50%	384	7.042
ZONA E	284.928	3.865	13.566	2.483	8.715	64%	4.025	14.125

Source: Cíclica [Space, Community, Ecology] for MITMA.

7.2.3. Analysis of the results obtained and segmentation of the residential building stock into packages.

The ‘Common Renovation Package’ of 10 402 cases and 13 280 250 dwellings is further segmented according to 2 criteria:

- Likelihood of intervention: High; Low.
- Efficiency of the intervention: High; Low.

By cross-referencing these variables, 3 other packages of dwellings are configured:

- ‘Priority Envelope Renovation’ Package: - High Efficiency, High Likelihood-
  .

  This package of dwelling has the highest cost-effectiveness for intervention from a financial and energy point of view.

- ‘Low Consumption’ or ‘Low Efficiency’ Package: - Low Efficiency, High Likelihood-
  .

These are dwellings which, due to the climatic zone in which they are located, start with very low energy consumption and therefore their renovation does not make sense from an energy point of view.

- ‘Renovation Unlikely’ Package: - Low Likelihood-.

  Even in the case of dwellings that can be renovated, it is assumed that it is impossible to renovate 100% of the dwellings.

Figure 7.12. Segmentation of the ‘Common Renovation Package’ of 13 280 250 dwellings into 3 packages

	LIKELIHOOD
	High
	Low
	LOW EFFICIENCY RENOVATION
	PRIORITY ENVELOPE RENOVATION
	7 101 517 dwellings
	LOW LIKELIHOOD ENVELOPE RENOVATION
	EFFICIENCY

Source: Cíclica [Space, Community, Ecology] for MITMA.

a) ‘Renovation Unlikely’ dwelling package.

3 simultaneous preconditions are applied to the subset of 10 402 cases and 13 280 250 dwellings (‘Common Renovation Package’) that limit the number of dwellings to renovate for each case, assuming the hypothesis that there is little real likelihood of renovating 100% of the dwellings in each case. Prior to the efficiency analysis, these preconditions establish the number of dwellings to be renovated per case according to the following criteria:

- Maximum per case: 80%.
- Construction period: 80% before 1940; 100% after 1940.
- Size of the municipality: 80% rural; 100% urban.

The joint application of these 3 preconditions rules out 2 865 213 dwellings as ‘Unlikely’ for renovation, leaving the ‘Potential Envelope Renovation’ package with a total of 10 415 037 dwellings.

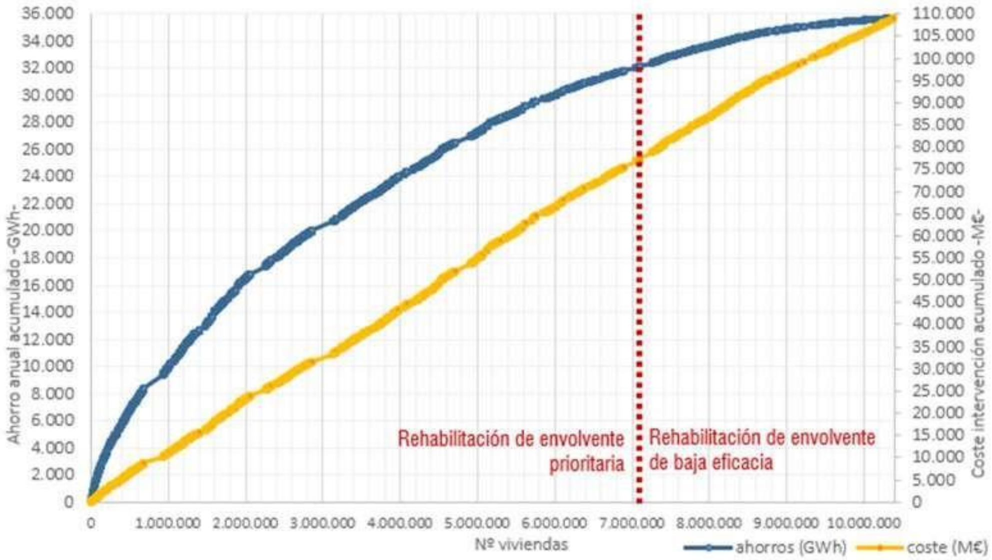
Within the ‘Unlikely’ dwelling package, there is a total of 2 164 952 dwellings with high efficiency (76% of the package), which are therefore likely to be renovated in the future with good results.

b) ‘Potential Envelope Renovation’, ‘Priority Envelope Renovation’ and ‘Low Efficiency Renovation’ dwelling packages.

The next step is to detect the group of dwellings with the greatest potential for renovation. In this sense, all cases are sorted according to their energy efficiency (€/kWh per year), which links the financial investment necessary to carry out the intervention (€/dwelling) with the annual energy savings achieved (kWh/household per year).

The attached graph shows the 10 415 037 dwellings of the complete 'Potential Envelope Renovation' Package, including the total cost of renovating all of them and the savings that could be achieved. The dwellings have been sorted by efficiency, so that the most cost-effective dwellings are shown to the left and the least cost-effective to the right. As can be seen, given the very different cost-effectiveness of the interventions, from a certain point onwards it is not cost-effective to renovate more dwellings, as costs continue to rise (with a function that is more or less a straight line, i.e. they are proportional to the number of dwellings renovated), while savings practically do not grow in a significant manner (as their function has the shape of a curve that tends to be horizontal to the right).

Figure 7.13. Distribution of dwellings by energy renovation potential

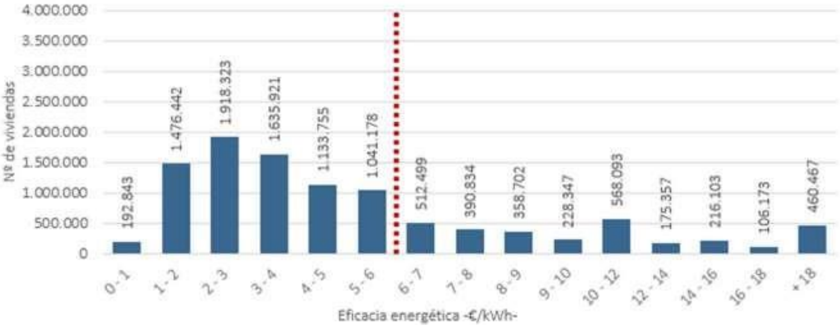


	Cumulative annual savings (GWh)
	Priority envelope renovation
	Low efficiency envelope renovation
	No of dwellings
	Savings (GWh)
	Cost (in millions of €)
	Cumulative intervention cost (in millions of €)

Source: Cíclica [Space, Community, Ecology] for MITMA.

In view of the above and below graphs, 7.1 million dwellings are selected as the 'Priority Envelope Renovation Package', the cost-effectiveness of which is around the efficiency threshold of €6/kWh, with this being the group of dwellings with the highest energy efficiency and therefore the highest potential for improvement per € invested from envelope renovation.

Figure 7.14. Distribution of dwellings by according to the energy efficiency indicator (€/kWh)



	No of dwellings
	Energy efficiency (€/kWh)

Source: Cíclica [Space, Community, Ecology] for MITMA.

Using this, 2 other packages of dwellings are established:

- 'Priority Envelope Renovation' Package: 7 101 517 dwellings,
- 'Low Efficiency Renovation' Package: 3 313 520 dwellings.

c) Summary of the segmentation of the residential building stock into homogeneous building packages for envelope renovation.

The Packages into which the Spanish residential building stock has been segmented, for the purposes of analysing the cost-effectiveness and viability of the renovation of their envelopes, are as follows:

Figure 7.15. Tree of the segmentation into Packages of the Spanish residential building stock.

				'MODELLABLE' PACKAGE: 16 598 127					
						'COMMON RENOVATION' PACKAGE: 13 280 250			
							'POTENTIAL RENOVATION' PACKAGE: 10 415 037		
								'PRIORITY ENVELOPE RENOVATION' PACKAGE	
MAIN DWELLINGS, WITHOUT HEATING	AJUSTE:	CEUTA AND MELILLA	'NON-SIGNIFICANT TECHNOLOGIES' PACKAGE	'ENERGY POVERTY DWELLINGS' PACKAGE	'DWELLINGS BUILT 2008-2020' PACKAGE	'RENOVATION UNLIKELY' PACKAGE	'LOW EFFICIENCY RENOVATION' PACKAGE	'2030-2050 PRIORITY ENVELOPE RENOVATION' PACKAGE	'2020-2030 PRIORITY ENVELOPE RENOVATION' PACKAGE
1 944 030	**2**	**6 178**	**223 318**	**2 572 361**	**745 516**	**2 865 213**	**3 313 520**	**1 200 079**	**5 901 438**

Source: MITMA.

7.2.4. Selection of strategic options for the scenarios.

Having defined the objective of renovating the 7 101 517 dwellings in the 'Priority Envelope Renovation' Package between 2030 and 2050, and in accordance with the annual paths for the number of dwellings to be renovated defined by the PNIEC and the MITMA modelling, it is now a question of selecting which dwellings are renovated in the period 2020-2030 and which are renovated between 2030 and 2050.

a) Description of the 3 scenarios and main results obtained

For this purpose, 3 possible renovation scenarios are analysed for the 'Priority Envelope Renovation' Package consisting of 8 670 cases and 7.1 million dwellings, depending on the order of annual intervention:

- Scenario 1: annual renovation order according to the intervention pathway, distributed proportionally in each period.
- Scenario 2: annual renovation order according to the intervention pathway with homogeneous distribution of the renovation rates by Autonomous Community.
- Scenario 3: annual renovation order according to the intervention pathway with intervention optimised according to energy efficiency.

Two intervention periods are also analysed:

- Period 1: from 2021 to 2030 '2020-2030 Priority Envelope Renovation'.
- Period 2: from 2031 to 2050 '2030-2050 Priority Envelope Renovation'.

Table 7.16. 2020-2050 dwelling renovation pathway for the 'Priority Envelope Renovation' Package.

	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Nº viviendas	30.000	35.000	40.000	45.000	50.000	100.000	150.000	200.000	250.000	300.000
% viviendas	0,42%	0,49%	0,56%	0,63%	0,70%	1,41%	2,11%	2,82%	3,52%	4,23%
Viviendas acumuladas	30.000	65.000	105.000	150.000	200.000	300.000	450.000	650.000	900.000	1.200.000

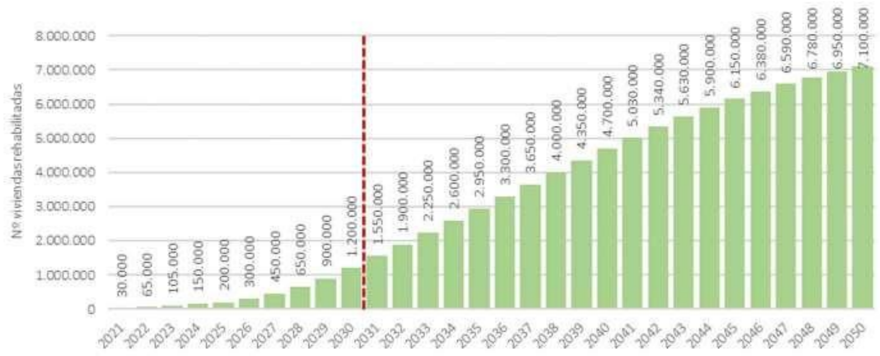
	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040
Nº viviendas	350.000	350.000	350.000	350.000	350.000	350.000	350.000	350.000	350.000	350.000
% viviendas	4,93%	4,93%	4,93%	4,93%	4,93%	4,93%	4,93%	4,93%	4,93%	4,93%
Viviendas acumuladas	1.550.000	1.900.000	2.250.000	2.600.000	2.950.000	3.300.000	3.650.000	4.000.000	4.350.000	4.700.000

	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050
Nº viviendas	330.000	310.000	290.000	270.000	250.000	230.000	210.000	190.000	170.000	150.000
% viviendas	4,65%	4,37%	4,08%	3,80%	3,52%	3,24%	2,96%	2,68%	2,39%	2,11%
Viviendas acumuladas	5.030.000	5.340.000	5.630.000	5.900.000	6.150.000	6.380.000	6.590.000	6.780.000	6.950.000	7.100.000

	No of dwellings
	% of dwellings
	Cumulative no of dwellings

Source: MITMA.

Table 7.17. Cumulative number of dwellings in the 2020-2050 dwelling renovation pathway for the 'Priority Envelope Renovation' Package.



	No of dwellings renovated

Source: MITMA.

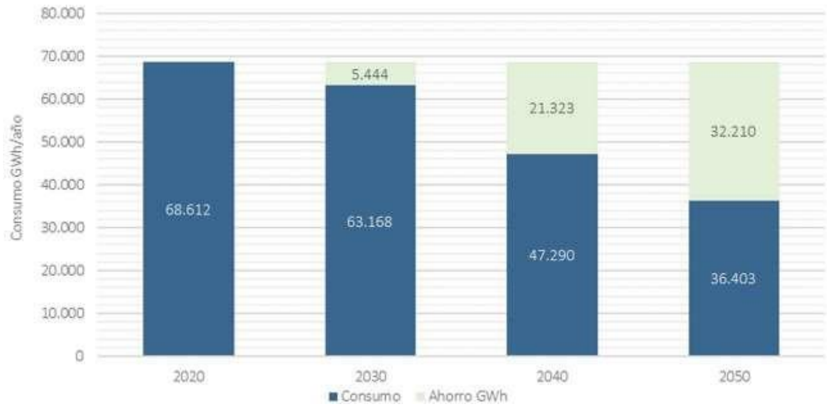
Scenario 1: 'Proportional Pathway'

The first 'Proportional Pathway' scenario considers the intervention pathways set by the PNIEC until 2030 and by the ERESEE for 2031-2050 and establishes the rate for intervention in dwellings in each case simultaneously. In this way, interventions are distributed in a homogenised manner across the 8 670 cases and the number of dwellings to be renovated for each case rises until it reaches the annual percentage value set by the intervention pathway.

- Scenario 1 achieves annual energy savings, compared to reference year 2020, of 8% for 2030 and 47% for 2050, equating to 5 444 and 32 210 GWh respectively.

- Likewise, with regard to the cumulative savings in the two analysis periods, savings of 3% are achieved for the period 2021-2030 and of 21% for the period 2021-2050.

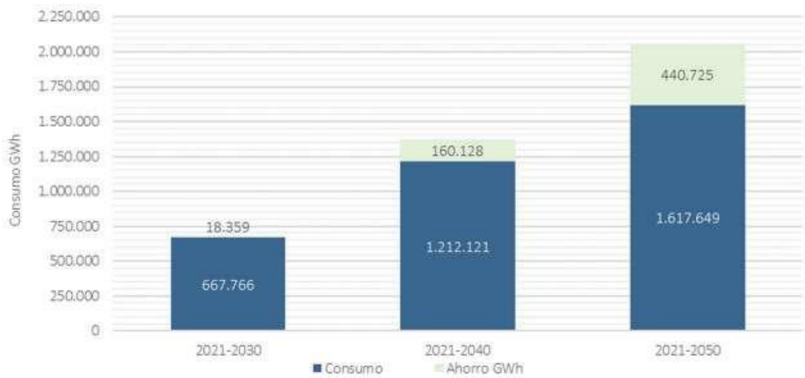
Figure 7.18. Consumption and Annual Saving Compared with Reference Year 2020 | Scenario 1



	Consumption in GWh per year
	Consumption
	Saving in GWh

Source: Cíclica [Space, Community, Ecology] for MITMA.

Figure 7.19. Consumption and Cumulative Annual Saving by period | Scenario 1



	Consumption in GWh per year
	Consumption
	Saving in GWh

Source: Cíclica [Space, Community, Ecology] for MITMA.

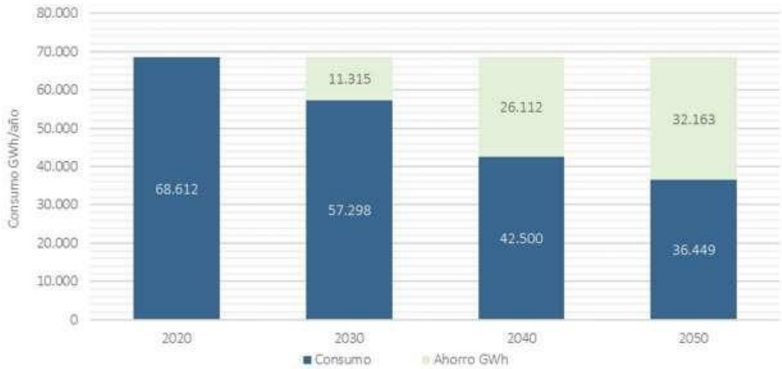
Scenario 2: 'Homogeneous Autonomous Community Pathway'

The second 'Homogeneous Autonomous Community Pathway' scenario considers the intervention pathways set by the PNIEC until 2030 and by the ERESEE for 2031-2050 and establishes the rate for intervention homogeneously across Autonomous Communities, taking into consideration the principle of efficiency when defining the intervention order. In this way, priority is given to the most efficient cases in each Autonomous Community and the number of dwellings to be renovated rises for all Autonomous Communities until it reaches the annual percentage value set by the intervention pathway.

Scenario 2 achieves annual energy savings, compared to reference year 2020, of 16% for 2030 and 47% for 2050, equating to 11 315 and 32 163 GWh respectively.

Likewise, with regard to the cumulative savings in the two analysis periods, savings of 7% are achieved for the period 2021-2030 and of 27% for the period 2021-2050.

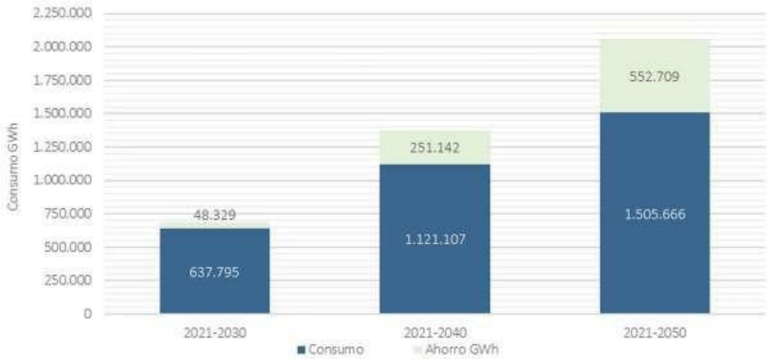
Figure 7.20. Consumption and Annual Saving Compared with Reference Year 2020 | Scenario 2



	Consumption in GWh per year
	Consumption
	Saving in GWh

Source: Cíclica [Space, Community, Ecology] for MITMA.

Figure 7.21. Consumption and Cumulative Annual Saving by period | Scenario 2



	Consumption in GWh per year
	Consumption
	Saving in GWh

Source: Cíclica [Space, Community, Ecology] for MITMA.

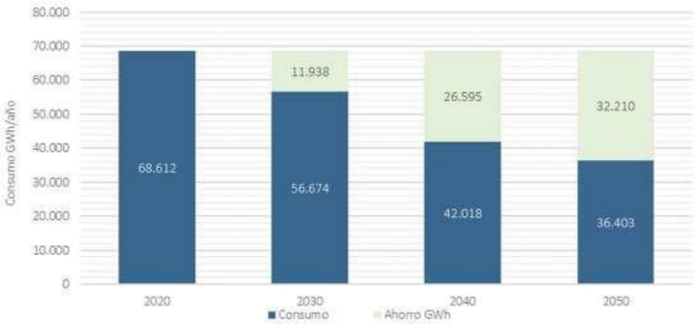
3. Scenario 3: 'Pathway Optimised for Efficiency'

The third scenario, 'Pathway Optimised for Efficiency', considers the intervention pathways set by the PNIEC until 2030 and by the ERESEE for 2031-2050 and establishes the order of intervention in dwellings according to their energy performance. In this way, priority is given to the most energy-efficient cases throughout the 17 Autonomous Communities and the number of dwellings to be renovated rises to the annual percentage value set by the intervention pathway, regardless of regional distribution.

Scenario 3 achieves annual energy savings, compared to reference year 2020, of 17% for 2030 and 47% for 2050, equating to 11 938 and 32 210 GWh respectively.

Likewise, with regard to the cumulative savings in the two analysis periods, savings of 8% are achieved for the period 2021-2030 and of 27% for the period 2021-2050.

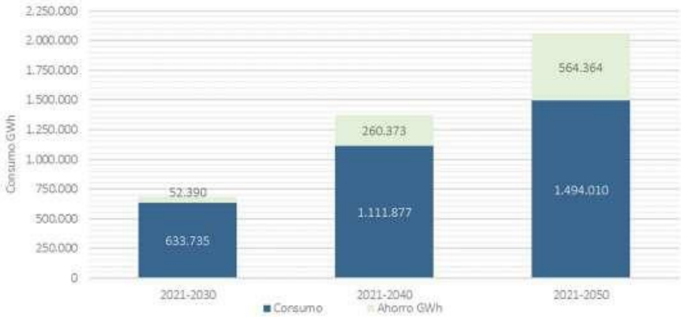
Figure 7.22. Consumption and Annual Saving Compared with Reference Year 2020 | Scenario 3



	Consumption in GWh per year
	Consumption
	Saving in GWh

Source: Cíclica [Space, Community, Ecology] for MITMA.

Figure 7.23. Consumption and Cumulative Annual Saving by period | Scenario 3



	Consumption in GWh per year
	Consumption
	Saving in GWh

Source: Cíclica [Space, Community, Ecology] for MITMA.

Scenario Selection.

To be on the safe side, the lowest-performing Scenario is used as the basis, which is Scenario 1 in which the 'Priority Envelope Renovation' Package is distributed proportionally between periods 2020-2030 and 2030-2050, with no need to start renovation for the most efficient dwellings within this package.

However, and depending on the application of the specific renovation plans of the Autonomous Communities within their territories, and if they were able to push Scenario 2 or 3, starting by renovating the most profitable dwellings in the 'Priority Envelope Renovation' Package between 2020 and 2030, the overall results would obviously also be better. The results of this potential optimisation are analysed in the overall Scenario analysis provided in Chapter 8.

7.2.5. Detailed Description of the 'Priority Envelope Renovation' Package and its objectives for 2030 and 2050.

In accordance with the distribution in Scenario 1, the 'Priority Envelope Renovation' Package, formed of 8 670 cases and 7.1 million dwellings, is split into 2 packages:

- 2021-2030 Priority Envelope Renovation,
- 2031-2050 Priority Envelope Renovation.

Figure 7.24. Splitting into 2 priority envelope renovation packages

	2021-2030 PRIORITY ENVELOPE RENOVATION
	1 200 079 dwellings
	2031-2050 PRIORITY ENVELOPE RENOVATION
	5 901 438 dwellings
	Period 2021-2030
	Time

Source: Cíclica [Space, Community, Ecology] for MITMA.

The dwellings to be renovated in each period are summarised, by cluster, in the table below:

Table 7.25. Distribution of dwellings to be renovated, by cluster and period

	Periodo 2021-2030				Periodo 2031-2050			
	Uu	Cc	Bb	Total	Uu	Cc	Bb	Total
<1900	20.530	4.847	9.094	34.471	100.895	23.752	44.749	169.396
01-40	32.364	8.609	20.002	60.975	159.033	42.193	98.293	299.519
41-60	56.702	26.501	73.345	156.548	278.826	130.271	360.554	769.651
61-80	115.021	52.046	388.302	555.369	565.423	256.725	1.909.180	2.731.328
81-07	185.739	55.923	151.054	392.716	913.273	275.460	742.811	1.931.544
08-20	-	-	-	-	-	-	-	-
>2021	-	-	-	-	-	-	-	-
Total	410.356	147.926	641.797	1.200.079	2.017.450	728.401	3.155.587	5.901.438

	Period 2021-2030
	Uu
	Cc
	Bb
	Total

Source: Cíclica [Space, Community, Ecology] for MITMA.

As can be seen, the analysis by dwelling type shows a predominance of block dwellings (Bb), which account for 53% of the total number of dwellings to receive intervention. Single-family dwellings account for 34% of the total number of dwellings of the 'Priority Envelope Renovation' Package, given their high energy performance index.

In addition, the analysis by construction stage reveals a higher number of dwellings built between 1961-1980, accounting for 46% of the total, followed by those built between 1981-2007, which account for 33%. Finally, dwellings built before 1960 account for 21% of the Package total.

The distribution by regionalised cluster per Autonomous Community is as follows, for each of the two periods:

Table 7.26. Description of the '2021-2030 Priority Envelope Renovation' Package by cluster and Autonomous Community

	Andalusia	Aragon	Asturias	Balearic Islands	Cantabria	Castile-La Mancha	Castile and Leon	Catalonia	Valencia	Extremadura	Galicia	Madrid	Murcia	Navarre	Basque Country	Rioja	TOTAL
Uu < 1 900	2 296	937	793	1 120	725	1 055	1 300	3 957	2 322	905	3 041	240	330	476	810	223	**20 530**
Uu 01-40	5 694	1 076	1 250	1 951	684	1 646	2 063	5 135	3 933	1 776	4 280	353	983	493	845	202	**32 364**
Uu 41-60	16 850	1 260	1 106	2 456	1 014	2 094	4 235	6 720	7 419	2 754	5 041	991	3 071	570	836	285	**56 702**
Uu 61-80	34 824	1 916	1 614	4 895	1 090	3 137	8 425	16 700	13 206	3 149	11 235	6 409	6 312	901	927	281	**115 021**
Uu 81-07	37 434	5 252	2 214	3 092	2 055	7 327	23 810	38 619	12 482	7 474	8 851	25 386	5 027	3 034	2 849	833	**185 739**
Cc < 1 900	786	203	62	231	86	135	195	1 301	386	149	92	239	36	145	737	64	**4 847**
Cc 01-40	1 427	193	96	623	98	278	257	2 157	1 069	187	282	838	244	149	664	47	**8 609**
Cc 41-60	4 226	696	765	1 686	414	1 372	565	5 416	2 913	771	983	3 453	1 055	576	1 487	123	**26 501**
Cc 61-80	6 109	1 835	636	1 516	346	3 976	1 898	13 946	5 141	1 686	3 411	7 492	1 881	497	1 436	240	**52 046**
Cc 81-07	3 455	2 213	976	0	320	7 142	5 065	15 127	0	2 930	960	13 898	0	1 271	1 580	986	**55 923**
Bb < 1 900	291	111	40	129	138	12	131	2 771	652	10	70	2 741	6	253	1 697	42	**9 094**
Bb 01-40	822	319	96	263	186	54	257	5 722	1 653	19	290	6 732	62	327	3 061	139	**20 002**
Bb 41-60	3 487	2 652	1 570	1 639	1 670	906	1 213	15 360	4 577	536	1 615	24 357	837	1 164	11 247	515	**73 345**
Bb 61-80	31 857	17 782	13 816	6 821	4 619	10 523	12 356	90 285	39 892	3 757	15 950	95 384	6 127	5 579	31 003	2 551	**388 302**
Bb 81-07	2 873	9 382	7 806	0	0	11 699	16 114	21 934	0	3 320	5 296	57 586	0	5 066	6 183	3 795	**151 054**
TOTAL	**152 431**	**45 827**	**32 840**	**26 422**	**13 445**	**51 356**	**77 884**	**245 150**	**95 645**	**29 423**	**61 397**	**246 099**	**25 971**	**20 501**	**65 362**	**10 326**	**1 200 079**

Source: Cíclica [Space, Community, Ecology] for MITMA.

Table 7.27. Description of the '2031-2050 Priority Envelope Renovation' Package by cluster and Autonomous Community

	Andalusia	Aragon	Asturias	Balearic Islands	Cantabria	Castile-La Mancha	Castile and Leon	Catalonia	Valencia	Extremadura	Galicia	Madrid	Murcia	Navarre	Basque Country	Rioja	TOTAL
Uu < 1 900	11 286	4 597	3 906	5 511	3 575	5 178	6 347	19 471	11 409	4 453	14 944	1 178	1 625	2 347	3 971	1 097	**100 895**
Uu 01-40	27 983	5 262	6 141	9 594	3 360	8 093	10 096	25 251	19 336	8 741	21 062	1 724	4 827	2 427	4 147	989	**159 033**
Uu 41-60	82 870	6 199	5 445	12 073	4 985	10 286	20 808	33 020	36 487	13 555	24 789	4 869	15 092	2 815	4 126	1 407	**278 826**
Uu 61-80	171 215	9 410	7 934	24 067	5 355	15 418	41 411	82 104	64 916	15 495	55 231	31 507	31 040	4 421	4 526	1 373	**565 423**
Uu 81-07	184 047	25 842	10 873	15 209	10 105	36 037	117 086	189 895	61 371	36 747	43 513	124 820	24 713	14 915	13 999	4 101	**913 273**
Cc < 1 900	3 820	995	302	1 127	417	665	940	6 405	1 885	740	460	1 167	186	711	3 621	311	**23 752**
Cc 01-40	6 988	928	466	3 061	480	1 352	1 258	10 611	5 254	909	1 358	4 113	1 190	738	3 254	233	**42 193**
Cc 41-60	20 777	3 421	3 762	8 292	2 033	6 747	2 734	26 633	14 320	3 795	4 846	16 982	5 187	2 831	7 303	608	**130 271**
Cc 61-80	30 038	9 011	3 128	7 459	1 694	19 527	9 311	68 580	25 270	8 295	16 778	36 843	10 088	2 439	7 087	1 177	**256 725**
Cc 81-07	16 977	10 879	4 798	0	1 577	35 122	24 917	74 875	0	14 410	4 721	68 334	01	6 235	7 762	4 853	**275 460**
Bb < 1 900	1 431	544	202	640	660	71	672	13 621	3 208	52	349	13 473	31	1 240	8 354	201	**44 749**
Bb 01-40	4 032	1 563	471	1 279	906	261	1 251	28 133	8 124	99	1 422	33 101	304	1 605	15 060	682	**98 293**
Bb 41-60	17 136	13 016	7 729	8 063	8 205	4 445	5 974	75 519	22 490	2 630	7 920	119 747	4 117	5 729	55 296	2 538	**360 554**
Bb 61-80	156 640	87 451	67 926	33 533	22 713	51 742	60 766	443 892	196 134	18 476	78 401	468 978	30 122	27 442	152 424	12 540	**1 909 180**
Bb 81-07	14 125	46 126	38 379	0	66 065	57 510	79 244	107 845	0	16 385	26 066	283 136	0	24 916	30 416	18 663	**742 811**
TOTAL	**749 365**	**225 244**	**161 462**	**129 908**	**3 575**	**252 454**	**382.8151.**	**205 855**	**470 204**		**301.8601**	**209 972**	**128 522**	**100 811**	**321 346**	**50 773**	**5 901 438**

Source: Cíclica [Space, Community, Ecology] for MITMA.

Table 7.28. Distribution of dwellings by Autonomous Community and renovation package - % of the total number of dwellings per renovation package.

CCAA	1. Rehabilitación de envolvente prioritaria 2021-2030		2. Rehabilitación de envolvente prioritaria 2031-2050		3. Rehabilitación de baja eficacia		4. Rehabilitación de envolvente con baja probabilidad		5. Viviendas 2008-20		6. Viviendas en Pobreza energética		TOTAL VIVIENDAS ANALIZADAS		TOTAL VIVIENDAS PRINCIPALES	
Andalucía	152.431	13%	749.365	13%	1.129.260	34%	545.535	19%	127.586	17%	488.468	19%	3.192.645	19%	3.253.681	17%
Aragón	45.827	4%	225.244	4%	11.789	0%	84.379	3%	18.864	3%	91.751	4%	477.854	3%	539.998	3%
Asturias, Principado de	32.840	3%	161.462	3%	72.434	2%	69.618	2%	16.370	2%	47.185	2%	399.909	2%	453.269	2%
Balears, Illes	26.422	2%	129.908	2%	130.064	4%	82.197	3%	18.453	2%	66.167	3%	453.211	3%	465.251	2%
Canarias	0	0%	0	0%	0	0%	0	0%	0	0%	0	0%	0	0%	865.336	5%
Cantabria	13.445	1%	66.065	1%	48.798	1%	41.836	1%	10.265	1%	33.847	1%	214.256	1%	241.496	1%
Castilla - La Mancha	51.356	4%	252.454	4%	12.176	0%	100.959	4%	25.824	3%	253.431	10%	696.200	4%	783.700	4%
Castilla y León	77.884	6%	382.815	6%	13.671	0%	166.092	6%	57.115	8%	209.535	8%	907.118	5%	1.013.448	5%
Cataluña	245.150	20%	1.205.855	20%	435.072	13%	520.857	18%	110.915	15%	430.449	17%	2.948.298	18%	3.074.972	16%
Comunitat Valenciana	95.645	8%	470.204	8%	735.266	22%	346.474	12%	91.974	12%	208.434	8%	1.947.997	12%	2.016.686	11%
Extremadura	29.423	2%	144.782	2%	38.803	1%	76.029	3%	20.073	3%	74.870	3%	383.980	2%	429.639	2%
Galicia	61.397	5%	301.860	5%	210.659	6%	188.079	7%	43.641	6%	162.677	6%	968.313	6%	1.086.712	6%
Madrid, Comunidad de	246.099	21%	1.209.972	21%	129.618	4%	340.027	12%	109.883	15%	290.810	11%	2.326.409	14%	2.641.725	14%
Murcia, Región de	25.971	2%	128.522	2%	191.439	6%	79.477	3%	27.655	4%	83.108	3%	536.172	3%	549.473	3%
Navarra, Comunidad Foral de	20.501	2%	100.811	2%	3.823	0%	44.999	2%	17.702	2%	40.955	2%	228.791	1%	258.222	1%
País Vasco	65.362	5%	321.346	5%	148.429	4%	158.345	6%	43.048	6%	65.791	3%	802.321	5%	912.666	5%
Rioja, La	10.326	1%	50.773	1%	2.219	0%	20.304	1%	6.148	1%	24.883	1%	114.653	1%	129.841	1%
Ciudades Autónomas	0	0%	0	0%	0	0%	0	0%	0	0%	0	0%	0	0%	55.543	0%
TOTAL	1.200.079	100%	5.901.438	100%	3.313.520	100%	2.865.213	100%	745.516	100%	2.572.361	100%	16.598.127	100%	18.771.653	100%

	Andalusia
	Aragon
	Asturias
	Balearic Islands
	Canary Islands
	Cantabria
	Castile-La Mancha
	Castile and Leon
	Catalonia
	Valencia
	Extremadura
	Galicia
	Madrid
	Murcia
	Navarre
	Basque Country
	Rioja
	Autonomous Cities
	Total
	1. 2021-2030 Priority envelope renovation
	3. Renovation of low efficiency dwellings
	4. Low likelihood envelope renovation
	5. Dwellings 2008-20
	6. Dwellings in energy poverty
	TOTAL DWELLINGS ANALYSED
	TOTAL MAIN DWELLINGS

Source: Cíclica [Space, Community, Ecology] for MITMA.

Table 7.29. Distribution of dwellings by Autonomous Community and renovation package - % of the total number of dwellings per Autonomous Community.

CCAA	1. Rehabilitación de envolvente prioritaria 2021-2030		2. Rehabilitación de envolvente prioritaria 2031-2050		3. Rehabilitación de baja eficacia		4. Rehabilitación de envolvente con baja probabilidad		5. Viviendas 2008-20		6. Viviendas en Pobreza energética		TOTAL VIVIENDAS ANALIZADAS		TOTAL VIVIENDAS PRINCIPALES	
Andalucía	152.431	5%	749.365	23%	1.129.260	35%	545.535	17%	127.586	4%	488.468	15%	3.192.645	98%	3.253.681	100%
Aragón	45.827	8%	225.244	42%	11.789	2%	84.379	16%	18.864	3%	91.751	17%	477.854	88%	539.998	100%
Asturias, Principado de	32.840	7%	161.462	36%	72.434	16%	69.618	15%	16.370	4%	47.185	10%	399.909	88%	453.269	100%
Balears, Illes	26.422	6%	129.908	28%	130.064	28%	82.197	18%	18.453	4%	66.167	14%	453.211	97%	465.251	100%
Canarias	0	0%	0	0%	0	0%	0	0%	0	0%	0	0%	0	0%	865.336	100%
Cantabria	13.445	6%	66.065	27%	48.798	20%	41.836	17%	10.265	4%	33.847	14%	214.256	89%	241.496	100%
Castilla - La Mancha	51.356	7%	252.454	32%	12.176	2%	100.959	13%	25.824	3%	253.431	32%	696.200	89%	783.700	100%
Castilla y León	77.884	8%	382.815	38%	13.671	1%	166.092	16%	57.115	6%	209.535	21%	907.118	90%	1.013.448	100%
Cataluña	245.150	8%	1.205.855	39%	435.072	14%	520.857	17%	110.915	4%	430.449	14%	2.948.298	96%	3.074.972	100%
Comunitat Valenciana	95.645	5%	470.204	23%	735.266	36%	346.474	17%	91.974	5%	208.434	10%	1.947.997	97%	2.016.686	100%
Extremadura	29.423	7%	144.782	34%	38.803	9%	76.029	18%	20.073	5%	74.870	17%	383.980	89%	429.639	100%
Galicia	61.397	6%	301.860	28%	210.659	19%	188.079	17%	43.641	4%	162.677	15%	968.313	89%	1.086.712	100%
Madrid, Comunidad de	246.099	9%	1.209.972	46%	129.618	5%	340.027	13%	109.883	4%	290.810	11%	2.326.409	88%	2.641.725	100%
Murcia, Región de	25.971	5%	128.522	23%	191.439	35%	79.477	14%	27.655	5%	83.108	15%	536.172	98%	549.473	100%
Navarra, Comunidad Foral de	20.501	8%	100.811	39%	3.823	1%	44.999	17%	17.702	7%	40.955	16%	228.791	89%	258.222	100%
País Vasco	65.362	7%	321.346	35%	148.429	16%	158.345	17%	43.048	5%	65.791	7%	802.321	88%	912.666	100%
Rioja, La	10.326	8%	50.773	39%	2.219	2%	20.304	16%	6.148	5%	24.883	19%	114.653	88%	129.841	100%
Ciudades Autónomas	0	0%	0	0%	0	0%	0	0%	0	0%	0	0%	0	0%	55.543	100%
TOTAL	1.200.079	6%	5.901.438	31%	3.313.520	18%	2.865.213	15%	745.516	4%	2.572.361	14%	16.598.127	88%	18.771.653	100%

	Andalusia
	Aragon
	Asturias
	Balearic Islands
	Canary Islands
	Cantabria
	Castile-La Mancha
	Castile and Leon
	Catalonia
	Valencia
	Extremadura
	Galicia
	Madrid
	Murcia
	Navarre
	Basque Country
	Rioja
	Autonomous Cities
	Total
	1. 2021-2030 Priority envelope renovation
	3. Renovation of low efficiency dwellings
	4. Low likelihood envelope renovation
	5. Dwellings 2008-20
	6. Dwellings in energy poverty
	Total DWELLINGS ANALYSED
	Total MAIN DWELLINGS

Source: Cíclica [Space, Community, Ecology] for MITMA.

Table 7.30. Distribution of dwellings by renovation package and cluster - % of the total number of dwellings per renovation package.

CLÚSTER	1. Rehabilitación de envolvente prioritaria 2021-2030		2. Rehabilitación de envolvente prioritaria 2031-2050		3. Rehabilitación de baja eficacia		4. Rehabilitación de envolvente con baja probabilidad		5. Viviendas 2008-20		6. Viviendas en Pobreza energética		TOTAL VIVIENDAS ANALIZADAS		TOTAL VIVIENDAS PRINCIPALES	
Uu <1900	20.530	2%	100.895	2%	2.371	0%	91.666	3%	0	0%	58.447	2%	273.909	2%	299.103	2%
Uu 01-40	32.364	3%	159.033	3%	4.008	0%	137.321	5%	0	0%	89.947	3%	422.673	3%	462.386	2%
Uu 41-60	56.702	5%	278.826	5%	11.203	0%	114.966	4%	0	0%	118.912	5%	580.609	3%	636.386	3%
Uu 61-80	115.021	10%	565.423	10%	23.123	1%	237.805	8%	0	0%	230.583	9%	1.171.955	7%	1.310.013	7%
Uu 81-07	185.739	15%	913.273	15%	556.324	17%	551.855	19%	0	0%	489.069	19%	2.696.260	16%	2.967.475	16%
Uu 08-20	0	0%	0	0%	0	0%	0	0%	262.433	35%	59.992	2%	322.425	2%	347.276	2%
Cc <1900	4.847	0%	23.752	0%	3.415	0%	21.629	1%	0	0%	9.600	0%	63.243	0%	70.623	0%
Cc 01-40	8.609	1%	42.193	1%	6.008	0%	34.879	1%	0	0%	15.906	1%	107.595	1%	122.182	1%
Cc 41-60	26.501	2%	130.271	2%	27.177	1%	50.415	2%	0	0%	41.110	2%	275.474	2%	327.156	2%
Cc 61-80	52.046	4%	256.725	4%	122.228	4%	128.768	4%	0	0%	105.100	4%	664.867	4%	797.373	4%
Cc 81-07	55.923	5%	275.460	5%	452.790	14%	234.169	8%	0	0%	183.691	7%	1.202.033	7%	1.473.665	8%
Cc 08-20	0	0%	0	0%	0	0%	0	0%	98.543	13%	17.978	1%	116.521	1%	146.344	1%
Bb <1900	9.094	1%	44.749	1%	5.355	0%	29.674	1%	0	0%	12.705	0%	101.575	1%	112.570	1%
Bb 01-40	20.002	2%	98.293	2%	11.268	0%	63.405	2%	0	0%	27.990	1%	220.958	1%	246.022	1%
Bb 41-60	73.345	6%	360.554	6%	92.646	3%	103.033	4%	0	0%	94.140	4%	723.718	4%	819.581	4%
Bb 61-80	388.302	32%	1.909.180	32%	458.538	14%	554.257	19%	0	0%	519.657	20%	3.829.934	23%	4.286.831	23%
Bb 81-07	151.054	13%	742.811	13%	1.537.066	46%	511.371	18%	0	0%	440.110	17%	3.382.412	20%	3.845.136	20%
Bb 08-20	0	0%	0	0%	0	0%	0	0%	384.540	52%	57.424	2%	441.964	3%	501.536	3%
TOTAL	1.200.079	100%	5.901.438	100%	3.313.520	100%	2.865.213	100%	745.516	100%	2.572.361	100%	16.598.127	100%	18.771.653	100%

	CLÚSTER
	1. 2021-2030 Priority envelope renovation
	3. Renovation of low efficiency dwellings
	4. Low likelihood envelope renovation
	5. Dwellings 2008-20
	6. Dwellings in energy poverty
	TOTAL DWELLINGS ANALYSED
	TOTAL MAIN DWELLINGS
	Uu < 1 900
	Cc < 1 900
	Bb < 1 900

Source: Cíclica [Space, Community, Ecology] for MITMA.

Table 7.31. Distribution of dwellings by renovation package and cluster - % of the total number of main dwellings per cluster.

CLÚSTER	1. 2021-2030 Priority Envelope Renovation		2. 2031-2050 Priority Envelope Renovation		3. Renovation of low efficiency dwellings		4. Low likelihood envelope renovation				6. Dwellings in Energy Poverty		TOTAL DWELLINGS ANALYSED		TOTAL MAIN DWELLINGS	
Uu < 1 900	20 530	7%	100 895	34%	2 371	1%	91 666	31%	0	0%	58 447	20%	273 909	92%	299 103	100%
Uu 01-40	32 364	7%	159 033	34%	4 008	1%	137 321	30%	0	0%	89 947	19%	422 673	91%	462 386	100%
Uu 41-60	56 702	9%	278 826	44%	11 203	2%	114 966	18%	0	0%	118 912	19%	580 609	91%	636 386	100%
Uu 61-80	115 021	9%	565 423	43%	23 123	2%	237 805	18%	0	0%	230 583	18%	1 171 955	89%	1 310 013	100%
Uu 81-07	185 739	6%	913 273	31%	556 324	19%	551 855	19%	0	0%	489 069	16%	2 696 260	91%	2 967 475	100%
Uu 08-20	0	0%	0	0%	0	0%	0	0%	262 433	76%	59 992	17%	322 425	93%	347 276	100%
Cc < 1 900	4 847	7%	23 752	34%	3 415	5%	21 629	31%	0	0%	9 600	14%	63 243	90%	70 623	100%
Cc 01-40	8 609	7%	42 193	35%	6 008	5%	34 879	29%	0	0%	15 906	13%	107 595	88%	122 182	100%
Cc 41-60	26 501	8%	130 271	40%	27 177	8%	50 415	15%	0	0%	41 110	13%	275 474	84%	327 156	100%
Cc 61-80	52 046	7%	256 725	32%	122 228	15%	128 768	16%	0	0%	105 100	13%	664 867	83%	797 373	100%
Cc 81-07	55 923	4%	275 460	19%	452 790	31%	234 169	16%	0	0%	183 691	12%	1 202 033	82%	1 473 665	100%
Cc 08-20	0	0%	0	0%	0	0%	0	0%	98 543	67%	17 978	12%	116 521	80%	146 344	100%
Bb < 1 900	9 094	8%	44 749	40%	5 355	5%	29 674	26%	0	0%	12 705	11%	101 575	90%	112 570	100%
Bb 01-40	20 002	8%	98 293	40%	11 268	5%	63 405	26%	0	0%	27 990	11%	220 958	90%	246 022	100%

Bb 41-60	73 345	9%	360 554	44%	92 646	11%	103 033	13%	0	0%	94 140	11%	723 718	88%	819 581	100%
Bb 61-80	388 302	9%	1 909 180	45%	458 538	11%	554 257	13%	0	0%	519 657	12%	3 829 934	89%	4 286 831	100%
Bb 81-07	151 054	4%	742 811	19%	1 537 066	40%	511 371	13%	0	0%	440 110	11%	3 382 412	88%	3 845 136	100%
Bb 08-20	0	0%	0	0%	0	0%	0	0%	384 540	77%	57 424	11%	441 964	88%	501 536	100%
TOTAL	1 200 079	6%	5 901 438	31%	3 313 520	18%	2 865 213	15%	745 516	4%	2 572 361	14%	16 598 127	88%	18 771 653	100%

Source: Cíclica [Space, Community, Ecology] for MITMA.

7.2.6. Microeconomic Cost-Benefit Analysis of the Selected Strategic Option

This section contains the microeconomic analysis for all 7.1 million dwellings of the 'Priority Envelope Renovation' Package. The analysis is carried out for four different time options (15, 20, 25 and 30 years) which makes it possible to determine, for each option, the different financial amounts of the investment (subject to the term of the bank loan) and the different financial amounts of energy savings, and, as a result, the percentage of the investment covered by these savings.

a. Considerations for the Microeconomic Analysis

In relation to the financial amount of the intervention that the promoter must pay at the time of the renovation, the following distribution assumption is made:

- Public subsidy: 33.3%.
- Promoter's upfront payment: 33.3%.
- Promoter's financing (bank loan): 33.3%.

Of the two thirds that the promoter pays, it is assumed that a portion thereof will be recovered through savings on the energy bill.

In relation to the costs linked to energy renovation, the following considerations are applied:

- Indirect Costs: 10%.
- General expenses: 13%.
- Industrial benefit: 6%.
- Technicians' fees: 7%.
- Intervention VAT: 10%.
- Fees VAT: 21%.
- Fees and permits: 3%.

In relation to the financing by the promoter, the following conditions are applied:

- Bank loan interest rate: 3%.
- Public aid to reduce the Interest Rate: -1%.

In relation to the price of domestic energy consumed, a price trend assumption is determined for the 2030 and 2050 scenarios based on available data on assumptions used in the PNIEC relating to 'Import Costs'.

Table 7.32. Energy price trend by source in relation to reference year 2020

	2020	2025	2030	2035	2040	2045	2050
Gases licuados de petróleo	100%	132%	146%	152%	161%	163%	166%
Gasoil	100%	132%	146%	152%	161%	163%	166%
Gas natural	100%	127%	138%	148%	153%	156%	160%
Biomasa	100%	100%	100%	100%	100%	100%	100%
Electricidad	100%	100%	100%	100%	100%	100%	100%

	Liquefied petroleum gases
	Fuel Oil
	Natural gas
	Biomass
	Electricity

Source: Cíclica [Space, Community, Ecology] for MITMA, based on actual 2020 price data and the 2020-2040 trend provided by MITERD.

b) Results of the Microeconomic Analysis

The financial investment in the renovation intervention for the 7.1 million dwellings of the ‘Priority Envelope Renovation’ Package totals €122 013 000 000 and breaks down as €101 984 000 000 for renovation operations, €5 999 000 000 in technicians’ fees, €11 578 in VAT and €2 571 000 000 in work permit fees.

Depending on the time option of the financing term, the total investment amount ranges from €131 898 000 000 to €143 071 000 000. The amount of interest on the bank loan (financing interest) is a minimum of €9 885 000 000 and a maximum of €21 058 000 000.

Table 7.33. Distribution of the investment in renovation (millions of €)

	Importe constructora	Importe técnico	Impuestos	Tasas	Intereses Financiación	Inversión total
OPCIÓN 1.	101.984	5.999	11.458	2.571	9.885	131.898
15 AÑOS	77%	5%	9%	2%	7%	
OPCIÓN 2.	101.984	5.999	11.458	2.571	13.463	135.476
20 AÑOS	75%	4%	8%	2%	10%	
OPCIÓN 3.	101.984	5.999	11.458	2.571	17.189	139.202
25 AÑOS	73%	4%	8%	2%	12%	
OPCIÓN 4.	101.984	5.999	11.458	2.571	21.058	143.071
30 AÑOS	71%	4%	8%	2%	15%	

	Construction company amount
	Technician amount
	Taxes
	Fees
	Financing Interest
	Total investment
	OPTION 1.
	15 YEARS

Source: Cíclica [Space, Community, Ecology].

With regard to the origin of the total investment, in the four time options private investment accounts for approximately two thirds of the total, while public investment accounts for the remaining third.

The private investment is broken down into €40 671 000 000 upfront and a further €40 671 000 000 to be financed through the bank loan in the four options, with the interest ranging from €6 439 000 000 to €13 447 000 000. The final amount for the private sector is between €87 781 000 000 and €94 789 000 000.

The public investment is divided between €40 671 000 000 in the form of public subsidies and a range of interest rate aid of €3 446 000 000 and €7 611 000 000. The final total is between €44 117 000 000 and €48 282 000 000.

Table 7.34. Distribution of the investment in renovation according to the origin of the amount (millions of €)

	Inversión total	INVERSIÓN PRIVADA				INVERSIÓN PÚBLICA		
		Entrada	Importe a financiar	Intereses Crédito	Inversión privada total	Subvencion es públicas	Ayudas al tipo de interés	Inversión pública total
OPCIÓN 1. 15 AÑOS	131.898	40.671 46%	40.671 46%	6.439 7%	87.781	40.671 92%	3.446 8%	44.117
OPCIÓN 2. 20 AÑOS	135.476	40.671 45%	40.671 45%	8.708 10%	90.050	40.671 90%	4.755 10%	45.426
OPCIÓN 3. 25 AÑOS	139.202	40.671 44%	40.671 44%	11.045 12%	92.387	40.671 87%	6.144 13%	46.815
OPCIÓN 4. 30 AÑOS	143.071	40.671 43%	40.671 43%	13.447 14%	94.789	40.671 84%	7.611 16%	48.282

	Total investment
	PRIVATE INVESTMENT
	PUBLIC INVESTMENT
	Upfront
	Amount to be financed
	Loan Interest
	Total private investment
	Public subsidies
	Interest rate aid
	Total public investment
	OPTION 1.
	15 YEARS

Source: Cíclica [Space, Community, Ecology].

The reduction in household energy consumption resulting from the renovation intervention leads to a reduction in the cost of energy in the variable term and tax components. According to calculations carried out, it is estimated that energy savings can reach as much as €40 839 000 000 over a period of 15 years and, at the high end, €86 689 000 000 over a period of 30 years.

Table 7.35. Distribution of energy bill amounts before and after renovation (millions of €)

	FACTURA ENERGÉTICA ESTADO ACTUAL			FACTURA ENERGÉTICA TRAS LA REHABILITACIÓN			Ahorros energético s
	Coste energía	Impuestos	Importe total	Coste energía	Impuestos	Importe total	
OPCIÓN 1. 15 AÑOS	47.742 81%	11.455 19%	59.196	14.794 81%	3.563 19%	18.357	40.839
OPCIÓN 2. 20 AÑOS	65.344 81%	15.627 19%	80.971	20.265 81%	4.863 19%	25.129	55.842
OPCIÓN 3. 25 AÑOS	83.326 81%	19.880 19%	103.206	25.857 81%	6.190 19%	32.047	71.159
OPCIÓN 4. 30 AÑOS	101.569 81%	24.187 19%	125.756	31.533 2%	7.534 15%	39.066	86.689

	ENERGY BILL CURRENT STATE
	ENERGY BILL AFTER RENOVATION
	Energy savings

	Energy cost
	Taxes
	Total amount
	Energy cost
	Taxes
	Total amount

Source: Cíclica [Space, Community, Ecology].

The financial savings generated allow for the recovery of between 31% and 61% of the total investment made, which, together with the public investment of approximately 33% of the amount, allows for a significant reduction of the private of the private sector’s contribution in the long term. With the 15 year time option, it is reduced from 67% to 36%. And with the longer term option, of 30 years, it is reduced from 67% to 6%.

Table 7.36. Distribution of renovation costs by concept (millions of €)

	Inversión pública total	Ahorros energéticos	Otras	Inversión total
OPCIÓN 1.	44.117	40.839	46.942	131.898
15 AÑOS	33%	31%	36%	
OPCIÓN 2.	45.426	55.842	34.208	135.476
20 AÑOS	34%	41%	25%	
OPCIÓN 3.	46.815	71.159	21.228	139.202
25 AÑOS	34%	51%	15%	
OPCIÓN 4.	48.282	86.689	8.100	143.071
30 AÑOS	34%	61%	6%	

	Total public investment
	Energy savings
	Other
	Total investment
	OPTION 1.
	15 YEARS

Source: Cíclica [Space, Community, Ecology].

However, the distribution of the savings generated is not homogeneous, but varies according to the characteristics and location of the dwellings. The percentage of the total amount of the renovation intervention covered by energy savings is a highly variable factor that, in certain cases, can exceed more than 100% of the investment made.

Table 7.37. Distribution of dwellings by percentage covered and building type

		TOTAL	>100%	100-70%	70-50%	50-30%	30-0%
OPCIÓN 1. 15 AÑOS	TOTAL	7.101.517	35.517	281.429	802.301	2.205.733	3.776.537
			0,50%	3,96%	11,30%	31,06%	53,18%
	Uu	2.427.806	20.866	89.941	202.971	604.336	1.509.692
	Cc	876.327	2.925	18.506	65.933	262.375	526.588
	Bb	3.797.384	11.726	172.982	533.397	1.339.022	1.740.257

		TOTAL	>100%	100-70%	70-50%	50-30%	30-0%
OPCIÓN 2. 20 AÑOS	TOTAL	7.101.517	217.265	804.757	1.117.987	2.723.862	2.237.646
			3,06%	11,33%	15,74%	38,36%	31,51%
	Uu	2.427.806	75.168	190.877	377.358	798.670	985.733
	Cc	876.327	15.571	65.004	115.120	359.623	321.009
	Bb	3.797.384	126.526	548.876	625.509	1.565.569	930.904

		TOTAL	>100%	100-70%	70-50%	50-30%	30-0%
OPCIÓN 3. 25 AÑOS	TOTAL	7.101.517	554.194	991.887	1.734.802	2.570.427	1.250.207
			7,80%	13,97%	24,43%	36,20%	17,60%
	Uu	2.427.806	197.902	249.731	431.273	952.527	596.373
	Cc	876.327	46.901	106.109	192.845	320.520	209.952
	Bb	3.797.384	309.391	636.047	1.110.684	1.297.380	443.882

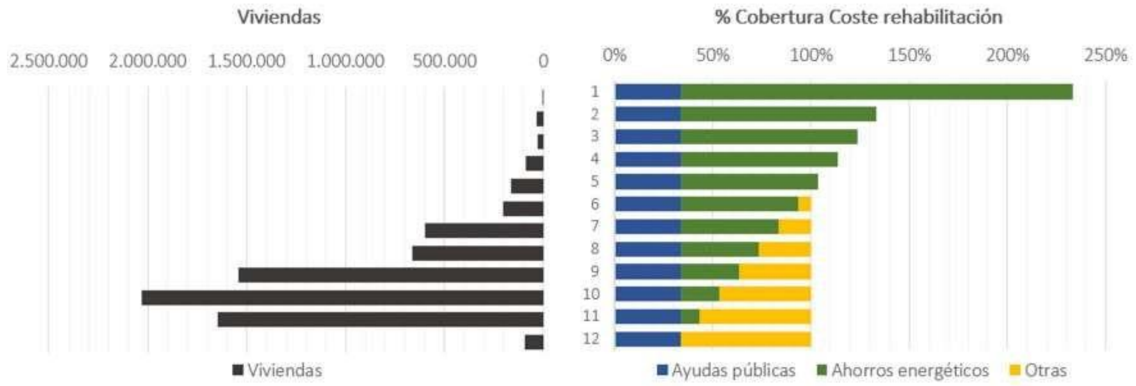
		TOTAL	>100%	100-70%	70-50%	50-30%	30-0%
OPCIÓN 4. 30 AÑOS	TOTAL	7.101.517	1.069.790	1.270.496	1.851.898	2.324.153	585.180
			15,06%	17,89%	26,08%	32,73%	8,24%
	Uu	2.427.806	285.798	398.921	517.331	767.099	458.657
	Cc	876.327	85.239	130.346	272.351	350.815	37.576
	Bb	3.797.384	698.753	741.229	1.062.216	1.206.239	88.947

	OPTION 1.
	15 YEARS
	TOTAL

Source: Cíclica [Space, Community, Ecology].

Option 1 with the 15-year analysis is, naturally, the option with the least favourable results, as that is the shortest of the four options. With this option, only 47% of the 7.1 million dwellings manage to cover 30% of the total investment made across the private and public sectors, compared with 53% which do not manage to achieve that level of coverage. The second-largest segment, representing 31% of the dwellings, is the segment comprising those able to cover between 30% and 50% of the investment through energy savings. The amount of dwellings in which the savings manage to cover more than 70% of the total investment and, therefore, allow the recovery of more than the full amount invested by households (67%) amounts to only 4.5% with this option.

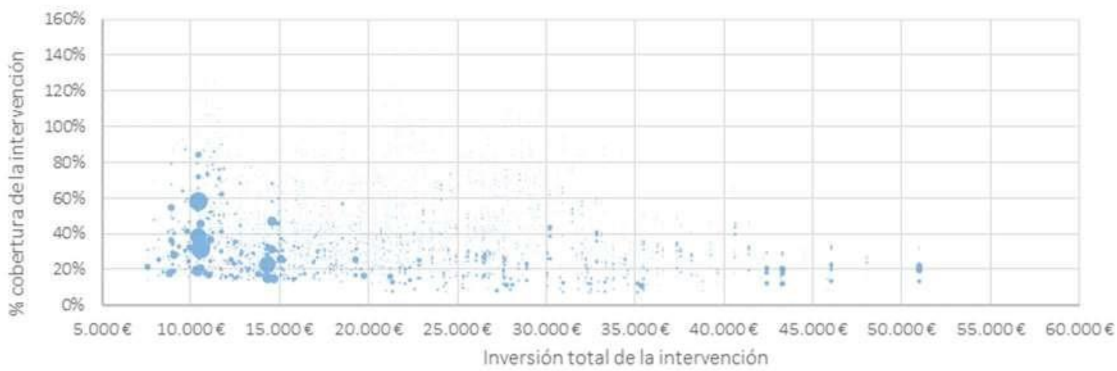
Figure 7.39. Distribution of dwellings by percentage covered | Option 1. 15 years



	Dwellings
	% of Renovation Cost Covered
	Public aid
	Energy savings
	Other

Source: Cíclica [Space, Community, Ecology].

Figure 7.40. Distribution of dwellings by percentage covered and total investment | Option 1. 15 years

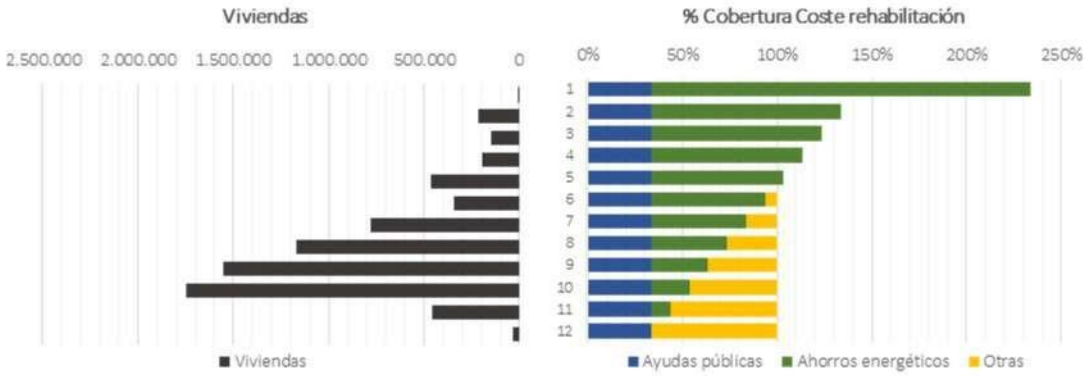


	% of the intervention covered
	Total Intervention Investment

Source: Cíclica [Space, Community, Ecology].

Under option 2 with the 20-year analysis, the group with the largest number of dwellings, representing 38% of the total 7.1 million dwellings, is the group for which savings are able to cover between 30% and 50% of the total investment; while the group able to cover less than 30% becomes less significant and is only the second-largest, representing 32%. This improving trend is also reflected in the groups that cover between 50% and 70% (16% of the dwellings) and the group that covers more than 70% (14% of the dwellings), in which the private sector is able to recover more than the total investment it has made.

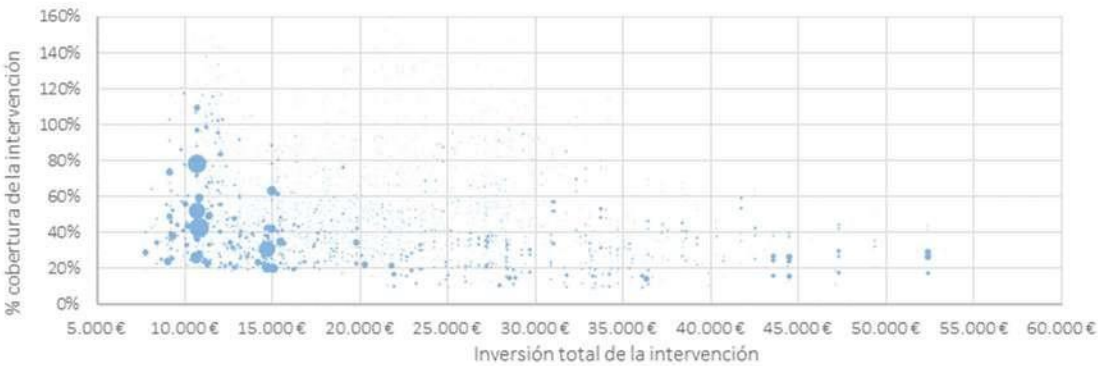
Figure 7.41. Distribution of dwellings by percentage covered | Option 2. 20 years



	Dwellings
	% of Renovation Cost Covered
	Public aid
	Energy savings
	Other

Source: Cíclica [Space, Community, Ecology].

Figure 7.42. Distribution of dwellings by percentage covered and total investment | Option 2. 20 years.

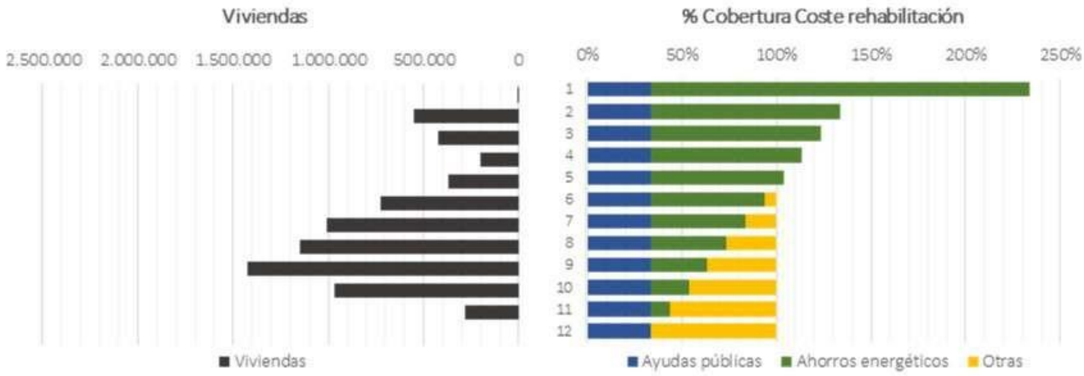


	% of the intervention covered
	Total Intervention Investment

Source: Cíclica [Space, Community, Ecology].

Under option 3 with the 25-year analysis, although the largest group of dwellings, representing 36% of the total, remains the group that manages to cover between 30% and 50% of the total investment, the trend of improved results in comparison with the options using shorter periods places the group of dwellings that achieve coverage of between 50% and 70%, 24% of the total, in second place. Under this option, 22% of the dwellings could cover more than 70% of the total investment (more than 100% of the private sector investment), while the group with a coverage percentage of less than 30% falls to last place, with 18% of the total 7.1 million dwellings.

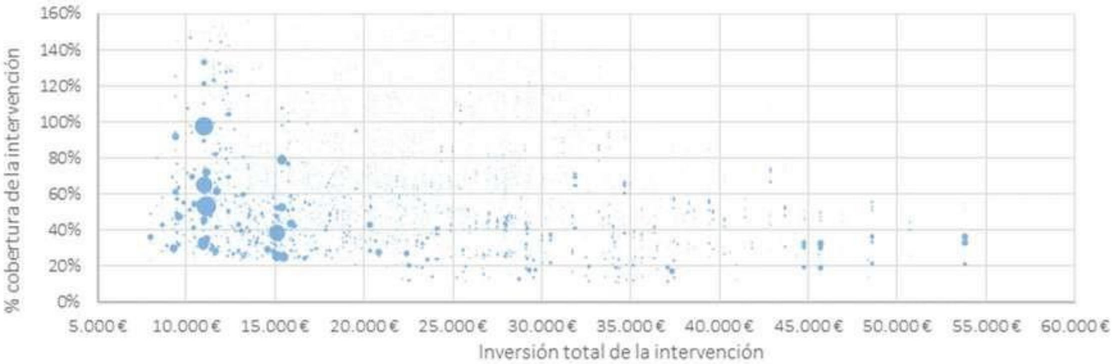
Figure 7.43. Distribution of dwellings by percentage covered | Option 3. 25 years.



	Dwellings
	% of Renovation Cost Covered

Source: Cíclica [Space, Community, Ecology].

Figure 7.44. Distribution of dwellings by percentage covered and total investment | Option 3. 25 years.

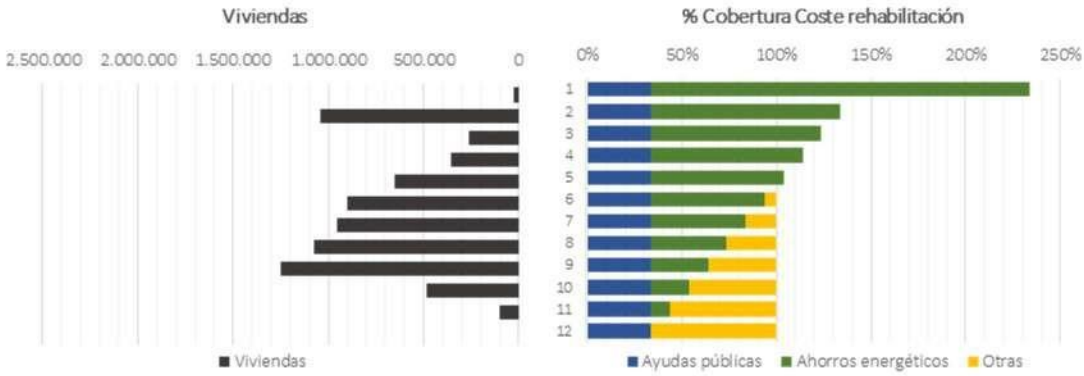


	% of the intervention covered
	Total Intervention Investment

Source: Cíclica [Space, Community, Ecology].

Finally, option 4 with the 30-year analysis is, naturally, the option that produces the best results, as that is the longest of the four options. Under this option, the largest two groups each contain more than 33% of the dwellings; firstly, the group that manages to cover more than 70% of the total investment, allowing the recovery of more than 100% of the amounts invested by the private sector; secondly, the groups that manages to recover between 30% and 50% of the total investment. The third-largest group, representing 26% of the dwellings, is the group able to cover between 50% and 70% of the investment, while the group that covers less than 30% of the total investment, which was the largest group under the 15-year option, is reduced in size and represents only 8% of the 7.1 million dwellings analysed under this longest-term option.

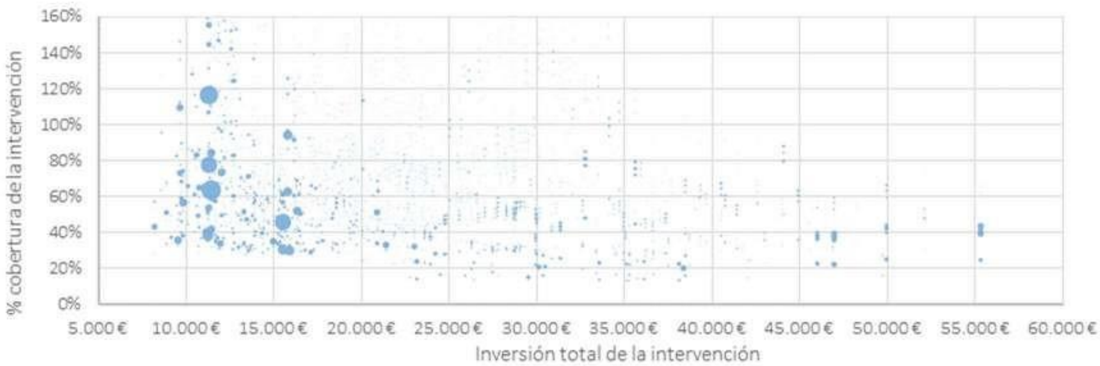
Figure 7.45. Distribution of dwellings by percentage covered | Option 4. 30 years.



	Dwellings
	% of Renovation Cost Covered
	Dwellings
	Public aid
	Energy savings
	Other

Source: Cíclica [Space, Community, Ecology].

Figure 7.46. Distribution of dwellings by percentage covered and total investment | Option 4. 30 years.



	200%
	€5 000
	% of the intervention covered
	Total intervention investment

Source: Cíclica [Space, Community, Ecology].

Ultimately, under any of the four options (including the least favourable one with an analysis period of only 15 years), it is shown that the energy savings and public aid can make the proposed financing schemes reasonably viable.

7.3. OTHER MENUS FOR THE ENVELOPE: PROPOSED PASSIVE AND BIOCLIMATIC ACTIONS FOR SUMMER CONDITIONS AND PARTIAL MENUS.

7.3.1. Proposed Passive and Bioclimatic Actions for Summer Conditions.

As we have seen, the impact of Climate Change in Spain will be particularly relevant in terms of the increase in demand for cooling and the intensification of extreme episodes (heatwaves, tropical nights, maximum temperatures, etc.). Urban areas will be particularly affected, with the addition of the 'heat island' effect.

Although demand for cooling currently represents barely 1% of total household energy consumption, according to the available data, we should again remember the data from the study published by IDAE in 2016 on the stock of heat pumps in Spain[138], according to which the country has 11.3 million heat pump units[139]: 8.5 million installed in homes[140], another 2.3 millions in the commercial-services sector and a further 1 million in industry (IDAE, ibid. p. 20), with almost 80% of them in the Mediterranean zone.

As we have also seen, there seems to be a clear disparity between the large size and power of the existing heat pump stock (estimated to be 77 673 MWt - op. cit., p. 24) and the low impact of the consumption of electricity for cooling on the total energy consumed by households. Therefore, looking to the future, it is important to be fully aware of the possible increase in consumption that could occur if the factors (cultural, adaptive thermal comfort, etc.) that could explain this divergence were to change, especially given the expected increase in demand for cooling as a result of climate change. The planned electrification of the stock and the future large-scale deployment of heat pumps for heating may imply (given that in most cases these are reversible devices) increased use for cooling too, meaning that households that currently do not consume energy for cooling would switch to doing so.

This is why it would be good to propose passive and bioclimatic actions for summer conditions, including the following:

- Measures to improve insulation, especially roof insulation, particularly in single-family dwellings or on the top floor of collective living blocks of dwellings, where they can have a significant impact. The establishment of gardens on flat roofs can also significantly improve insulation.
- Measures to create shade on façades, such as awnings, sunshades or overhangs, and on flat roofs, such as pergolas. It is particularly important to provide shading for glazed openings that do not yet have movable elements for this purpose (blinds or awnings), as is the case in many glazed enclosed balconies in houses built in the last two decades, or in balconies that are provisionally enclosed by the owners, without the appropriate protection.

Figure 7.47. Installation of blinds (on the outside) and awnings in glazed enclosed balconies and openings.

Source: E. de Santiago.

[138] IDAE (2016) 'Estudios IDAE 001: Parque de Bombas de Calor en España. Síntesis del Estudio". https://www.idae.es/publicaciones/sintesis-del-estudio-parque-de-bombas-de-calor-en-espana-estudios-idae-001
[139] According to the data from the survey conducted for that study, of the 11.3 million units, 5.4 million (48%) are only used for cooling, even though they also have a heating function.
[140] According to the study data, of the total of 18 million households, approximately 5.8 million (i.e. approximately 32%) had a heat pump (IDAE, ibid, p. 20). Data from the SPAHOUSEC II Study (IDAE, 2019) are similar, estimating that 30% of the Spanish households that have individual heating have some type of air conditioning system, which would give 5.7 million households with a heat pump.

- Changes in the albedo or colour of the enclosing elements, to increase the reflected energy and decrease the absorbed energy.
- Bioclimatic strategies for vegetation and to promote evapotranspiration, such as the promotion of vegetation (in single-family dwellings, in windows, on balconies and on green roofs in collective housing) and the presence of water.

Figure 7.48. Vegetation on balconies.

Source: E. de Santiago.

- Improving the microclimatic conditions of the built environment, both of single-family dwelling plots and public spaces, in both urban and rural areas. In all of these, vegetation, increased shading, the presence of water, the provision of permeable paving, etc. can significantly improve these conditions.

Figure 7.49. Vegetation, shade and microclimatic conditions of the street or surroundings of the building (historic centre and periphery)

Source: E. de Santiago.

In any event, the importance of promoting traditional heat mitigation techniques (daytime shading and night-time ventilation strategies, cross ventilation, irrigation for evaporative dissipation of latent heat, etc.).

Insofar as, notwithstanding their importance in terms of comfort, these actions would have little impact on the reduction of current consumption[141], they are considered alongside measures to reduce demand through actions on the building envelope, and no additional calculation has been made in the scenarios considered.

7.3.2. Proposed Partial Passive Actions on the Envelope.

In addition to the menus for deep renovation of the envelope, other partial menus for action on elements of the envelope can be considered, which will be so-called 'light' or 'medium' renovations[142]. The problem with these minor partial actions is that, due to their greater ease of execution, they may compete with or contradict other deep actions on the entire envelope, delaying or even discouraging them.

To avoid this, two principles should be taken into account:

- From the perspective of the building, future instruments such as the Existing Building Book or the Building Passport (including a long-term action and investment plan) can be used to articulate and coordinate over time the sequenced development of partial actions until finally achieving the target of deep renovation.
- From the point of view of the Public Administrations competent in this area, there should be a coordinated approach for aid for deep actions on the envelope and, where appropriate, for aid for partial actions (Renove Plans or similar), so that they do not compete with each other and so that the latter do not impede or discourage the former. Given that the target of the deep renovation of 7.1 million envelopes at national level is clearly set, until there is a consolidated development of an instrument such as those mentioned above that clearly allows the sequencing of partial actions by phases, in the event that public aid is proposed for partial actions, and so as to avoid them competing with each other, it should be clearly aimed at dwelling packages other than this one, there being, as we have seen, sufficient margin for this in the segmentation of the residential stock.

In reality, the majority of partial actions on the envelope (with the possible exception of actions specifically aimed at openings[143] which, due to the simplicity of their execution, are relatively independent of any other work and can be considered in almost any circumstance) make little sense independently and yet are perfectly complementary or synergistic with other types of work that are normally carried out on façades or roofs, such as maintenance or conservation work. Such work includes the following, in particular:

- Waterproofing and repair work on roofs (pitched or flat) which could be used as an opportunity to install insulation under the tiles at the same time, in the case of pitched roofs, or to create an inverted roof, in the case of flat roofs.
- Waterproofing work on exposed party walls in which, in addition to the waterproofing material (paint, sheet metal, etc.), it is always advisable to install insulation.
- Conservation work on façades that, due to its importance, deserves separate consideration.

As is well known, in Spain, and by virtue of the 'duty of conservation' (Article 15 of Royal Decree 7/2015), owners are obliged to conserve buildings 'in the legally required condition in terms of safety, health, universal accessibility, ornamentation and other conditions required by law to support such uses'. Given that most of the conservation deficiencies detected in buildings occur in façades and roofs[144], mandatory conservation work, in

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[141]In any event, they would prevent increased demand for cooling in the future.

[142]According to the EU Building Stock Observatory, the following levels of depth of reforms have been developed in the context of primary energy savings: — light (less than 30%); — medium (between 30% and 60%), and — deep (more than 60%).

[143] Renewal of frames and glazing of openings, installation of double glazing, shutters, etc.

[144] According to data from the ITE Observatory of the ICCL (http://www.iteweb.es/), approximately 30% of the ITEs or IEEs are unfavourable, of which approximately 60% detail deficiencies in the façades and/or the other 40% detail deficiencies in roofs, well above other deficiencies such as those of a structural nature or concerning installations.

the event that it corresponds to 'major renovations', may also include an obligation to improve energy performance.

This idea was introduced in Directive 2010/31/EU of the European Parliament and of the Council of 19 May 2010 on the energy performance of buildings, Article 7 of which states that, in existing buildings, *'Member States shall take the necessary measures to ensure that when buildings undergo major renovation, the energy performance of the building or the renovated part thereof is upgraded in order to meet minimum energy performance requirements set in accordance with Article 4 in so far as this is technically, functionally and economically feasible'*. Based on this, it was incorporated into the Technical Building Code (Basic Document on Energy Savings [DBHE], in Part HE1 Limitation of demand), which currently states the following in Section 2.2.2.1 Limitation of the Energy Demand of the Building in Existing Buildings:

'1 When the intervention leads to changes in the internal or external conditions of an element of the "thermal envelope" resulting in an increase of the "energy demand" of the building, the characteristics of this element shall comply with those laid down in this Basic Document.

2 In renovation work in which more than 25% of the total area of the final 'thermal envelope of the building is renovated and in work aimed at changing the "characteristic use" of the building, the "combined energy demand" of the building shall be limited so that it is lower than that of the "reference building".

3 In renovation work not covered in the previous case, the elements of the "thermal envelope" that are replaced, incorporated or substantially modified shall comply with the limitations set out in table 2.3. When work is being performed on multiple elements of the "thermal envelope[145]" simultaneously, the "thermal transmittance" values of the table may be exceeded if the "combined energy demand" is no greater than that obtained by applying the values of the table to the affected elements'.

In all other cases, i.e. where the remedying of identified conservation deficiencies does not lead to 'major renovations' in which more than 25% of the total area of the 'thermal envelope' is renovated, the IEE can also be an instrument that generates synergies between such work and an improvement, in this case voluntary, in energy efficiency. Indeed, Article 6(f) of Royal Decree 235/2013, of 5 April 2013, approving the basic procedure for the certification of the energy performance of buildings, requires the certificate to include a 'document of recommendations for the cost-optimal or cost-effective improvement of the energy performance of a building or building unit, unless there is no reasonable potential for such improvement compared to the energy performance requirements in force'[146]. Therefore,

and although these recommendations remain as such, the time at which the owners must undertake the mandatory work to remedy the deficiencies detected in the state of conservation of façades and/or roofs is a

[145] The terms in quotation marks are precisely defined in the Basic Document itself. Specifically, the thermal envelope of the building is defined as follows: 'The thermal envelope of the building is composed of all the enclosing elements that separate living spaces from the outside, the ground or another building, and all the internal partitions that separate living spaces from non-living spaces in contact with the outside environment. The thermal envelope may incorporate, at the discretion of the designer, non-habitable spaces adjacent to habitable spaces'.

[146]It also establishes that:

'The recommendations included in the energy performance certificate shall cover:
i. measures carried out in connection with a major renovation of the building envelope or technical building systems; and
ii. measures for individual building elements independent of a major renovation of the building envelope or technical building systems.
The recommendations included in the energy performance certificate shall be technically feasible and may provide an estimate for the range of payback periods or cost-benefits over its economic lifecycle.
The energy performance certificate shall provide an indication as to where the owner or tenant can receive more detailed information, including as regards the cost-effectiveness of the recommendations made in the energy performance certificate. The evaluation of cost effectiveness shall be based on a set of standard conditions, such as the assessment of energy savings, underlying energy prices and a preliminary cost forecast. In addition, it shall contain information on the steps to be taken to implement the recommendations. Other information on related topics, such as energy audits or incentives of a financial or other nature and financing possibilities may also be provided to the owner or tenant. For this purpose, the relevant criteria of Commission Delegated Regulation (EU) No 244/2012 of 16 January 2012 may be applied to calculate cost-optimal levels of minimum energy efficiency requirements for buildings and building elements.'

unique opportunity for them to consider the need to follow the recommendations of the Energy Performance Certificate and voluntarily and jointly carry out energy renovation works on the building envelope.

Chapter 5 contains an analysis of the potential of the IEE, and it is worth recalling here that - if it is considered to be implemented throughout Spain - in the decade 2020-2030, no fewer than 6.7 million dwellings should be subject to the IEE (for collective dwellings 50 or more years old), 8.3 million in the decade 2030-2040 and 10.4 million between 2040 and 2050.

Assuming that only between 5% and 10% of the dwellings obliged to have an IEE have to carry out conservation work on the façades, the table reflects the significant potential for synergies that could arise between these mandatory works and the (complete or partial) energy renovation of the envelope.

Figure 7.50. Assumption of synergies between mandatory conservation works derived from the IEE in collective dwellings and energy renovation works on façades (thousands of dwellings).

IEE collective dwelling assumption	2020-2030	2030-2040	2040-2050	2050-2060	Total 2020-2050
10% IEE renovation on collective dwellings reaching 50 years of age	292.6	163.0	202.7	206.2	658.4
10% IEE renovation on reaching 60, 70, 80, 90 or more years of age	381.8	674.4	837.4	1 040.1	1 893.6
	674.4	837.4	1 040.1	1 246.4	2 552.0

IEE collective dwelling assumption	2020-2030	2030-2040	2040-2050	2050-2060	Total 2020-2050
5% IEE renovation on collective dwellings reaching 50 years of age	146.3	81.5	101.4	103.1	329.2
5% IEE renovation on reaching 60, 70, 80, 90 or more years of age	190.9	337.2	418.7	520.1	946.8
	337.2	418.7	520.1	623.2	1 276.0

Source: MITMA.

Although the IEE is not, in principle, applicable to single-family dwellings, the high volume of existing dwellings means that there is a significant potential for synergies. Using a rather conservative assumption that only 25% of single-family dwellings have to undertake a thorough repair of their façades at least once in their entire lifecycle (100 years), a high number of dwellings are likely to be able to establish synergies between conservation and energy renovation.

Figure 7.51. Assumption of synergies between mandatory conservation in single-family dwellings and energy renovation works on façades (thousands of dwellings).

25% renovation single-family dwelling assumption	2020-2030	2030-2040	2040-2050	2050-2060	Total 2020-2050
1% renovation on single-family dwellings reaching 20 years of age	10.5	2.0	3.3	3.2	15.8
1% renovation on single-family dwellings reaching 30 years of age	12.0	10.5	2.0	3.3	24.4
1% renovation on single-family dwellings reaching 40 years of age	8.7	12.0	10.5	2.0	31.2
2% renovation on single-family dwellings reaching 50 years of age	14.7	17.3	24.0	21.0	56.0
5% renovation on single-family dwellings reaching 60 years of age	27.9	36.8	43.3	60.0	108.0
5% renovation on single-family dwellings reaching 70 years of age	19.8	27.9	36.8	43.3	84.5
5% renovation on single-family dwellings reaching 80 years of age	11.9	19.8	27.9	36.8	59.5
5% renovation on single-family dwellings reaching 90 years of age	38.2	50.1	69.8	97.8	158.1
	143.6	176.3	217.6	267.3	537.6

Source: MITMA.

The same potential is found in floor slabs and roofs, especially in the repair of the latter.

Ultimately, these figures show the potential for creating synergies between partial actions and in the possibility of improvements to energy efficiency linked to other works, so that if these could be linked, a large part of the costs of energy efficiency works could be incorporated into the costs of mandatory conservation works.

7.4. INTERVENTION MENUS AND SCENARIOS FOR HEATING INSTALLATIONS.

7.4.1. Heating Installation Matrices and Methodology.

To model the changes in heating installations, MITMA has developed a matrix table that makes it possible to calculate the equipment, consumption and investments up to 2030, entering the 2020 baseline data for the dwellings segmented by packages and in coherence with the installation modelling carried out by MITMA based on TIMES-SINERGIA for the LTS 2050. The table functions based on:

- Coefficients that determine the number of pieces of equipment to be renewed for each technology. The coefficient for households that renew equipment without changing technology is obtained based on the lifecycle of the equipment according to MITERD and the CSIC-Eduardo Torroja Institute for Construction Science (Construction Quality Unit). The coefficient for households changing technologies and fuels is an assumption taken from the MITMA model based on the pathway of the number of pieces of equipment and fuels in the TIMES-SINERGIA tables, to meet the targets set by the PNIEC. The allocation is made for single-family dwellings, multi-family dwellings with individual systems and multi-family dwellings with collective systems (these are grouped in the final matrix in proportion to their distribution at national level, as there is no regionally disaggregated data for collective and individual equipment). For the design of these coefficients, the proposals of the ATECYR work[147] for MITMA have been taken into account and are presented in summary form in Annex A.3. Five assumptions have been made for these coefficients, with the one that best fits the fuel switch pathway proposed by PNIEC ultimately being used.
- Coefficients of the relationship between initial consumption in 2020 and final consumption in 2030, created by MITMA and the CSIC-Eduardo Torroja Institute for Construction Science (Construction Quality Unit) based on the performance of existing and renewed equipment and equipment technologies (with the corresponding date assumptions) used in the TIMES-SINERGIA model. These coefficients are set out in Annex A.4.
- Prices for new or renewed equipment, established by the CSIC-Eduardo Torroja Institute for Construction Science (Construction Quality Unit).

As output, the matrices offer:

- Number of pieces of heating equipment renewed without switch in fuel, with switch in fuel and not renewed.
- Energy consumed and savings.
- Costs of renewals without switch in fuel and with switch in fuel.

[147] ATECYR (2019): *Informe sobre prospectiva y evolución futura de los sistemas de climatización y ACS en la edificación residencial.*

7.4.2. Matrices of Criteria for Changes in Heating Installations for the Target Scenario.

Below are the matrices of criteria for changes in installations, created based on the proposals of the aforementioned work by ATECYR and with the final objective of alignment with the consumptions by fuel in 2030 set by PNIEC and the TIMES-SINERGIA model.

The design is made by distinguishing between installations in multi-family dwellings with collective systems and individual systems, on the one hand, and single-family dwellings, on the other.

Figure 7.52. Matrix of installation changes in multi-family dwellings with collective systems. (%).

MULTI-FAMILY, COLLECTIVE SYSTEMS	Lifecycle	2020	2030													
		DWELLINGS 2020	Aerothermal heat pump		NG boiler		Heating fuel oil boiler		LPG boiler		Boiler or electric radiator		Solar Thermal Panels		Boilers Biomass Pellets	
			N	E	N	E	N	E	N	E	N	E	N	E	N	E
Aerothermal heat pump	20	22 035	37.5	62.5												
Coal boilers and stoves		10 789	10.0		50.0								10.0		30.0	
NG and biogas boiler	25	1 288 932			30.0	70.0										
Heating fuel oil boiler	25	292 986	10.0		40.0			20.0					10.0		20.0	
LPG boiler	25	136 942	10.0		40.0					20.0			10.0		20.0	
Boiler or electric radiator																
NG convectors																
LPG stoves	10															
Solar thermal panels	20	8 277											37.5	62.5		
TOTAL		1 759 961														

Notes: Lifecycle: years. N: % New equipment. E: % Existing equipment. Source: MITMA.

The matrix should be interpreted as follows:

- Aerothermal heat pumps. In 2030, it is assumed that the equipment existing in 2020 will be retained, with the equipment that needs it due to reaching the end of its lifecycle being renewed[148] (37.5%).
- Central coal boilers. The target is to eliminate them completely by 2030. It is hypothesised that 50% will be replaced by central Natural Gas boilers (in urban areas), 30% will be replaced by central Biomass boilers (in rural areas, transforming the coal bunker into a biomass store), assuming that the remaining 20% (corresponding to small buildings with few dwellings) can be divided equally between small centralised Heat Pumps (10%) and collective systems with Solar Thermal Panels (10%).
- Central Natural Gas boilers. It is assumed that the existing ones will be retained, with those that need it due to reaching the end of their theoretical lifecycle (estimated to be 25 years), with this being extended by an additional 25% (which ultimately results in an assumed renewal rate of 26.8%), being renewed.
- Fuel Oil boilers and LPG boilers. In both cases, the target is to replace as much equipment as possible by 2030, with an estimated 20% of the existing pieces of equipment remaining by that date. It is assumed that 40% of the existing equipment will be replaced by collective Natural Gas boilers (in urban areas), a further 20% (rural areas) may switch to Biomass, with the remaining 20% corresponding to homes in small collective dwelling buildings where it may be feasible to switch to a centralised Heat Pump or collective Solar Thermal Panels.
- The remaining equipment existing in 2020, which are the Solar Thermal Panels, are retained in 2030, with those that need it being renewed (assumed to be 37.5%).

[148] For all equipment considered, and as a conservative hypothesis, it is assumed that households (due to various circumstances, especially their financial situation) 'stretch' the lifecycle of the equipment, with the end result that only 75% of the equipment that would theoretically need renewal due to reaching the end of its lifecycle is renewed.

Figure 7.52. Matrix of installation changes in multi-family dwellings with individual systems. (%).

MULTI-FAMILY, INDIVIDUAL SYSTEMS	Lifecycle	2020	2030													
		DWELLINGS 2020	Aerothermal heat pump		NG boiler		Heating fuel oil boiler		LPG boiler		Boiler or electric radiator		Solar thermal panels		Boilers Biomass Pellets	
			N	E	N	E	N	E	N	E	N	E	N	E	N	E
Aerothermal heat pump	20	1 102 562	37.5	62.5												
Coal boilers and stoves		48 141	20.0		40.0						10.0				30.0	
NG and biogas boiler	15	4 775 082			50.0	50.0										
Heating fuel oil boiler	15	1 243 225	10.0		40.0			20.0			5.0				25.0	
LPG boiler	15	120 643	10.0		40.0					20.0	5.0				25.0	
Boiler, electric water heater or radiator	20	1 557 878	18.8								18.8	62.5				
NG convectors and heat pumps	18	325 689	70.0								30.0					
LPG stoves		328 042	70.0								30.0					
Solar thermal panels	20	-														
TOTAL		9 501 262														

Notes: Lifecycle: years. N: % New equipment. E: % Existing equipment. Source: MITMA.

In multi-family dwellings with individual systems, the following hypotheses are made for 2030:

- Aerothermal heat pumps. The existing equipment will be retained, with 75% of the equipment that needs it due to having reached the end of its lifecycle, with its estimated lifecycle being extended, being renewed (resulting in an assumed renewal rate of 37.5%).
- Coal boilers and stoves. The target is to eliminate them completely by 2030. It is hypothesised that 40% will be replaced by central Natural Gas boilers (in urban areas), 30% will be replaced by central Biomass boilers (in rural areas, transforming the coal bunker into a biomass store), assuming that the remaining 30% corresponds to Stoves (therefore, without circuits or radiators) and these will be replaced by Heat Pumps (20%) or Electric Radiators (10%).
- Central Natural Gas boilers. It is assumed that the existing ones will be retained, with the 75% that need it due to reaching the end of their lifecycle, estimated to be 15 years, being renewed (resulting in an assumed final renewal rate of 50%).
- Fuel Oil boilers and LPG boilers. In both cases, the target is to replace as much equipment as possible by 2030, with a realistic estimate being that only 20% of the existing pieces of equipment will remain by that date, with it being possible to retain most of the existing installation (circuit and radiators). It is assumed that 40% of the existing equipment will be replaced by collective Natural Gas boilers (in urban areas) and that a further 25% (rural areas) may switch to individual Biomass boilers. In the remaining 15% of cases, it is assumed that a more profound change will take place, with the existing installation being dismantled in order to switch to Heat Pumps (10%, especially in areas with high cooling needs) or Electric Radiators (only 5%).
- Electrical Equipment, which can be: Electric Radiators, Electric Boilers (which heat water circulating through a distribution circuit serving radiators) and, to a lesser extent, Underfloor Heating. It is assumed that in 2030, the equipment (62.5%) that has not reached the end of its lifecycle (estimated to be 20 years) will be maintained, or its lifecycle will be extended in practice, and that the rest, in equal parts, will either be renewed or switched to Heat Pumps.
- Finally, for the remaining equipment (Natural Gas Convectors and LPG Stoves), the target is their complete replacement in 2030 by more efficient equipment: 70% by Heat Pumps and 30% by one of the above mentioned Electric Systems.

In view of the foregoing, and applying the above distribution hypotheses to the number of existing central and individual equipment at national level, the following proportional distribution is obtained:

Figure 7.53. Matrix of installation changes in multi-family dwellings. (%).

MULTI-FAMILY	Lifecycle	2020 DWELLINGS 2020	2030 Aerothermal heat pump		NG boiler		Heating fuel oil boiler		LPG boiler		Electric boiler or radiator		Solar thermal panels		Boilers Biomass Pellets	
			N	E	N	E	N	E	N	E	N	E	N	E	N	E
Aerothermal heat pump	20	1 124 596	37.5	62.5												
Coal boilers and stoves		58 931	18.2		41.8						8.2		1.8		30.0	
NG and biogas boiler	17.1	6 064 014			45.7	54.3										
Heating fuel oil boiler	16.9	1 536 211	10.0		40.0			20.0			4.0		1.9		24.0	
LPG boiler	20.3	257 585	10.0		40.0					20.0	2.3		5.3		22.3	
Boiler, electric water heater or radiator	20	1 557 878	18.8								18.8	62.5				
NG convectors and heat pumps	18	325 689	70.0								30.0					
LPG stoves		328 042	70.0								30.0					
Solar thermal panels	20	8 277											37.5	62.5		
TOTAL		11 261 222														

Notes: Lifecycle: years. N: % New equipment. E: % Existing equipment. Source: MITMA.

In the case of single-family dwellings, the hypotheses regarding installation changes are the following, which are set out in the table below:

Figure 7.54. Matrix of installation changes in single-family dwellings. (%).

SINGLE-FAMILY	Lifecycle	2020 DWELLINGS 2020	2(30 Aerothermal heat pump		NG boiler		Heating fuel oil boiler		LPG boilers		Boiler or electric radiator		Solar thermal panels		Boilers Biomass (wood and pellets)		Wood cassettes		Stoves, braziers Wood fireplaces		Geothermal boiler	
			N	E	N	E	N	E	N	E	N	E	N	E	N	E	N	E	N	E	N	E
Aerothermal heat pump	20	239 755	37.5	62.5																		
Coal boilers and stoves		32 984	10.0		10.0								20.0		20.0		40.0					
NG and biogas boiler	15	1 095 422	10.0		30.0	50.0									10.0							
Heating fuel oil boiler	15	1 157 602	10.0		20.0			20.0			10.0		20.0		20.0							
Direct-use geothermal boiler	50	22 366																				100.0
LPG boiler	15	177 787	10.0		20.0					20.0	10.0		20.0		20.0							
Biomass boilers (wood and pellets)	15	1 037 718													50.0	50.0						
Biofuel boilers	15	1 175													50.0	50.0						
Boiler, electric water heater or radiator	20	365 664	27.5									62.5	10.0									
NG convectors and stoves	18	46 901	30.0								20.0		10.0				40.0					
LPG stoves	20	128 816	30.0								20.0		10.0				40.0					
Wood stoves, braziers, fireplaces	50	1 231 904	20.0												10.0		40.0			30.0		
Solar thermal panels	20	28 306											37.5	62.5								
		5 566 401																				

Notes: N: New. E: Existing. Source: MITMA.

- Heat Pump. The equipment existing in 2020 will be retained, with 75% of the equipment that needs it due to having reached the end of its lifecycle being replaced between 2020 and 2030 (resulting in an assumed rate of 37.5%).

- Coal stoves and boilers. The target is to eliminate these by 2030, assuming that the dwellings with a proper heating system (boiler, water distribution circuit and radiators) will switch to Biomass (20%), Solar Thermal Panels (20%) or Natural Gas (10%), while dwellings with only Coal Stoves will switch to Heat Pumps (10%) or Biomass Cassette Fireplaces (40%).

- Natural Gas Boilers. It is assumed that 50% of the equipment existing in 2020 will be retained: including (in addition to those still within their lifecycle, which is estimated to be 15 years) 25% of the equipment that should be renewed, but for which it is assumed that this theoretical lifecycle will be extended in practice. Of the remaining 50%, 30% will be renewed retaining Natural Gas as the fuel, but it is assumed that 20% will have already started the transition to other non-fossil energy sources, given that in the final scenario set out for 2050 it is assumed that energy based on fossil fuels (particularly Natural Gas) will have disappeared completely in single-family dwellings. This 20% is assumed to switch to Biomass Boilers (10%) or Heat Pumps (10%).

- Fuel Oil and LPG boilers. As in multi-family dwellings, in both cases, the target is to replace as much equipment as possible by 2030, with a realistic estimate being that only 20% of the existing pieces of equipment will remain by that date, with it being possible to retain most of the existing installation (circuit and radiators). It is assumed that 20% of the existing equipment will be replaced by collective Natural Gas boilers (in urban areas) and that a further 20% (rural areas) will switch to individual Biomass boilers. In the remaining 40% of cases, it is assumed that 20% may switch to Solar Thermal Panels (20%), 10% to Heat Pumps (especially in areas with high cooling needs) and the other 10% to Electrics Systems.

- Electrical Equipment in single-family dwellings, which may be Electric Radiators, Electric Boilers (which heat water circulating through a distribution circuit serving radiators) and, to a lesser extent, Underfloor Heating. It is assumed that in 2030, the equipment that is within its theoretical lifecycle (20 years) or the 25% for which the lifecycle is extended even further (resulting in a total of 62.5%) will be retained and that the rest will either switch to Heat Pumps (estimated at 27.5%, mainly corresponding to Electric Radiators that are decommissioned) or to Solar Thermal Panels (10%).
- Natural Gas Convectors and LPG Stoves. It is assumed that both systems will disappear completely by 2030, and it is estimated that they will mostly be replaced by individual equipment that does not require the installation of a complete heating system from scratch, such as Heat Pumps (30%), Biomass Cassettes (40%) or an Electric System (20%) and, to a lesser extent, Solar Thermal Panels (10%).
- As mentioned above, the use of Biomass in single-family dwellings makes an important contribution to consumption in the residential sector in 2020 and therefore how this use evolves by 2030 is decisive. It has been assumed that the existing dwellings in 2020 with Pellet-fuelled Biomass Boilers will retain them in 2030, with 50% of them having been renewed. In turn, for those with Wood-burning Fireplaces or Stoves (which are the dwellings with the highest relative unit consumption and represent a very high percentage of total consumption) it is assumed that 30% will remain as they are, a further 50% will retain Biomass as fuel, although they will simply and cheaply improve performance by simply installing Cassettes (in 40% of homes), or a complete installation will be carried out incorporating a boiler, circuit and radiators in a much lower percentage of cases (10%). It is estimated that the remaining 20% will switch to Heat Pumps, especially in areas with demand for cooling.

Finally, in the few existing dwellings using geothermal energy (estimated to be fewer than 25 000), it is assumed that there will be no significant changes between 2020 and 2030. In this regard, it is worth mentioning that the GEO4CIVHIC project[149] is studying the integration of geothermal energy in the renovation of buildings, both public and historical. From April 2018 to April 2022, this Horizon 2020-funded initiative aims to identify and develop the most suitable geothermal heating and cooling solutions based on building type, climate and geological conditions.

7.4.3. General Results of the Target Scenario for Heating Installations.

Applying these criteria to the calculation matrix makes it possible to obtain results on the number of pieces of equipment renewed without switch in fuel, renewed with switch in fuel.and not renewed; energy consumed and savings; and costs of renewals without switch in fuel and with switch in fuel.

They are applied differently for each of the dwelling packages into which the housing stock has been divided for the analysis of the interventions on the envelope, so that specific criteria can be applied to each of the Packages.

The results for the installations for Scenario C or the Base Scenario are given in detail in Chapter 9.

7.4.4. Matrices of Criteria for of the Baseline Scenario for Heating Installations.

[149] http://geo4civhic.eu/

A baseline scenario was also considered for the trend of installations in the 13 193 581 000 000 homes modelled without Energy Poverty in 2020, with the following hypotheses:

In single-family dwellings, for Natural Gas, Biomass, Fuel Oil and LPG boilers, taking into account the estimated theoretical lifecycle of such equipment (around 15 years), it is assumed that 50% of the existing equipment will be replaced before 2030 (compared to the 66% that would theoretically require replacement). For electrical equipment (Heat Pumps and Radiators or Electric Boilers), taking into account their lifecycle, it is assumed that 37.5% will be renewed. As for the technologies that are assumed to be changed due to the simple trend of the market and the obsolescence of existing equipment, it is assumed that all coal-fuelled equipment will be replaced completely and 80% of LPG Stoves and 30% of Wood-burning Stoves and Fireplaces will be replaced. This means that, of the 4 242 061 single-family dwellings without energy poverty in 2020, 2 307 265 will have the same equipment in 2030 (54.4%), 1 482 500 will renew the equipment without changing fuel (34.9%) and 452 296 will change equipment and switch fuel (10.7%). The estimated cost would be €6 128 100 000, divided into €4 856 100 000 for renewed equipment and €1 272 000 000 for those changing fuel. This scenario would achieve savings in 2030 of 3 050 028.6 MWh compared to the original consumption in 2020, which is approximately 7.7%.

Figure 7.55. *Matrix of installation changes in single-family dwellings according to the baseline hypothesis. (%)*

SINGLE-FAMILY	Lifecycle	2020 DWELLINGS 2020	2020 DWELLINGS 2020, WITHOUT FUEL	2030 Aerothermal heat pump N	E	NG boiler N	E	Heating fuel oil boiler N	E	LPG boilers N	E	Boiler or electric radiator N	E	Solar thermal panels N	E	Boilers Biomass (wood and pellets) N	E	Wood cassettes N	E	Stoves, braziers and fireplaces N	E	Geothermal boiler N	E	NG convectors and stoves N	E
Aerothermal heat pump	20	239 755	174 082	37.5	62.5																				
Coal boilers and stoves		32 984	-	10.0		10.0								20.0		20.0		40.0							
NG and biogas boiler	15	1 095 422	882 303			50.0	50.0																		
Heating fuel oil boiler	15	1 157 602	928 465					50.0	50.0																
Direct-use geothermal boiler	50	22 366	-																				100.0		
LPG boiler	15	177 787	143 153							50.0	50.0														
Biomass boilers (wood and pellets)	15	1 037 718	843 915													50.0	50.0								
Biofuel boilers	15	1 175	-													50.0	50.0								
Boiler, electric water heater or	20	365 664	128 136	27.5									62.5	10.0											
NG convectors and stoves	18	46 901	36 604																					50.0	50.0
LPG stoves	20	128 816	103 748									20.0						80.0							
Wood stoves, braziers, fireplaces	50	1 231 904	1 001 655	10.0												10.0		10.0			70.0				
Solar thermal panels	20	28 306	-												100.0										
		5 566 401	4 242 061																						

Notes: Lifecycle: years. N: % New equipment. E: % Existing equipment. Source: MITMA.

In the case of multi-family dwellings, the hypotheses considered are a renewal of 45.75% of the Natural Gas equipment and Biomass, Fuel Oil and LPG Boilers, as well as 37.5% for electrical systems (Heat Pumps and Radiators or Electric Boilers). The complete replacement of coal-fuelled equipment and the renewal of 50% of Natural Gas convectors and LPG Stoves are also considered within this baseline scenario. This means that, of the 8 951 521 dwellings modelled as multi-family and without energy poverty existing in 2020, in 2030, 4 985 953 would have the same equipment (55.7%), 3 802 457 would renew the equipment (42.5%) and 163 111 homes would switch fuel (1.8%). The estimated cost would be €5 601 300 000: €5 248 500 000 for renewed equipment and €352 800 000 for those changing fuel. This would result in savings of 2 284 401.1 MWh, approximately 8.7% of multi-family dwelling consumption in 2020.

Figure 7.56. Matrix of installation changes in multi-family dwellings according to the baseline hypothesis. (%)

MULTI-FAMILY	Lifecycle	2020		2030																	
		DWELLINGS 2020	DWELLINGS 2020, WITHOUT ENERGY POVERTY(*)	Aerothermal heat pump		NG boiler		Heating fuel oil		LPG boiler		Boiler or electric radiator		Solar thermal panels		Biomass Pellet Boilers		NG convect		LPG stoves	
				N	E	N	E	N	E	N	E	N	E	N	E	N	E	N	E	N	E
Aerothermal heat pump	20	1 124 596	981 241	37.5	62.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Coal boilers and stoves		58 931	-	18.2	-	41.8	-	-	-	-	-	8.2	-	1.8	-	30.0	-	-	-	-	-
NG and biogas boiler	17.1	6 064 014	5 037 305	-	-	45.7	54.3	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Heating fuel oil boiler	16.9	1 536 211	1 304 938		-		-	45.7	54.3	-	-		-		-		-	-	-	-	-
LPG boiler	20.3	257 585	216 008		-		-	-	-	45.7	54.3		-		-		-	-	-	-	-
Boiler, electric water heater or	20	1 557 878	869 924	18.8	-	-	-	-	-	-	-	18.8	62.5	-	-	-	-	-	-	-	-
NG convectors and heat pumps	18	325 689	261 249		-	-	-	-	-	-	-		-	-	-	-	-	50.0	50.0	-	-
LPG stoves		328 042	280 856		-	-	-	-	-	-	-		-	-	-	-	-	-	-	50.0	50.0
Solar thermal panels	20	8 277	-	-	-	-	-	-	-	-	-	-	-	37.5	62.5	-	-	-	-	-	-
TOTAL		11 261 222	8 951 521																		

Notes: Lifecycle: years. N: % New equipment. E: % Existing equipment. Source: MITMA.

7.4.5. General Results of the Target Scenario for Heating Installations.

Adding together the single-family and multi-family dwellings, in total, of the 13 193 581 000 000 dwellings modelled without energy poverty in 2020, 7 293 218 000 000 would have the same equipment in 2030, 5 284 957 000 000 would renew the equipment without changing fuel and 615 406 000 000 would change equipment and switch fuel. This would result in savings of 7 638 416 MWh, with an estimated total investment of €11 729 000 000. €10 105 000 000 for renewed equipment and €1 625 000 000 for equipment involving a switch in fuel.

Figure 7.57. Results of the Baseline Scenario for Installations.

	Dwellings 2020	Consumption	CONSUMPTION PER DWELLING	Consumption 2030	CONSUMPTION PER DWELLING	Savings	SAVINGS PER	%	Consumption	DWELLINGS 2020	DWELLINGS THAT SHOULD RENEW	EXISTING DWELLINGS	DWELLINGS THAT RENEW	DWELLINGS SWITCH	EXTRA RENEWALS
TOTAL	13 193 581	66 116 190	5 011	58 477 775	4 432	7 638 416	579	11.6		13 193 581	7 179 139	7 293 218	5 284 957	615 406	-1 278 775
UNIFAM:	4 242 061	39 823 658	9 388	34 469 644	8 126	5 354 014	1 262	13.4		4 242 061	2 288 873	2 307 265	1 482 500	452 296	- 354 077
PLURI:	8 951 521	26 292 532	2 937	24 008 131	2 682	2 284 401	255	8.7		8 951 521	4 890 266	4 985 953	3 802 457	163 111	- 924 698

Source: MITMA.

7.5. INTERVENTION MENUS AND SCENARIOS FOR DHW INSTALLATIONS.

7.5.1. Baseline Hypothesis and Scenario.

As a baseline hypothesis for DHW, it is assumed that there are no spontaneous switches in fuel in relation to the existing equipment, more so than in the case of coal, which will disappear completely in the decade 2020-2030. Therefore, the trend of this equipment is determined exclusively by the renewal (in principle, without any switch in fuel) of the equipment that reaches the end of its lifecycle in the period 2020-2030, it being considered that one third of the equipment that should theoretically be renewed has its lifecycle extended in practice[150]. In addition, the stock will be increased by the equipment corresponding to newly built dwellings, which is assumed to be distributed approximately as follows: half of them will be Natural Gas combi-boilers; a quarter will be Solar Panels; and the remaining quarter will be Heat Pumps with DHW.

[150]This is a particularly conservative hypothesis, with this extension being explained by families' financial difficulties, lower use than estimated, etc.

Under these hypotheses, the results show an almost even split between DHW equipment that has been renewed (9 237 745) and that which has not (9 513 474), the complete replacement of coal-fired equipment and the addition of 1 245 852 new pieces of equipment.

Figure 7.58. Matrix for the trend of DHW equipment, 2020-2030. Baseline Hypothesis.

DHW, BASELINE SCENARIO	2020	2030							
	NO OF PIECES OF EQUIPMENT	NO OF PIECES OF EQUIPMENT NOT CHANGING FUEL	NO OF PIECES OF EQUIPMENT NOT CHANGING FUEL, BUT RENEWED	NO OF PIECES OF EQUIPMENT NOT CHANGING FUEL, NOT RENEWED	NO OF NEW PIECES OF EQUIPMENT IN NEW DWELLINGS	NO OF NEW PIECES OF EQUIPMENT DUE TO	NO OF PIECES OF EQUIPMENT LOST DUE TO SWITCH IN FUEL	NO OF PIECES OF EQUIPMENT LOST THAT SWITCH FUEL	NO OF PIECES OF EQUIPMENT
DHW Coal	20 433	-	-	-	-	-	- 20 433	- 20 433	-
DHW Electricity	2 275 576	2 275 576	1 120 606	1 154 970	-	133	-	-	2 275 709
DHW Natural Gas	10 619 297	10 619 297	4 867 139	5 752 158	676 252	9 628	-	-	11 305 177
DHW, Heating Fuel Oil	715 711	715 711	369 354	346 357	-	-	-	-	715 711
DHW, Propane/Butane	2 409 221	2 409 221	1 211 449	1 197 772	-	-	-	-	2 409 221
DHW, Solar Thermal	2 043 769	2 043 769	1 329 392	714 377	282 230	3 967	-	-	2 329 966
Heat Pump and DHW	250 042	250 042	114 277	135 766	287 370	6 706	-	-	544 119
DHW, Biomass	407 583	407 583	225 529	182 054	-	-	-	-	407 583
DHW, Geothermal	30 021	30 021		30 021	-	-	-	-	30 021
TOTAL	18 771 653	18 751 219	9 237 745	9 513 474	1 245 852	20 433	- 20 433	- 20 433	20 017 505

Source: MITMA, on the model for stock in 2020, based on MITERD (TIMES-SINERGIA model) and IDAE data.

7.5.2. Target Hypothesis and Scenario.

The Hypothesis of the Target Scenario for DHW has been constructed on the basis of two criteria: firstly, the application of the switches in fuel necessary to meet the general PNIEC targets in 2030 and, secondly, the renewal of all equipment that theoretically reaches the end of its lifecycle in the decade 2020-2030, without considering (as is done in the baseline hypothesis) that a certain percentage of households will extend their use.

The foreseen switches in fuel imply the complete disappearance of Coal by 2030, together with very significant reductions in DHW equipment using Fuel Oil, LPG and (within the Biomass segment) Wood.

The renewal of equipment and its replacement by more efficient equipment (but using the same fuel) will be particularly intense (reaching approximately two thirds of the existing equipment) in Natural Gas Heaters and Combi-Boilers and in Electric Heaters and Combi-Boilers.

In turn, as is the case in newly built dwellings, it is assumed that the equipment replaced with other equipment that uses a different fuel will mainly switch to Natural Gas, Heat Pumps with DHW and Solar Panels.

In addition to the equipment in newly built dwellings (the distribution of this is assumed to be identical to that of the baseline scenario), in total, according to this Target Scenario 9 734 480 pieces of equipment would be renewed without changing fuel, 5 835 937 would remain and not be renewed and 3 201 236 pieces of equipment would be renewed and also switch fuel.

The results broken down by fuel are shown in the table below.

Figure 7.59. Matrix for the trend of DHW equipment, 2020-2030. Target Scenario Hypothesis

DHW, TARGET SCENARIO	2020	2030							
	NO OF PIECES OF EQUIPMENT	NO OF PIECES OF EQUIPMENT NOT CHANGING FUEL	NO OF PIECES OF EQUIPMENT NOT CHANGING FUEL, BUT RENEWED	NO OF PIECES OF EQUIPMENT NOT CHANGING FUEL, NOT RENEWED	NO OF NEW PIECES OF EQUIPMENT IN NEW DWELLINGS	NO OF NEW PIECES OF EQUIPMENT DUE TO	NO OF PIECES OF EQUIPMENT LOST DUE TO SWITCH IN FUEL	NO OF PIECES OF EQUIPMENT LOST THAT SWITCH FUEL	NO OF PIECES OF EQUIPMENT
DHW Coal	20 433	-	-	-	-	-	- 20 433	- 20 433	-
DHW Electricity	2 275 576	2 158 343	1 438 895	719 448	-	41 975	- 117 233	- 75 258	2 200 318
DHW Natural Gas	10 619 297	10 619 297	7 079 532	3 539 766	676 252	970 036	-	1 646 288	12 265 585
DHW, Heating Fuel Oil	715 711	41 413	-	41 413	-	-	- 674 298	- 674 298	41 413
DHW, Propane/Butane	2 409 221	261 039	-	261 039	-	-	- 2 148 182	- 2 148 182	261 039
DHW, Solar Thermal	2 043 769	2 043 769	976 862	1 066 906	282 230	1 160 264	-	1 442 494	3 486 263
Heat Pump and DHW	250 042	250 042	125 021	125 021	287 370	1 028 961	-	1 316 331	1 566 374
DHW, Biomass	407 583	171 254	114 169	57 085	-	-	- 236 329	- 236 329	171 254
DHW, Geothermal	30 021	25 259	-	25 259	-	-	- 4 762	- 4 762	25 259
TOTAL	18 771 653	15 570 416	9 734 480	5 835 937	1 245 852	3 201 236	- 3 201 236	1 245 852	20 017 505

Source: MITMA, on the model for stock in 2020, based on MITERD (TIMES-SINERGIA model) and IDAE data.

7.6. APPROACHES TO INTERVENTION IN HOUSEHOLDS EXPERIENCING ENERGY POVERTY.

This section details the approaches for the Package of Dwellings in 'Energy Poverty'. We start with a regionalised segmentation by provinces of the homes in Energy Poverty (point 7.6.1) and then propose different Intervention Menus (7.6.2), including passive measures on the envelope (a), express measures (b) and measures on installations (c). Finally, two different scenarios are analysed for the renovation of these homes in Energy Poverty and the results are presented.

7.6.1. Regionalised Segmentation by Provinces of the Homes in Energy Poverty in Spain.

In relation to Measures 10 (Comprehensive Renovation of Buildings) and 11 (Other measures derived from the analysis in the ERESEE) of the National Strategy to combat Energy Poverty 2019-2024, which refer to the 2020 ERESEE, and in order to design scenarios that consider the deep renovation of homes in Energy Poverty, we have proceeded in the same way as in the rest of this 2020 ERESEE; i.e., the stock of dwellings in Energy Poverty has been segmented according to certain homogeneous characteristics, which are as follows:

- Year of construction. Households residing in dwellings built after the approval of the Technical Building Code (since 2007) have been discarded, as it is considered that their Energy Poverty situation does not stem so much from the state of the dwelling as from the economic conditions of the households.
- Province. The segmentation at provincial level allows for subsequent differentiation and grouping of homes in Energy Poverty by Autonomous Community and by Climatic Zone.
- Building type, differentiating between single-family and multi-family dwellings, involving a single owner or a homeowners' association, which is a decisive factor in decision-making for renovation.
- Size of the municipality, differentiating between rural (fewer than 20 000 inhabitants) and urban (more than 20 000 inhabitants).

The regionalised distribution of the households in Energy Poverty according to these criteria is based on the report *Pobreza, vulnerabilidad y desigualdad energética. Nuevos enfoques de análisis*[151] by the Environmental Sciences Association (Asociación de Ciencias Ambientales - ACA, 2016), considering only households in a situation

[151] https://www.cienciasambientales.org.es/index.php/comunicacion/noticias/567-3er-estudio-pobreza-energetica-en-espana-nuevos-enfoques-de-analisis

of *Disproportionate Expense 2M* (equivalent to groups G1 and G3 described in Section 5.4.1 on regional characterisation by homogeneous groups of households in Energy Poverty in Spain.

The result of this segmentation is shown, grouped by climatic zones and broken down by province, in the following table:

Figure 7.60. Number of households in Energy Poverty with disproportionate expenditure (2M), by province and climatic zone (except Las Palmas, Santa Cruz de Tenerife, Ceuta and Melilla).

Z Clim	Provincia	URBANO Plurifamiliar	URBANO Unifamiliar	RURAL Plurifamiliar	RURAL Unifamiliar	N hogares
A	Almería	12.500	9.380	6.465	12.713	41.058
A	Cádiz	26.290	26.381	4.703	11.029	68.403
A	Huelva	8.650	4.004	5.713	12.785	31.152
A	Málaga	38.392	32.107	4.215	20.939	95.653
	Zona Climática A	85.832	71.872	21.096	57.466	236.266
B	Alicante/Alacant	41.859	11.699	9.865	14.319	77.742
B	Balears, Illes	30.361	14.594	4.784	16.428	66.167
B	Castellón/Castelló	11.453	3.099	4.528	4.843	23.923
B	Córdoba	15.161	9.770	5.857	15.427	46.215
B	Murcia	44.137	28.754	0	10.217	83.108
B	Sevilla	40.464	28.014	8.448	32.540	109.466
B	Tarragona	20.419	3.927	11.983	9.968	46.297
B	Valencia/València	52.576	12.434	18.512	23.247	106.769
	Zona Climática B	256.430	112.291	63.977	126.989	559.687
C	Badajoz	12.954	6.403	5.633	21.107	46.097
C	Barcelona	174.260	37.969	42.579	59.756	314.564
C	Cáceres	6.555	2.219	5.145	14.854	28.773
C	Coruña, A	22.863	11.112	6.268	27.307	67.550
C	Granada	16.632	6.057	9.941	25.363	57.993
C	Jaén	10.248	4.647	7.629	16.004	38.528
C	Pontevedra	18.499	11.996	5.305	19.207	55.007
C	Cantabria	13.507	3.735	6.673	9.932	33.847
C	Toledo	22.571	2.926	24.655	35.801	85.953
C	Bizkaia	22.812	846	8.503	2.808	34.969
	Zona Climática C	320.901	87.910	122.331	232.139	763.281
D	Araba/Álava	7.567	202	1.549	853	10.171
D	Albacete	18.584	6.813	6.281	15.623	47.301
D	Ciudad Real	18.525	8.028	15.368	20.642	62.563
D	Cuenca	6.687	585	7.507	11.067	25.846
D	Girona	14.961	2.846	16.540	9.935	44.282
D	Guadalajara	11.569	1.689	5.307	13.203	31.768
D	Gipuzkoa	9.940	778	8.516	1.417	20.651
D	Huesca	3.202	87	8.511	4.944	16.744
D	Lleida	7.071	480	11.325	6.430	25.306
D	Rioja, La	10.270	387	7.861	6.365	24.883
D	Lugo	4.414	1.064	4.174	10.671	20.323
D	Madrid	260.920	29.890	0	0	290.810
D	Navarra	12.332	694	14.068	13.861	40.955
D	Ourense	5.059	719	3.302	10.717	19.797
D	Asturias	28.469	3.831	7.126	7.759	47.185
D	Palencia	2.751	691	1.728	8.702	13.872
D	Salamanca	5.484	1.062	4.134	18.839	29.519
D	Segovia	2.032	547	2.355	8.119	13.053
D	Teruel	2.116	212	4.863	2.769	9.960
D	Valladolid	10.704	6.523	3.194	23.868	44.289
D	Zamora	3.016	655	2.046	9.897	15.614
D	Zaragoza	34.732	3.611	8.555	18.149	65.047
	Zona Climática D	480.405	71.394	144.310	223.830	919.939
E	Ávila	2.107	1.040	2.598	8.096	13.841
E	Burgos	7.662	3.093	1.752	17.769	30.276
E	León	8.144	3.769	5.254	24.080	41.247
E	Soria	1.388	399	1.224	4.813	7.824
	Zona Climática E	19.301	8.301	10.828	54.758	93.188
	Total	1.162.869	351.768	362.542	695.182	2.572.361

	Climatic Zone C
	Araba/Álava
	Albacete
	Ciudad Real
	Cuenca
	Girona
	Guadalajara
	Gipuzkoa
	Huesca
	Lleida
	Rioja
	Lugo
	Madrid
	Navarre
	Ourense
	Asturias
	Palencia
	Salamanca
	Segovia
	Teruel
	Valladolid
	Zamora
	Zaragoza
	Climatic Zone D
	Ávila

	Burgos
	León
	Soria
	Climatic Zone E
	Total
	Climatic Zone Province
	Almería
	Cádiz
	Huelva
	Malaga
	Climatic Zone A
	Alicante
	Balearic Islands
	Castellón
	Córdoba
	Murcia
	Sevilla
	Tarragona
	Valencia
	Climatic Zone B
	Badajoz
	Barcelona
	Cáceres
	A Coruña
	Granada
	Jaén
	Pontevedra
	Cantabria
	Toledo
	Biscay
	URBAN
	Single-family
	Multi-family
	No of households
	RURAL:

Source: GBCe for MITMA.

This regionalised segmentation makes it possible to define more tailored intervention menus and therefore to estimate more realistic budgets that can be aggregated by climatic zone and by Autonomous Community.

7.6.2. Intervention Menus for the Rehabilitation of Households in Energy Poverty.

As reflected in the National Strategy against Energy Poverty 2019-2024, the renovation measures for households in Energy Poverty should prioritise passive energy efficiency solutions. Indeed, in households with energy expenditure that exceeds twice the median (criterion 2M, equivalent to the aforementioned groups G1 and G3), passive measures such as envelope improvement or window replacement can lead to a reduction in demand, resulting in lower consumption and savings on energy bills. Therefore, through these interventions, situations of Energy Poverty could be alleviated to a large extent by lowering the energy expenditure of the beneficiary households, to the extent that a certain number of them would overcome the situation of Energy Poverty from the point of view of criterion 2M. In households in extreme situations of Energy Poverty, with no or very low energy consumption, improving energy efficiency by renovating the envelope would achieve not only energy and cost savings, but also (in the absence of these) a direct improvement in the comfort of the inhabitants.

When Energy Poverty has other dimensions, such as Hidden Energy Poverty (HEP criterion), passive solutions may not lead to a decrease in consumption and, therefore, energy bills. Households in HEP are defined as having abnormally low energy consumption, as they decide to forgo thermal comfort in order to allocated these financial resources to other aspects (food, lighting, transport, etc.). However, the energy renovation of such dwellings can also lead to a considerable improvement in living conditions and, therefore, the health of their inhabitants.

a) Passive Measures for the Renovation of the Envelope in Households in Energy Poverty.

Therefore, and in relation to Measures 10 and 11 of the National Strategy to Combat Energy Poverty 2019-2024, this 2020 ERESEE contains an analysis of the energy renovation of dwellings in Energy Poverty through passive solutions for intervention in the envelope (openings, façades and roof). To establish the intervention menus for households in Energy Poverty and adapte them to each case, we have taken into account the climatic zone of the province (simplified, in accordance with SPAHOUSEC for the Atlantic, Mainland Spain and the Mediterranean[152]), the type (single-family or multi-family), the size of the municipality (urban or rural), the estimated geometric characteristics based on the 2011 Housing Census[153] (façade, roof, floor and glazed surfaces) and the cost of the measures to be implemented[154]. In this manner, the following intervention menus have been defined, which are described in detail in Annex A.5:

Menu for External Intervention on Multi-Family Buildings.

This includes the external cladding of the enclosing elements with EIFS, insulation on roofs and floors, the installation of double glazing and (in Mediterranean and mainland climatic zones) the installation of awnings on south-facing façades.

This is considered the main intervention menu to be carried out in urban environments in which Energy Poverty is concentrated in multi-family buildings, situated (in turn and in most cases) in Vulnerable Neighbourhoods. In general, these neighbourhoods are low-income and very homogeneous, so not only are situations of Energy Poverty quite common, but situations of monetary poverty are also, as well as the existence of other problems such as deficiencies in the conservation of dwellings, an absence of lifts or accessibility problems, the deterioration of public spaces, etc. All of this means that the optimal way to tackle Energy Poverty in these cases is through Integrated Urban Regeneration Plans, once the areas of concentration of Urban Poverty and their relationship with the Vulnerable Neighbourhoods have been properly identified in each municipality.

Menu for Internal Intervention on Multi-Family Buildings.

This includes internal cladding with EPS, on both walls (in the event there is no cavity; if there is, it can also be injected) and ceilings, the replacement of window frames with new frames with thermal breaks and double glazing and the installation of awnings on south-facing façades.

This is considered the main menu for intervention in situations of Energy Poverty in multi-family dwellings in which there is no area concentration of these situations, i.e., in which Energy Poverty occurs only in isolated instances in some dwellings in the building and not in others, which leads to individualised actions dwelling by dwelling, and not building by building (which allows intervention on the exterior of the façades) or at neighbourhood level, as proposed in the previous menu.

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[152]See Section 5.4.1 regional characterisation by homogeneous groups of households in energy poverty in Spain.

[153]Segmentation of the residential stock in Spain into type clusters. Study (01) for the 2020 ERESEE *Estrategia a largo plazo para la Rehabilitación Energética en el Sector de la Edificación en España*. Subdirectorate-General of Urban Policy – MITMA. March 2019.

[154]The cost of the measures has been obtained from the report entitled *Re-habilitación exprés para hogares vulnerables*. *Soluciones de bajo coste* (De Luxán et al., 2017) https://www.fundacionnaturgy.org/rehabilitacion-viviendas-colectivos-vulnerables/

Menu for Partial Intervention on Single-Family Buildings.

This is considered the main menu for intervention on single-family dwellings where the low occupancy makes it possible to improve comfort conditions by taking action only on a small part of the dwelling, intervening in only the main living areas (for example: living room or kitchen-diner and bedroom), it being estimated that the intervention will take place on 30% of the area of building envelope. This type of situation can arise in large single-family dwellings inhabited by elderly couples or elderly people living alone (situations that are very common in rural areas), in which the investment required for complete renovation would be very costly.

The proposed menu includes internal cladding with EPS, on both walls (in the event there is no cavity; if there is, it can also be injected) and ceilings, the replacement of window frame with new frames with thermal breaks and double glazing and the installation of awnings on south-facing façades.

Menu for Complete Intervention on Single-Family Buildings.

In all cases, this menu is considered complementary to the previous one, in both rural and urban contexts, it being convenient in large households that use the entire dwelling.

This includes external cladding of walls with EPS-type EIFS, internal cladding on ceilings with EIFS, the replacement of window frames with new frames with thermal breaks and double glazing and the installation of awnings on south-facing façades.

The costs of these menus per dwelling (which - for further information - are broken down in Annex A.5) would be as follows:

Figure 7.61. Costs of the Envelope Renovation Menus in Households with Energy Poverty.

Menu:	Range of prices	Average price
Menu for external intervention on multi-family buildings	€6 608 - €10 592	€8 856
Menu for internal intervention on multi-family buildings	€4 086 - €6 294	€5 301
Menu for partial intervention on single-family buildings	€1 888 - €3 563	€2 836
Menu for complete intervention on single-family buildings	€8 812 - €16 628	€13 282

Source: GBCe for MITMA.

b) Express Measures: Micro-Improvements and Repairs.

The National Strategy to Combat Energy Poverty 2019-2024 includes a short-term Measure 7, with measures for express renovation in dwellings. Indeed, in the most pressing situations of Energy Poverty linked to the poor state of the dwelling, the living conditions of a dwelling can be improved in relative terms through micro-improvements. There are currently several initiatives[155] associated with social intervention programmes that implement micro-improvements to energy efficiency in vulnerable households (replacement of light bulbs with LEDs, installation of chrono-thermostats, aerators for taps, etc.), repairs (sealing cracks, fitting weather stripping, insulation of roofs, etc.) and consumption habits (adaptation of contracted tariffs and training).

[155] To name but a few: the ACA (Asociación de Ciencias Ambientales - Environmental Sciences Association) has established an extensive network of Energy Consumer Information Points that provide advice and raise awareness concerning Energy Poverty; the Association Socaire provides energy audits and carries out micro-improvements in dwellings in vulnerable neighbourhoods of Madrid through energy windows in neighbourhood associations; for its part, Barcelona City Council has, via the Climate Plan, promoted the REVISO tool for diagnosis and action against Energy Poverty, developed by Fundación Habitat 3, Ecoserveis and GBCe, for social housing management entities.

Other interesting, recommendable and applicable measures are, in any case, bioclimatic measures, such as, in summer, the shading of openings and the improvement of thermal conditions by means of evapotranspiration through the placement of vegetation on windows.

For the purpose of this 2020 ERESEE, these express and bioclimatic measures are considered complementary to the other proposed measures for the envelope and installation.

c) Active Measures on installations.

The National Strategy to Combat Energy Poverty 2019-2024 includes in Measure 9, actions to replace equipment with equipment that is more energy efficient. Given that households with Energy Poverty tend to reduce their consumption, the improvement of equipment efficiency in these cases will be primarily focused on improving their performance and therefore the level of comfort that can be achieved with the same level of expenditure, instead of focusing on energy savings, as is the case in households without Energy Poverty.

Given that in households in Energy Poverty, as in other households, it will be necessary to renew equipment when it reached the end of its lifecycle, it is proposed to apply the same menus to the installations as in the other households, with the difference that in this case a higher percentage of public financing will be assumed, which may even have to cover 100% of the investment in extreme cases. Obviously, in addition to equipment replacement measures, general measures to improve the efficiency of installations, such as pipe insulation, installation of regulating valves, meters, etc., are always considered in all cases.

In any case, to implement measures of this type, a prior diagnosis must be performed by the competent technician in order to implement such measures when necessary and thus not compromise the viability of other energy efficiency measures such as those performed on the envelope.

Finally, it is worth remembering that these actions on installations are of particular interest when they allow self-consumption and therefore free users from a large part of the costs of the energy bill or when they are related to larger scale interventions, such as district networks, centralised equipment, energy communities, etc., which have a great potential to tackle Energy Poverty at neighbourhood level.

Another very important cross-cutting measure is the training of households in energy sovereignty, as one of the keys to enable them to reduce their consumption in an intelligent manner.

7.6.3. Renovation Scenarios for Households in Situations of Energy Poverty.

Based on the regionalised segmentation and the definition of the intervention menus presented above, two scenarios are established for the renovation of households in situations of Energy Poverty.

- Scenario 1. Active Measures for installations in households in Energy Poverty.
- Scenario 2. Passive measures for the energy renovation of the envelope and active measures on installations.

The Scenarios are analysed exclusively up to 2030, given the high extent to which Energy Poverty is linked to economic circumstances at the time, the variability of the households subject to it and, therefore, the difficulties in carrying out scenarios over periods longer than a decade.

a) Scenario 1. Active Measures for installations in households in Energy Poverty.

As already mentioned, in this Scenario, the same hypotheses are applied regarding installations as are applied to the other packages considered in the 2020 ERESEE , which assumes that existing equipment that needs renewal due to reaching the end of its lifecycle will be renewed and equipment with technologies identified as a target to be eliminated (coal) or drastically reduced (LPG and Fuel Oil) by 2030 will be replaced. The model is applied to 96% of the dwellings considered in the Energy Poverty Package, which represent more than 1 million single-family dwellings and 1.4 million multi-family dwellings. The summary results are provided in the attached tables:

Figure 7.62. Results of the application of active measures for installations in households in Energy Poverty (Scenario 1).

	DWELLINGS 2020	% dwellings modelled	DWELLINGS 2020 modelled	CONSUMPTION 2020	CONSUMPTION PER DWELLING 2020	CONSUMPTION 2030	CONSUMPTION PER DWELLING 2030	SAVINGS 2020 2030	AHORROS PER DWELLING	% SAVING
'Energy Poverty' package	2 572 361	94	2 417 773	6 566 950	2 716	5 185 865	2 145	1 381 086	571	21.0
SINGLE-FAMILY			1 004 825	4 440 705	4 419	3 333 978	3 318	1 106 727	1 101	24.9
MULTI-FAMILY			1 412 949	2 126 246	1 505	1 851 887	1 311	274 359	194	12.9

	DWELLINGS 2020 modelled	DWELLINGS THAT SHOULD RENEW	DWELLINGS THAT REMAIN THE SAME	DWELLINGS THAT RENEW	DWELLINGS THAT CHANGE
'Energy Poverty' Package	2 417 773	1 317 961	1 019 360	614 638	783 776
SINGLE-FAMILY	1 004 825	545 802	368 933	176 074	459 818
MULTI-FAMILY	1 412 949	772 159	650 427	438 564	323 958

Source: MITMA.

Ultimately, as a baseline, of the 2.4 million dwellings considered, 1.3 million would require renewal due to reaching the end of their lifecycle. In the envisaged Scenario, it is assumed that public aid would be necessary for the renewal of 0.6 million pieces of equipment retaining the same fuel and 0.7 million pieces of equipment switching to a more efficient fuel.

The total investment (public and private) required to achieve this would be €3 441 000 000 (€2 226 000 000 for single-family dwellings and 1 215 000 000 for multi-family dwellings), of which €2 290 000 000 would be for equipment renewal and €2 595 000 000 would be for new equipment involving a switch in fuel. Bearing in mind that these are households in a situation of Energy Poverty and that (as seen in Section 5.4) this coincides to a large extent with financial poverty, the following financing hypotheses are applied according to the household's IPREM: 100% of the cost for households in Energy Poverty with income of below the IPREM, 75% for households with income between 1 and 2 times the IPREM, 50% for households with income between 2 and 3 times the IPREM and 20% for households with income of over 3 times the IPREM.

Figure 7.63. Public financing hypothesis for households in Energy Poverty (% of cost) based on IPREM and number of households in each situation.

	Under 1xIPREM	Between 1 and 2xIPREM	Between 2 and 3xIPREM	Over 3xIPREM
% Financing	100%	75%	50%	20%
% Households	19.0%	44.9%	24.2%	11.9%

Source: MITMA based on A. Sanz Fernández and C. Sánchez-Guevara (Polytechnic University of Madrid, UPM).

Under these hypotheses, the total amount of public funding would amount to €2 310 000 000.

Figure 7.64. Distribution of financing by type of household in Energy Poverty by IPREM (millions of €). Scenario 1.

EP Scenario, Installations	Under 1xIPREM	Between 1 and 2xIPREM	Between 2 and 3xIPREM	Over 3xIPREM	Total
TOTALS, MILLIONS OF €	654.3	1 543.7	832.9	410.4	3 441.3
PUBLIC INV. MILLIONS OF €	654.3	1 157.7	416.4	82.1	2 310.6

Source: MITMA based on A. Sanz Fernández and C. Sánchez-Guevara (Polytechnic University of Madrid, UPM).

b) Scenario 2. Combination of Passive Measures for the Energy Renovation of the Envelope and Active Measures on Installations in Households in Energy Poverty.

In this Scenario, the previous measures on the installations are combined with the renovation of the envelope, taking into consideration the intervention menus established in the previous section, which are:

- Menu for External Intervention on Multi-Family Buildings.
- Menu for Internal Intervention on Multi-Family Buildings.
- Menu for Partial Intervention on Single-Family Buildings.
- Menu for Complete Intervention on Single-Family Buildings.

In order to determine the number and regional distribution of the dwellings in Energy Poverty on which the envelope would be renovated with each of the above menus, the following complementary hypotheses must be made (See Annex A.6).

- Given that there is a direct correlation between Energy Poverty and Financial Poverty, and a direct relationship between these and the poor state of conservation of dwellings, it is considered that a certain percentage of households in Energy Poverty are located in dwellings with major construction and even structural deficiencies that it is not possible or cost-effective to renovate, with a better option being their demolition and rebuilding and the rehousing of their inhabitants. This percentage is estimated to be 10% of the total number of dwellings in Energy Poverty.

In contrast, another certain percentage of households (estimated to be 40%) are considered to be in a moderate situation of Energy Poverty, being either of a temporary nature or being more related to the economic conditions of the household than to the construction conditions of the dwelling; therefore, for them, the best possible options are considered to be the currently existing financial aid, such as the Electricity and/or Thermal Social Payment.

Under the hypotheses, the number of households in Energy Poverty eligible for energy renovation of the envelope is estimated to be 50%.

- The target for the renovation of the envelope of dwellings in Energy Poverty is established for the long term, distributing the interventions to be made on this housing stock proportionally over the next three decades until 2050. This means that the target established for this Scenario 2 for 2030 is intervention on the appropriate one third of the total stock of dwellings in Energy Poverty, determined in application of the other criteria
- Depending on the type of building and the size of the municipality, one of the four intervention menus described above is prioritised over the others, with efforts being made to adapt them as best as possible to each specific context. For example, in multi-family dwellings in urban municipalities, it is assumed that Energy Poverty is concentrated in certain neighbourhoods, associated with other vulnerability problems, meaning that priority (75%) is given to the menu consisting of comprehensive intervention at building level (external intervention), as opposed to the menu of dwelling-by-dwelling internal intervention (25%). In multi-family dwellings in rural municipalities, it is assumed that Energy Poverty

does not tend to concentrate so much in areas or buildings but is more evenly distributed throughout the housing stock, meaning that individual internal interventions in dwellings are prioritised. In the case of single-family dwellings, the partial renovation menu is considered to be the most common, with complete renovation of dwellings being reserved for specific cases. These criteria are summarised in the following table:

Figure 7.65. Summary table of intervention criteria considered for Energy Poverty by building type and location.

Municipality	Type	% of intervention of the case		Intervention menu
Urban	Multi-family	Priority	75%	Multi-family, external
		Secondary	25%	Multi-family, internal
	Single-family	Priority	75%	Single-family, partial
		Secondary	25%	Single-family, complete
Rural	Multi-family	Priority	75%	Multi-family, internal
		Secondary	25%	Multi-family, external
	Single-family	Priority	75%	Single-family, partial
		Secondary	25%	Single-family, complete

Source: GBCe for MITMA.

- Priority is also given to interventions in the regions with the highest rates of Energy Poverty, calculated based on the indicator 2M. The 2M Energy Poverty data are available by region by Autonomous Community, with priority being given to actions in those where the percentage of households living in Energy Poverty exceeds 15%. In other regions where the Energy Poverty rates are below 15%, intervention is planned on 75% of the dwellings that meet the rest of the criteria.
- Finally, Energy Poverty interventions are prioritised according to the climatic severity of the dwellings in winter. To this end, it is proposed to renovate 100% of the dwellings that meet the above criteria in climatic zones D and E, while in climatic zones C, B and A it is proposed to renovate 90%, 80% and 70%, respectively.

The joint imposition of these criteria establishes a regional prioritisation, so as to provide relief in the areas with the greatest problems of Energy Poverty, which is shown, distributed by Autonomous Community, in Annex A.6.

The results of the application of the menus for the renovation of the envelope in dwellings in Energy Poverty for 2030 and the calculation of the costs by Autonomous Community are shown in the following table:

Figure 7.66. Distribution of the number of dwellings and the costs for renovation of the envelope in households in Energy Poverty to 2030 by Autonomous Community (except for the Canary Islands, Ceuta and Melilla).

	Dwellings in EP	Dwellings in EP to be renovated (according to the intervention menu)						Total budget
	(2M)	Multi-family, external	Multi-family, internal	Single-family, partial	Single-family, complete	Total	% for EP intervention	(millions of €)
Andalusia	488 468	15 165	8 874	21 437	7 146	52 622	10.8	€321 950 000
Aragon	91 751	4 740	3 517	2 911	970	12 138	13.2	€78 760 000
Asturias	47 185	3 062	1 659	1 163	388	6 271	13.3	€43 220 000
Balearic Islands	66 167	2 254	1 039	2 245	748	6 285	9.5	€43 910 000
Cantabria	33 847	1 484	1 034	1 256	419	4 193	12.4	€24 820 000
Castile and Leon	253 431	10 638	9 201	12 535	4 178	36 553	14.4	€241 750 000
Castile-La Mancha	209 535	5 867	4 378	15 895	5 298	31 439	15.0	€203 700 000
Catalonia	430 449	22 537	14 190	12 081	4 027	52 835	12.3	€412 300 000
Valencia	208 434	8 771	5 080	5 243	1 748	20 842	10.0	€149 530 000
Extremadura	74 870	2 227	1 710	4 330	1 443	9 711	13.0	€50 160 000
Galicia	162 677	5 064	3 162	8 370	2 790	19 386	11.9	€122 150 000
Madrid	290 810	27 368	9 123	2 948	983	40 422	13.9	€331 480 000
Murcia	83 108	3 426	1 142	3 136	1 045	8 750	10.5	€42 720 000
Navarre	40 955	1 649	1 689	1 380	460	5 178	12.6	€37 460 000
Basque Country	65 791	3 999	2 712	564	188	7 463	11.3	€49 700 000
Rioja	24 883	1 315	1 153	701	234	3 403	13.7	€27 840 000
Spain	2 572 361	119 567	69 661	96 196	32 065	317 490	12.3	€2 181 450 000

Source: GBCe for MITMA.

By climatic zones, the results would be as follows:

Figure 7.67. Distribution of the number of dwellings and the costs for renovation of the envelope in households in Energy Poverty to 2030 by winter and summer climatic zones of the Technical Building Code (except for the Canary Islands, Ceuta and Melilla).

Winter climatic	Dwellings in EP - KIM -	Dwellings renovated	Total budget (millions of €)	1. MF external menu - No Dwellings -	1. MF external menu - Cost/dwelling	2. MF internal menu - No Dwellings -	2. MF internal menu - Cost/dwelling	3. SF complete menu - No Dwellings -	3. SF complete menu - Cost/dwelling	4. SF partial menu	4. SF partial menu - Cost/dwelling -
A3	164 056	17 680	€121 190 000	5 513	€8 938	2 487	€5 445	2 420	€12 979	7 260	€2 781
A4	41 058	4 430	€23 340 000	1 196	€7 631	866	€4 647	592	€10 201	1 776	€2 186
B3	326 264	33 847	€219 740 000	13 342	€8 774	7 221	€5 355	3 321	€12 433	9 963	€2 664
B4	264 575	27 839	€170 340 000	9 144	€8 474	5 144	€5 156	3 388	€12 077	10 164	€2 588
C1	259 209	31 369	€201 460 000	11 855	€8 252	7 280	€4 878	3 059	€13 229	9 176	€2 784
C2	378 643	46 391	€368 080 000	19 829	€9 786	11 636	€5 906	3 732	€14 407	11 195	€3 087
C3	57 993	6 242	€37 740 000	1 631	€8 699	1 250	€5 294	840	€11 736	2 520	€2 515
C4	199 351	26 259	€154 940 000	6 625	€8 496	6 087	€5 081	3 387	€11 351	10 160	€2 432
D1	85 321	10 843	€74 230 000	3 236	€9 339	2 839	€5 544	1 192	€14 919	3 576	€3 185
D2	179 908	26 033	€181 570 000	6 173	€9 834	5 828	€5 845	3 508	€13 626	10 524	€2 919
D3	522 795	72 579	€543 130 000	38 417	€9 144	17 061	€5 431	4 275	€13 333	12 826	€2 857
E1	93 188	13 976	€85 680 000	2 606	€8 831	1 962	€5 248	2 352	€12 372	7 056	€2 651
Spain	**2 572 361**	**317 490**	**€2 181 450 000**	**119 567**	**€8 850**	**69 661**	**€5 319**	**32 065**	**€12 722**	**96 196**	**€2 721**

Source: GBCe for MITMA.

In summary, 317 490 dwellings would be renovated, generating savings of 230 712 MWh and with a total cost of €2 181 000 000, of which almost 60% would correspond to multi-family dwellings and 40% would correspond to single-family dwellings, with the most frequent type of intervention being external intervention on multi-family dwellings (37.7%), followed by partial intervention on the envelope of single-family dwellings (30.3%), the internal action menu on multi-family dwellings one dwelling at a time (21.9%) and, finally, with 10.1%, the complete intervention menu in single-family dwellings.

We have added to these results the intervention on the installations, modelling the same actions as in Scenario 1, but this time operating on 83% of the building stock in Energy Poverty[156].

Figure 7.68. Results of the application of active measures for installations in households in Energy Poverty (Scenario 2).

	DWELLINGS 2020	% dwellings modelled	DWELLINGS2020 modelled	CONSUMPTION2020	CONSUMPTION PER DWELLING	CONSUMPTION 2030	CONSUMPTION PER DWELLING	SAVINGS 2020-2030	SAVINGS PER DWELLIN	% SAVING
'Energy Poverty' Package	2 572 361	83	2 013 882	5 469 935	2 716	4 319 561	2 145	1 150 374	571	21.0
SINGLE-FAMILY			836 968	3 698 881	4 419	2 777 034	3 318	921 847	1 101	24.9
MULTI-FAMILY			1 176 915	1 771 054	1 505	1 542 527	1 311	228 527	194	12.9

	DWELLINGS 2020 modelled	DWELLINGS THAT SHOULD RENEW	DWELLINGS THAT REMAIN THE SAME	DWELLINGS THAT RENEW	DWELLINGS THAT SWITCH
'Energy Poverty' Package	2 013 882	1 097 794	849 075	511 962	652 845
SINGLE-FAMILY	836 968	454 625	307 302	146 661	383 005
MULTI-FAMILY	1 176 915	643 169	541 773	365 301	269 840

Source: MITMA.

Combining the renovation of the envelope and the installations, the total energy savings would amount to 1 381 086 MWh and the cost would be €5 048 000 000 (€2 181 000 000 for the envelope and €2 866 000 000 for the installations). Applying the same hypotheses regarding public financing needs as in Scenario 1[157], this would amount to a total of €3 389 000 000, distributed as specified in the table below, by household according to IPREM brackets:

Figure 7.69. Distribution of financing by type of household in Energy Poverty by IPREM (millions of €). Scenario 2.

EP Scenario, Installations + Envelope	Under 1xIPREM	Between 1 and 2xIPREM	Between 2 and 3xIPREM	Over 3xIPREM	Total
TOTALS, MILLIONS OF €	959.8	2 264.3	1 221.7	602.0	5 047.8
PUBLIC INV. MILLIONS OF €	959.8	1 698.2	610.9	120.4	3 389.3

Source: MITMA based on A. Sanz Fernández and C. Sánchez-Guevara (Polytechnic University of Madrid, UPM).

[156]This makes it possible to obtain the same total energy savings as in Scenarios 1 and 2, so that they can be incorporated into the Total Scenario on all housing stock packages interchangeably without altering the final savings results.

[157]100% of the cost for households in Energy Poverty with income of below the IPREM, 75% for households with income between 1 and 2 times the IPREM, 50% for households with income between 2 and 3 times the IPREM and 20% for households with income of over 3 times the IPREM.

8. RENOVATION PROPOSALS (MENUS). COST-EFFECTIVE APPROACHES TO RENOVATION AND ECONOMIC EVALUATION OF OPTIONS. TERTIARY SECTOR.

8.1. GENERAL CONSIDERATIONS

Buildings in the tertiary sector in Spain have very significant potential for savings, although, as will be seen throughout this section, they require a very different approach to that of the housing stock. The tertiary sector, although in number of buildings it represents only 5.56% of the total number of real estate properties and in area it represents less than 13% of the total number of built square metres, it is responsible for 42% of the final energy consumption due to building. (See Table 2.21 in Section 2.4. The trend of energy consumption in the tertiary sector, within the second Diagnosis: energy consumption in the building sector and its trend 2014-2020.

Another decisive characteristic of this sector is the important role played by the real estate owned by the authorities, both the Central State Administration and the local and regional administrations, in the sector as a whole. As set out in section 6 of this document, a very significant part of the savings targets established in the PNIEC for the building sector are attributed to public buildings, as they should set an example; therefore, a specific part of this section will be dedicated to them.

8.2. PRIVATE TERTIARY SECTOR

The tertiary sector building stock has different characteristics to the housing stock. Thus, it is worth highlighting that the service sector buildings have an ownership structure in which a large part of the owners of the buildings have legal personality, unlike what happens in the housing stock, and in many cases, they are owners of the entire building, meaning that decision-making regarding intervention on them should, in principle, be more flexible.

Managers in the no-residential sector are mostly receptive to energy efficiency interventions (given the attractive return on investment); however, the execution of energy renovation projects is not a widespread practice. This is due to the fact that energy efficiency often competes with other investments and reduces the returns on other investments, such as investment in new equipment, for example.

However, Energy Service Companies (ESCOs) have already been active in the sector for years, as many of them are operators or maintain buildings and, therefore, their energy efficiency work can be combined with other services and paid for by long-term contracts that also include work on the building envelopes. Energy performance contracts would thus join energy supply and maintenance contracts.

Unlike the residential sector, the tertiary sector is much more familiar with energy efficiency measures and, in turn, managers of large commercial properties are already implementing such measures outside Spain and importing this knowledge to our country.

Energy efficiency investments in the non-residential sector currently seek almost immediate returns, which explains their lack of depth. Due to the volatility of the general business climate and the desire to achieve maximum return on investment, the majority of efficiency investments made in non-residential buildings have focused on equipment and lighting replacement. It can be argued that many of the barriers that currently prevent an optimal approach to buildings in the residential sector are also present in the non-residential sector. However, the tertiary sector requires a different methodological approach than the residential sector to determine long-term efficiency parameters, as well as to implement passive measures that have more drawn-out returns.

In addition, the non-residential sector includes buildings with very different uses, the energy consumptions of which follow very different patterns, which makes it difficult to envisage that the same actions will always generate the same savings yields. This needs to be addressed through sectoral strategies that take into account this diversity of uses.

The availability of information on energy consumption in non-residential buildings is not complete and is based on data estimated from consumption by different sources and the use of the Land Register and other sources to determine the surface area and uses of the sector.

8.2.1. Working Procedure.

8.2.1.1. Knowledge of the Building Stock.

In order to approach this question, in view of the aforementioned difficulties, various studies have been carried out that address the different variables that come into play in understanding the energy performance of the tertiary sector building stock and its potential for improvement.

Firstly, a detailed study of the building stock has been carried out, the analysis of which, as we have seen in the section dedicated to diagnosis, allowed us to discover distribution of built square metres across the different uses of the tertiary sector and the relative weight of each of them. It has also been possible to identify the distribution by construction decade within each use and type, as well as the climatic zone in which each use has a greater presence.

8.2.1.2. Knowledge of Consumption by Building Type.

The second study carried out aims to determine the consumption of each of the building types identified in the previous study. In order to complete this study, it was first necessary to define the types within each of the uses to be studied. This definition has taken into account relevant data on the energy performance of buildings, such as their use profile, their internal load level and a homogeneous range of floor area. Once these types had been established, data was gathered from energy audits carried out on buildings in the tertiary sector[158]. When the data available for each typology was sufficient and there was sufficient homogeneity between the different buildings, it was possible to obtain the consumption data per square metre for each of the services, differentiating between the different climatic zones studied; when these two conditions were not met, it was left as a range between a maximum and a minimum value. This information has made it possible to compare the absolute values of consumption by service within the different types for a single use, calculate the percentage distribution of consumption by service (heating, domestic hot water, etc.) in each of the types defined and detect homogeneities or differences in consumption patterns across the different types. In short, the work seeks to find out the consumption in each type in order to detect the savings potential in each of them. This will be taken into account when defining interventions in the next part of the work. Below are some examples of defined type information sheets, which were used to organise the data analysed.

[158]Study carried out by the ASOCIACIÓN DE EMPRESAS DE EFICIENCIA ENERGÉTICA [Association of Energy Efficiency Companies] (A3e)

Figure 8.1. Information Sheet example 1 Office use. Type Information Sheet, Small office in mixed-use building, Medium office in exclusive-use building and Large office in exclusive-use building.

USE: OFFICE	
Sub-type	Small office. Mixed-use building
Area (m2)	250 - 700
Use profile	8 hours M-F
Internal load level	Low CFI 2
Most common air-conditioning and DHW production systems	Stand-alone systems and systems based on equipment VRV:
Predominant construction period	1971-1980
Breakdown by climatic zone	D3

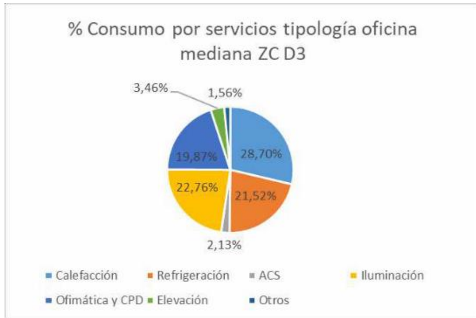
USE: OFFICE	
Sub-type	Medium office. Exclusive-use building
Area (m2)	700 - 3 500
Use profile	8 hours M-F
Internal load level	Low CFI 5
Most common air-conditioning and DHW production systems	Stand-alone systems and systems based on VRV equipment and heat pumps.
Predominant construction period	2002-2011
Breakdown by climatic zone	D3

USE: OFFICE	
Sub-type	Large office. Exclusive-use building
Area (m2)	4 500 - 25 000
Use profile	8 hours M-F
Internal load level	Medium CFI 8
Most common air-conditioning and DHW production systems	Centralised air-conditioning systems, such as chillers, boilers and APUs.
Predominant construction period	1991-2001
Breakdown by climatic zone	D3

Consumption analysis		Small office. Mixed-use building
Extreme winter climatic zone (E1)		
SYSTEM	CONSUMPTION (kWh/year)	CONSUMPTION (kWh/m^2)
Heating	6500 - 18 000	22.45
Cooling	3 000 - 9 800	11.14
DHW	500 - 1 400	1.66
Lighting	5 300 - 17 000	17.8
Office automation and data processing	2 600 - 10 500	13.72
Lift	650 - 2 100	2.7
Other	350 - 1 200	1.22

Consumption analysis		Medium office. Exclusive-use building
Extreme winter climatic zone (E1)		
SYSTEM	CONSUMPTION (kWh/year)	CONSUMPTION (kWh/m^2)
Heating	18 500 - 90 000	26.41
Cooling	8 600 - 53 000	12.38
DHW	1 300 - 6 000	1.95
Lighting	14 600 - 74 800	20.94
Office automation and data processing	10 500 - 48 000	18.29
Lift	1 600 - 3 500	3.18
Other	1 000 - 5 000	1.44

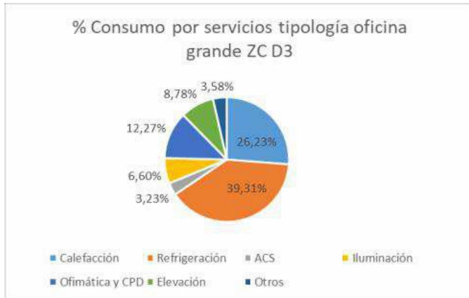
Consumption analysis		Medium office. Exclusive-use building
Extreme winter climatic zone (E1)		
SYSTEM	CONSUMPTION (kWh/year)	CONSUMPTION (kWh/m^2)
Heating	160 000 - 850 000	48.39
Cooling	230 000 - 1 315 000	59.34
DHW	32 500 - 158 000	5.96
Lighting	63 000 - 357 000	10.52
Office automation and data processing	32 400 - 175 000	22.63
Lift	4 500 - 25 000	16.2
Other	32 400 - 182 000	6.6



Extreme summer climatic zone (C4)		
SYSTEM	CONSUMPTION (kWh/year)	CONSUMPTION (kWh/m^2)
Heating	2 300 - 9 500	13.57
Cooling	5 500 - 18 000	27.84
DHW	400 - 1 000	1.4
Lighting	3 200 - 13 700	19.65
Office automation and data processing	2 500 - 11 500	16.53
Lift	500 - 2 000	2.85
Other	150 - 950	1.35

Extreme summer climatic zone (C4)		
SYSTEM	CONSUMPTION (kWh/year)	CONSUMPTION (kWh/m^2)
Heating	5 000 - 16 000	20.81
Cooling	3 500 - 13 500	27.86
DHW	450 - 1 200	1.38
Lighting	3 400 - 16 500	19.66
Office automation and data processing	2 800 - 11 000	16.54
Lift	500 - 1 850	5.01
Other	250 - 1 150	1.18

Extreme summer climatic zone (C4)		
SYSTEM	CONSUMPTION (kWh/year)	CONSUMPTION (kWh/m^2)
Air conditioning	8 500 - 31 000	39.59
DHW	19 500 - 97 000	59.34
Lighting	900 - 4 800	4.88
Office automation and data processing	13 000 - 65 000	9.97
Lift	11 500 - 43 500	17.49
Other	1 500 - 3 500	15.46



Climatic zone with the most m^2 of the type (D3)		
SYSTEM	CONSUMPTION (kWh/year)	CONSUMPTION (kWh/m^2)
Heating	5 000 - 16 000	20.91
Cooling	3 500 - 13 500	14.85
DHW	450 - 1 200	1.46
Lighting	3 400 - 16 500	13.09
Office automation and data processing	2 800 - 11 000	13.72
Lift	500 - 1 850	2.38

Climatic zone with the most m^2 of the type (D3)		
SYSTEM	CONSUMPTION (kWh/year)	CONSUMPTION (kWh/m^2)
Heating	15 500 - 77 000	22.01
Cooling	11 500 - 58 000	16.5
DHW	1 000 - 5 500	1.63
Lighting	12 500 - 70 000	17.45
Office automation and data processing	11 000 - 52 000	15.24
Lift	1 700 - 3 700	2.65

Climatic zone with the most m^2 of the type (D3)		
SYSTEM	CONSUMPTION (kWh/year)	CONSUMPTION (kWh/m^2)
Heating	160 000 - 850 000	48.39
Cooling	230 000 - 1 315 000	59.34
DHW	32 500 - 158 000	5.96
Lighting	63 000 - 357 000	10.52
Office automation and data processing	32 400 - 175 000	22.63
Lift	4 500 - 25 000	16.2

Other	250 - 1 150	1.08

Other	1 200 - 4 800	1.2

Other	32 400 - 182 000	6.6

	% Consumption by service type, small office, CZ D3
	Heating
	Cooling
	DHW
	Lighting
	Office automation and data processing
	Lift
	Other
	% Consumption by service type, medium office, CZ D3
	Heating
	Cooling
	DHW
	Lighting
	Office automation and data processing
	Lift
	Other
	% Consumption by service type, large office, CZ D3
	Heating
	Cooling
	DHW
	Lighting
	Office automation and data processing
	Lift
	Other

Source: MITMA based on a report prepared by A3e based on data from energy audits.

*Figure 8.2. Information Sheet example 2 Medical Use. Type Information Sheet, Large Hospital, Medium Hospital and Primary Care Centre***.**

USE: MEDICAL	
Sub-type	Large Hospital
Area (m2)	49 000 - 181 000
Use profile	24 hours M-S
Internal load level	High CFI 10
Most common air-conditioning and DHW production systems	Heating and cooling system with heat and cold generation by boilers, coolers and combined heat and power production unit; and also with decentralised air conditioning with heat pumps
Predominant construction period	2002-2011
Breakdown by climatic zone	D3

USE: MEDICAL	
Sub-type	Hospital
Area (m2)	4 500 - 48 000
Use profile	24 hours M-S
Internal load level	High CFI 10
Most common air-conditioning and DHW production systems	Heating and cooling system with heat and cold generation by boilers and coolers; and decentralised air conditioning with heat pumps. DHW by natural gas boiler
Predominant construction period	2002-2011
Breakdown by climatic zone	D3

USE: MEDICAL	
Sub-type	Primary care centre
Area (m2)	500 - 9 000
Use profile	10 hours M-F
Internal load level	Medium CFI 8
Most common air-conditioning and DHW production systems	Combi-boiler with how water generation for DHW and heating. Cold generation by equipment with heat pumps.
Predominant construction period	2002-2011
Breakdown by climatic zone	D3

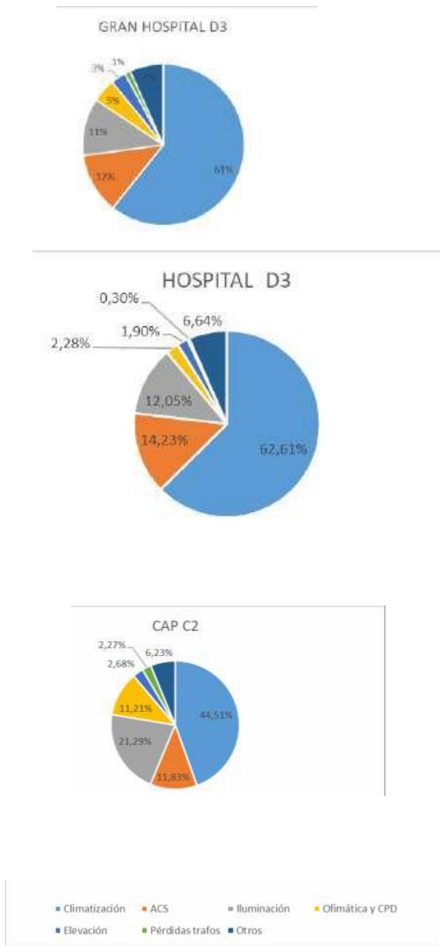
Consumption analysis	Large Hospital	
Predominant climatic zone of the type (D3)		
SYSTEM	CONSUMPTION (kWh/year)	CONSUMPTION (kWh/m^2)
Air conditioning	36 000 000.00	61%
DHW	7 200 000.00	12%
Lighting	6 800 000.00	11%
Office automation and data processing	2 800 000.00	5%
Lift	1 800 000.00	3%
Transformer losses	670 000.00	1%
Other	4 000 000.00	7%

Consumption analysis	Hospital	
Predominant climatic zone of the type (D3)		
SYSTEM	CONSUMPTION (kWh/year)	CONSUMPTION (kWh/m^2)
Air conditioning	2 000 000 - 3 300 000	62.61%
DHW	350 000 -750 000	14.23%
Lighting	250 000 - 635 000	12.05%
Office automation and data processing	4 500 - 120 000	2.28%
Lift	30 000 - 100 000	1.90%
Transformer losses	8 500 - 16 000	0.30%
Other	150 000 - 350 000	6.64%

Consumption analysis	Primary care centre	
Climatic Zone (C2)		
SYSTEM	CONSUMPTION (kWh/year)	CONSUMPTION (kWh/m^2)
Air conditioning	55 000 - 715 000	44.51%
DHW	8 200 - 190 000	11.83%
Lighting	6 500 - 342 000	21.29%
Office automation and data processing	4 600 - 180 000	11.21%
Lift	2 300 - 43 000	2.68%
Transformer losses	16 500 - 36 400	2.27%
Other	1 200 - 100 000	6.23%

Second predominant climatic zone of the type (C2)		
SYSTEM	CONSUMPTION (kWh/year)	CONSUMPTION (kWh/m^2)
Combined heat and power production	7 500 000 - 24 000 000	18%
Air conditioning	8 000 000 - 47 500 000	35%
DHW	1 300 000 - 14 000 000	10%
Lighting	2 000 000 - 28 000 000	21%
Office automation and data processing	74 500 - 11 500 000	8%
Lift	184 000 - 820 000	1%
Transformer losses	88 500 - 520 000	0%
Other	1 200 000 - 3 900 000	3%

Second predominant climatic zone of the type (C2)		
SYSTEM	CONSUMPTION (kWh/year)	CONSUMPTION (kWh/m^2)
Air conditioning	460 000 - 8 500 000	48%
DHW	141 300 - 2 600 000	15%
Lighting	145 500 - 2 000 000	11%
Office automation and data processing	48 400 - 820 000	5%
Lift	10 000 - 970 000	5%
Transformer losses	6 500 - 222 500	1%
Other	13 500 - 2 227 000	12%
Other installations	230 000 - 550 000	3%



	LARGE HOSPITAL D3
	HOSPITAL D3
	PCC C2

	Air conditioning
	DHW
	Lighting
	Office automation and data processing
	Lift
	Other
	Losses
	Other

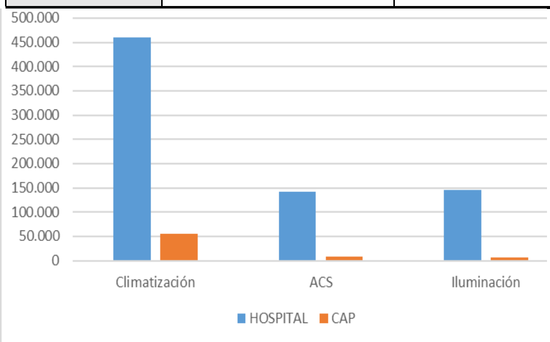
Source: MITMA based on a report prepared by A3e based on data from energy audits.

8.2.1.3. Comparison of Consumption between Different Types for the Same Use.

As indicated previously, the analyses carried out allow a comparison of the absolute and per square metre consumption values of each service within the different types for the same use. The following tables and graphs show that the consumption in absolute values due to air conditioning in the average Hospital in its upper value range is more than ten times higher than that of the primary care centre, meaning that the same percentage reduction in consumption would generate much greater savings in the former case.

Figure 8.3. Comparison of absolute consumption values, Medium Hospital and primary care centre (lower value range) in climatic zone C2

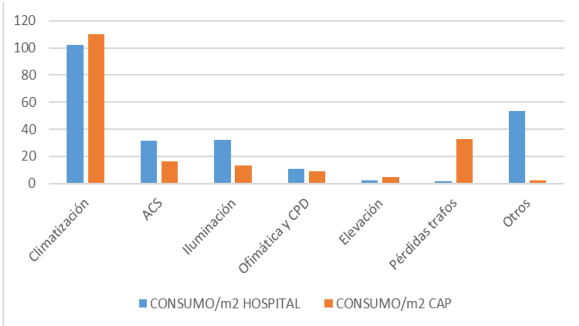
HOSPITAL	MIN. CONSUMPTION VOL. (kWh)	MIN. CONSUMPTION VOL.
SYSTEM	HOSPITAL	PCC
Air conditioning	460 000	55 000
DHW	141 300	8 200
Lighting	145 500	6 500
Office automation and data processing	48 400	4 600
Lift	10 000	2 300
Transformer losses	6 500	16 500
Other	240 000	1 200



	Air conditioning
	DHW
	Lighting
	HOSPITAL
	PCC

Figure 8.5. Comparison of consumption per m² between Medium Hospital and primary care centre (lower value range) in climatic zone C2

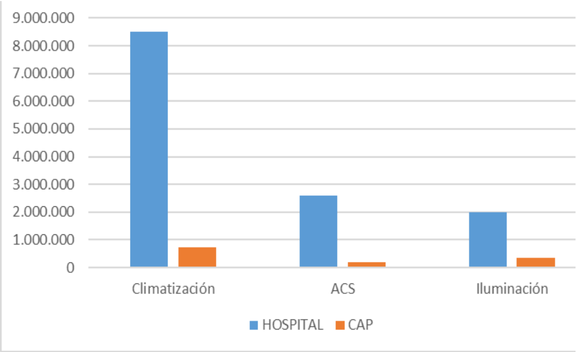
MIN. AREA (m²)			CONSUMPTION kWh/m²	
HOSPITAL	PCC		HOSPITAL	PCC
4 500	500	Air conditioning	102	110
		DHW	31	16
		Lighting	32	13
		Office automation and data processing	11	9
		Lift	2	5
		Transformer losses	1	33
		Other	53	2



	Air conditioning
	DHW
	Lighting
	Office automation and data processing
	Lift
	Transformer losses
	Other
	CONSUMPTION/m² HOSPITAL
	CONSUMPTION/m² PCC

Figure 8.4. Comparison of absolute consumption values, Medium Hospital and primary care centre (upper value range) in climatic zone C2

HOSPITAL	MAX. CONSUMPTION VOL. (kWh)	MAX. CONSUMPTION VOL.
SYSTEM	HOSPITAL	PCC
Air conditioning	8 500 000	715 000
DHW	2 600 000	190 000
Lighting	2 000 000	342 000
Office automation and data processing	820 000	180 000
Lift	970 000	2 300
Transformer losses	222 500	36 400
Other	2 797 000	100 000

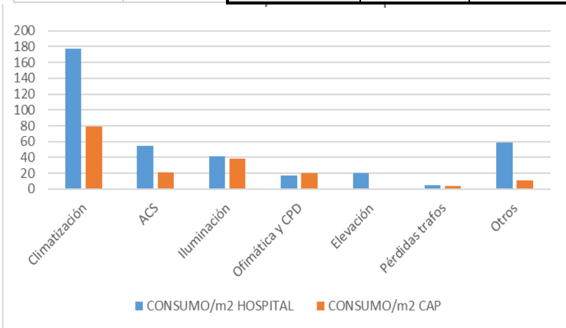


	Air conditioning
	DHW
	Lighting
	HOSPITAL
	PCC

Figure 8.6. Comparison of consumption per m² between Medium Hospital and primary care centre (upper value range) in climatic zone C2

MAX. AREA (m²)			CONSUMPTION (kWh/m²)	
HOSPITAL	PCC	SYSTEMS	HOSPITAL	PCC
48 000	9 000	Air conditioning	177	79
		DHW	54	21
		Lighting	42	38
		Office automation	17	20

		and data processing		
		Lift	20	0
		Transformer losses	5	4
		Other	58	11



	Air conditioning
	DHW
	Lighting
	Office automation and data processing
	Lift
	Transformer losses
	Other
	CONSUMPTION/m² HOSPITAL
	CONSUMPTION/m² PCC

8.2.1.4. Percentage Distribution of Consumption by Service of the Types Studied.

The following table shows the data obtained on the consumption of the types studied, completing only those cases for which sufficient data were available.

Figure 8.7. Table showing the percentage distribution of consumption by service in each of the types and climatic zones studied.

CLIMATIC ZONE	USE:	OFFICE			COMMERCIA		HOSPITAL			TRAINING		HOTELS	
	TYPE / SYSTEM	Small offices in mixed-use buildings	Medium offices in exclusive-use	Large office in exclusive-use building	Large business	Small business	Large hospital	Hospital	Primary care centre	Colleges	Training centres in constant use	Medium hotel	Large hotel
C4	Heating	16%	23%	26%						63%	57%		
	Cooling	33%	30%	39%									
	DHW	2%	1%	3%						5%	5%		
	Lighting	24%	21%	7%						22%	16%		
	Heating	32%	31%	29%						69%	46%		
	Cooling	16%	15%	35%									
	DHW	2%	2%	4%						5%	4%		

	Lighting	25%	25%	6%						16%	15%		
D3	Heating	31%	29%	26%	62%	55%	61%	63%		67%	60%	49%	45%
	Cooling	22%	22%	39%									
	DHW	2%	2%	3%	2%	2%	12%	14%		5%	4%	10%	10%
	Lighting	19%	23%	7%	4%	15%	11%	12%		19%	17%	25%	24%
C1	Heating				61%	52%						44%	43%
	Cooling												
	DHW				2%	2%						10%	9%
	Lighting				5%	16%						28%	25%
C2	Heating						35%	48%	45%				
	Cooling												
	DHW						10%	15%	12%				
	Lighting						21%	11%	21%				
B4	Heating				58%	49%						43%	41%
	Cooling												
	DHW				2%	2%						10%	9%
	Lighting				5%	17%						29%	26%

Source: MITMA based on a report prepared by A3e based on data from energy audits.

8.2.1.5. Knowledge of the Most Common Installations in these Types.

The third study consists of identifying the most common thermal installations that meet the demands for ventilation, heating, domestic hot water (DHW) and cooling in each of the types identified within the different uses of buildings in the tertiary sector. To answer this question, we used the study carried out by ATECYR entitled *Informe sobre prospectiva y evolución futura de los sistemas de climatización y ACS en EDIFICIOS TERCIARIOS.*

Based on the study carried out, we can establish that the following 11 thermal installations are most common in tertiary-use buildings that combine the various most common generators together with the different forms of distribution:

1. Boiler only **(BOIL)** is used in buildings with heating only installation, DHW service may also be available.
2. Cooler only (**COOL**), applicable in buildings with only cooling.
3. Boiler plus Cooler **(BOIL+COOL(*)**), water systems with heat and cold production with two-pipe or four-pipe distribution.
4. Boiler plus Cooler plus Combined Heat and Power Unit(**BOIL+COOL+CHP(*)**), really this is a similar installation to
   No 3, the heat production of which includes a CHP unit
5. Boiler plus Cooler with Heat Recovery (**BOIL+COOLr(*)**).
6. Reversible heat pump (**RHP(*)**)
7. 4-Pipe heat pump (**4PHP**).
8. Direct expansion (**EXP**) includes all types of installations in which the thermal fluid that flows through the premises is the coolant.
9. Variable coolant volume with recovery (**EXPr**) are variable coolant flow installations that allow the simultaneous use of cooling and heating.

10. Rooftop units (**RT**), in this case the installation forms part of the generation equipment, it is an all-air system.

11. Condensation ring (COND RING), the indoor units are water-condensed reversible heat pumps; a network of pipes connects all indoor units; the installation requires boilers and cooling towers. This system is often classified as either a water or direct expansion system.

The following table shows the distribution of these installations according to use and building type and winter climatic zone classified in accordance with the Basic Document on Energy Savings of the Technical Building Code in which it is located (**A, B, C, D or E**)

The matrix shows the type of installation, basically its generation subsystem, while also making the distinction, within the water systems, between two-pipe and four-pipe distribution.

Figure 8.8. Type of system according to building use and its climatic zone.

REFERENCE	SYSTEMS USES	DISTRIBUTION	Offices	Hotels/Homes	Hospitals	Shopping Centres	Universities	Schools/Institutes	Supermarkets
	Heating Consumption		Low	High	High	Low	Medium	Medium	Low
	Cooling Consumption		High	High	High	High	Medium	None	Medium
	DHW Consumption		None	High	High	None	None	Low	None
1	**CLD:**			DE(**)				**ABCDE:**	
2	**ENF:**					**AB:**			
3	**BOIL+COOL**	2P	BCDE:	ABCDE:	ABCDE:	CDE:	BCDE:		
		4P	BCDE:	ABCDE:	ABCDE:		CDE:		
4	**BOIL+COOL+CHP**	2P			ABCDE:				
		4P			ABCDE:				
5	**BOIL+COOLr**	2P		ABCDE:	ABCDE:				
		4P		ABCDE:	ABCDE:				
6	**RHP**	2P	ABCD:	ABCD (*)	ABCD (*)	CDE:	ABCD:		
		4P	ABCD:	ABCD (*)	ABCD (*)		CD:		
7	**4PHP**	4P	ABCD:	ABCD (*)	ABCD (*)				
8	**EXP:**		ABCD:	ABCD (*)			ABCD:		
9	**EXPr**		ABCD:						
10	**RT:**					ABCDE:	ABC:		ABCDE:
11	**COND RING**		CDE:			ABCDE:			

(*)When there is a demand for DHW (hotels, homes and hospitals) there will also be a boiler

Source: Informe sobre prospectiva y evolución futura de los sistemas de climatización y ACS en EDIFICIOS TERCIARIOS, drawn up by ATECYR.

8.2.2. Intervention Proposals. Scenario 2020- 2030.

Based on this characterisation of the installations, and using the building stock decarbonisation scenario set out in the PNIEC and the LTS as a guide, possible changes and improvements to be to installations are proposed, together with interventions on the envelope, all seeking to follow the path set out in these two energy policy instruments. In the selection of interventions, in addition to the achievement of these targets, the economic optimisation of each solution is taken into account, hence the importance of knowing the existing installations in order to assess, for example, the possibility of using the distribution systems or heaters already installed.

The targets and pathway outlined above have been described in more detail in chapter 6 of this strategy. Briefly, it is worth highlighting that the LTS sets an important target of reducing the consumption attributed to buildings in this sector; it also prioritises a reduction in the use of fossil fuels by 2030, until they are completely eliminated by 2050, it establishes a slight increase in the use of renewable energies in this sector, as well as a significant percentage increase in the consumption that is predicted for electricity. In relation to the changes in installations, the information that can be taken from the following table is relevant:

Figure 8.9. Type of renovation according to the original generation equipment. Scenario 2020- 2030

REF:	ORIGINAL EQUIPMENT	DIS:	RENOVATION		
1	CLD:		COND BOIL	HP(**)	
2	ENF:		ENF:		
3	BOIL+COOL	2P	COND BOIL+COOLr	COND BOIL+RHP	RHP
		4P		COND BOIL+4PHP	4PHP
4	BOIL+COOL+CHP	2P	COND BOIL+C	COND BOIL+COOLr+CHP	COND BOIL+RHP
		4P			
5	BOIL+COOLr	2P	COND BOIL+COOLr	COND BOIL+RHP	
		4P			COND
6	RHP	2P	RHP		
		4P		4PHP	
6(*)	RHP+BOIL_DHW	2P	RHP+ BOIL_DHW		
		4P		4PHP+COND	
7	4PHP	4P	4PHP		
8	EXP:		EXP:	RHP	
9	EXPr		EXPr	4PHP	
10	RT:		RT:		
11	COND RING		COND RING(***)		

(*)Buildings in which there is a boiler for the DHW service in addition to the RHP

(**)Only in Zones ABCD

(***)Analyse the integration of renewable and residual energies in the ring

In the 'RENOVATION' column, the first option is always to replace existing generators with better performing services; boiler replacement should always be done using condensing boilers (COND BOIL).

Source: Informe sobre prospectiva y evolución futura de los sistemas de climatización y ACS en EDIFICIOS TERCIARIOS, drawn up by ATECYR.

Description of the proposed action menus. Scenario 2020- 2030.

Lighting.	**Switch to LED:** Completely replace the current lighting system with another system with LED technology. Clearly, the level of brightness and the quality of light in each room must be maintained or improved.
	Natural lighting: In uses with major lighting requirements and in which, due to the architectural configuration, natural lighting can be used, even in those interventions in which Basic Document 3 on Energy Savings of the Technical Building Code does not make it compulsory to consider the installation of systems for the use of natural light that automatically regulate, in proportion to the amount of natural light, the lighting level of lights positioned less than 5 metres from a window and those located under a skylight, when certain conditions regarding the light transmission of the glass, glazed surface and shadows from the surroundings are met.
	Presence detection and switches. When, following the assessment of the building, it is considered that there are no usage habits that guarantee the switching off of lights in rooms, or parts thereof, when there are no people in them, this measure should be advised. Remember that the renewal of such equipment is obligatory according to Basic Document 3 on Energy Savings of the Technical Building Code in part of the building on which intervention takes place (if it is a change of use or is a building of more than 1 000 m^2 in which more than 25% of the lighting installation is renewed, the obligation applies to the entire lighting installation).
Air conditioning.	**Production improvement**. This consists of changing the production subsystem equipment. The alternatives considered are: - Switch to a condensing boiler - Renewal of chillers and HP - Switch to HP boilers

	Distribution improvement. Energy efficiency improvements in the distribution subsystem consist of: - Switch from four-pipe to two-pipe. Many buildings with four-pipe distribution can switch to two-pipe distribution without lowering the quality of thermal comfort, which would result in significant energy savings in relation to the energy losses of the water-based distribution system. In these cases, the installation of single-zone direct expansion units should be considered in those rooms that lose thermal comfort. - Variable speed hydraulic circuits. - Variable speed fans. **Saving energy.** The following three measures are considered: - Use of recovery units. Using and transferring the enthalpy of the air to be expelled outside (with an energy content similar to that of the air inside) to the air used for ventilation means significant savings in the energy consumption of the thermal generators. - Free cooling. This is a measure that would only save energy in cooling systems, when indoor and outdoor conditions are favourable. The air handling units must have the necessary dampers to perform this action.
	- Ventilation flow control. In buildings with intermittent and/or non-constant use, it must be possible to control ventilation levels in line with actual occupancy at any time.
Automation, control and monitoring.	The ability to ascertain the real needs of the building and adapt the consumption of the thermal installation to those needs, and for this to be done automatically, is essential to optimise the overall consumption of the building. The trend should be more towards smart and autonomous buildings and a building renovation should converge towards this situation.
Maintenance.	The ability to maintain the expected consumption and overall performance of the thermal installations in buildings during their operation is vital in order to reach the expected consumption thresholds, and this cannot be achieved without proper maintenance.
DHW	The specific measures for the DHW service in those tertiary building uses where there is a medium or high level of consumption of DHW are: - Switch to a condensing boiler. - Insulation on pipes. - Solar-powered installation. Certain uses and certain zones of the Technical Building Code are conducive to the installation of thermal generation using solar thermal panels.

Envelope.	We must not forget that thermal installations cater to the demand of the building, i.e. if this demand does not exist, there is no energy consumption from these installations. This is why all renovations should consider the following: - Insulation. This is a measure that mainly influences the consumption of the thermal generators supplying the heating systems. - Improvement of openings. This is a measure that affects and improves the energy consumption of cooling systems, by reducing the solar factor of the opening, and the energy consumption of heating systems, as the thermal transmittance of the opening is lowered. A change to the openings in the building also improves the permeability of the building, controlling and preventing air flows entering into the building. - Shading devices to reduce the cooling demand, which are of particular interest in buildings with a large glazed façade area.

Each of these actions can be assigned a relative value indicating the potential savings on the final energy consumption of the building. This analysis enabled the creation of the following table:

Figure 8.10. Intervention menu by type and climatic zone of the Technical Building Code.

	TYPES STUDIED	OFFICE		COMMERCIAL				MEDICAL		EDUCATIONAL		HOTELS	
		office in exclusive-use building		Shopping centres		Small business		Hospital		Schools/institutes		Medium hotel	
	CLIMATIC ZONE	AB:	CDE:	AB:	CDE:	AB:	CDE:	AB:	CDE:	AB:	CDE:	AB:	CDE:
Lighting	Switch to LED	9.5	10.0	20.0	20.0	12.0	10.0	5.0	5.0	21.3	17.5	5.0	5.5
	Natural lighting	1.9	2.0	6.0	6.0	3.6	3.0	0.5	0.5	4.7	3.6	0.5	0.6
	Presence detection and switches	1.0	1.0	0.8	0.8	0.5	0.4	0.5	0.5	3.0	2.7	1.0	1.1
Production improvement	Switch to condensing boiler(*)	0.9	1.7	2.6	4.2	2.5	3.6	3.4	3.5	3.5	4.9	2.8	3.2
	Renewal of HP Switch from boilers to	4.9	3.1	4.9	2.8	4.2	2.4	3.3	2.3	2.5	1.6	2.8	1.6
	HPs(*)	2.1	3.4	6.0	8.4	5.6	7.3	6.7	5.9	7.9	9.8	5.6	5.3
Distribution improvement	Switch from four-pipe to two-pipe	6.1	5.3	8.0	8.0	-	-	9.4	8.9	6.8	6.8	7.9	7.4
	Variable speed hydraulic circuits.	2.4	2.0	3.0	2.8	2.7	2.4	2.7	2.5	2.2	2.6	2.2	2.0
	Variable speed fans.	1.9	1.6	2.5	2.5	2.2	2.2	2.3	2.2	2.0	2.4	1.9	1.8
Saving energy	Use of recovery units	1.9	2.5	2.5	3.8	4.2	2.2	3.0	4.3	2.0	3.8	2.5	3.6
	Free cooling(**)	2.9	2.5	2.9	2.2	-	2.4	0.9	0.9	1.6	1.2	0.8	0.7
	Ventilation flow control	1.2	1.0	6.3	6.4	-	7.0	1.5	1.4	4.0	4.1	2.0	1.9
Other	Automation, control and monitoring	3.6	3.1	4.7	4.7	4.2	4.1	4.4	4.2	3.8	4.5	3.7	3.5
	Maintenance.	2.9	2.5	3.8	3.8	3.4	3.3	3.5	3.4	3.0	3.6	3.0	2.8
DHW	Switch to a condensing boiler	-	-	-	-	-	-	1.1	1.2	0.6	0.8	1.5	1.7
	Insulation on pipes	-	-	-	-	-	-	1.4	1.6	0.8	1.0	2.0	2.2
	Solar-powered installation	-	-	-	-	-	-	3.5	4.0	2.0	2.5	5.0	5.5
	Insulation(*)	1.5	2.9	4.2	7.4	3.9	6.4	5.9	6.9	5.6	8.6	4.9	6.1
	Improvement of openings	4.7	4.2	6.3	6.4	5.6	5.6	6.0	5.7	5.2	6.3	5.0	4.8

Enhanced intervention
Medium intervention
Low intervention

Source: MITMA based on the Informe sobre prospectiva y evolución futura de los sistemas de climatización y ACS en EDIFICIOS TERCIARIOS, drawn up by ATECYR.

For the weighting of each intervention, as shown in the table above named *Figure 8.9. Intervention menu by type and climatic zone of the Technical Building Code,* the following was taken into account:

- the percentage (%) of estimated savings on the services directly influenced by each action, which will vary for each type;
- the proportion of the total consumption represented by the service for which consumption is reduced;
- the climatic zone in which the buildings are located;
- the most likely pre-existing installations;
- the actual use or operation of the building, characteristics of the users, etc.

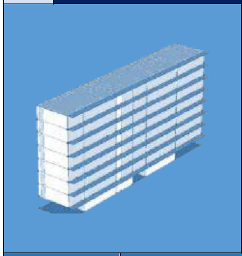
8.2.3. Theoretical case study. Intervention simulation and costs.

Finally, energy simulations have been used to analyse the effect that some of the proposed interventions would have on two types that are highly representative within the building stock and have a great potential for energy savings to be achieved. The costs of these interventions have also been calculated.

The types studied were, on the one hand, a Medium-sized office, located in an exclusive-use office building and the primary care centre type, as typified in Figures 8.1 and 8.2.

Figure 8.11. Analysis of some of the actions proposed on the basis of two theoretical examples.

1	THEORETICAL CASE STUDY: **OFFICE USE.**	**MEDIUM OFFICE BUILDING TYPE IN EXCLUSIVE-USE OFFICE BUILDING**



Characteristic elements of the type.

Use:	Office
Construction period	1980-2006
Constructive solutions	NBE-CT 79.
Number of floors	8
Built area (m^2)	3 157
Area of roof	241
Compactness	2.69
Internal load level	CFI 8
Use profile	8 hours M-F

Climate Data / **Description of thermal envelope**

Technical Building Code Climatic Zone	Envelope element	Area	U $W/m^2 K$
D3	Roof	241	0.49
Orientation	Opaque	434	0.85
North-South	Openings	1 214	2.98

Description of the systems

Heating	Old heat pump
Cooling	Old heat pump
DHW	Old Natural Gas Boilers.
Lighting installations	Fluorescent lamps

Final energy consumption (kWh/m²·per year)

FE Heat	FE Cool	FE DHW	FE Light	% Heat	% Cool	DHW	% Light	Total FE
33	25	4	11	45	35	5	15	73

Renovation actions studied

Action Level 1

Description	Title		
Improvement of insulation in roof, façades, floor and improvement of window glass to reinforced Low E glass.	**Level 1. Action on the envelope**		
	Envelope element	Area	U $W/m^2 K$
	Roof	241	0.32
	Opaque	434	0.26
	Openings	1 214	1.54

Final energy consumption after Level 1 action (kWh/m² per year)

FE Heat	FE Cool	FE DHW	FE Light	% Heat	% Cool	DHW	% Light	Investment in euros/m²
5	9	4	11	19	31	12	37	211

Action Level 2

Title

Level 2. Action on the thermal envelope and subsequent replacement of existing installations with more efficient ones

Services	Previous systems	New systems
Heating	Old heat pump	New heat pump
Cooling	Old heat pump	New heat pump
DHW	Old Natural Gas Boilers.	New Natural Gas Boiler
Lighting.	Fluorescent lamps	Lighting installations: LED.

Final energy consumption after Level 1 and Level 2 action (kWh/m² per year)

FE Heat	FE Cool	FE DHW	FE Light	% Heat	% Cool	DHW	% Light	Investment in euros/m²
6	8	1	5	30	40	4	27	369

Analysis % Savings / Investment

Intervention Level 1. Envelope

FE Heat Saving	FE Cool Saving	FE DHW Saving	FE Light Saving	% FE Heat Saving	% FE Cool Saving	% FE DHW Saving	% FE Light Saving	Investment in euros/m²
28	16	0	0	83	65	0	0	211

Intervention Level 2. Envelope + installation change

FE Heat Saving	FE Cool Saving	FE DHW Saving	FE Light Saving	% FE Heat Saving	% FE Cool Saving	% FE DHW Saving	% FE Light Saving	Investment in euros/m²
27	17	3	6	81	67	80	49	369

1	THEORETICAL CASE STUDY: MEDICAL	**PRIMARY CARE CENTRE BUILDING TYPE**

Characteristic elements of the type.

Use:	Medical
Construction period	1980-2006
Constructive solutions	NBE-CT 79.
Number of floors	1
Built area (m^2)	2 014
Area of roof	2 014
Compactness	0.8
Internal load level	CFI 8
Use profile	12 hours M-S

Climate Data / **Description of thermal envelope**

Technical Building Code Climatic Zone	Envelope element	Area	U $W/m^2 K$
D3	Roof	2014	0.80
	Ground	2014	0.81
Orientation	Opaque	982	1.28
North-South	Openings	517	2.71

Description of the systems

Heating	Old fuel oil boiler
Cooling	Old heat pump
DHW	Old fuel oil boiler
Lighting installations	Fluorescent lamps

Final energy consumption (kWh/m²·per year)

FE Heat	FE Cool	FE DHW	FE Light	% Heat	% Cool	DHW	% Light	Total FE
115	31	8	15	68	19	5	9	169

Renovation actions studied

Action Level 1

Description	Title		
Improvement of insulation in roof and façades and improvement of window glass to reinforced Low E glass	**Level 1. Action on the envelope**		
	Envelope element	Area	U $W/m^2 K$
	Roof	2014	0.29
	Opaque	982	0.34
	Ground	2 014	0.81
	Openings	517	1.86

Final energy consumption after Level 1 action (kWh/m² per year)

FE Heat	FE Cool	FE DHW	FE Light	% Heat	% Cool	DHW	% Light	Investment in euros/m²
62	35	8	15	51	29	7	13	151

Title

Level 2. Action on the thermal envelope and subsequent replacement of existing installations with more efficient ones

Services	Previous systems	New systems
Heating	Old fuel oil boiler	Natural Gas Boiler
Cooling	Old heat pump	Aerothermal
DHW	Old fuel oil boiler	Natural Gas Boiler
Lighting.	Fluorescent lamps	Lighting installations: LED.

Final energy consumption after Level 1 and Level 2 action (kWh/m²·per year)

FE Heat	FE Cool	FE DHW	FE Light	% Heat	% Cool	DHW	% Light	Investment in euros/m²
39	11	1	5	69	20	2	9	390

Analysis % Savings / Investment

Intervention Level 1. Envelope

FE Heat Saving	FE Cool Saving	FE DHW Saving	FE Light Saving	% FE Heat Saving	% FE Cool Saving	% FE DHW Saving	% FE Light Saving	Investment in euros/m²
53	-4	0	0	46	-12	90	0	151

Intervention Level 2. Envelope + installation change

FE Heat Saving	FE Cool Saving	FE DHW Saving	FE Light Saving	% FE Heat Saving	% FE Cool Saving	% FE DHW Saving	% FE Light Saving	Investment in euros/m²
76	20	7	10	66	65	98	66	390

Source: MITMA based on a simulation carried out by IETcc - CSIC

8.2.4. Proposed Actions for the 2040 and 2050 Scenarios.

The following is a brief overview of what could be the alternatives for thermal installations in a renovation from 2030 onwards. However, the detailed study should be carried out at the beginning of the period, when networks, metering, smart buildings and intelligent buildings, self-generation and thermal and electrical storage will have been developed, or not, in the market in a mature way and the energy savings achieved to that point with the measures implemented, the real mix of electricity production, the consumption of biofuels and the real consumption and import of energy in our country will be really known. In any event, it is clear that during this period, the focus of renovation should be on non-fossil fuel based heating and cooling technologies.

All indications are that the energy transition is on track to reach a low-carbon, electrified economy with a high percentage of its production distributed to consumers by 2050.

This is why, in the period 2031-2050, the transformation of a building into an efficient building will opt for changes in the energy source, and therefore, foreseeably, promoting the change to heat pumps (aerothermal, hydrothermal and geothermal) or other heating and cooling solutions based on renewable energies, fuel cells or residual heat.

In order to facilitate the penetration of heat pumps and the integration of renewable forms of energy, as well as to reduce consumption, it will be essential that the building envelopes have also undergone energy renovation.

Other issues to be taken into account:

- The foreseeable amendment of the fluorinated greenhouse gas Regulation (F-Gas Regulation 517/2014) resulting from the Commission’s analysis of the Regulation in 2021 and the maturity of certain coolants will also accelerate the switch of heating and cooling systems to heat pump technologies.
- Another important issue in moving towards a carbon free economy is to be able to use residual industrial heat or cooling in the building sector.
- In a foreseeable scenario of distributed energy production, combined heat and power production should also be promoted in the renewal of thermal generators as it can produce significant energy and CO_2 savings.
- If the building undergoes a major renovation, it should become a smart building connected to a network that allows remote or automatic control of heating and cooling, water heating, lighting and appliances based on date and time, humidity, outside temperature and building occupancy. Buildings should be increasingly able to use information and communication technologies and electronic systems to adapt the operation of the building to the needs of the occupant and the local energy grid and to improve its energy efficiency and performance.
- Over the period 2040-2050, renovation should be carried out with a holistic district or neighbourhood approach and should be integrated into the neighbourhood energy efficiency and urban planning policy, ensuring that all buildings meet minimum energy requirements through general renovation schemes applicable to all buildings in an environment rather than to a single building; therefore, district networks can play an important role.

In view of the foregoing, and adhering to the energy route described qualitatively in the Integrated National Energy and Climate Plan, the trend is to electrify our cities in order to provide coverage and flexibility for a mostly renewable electricity generation mix by 2050. In this respect, as mentioned, heating and cooling demands will be met to a large extent by electricity, with heat pumps being the main type of equipment. However, it should not be forgotten that there will be combustion equipment that can be fuelled by renewable fuels, such as green hydrogen, biomethane or indigenous biomass.

8.3. PUBLIC TERTIARY SECTOR.

The use and type of the buildings in the public sector is, to a large extent, similar to the buildings described in the previous point on the private tertiary sector; therefore, the measures described above are applicable. However, the existence of energy inventories published by the administration allows for a more detailed study. Specifically, in this section, menus will be developed for the buildings included in the Energy Inventory, which does not include the protected buildings of the Central State Administration, which represent a considerable number of the total public building stock, although their particular features and different degrees of protection make the implementation of standard measures difficult, they should be the object of a specific study to examine their possible energy renovation.

In order to assign intervention menus, the public building stock has been split into clusters by use and climatic zone, understanding that buildings of the same use share similar type characteristics, resulting in 20 different clusters.

Figure 8.12. Definition of intervention clusters by use and climatic zone, with their areas.

Use	Climatic Zones AB		Climatic Zones CDE	
	Cluster	Area (m²)	Cluster	Area (m²)
Offices	A1	1 037 976	A2	3 446 429
Prison	B1	1 326 620	B2	2 358 719
Police station	C1	374 261	C2	1 050 143
Research centre	D1	87 803	D2	625 279
Administrative use in buildings with other types	E1	36 425	E2	220 511
Care centre	F1	82 564	F2	137 385
Educational buildings and areas of similar use in buildings with other types	G1	102 746	G2	106 951
Singular buildings	H1	14 760	H2	83 828
Barracks	I1	12 458	I2	58 288
Residence	J1	9 370	J2	17 540

Source: PARAE Programme (GBCe)

In the measures applied to each cluster, lighting, air conditioning (improvement of production, distribution and energy saving), DHW production and the thermal envelope of the buildings have been considered. These measures have been assigned to each cluster according to the type of each cluster, for which the types of public buildings have been equated to other types of private tertiary buildings described in the previous point. The result of these hypothesis makes it possible to determine approximate maximum potential savings, as shown in the table below.

Figure 8.13. Definition of intervention clusters by use and maximum potential saving.

Uses	Assimilated use in tertiary building	Cluster	Potential saving
Offices	Office	A1	35.8%
		A2	28.6%
Prison	Public residential: Hotel/Hospital stay	B1	35.9%
		B2	36.2%
Police station	Office	C1	32.2%
		C2	25.5%
Research centre	Training centres	D1	56.4%
		D2	59.2%

Administrative use in buildings with other types	Offices	E1	32.2%
		E2	25.5%
Care centre	Offices	F1	32.2%
		F2	25.5%
Educational buildings and areas of similar use in buildings with other types	Schools/Institutes	G1	62.6%
		G2	63.6%
Singular buildings	Not assigned. Require special audits	H1	
		H2	
Barracks	Public residential (50%) Offices (50%)	I1	46.1%
		I2	40.8%
Residence	Public residential: Hotel/Hospital with stay	J1	44.0%
		J2	42.3%

Source: PARAE (GBCe) Programme of the Informe sobre prospectiva y evolución futura de los sistemas de climatización y ACS en EDIFICIOS TERCIARIOS, drawn up by ATECYR.

In order to determine the renovation interventions to be carried out on the public building stock owned by the Central State Administration and the energy saving targets, annual renovation targets of 300 000 m²/year (over 3% of the area) have been considered.

The priority for intervention in the different buildings has been assessed according to a weighted index based on energy rating, savings potential and opportunity for intervention according to use, consumption level and energy source.

Figure 8.14. Possible prioritisation criteria for intervention in public buildings.

	Consumption	Energy Performance Certificate	Main use (Cluster)	Energy sources	Potential saving by cluster
Higher priority	Very high consumption (200 - 300 kWh)	G	Offices (A)	Heating fuel oil	G - Educational buildings and areas of similar use in buildings with other types
		F and no data	Research centre (D)	Propane	D - Research centre
	High consumption (100 - 200 kWh)	E	Classroom building (G)	Natural Gas	I - Barracks
		D	Warehouse (E)	Electricity	J - Home
	Medium consumption (50 - 100 kWh)	C	Records office (E)		B - Prison
		B	Care centre (F)		A - Offices
	Low consumption (30 - 50 kWh)	A	Prison (B)		F - Care centre
			Police station (C)		E - Administrative use in buildings with other types
	Abnormally low (0 - 30 kWh)		Barracks (I)		C - Police station
			Garage (E)		H - Singular buildings
	Abnormally high (300 - 2 000 kWh)		Hangar (E)		

Lower priority			Test track (G) Home (J) Workshop (E) Auditorium (H) Data processing centres (H) Hospital (H) Museum (H)		

Source: PARAE Programme (GBCe)

This analysis has been taken into account for the definition of the action scenarios on the public building stock, which will be developed in the chapter entitled *Scenarios, results and expected impact.*

CHAPTER 9. SCENARIOS, RESULTS AND EXPECTED IMPACT.

9.1. ANALYSIS OF SCENARIOS IN THE RESIDENTIAL SECTOR TO 2030.

Taking into account the partial scenarios and hypotheses for the envelope and heating and DHW installations described in Chapter 7 above, six scenarios have been calculated and analysed for the decade 2020-2030, the general results of which are presented in this section. These are:

Scenario A: 'Baseline Scenario'

Scenario B: 'Only Installations Scenario'.

Scenarios C, D, E and F: 'Envelope+Installations Scenarios', including a Basic Scenario (C) and three optimised scenarios (D, E and F).

The results of each of these scenarios are described and analysed below.

9.1.1. Scenario A ('Baseline').

Figure 9.1. Scenario A Summary Table ('Baseline').

Scenario A ('Baseline')	NO DWELLINGS, ENVELOPE	NO DWELLINGS, INSTALLATION RENEWAL	NO DWELLINGS INSTALLATION CHANGES	NO DWELLINGS RENEWED+CHANGES	ENVELOPE COST	INSTALLATION RENEWAL COST	INSTALLATION CHANGES COST	TOTAL COST
DHW INSTALLATIONS		6 595 266		6 595 266		6 530	-	6 530
HEATING INSTALLATIONS		5 284 957	615 406	5 900 364		10 105	1 625	11 729
ENVELOPE								
TOTAL	**-**	**11 880 224**	**615 406**	**12 495 630**	**-**	**16 635**	**1 625**	**18 259**

Source: MITMA.

This baseline scenario is intended to model the scenario that would develop without (or with minimal) public intervention, simply because of market conditions. As the main hypothesis, it is assumed that in this scenario there would be no spontaneous interventions to renovate the envelope of dwellings[159], reducing the actions between 2020 and 2030 exclusively to the installations, in which it is assumed that only the equipment that needs it due to reaching the end of its theoretical lifecycle during that decade will tend to be renewed (without a switch in fuel). Exceptionally, this scenario also includes the changing of equipment that strictly needs it so as to replace coal, which would receive the corresponding public aid.

Under these hypotheses, 12.5 million pieces of equipment would be renewed or changed, of which the majority would be simple replacements due to the existing equipment reaching the end of its lifecycle (11.8 million pieces

[159]It is estimated that, as at present, renovation of the building envelope would tend not to be undertaken without public support.

of equipment, compared to only 0.6 million replacements involving a switch in fuel, as these changes usually require some incentive or public support to be carried out)[160]. Actions to renew existing equipment would affect 9.2 million pieces of DHW equipment (2.6 million of which are assumed to be combi-boilers[161] with 6.6 million being only DHW equipment) and 5.9 million pieces of heating equipment or boilers (assuming that half of those, 2.6 million, will be renewed as combi-boilers).

The estimated investment (€18 259 000 000[162]) would be almost entirely private (€17 934 000 000) and dedicated exclusively to the replacement (without a switch in fuel) of the equipment (heaters and water heaters, boilers, combi-boilers, heat pumps, etc.) that need to be renewed due to reaching the end of their lifecycle in this decade. In addition to this would be the changing of the equipment that strictly needs it so as to replace coal, with public aid of €325 million financing 20% of the necessary investments.

This would result in total savings of 9 319 385 MWh in 2030 and 51 256 616 MWh over the whole decade, 17.2% of which would correspond to DHW and 82.8% of which would correspond to heating.

9.1.2. Scenario B (‘Only Installations’).

In this scenario, only actions on the installations have been modelled, designing an ideal scenario of intervention on the installations in an attempt to achieve the objectives of the PNIEC. This modelling corresponds to the hypotheses of matrices of changes to heating and DHW installations set out in the previous chapter. Its implementation would require intervention on 17.4 million pieces of equipment: renewing (without a switch in fuel) 11.8 million pieces of equipment due to reaching the end of their lifecycle and replacing a further 5.5 million pieces of equipment while switching to a more efficient fuel with lower emissions. The renewal of equipment would breakdown into 4.2 million pieces of heating equipment (of which it is estimated that half would be combined service equipment, with DHW[163]) and 7.6 million pieces DHW of equipment (plus the aforementioned 2.1 million pieces of combined service equipment), while of the 5.5 million pieces of equipment replaced involving a switch in fuel, 4.7 million would be heating equipment (2.3 million of which would be combined service equipment and would therefore also reduce DHW consumption) and 0.86 million would be DHW equipment exclusively. Thus, the total breakdown of the 17.4 million pieces of equipment would be 8.9 million pieces of heating equipment (including 4.4 million pieces of combined service equipment providing both services) and 8.5 million pieces of DHW equipment (plus the combined service equipment included in the numbers for heating equipment).

Figure 9.2. Scenario B Summary Table (‘Only Installations’).

Scenario B (Installations)	NO DWELLINGS, ENVELOPE	NO DWELLINGS, INSTALLATION RENEWAL	NO DWELLINGS INSTALLATION CHANGES	NO DWELLINGS RENEWED+CHANGES	ENVELOPE COST	INSTALLATION RENEWAL COST	INSTALLATION CHANGES COST	TOTAL COST
DHW INSTALLATIONS		7 611 642	860 955	8 472 597		6 668	1 027	7 695
HEATING INSTALLATIONS		4 245 676	4 680 562	8 926 238		8 827	11 590	20 417
ENVELOPE								
TOTAL	-	**11 857 318**	**5 541 517**	**17 398 835**	-	**15 495**	**12 617**	**28 112**

Source: MITMA.

The total cost of the actions would be €28 112 000 000, of which €15 495 000 000 would correspond to baseline renewals due to obsolescence of existing equipment and €12 617 000 000 would correspond to the replacement of equipment involving a switch in fuel, with the latter practically concentrated in the change of heating equipment and combined service equipment (11 590 000 000 pieces of equipment, compared with only 1 027 000 000 pieces of exclusively DHW equipment). Of the total investment amount (€28 112 000 000), €25 588 000 000 would correspond to private investment and €2 523 000 000 would correspond to public

[160]The number of households would be lower, given that, with the exception of combi-boilers, savings in DHW and heating equipment are calculated separately.
Although the calculation model calculates savings in DHW and heating, in order to avoid double counting in all tables in this section, combi-boilers providing both services are calculated in the heating row.
[161]In accordance with the previous note, in order to avoid double counting in the number of units, combi-boilers are only included in the table in the Heating row (not in the DHW row).
[162]All amounts in this section are without considering indirect expenses, industrial benefit , taxes, etc., which were considered in the microeconomic cost-benefit analysis.
[163]Similarly, households with such equipment are only counted in the tables once, in the Heating row.

investment in order to achieve 20% financing of all non-baseline action to replace equipment involving a switch in fuel.

Total savings in 2030 compared to 2020 would amount to 18 752 914 MWh (21% on DHW and 79% on heating), and the cumulative savings over the decade would be 103 141 026 MWh.

9.1.3. Scenarios C, D, E and F ('Envelope+Installations').

In all of these scenarios, intervention on DHW and heating installations is combined with renovation of the envelope of 1 200 079 dwellings, in line with the numerical target already advanced by the PNIEC at that time.

Starting with the installations, the menus proposed in all of these Scenarios, C, D, E and F, are based on very similar hypotheses to Scenario B (in this case also applied to the 1.2 million dwellings on which the envelope is renovated), obtaining very similar results, which are summarised in the table below:

Figure 9.3. Summary table for Scenarios A, B, C, D, E and F.

	NO DWELLINGS, ENVELOPE	NO DWELLINGS, INSTALLATION RENEWAL	NO DWELLINGS INSTALLATION CHANGES	NO DWELLINGS RENEWED+CHANGES	ENVELOPE COST	INSTALLATION RENEWAL COST	INSTALLATION CHANGES COST	TOTAL COST
DHW INSTALLATIONS		7 631 850	840 747	8 472 597		6 685	1 003	7 688
HEATING INSTALLATIONS		4 205 259	4 720 979	8 926 238		8 835	11 781	20 616
ENVELOPE	1 200 079				13 167			13 167
TOTAL	**1 200 079**	**11 837 109**	**5 561 726**	**17 398 835**	**13 167**	**15 520**	**12 784**	**41 471**

Source: MITMA.

In all of these Scenarios, C, D, E and F, intervention would be carried out (as in Scenario B) on 17.4 million pieces of equipment taking the form of the renewal (without a switch in fuel) of 11.8 million pieces of equipment due to reaching the end of their lifecycle and the replacement of a further 5.5 million pieces of equipment (involving a switch in fuel). The renewal of equipment would breakdown into 4.2 million pieces of heating equipment (of which half would be combined service equipment[164]) and 7.6 million pieces DHW of equipment (plus the aforementioned 2.1 million pieces of combined service equipment), while of the 5.5 million pieces of equipment replaced involving a switch in fuel, 4.7 million would be heating equipment (2.3 million of which would be combined service equipment) and 0.84 million would be DHW equipment exclusively. Thus, the total breakdown of the 17.4 million pieces of equipment would be 8.9 million pieces of heating equipment (including 4.4 million pieces of combined service equipment) and 8.5 million pieces of DHW equipment (plus the aforementioned combined service equipment).

In terms of results, the only notable difference from Scenario B is the slight reduction in the savings obtained in heating, given that (as has been stated) the menus for intervention on the installations have also been applied (in the corresponding part) in the package of 1.2 million dwellings in which action is taken on the envelope, meaning that as consumption in these dwellings has previously or simultaneously been significantly reduced with the renovation of the envelope, the subsequent renewal or replacement of the installations would have an effect on a level of consumption that would already be significantly reduced compared to the original level. A first paradox becomes apparent here: while, from the point of view of synergies and economies of scale, it seems advisable to combine interventions on the envelope and the installations, from the point of view of strictly maximising energy savings, greater results are achieved by acting on separate dwellings.

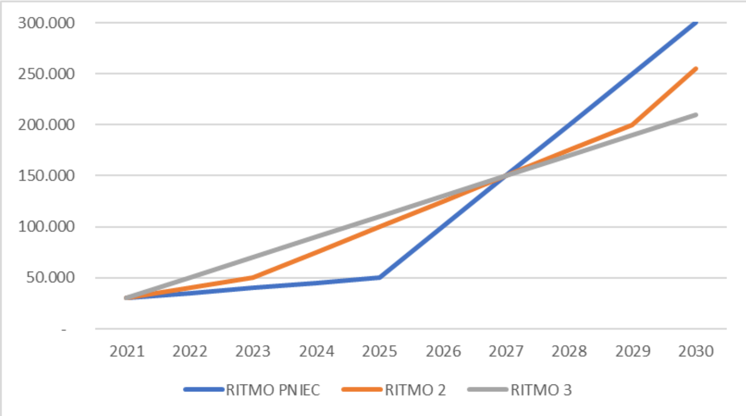
With regard to interventions on the envelope, as stated above, all of these Scenarios, C, D, E and F, consider action on 1 200 079 dwellings. However, two optimisations have been implemented on this starting point (Scenario C or base scenario):

An optimisation of the annual rate of dwellings renovated, maintaining the total number to be renovated in the decade 2020-2030, but attempting to bring this rate forward compared to the pathway drawn out by the PNIEC which, as can be seen in the Figure, sets out a very slow take-off until 2025, to then grow rapidly from that year onwards. Two options have been analysed (Rate 2 and Rate 3), of which Rate 3 is ultimately taken into account, as it is the one that progresses in a more sustained and constant manner over the entire decade and therefore

[164] As in the previous cases, in order to avoid double counting, all combined service equipment are counted only in the Heating row.

allows for greater cumulative savings and generates more employment in the initial years, thereby helping to combat the economic crisis caused by Covid-19. This rate optimisation is used in Scenarios D and F.

Figure 9.4. Optimisation of the rate of envelope renovation.



	PNIEC RATE
	RATE 2
	RATE 3

	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
PNIEC RATE	30 000	35 000	40 000	45 000	50 000	100 000	150 000	200 000	250 000	300 079
RATE 2	30 000	40 000	50 000	75 000	100 000	125 000	150 000	175 000	200 000	255 079
RATE 3	30 000	50 000	70 000	90 000	110 000	130 000	150 000	170 000	190 000	210 079

Source: MITMA based on PNIEC data.

A (second) optimisation of the dwellings to be renovated, retaining the same total number (1 200 079 dwellings), but starting with the most cost-effective dwellings, from the point of view of investment in energy efficiency. As seen previously in Chapter 7, a (first) optimisation of the dwellings to be renovated has been carried out, based on the division of the total Spanish residential stock into several homogeneous packages, within which the 7.1 million target dwellings to be renovated by 2050 have been identified which, in principle, are considered to be renovated and distributed over decades in proportion with the general targets: 1.2 million between 2020 and 2030 and the rest between 2030 and 2050. After this first optimisation of the 7.1 million dwellings, in this second optimisation the package of the most cost-effective 1.2 million is selected, so that in this option renovation would start in the decade 2020-2030 for package of the 1.2 million most cost-effective dwellings within the total target package of 7.1 million. This optimisation is used in Scenarios E and F.

Starting from Scenario C as the ‘Base Envelope+Installations Scenario’, the combination of the above optimisations results in the following ‘Optimised Envelope+Installations Scenarios’:

- Scenario D, in which only the optimisation of the rate of renovation of the 1.2 million dwellings is applied;
- Scenario E, in which only the (second) optimisation of the dwellings to receive intervention is applied to the most cost-effective dwellings of the package to be renovated by 2050;
- Scenario F, in which both optimisations are combined: rate of renovation and action on the most cost-effective dwellings.

In terms of investment, the investment corresponding to the installations (€28 304 000 000) is very similar to that of Scenario B, but adding the cost of interventions on the envelope (€13 167 000 000) would bring the total to €41 471 000 000. However, most of this investment would correspond to private investment in the baseline renovation of installations due to obsolescence (€15 520 000 000) and a further €12 784 000 000 in equipment replaced involving a switch in fuel, of which €2 557 000 000 would correspond to the public investment necessary to finance the cost of 20% of these replacements involving a switch in fuel. The total amount of public investment would include a further €4 389 000 000 (making a total of €6 946 000 000), to complement (covering 33.3%) the private investment of €8 778 000 000 in actions on the envelope.

As will be seen below, given that the number of dwellings to be renovated in each of these four scenarios is the same, with the same total investment, considerably better results could be achieved if any of the optimised scenarios were implemented.

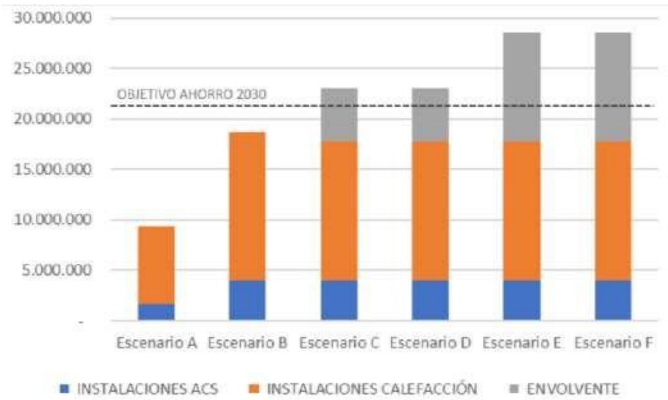
9.1.4. Comparison of the Total Results of the Scenarios.

As discussed in Chapter 6, the explicit energy savings target for the residential sector between
2020 and 2030 is 26 394 GWh, of which, according to MITMA's modelling based on TIMES-Sinergia by MITERD for the LTS 2050, a saving of 21 910 GWh would correspond to a joint target for heating and DHW uses in the 2020 ERESEE.

The Baseline Scenario (Scenario A) achieves a saving of only 9 319 385 MWh and thus falls below half of the established targets. In turn, Scenario B (intervention only on installations) also falls short (18 752 914 MWh), which confirms the need for intervention on the envelope.

Of the scenarios that combine interventions on the installations and the envelope, Scenario C strictly achieves the targets (21 999 123 MWh). Scenario D, in which only the rate of renovation is modified, while beating the cumulative targets, achieves the same overall result. Finally, Scenarios E and F obtain the best overall results, achieving savings of 28 507 229 MWh using the same amounts of investment and the intervening on the same number of dwellings.

Figure 9.5. Total energy savings in 2030 compared to 2020 (MWh).

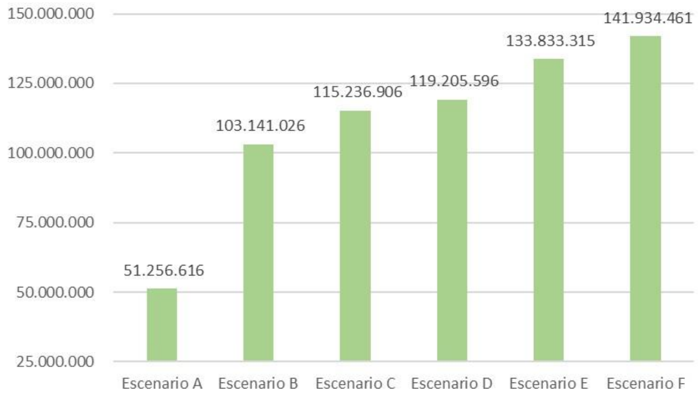


	2030 SAVING TARGET
	Scenario A
	DHW INSTALLATIONS
	HEATING INSTALLATIONS
	ENVELOPE

Source: MITMA.

In terms of cumulative savings, the graph below shows how these results show even more clearly than the previous ones the notable improvement that can be achieved (with identical investment and number of renovated) by implementing one of the optimisations proposed for Scenario C (or Base Envelope+Installations Scenario): based on the results obtained in this scenario (115 236 906 MWh) and with the same investment, optimisation of the renovation path, bringing it forward in time (Scenario D), would make it possible to achieve additional savings of 2.4% (3 968 690 MWh), optimisation of the dwellings receiving intervention (Scenario E) would achieve additional savings of 15.6% (18 596 410 MWh), and the combination of both (Scenario F), would achieve almost 20% extra (26 697 555 GWh).

Figure 9.6. Cumulative energy savings between 2020 and 2030 (MWh).



	Scenario A

Source: MITMA.

9.2. DETAILED DESCRIPTION OF SCENARIO C (BASE SCENARIO) FOR THE RESIDENTIAL SECTOR.

9.2.1. Results for Heating.

The tables below present the main results for Heating under Scenario C (Base Scenario), broken down by package considered. The results for initial and final consumption up to 2030 are included, together with a summary with the number of pieces of equipment that should be renewed due to reaching the end of their lifecycle, those to be renewed without a switch in fuel and those for which there is a switch in fuel.

Figure 9.7. General results for consumption for Heating in Scenario C (Base Scenario).

PACKAGES	DWELLINGS 2020	% dwellings modelled	DWELLINGS 2020 modelled	CONSUMPTION 2020 MWh	CONSUMPTION PER DWELLING 2020 MWh	CONSUMPTION 2030 MWh	CONSUMPTION PER DWELLING 2030 MWh	SAVINGS 2020-2030 MWh	SAVINGS PER DWELLING kWh	% SAVING
'2020-2030 Priority Envelope Renovation' Package	**1 200 079**	**100**	**1 200 079**	**7 594 818**	**6 329**	**1 867 378**	**1 556**	**5 727 440**	**4 773**	**75.4**
SINGLE-FAMILY			415 374	4 494 296	10 820	941 031	2 266	3 553 266	8 554	79.1
MULTI-FAMILY			784 705	3 100 522	3 951	926 347	1 181	2 174 175	2 771	70.1
'2030-2050 Priority Envelope Renovation' Package	**5 901 438**	**94**	**5 574 060**	**35 863 753**	**6 434**	**28 570 155**	**5 126**	**7 293 598**	**1 308**	**20.3**
SINGLE-FAMILY			1 928 853	21 182 672	10 982	15 742 814	8 162	5 439 858	2 820	25.7
MULTI-FAMILY			3 645 207	14 681 080	4 028	12 827 341	3 519	1 853 740	509	12.6
'Low Consumption Dwellings' Package	**3 313 520**	**93**	**3 087 455**	**4 520 804**	**1 464**	**3 862 275**	**1 251**	**658 529**	**213**	**14.6**
SINGLE-FAMILY			581 699	1 674 458	2 879	1 412 867	2 429	261 592	450	15.6
MULTI-FAMILY			2 505 756	2 846 345	1 136	2 449 408	978	396 938	158	13.9
'Renovation Unlikely' Package	**2 865 213**	**94**	**2 696 983**	**16 274 554**	**6 034**	**12 817 518**	**4 753**	**3 457 036**	**1 282**	**21.2**
SINGLE-FAMILY			1 087 286	11 167 169	10 271	8 357 164	7 686	2 810 005	2 584	25.2
MULTI-FAMILY			1 609 698	5 107 384	3 173	4 460 354	2 771	647 031	402	12.7
'Dwellings built 2008-2020' Package	**745 516**	**94**	**701 563**	**2 162 551**	**3 082**	**1 705 410**	**2 431**	**457 141**	**652**	**21.1**
SINGLE-FAMILY			251 887	1 490 610	5 918	1 121 420	4 452	369 190	1 466	24.8
MULTI-FAMILY			449 676	671 941	1 494	583 990	1 299	87 951	196	13.1
'Energy Poverty' Package	**2 572 361**	**94**	**2 417 773**	**6 566 950**	**2 716**	**5 185 865**	**2 145**	**1 381 086**	**571**	**21.0**
SINGLE-FAMILY			1 004 825	4 440 705	4 419	3 333 978	3 318	1 106 727	1 101	24.9
MULTI-FAMILY			1 412 949	2 126 246	1 505	1 851 887	1 311	274 359	194	12.9
'Non-Significant Technologies' Package	**34 244**		**150 864**	**718 596**	**4 763**	**638 687**	**4 234**	**79 909**	**530**	**11.1**
SINGLE-FAMILY			83 656	478 267	5 717	475 147	5 680	3 121	37	0.7
MULTI-FAMILY			67 208	240 329	3 576	163 540	2 433	76 788	1 143	32.0
'Remainder Not Modelled' Package			**998 846**	**4 506 414**	**4 512**	**4 506 414**	**4 512**			
SINGLE-FAMILY			223 812	2 784 503	12 441	2 784 503	12 441			
MULTI-FAMILY			775 034	1 721 911	2 222	1 721 911	2 222			
TOTALS	**16 827 624**		**16 827 624**	**78 208 440**	**4 648**	**59 153 701**	**3 515**	**19 054 739**	**1 132**	**24.4**
SINGLE-FAMILY			5 577 391	47 712 681	8 555	34 168 923	6 126	13 543 758	2 428	28.4
MULTI-FAMILY			11 250 232	30 495 759	2 711	24 984 778	2 221	5 510 981	490	18.1

Source: MITMA.

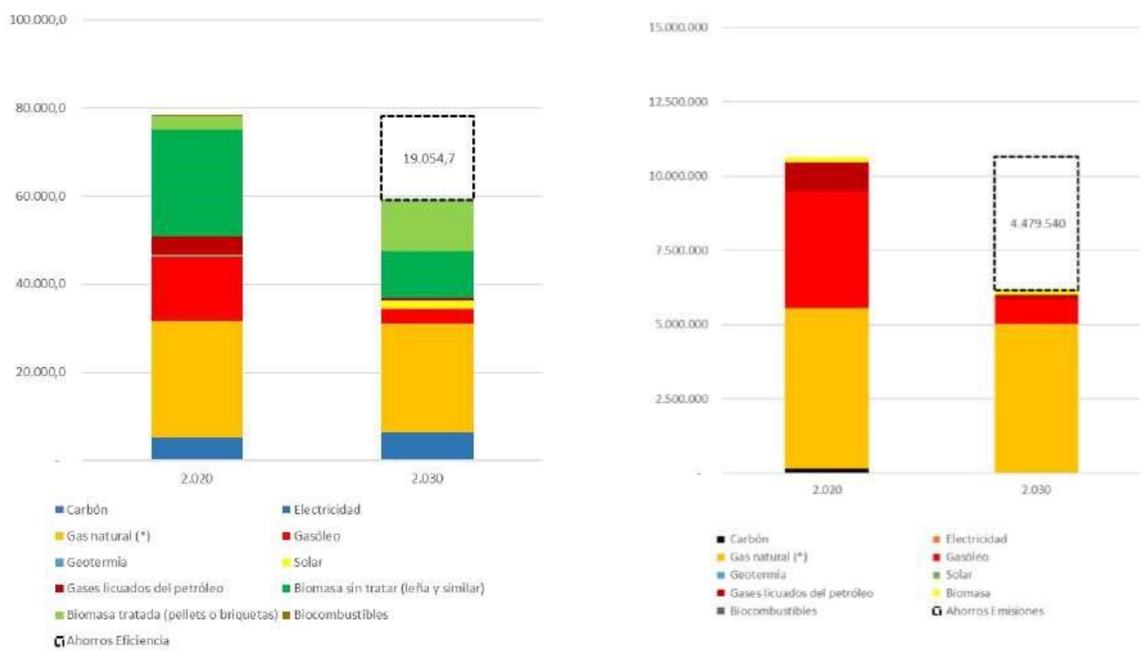
Figure 9.8. Summary table of renewals and changes of Heating equipment under Scenario C (Base Scenario).

PACKAGES	DWELLINGS 2020 modelled	EQUIPMENT THAT SHOULD BE RENEWED	EQUIPMENT THAT REMAINS THE SAME	EQUIPMENT THAT IS RENEWED	EQUIPMENT THAT SWITCHES FUEL
'2020-2030 Priority Envelope Renovation' Package	**1 200 079**	**612 291**	**473 396**	**298 334**	**361 790**
SINGLE-FAMILY	415 374	203 786	163 247	64 120	188 007
MULTI-FAMILY	784 705	408 505	376 708	234 214	173 783
'2030-2050 Priority Envelope Renovation' Package	**5 574 060**	**3 010 926**	**2 328 093**	**1 466 981**	**1 778 986**
SINGLE-FAMILY	1 928 853	1 001 885	689 369	315 280	924 204
MULTI-FAMILY	3 645 207	2 009 041	1 638 724	1 151 702	854 782
'Low Consumption Dwellings' Package	**3 087 455**	**1 704 870**	**1 508 855**	**938 604**	**639 996**
SINGLE-FAMILY	581 699	358 792	247 689	139 227	194 782
MULTI-FAMILY	2 505 756	1 346 078	1 261 166	799 377	445 214
'Renovation Unlikely' Package	**2 696 983**	**1 468 887**	**1 147 802**	**697 627**	**851 554**
SINGLE-FAMILY	1 087 286	587 741	396 868	188 977	501 440
MULTI-FAMILY	1 609 698	881 146	750 934	508 650	350 114
'Dwellings built 2008-2020' Package	**701 563**	**382 165**	**302 630**	**185 971**	**212 962**
SINGLE-FAMILY	251 887	136 669	92 680	44 325	114 882
MULTI-FAMILY	449 676	245 496	209 951	141 646	98 079
'Energy Poverty' Package	**2 417 773**	**1 317 961**	**1 019 360**	**614 638**	**783 776**
SINGLE-FAMILY	1 004 825	545 802	368 933	176 074	459 818
MULTI-FAMILY	1 412 949	772 159	650 427	438 564	323 958
'Non-Significant Technologies' Package	**150 864**	**18 291**	**55 845**	**3 104**	**91 915**
SINGLE-FAMILY	83 656	14 153	50 671	0	32 984
MULTI-FAMILY	67 208	4 139	5 173	3 104	58 931
'Remainder Not Modelled' Package	**1 065 405**	**-**	**1 065 405**	**-**	**-**
SINGLE-FAMILY	223 812		223 812		
MULTI-FAMILY	775 034		775 034		
TOTAL	**16 827 624**	**8 515 391**	**7 901 385**	**4 205 259**	**4 720 979**
SINGLE-FAMILY	5 577 391	2 848 828	2 233 270	928 003	2 416 118
MULTI-FAMILY	11 250 232	5 666 563	5 668 116	3 277 256	2 304 861

Source: MITMA.

In terms of energy, savings in Heating in existing dwellings total 19 054.7 GWh, while savings in CO_2 emissions total 4.4 million tonnes of CO_2 equivalent.

Figure 9.9. Results for consumption for Heating in Scenario C (Base Scenario) in terms of energy consumption (left) in GWh and CO_2 emissions (right) in tonnes of CO_2 equivalent.



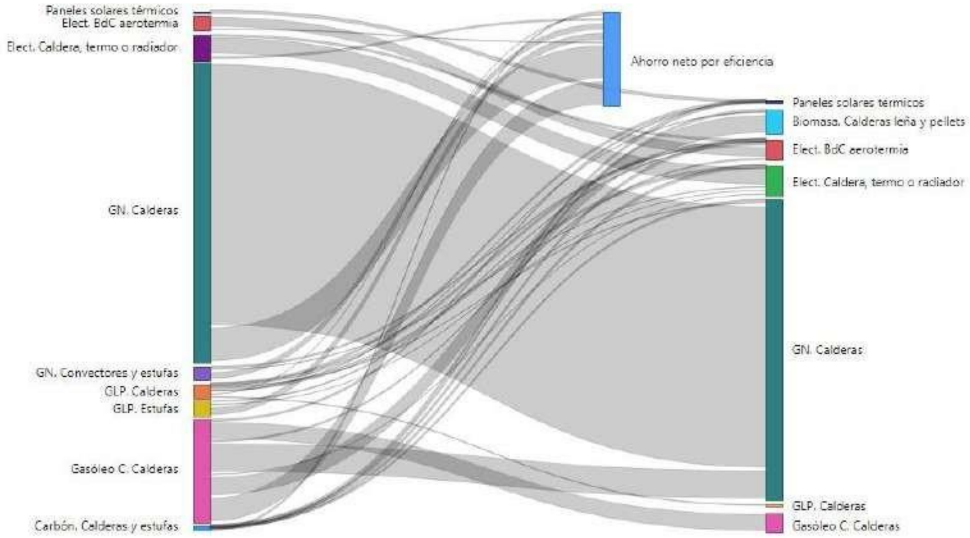
	Coal
	Natural gas (*)
	Geothermal
	Liquefied petroleum gases
	Electricity
	Fuel oil
	Solar

	Untreated biomass (firewood and similar)
	Biofuels
	Treated biomass (pellets or briquettes)
	Efficiency savings
	Coal
	Natural gas (*)
	Geothermal
	Liquefied petroleum gases
	Biofuels
	Electricity
	Fuel oil
	Solar
	Biomass
	Emissions savings

Source: MITMA.

The following few diagrams provide a breakdown of changes in consumption for Heating in multi-family dwellings, single-family dwellings and overall:

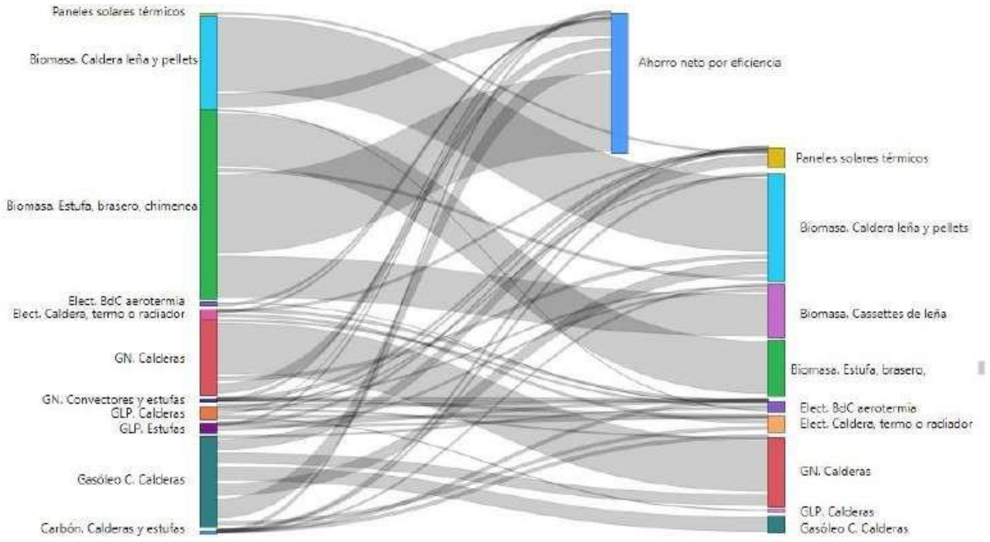
Figure 9.10. Diagram of changes in consumption for Heating in multi-family dwellings by fuel type (left 2020, right 2030). Scenario C (Base Scenario).



	Solar thermal panels Electric aerothermal HP
	Electric boiler, water heater or radiator
	NG. Boilers
	NG. Convectors and stoves
	LPG. Boilers
	LPG. Stoves
	Heating fuel oil Boilers
	Coal, Boilers and Stoves
	Net efficiency saving
	Solar thermal panels
	Biomass Boilers (wood and pellets)
	Electric aerothermal HP
	Electric Boiler, water heater or radiator
	NG. Boilers
	LPG, Boilers
	Heating fuel oil Boilers

Source: MITMA.

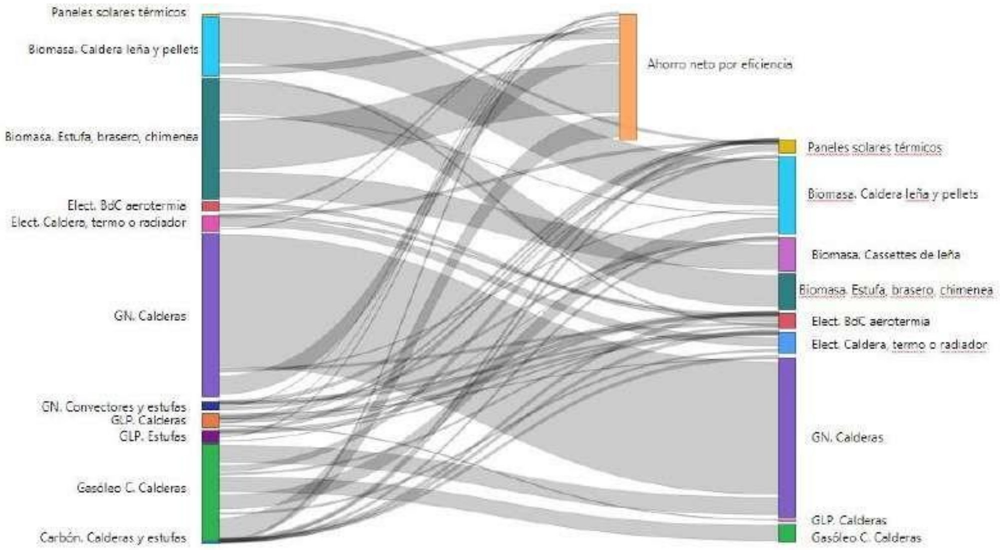
Figure 9.11. Diagram of changes in consumption for Heating in single-family dwellings by fuel type (left 2020, right 2030). Scenario C (Base Scenario).



Source: MITMA.

	Solar thermal panels
	Biomass Boiler, wood and pellets
	Biomass Stove, brazier, fireplace
	Electric aerothermal HP
	Electric Boiler, water heater or radiator
	NG. Boilers
	NG. Convectors and stoves
	LPG. Boilers
	LPG. Stoves
	Heating fuel oil Boilers
	Coal, Boilers and stoves
	Net efficiency saving
	Solar thermal panels
	Biomass Boilers (wood and pellets)
	NG. Boilers
	LPG, Boilers
	Heating fuel oil Boilers
	Electric aerothermal HP
	Electric Boiler, water heater or radiator

Figure 9.12. Diagram of changes in consumption for Heating in the residential sector (multi-family and single-family dwellings together) by fuel type (left 2020, right 2030). Scenario C (Base Scenario).



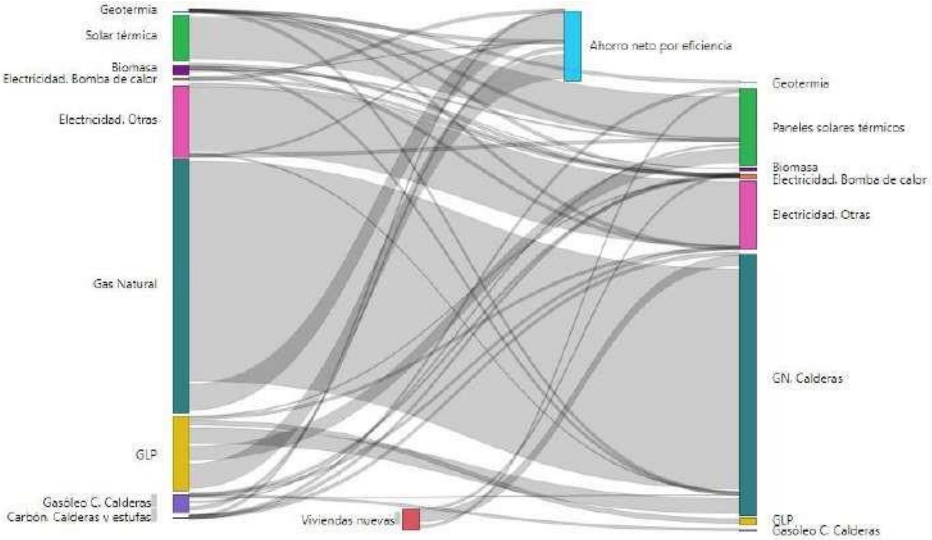
	Solar thermal panels
	Biomass Boiler, wood and pellets
	Biomass Stove, brazier, fireplace
	Electric aerothermal HP
	Electric Boiler, water heater or radiator
	NG. Boilers
	NG. Convectors and stoves
	LPG. Boilers
	LPG. Stoves
	Heating fuel oil Boilers
	Coal, Boilers and stoves
	Net efficiency saving
	Solar thermal panels
	Biomass Boilers (wood and pellets)
	NG. Boilers
	LPG. Boilers
	Heating fuel oil Boilers
	Electric aerothermal HP
	Electric Boiler, water heater or radiator

Source: MITMA.

9.2.2. Results for DHW.

The following diagram provides a breakdown of consumption for DHW in dwellings and its trend between 2020 and 2030. Energy savings in existing dwellings amount to 2 944.4 GWh (deducting the consumption for DHW of the new dwellings built in the decade from the total savings of 3 942.1 GWh) and savings in CO_2 emissions amount to 1 025 589 T.

Figure 9.13. Diagram of changes in consumption for DHW in the residential sector by fuel type (left 2020, right 2030). Scenario C (Base Scenario).



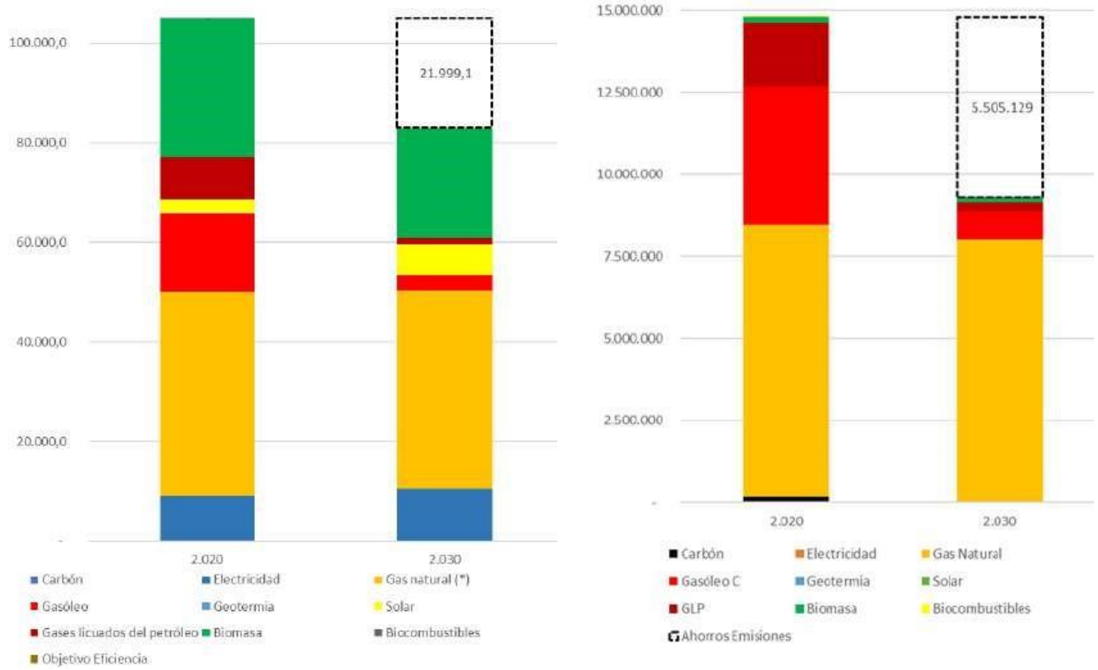
	Geothermal
	Solar thermal
	Biomass Electricity Aerothermal
	Electricity Other
	Natural Gas
	LPG
	Heating fuel oil boilers, Coal Boilers and stoves
	New dwellings

Source: MITMA.

9.2.3. Final Results for Heating and DHW in terms of Energy and Emissions and Trend 2020-2030. Scenario C (Base Scenario).

The following graphs show the change in the consumption of energy for heating and DHW in the residential sector (left) and in CO_2 emissions, separated by energy source, between 2020 and 2030. The total energy savings achieved amount to 21 999.1 GWh, with total emissions savings of 5.5 million tonnes of CO_2 equivalent.

Figure 9.14. Total expected results for Scenario C (Base Scenario) in terms of energy consumption (left) in GWh and in emissions (right) in tonnes of CO_2 equivalent.

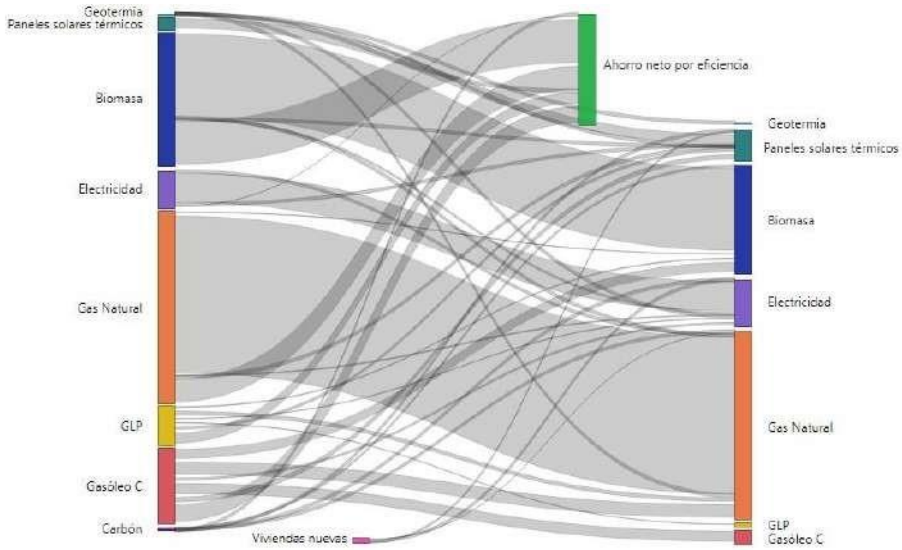


	Coal
	Fuel oil
	Liquefied petroleum gases
	Efficiency Target
	Electricity
	Geothermal
	Biomass
	Coal
	Heating fuel oil
	LPG
	Emissions savings
	Electricity
	Geothermal
	Biomass
	Natural Gas
	Solar
	Biofuels
	100 000.0

Source: MITMA.

The figure below provides a breakdown of total consumption for Heating and DHW and the 2020-2030 trend in consumption:

Figure 9.15. Diagram of changes in consumption for Heating and DHW in the residential sector by fuel type (left 2020, right 2030). Scenario C (Base Scenario).



	Geothermal Solar thermal panels
	Net efficiency saving
	Biomass
	Geothermal
	Solar thermal panels
	Electricity
	Biomass
	Natural Gas
	Electricity
	LPG
	Natural Gas
	Heating fuel oil
	Coal
	New dwellings
	LPG
	Heating fuel oil

Source: MITMA.

9.2.4. Details and Analysis of the Investments.

The table below details the investments that would be necessary to fully implement Scenario C (Base Scenario). It includes the different actions covered in this scenario: renewal of DHW and heating equipment due to reaching the end of its lifecycle (in which it is assumed that the private investments to be made fall within the baseline scenario and therefore do not require public aid), replacement of DHW and heating equipment with a switch in fuel (in which it is assumed that there is public investment to encourage the achievement of the energy targets in 2030), and, finally, energy renovation actions on the envelope.

Figure 9.16. Summary table of the annualised investments necessary for Scenario C (Base Scenario).

NUMBER OF ACTIONS	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	TOTAL
DHW Equipment. Renewal due to reaching the end of its lifecycle.	763 185	763 185	763 185	763 185	763 185	763 185	763 185	763 185	763 185	763 185	7 631 850
DHW Equipment. Renewal involving a switch in fuel	84 075	84 075	84 075	84 075	84 075	84 075	84 075	84 075	84 075	84 075	840 747
Heating Equipment. Renewal due to reaching the end of its lifecycle.	420 526	420 526	420 526	420 526	420 526	420 526	420 526	420 526	420 526	420 526	4 205 259
Heating Equipment. Renewal due to a switch in fuel	472 098	472 098	472 098	472 098	472 098	472 098	472 098	472 098	472 098	472 098	4 720 979
Dwelling with Energy Renovation of the envelope	30 000	35 000	40 000	45 000	50 000	100 000	150 000	200 000	250 000	300 079	1 200 079

TOTAL INVESTMENT	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	TOTAL
DHW Equipment. Renewal due to reaching the end of its lifecycle.	668.5	668.5	668.5	668.5	668.5	668.5	668.5	668.5	668.5	668.5	6 685
DHW Equipment. Renewal involving a switch in fuel	100.3	100.3	100.3	100.3	100.3	100.3	100.3	100.3	100.3	100.3	1 003
Heating Equipment. Renewal due to reaching the end of its lifecycle.	883.5	883.5	883.5	883.5	883.5	883.5	883.5	883.5	883.5	883.5	8 835
Heating Equipment. Renewal due to a switch in fuel	1 178.1	1 178.1	1 178.1	1 178.1	1 178.1	1 178.1	1 178.1	1 178.1	1 178.1	1 178.1	11 781
Dwelling with Energy Renovation of the envelope	329.1	384.0	438.9	493.7	548.6	1 097.2	1 645.7	2 194.3	2 742.9	3 292.3	13 167
TOTAL	3 159.5	3 214.4	3 269.2	3 324.1	3 379.0	3 927.5	4 476.1	5 024.7	5 573.3	6 122.7	41 471

TOTAL PRIVATE INVESTMENT	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	TOTAL
DHW Equipment. Renewal due to reaching the end of its lifecycle.	668.5	668.5	668.5	668.5	668.5	668.5	668.5	668.5	668.5	668.5	6 685.3
DHW Equipment. Renewal involving a switch in fuel	80.2	80.2	80.2	80.2	80.2	80.2	80.2	80.2	80.2	80.2	802.4
Heating Equipment. Renewal due to reaching the end of its lifecycle.	883.5	883.5	883.5	883.5	883.5	883.5	883.5	883.5	883.5	883.5	8 834.9
Heating Equipment. Renewal due to a switch in fuel	942.5	942.5	942.5	942.5	942.5	942.5	942.5	942.5	942.5	942.5	9 424.6
Dwelling with Energy Renovation of the envelope	219.4	256.0	292.6	329.1	365.7	731.4	1 097.2	1 462.9	1 828.6	2 194.9	8 777.8
TOTAL	2 794.1	2 830.7	2 867.3	2 903.9	2 940.4	3 306.1	3 671.9	4 037.6	4 403.3	4 769.6	34 524.9

BASELINE PRIVATE INVESTMENT	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	TOTAL
DHW Equipment. Renewal due to reaching the end of its lifecycle.	668.5	668.5	668.5	668.5	668.5	668.5	668.5	668.5	668.5	668.5	6 685.3
DHW Equipment. Renewal involving a switch in fuel											
Heating Equipment. Renewal due to reaching the end of its lifecycle.	883.5	883.5	883.5	883.5	883.5	883.5	883.5	883.5	883.5	883.5	8 834.9
Heating Equipment. Renewal due to a switch in fuel											
Dwelling with Energy Renovation of the envelope											
TOTAL	1 552.0	1 552.0	1 552.0	1 552.0	1 552.0	1 552.0	1 552.0	1 552.0	1 552.0	1 552.0	15 520.2

PRIVATE INVESTMENT INDUCED BY PUBLIC AID	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	TOTAL
DHW Equipment. Renewal due to reaching the end of its lifecycle.											
DHW Equipment. Renewal involving a switch in fuel	80.2	80.2	80.2	80.2	80.2	80.2	80.2	80.2	80.2	80.2	802.4
Heating Equipment. Renewal due to reaching the end of its lifecycle.											
Heating Equipment. Renewal due to a switch in fuel	942.5	942.5	942.5	942.5	942.5	942.5	942.5	942.5	942.5	942.5	9 424.6
Dwelling with Energy Renovation of the envelope	219.4	256.0	292.6	329.1	365.7	731.4	1 097.2	1 462.9	1 828.6	2 194.9	8 777.8
TOTAL	1 242.1	1 278.7	1 315.3	1 351.8	1 388.4	1 754.1	2 119.8	2 485.6	2 851.3	3 217.6	19 005

PUBLIC INVESTMENT	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	TOTAL
DHW Equipment. Renewal due to reaching the end of its lifecycle.											
DHW Equipment. Renewal involving a switch in fuel	20.1	20.1	20.1	20.1	20.1	20.1	20.1	20.1	20.1	20.1	201
Heating Equipment. Renewal due to reaching the end of its lifecycle.											
Heating Equipment. Renewal due to a switch in fuel	235.6	235.6	235.6	235.6	235.6	235.6	235.6	235.6	235.6	235.6	2 356
Dwelling with Energy Renovation of the envelope	109.7	128.0	146.3	164.6	182.9	365.7	548.6	731.4	914.3	1 097.4	4 389
TOTAL	365.4	383.7	402.0	420.2	438.5	621.4	804.2	987.1	1 170.0	1 353.1	6 946

Source: MINISTRY OF TRANSPORT, MOBILITY AND THE URBAN AGENDA (MITMA)

The total volume of investment required for 2020-2030 would be €41 471 000 000, of which €15 520 000 000 would correspond to private investments (considered baselines investments) for the renewal of DHW and/or heating equipment due to it simply reaching the end of its lifecycle. The public investment (€6 946 000 000) would be used to incentivise envelope renovation (€4 389 000 000), covered one third of the total investment needed, while the other €2 557 000 000 would be used for the replacement of DHW and/or heating equipment with the switches in fuel needed to achieve the energy targets set for 2030 (covering one fifth of the total investment). Thus, the percentages of public investment compared to the private investment induced by the former would be 25% in the case of the installations and 50% in the case of the envelope.

Figure 9.17. Summary extract from the 2020-2030 investment table. Scenario C (Base Scenario).

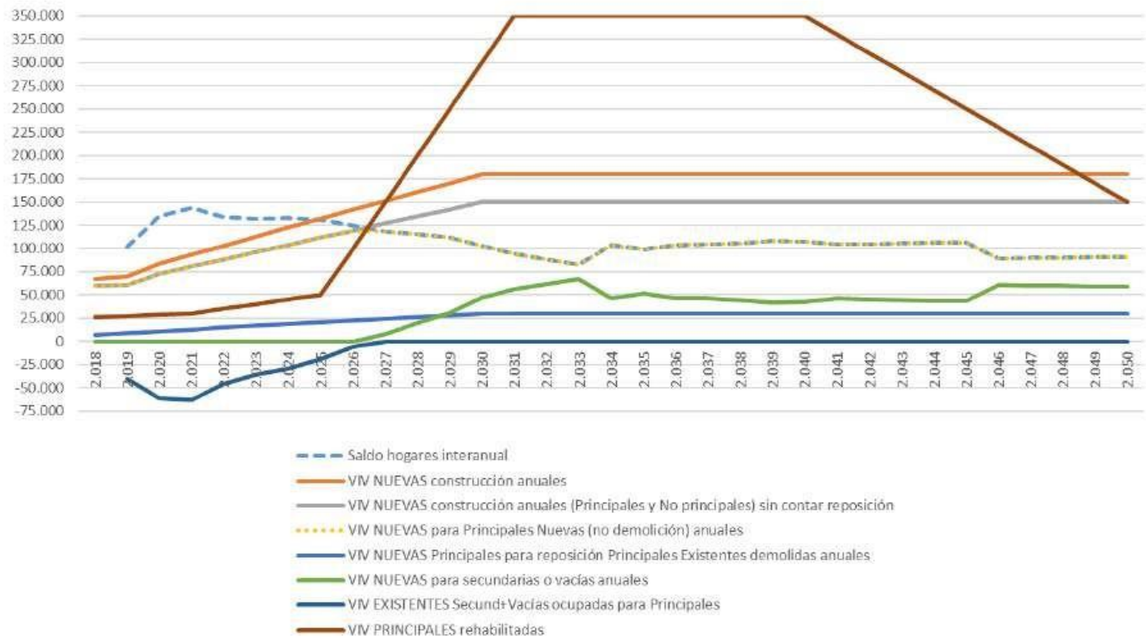
	TOTAL COST	PRIVATE INVESTMENT	OF WHICH, BASELINE INVESTMEN	INDUCED BY PUBLIC INVESTMENT	PUBLIC INVESTMENT	% OF PUBLIC INVESTMENT COMPARED TO PRIVATE INVESTMENT
DHW INSTALLATIONS	7 688.2	7 487.7	6 685.3	802.4	200.6	25.0
HEATING INSTALLATIONS	20 615.6	18 259.5	8 834.9	9 424.6	2 356.1	25.0
ENVELOPE	13 166.7	8 777.8	-	8 777.8	4 388.9	50.0
TOTAL	**41 470.6**	34 524.9	15 520.2	19 004.7	6 945.6	

Source: MITMA.

9.3. ANALYSIS OF SCENARIOS IN THE RESIDENTIAL SECTOR TO 2050.

The graph in Figure 9.18 shows the trend model of the residential building sector and the flows of dwellings into which the path of rehabilitated dwellings has been incorporated. In the period 2020-2030, it shows the path designed by the PNIEC, which assumes moving from the current environment of 25 000 dwellings renovated per year to the target set by the PNIEC of reaching 300 000 per year in 2030. From this point, it is assumed that the figures will stabilise at around 350 000 dwellings with deep renovation (including envelope) during the decade 2030-2040, to gradually decrease to 150 000 in 2050[165]. This would bring the total number of dwellings receiving deep renovation between 2020 and 2030 to 1 200 000 with a further 5 900 000 between 2021 and 2050, making a total of 7 100 000.

Figure 9.18. Indicative pathway of dwellings receiving deep renovation, 2020-2050.



	Year-on-year household balance
	NEW DWELLINGS annual construction
	NEW DWELLINGS annual construction (main and non-main) excluding replacement

[165]Although already outside the ERESEE, this figure would correspond to a balanced split (similar to the European average) between new construction and renovation. In the worst case scenario, it is considered that the minimum volumes would be similar to the current volume (25 000), due simply to the conservation of the existing housing stock.

	NEW DWELLINGS for New Main Dwellings (no demolition) per year
	NEW Main DWELLINGS to replace Existing Main Dwellings demolished per year
	NEW Secondary or Empty DWELLINGS per year
	EXISTING Secondary + Empty DWELLINGS occupied as Main Dwellings
	MAIN DWELLINGS renovated

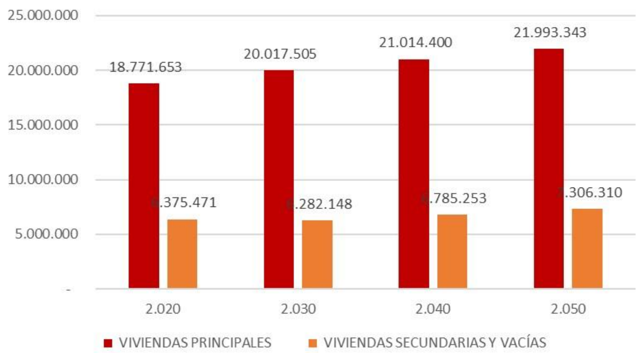
TREND TO 2020, 2030, 2040 AND 2050	2 020	2 030	2 040	2 050
CUMULATIVE NEW DWELLINGS annual construction	153 999	1 521 039	3 321 039	5 121 039
CUMULATIVE NEW DWELLINGS annual construction (Main and Non-Main) excluding replacement	133 893	1 286 422	2 786 422	4 286 422
CUMULATIVE NEW DWELLINGS for New Main Dwellings (no demolition) per year	133 893	1 180 537	2 177 432	3 156 375
CUMULATIVE NEW Main DWELLINGS to replace Existing Main Dwellings demolished per year	20 105	234 617	534 617	834 617
CUMULATIVE NEW Secondary or Empty DWELLINGS per year	0	105 886	608 991	1 130 047
CUMULATIVE EXISTING Secondary + Empty DWELLINGS occupied as Main Dwellings	-61 364			
CUMULATIVE MAIN DWELLINGS renovated	56 017	1 256 017	4 756 017	7 156 017

CUMULATIVE TREND BY DECADE	2021-2030	2031-2040	2041-2050	2021-2050
CUMULATIVE NEW DWELLINGS annual construction	1 367 040	1 800 000	1 800 000	4 967 040
CUMULATIVE NEW DWELLINGS annual construction (Main and Non-Main) excluding replacement	1 152 529	1 500 000	1 500 000	4 152 529
CUMULATIVE NEW DWELLINGS for New Main Dwellings (no demolition) per year	1 046 643	996 895	978 943	3 022 481
CUMULATIVE NEW Main DWELLINGS to replace Existing Main Dwellings demolished per year	214 511	300 000	300 000	814 511
CUMULATIVE NEW Secondary or Empty DWELLINGS per year	105 886	503 105	521 057	1 130 047
CUMULATIVE EXISTING Secondary + Empty DWELLINGS occupied as Main Dwellings	-199 209	0	0	
CUMULATIVE MAIN DWELLINGS renovated	1 200 000	3 500 000	2 400 000	7 100 000

Sources: MITMA based on statistics from MITMA, INE, European Commission Ageing Report, PNIEC.

With this indicative trend for the building sector, the distribution between main, secondary and empty dwellings would be as illustrated in the following graph:

Figure 9.10. Estimate of the stock of main, secondary and empty dwellings, 2020-2030.



	MAIN DWELLINGS
	SECONDARY AND EMPTY DWELLINGS

Sources: MITMA based on statistics from MITMA, INE, European Commission Ageing Report.

The figure below shows the trend for the residential stock between 2020 and 2050, segmented into different packages according to the heating consumption of the dwellings.

The starting point in 2020 is a stock of 18 771 653 main dwellings, of which 1 950 208 have no heating consumption. Of the rest of the stock, a few packages stand out with relatively low starting levels for consumption: 3.3 million that, due to their location in benign climatic zones, start with a unit consumption of less than 15 kWh/m^2 (of which 2.3 million have consumption of even less than 10 kWh/m^2), and other small packages corresponding to new dwellings built between 2018 and 2020 (153 999) and those built after the approval of the Technical Building Code (745 516), which are estimated to have a starting consumption of 30 kWh/m^2. Finally, it is considered that the number of existing dwellings that have been deeply renovated prior to 2020 would be only around 56 017 dwellings, with a consumption of around 35 kWh/m^2, compared to the almost 55 kWh/m^2 that would be the consumption of the remaining package of 12.5 million existing dwellings in 2020.

With the renovation path proposed and described in this ERESEE, 7.1 million dwellings would be renovated by 2050, reducing their unit consumption to around 12 kWh/m^2. The stock of newly built homes constructed between 2020 and 2050 would reach 3,9 million dwellings, all of which would already be Nearly Zero Energy Buildings, as they will have been built in accordance with the technical requirements in force from 2020 onwards. In the packages of dwellings built after the approval of the Technical Building Code and those with low initial consumption due to their location in benign climatic zones, even if they are not considered for deep interventions on the envelope, the actions on the installations and the partial menus on the envelope (replacement of windows, insulation of roofs, etc.) carried out between 2020 and 2050 could achieve unit consumption levels similar to those of dwellings that have undergone deep renovation. Finally, the package of dwellings without renovation[166] would have fallen from 12.5 million in 2020 to 4.5 million in 2050, with their consumption also being reduced by interventions to improve the efficiency of installations.

Figure 9.11. Indicative trend of the residential stock of main dwellings 2020-2050 and Nearly Zero Energy Buildings.

	MAIN DWELLINGS, without Heating(*)
	MAIN NZEB DWELLINGS, Low Consumption
	MAIN ZNEB DWELLINGS, New and Demolished
	MAIN DWELLINGS not Renovated
	MAIN DWELLINGS Renovated
	MAIN NZEB DWELLINGS (2008- 2020)

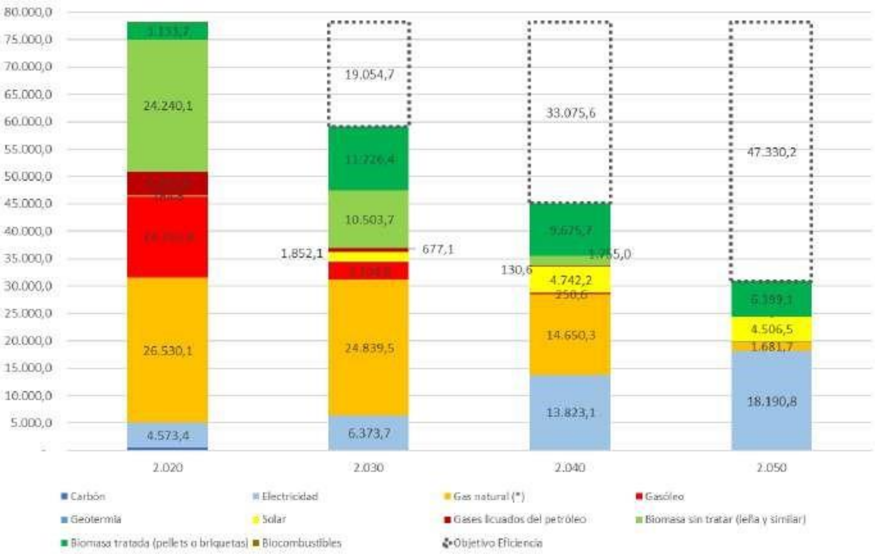
	No of Dwellings 2020	Consumption 2020 MWh	Unit Consumption 2020 per dwelling kWh	Consumption 2020 kWh/m²	No of Dwellings 2030	Consumption 2030 MWh	Unit Consumption 2030 per dwelling kWh	Consumption 2030 kWh/m2
MAIN DWELLINGS	18 771 653	78 208 440	4 166	40	21 993 343	30 878 213	1 404	13
MAIN DWELLINGS, without Heating(*)	1 950 208	-	-	-	2 232 608			-
MAIN DWELLINGS with Heating	16 827 624	78 208 440	4 648	45	19 760 735	30 878 213	1 563	15
MAIN DWELLINGS not Renovated	12 552 394	70 282 743	5 599	54	4 554 691	15 245 100	3 347	32
MAIN NZEB DWELLINGS, Low Consumption	3 313 520	4 933 132	1 489	14	3 313 520	3 313 520	1 000	10
MAIN DWELLINGS Renovated	56 017	196 060	3 500	34	7 156 017	8 587 220	1 200	12
MAIN ZNEB DWELLINGS, New and Demolished	153 999	478 767	3 109	30	3 990 991	2 614 099	655	6
MAIN NZEB DWELLINGS (2008-2020)	745 516	2 317 738	3 109	30	745 516	1 118 274	1 500	14

Source: MITMA.

Using these forecasts, a model has been developed that, in coordination with the results of the TIMES-SINERGIA model for the LTS 2050, makes it possible to estimate the corresponding consumptions for Heating and DHW, differentiated by energy source. The results are as follows:

[166]It should not be forgotten that this ‘residual’ package is the one that groups together the dwellings that we have called ‘low probability of intervention’ (due to construction characteristics of the building, its ownership, etc.) and the situations of energy poverty.

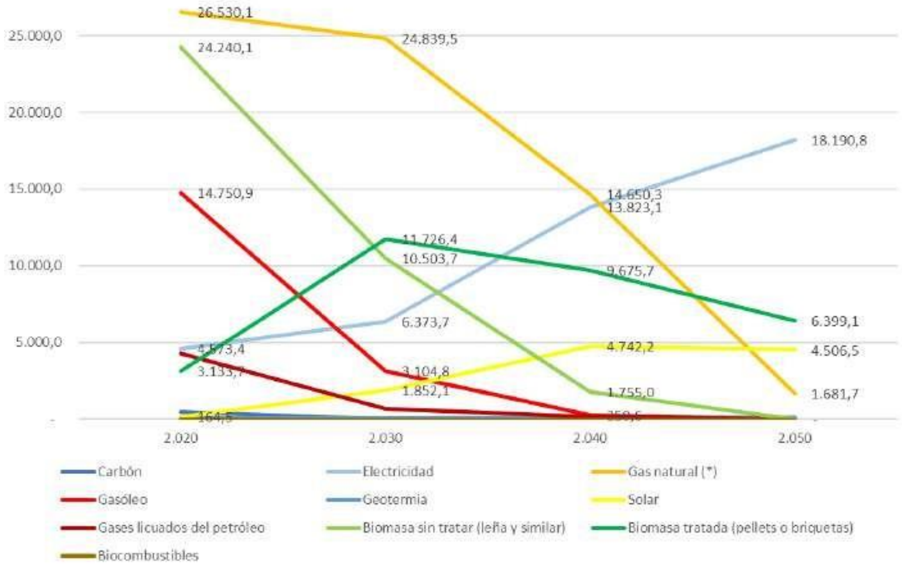
Figure 9.12. Indicative pathway and targets for the trend of consumption for Heating in the residential sector 2020-2050. (GWh).



	Coal
	Geothermal
	Treated biomass (pellets or briquettes)
	Electricity
	Solar
	Biofuels
	Natural gas (*)
	Liquefied petroleum gases
	Efficiency Target
	Fuel oil
	Untreated biomass (firewood and similar)

Source: MITMA based on the 2020 ERESEE and LTS 2050.

Figure 9.13. Indicative pathway and targets (broken down by energy source) for the trend of consumption for DHW in the residential sector 2020-2050. (GWh).



	Coal
	Fuel oil
	Liquefied petroleum gases
	Biofuels

	Electricity
	Geothermal
	Untreated biomass (firewood and similar)
	Natural gas (*)
	Solar
	Treated biomass (pellets or briquettes)

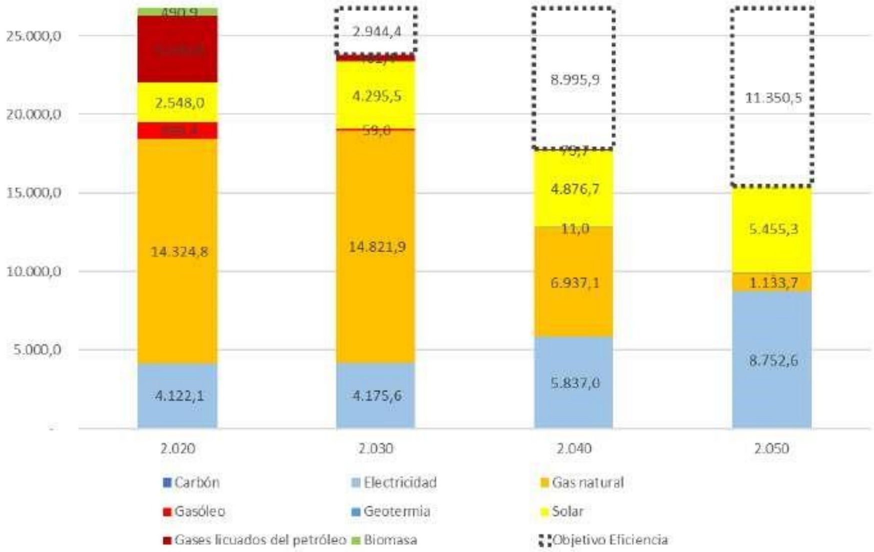
Source: MITMA based on the 2020 ERESEE and LTS 2050.

In view of the graphs above, the following main conclusions can be drawn on the indicative trend of energy consumption for heating in the residential sector:

- Fossil fuel-based energy is set to disappear almost entirely by 2050.
- Biomass, which (including Wood and Pellets) is the energy source with the greatest weighting in consumption in 2020 (especially in single-family dwellings), would have a very different trend in the decade 2020-2030 and thereafter. The target by 2030 would essentially be the reversal of the current total ratio between wood and treated biomass (pellets or briquettes), together with a net reduction in absolute terms; to that end, it would be essential to take action on the most inefficient systems, such as wood-burning fireplaces, stoves and braziers when deploying treated biomass equipment, particularly in rural areas. However, from 2030, the capacity to install new biomass equipment would be reduced, due to the need to use this fuel for the decarbonisation of other economic sectors where there are fewer alternatives than in the residential sector. This is why, in the period 2030-2050, Biomass should be further reduced, mainly Wood.
- Natural Gas, currently the second most important energy source for Heating, would tend to disappear along with the other fossil fuels heading towards 2050, although at that date a certain amount of consumption (mainly associated with collective boilers in multi-family dwellings in urban areas where it is difficult to switch to another system, not so much in individual systems in multi-family or single-family dwellings), which would be Biogas, Biomethane or other Renewable Gases, would appear to have been assigned to it. However, in the decade 2020-2030, Natural Gas would act as an intermediate vector for some replacements of other more inefficient equipment or other fossil fuels to be phased out more quickly (Coal, Fuel Oil, LGP).
- In the case of Coal, the target would be the complete phasing out of coal for heating use in 2020. For Fuel Oil and LPGs, the target would be to replace as much equipment as possible in the 2030 scenario, although it is considered that by that date there would be some remaining equipment (around 20%), which would disappear subsequently.
- The only vector experiencing sustained growth throughout the period would be electricity, with a clear trend towards the electrification of households, including for Heating uses, primarily for the deployment of Heat Pumps.
- Finally, it is considered that there will be some deployment of Solar Energy to support heating, with geothermal energy being maintained.

In the case of DHW, the modelling, based on TIMES-SINERGIA for the LTS 2050, provides the following indicative results:

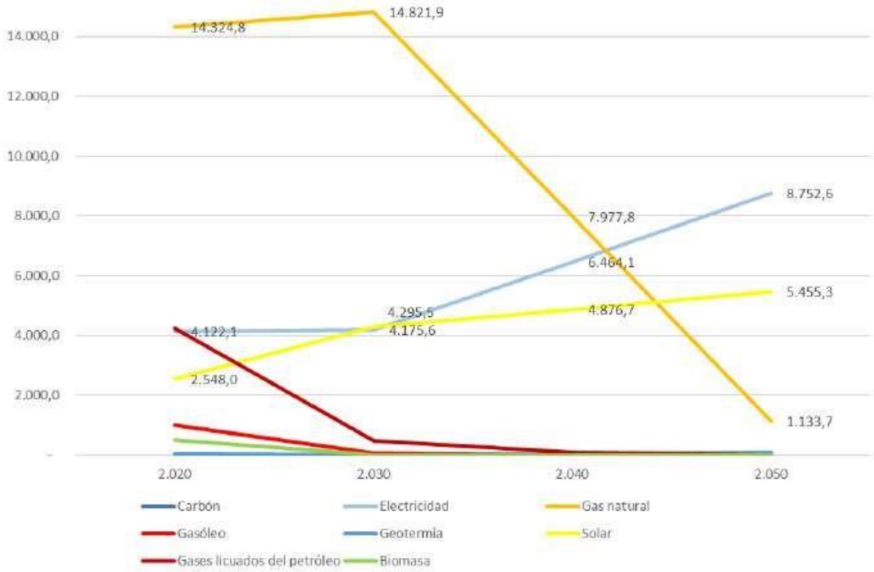
Figure 9.14. Indicative pathway and targets for the trend of consumption for DHW in the residential sector 2020-2050. (GWh).



	Coal
	Fuel oil
	Liquefied petroleum gases
	Electricity
	Geothermal
	Biomass
	Natural gas
	Solar
	Efficiency Target

Source: MITMA based on the 2020 ERESEE and LTS 2050.

Figure 9.15. Indicative pathway and targets (broken down by energy source) for the trend of consumption for DHW in the residential sector 2020-2050. (GWh).



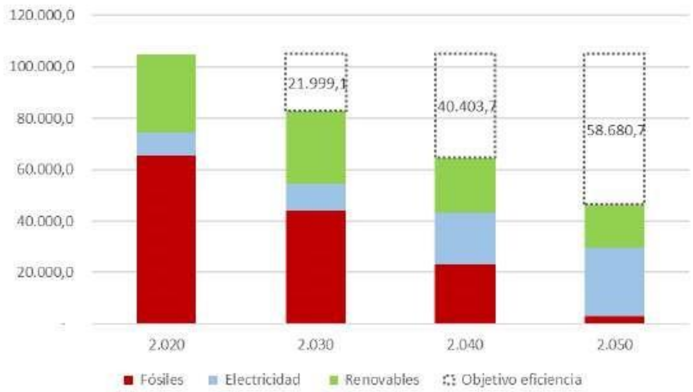
	Coal
	Fuel oil
	Liquefied petroleum gases
	Electricity
	Geothermal
	Biomass
	Natural gas
	Solar

Source: MITMA based on the 2020 ERESEE and LTS 2050.

The following conclusions can be drawn from the indicative 2020-2050 pathway for DHW energy consumption:

- Likewise, fossil fuel-based energy is set to disappear almost entirely by 2050.
- Natural Gas, the fuel with the highest weighting in 2020, would act as an intermediate vector in the period 2020-2030, to then fall very sharply in the following two decades, with a certain amount allocated in 2050, corresponding to Biogas, Biomethane or other Renewable Gases.
- The target for Coal would be its elimination by 2030 and for Fuel Oil, LPG and Biomass Equipment for DHW use the target would be the replacement of many pieces of equipment as possible.
- The fastest growing technologies would be Solar and Electricity, which would absorb virtually all demand in 2050.
- Adding together the Heating and DHW uses would result in the following indicative target graph which, as can be seen from a comparison with Figure 6.7 of Chapter 6, covers almost all of the efficiency targets assigned to the residential sector by the PNIEC and the LTS 2050:

Figure 9.16. Indicative total energy consumption targets and cumulative savings for Heating and DHW in the residential sector, 2020-2050. (GWh).



	Fossil fuels
	Electricity
	Renewables
	Efficiency target
	2020
	20 000.0

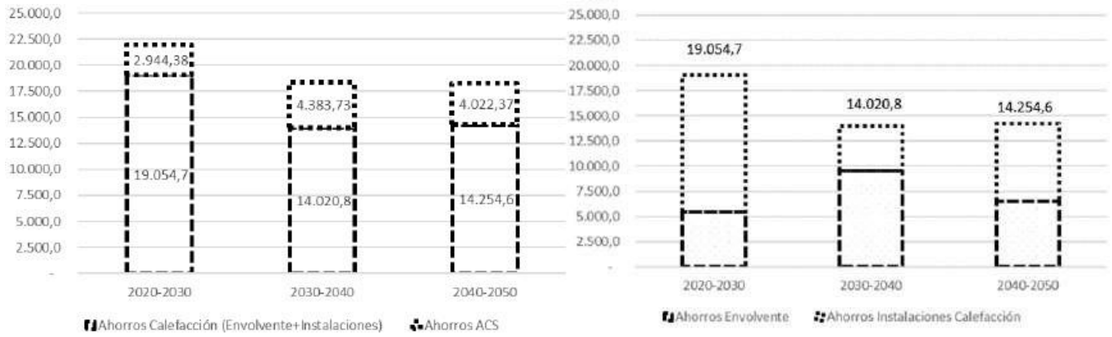
	2020	2030	2040	2050
TOTAL	104 982.4	82 983.3	64 578.7	46 301.7
Fossil fuels	65 605.1	43 963.7	23 094.0	2 815.5
Electricity	8 695.5	10 549.3	20 287.2	26 943.4
Renewables	30 681.7	28 470.3	21 197.6	16 542.8
Efficiency Target (cumulative)		21 999.1	40 403.7	58 680.7

Source: MITMA.

The indicative savings targets would therefore be 21 999.1 GWh for the decade 2020-2030 (37.5% of the total 58 680.7 to be achieved by 2050), 18 404.6 for 2030-2040 (31.4%) and 18 277 for 2040-2050 (31.1%).

The left-hand graph below and the attached table show the distribution of the savings corresponding to Heating and DHW in each period and, the right-hand graph also shows the distribution of the savings corresponding to interventions on the envelope and on the installations in each decade. Between 2020 and 2030, the result is a distribution in which most of the savings correspond to installations (almost 71.4%), as intervention takes place on relatively few envelopes (1.2 million), while the renewal of installations is based on relatively high initial consumption levels, which makes it relatively easy to achieve significant savings. In contrast, in the decade 2030-2040, once the cruising speed of annual renovation of 350 000 dwellings has been achieved, the deep renovation of 3.5 million dwellings in this period would account for two thirds of the savings, compared to one third for the installations. Finally, in the decade 2040-2050, the savings would be almost equally divided between those achieved through intervention on the envelope (2.4 million dwellings) and on the installations.

Figure 9.17. Savings by decade in Heating and DHW (left) and breakdown of Heating savings through interventions on the envelope and installations (right). (GWh). Percentage distribution by decade.



	Heating Savings (Envelope+Installations)
	25 000.0
	2 944.38

	2 500.0
	DHW Savings
	Envelope Savings
	Heating Installation Savings

	2020-2030	2030-2040	2040-2050	TOTAL 2020-2050
General total	21 999.1	18 404.6	18 277.0	58 680.7
Heating	19 054.7	14 020.8	14 254.6	47 330.2
DHW	2 944.4	4 383.7	4 022.4	11 350.5

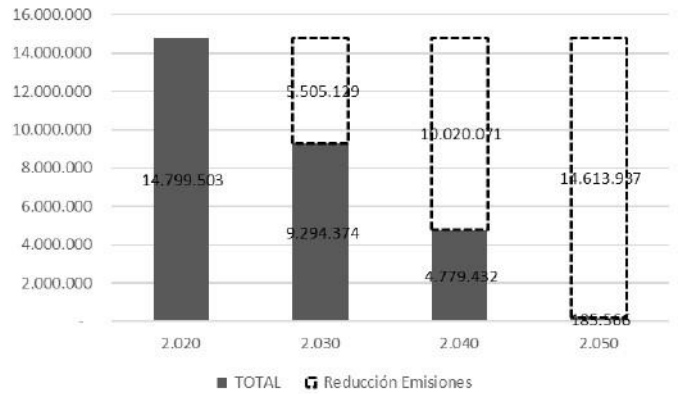
	2020-2030	2030-2040	2040-2050	TOTAL 2020-2050
General total	37.5	31.4	31.1	100.0
Heating	40.3	29.6	30.1	100.0
DHW	25.9	38.6	35.4	100.0

Source: MITMA.

Due to its significance in absolute terms, it is worth stressing the importance of intervening as early as possible on the envelopes and planning these interventions well together with the renovation of installations so that the situation described in Section 7.1.6 and Figure 7.4 does not arise. Indeed, the package of 5.9 million dwellings for which deep intervention on their envelopes is proposed for between 2030 and 2050 would have a total savings potential of 26 766 GWh if operating on the initial 2020 consumption level (38 412 GWh, lowered to 11 646 GWh following deep intervention). However, the fact that intervention will not take place until after 2030 means that many installations in this package will be renewed simply due to reaching the end of their lifecycle in the decade 2020-2030, meaning that the subsequent intervention on the envelope will take effect on an initial consumption level that has previously been reduced by this renewal of the installations and, therefore, capitalising on the energy savings and their cost effectiveness will be much more complicated.

Finally, with regard to C0₂ emissions, the figure below demonstrates that the Heating and DHW uses covered by this ERESEE also meet virtually all the targets set for the residential sector for the PNIEC and the LTS 2050.

Figure 9.18. Indicative emission reduction targets for Heating and DHW uses in the residential sector, 2020-2050. (Tonnes of CO_2 equivalent).



	TOTAL
	Emissions Reduction
	16 000 000
	2 000 000
	2.20

	2 020	2 030	2 040	2 050
TOTAL	14 799 503	9 294 374	4 779 432	185 566
Emissions Reduction Target (cumulative)		5 505 129	10 020 071	14 613 937

Source: MITMA.

9.4. ANALYSIS OF SCENARIOS IN THE TERCIARY SECTOR TO 2030.

In buildings in the tertiary sector, although, as with residential buildings, financial viability continues to be the fundamental element for the promotion of energy renovation, the fact that the cost of the energy necessary for the use of the building is included in an accounting balance sheet and is essential for the development of an activity and that many of these buildings, due to their use and size, may have a significant savings potential, facilitates the reduction of amortisation periods and, consequently, the implementation of larger-scale interventions.

9.4.1. Scenario definition. General considerations.

The approach to possible scenarios for the tertiary sector building stock should take into consideration the energy efficiency improvement targets set by the Integrated National Energy and Climate Plan 2021-2030 (PNIEC). In order to meet the targets, the Plan determines lines of action and a savings pathway that in themselves represent a base scenario.

An initial base scenario is therefore proposed, defining the scope of the interventions and their saving percentage, estimated based on the *Informe sobre prospectiva y evolución futura de los sistemas de climatización y ACS de Atecyr* for MITMA and the degree of implementation (average annual percentage of consumption on which action must be taken) necessary to ensure compliance with the savings pathway of the Integrated National Energy and Climate Plan up to 2030 and the LTS 2050 (Long-term Strategy for a Modern, Competitive and Climate-Neutral Spanish Economy in 2050) target scenario from 2030 to 2050. The measures studied in the first tranche up to 2030 are those proposed by the PNIEC and, in the base scenario, strict compliance with the savings established with the lowest possible impact in terms of intervention percentage for the housing stock is proposed. For the definition of the baseline scenario and the base target scenario, the various hypotheses and starting data of the PNIEC are taken on through this procedure. From 2030 onwards, more comprehensive intervention measures are considered with the aim of strictly meeting the consumption levels of the LTS 2050 target scenario.

Subsequently, an improved scenario is proposed in which, without increasing the degree of implementation of the base scenario, the depth of the interventions is increased, with the solutions always being cost effective, and the percentage reduction in final energy consumption in comparison with the base scenario is calculated.

Compliance with the PNIEC guarantees the base scenario and the consumptions set out in the LTS 2050. Actions carried out to promote energy renovation can change the final intermediate scenario, bringing it closer to the base scenario or to the improved scenario.

For the definition of the scenarios, the starting point is the forecast of total final energy consumption for 2020 in the services sector of LTS 2050 and its distribution by services (heating, cooling, DHW, lighting and other uses) and, using a projection to 2020 of the data from the 2017 Annual Energy Consumption Report of the IDAE Institute (MITERD), which is the latest available, a breakdown is carried out by type of building use of the total consumption data. Finally, based on the data from the Study of installations in buildings in the tertiary sector of the *Informe sobre tipologías, consumos, actuaciones de mejora y potenciales ahorros en el parque edificatorio del sector terciario* by A3e for MITMA and from the *Informe sobre prospectiva y evolución futura de los sistemas de climatización y ACS de Atecyr* for MITMA, consumption for each type is broken down by service.

Figure 9.1. Final energy consumption forecast for 2020 by type and service (GWh).

(GWh)	Total	Heating	Cooling	DHW	Lighting	Other
Total	131 858	35 054	*9 490*	17 968	17 834	51 512
Offices	41 323	7 563	4 138	3 515	4 851	21 256
Hospitals	11 412	2 784	559	4 301	609	3 159
Trade	44 045	14 963	2 743	1 976	9 069	15 294
Hospitality	9 090	2 186	423	2 697	593	3 191
Education	6 711	2 903	359	833	992	1 624
Other uses	19 277	4 655	1 268	4 646	1 720	6 988

Source: MITMA based on the LTS 2050 and IDAE, A3E, ATECYR.

The PNIEC proposes measures differentiating between the building stock of the private sector, that of the Central State Administration and that of the Autonomous Communities and Local Administration. Consumption is distributed between the three sectors based on the energy inventory of buildings belonging to the Central State Administration carried out annually by the Ministry for Ecological Transition and the Demographic Challenge in compliance with Directive 2012/27/EU. The distribution between the private sector building stock and that of the Autonomous Communities and Local Administration is based on hypotheses that are themselves based on the following economic and employment statistics: the Statistical Notice on Personnel Working for the Public Administrations published by the Ministry of Territorial Policy and Civil Service, the 2018 Annual Report on the National Health System on health expenditure published by the Ministry of Health, Consumption and Social Welfare, the Education Panorama Report, OECD Indicators and the Data and Figures Report for the 2019/2020 Academic Year, both published by the Ministry of Education and Vocational Training.

Figure 9.2. Final energy consumption forecast for 2020 by type and sector (GWh).

(GWh)	Total	AGE	AC and Local Admin.	Private sector
Total	131 858	1 024	14 435	116 399
Offices	41 323	616	1 325	39 382
Hospitals	11 412	0.3	9 125	2 287
Trade	44 045	0	0	44 045
Hospitality	9 090	362	0	8 728

Education	6 711	35	3 962	2 714
Other uses	19 277	11	23	19 243

Source: MITMA based on MITERD, MPTFP, MSCBS, MEFP.

The breakdown by service for the private sector is as follows:

Figure 9.3. Final energy consumption forecast for 2020 in the private sector by type and service (GWh).

(GWh)	Total	Heating	Cooling	DHW	Lighting	Other
Total	116 399	30 649	8 616	13 750	16 502	46 882
Offices	39 382	7 208	3 943	3 350	4 623	20 258
Hospitals	2 287	558	112	862	122	633
Trade	44 045	14 963	2 743	1 976	9 069	15 294
Hospitality	8 728	2 099	406	2 588	570	3 065
Education	2 714	1 174	146	337	401	656
Other uses	19 243	4 647	1 266	4 637	1 717	6 976

Source: MITMA based on MITERD, MPTFP, MSCBS, MEFP, ELP 2050, IDAE, A3E, ATECYR.

The measures proposed by PNIEC are intended to incrementally add savings to the savings already occurring in the baseline scenario, i.e., the measures are in addition to those that would occur in the stock without the proposed interventions. In the private sector, in addition to the baseline savings that would occur due to the replacement of existing buildings with new NZEBs, energy renovations due to the optimisation of running costs, the company's energy or commercial policy or maintenance needs themselves, are the three measures established for this sector in the PNIEC.

- Thermal envelope: action on the thermal envelope of the building to achieve a reduction in the building's demand for heating and cooling.
- Thermal installations: action on thermal installations for heating, air conditioning, domestic hot water and ventilation to achieve a reduction in energy consumption for heating, cooling, DHW and the incorporation of renewable energy sources.
- Lighting installations: action on the interior lighting installations of buildings to adapt them in line with the required energy values, incorporating regulation systems according to the activity and the level of natural light input.

9.4.2. Base Scenario. Private sector.

9.4.2.1. Thermal Envelope. Base Scenario.

The following table shows the trend of the consumption of heating and cooling services for the different types of private buildings in the tertiary sector, in the base scenario.

Figure 9.4. Disaggregated data for the base scenario for interventions on the envelope in the private tertiary sector.

(GWh)	Consumption		Average action %	Saving		2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
	Heat.	Cool.		Heat.	Cool.										
Offices	7 208	3 943	0.1%	14%	13%	11 150	11 148	11 147	11 145	11 144	11 142	11 141	11 139	11 138	11 136
Hospitals	558	112	0.1%	14%	13%	669	669	669	669	669	669	669	669	669	669
Trade	14 963	2 743	0.1%	14%	13%	17 704	17 702	17 699	17 697	17 694	17 692	17 689	17 687	17 685	17 682
Hospitality	2 099	406	0.1%	14%	13%	2 505	2 505	2 505	2 504	2 504	2 504	2 503	2 503	2 503	2 502
Education	1 174	146	0.1%	14%	13%	1 319	1 319	1 319	1 319	1 319	1 318	1 318	1 318	1 318	1 318
Other uses	4 647	1 266	0.1%	14%	13%	5 912	5 911	5 910	5 909	5 909	5 908	5 907	5 906	5 905	5 904

Base scenario	39 260	39 255	39 249	39 244	39 238	39 233	39 228	39 222	39 217	39 211
PNIEC Target	39 264	39 263	39 261	39 260	39 259	39 258	39 256	39 255	39 254	39 252
Cumulative saving of the base scenario										297
PNIEC cumulative saving target										71

Source: MITMA based on MITERD, MPTFP, MSCBS, MEFP, ELP 2050, IDAE, A3E, ATECYR.

The proposed intervention leads to savings of 14% in heating and 13% in cooling. These savings can currently be achieved with action equivalent to an intervention on the façade openings.

With this intervention on a minimal part of the housing stock, representing 0.1% of total consumption, the cumulative saving in 2030 would be above that established by the PNIEC and the conditions established for the base scenario would be met.

The low level of action in the stock makes it unnecessary, in this scenario, to consider deep interventions. For the same reason and because of the similar savings of the proposed intervention in all types, it also seems unnecessary to adjust the average annual action percentage by type of use.

9.4.2.2. Thermal Installations. Base Scenario.

The following table shows the trend of the consumption of heating, cooling and DHW services for the different types of buildings in the tertiary sector in the base scenario.

Figure 9.5 Disaggregated data for the base scenario for interventions on the thermal Installations in the tertiary sector.

(GWh)	Consumption			Action %	Saving			2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
	Heat.	Cool.	DHW		Heat.	Cool.	DHW										
Offices	7 208	3 943	3 350	0.1%	30%	0%	15%	14 499	14 496	14 494	14 491	14 488	14 486	14 483	14 480	14 478	14 475
Hospitals	558	112	862	0.1%	30%	0%	15%	1 531	1 531	1 530	1 530	1 530	1 529	1 529	1 529	1 528	1 528
Trade	14 963	2 743	1 976	0.1%	30%	0%	15%	19 678	19 673	19 669	19 664	19 659	19 654	19 649	19 644	19 639	19 635
Hospitality	2 099	406	2 588	0.1%	30%	0%	15%	5 093	5 092	5 091	5 090	5 089	5 088	5 087	5 086	5 085	5 084
Education	1 174	146	337	0.1%	30%	0%	15%	1 656	1 656	1 655	1 655	1 654	1 654	1 654	1 653	1 653	1 652
Other uses	4 647	1 266	4 637	0.1%	30%	0%	15%	10 547	10 545	10 543	10 541	10 539	10 537	10 534	10 532	10 530	10 528

Base scenario	53 004	52 993	52 981	52 970	52 959	52 947	52 936	52 924	52 913	52 902
PNIEC Target	53 008	53 000	52 992	52 984	52 976	52 968	52 960	52 953	52 945	52 937
Cumulative saving of the base scenario										625
PNIEC Target										431

Source: MITMA based on MITERD, MPTFP, MSCBS, MEFP, ELP 2050, IDAE, A3E, ATECYR.

In this case, with a proposed intervention on the heating and DHW installations, which represents savings of 30% and 15%, respectively, the minimum savings conditions established for the base scenario are achieved, as in the previous case, with a low action percentage for the stock.

As in the previous case, the low level of action on the stock and the similarity in savings per intervention for all types makes it unnecessary, in this scenario, to consider deep interventions or to adjust the average annual action percentage by type of use.

9.4.2.3. Lighting. Base Scenario.

The following table shows the trend of the consumption of the lighting installation for the different types of buildings in the tertiary sector in the base scenario.

Figure 9.6. Disaggregated data for the base scenario for interventions on the lighting Installations in the tertiary sector.

(GWh)	Light. Consumption	Action %	Light. Savings	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Offices	4 623	1.6%	50%	4 586	4 549	4 513	4 477	4 441	4 406	4 370	4 335	4 301	4 266
Hospitals	122	1.6%	50%	121	120	119	118	117	116	115	114	114	113
Trade	9 069	1.6%	50%	8 996	8 924	8 853	8 782	8 712	8 642	8 573	8 504	8 436	8 369
Hospitality	570	1.6%	50%	565	561	556	552	547	543	539	534	530	526
Education	401	1.6%	50%	398	395	392	388	385	382	379	376	373	370
Other uses	1 717	1.6%	50%	1 704	1 690	1 677	1 663	1 650	1 637	1 624	1 611	1 598	1 585
Base scenario				16 370	16 239	16 109	15 981	15 853	15 726	15 600	15 475	15 351	15 229
PNIEC Target				16 377	16 251	16 125	16 000	15 874	15 749	15 623	15 497	15 372	15 246
Cumulative saving of the base scenario													7089
PNIEC Target													6908

Source: MITMA based on MITERD, MPTFP, MSCBS, MEFP, ELP 2050, IDAE, A3E, ATECYR.

The higher savings allocated to this measure compared to the previous ones requires increasing both the level of action on the stock and the savings per intervention. However, there are currently cost-effective and technically simple solutions, such as switching to LEDs, which make it possible to achieve these savings and facilitate the wider implementation of this action within the stock.

This high level of implementation, however, may mean that the savings potential of this intervention will be exhausted by the end of the period 2020-2030. The savings targets that may need to be met in these installations after that date will depend on additional interventions that, although simple to implement, do not offer such high levels of savings.

For this measure, it is feasible to increase the level of intervention with solutions that are easily integrated into the proposal. In this case, the savings per intervention would rise by between 10% and 15%, depending on the type, and the level of intervention would fall to 1.3%.

9.4.3. Base Scenario. Public Sector.

9.4.3.1. Central State Administration. Base Scenario.

In this case, as the PNIEC measure, like Article 5 of Directive 2012/27/EU, marks the global nature, at energy level, of the interventions on buildings and greater savings requirements, actions are considered that contemplate simultaneous interventions on multiple aspects. The consumption levels shown below are for the installations affected by all aspects covered by the intervention and the savings percentages refer to the savings on the affected system. The savings levels correspond to deep interventions which, as indicated, cover several aspects simultaneously:

Figure 9.7. Savings data per installation of the deep intervention proposed for the base scenario.

Savings the intervention selected	Heating	Cooling	DHW	Lighting
Offices	68%	33%	70%	60%
Hospitals	65%	34%	70%	55%
Trade	68%	33%	70%	65%
Prison/CSR	65%	34%	70%	65%
Education	68%	33%	70%	60%
Other uses	64%	33%	70%	60%

Source: MITMA based on ATECYR data.

The following table shows the trend of the consumption of heating, cooling, DHW and lighting installations (EPBD) for the different types of buildings of the Central State Administration in the base scenario for a deep intervention.

Figure 9.8. Disaggregated data for the base scenario for interventions on buildings of the Central State Administration.

(GWh)	EPBD consumption	Action %	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Offices	299	4%	292	285	278	272	265	259	253	247	241	236
Hospitals	0.2	4%	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
Trade	0	4%	0	0	0	0	0	0	0	0	0	0
Prison/CSR	235	4%	229	223	217	212	206	201	196	191	186	181
Education	27	4%	26	25	25	24	23	23	22	22	21	21
Other uses	7	4%	7	7	6	6	6	6	6	6	5	5
Total	568		554	540	527	514	501	489	477	465	454	442

Cumulative saving of the base scenario 717

PNIEC Target 701

Source: MITMA based on MITERD, MPTFP, MSCBS, MEFP, ELP 2050, IDAE, A3E, ATECYR.

In the public sector, added to the baseline savings produced for the reasons mentioned above in the case of the private sector is the obligation, in accordance with Article 5 of Directive 2012/27/EU, for 3% of the total floor area of heated and/or cooled buildings owned and occupied by the Central State Administration to be renovated each year to ensure the buildings meet the energy performance requirements of the legislation in force. The measure proposed for the Central State Administration is therefore incremental to the 3% required by Directive 2012/27/EU. This high level of intervention on the stock is combined with a high level of action on each building, which is necessary to achieve the energy efficiency required by current legislation. This, together with the actions previously carried out to comply with Article 5 of Directive 2012/27/EU will mean that by the end of the 2020-2030 period, with deep interventions having been carried out on almost the entire building stock of the Central State Administration that could be improved, this building stock will be close to exhausting its savings potential. After that date, increases in savings, in addition to being smaller, would need to be achieved through alternative actions or by increasing the efficiency of the building stock beyond the regulatory minimum.

In this case, if the special characteristics of prison/CSR buildings and the difficulty of carrying out the proposed interventions in them were taken into account, the level of intervention for this type could be shifted to office buildings. Actions on office buildings accounting for 6% of consumption and 2% in the case of prison/CSR buildings would result in a similar consumption trend and cumulative savings as shown in the foregoing table.

The differences in the savings potential by building use do not have a great influence, as the types available to the Central State Administration within its building stock have a similar potential. Other, less comprehensive actions would be possible, but the scenario would become very demanding in term of the volume of interventions on the building stock.

9.4.3.2. Autonomous Communities and Local Administration. Base Scenario.

As in the previous case, as the PNIEC establishes measures that assume interventions on the building as a whole, at energy level, the consumption levels and savings shown are for the installations affected by all aspects covered by the intervention and the savings percentages refer to the savings on the affected system.

The following table shows the trend of the consumption of heating, cooling, DHW and lighting installations (EPBD) for the different types of buildings of the Autonomous Communities and Local Administration in the base scenario.

Figure 9.9. Disaggregated data for the base scenario for interventions on buildings of the Autonomous Communities and Local Administration.

(GWh)	EPBD consumption	Action %	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Offices	643	1%	640	636	632	628	625	621	617	614	610	606
Hospitals	6599	2.4%	6496	6395	6296	6198	6102	6008	5915	5823	5733	5644
Trade	0.0	1%	0	0	0	0	0	0	0	0	0	0
Hospitality	0.0	1%	0	0	0	0	0	0	0	0	0	0
Education	3004	2.4%	2 957	2 911	2 866	2 822	2 778	2 736	2 693	2 652	2 611	2 571
Other uses	15	1%	15	15	14	14	14	14	14	14	14	14
Total	10260		10 108	9 957	9 809	9 663	9 520	9 378	9 239	9 102	8 967	8 835

Cumulative saving of the base scenario 8027

PNIEC Target 7924

Source: MITMA based on MITERD, MPTFP, MSCBS, MEFP, ELP 2050, IDAE, A3E, ATECYR.

The conditions imposed on this sector in this scenario require to performance of interventions of a similar depth to those selected for the Central State Administration, without it being necessary, in this case, to reach such high levels of intervention on the building stock.

A specific characteristic of this sector is that two types, hospital and educational buildings, account for most of the consumption and are also the buildings with the greatest savings potential. In addition, the decision-making power regarding such buildings in the public sector is often concentrated, which facilitates decision-making and the promotion of interventions in several buildings in a coordinated manner. For this reason, the scenario promotes intervention in these two types, in line with current European policies, assigning them a higher action percentage.

For this measure, it is feasible to decrease the level of intervention per building, though in this case it is necessary to increase the intervention percentage for the building stock. For a less comprehensive intervention involving savings of 6% for heating, 14% for cooling, 20% for DHW and 10% for lighting, compared to those shown in the table, it would be necessary to increase the intervention for the hospital and educational building stock to 3%, while keeping the rest at 1%.

9.5. SUMMARY. BASE SCENARIO. PUBLIC AND PRIVATE SECTOR.

The following tables show the overall savings and consumption data for the EPBD services in the base scenario resulting from the partial measures seen above.

Figure 9.10 Cumulative and total annual savings of the base scenario for buildings in the tertiary sector, 2020-2030.

(GWh)	Action %	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	Total
Private sector - Lighting	1.6%	132	263	393	522	650	776	902	1027	1151	1274	7089
Private sector - Thermal installation	0.1%	11	23	34	46	57	68	80	91	102	114	625
Private sector - thermal envelope	0.1%	5	11	16	22	27	32	38	43	49	54	297
Central State Administration - Global intervention	4.0%	14	28	41	54	67	79	91	103	114	125	717
Autonomous Communities and Local Administration - Global intervention	1/2.4%	153	303	451	597	741	882	1021	1158	1293	1426	8027
Total		316	628	936	1240	1541	1839	2132	2422	2709	2993	16756

PNIEC Target 16 035

Source: MITMA based on MITERD, MPTFP, MSCBS, MEFP, ELP 2050, IDAE, A3E, ATECYR.

Figure 9.11. Annual consumption by type in the base scenario for buildings in the tertiary sector, 2020-2030.

(GWh)	Consumption 2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Offices	20 067	20 015	19 963	19 912	19 862	19 812	19 762	19 713	19 664	19 616	19 568
Hospitals	8 252	8 148	8 046	7 945	7 846	7 749	7 653	7 558	7 465	7 374	7 284
Trade	28 752	28 672	28 593	28 514	28 436	28 358	28 281	28 205	28 129	28 054	27 979
Hospitality	5 899	5 887	5 875	5 863	5 852	5 840	5 829	5 818	5 808	5 797	5 787
Education	5 088	5 037	4 987	4 937	4 889	4 841	4 793	4 747	4 701	4 656	4 612
Other uses	12 288	12 271	12 255	12 238	12 221	12 205	12 188	12 172	12 156	12 140	12 124
Base scenario	80 030	79 718	79 410	79 106	78 805	78 507	78 214	77 923	77 637	77 353	
PNIEC Target	80 054	79 762	79 470	79 178	78 886	78 594	78 303	78 011	77 719	77 427	

Source: MITMA based on MITERD, MPTFP, MSCBS, MEFP, ELP 2050, IDAE, A3E, ATECYR.

Based on the 2030 consumption values of the LTS 2050 (Long-term Strategy for a Modern, Competitive and Climate-Neutral Spanish Economy in 2050) Target Scenario, the base scenario is extended to 2050. As mentioned above, there are measures that have little room for development in 2030, such as those concerning lighting, but there is still potential in actions on the envelope and air conditioning systems. For this reason, global intervention measures are proposed which, given that the building stock of the Central State Administration has had its savings margin reduced by many of the previous interventions being focused on it and that the Administration already has a high level of intervention, should be concentrated in the private sector. It is foreseeable that technological advances and the impetus provided by the actions prior to energy rehabilitation will, from 2030 onwards, facilitate the implementation of deep intervention measures in the private sector, equal to those adopted up to 2030 for the buildings of the Administration. Therefore, in this scenario it is proposed to retain the deep intervention, the savings per installation of which are specified above, for the entire building stock.

9.6. BASE SCENARIO. TERTIARY SECTOR. 2030-2050.

Based on these assumptions, the following table shows the trend for consumption in the period 2030 to 2050 and the values of the LTS 2050 Target Scenario.

Figure 9.11. Annual consumption by type in the base scenario for buildings in the tertiary sector, 2030-2050.

(GWh)	Consumption, LTS 2030	Action %	2035	% act.	2040	% act.	2045	% act.	2050
Offices	16 380	5.7%	13 429	6.1%	10 854	4.3%	9 351	1.6%	8 851
Hospitals	6 097	5.7%	5050	6.1%	4127	4.3%	3582	1.6%	3400
Trade	23 421	5.7%	19 202	6.1%	15 520	4.3%	13 370	1.6%	12 655
Hospitality	4 844	5.7%	4 012	6.1%	3 279	4.3%	2 846	1.6%	2 701
Education	3 860	5.7%	3165	6.1%	2558	4.3%	2204	1.6%	2086
Other uses	10 149	5.7%	8427	6.1%	6905	4.3%	6006	1.6%	5704
		Base scenario	53 285		43 243		37 359		35 398
		LTS 2050 target	53 413		43 358		37 441		35 459

Source: MITMA based on MITERD, MPTFP, MSCBS, MEFP, ELP 2050, IDAE, A3E, ATECYR.

The data reflect the savings needed to meet the target scenario without deducting the baseline savings; therefore, not all the actions reflected in the tables have to be driven by actions to promote energy renovation and it is expected that from 2030 the target scenario will be close to the baseline scenario. The actions should therefore solely balance the target scenario to the extent that the baseline scenario strays from it. In any event, the scenario shows that from 2030 onwards, the effort put into implementation of energy renovation will need to be increased significantly, even taking into consideration technological progress of construction systems and equipment and the consequent increase in savings in the proposed actions. In this situation, it is essential to promote savings in a baseline scenario that the previous actions and the technological advances indicated above can promote.

9.7. IMPROVED SCENARIO. PUBLIC AND PRIVATE SECTOR.

An improved scenario is presented that reduces the consumptions of the base scenario in the years 2030 and 2050. This scenario may require additional actions to promote renovation, but allows for savings to be brought forward, achieving a 7% reduction in consumption in 2030 and an 8% reduction in 2050, compared to the base scenario.

The scenario envisages an increase in the depth of the interventions on the private sector building stock in the period 2020-2030 without increasing the intervention volume. The already high level of intervention on the building stock of the public administrations in the base scenario is maintained.

The scenario for the private sector would be as follows:

Figure 9.12 Annual consumption by type in the improved scenario for buildings in the private sector in the period 2020-2030.

(GWh)	Consumption EPDB	Action %	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Offices	19 125	1.6%	18 943	18 764	18 586	18 410	18 236	18 063	17 893	17 724	17 556	17 390
Hospitals	1 653	1.6%	1 636	1 619	1 602	1 586	1 569	1 553	1 537	1 521	1 505	1 490
Trade	28 752	1.6%	28 457	28 166	27 878	27 593	27 310	27 031	26 755	26 481	26 211	25 943
Hospitality	5 664	1.6%	5 605	5 546	5 489	5 432	5 375	5 319	5 264	5 209	5 155	5 102
Education	2 058	1.6%	2 036	2 015	1 995	1 974	1 954	1 933	1 914	1 894	1 874	1 855
Other uses	12 267	1.6%	12 144	12 023	11 902	11 784	11 666	11 549	11 434	11 320	11 207	11 095
Total	69 518		68 822	68 133	67 452	66 778	66 110	65 450	64 796	64 149	63 509	62 876

Source: MITMA based on MITERD, MPTFP, MSCBS, MEFP, ELP 2050, IDAE, A3E, ATECYR.

The following tables show the overall savings and consumption data for the EPBD services for 2020 to 2030 in the improved scenario, resulting from the scenario for the private sector seen previously and the base scenario for the Administration sector.

Figure 9.13 Cumulative and total annual savings of the improved scenario for buildings in the tertiary sector, 2020-2030.

(GWh)	Action %	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	Total
Private sector - Global intervention	1.6%	696	1 384	2 066	2 740	3 407	4 068	4 721	5 368	6 009	6 642	37 101
Central State Administration - Global intervention	4.0%	14	28	41	54	67	79	91	103	114	125	717
Autonomous Communities and Local Administration - Global intervention	1/2.4%	153	303	451	597	741	882	1 021	1 158	1 293	1 426	8 027
Total		863	1 715	2 558	3 391	4 215	5 029	5 834	6 630	7 416	8 193	45 845
											Base scenario	16 756

Source: MITMA based on MITERD, MPTFP, MSCBS, MEFP, ELP 2050, IDAE, A3E, ATECYR.

Figure 9.14. Annual consumption by type in the improved scenario for buildings in the tertiary sector, 2020-2030.

(GWh)	Consumption 2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Offices	20 067	19 875	19 685	19 496	19 310	19 126	18 943	18 763	18 584	18 407	18 232
Hospitals	8 252	8 132	8 015	7 899	7 784	7 672	7 561	7 452	7 344	7 238	7 134
Trade	28 752	28 457	28 166	27 878	27 593	27 310	27 031	26 755	26 481	26 211	25 943
Hospitality	5 899	5 834	5 770	5 706	5 643	5 581	5 520	5 460	5 400	5 341	5 283
Education	5 088	5 019	4 952	4 886	4 820	4 755	4 692	4 629	4 567	4 506	4 446
Other uses	12 288	12 165	12 044	11 923	11 804	11 686	11 569	11 454	11 340	11 226	11 115
	Improved scenario	79 483	78 631	77 788	76 954	76 131	75 317	74 512	73 716	72 930	72 152
	Base scenario	80 030	79 718	79 410	79 106	78 805	78 507	78 214	77 923	77 637	77 353

Source: MITMA.

In the improved scenario, the additional contributions of the private sector to the saving amount to a reduction of 6.7% of final energy consumption in EPBD uses in 2030.

As done previously for the base scenario and based on the same assumptions, using the 2030 consumption values of the LTS 2050 Target Scenario, the base scenario is extended to 2050. The reductions in consumption achieved up to 2030 translate into the 2030 consumption value of the LTS 2050 Target Scenario. As in the base scenario, a deep intervention is proposed covering several aspects simultaneously with the savings already specified. The following table shows the trend for consumption in the period 2030 to 2050.

Figure 9.15. Annual consumption by type in the improved scenario for buildings in the tertiary sector, 2030-2050.

(GWh)	Consumption, LTS 2030	Action %	Saving	2035	% act.	Saving	2040	% act.	Saving	2045	% act.	Saving	2050
Offices	15 048	4.1%	45%	12 337	7.7%	45%	9 972	5.6%	45%	8 590	2.1%	55%	8 131
Hospitals	5 888	4.1%	55%	4 877	7.7%	55%	3 985	5.6%	55%	3 459	2.1%	65%	3 284
Trade	21 412	4.1%	55%	17 555	7.7%	55%	14 189	5.6%	55%	12 223	2.1%	65%	11 570
Hospitality	4 360	4.1%	45%	3 611	7.7%	45%	2 951	5.6%	45%	2 562	2.1%	55%	2 431
Education	3 670	4.1%	55%	3 009	7.7%	55%	2 432	5.6%	55%	2 095	2.1%	65%	1 983
Other uses	9 173	4.1%	40%	7 617	7.7%	40%	6 242	5.6%	40%	5 428	2.1%	50%	5 156

	2035		2040		2045		2050
Improved scenario	49 006		39 770		34 358		32 555
Base scenario	53 401		43 282		37 338		35 420
LTS 2050 target scenario							35 459

Source: MITMA based on MITERD, MPTFP, MSCBS, MEFP, ELP 2050, IDAE, A3E, ATECYR.

The data show that the cumulative savings prior to 2030 can be sustained until 2050. The increase in savings makes it possible to achieve the consumption target of the LTS 2050 Target Scenario before 2045 and represents a reduction in consumption in 2050 of 8%, compared to the base scenario. In contrast, the scenario is based on the promotion of energy renovation in the private sector in the earliest period; therefore, in this scenario, additional promotion actions might be necessary, and it is also necessary to maintain the high percentages of action on the stock and the level of interventions of the base scenario for the period 2030-2050.

9.8. MACROECONOMIC IMPACT OF THE RENOVATION SCENARIOS.

This section analyses the socio-economic impact of a policy or scenario that includes renovation of the thermal envelope and the replacement of thermal installations in the residential sector in the period 2021-2030.

9.8.1. Methodology

The ERESEEE economic impact analysis has been carried out by the Basque Centre for Climate Change (BC3)[167] for MITMA. The DENIO economic model, which has also been used in the analysis of the impacts of the 2021-2030 PNIEC and the features of which are explained in Annex A.7, has been used.

DENIO is a Dynamic Econometric Input-Output model for the Spanish economy, which has its origin in the FIDELIO model of the Joint Research Centre (JRC) of the European Commission. The model has been developed by the Basque Centre for Climate Change (BC3) in collaboration with the Centre of Economic Scenario Analysis and Research (CESAR). This model makes it possible to simulate the effect of a wide range of economic, fiscal, energy or environmental policies. In addition, the model has been estimated econometrically using the latest available data from the Spanish National Statistics Institute (*Instituto Nacional de Estadística* - INE), Banco de España and EUROSTAT.

The DENIO model includes cross-sectoral information on 88 sectors, as well as the expenditure and income of 22 000 households representing all Spanish households, according to different socio-demographic characteristics (income level, size, composition, etc.). The model also includes detailed public sector accounts, including the income and expenditure of the Public Administrations, together with deficit and public debt.

Additionally, the model makes it possible to determine the energy saving generated by the energy renovation actions on buildings in the residential sector. For this purpose, the baseline scenario (PNIEC scenario without a renovation policy for the residential sector) has been compared with the scenario in which the energy renovation actions are carried out on dwellings (PNIEC scenario with a renovation policy). In this way, the economic impacts

[167]Basque Centre for Climate Change (BC3) (2020): *Impacto económico de la rehabilitación energética de viviendas en España en el periodo 2021-2030*
https://www.mitma.gob.es/el-ministerio/planes-estrategicos/estrategia-a-largo-plazo-para-la-rehabilitacion-energetica-enel-sector-de-la-edificacion-en-espana

are made on the basis of a concrete PNIEC compliance pathway. The changes from one scenario to the other are the economic impact results presented below.

9.8.2. Scenario analysed in DENIO.

The scenario entered into the DENIO model aims to reflect the scenario referred to in the previous sections as Scenario C or the Base Scenario as closely as possible. The data entered into DENIO includes information on the number of dwellings renovated in the period 2021-2030, the type of renovation, the additional investments needed to undertake the renovation, the percentage of public aid and the distribution of public aid by household type. Given that, due to the requirements of DENIO, the presentation of the data is slightly different[168] from the data previously presented in Scenario C or the Base Scenario, they are shown below:

Total investments in both actions amount to €27 123 000 000, of which public funding would cover €7 307 000 000, €4 833 000 000 would come from state funds and €2 474 000 000 would come from European funds.

The number of actions on the thermal envelope of buildings in the residential sector is increasing over the period, starting at 30 000 dwellings renovated in 2021 and rising to over 300 000 in 2030. The total number is 1 200 079 dwellings, which would represent an investment of €15 560 000 000. Public investment for this action would amount to one third of the total amount invested, €4 995 000 000, two thirds of which would come from the General State Budget (€3 330 000 000) with the other third coming from other funds (€1 665 000 000).

Figure 9.16: Investments in renovation of the thermal envelope by origin in the period 2021-2030.

	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	Total
Number of dwellings renovated (in thousands)	30	35	40	45	50	100	150	200	250	300	1 200
Investments (in millions of €)	389	454	519	583	648	1 297	1 945	2 593	3 241	3 891	15 560
Total aid (in millions of €)	125	146	166	187	208	416	624	832	1 040	1 249	4 995
Public Administration aid (In millions of €)	83	97	111	125	139	277	416	555	694	833	3 330
European Aid (ERDF) (in millions of €)	42	49	55	62	69	139	208	277	347	416	1 665

Source: Basque Centre for Climate Change (BC3) for MITMA.

In contrast, replacements of thermal installations with more efficient ones represents intervention on 384 529 installations annually. The total number of interventions over the entire period is 3 845 288, which would represent an investment of €11 563 000 000. Public aid would cover one fifth of the total amount invested (€2 313 000 000), 13% of the amount invested would come from the General State Budget (€1 503 000 000) with 7% coming from other funds (€809 000 000).

[168] In particular, baseline investments (in installations), which have been presented in aggregated format in Scenario C or the Base Scenario, form part of the DENIO baseline model, which explains the differences between figures.

Figure 9.17: Investments in the replacement of thermal installations by origin in the period 2021-2030.

	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	Total
Number of inst. replaced (in thousands)	385	385	385	385	385	385	385	385	385	385	3 845
Investments (in millions of €)	1 156	1 156	1 156	1 156	1 156	1 156	1 156	1 156	1 156	1 156	11 563
Total aid (in millions of €)	231	231	231	231	231	231	231	231	231	231	2 313
Public Administration aid (In millions of €)	150	150	150	150	150	150	150	150	150	150	1 503
European Aid (ERDF) (in millions of €)	81	81	81	81	81	81	81	81	81	81	809

Source: Basque Centre for Climate Change (BC3) for MITMA.

The figure below shows the energy savings due to the all of the energy renovation actions. These savings amount to 1 454 ktoe in 2030, 961 ktoe of which is due to the replacement of thermal installations and 493 ktoe of which is due to the renovation of the thermal envelope. This would mean a total cumulative saving of 6 949 ktoe over the entire period, 1 665 ktoe from renovation of the thermal envelope and 5 285 ktoe from the replacement of thermal installations. The ratio of ktoe saved per million of euro invested is higher for the replacement of thermal installations (0.083 ktoe/million €) than for the renovation of the thermal envelope (0.032 ktoe/million €).

Figure 9.18: Energy saving per vector in households (ktoe) in the period 2021-2030.

	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	Total
Electricity	3	5	8	11	14	18	23	28	34	41	187
Gas	13	27	41	56	72	95	125	163	208	260	1 059
Fuel oil	34	68	103	139	175	215	261	311	367	427	2 100
Biomass	59	119	179	240	302	372	449	533	626	726	3 604
TOTAL	108	219	331	446	563	700	858	1 036	1 235	1 454	6 949

Source: Basque Centre for Climate Change (BC3) for MITMA.

9.8.3. Results.

To analyse the economic impact of the energy renovation policy for buildings in the residential sector, the baseline scenario (PNIEC scenario without a renovation policy for the residential sector) has been compared with the scenario from the previous section in which the energy renovation actions are carried out on dwellings (PNIEC scenario with a renovation policy). In this way, the economic impacts are made on the basis of a concrete PNIEC compliance pathway. The changes from one scenario to the other are the economic impact results presented below.

a) Impact on Household Energy Bills.

Savings on energy bills due to the joint effect of the renovation of the thermal envelope and the replacement of the thermal installations with more efficient ones would amount to a total of €1 575 000 000 in 2030, which would imply a cumulative saving of €7 206 000 000 over the whole period.

The replacement of the thermal installations alone would result in energy bill savings of €1 014 000 000 in 2030 and cumulative savings of €5 361 000 000 over the ten years. In addition, renovation on the thermal envelope would result in a bill saving of €561 000 000 in 2030 and cumulative savings of €1 845 000 000 (see table below).

Figure 9.19: Household energy bill saving (millions of €) in the period 2021-2030.

	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	Total
Renovation Thermal Envelope	12	26	43	64	88	134	203	297	416	561	1 845
Replacement of Thermal Installations	85	175	271	372	480	582	686	793	902	1 014	5 361
TOTAL	97	201	314	436	568	716	890	1 090	1 318	1 575	7 206

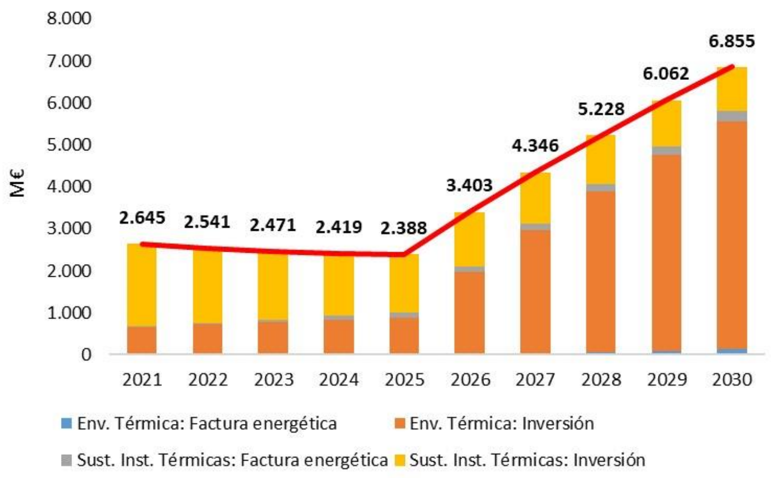
Source: Basque Centre for Climate Change (BC3) for MITMA.

b) Impact on GDP and Employment.

The figure below shows the effect of the policy of energy renovation on buildings in the residential sector on Spanish GDP. The impact on the economy is positive over the whole period, generating an economic boost of between €2 388 000 000 and €6 855 000 000 between 2021 and 2030, which would represent an additional contribution of 0.47% to Spanish GDP in 2030.

This positive effect would be generated in the first half of the period by the investments made due to the replacement of thermal installations and, as the period progresses, so does the effect of investments in the renovation of the thermal envelope. The effect of energy savings has a small but positive impact on the economy[169].

Figure 9.20: Variation in GDP (millions of €) in the period 2021-2030.



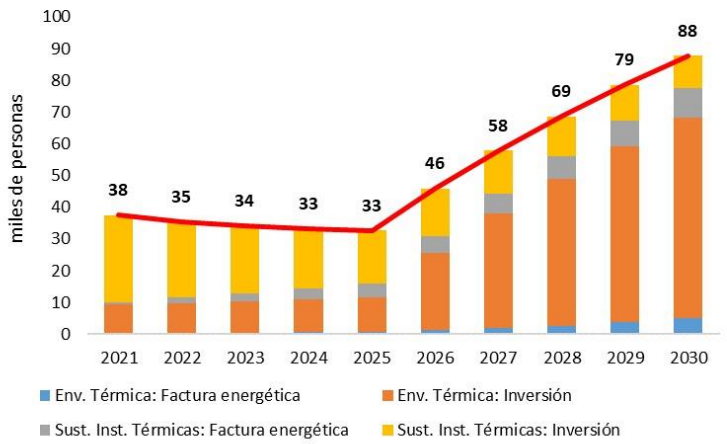
	Thermal Envelope: Energy bill
	Repl. Thermal Inst: Energy bill
	Thermal Envelope: Investment
	Repl. Thermal Inst: Investment
	1 000
	Millions of euro

Source: Basque Centre for Climate Change (BC3) for MITMA.

The effect on employment is also positive over the whole period (see figure below). Between 33 000 and 88 000 new jobs would be created between 2021 and 2030. The positive effect on employment would be generated by the investments made due to the replacement of thermal installations in the first half of the decade and, as the period progresses, so does the effect of investments in the renovation of the thermal envelope. The effect of the energy saving is positive and becomes more noticeable as the period progresses.

Figure 9.21: Variation in employment (thousands of persons) in the period 2021-2030.

[169]It has been assumed that 100% of the energy bill savings generated by energy efficiency improvements of households are spent on other items.



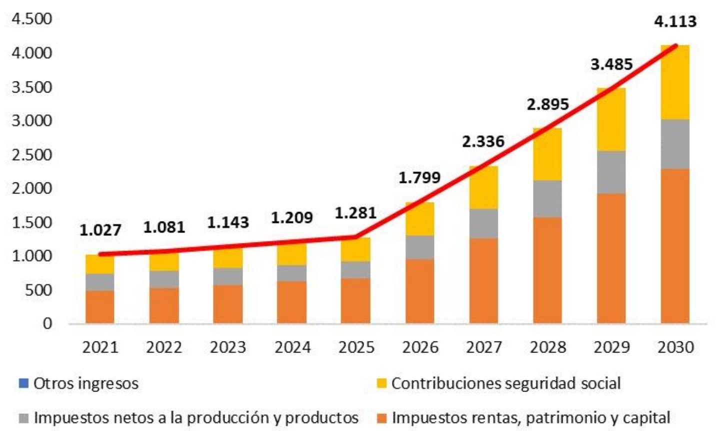
	Thermal Envelope: Energy bill
	Repl. Thermal Inst: Energy bill
	Thermal Envelope: Investment
	Repl. Thermal Inst: Investment
	1 000
	thousands of persons

Source: Basque Centre for Climate Change (BC3) for MITMA.

c) Impact on the Accounts of Public Administrations.

The figure below shows the impact on the revenue side of the accounts of Public Administrations. The net effects on revenue collection are positive throughout the whole period. In this sense, although revenues from some taxes, such as energy taxes, would be reduced, they would be more than compensated by increased revenues from other taxes. In particular, taxes on income, wealth and capital would increase by between €495 000 000 and €2 295 000 000 and social security contributions would rise by between €278 000 000 and €1 087 000 000 over the whole decade.

Figure 9.22: Impact on the accounts of Public Administrations in the period 2021-2030 (revenue), in millions of €.

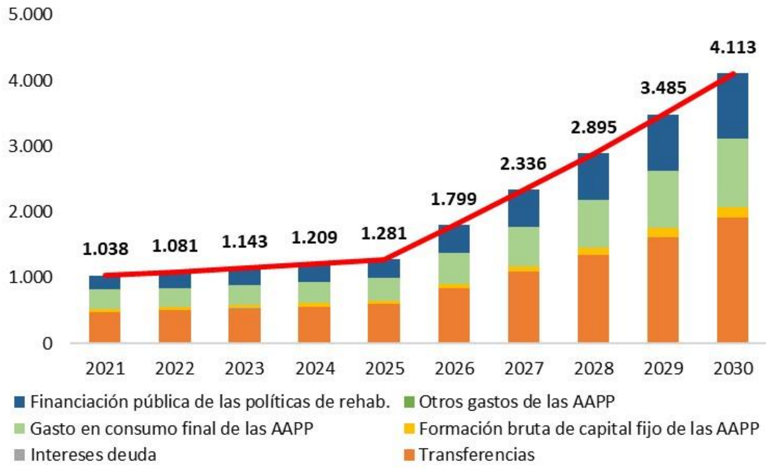


	Other revenue
	Net taxes on production and products
	Social security contributions
	Taxes on income, wealth and capital

Source: Basque Centre for Climate Change (BC3) for MITMA.

The following table shows the variation in public expenditure. The revenue of Public Administrations would comfortably cover the public funding for energy renovation policies, which is €4 833 000 000 during the whole period 2021-2030. The rest of the tax revenue, around €15 548 000 000, could be used for other purposes and expenses of the Public Administrations. It is important to note that the increase in public expenditure is exclusively the result of the economic impact of the thermal envelope renovation policy, as it has been assumed that public aid for renovation is offset by a reduction in other items[170].

Figure 9.23: Impact on the accounts of Public Administrations in the period 2021-2030 (expenditure), in millions of €.



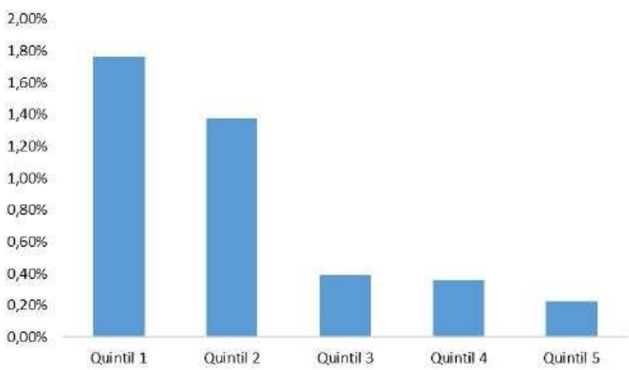
	Public funding of renovation policies
	Final consumption expenditure of Public Administrations
	Interest on debt
	Other Public Administration expenditure
	Public Administration gross fixed capital formation
	Transfers

Source: Basque Centre for Climate Change (BC3) for MITMA.

d) Redistributive Effects of the Target Scenario.

The figure below shows the effect on household disposable income by income quintile in 2030, with quintile 1 grouping together the 20% of households with the lowest incomes and quintile 5 grouping together the 20% with the highest incomes. It is noted that the renovation of dwellings would have a progressive effect[171]. Disposable income would increase in all quintiles, but would increase more in the lowest income quintiles, by 1.76% for quintile 1 and 1.38% for quintile 2.

Figure 9.24: Variation in household disposable income by income quintile in 2030.



[170]The modelling has been carried out under the assumption of the existence of a balanced budget between the revenue and expenditure of the Public Administration in order to simplify the analysis.

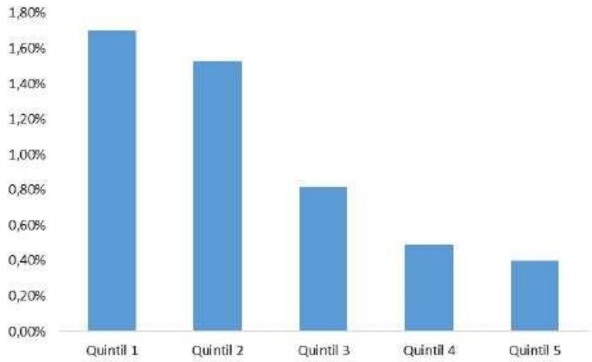
[171]The study assumes that the beneficiaries of renovation aid will be concentrated mainly in lower income households, in line with policies against energy poverty.

	Quintile 2
	0.00%

Source: Basque Centre for Climate Change (BC3) for MITMA.

The following figure shows the effect on final household consumption expenditure by income quintile in 2030. It can be seen that expenditure would increase in all quintiles, but would increase more in the lowest income quintiles, by 1.70% for quintile 1 and 1.52% for quintile 2.

Figure 9.25: Variation in final household consumption by income quintile in 2030.



	Quintile 2
	0.00%

Source: Basque Centre for Climate Change (BC3) for MITMA.

e) Summary of Economic Impacts.

In view of the results presented in the previous sections, it can be concluded that the policy analysed in this report on thermal envelope renovation and replacement of thermal installations would have a very positive socio-economic impact if it were able to mobilise the envisaged private investment.

In summary:

- Investment. The policy foresees the renovation of the thermal envelope of a total of 1 200 079 dwellings and the replacement of 3 845 288 thermal installations, which would require an investment of €27 122 000 000 over the decade, of which 27% (€7 307 000 000) would come from public funds (state and European).
- Energy Saving. The total cumulative energy saving would amount to 6 949 ktoe, which would mean a cumulative saving of €7 206 000 000 on household energy bills. Moreover, this saving will continue beyond the period analysed here.
- GDP. The economic impact in terms of GDP would be between €2 645 000 000 and €6 855 000 000 over the period, which would represent an increase of 0.47% of projected GDP in 2030.
- Employment. The policy would generate between 33 000 and 88 000 jobs over the period, which would represent an increase of 0.44% of projected employment in 2030.
- Public Administrations. The net impact on the accounts of Public Administrations is positive. Revenues would increase by between €1 027 000 and €4 113 000 000 per year over the period, which would make it possible to comfortably cover the public expenditure needed to finance the policy1, which is between €219 000 000 and €1 000 000 000 per year.
- Distributive impact. The policy would tend to have a progressive impact. Disposable income increases in all household types, but it increases more in the lowest income households (it increases by 1.7% for households in income quintile 1 and 1.52% for households in income quintile 2, for 2030).

9.9. LONG-TERM IMPACT AND BENEFITS: IMPACT OF ENERGY RENOVATION IN DWELLINGS ON AIR QUALITY, CONDENSATION AND HUMAN HEALTH.

As stated in the report *Estimación del efecto de la rehabilitación energética en la salud de las personas*, by Joana Ortiz and Jaume Salom (2016, IREC)[172], the relationship between health and housing is well established and there are numerous studies that demonstrate that poor housing conditions cause health problems; however, the relationship between health and energy efficiency needs to be explored further and more studies are needed to determine its effect clearly and for each of the problems that can occur in dwellings, such as problems relating to noise, air quality, etc.

There is a general consensus that energy renovation improves indoor comfort conditions, reducing the amount of time that the user is exposed to inappropriate temperatures in winter or summer, the problems of condensation or humidity inside the façades and the noise levels to which they are exposed. At the same time, energy renovation leads to a reduction in energy consumption and, in the case of equipment replacement, it can lead to a change in the energy source used to meet the air conditioning and DHW production needs, incorporating renewable sources.

This section contains a brief examination, based on a bibliographical review on the aspects related to the impact of energy renovation on the healthiness of dwellings, i.e.:

- impact on indoor air quality;
- impact on condensation;
- impact on general state of health.

9.9.1. Impact of Energy Renovation on Indoor Air Quality.

A comprehensive energy renovation usually involves the replacement of external joinery with less air-permeable joinery, together with other interventions that increase the air tightness of the thermal envelope. Although this is beneficial from an energy saving point of view, it may not be beneficial from the point of view of indoor air quality, which may deteriorate.

In general, the ventilation of existing housing stock, especially if it predates 2006, relies heavily on draughts, together with the extraction of air through shunts and the traditional opening of windows in the mornings or at specific times. Therefore, if before an intervention the ventilation of dwellings was largely based on draughts through the thermal envelope, reducing these after an intervention to improve the joinery may eliminate or reduce this source of outside air. Accordingly, in a comprehensive energy renovation, it is essential to allow air intake with a specific ventilation system that makes up for the elimination of draughts, such as an aerator or micro-ventilation for example. Basic Document DB HS3 of the Technical Building Code establishes the need to introduce one of these intake openings when the air permeability of the joinery is class 2 or higher.

As an example of the impact that energy renovation can have on indoor air quality when the loss of ventilation through draughts is not taken into account, the following recent study is worthy of mention: *Effects of buildings' refurbishment on indoor air quality. Results of a wide survey on radon concentrations before and after energy retrofit interventions* (Luca Pampuria et al.)[173]. This research focused on the analysis of radon as an indoor air pollutant, with the collection and analysis of data from 154 buildings in southern Switzerland by a joint Swiss-Italian team.

Tables 3 and 4 of the article in question are reproduced below. The left-hand table shows the radon concentration values with window replacement (category 1 in the table) and without window replacement (category 2), before and after the intervention; and the right-hand table shows the number of buildings that increased, maintained or decreased their radon concentration.

Figure 9.26. Effects of renovation on Radon gas concentration.

[172] http://www.lacasaqueahorra.org/documentos/estimacionEfectoRehabilitacionSalud.pdf
[173] https://doi.org/10.1016/j.scs.2018.07.007

Table 3. Classification of the energy retrofit interventions by types (involving or not windows replacement).

Category	Types of energy-saving measure	Number of buildings [-]	Mean concentration before energy remediation [Bq/m³]	Mean concentration after energy remediation [Bq/m³]	Increase [Bq/m³]	Increase [%]
1	Energy-saving measures involving the replacement of windows	82	148.4	198.0	49.6	33
2	Energy-saving measures not involving the replacement of windows	72	163.3	180.8	17.5	11
Total/Average		154	155.4	189.9	34.6	22

Table 4. Evaluation of the energy retrofit interventions for evaluating their influence on radon concentrations in terms of increasing or decreasing.

Category	Types of energy saving measure	Number of buildings [-]	Number of buildings with increased radon concentration [-]	Number of buildings with no variation of radon concentration [-]	Number of buildings with decreased radon concentration [-]
1	Energy saving measures involving the replacement of windows	82	59	2	21
2	Energy saving measures not involving the replacement of windows	72	41	0	31
	Total	154	100	2	52

Tables 3 and 4 of the publication: Effects of buildings' refurbishment on indoor air quality. Results of a wide survey on radon concentrations before and after energy retrofit interventions https://doi.org/10.1016/j.scs.2018.07.007

Its conclusions highlight that when performing the energy renovation of a building, the indoor air quality factor should be taken into account, not just energy savings, as well as the possible need to increase ventilation.

9.9.2. Impact of Energy Renovation on Condensation.

In the case of condensation, the situation is similar: as ventilation is reduced, relative humidity can increase and it is very common that after a comprehensive energy renovation in a dwelling, if not taken into account and foreseen, surface condensation problems can arise on the inner side of the thermal envelope.

This supports the conclusion that, in a comprehensive energy renovation, it is essential to allow air intake with a specific ventilation system that makes up for the elimination of draughts, such as an aerator or micro-ventilation for example. Basic Document DB HS3 of the Technical Building Code establishes the need to introduce one of these intake openings when the air permeability of the joinery is class 2 or higher.

9.9.3. Impact of Energy Renovation on General State of Health.

Comprehensive energy renovation also has a positive effect on the number of hours per day in which users of the building maintain thermal comfort conditions, and this can be reflected in their overall health.

The figure below reproduces Table 16 of the cited report by J. Ortiz and J. Salom (2016)[174], showing the number of dwellings in which any of the indicated situations are present before energy renovation (current situation), the impact of energy renovation using the Odds Ratio and its confidence intervals, and the number of dwellings that would have any of these situations if the dwellings were renovated. It can be seen that the number of dwellings in the current situation with a health problem is higher than the number of dwellings if energy renovation had been applied. Looking at the confidence interval (minimum and maximum effect), it is certain that, in the worst case scenario, the current situation would be very similar to the situation after energy renovation. This is due to the fact that the confidence interval of the Odds Ratio is very close to 1. However, its important to note that this phenomenon is not reflected in the self-perceived health indicator, as the situation is better throughout the range.

Figure 9.27. Effects of renovation on human health. Number of dwellings with at least one person with health problems.

[174]This extrapolation of the conclusions should be taken with some caution, as the cited study does not provide specific data on the type of renovation (only passive and active renovation is mentioned, with passive renovation corresponding to envelope intervention and active renovation corresponding to intervention on the heating system) and, therefore, it is not possible to confirm that the hypotheses between this study and the ERESEE are fully consistent.

Número de viviendas		Situación inicial	Odds Ratio	Intervalo confianza	Efecto de la rehabilitación		
					Promedio	Máximo	Mínimo
Salud autopercibida mala o muy mala	25-64	117,640	0.59	0.47-0.74	69,290	54,938	87,407
	>65	113,358			66,768	52,938	84,225
Hipertensión	25-64	292,556	0.77	0.61-0.97	225,268	178,459	284,365
	>65	220,034			169,427	134,221	213,873
Enfermedades cardíacas	25-64	3,399	0.69	0.52-0.92	2,346	1,768	3,114
	>65	10,045			6,931	5,223	9,201

	Number of dwellings
	Initial situation
	Odds Ratio
	Confidence interval
	Effect of the renovation
	Average
	Maximum
	Minimum
	Poor or very poor self-perceived health
	Hypertension
	Heart diseases

Source: Table 16 J. Ortiz and J. Salom (2016) Estimación del efecto de la rehabilitación energética en la salud de las personas.

If we apply[175] the conclusions[176] of the study by J. Ortiz and J. Salom (2016) to the results of the Scenarios proposed in this ERESEE, the following results would be obtained in relation to the beneficial impact on health of renovation:

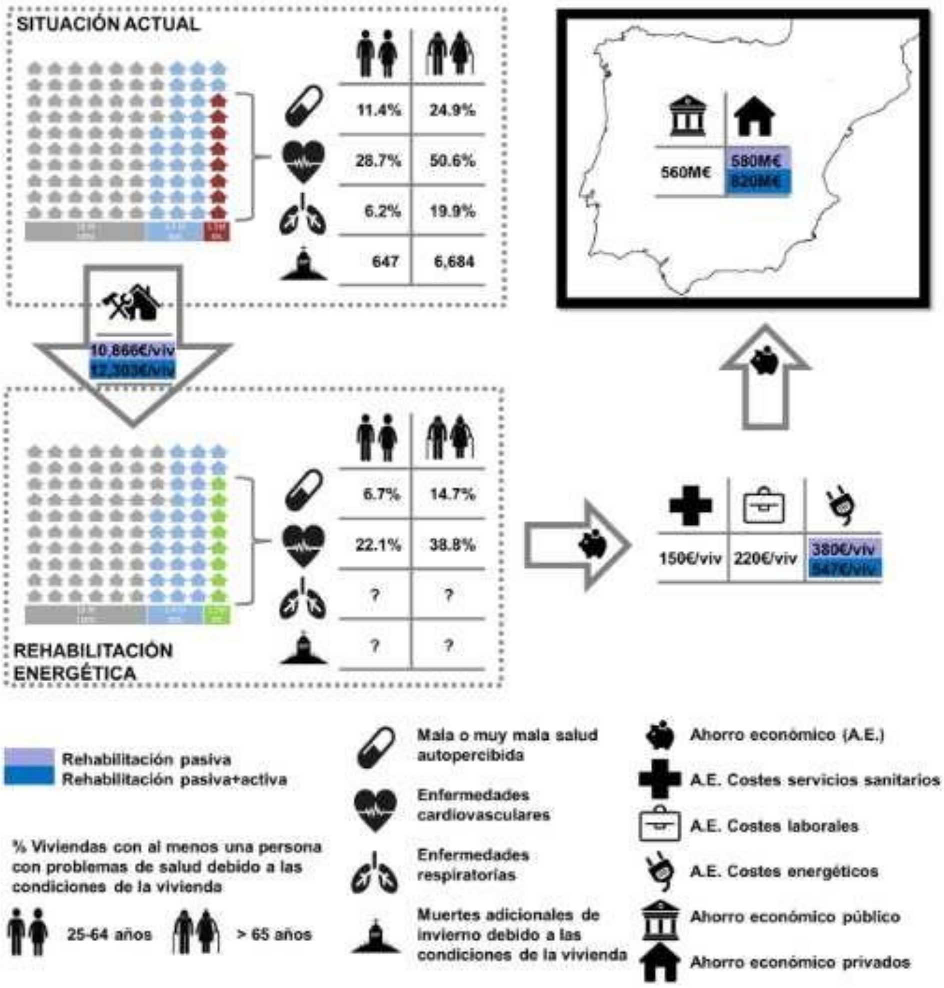
The energy renovation of 1.2 million dwellings would prevent:

- some 80 000 people from perceiving themselves as having poor or very poor health;;
- some 96 000 people would not be diagnosed with cardiovascular problems;
- families could save between €400 and €550 per year on their energy bills, which would virtually halve the total energy costs of the household;
- the Public Administration would save around €370 per dwelling, in health and labour costs.
- It would be possible to reduce the number of additional winter deaths due to cold temperatures in the dwelling, which currently stands at 650 people aged under 65 and around 6 700 people aged over 65.

Figure 9.28. Economic impact of energy renovation from a health and energy point of view.

[175]This extrapolation of the conclusions should be taken with caution, as the study does not provide concrete data on the type of energy renovation and supplementary ventilation measures have not been set out, only passive and active renovation is mentioned, with passive renovation corresponding to envelope intervention and active renovation corresponding to intervention on the heating system.

[176]They have simply been applied proportionally, instead of on 1.5 million dwellings, on the 1.2 million dwellings to be renovated between 2020 and 2030.



	CURRENT SITUATION
	ENERGY
	RENOVATION
	€560 MILLION
	6.7%
	€150/dwelling
	Passive renovation
	Passive+active renovation
	% of dwellings with at least one person with health problems due to the conditions of the dwelling
	Aged 25-64
	Aged > 65
	Poor or very poor self-perceived health
	Cardiovascular diseases
	Respiratory diseases
	Additional winter deaths due to the conditions of the dwelling
	Financial saving (F.S.)
	F.S. Health service costs
	F.S. Labour costs
	F.S. Energy costs
	Public financial saving
	Private financial saving

Passive (purple) and passive + active (blue) renovation. Health problems: poor or very poor self-perceived health, cardiovascular diseases, respiratory diseases, and additional winter death due to cold temperatures in the dwelling (from top to bottom). Financial savings in health, labour and energy and financial savings in the public and private sector (from left to right).

Source: J. Ortiz and J. Salom (2016), Estimación del efecto de la rehabilitación energética en la salud de las personas.

PART III. IMPLEMENTATION.

10. IMPLEMENTATION: MAIN AREAS OF ACTION AND MEASURES PROPOSED MAIN AREAS OF ACTION AND MEASURES.

1. STRUCTURING AREA. PROMOTING SECTORAL, VERTICAL AND HORIZONTAL COORDINATION.

Area 1 Targets: The aim of this area would be the promotion or creation, where appropriate, of the administrative structures needed to develop and promote the ERESEE at national and regional level, arranging the necessary coordination as follows: vertically, between the various Administrations (State, Autonomous Community, municipalities); sectorally, between the various ministerial departments involved; and horizontally, taking into account the key players in the renovation sector and bringing together other existing initiatives. The following actions are proposed to do this:

Measure 1.1. Political leadership and the promotion or creation, where appropriate, of the administrative structures and human resources needed to plan and promote renovation from the Public Administrations.

Approval of a State Pact that provides stability and continuity to the renovation of the building stock and allows its decarbonisation by 2050, with the aim of creating confidence for citizens, as well as for companies and professionals in the renovation sector.

Measure 1.2. Promotion of inter-ministerial coordination on energy renovation (Inter-Ministerial Working Group).

Continuation of the Inter-Ministerial Working Group on energy renovation and efficiency in the building sector, created for the development of the ERESEE, the objective of which is promotion and coordination between ministerial departments in this area, and in particular: the alignment of the successive versions of the ERESEE with the Integrated National Climate and Energy Plan and the Long-term Strategy for a Modern, Competitive and Climate-Neutral Spanish Economy in 2050; the promotion of the different regulatory amendments necessary to eliminate the barriers identified (Measure 5.2); the coordination of existing public financing lines and the design of new ones (Measure 4.1) that allow for an increase in the scale of actions (Measure 8.5); the identification of the changes that the construction sector needs to address in order to switch from new builds to renovation while, at the same time, moving towards its modernisation (Measure 9.2); the analysis of the training needed to reach this process (Measures 9.3 and 9.4); identification of benefits that are directly produced in the health of building users due to the renovation of buildings, as well as other associated indirect benefits, such as a reduction in health expenditure, etc.

Measure 1.3. Promotion of coordination with the Autonomous Communities on energy renovation (Technical Working Group for Working with the Autonomous Communities).

It is necessary to involve the Autonomous Communities in the deployment of renovation, promoting and coordinating the development of Strategies/Plans at Autonomous Community level, specifying the regionalised objectives of the ERESEE. These instruments should be aligned and in synergy with other cross-cutting policies, such as the fight against climate change, depopulation, employment policies, the fight against poverty, etc. and take advantage of existing analytical tools (Measure 11.3). To that end, the creation of a Technical Working Group for Working with the Autonomous Communities is proposed.

Similarly to Measure 1.2, the Autonomous Communities should, within their areas of competence, promote coordination between the sectoral bodies responsible for renovation (of both dwellings and tertiary sector buildings) and energy (Regional Energy Institutes or Agencies).

The development of the Action Plans for the renovation of the public building stock of the Autonomous Communities, including public housing, should also be coordinated (Measures 3.1 and 3.2).

Measure 1.4. Promotion of coordination with the Local Administrations on energy renovation (Technical Working Group for Working with Local Bodies/the Spanish Federation of Municipalities and Provinces - FEMP).

Local Administrations must play a leading role in the implementation of renovation. Within the framework of a Technical Working Group to be established with the collaboration of Local Bodies/FEMP, the creation of a permanent platform for dialogue between municipalities and the exchange of innovative experiences is proposed, together with work on several specific lines of action:

a) The development of local or supra-local Renovation Plans as a medium-term requirement for accessing funding from the State or Autonomous Community. These Renovation Plans must be properly articulated and framed with other instruments such as the Urban Agenda Action Plans, conventional Urban Plans (General Plans, PERIs, etc.) and sectoral instruments (Special Thematic Plans for mobility, infrastructures, Special Plans for the Protection of Historic Sites, etc.). It is proposed to develop a standard methodology based the existing tools such as the Vulnerability Observatory (Vulnerability Atlas and Residential Building Atlas) (Measure 11.3).

In parallel, or in a coordinated manner, a specific Renovation Plan should also be established for buildings owned by the municipality (Measure 3.2).

b) The local Renovation Plans must take a long-term view of urban regeneration and renovation within their areas of competence. They must analyse and plan precisely the type of actions to be carried out, taking into account the characteristics of the buildings and the socio-economic profile of the residents, identifying the areas in which the market can foreseeably act on its own (isolated actions, with private financing or limited public support - Measure 5.3) and the areas where a greater public promotion will be necessary (energy poverty, regeneration of vulnerable neighbourhoods, etc.), identifying the optimal instruments for their development (delimitation of areas, Integrated Urban Regeneration and Renovation Areas, etc.) including, where appropriate, the corresponding urban development instruments.

c) Promotion, reorientation or creation of the administrative structures necessary for the implementation of the Autonomous Community Strategies/Plans and the Local Renovation Plans. Leadership, global vision and joint long-term planning of actions must be the responsibility of the municipalities. It is therefore necessary to create structures such as Renovation Offices/One-Stop Shops to plan, promote, manage and implement actions. In cities, it is necessary to create Offices in the neighbourhoods to be renovated, and, for small municipalities, to establish a network on a regional scale (regional offices, such as in the Autonomous Community of Navarre). Its creation and maintenance over time should be financed over time, as well as the management and social and administrative support teams. (Measure 4.4).

Measure 1.5. Maintenance of a permanent dialogue with stakeholders involved in the sector (Working Group).

As a continuation of the working groups set up for the process of participation in the preparation of the ERESEE, it is proposed to open up a dialogue with stakeholders in the sector involved in the implementation of a series of necessary measures, such as Measures 3.3, 5.2, 8.2, 9.1, 9.2, 9.3 and 9.4.

2. REGULATORY DEVELOPMENT AND ADMINISTRATIVE MEASURES IN FAVOUR OF ENERGY RENOVATION.

Area 2 Targets: This area seeks to promote the development of the existing regulatory framework on renovation, considering the framework of competences, as well as to provide instruments and tools to the municipalities so that they can implement urban renovation, regeneration and renewal actions.

Measure 2.1. Regulatory development and removal of barriers at State level.

In the area of State regulation, the following is proposed:

- Streamlining the procedures and processing of aid.
- Including the construction sector in the Draft Bill on Climate Change and Energy Transition.
- Completing the integration of renovation into the Technical Building Code, with the flexibility criteria that renovation requires.

- Assessing the need to strengthen the role of Homeowners' Associations in the Law on Commonhold Property (with a view to obtaining loans, improving accessibility, performing renovation work in common spaces, etc.) (Measure 8.1).
- Identifying other potential barriers to renovation (banking regulations, energy regulations, etc.) (Measures 5.2, 7.6 and 7).

Measure 2.2. Regulatory development and removal of barriers at Autonomous Community level.

Within the framework of the coordination proposed in Measure 1.3, two main areas of work are proposed:

Incorporation into Autonomous Community legislation and full development of the new features introduced by Law 8/2013, which are now incorporated into the recast text of the Land and Urban Renovation Act (approved via Royal Legislative Decree 7/2015).

- Review of the parameters of the ratio of allocations/increases in density in consolidated areas.
- Streamlining and installation of IT tools for the processing of authorisations, qualifications, subsidies, etc.
- Review of Autonomous Community taxes to promote renovation.
- Work specifically on the situation of the Building Assessment Report (*Informe de Evaluación de Edificios* - IEE) after the Constitutional Court's ruling, which annulled the basic state regulation, delving into:
- The coordination of developments of equivalent instruments at Autonomous Community level.
- Coordination between Administrations of information, IT tools and other instruments to facilitate data exchange.

Measure 2.3. Development of instruments and removal of barriers at local level.

Within the framework of the Technical Working Group for Working with Local Bodies/FEMP (Measure 1.4), the following is proposed:

- The development of local or supra-local Renovation Plans (Measure 1.4).
- The creation of the administrative structures necessary for the implementation of the municipal Renovation Plans (Measures 1.4 and 4.4) or the strengthening of existing ones, if they exist.
- The development of Renovation Plans through Integrated Urban Renewal and Regeneration Areas (Measure 1.4).
- The promotion of measures to simplify and streamline the procedures for granting municipal authorisations, such as building permits, activity licences, etc., establishing homogeneous mechanisms that include, among others, prior notification, simple notification or the classification of renewable energy installations as minor works.
- The promotion of the Building Assessment Report (IEE) or the Building Technical Inspection (ITE) as a triggering instrument (Measure 8.3).
- The review of municipal taxes to promote renovation (Measure 4.3).
- The development of relevant mechanisms (urban gains, energy distributed, etc.) to complement private financing (Measure 5.3).

Measure 2.4. Legal limitation of consumption deemed unnecessary or inappropriate.

Analysis of possible legal instruments to force the elimination of unnecessary or inappropriate consumption, such as:

- The obligation to switch off the lighting of façades, the interior lighting of tertiary buildings, offices and shopping centres after a certain period of time from the closing of the business.

- Establishing limits in the Law on Air Quality and Atmospheric Protection on the emission of pollutants into the atmosphere from the use of fossil fuel-fire heating systems in open spaces that are not covered by the RITE.

Measure 2.5. Promotion of renovation in small municipalities.

The population distribution in Spain is heterogeneous, with several Autonomous Communities characterised by a very large number of very small municipalities that would require specific measures to promote renovation, such as the recovery of buildings that could be used for social rental, which would optimise municipal resources, restore valuable heritage buildings, revitalise the traditional spaces of the municipal urban fabric and, above all, fix the population in rural areas.

Measures of this type require the joint action of the municipality, the Provincial Council (the administration in charge of legal, economic and technical assistance and cooperation with the Municipalities) and the Autonomous and State Administration.

Measure 2.6. Promoting the installation of control and automation systems in the tertiary and industrial sector.

Obligation to install control devices for installations in buildings with more than a certain level of installed power, to enable continuous monitoring and control of the installations, detecting deviations in performance and anticipating maintenance actions with predictive systems. And promotion of the use of these control devices in lower power installations, when the technical and economic conditions for their installation are favourable.

(The approval of Directive (EU) 2018/844 of the European Parliament and of the Council amending Directive 2010/31/EU on the energy performance of buildings made it necessary to transpose into the Spanish legal system the amendments that this Directive introduced concerning new obligations in respect of the automation and control systems of these technical installations. These issues have been introduced in a draft Royal Decree amending the Regulation on Thermal Installations, which is currently being processed).

3. RENOVATION OF PUBLIC ADMINISTRATION BUILDINGS AND OTHER EXEMPLARY MEASURES.

Area 3 Target: Extending the requirement established in Article 5 of Directive 2012/27/EU, according to which 3% of the total floor area of buildings with heating and/or cooling systems owned and occupied by the Central State Administration must be renovated annually, increasing this percentage and extending its application to buildings not included in the inventory. It is also proposed to extend this commitment to the rest of the Public Administrations (Autonomous Communities and Local Bodies), within their respective spheres of competence.

Measure 3.1. Promotion of inter-Administration coordination in relation to the energy renovation of the buildings of the Public Administrations.

It is necessary that the competent administrations (central, regional or local) implement the necessary mechanisms for the coordination of measures for the renovation of the public building stock.

Promoting the development of tools that make it possible to collect, share and report on best practices, forming appropriate communication mechanisms to act as a lever for the dissemination and extension of best practices in the different administrations.

Measure 3.2. Incorporation, within the public administration building stock subject to renovation, of buildings exempt from the obligation set out in Article 5 of the Energy Efficiency Directive but which should be considered in the renovation strategy.

The reference in Article 2a of the Energy Performance of Buildings Directive, which develops the content of the long-term renovation strategy, to Public Administration buildings is broader than the obligation set out in Article 5 of the Energy Efficiency Directive, since, in addition to referring to buildings owned by all administrations, not just central administration, it also refers to buildings that are not occupied by them (rented social housing, or buildings transferred for private use), as well as other buildings that are excluded from the obligation set out in the aforementioned article (e.g. buildings used for defence purposes).

Measure 3.3. Development of Action Plans for each competent Administration (Ministries, Regional Ministries, City Councils, etc.).

The roll-out of renovation of the public building stock of the Administrations should be carried out by means of:

- The preparation of an energy inventory for the building stock, by carrying out an initial diagnosis of the consumption of each building, its construction characteristics, its climatic zone, the age and performance of its installations, etc.
- The preparation of an action plan prioritising the actions with the greatest savings potential.
- The incorporation into the budgets of the corresponding Administration of the necessary financing to undertake the actions.

Renovation plans, specific to each territorial area, should be ambitious and show, through pilot projects, the viability of renewable technologies and alternatives, including collective supply through urban systems or thermal connection between buildings and hybridisation between technologies, which are often difficult to develop in the private sector.

Local strategies should identify the availability of sites for the location of renewable energy collection systems such as solar thermal collectors or geothermal boreholes for collective use by neighbouring buildings, as well as the determination of the conditions (deadlines, economic conditions, responsibilities, etc.) under which these sites could be used by third parties. Incorporating, within the assessment of the potential for residual energy use and renewable energy use, layers that allow for the identification of the available spaces mentioned above and with the location of buildings used by Public Administrations.

Measure 3.4. Development of procurement models and common funding schemes (European funds, etc.).

It is proposed to work on a series of issues common to all Administrations (new Eurostat rules for the calculation of energy efficiency investments, new UNE standard for Energy Service Providers, alternatives in the new Public Sector Contracts Law for EPCs, etc.), in the drafting of model contracts to undertake these actions with the possibility of incorporating Energy Service Companies, disseminating them among all Administrations concerned.

It is also proposed to analyse possible formulas allowing access to European Union funding to carry out these actions.

Measure 3.5. Extending the scope of Royal Decree 56/2016 to buildings used or owned by Public Administrations

Showcasing the exemplary character of the Administration, extending the scope of application of the requirements established in Royal Decree 56/2016, of 12 February 2016, transposing Directive 2012/27/EU of the European Parliament and of the Council, of 25 October 2012, on energy efficiency, as regards energy audits, accreditation of service providers and energy auditors and promoting efficiency in the supply of energy, for buildings owned or used by the Public Administrations.

Measure 3.6. Specialised training for public procurement technicians and managers.

The creation of a Specific Continuous Training Plan will be studied for technicians of Public Administrations at different levels: state, regional and local, both for those working in the field of public procurement and for those in charge of building maintenance, so that they are aware of this obligation set by the European Union to renovate the public building stock of Public Administrations and to allow for the proper implementation of the Action Plans contemplated in Measure 3.3.

Measure 3.7. Promoting the renovation of public housing stock

Promoting the renovation of the public rental housing stock, as an exemplary measure by the Administration, promoting the use of innovative practices that can be replicated in other areas. In particular, intervention on the public housing stock benefits the most vulnerable population and those likely to find themselves in energy poverty.

4. PUBLIC FINANCING MEASURES.

Area 4 Target: The aim is to continue with the public aid programmes from recent years, resolving the aspects that have been identified as areas for improvement. To do this, some new actions are established and some general criteria are recommended to take into account in the definition of new programmes or in the reform or continuation of existing programmes.

Measure 4.1. Creation of a Renovation Plan that coordinates the existing aid lines and designs future ones.

MITMA, in collaboration with the Inter-Ministerial Working Group created for the preparation of the ERESEE and with the Autonomous Communities through the relevant coordination bodies, will draw up a Renovation Plan, which integrates energy targets with the other needs identified in the sector (habitability, accessibility, etc.) and includes, among other issues, the criteria for the design of the new aid lines for the financing of building renovation with state funds, in particular the following:

- National Energy Efficiency Fund
- State Plan (MITMA)
- Future PAREER Programme (IDAE)
- ICO lines for renovation.
- European Funds: Design of new lines to promote private and public renovation.
- Guarantee Fund to cover defaults on loans to private financial institutions (Measure 5.1).

The following general criteria are proposed for public aid in the energy renovation sector.

- Enabling renovation aid to be granted on a non-competitive basis and a percentage of the aid to be advanced. Establishing a clear compatibility regime between the different forms of renovation aid (direct or indirect).
- Including the construction sector in the Draft Bill on Climate Change and Energy Transition.
- Prioritising actions according to climatic zone and give priority to intervention in dwellings with higher nominal energy consumption and higher returns on investment, making this criterion compatible with the necessary special treatment of situations of energy poverty (Measure 10.1) since, although they are low-consumption dwellings, they actually have a high energy demand, which is not satisfied by the economic situation of the users, and consequently high latent consumption.
- Encouraging the combination of different financing sources, both public and private, and of different types such as loans and subsidies
- Designing financing schemes adapted to the social reality of Spanish households, defining the type of aid (loans with public funds, private loans with interest subsidies and/or public guarantee fund, non-refundable subsidies, tax deductions, etc.) and the percentage covered according to the income of the family unit and the characteristics of the households (retired people, single-parent families, etc.), paying special attention to the most disadvantaged and vulnerable households.
- Strengthening the synergies between compulsory conservation works and voluntary works to improve energy performance on the envelope.
- Adjusting the aid in accordance with the types, paying particular attention to the differences between collective and single-family dwellings.
- Promoting the renovation, extension and improvement of the efficiency of the existing stock of renewable air conditioning and DHW installations (including the possibility of their integration and hybridisation with existing heat generation equipment), adapted to the obligations linked to air quality, and limit aid that promotes the consumption of fossil energies in renovations of existing generation systems, in a manner consistent with the objectives set out in the PNIEC.
- Where objective requirements are called for to apply for the public aid, associating them with the Energy Performance Certificate (or other elements that establish and compose it, such as the Existing Building Book or Energy Passport), before and after the actions to be carried out, preferably with the percentage of saving, due to being quantified more easily and homogeneous than the jump between ratings.

- Establishing an agreed system of minimum indicators (number of actions, number of dwellings, budget, aid granted, energy and CO_2 savings, etc.) broken down annually and regionally, so that there can be consistent and comparable monitoring of both the assessment and the impact of the measures adopted (Measures 4.6 and 11.4).
- Analysing the advisability of qualifying the requirements called for to grant aid according to the climatic zones, adapting them to the specific distribution of consumption and the related savings potential, as well as adjusting this aid, prioritising the deepest or integral interventions
- Examining the possibility of permitting partial interventions or interventions in stages, following the logical sequences proposed in the 2014 ERESEE, in any cases where there is an integrated project that may be approached in stages, and where there are not enough resources to undertake it all at once. In this sense, it is also worth evaluating the potential entry into competition of possible RENOVE Plans for isolated elements that could be approached with other more integral lines of aid, to improve the envelope or the systems
- Including Energy Service Companies (ESCOs) or other companies (construction companies, developers, real estate companies, etc.) that develop ‘turnkey’ renovation projects for Homeowners’ Associations as potential beneficiaries.
- Incorporating or designing new specific lines that allow the launch of competitive calls for pilot actions, which allow innovation and testing of new models (Measures 5.3, 7.4, 7.5, 7.6 and 7.7).
- Consideration of specific situations of Energy Poverty when designing the aid. (Measures 6.2 and 6.3).
- Investigating the possibility of creating aid programmes to support the renovation of buildings for tertiary use, with programmes differentiated according to types and uses, given the great diversity of situations covered by the sector. Analysing new financing alternatives that allow greater penetration in this sector.

- Creation of value associated with renovation, both financial and non-financial, making it possible to trigger a new revenue stream associated with greening and energy efficiency beyond the monetary benefits.
    - Financial: capitalising benefits and savings, quantifying the benefits through the valuation of the renovated building, the improvement of the EPC rating, etc., translating them into savings in CO_2 emissions, aligned with the objective of decarbonisation.
    - Non-financial: impacts on public health, savings in materials compared to a new building, comfort, habitability, comfort, safety, etc.

Specific proposals for the design of the new State Plan.

- Permitting the financing of renovation works in single-family dwellings and extending the age range for the dwellings that can access aid.
- Including social support measures for families with more limited resources, by increasing the percentage subsidised and opening a line of loans with subsidised interest rates and average terms (5-10 years).
- Encouraging synergies between energy renovation and compulsory conservation works.
- Qualifying the demand savings requirements to access energy renovation aid taking the different climatic zones into account and adapting them to the specific distribution of consumption and the related savings potential.
- Harnessing the potential of ARRUs as the most appropriate tool to use as a catalyst for renovation. Adapting the execution deadlines required for urban regeneration actions.

Drawing up a new PAREER Programme.

- Drawing up a new PAREER Programme, taking into account regionalisation.

Specific proposals for the ICO SMEs and Entrepreneurs Facility.

- Promoting its dissemination and knowledge among individuals and homeowners' associations.
- Seeking to promote energy renovation within this line.

Specific proposals for European Funds/EIB Financing.

Using European funds as leverage for the activation of private financing, under a system of 'Blended Finance Instruments' that allows for a multiplier effect.

It is proposed to analyse the possibility of creating a Revolving Fund, using EIB funds, to finance urban regeneration actions led by town and city councils and Autonomous Communities.

Measure 4.2. Amendment of the Subsidies Law.

Analysing the possibility of amending the Subsidies Law so as not to count aid for housing renovation as income of the Family Unit, to avoid the loss or failure to receive other social subsidies or aid among families with fewer economic resources.

Measure 4.3. Study of a new tax system favourable to renovation, in both the residential and tertiary sectors.

- Analysing the possibility of establishing (both in the state and regional quotas) for renovation works, complementing or replacing the current subsidies, as this system is simpler for citizens and can help to bring to light works that are currently carried out in the underground economy.
- Clarification of the reduced rate of Value Added Tax (VAT) for renovation, by products.
- Analysing the possibilities of implementing the Euro-PACE model in Spain.
- Systematic review of the possibilities of new taxation through other taxes, e.g. analysis of the possibility of linking energy efficiency (in KWh/m^2 or rating in the Energy Certificate) to the Property Transfer Tax (*Impuesto Transmisiones Patrimoniales* - ITP) or Real Estate Tax (*Impuesto sobre Bienes Inmuebles* - IBI). Study of possible exemptions from municipal taxes such as Construction, Installations and Works Tax (*Impuesto sobre Construcciones, Instalaciones y Obras* - ICIO), building permits, etc.
- Analysing the possibility of introducing tax breaks in Corporation Tax for companies that invest in improving the energy efficiency of their buildings.
- Examining the possibility of introducing tax breaks in Corporation Tax for companies in the construction sector that invest in implementing the digitalisation or industrialisation of their business.

Measure 4.4. Creation of a network of Offices/Shops for citizens.

It is essential to create environments of trust in which citizens have access to technical and finance information and in which administrative procedures are facilitated. This would involve creating a network of physical and virtual spaces, which - regardless of their name ('one-stop shop', 'multi-service shop', 'network of renovation offices', etc.) - would offer a response to the following needs: technical advice on technical, legal and economic aspects; access to the list of renovation agents and professionals; information on sources of financing; existing business models in the market, etc. Public funding should be provided for its creation and maintenance over time, as well as management teams and social and administrative support. It should consist of at least the following two elements (Measure 1.4):

- An integrated web portal or platform, supported by a dedicated technical team, with continuously updated information on available public aid, including deadlines for calls for applications, to facilitate citizens' access to it. This platform can also provide information on methods, techniques and financing that contribute to the improvement of energy performance as referred to in Article 20 of Directive 2010/31/EU.

- A network of Renovation Offices/One-Stop Shops suitably deployed throughout the territory (in cities, Offices in the neighbourhoods to be renovated and, in rural areas, a regional or decentralised network) to plan, promote, manage and implement the actions. (Measure 1.4). It is advisable to learn about existing experiences and see the failures and how to solve them and improve the service.

Measure 4.5. Improving the subsidy database.

In addition to Measure 4.4, it is proposed to improve the existing subsidy database, or replace it with an exhaustive and updated database of subsidies and economic incentives of all types (fiscal, financial, etc.) and of any origin (European, national, regional or local), which, by means of an appropriate coding system, will allow the identification and filtering of all available subsidies for the action to be undertaken, taking into account information such as type of applicant, location, type of building, position, etc.

This database should be able to link the improvement measures proposed in the energy performance certificates with the available aid in as automated a way as possible.

Measure 4.6. Monitoring and follow-up of publicly financed actions.

It is essential that the new public aid that is designed incorporates a precise system of indicators for monitoring the actions (savings achieved, investment, etc.) that allows for the analysis of aggregate data and the subsequent evaluation of public policies. (Measure 11.4).

5. MEASURES TO ENCOURAGE AND MOBILISE PRIVATE FINANCING.

Area 5 Targets: Encouraging the mobilisation of private financing, removing the barriers that are currently preventing large-scale deployment.

Measure 5.1. Creation of a Guarantee Fund to cover defaults.

It is proposed to continue working on the possibility of creating a system of guarantees or a ‘Limited Guarantee Fund’ to cover potential default on the loans from private financial institutions.

Measure 5.2. Identification and removal of existing barriers to private financing.

Within the framework of a specific working sub-group for working with financial institutions (Measure 1.5), the aim would be to promote the development of new financial products that are specifically adapted to the renovation of dwellings, with a special focus on homeowners’ associations. The following actions are proposed to do this:

- Assessing the possibility of amending the Commonhold Property Law to facilitate the granting of loans to homeowners’ associations and thus facilitate the financing of renovation works with full legal guarantees. (Measure 8.1).
- Revising the banking regulations derived from the Basel III Agreements (Royal Decree 84/2015 on the regulation, supervision and solvency of credit institutions and the Bank of Spain regulations derived from it) so that renovation loans require less capital from financial institutions, so that they can pass on this improvement in more attractive products, with longer terms and lower interest rates (improving the current ones, which are identical to consumer loans, at around 6%).
- Progress in risk analysis modelling and classification.
- Examining the possibility of creating mortgage loans ‘with an indefinite grace period’, in which the financial institution would own the capital gain derived from the improvement made by the renovation, which it would receive when the property is transferred by sale or inheritance.

Measure 5.3. Activation of mechanisms from the public sector to complement the financing of actions (urban capital gains, energy production, etc.).

Law 8/2013 introduced different possibilities to complement the financing of urban renovation, regeneration and renewal actions (reinvestment of urban capital gains from changes of use or increases in land eligible for construction, rental of roofs for the installation of solar panels, etc.). It is the responsibility of the local authorities to activate them, within the framework of actions at neighbourhood level as part of the Municipal Plans (Measure 1.4).

Measure 5.4. Promotion of Public-Private Partnership (PPP) actions.

Where appropriate, and in accordance with the strategic vision of the Municipal Plans, City Councils can promote the creation of Consortia and other formulas for Public-Private Partnerships to promote the urban regeneration of certain neighbourhoods.

Citizen participation in these initiatives (public-private-citizen) can increase uptake, help identify local needs (energy efficiency or renewable energy) and identify households in energy poverty. Carrying out a study, together with the Autonomous Communities and Local Administrations, of the potential impact of this type of partnership on the reduction of energy poverty.

Measure 5.5. Measures to insure the debt.

Studying the feasibility of insuring the debt of financial institutions for renovation loans together with private insurers, in a 'co-insurance' model.

6. COMBATTING ENERGY POVERTY.

Area 6 Targets: This area incorporates the measures considered in the National Strategy to Combat Energy Poverty 2019-2024 that are directly related to energy renovation.

Measure 6.1. Improving knowledge of energy poverty.

In order to intervene regionally in respect of energy poverty, it is necessary to improve knowledge of the phenomenon on a regional scale, at the level of Autonomous Communities and in large cities, by creating maps and geo-referenced information, monitoring consumption, etc. (Measure 11.1). It is important to align this issue with other directly related policies: urban poverty and vulnerability, ageing, social policies, etc. Synergies should be created with existing tools. (Measure 11.3).

Measure 6.2. Creation of administrative structures to combat energy poverty.

Intervention at regional level to combat fuel poverty requires the creation of the necessary administrative structures, or the reorientation of existing ones, for implementation at Autonomous Community and local level. (Measure 1.4).

Measure 6.3. Reduction of the number of people living in energy poverty.

The aim is the coordinated development of a specific financing line to combat energy poverty to be incorporated into the design of the general public financing framework (Measures 4.1 and 4.2). This line should be articulated so as to encompass the following measures proposed in the National Strategy to Combat Energy Poverty 2019-2024:

Measure 7. Express renovation of dwellings.

Measure 8. Promotion of the public dwelling stock under the social rental scheme with subsidies for energy supply expenses for particularly vulnerable groups.

Measure 9. Replacement of equipment with more energy efficient equipment.

Measure 10. Comprehensive building renovation.

Measure 11. Other measures derived from the ERESEE analysis.

Measure 6.4. Measures to protect consumers and raise social awareness.

This measure includes some of the measures set out in Area IV of the National Strategy to Combat Energy Poverty 2019-2024, specifically Measures 15 (Website that functions as a general access point for information on energy poverty) and 17 (Information on consumption habits, energy saving and improving energy performance).

Measure 6.5. Promoting the monitoring of the consumption of families in a situation of financial vulnerability.

Real-time information on consumption can help users to be more aware of their consumption so that they can manage it in the most appropriate way, changing patterns of use or inefficient use of air-conditioning systems, domestic hot water, lighting or household appliances, in line with the provisions of the *measure to improve information to vulnerable consumers* included in the Strategy to Combat Energy Poverty.

Measure 6.6. Specific measures for the public stock of rental housing.

Development by the corresponding bodies of specific multi-year plans to undertake improvements to the envelope of the public housing stock, prioritising the renovation of buildings occupied by vulnerable families.

Promoting the monitoring of the consumption of the public housing stock to detect possible dysfunctions. Information for users on the best use of their buildings, including both passive measures and ventilation strategies and shading, as well as information on the optimal functioning of air conditioning, ventilation and DHW production systems.

7. MEASURES FOR THE DEPLOYMENT OF A NEW ENERGY MODEL IN THE CONSTRUCTION SECTOR.

Area 7 Targets: Contributing to the deployment of a new energy model in the construction sector, in coordination with the sectoral energy and climate targets set for this sector.

Measure 7.1. Research, forward planning and strategy.

Promotion of research and development of new technologies and applications for the construction sector. Forward planning and strategy studies on energy consumption in buildings, the use of renewable energies, district grids, the use of residual heat, etc. (Measures 7.4, 7.5, 7.6 and 7.7). Development of the measures necessary to allow the statistical use of the data from energy companies (Measure 11.1).

Encouraging innovation in renovation interventions through favourable treatment of innovations in aid schemes.

Measure 7.2. Development of a more favourable regulatory framework for small consumers in the domestic sector.

Exploration of the scope for improvement in the current regulatory framework to favour small consumers in the domestic sector and to promote energy efficiency, e.g. by reducing fixed billing terms, allowing centralised contracting, etc.

Measure 7.3. Establishing a demanding regulatory limit for energy consumption in construction and encourage a significant part of this consumption to be covered by energy from renewable sources in construction.

The amendment of the Technical Building Code published in December 2019, establishes the limit levels of total primary energy consumption and non-renewable primary energy consumption that new buildings and those on which certain interventions are carried out must comply with, these being very demanding values, which implies that, in addition to limiting their energy consumption, a significant part thereof must be covered by energy sources of renewable origin.

In addition to the aforementioned indicators of non-renewable primary energy consumption and total energy consumption, which already indicate a necessary contribution of renewable energy, the Technical Building Code contains a section called *Minimum contribution of renewable energy to cover demand for DHW*, in which a renewable contribution percentage of 70% of the annual energy demand for DHW is set, which can be reduced to 60% for demand levels of less than 5 000 l/day.

There is also another section that establishes a minimum amount of electricity generation for tertiary buildings that are newly constructed or completely renovated and have a surface area of more than 3 000 m^2.

An amendment to the Technical Building Code is currently being processed which will involve, on the one hand, an extension of this electricity generation requirement to the residential sector and the tertiary sector and, on the other hand, the establishment of minimum infrastructure provisions for electric vehicle charging, thus transferring to the Technical Building Code something that is already regulated in this respect in the Low-Voltage Electro-Technical Regulation (REBT), although extending the scope of the requirement to comply with the provisions of Directive 844/2018 in this regard.

The Regulation on Thermal Installations in Buildings (RITE) also foresees a double amendment of the targets in the short and medium term.

In the short term, a first amendment (Phase I) is pending approval, which will incorporate requirements derived from the amendment of European Directives, in particular those on Energy Efficiency in Buildings, Renewable Energies, Energy Efficiency and Ecodesign. These amendments will establish changes at the level of greater integration of renewable energies in buildings, alignment of Spanish regulations with the Ecodesign Regulations, improvement in inspection systems, incorporating ventilation and heat recovery, and promoting control and information mechanisms for both users and Public Administrations.

In its second amendment (Phase II), which has already begun and is expected to last one year, changes will be made to comprehensively improve the mechanisms for renewable and non-renewable energy generation, increase energy efficiency requirements and address the application of the regulation to new technologies, so that their penetration in Spanish buildings is homogeneous and regulated like the rest of the systems.

In addition, it is also necessary to design a public financing framework for the change of installations and the promotion of renewable energies in line with the sectoral objectives of the national energy and climate framework. (Measure 4.1).

In order to promote the replacement of existing thermal installations, it is proposed to include obligations in the RITE that allow users to identify the state of their installations, such as, for example, requiring the installation of meters for energy supplied and for fuel or electricity consumption in older generators, a certain power, etc., and to take decisions regarding their replacement. It is also necessary to strengthen synergies with regard to the implementation of obligations relating to installations, such as the obligation to track consumption, distribution in heating emitters, etc. that promote the improvement of thermal installations or the installation of energy meters in existing installations, etc. in order to optimise actions in buildings and guarantee the adequate acceptance of the implementation of these measures.

Studying the possibility of establishing the obligation to publicise the adoption of energy efficiency measures in thermal installations or the incorporation of renewable energies within the RITE, giving visibility to the information on the measures adopted by incorporating signs that are visible from the outside and to give an exemplary character to this type of action.

Study of possible tax breaks to promote the use of renewable energies in those cases where their implementation is not mandatory because they are outside the scope of application of the Technical Building Code, or for those cases where the implementation of an electricity generation system is mandatory, but the minimum thresholds set are exceeded in a certain proportion.

Encouraging the use of renewable energy in district grids or the implementation of urban electricity generation grids.

Measure 7.4. Promoting bioclimatic techniques and devices in climate change mitigation and adaptation.

Encouraging passive architecture, through design strategies in line with the reduction of the demand of the building versus consumption.

In relation to climate change and the increase in heat waves, encouraging the deployment of shading and heat dissipation devices, both in buildings and public spaces, in connection with urban regeneration actions at neighbourhood scale and Municipal Plans (Measure 1.4).

Adapting the calculation methodology to encourage the use of shading devices where energy simulations show improvements in reducing consumption and emissions.

Also promoting bioclimatic techniques and devices for heat recovery, thermal inertia devices, air conditioning, etc.

In those neighbourhood actions in which intervention is carried out in the open, encouraging that the external ground be treated using permeable materials that reduce the heat island effect. For the same purpose, the incorporation of vegetation and the use of light-coloured finishing materials as roofing materials should be considered.

Measure 7.5. Encouraging Energy Associations and District Grids.

Promoting distributed energy network models at neighbourhood and building level, both for their value in their own right and as a potential catalyst for larger-scale interventions (Measure 8.5). Promoting the grouping together of Homeowners' Associations in service partnerships, favouring their association and empowerment (Measure 10.2).

Evaluation, by the promoting Public Administration, of the possibility of implementing district grids in each area in which an urban regeneration project is carried out on a neighbourhood scale, especially in those neighbourhoods with high incidence rates of poverty and energy vulnerability. Incorporation of a global vision in the Municipal Plans (Measure 1.4) on energy distribution at neighbourhood level.

Evaluating at municipal level the advisability of requiring the installations of District Grids in new urban developments, in line with the PNIEC (Measure 1.6. Framework for the development of thermal renewable energies).

Evaluating the installation of district grids in large logistics, industrial and university hubs, etc. located on the outskirts of urban centres, where it may be easier to implement district grids compared to a traditional urban centre, and where consumption, being high, may lead to a moderate return on investment.

Promoting the connection of a public building with high consumption to the district grids in its early stages as support for the viability of the operation. The use of renewable energy sources and synergies between buildings with very different use profiles, such as between tertiary and residential, should also be pursued and, where possible, the use of residual heat from industrial processes or urban transport should be promoted.

Identifying proactive stakeholders in the sector and working with them to propose models through which energy associations could contribute to energy renovation.

Giving visibility to model projects and their benefits for citizens.

Measure 7.6. Development of Self-Consumption.

Promotion and development of Self-Consumption within the framework of the Self-Consumption Strategy set out in the PNIEC.

Analysis and proposal of solutions for the existing mismatch between production and consumption throughout the year (mainly winter/summer).

Connection with the encouragement of energy associations and energy distributed at district level. (Measure 7.4).

Measure 7.7. Re-evaluation and improvement of the Energy Certification of Buildings (EEC).

It is proposed to re-evaluate the Energy Certification of Buildings (EEC) as a decision-making tool both for citizens and for the design of public policies by Administrations. To that end, the readability and viewing of information should be improved for citizens, certification scales (ratings) should be reviewed, etc.

A Royal Decree is currently being processed to replace Royal Decree 235/2013, which approves the basic procedure for Energy Certification. The new Royal Decree broadens the scope of application to include certain renovation actions and in which the measures to improve certification take on greater importance, establishing that they must include a forecast of the investment recovery periods, as well as estimates of the improvements in comfort, health and well-being conditions, and must also indicate the most appropriate time sequence for undertaking the proposed measures.

The aim of these amendments is to ensure that, prior to undertaking any intervention in the building, the owner has the best possible information on improvements in the planned action that may lead to energy savings and an increase in the habitability conditions of the building, in order to be able to make decisions on the action to be taken or to be aware of them with a view to future interventions.

Measures should also be taken to ensure the technical quality of the Certificates that are issued, as the overall low quality of the Certificates is one of the major weaknesses of this instrument.

The Energy Certification of Buildings (EEC) should be one of the key components of other demand triggering and catalysing instruments such as the IEE or ITE (Measure 8.3), the Building Passport or the Existing Building Book (Measure 8.4), which are properly integrated. It will be necessary to analyse the objectives and limits of each of them in order to develop a structured scheme that covers all needs and avoids overlaps and duplication.

Measure 7.8 Promoting the collective use of electrical and thermal renewable energy installations through renewable energy associations.

Promoting the collective use of electrical and thermal renewable energy installations through renewable energy associations in general and specifically in areas where special protection of air quality is required and where the consumption of people living in fuel poverty can be aggregated.

Considering the use of urban air-conditioning systems in plans for new urban developments. Making the necessary information available to all stakeholders: models of municipal ordinances, dissemination of success stories, new forms of financing that provide renewable energy associations with access, etc.

The promotion of the collective use of renewable installations to supply consumers in energy poverty allows the possible debt generated by an individual consumer to be diluted in an association that can more easily absorb transitory defaults, especially if these associations are supplied by renewable energy generation systems that do not involve energy consumption costs.

Identifying those sites where the energy demands of users in energy poverty can be aggregated and supplied collectively through the development of energy poverty maps obtained from existing mechanisms related to thermal and electricity social vouchers.

Measure 7.9. Promoting storage systems in buildings.

Promotion and inclusion of localised distributed storage systems in urban areas, associated with public and private photovoltaic installations (on roofs of buildings or public spaces, or on roofs or common spaces of residential buildings or neighbourhood communities).

Integration of storage systems associated with renewable electrical or thermal energy generation facilities, integrated in buildings or common spaces associated with them in Energy Associations (Related to Measures 7.4, 7.6 and 7.7)

Oversizing of self-consumption installations in public buildings (such as schools, institutes or hospitals), or private buildings (such as hotels, office buildings or residential or private buildings), so that surpluses can be shared by companies or individuals in their vicinity that do not have the space to build a renewable energy installation, which would allow better use to be made of them. The inclusion of storage systems would optimise these oversized systems, allowing for better management and use of the associated resources that could be shared within an energy association.

Specific aid for storage systems, within the calls for aid for renewable energy generation systems in buildings.

8. MEASURES FOR ACTIVATION AND AGGREGATION OF DEMAND.

<u>Area 8 Targets</u>: Developing measures that can contribute to the activation of demand, facilitating decision-making and financing in homeowners' associations, as well as the search for synergies between energy renovation and mandatory conservation works. Also promoting the aggregation of demand at building and neighbourhood level.

Measure 8.1. Amendment of the Commonhold Property Law to facilitate decision-making, financing and aggregation of demand at building level.

Amending the Commonhold Property Law to promote collective self-consumption and energy associations, in order to remove potential barriers to the development of collective self-consumption in buildings, adapting its content to the development of these new energy models.

Measure 8.2. Promotion of the positions of the 'Head Technician' and Property Administrators as activating agents.

Intermediate positions such as the 'Head Technician', the 'Energy Renovation Management Agent' or the Property Administrators can play a mediating role between the different interests that may exist in the Homeowners' Associations and articulate the renovation demands, offering information, technical and economic advice, etc. The generation of trust and empathy is key. There are synergies between this measure and Measures 8.3 and 8.4. They can also play a key role in the creation of energy associations.

Measure 8.3. The IEE or the ITE as an instrument triggering synergies between mandatory work and work relating to energy renovation.

With regard to what Directive (EU) 2018/844 refers to as 'trigger points', the instruments which already exist in Spain, namely the Building Technical Inspection (*Inspección Técnica de Edificios*: ITE) or the Building Assessment Report (*Informe de Evaluación de los Edificios*: IEE), which - once a building is more than 50 years old - are usually carried out every ten years, can play a key role as triggers and catalysts for synergies between mandatory conservation work and voluntary work relating to energy efficiency. To that end, the following is required:

- Promotion and coordination of the implementation of the IEE in the Autonomous Communities and municipal councils, following the judgment of the Constitutional Court. (Measure 2.2 and 2.3).
- Coordination of the regional registers of the Autonomous Communities. (Measure 2.2).
- Development and continuous updating of the IT tool for the IEE.
- Promotion of the existing building owner's manual.
- Emphasis on actively informing homeowners' associations, on an individual basis, immediately prior to the date on which they have to undergo the ITE or the IEE, emphasising the synergies between mandatory and voluntary work, financing options, etc.

Measure 8.4. Analysis of the potential for developing the idea of the energy passport through the existing building owner's manual.

Following Directive (EU) 2018/844, the idea has been proposed of analysing the potential deployment of the building passport in Spain by integrating it with the existing building owner's manual. The building passport should be understood as an instrument that accompanies the building's ownership (fundamentally, homeowners' associations) over time, planning and guiding it in a process of extensive renovation in sequenced stages. Its implementation within the framework of the existing building owner's manual would make it possible to integrate improvements (third level of the duty of conservation) relating to energy efficiency with other improvements (habitability, accessibility, etc.), which have to be tackled in a comprehensive renovation. Its content would include all of the information relating to the building's current situation and its state of repair (through the Building Technical Inspection (ITE) or the Building Assessment Report (IEE)) and, in addition, it would contain an assessment of the potential for improvement and a long-term renovation plan, by way of a roadmap for achieving the goals set.

Support schemes should be linked to the existence of the existing building owner's manual (the basic content of which should be regulated) and it would be a good idea if such schemes included support for the preparation of the manual.

How the treatment of actions carried out as part of the sequential renovation defined in the existing building owner's manual is envisaged in support plans must be analysed.

Measure 8.5. Measures for coordinating and aggregating demand at district level.

The aggregation of demand at district level must be led by the municipal councils or Autonomous Communities, proposing the relevant projects (publicly or privately managed) for Renovation and Integrated Urban

Regeneration Areas, in accordance with the overall long-term vision of their respective municipal plans (Measure 1.4). In those projects, demand may be activated through offices/service points (Measures 1.4 and 4.4) set up in the region. Proposing projects at this level favours interventions involving the comprehensive renovation of buildings (conservation, accessibility, energy renovation, habitability and public space), the formation of energy communities and/or the establishment of district networks (Measure 7.6), as well as integrated urban regeneration (with complementary measures in the social and educational spheres and in relation to employment, improving environmental quality, etc.).

Depending on each particular case, it may be necessary to implement some of the concepts put forward in Law 8/2013 (administrative associations, groupings of homeowners' associations, renovation cooperatives, etc.).

We must also remember the instruments for activating demand that are already permitted by national legislation: the demarcation of areas and the imposition in those areas of the third level of the duty of conservation (work to improve quality and sustainability).

Measure 8.6. Analysis of the future introduction of mandatory renovation measures linked to energy ratings.

Following the provisions of Directive (EU) 2018/844 in relation to 'trigger points', the possibility of introducing obligations will be studied, for example, in relation to establishing certain minimum standards of habitability and energy efficiency (possibly based on the energy certification rating) as a requirement for the conveyance (sale) or letting of property, or the linking of those standards to certain taxes (immovable property tax (*impuesto sobre bienes inmuebles*: IBI), capital transfer tax, etc.). (Measure 4.3).

Measure 8.7. Analysis of possible actions to activate demand for renovation in the residential sector.

When the royal decree on the energy certification buildings is revised, its scope of application is expected to be expanded to require certification to be carried out in relation to all interventions involving existing buildings, regardless of whether the property is going to be let or sold. That information will allow the user to be aware of the energy performance of the property and guide him or her as to the nature of the intervention required.

Measure 8.8. Analysis of possible actions to activate demand for renovation in the tertiary sector.

As is the case with buildings or homes intended to be sold or let, by means of the amendment to the royal decree regulating the energy certification of buildings it is proposed that buildings intended for public residential use must publish their energy efficiency label in their adverts or on their websites and, on the basis of that label, determine the CO2 emissions associated with a guest's stay in each establishment.

That information will allow the user to be aware, approximately, of the environmental impact (in a manner similar to its carbon footprint) of his or her stay in the tourist accommodation, on the basis of the energy rating. To that end, a common methodology will be established so that the proportional part of the emissions indicated in the label can be determined, simply, according to the number of people and the number of days stayed in the relevant accommodation (kg CO2/person/day).

This could represent a determining factor in whether a user opts for one offer of accommodation or another and, in turn, could act as an incentive for an establishment to improve its energy rating by means of alterations and energy renovation work on buildings of this kind in the tertiary sector, which are major consumers of energy and which, often, the support schemes are not able to motivate to invest in energy improvements.

Measure 8.9. Creating a 'Sustainable City' seal.

- The purpose is to accredit those municipal councils that are committed to the ERESEE in order to make all of the buildings in their municipality sustainable. The seal would involve:
- Implementing the existing building owner's manual in accordance with the ERESEE and the PNIEC.
- Adopting a tax position (IBI) that incentivises renovation, while trying not to damage revenues, by means of neutral taxation.
- Facilitating and speeding up the processing of consents and permissions for renovation.

- Defining district-level renovation programmes and publicising them, so that members of the public know where to go and where their building is located in those programmes.

- Promoting district networks.

9. SUPPLY-SIDE MEASURES: PROFESSIONALISATION, MODERNISATION OF THE RENOVATION SECTOR, TRAINING AND QUALIFICATIONS.

Area 9 Objectives: Encouraging the emergence of a professional and modernised offering of renovation as a complete service.

Measure 9.1. Promoting professionalisation and the provision of comprehensive and 'turnkey' renovation services.

Cooperation with the business and professional sectors involved in renovation, to promote the professionalisation of the sector, the provision of 'turnkey' comprehensive services and access to such services on the part of the public. Promoting coordination between different sectors (construction companies, financial institutions, ESCOs, etc.), in order to create unitary product packages.

Promoting the creation of comparison platforms in the field of construction, in order to give visibility to the comprehensive renovation services offered.

Measure 9.2. Promoting the modernisation of the renovation sector (R&D+i, industrialisation, digitalisation, monitoring).

Promoting research, industrialisation and prefabrication in relation to renovation. Promoting the use of digital technologies in renovation: building information modelling (BIM) methodology, photogrammetry and digital measurement, thermography, etc. Promotion of the use of devices to monitor and control heating and cooling installations, domestic hot water production, solar-controlled mobile elements, ventilation, etc.

Measure 9.3. Initial and ongoing professional training of workers in the construction sector and the renovation subsector.

Promoting initial professional training (of workers in the construction sector and the renovation subsector), adapting skill sets to meet the market's new needs (industrialisation, digitalisation, monitoring, maintenance of renewable energy installations, etc.). Designing new intermediate and higher-level training modules and courses related to the renovation of buildings and installations. Incentivising dual professional training.

Promoting ongoing professional training to recycle workers from the construction sector, including the recognition or accreditation of the workers' professional skills.

Using digital media, such as MOOC (Massive Open Online Courses) courses to facilitate access to training for largest possible number of professionals. Making use of existing platforms such as 'Formate.es' of the State Public Employment Service.

Measure 9.4. Improving the initial and ongoing academic training of technicians.

Adapting the academic training of professionals directly related to renovation to the specific knowledge requirements (construction pathology and diagnostic techniques, renovation techniques, training on installations and renewable energy, energy communities, thermography, financing models, etc.).

Incorporating into academic curricula the content and skills necessary to be able to practise as competent technicians, to enable them to carry out energy certification, ITEs and the IEE.

Measure 9.5. Supporting technical guides to promote the decarbonisation of the existing building stock and the development of demonstration pilot projects.

Developing technical guides that establish guidelines and recommendations to guide technicians in their decision-making, assessing the different refurbishment or replacement options for thermal installations in existing buildings and promoting the use of renewable energy, according to the type of building (multi-family residential building, single-family dwelling, dwelling in a multi-family residential building, offices, etc.) and its particular characteristics (availability of common areas, basements, roofs, areas available to carry out geothermal surveying, options for collective supply, climatic zone, particular characteristics of the existing heating/cooling system and of the heat distribution and emission system, etc.).

10. INFORMATION AND SOCIETY AREA. CITIZEN-CENTRED.

Area 10 Objective: The aim of this area is to foster a cultural change among the public, arousing greater social awareness of energy saving, building maintenance and renovation and highlighting the value of the urban regeneration of our towns and cities. Furthermore, it would also seek to disseminate - at a more technical level - any pioneering and innovative experiences in relation to renovation and urban regeneration which, on account of their appeal, could be transferred to other places.

Measure 10.1. Development and initiation of a strategy for communication with the public: defining the message, target audience, channels, etc.

Developing and initiating a strategy for communication with the public: defining the message, target audience, channels, etc. The idea is to go beyond the strict approach of the financial return on the investment through the energy savings achieved, also emphasising the improvement in comfort and quality of life and the reassessment of buildings, as well as the synergies that may arise between mandatory conservation work on the building envelope and voluntary work to improve its energy efficiency. (Measure 8.3).

Establishing a national communication strategy, which defines a message for a target audience, adapting the medium and messages with the fundamental aim of disseminating best practice and replicable examples of success.

Measure 10.2. Going further in empowering citizens.

Going beyond simply providing information to empower citizens in relation to renovation and new energy models and, most especially, self-consumption (Measure 7.7), strengthening the key role of homeowners' associations in creating demand, establishing participatory tools and incentivising citizens' initiatives. To achieve all of that, the following is proposed:

- Developing or supporting initiatives to create specific tools for making energy renovation comprehensible and accessible to the public (ranging from specific guides to online tools).
- Promoting self-consumption (Measure 7.7).
- Creating citizens' demonstration networks and forums for sharing experiences.
- Including citizens (active public participation) in district-level urban regeneration projects and municipal-level renovation plans (Measure 1.4).
- Encouraging citizens to undertake projects independently by means of tax incentives (Measure 4.3) and promoting private financing (Measure 5.2).
- Promoting users' awareness by publicising actions undertaken at neighbourhood level and increasing interaction and improving understanding in relation to the functioning of their own installations.

Promoting the installation and use of monitoring systems, the metering of energy generated and consumed, etc., to enable users to be aware of the functioning and performance of their installations, so that they make better use of them or replace or improvement them. It is necessary to improve the public's understanding regarding its potential for interaction with its thermal demand and thermal generation. With the increasing use of intelligent devices in buildings, it is something which is now viable, but which is not exploited sufficiently. Such information could be supplied at the level of the individual user or collectively and, in the case of homeowners' associations or associations relating to buildings in general, linked to the data on consumption, performance, maintenance, etc., of the thermal generation systems registered in the building owner's manual.

Informing end consumers regarding energy efficiency and regarding the quota of renewable energy in the heat networks to which they are connected.

Promoting energy communities, by proposing models through which energy communities could contribute to energy renovation (e.g. mechanisms to incentivise energy communities with the initial aim of installing photovoltaic panels to implement energy efficiency mechanisms).

Measure 10.3. Informing the business sector of the potential for improving the energy efficiency of its buildings.

Carrying out information campaigns aimed at SMEs to promote the energy renovation of their buildings, showing the savings that can achieved with certain interventions and the competitive improvement that making those changes would offer them.

An information campaign relating to the existing support, tax relief and other policies to support the renovation of buildings in this sector and the replacement of their installations.

Communications that highlight the increase in productivity that goes with working in a building with greater thermal comfort and better lighting.

Measure 10.4. Dissemination at the technical level: sharing knowledge, experiences and best practice.

Holding information days throughout the country, in coordination with the different public authorities (Autonomous Communities, municipal councils through the Spanish Federation of Municipalities and Provinces (Federación Española de Municipios y Provincias: FEMP) and the principal actors involved in the renovation sector. Promoting an Annual National Congress on Renovation.

Promoting an Observatory Platform on Renovation, for the dissemination of best practice (actions, management mechanisms, innovative financing, etc.), creating a ‘experience bank’ that can serve as an example for other initiatives.

Promoting awards at any level (national, regional or municipal) that confer prestige (although they may only be of an honorary nature) on actions relating to urban renovation, regeneration and renewal.

11. CROSS-CUTTING AREA. DEVELOPMENT OF STATISTICS, INDICATORS AND MONITORING.

Objective for Cross-cutting Area 11: Overcoming the current lack of awareness regarding real energy consumption in the residential sector in Spain, in order to promote energy and renovation policies adequately. Developing indicators for monitoring actions with public financing, in order to be able to assess public policies appropriately.

Measure 11.1. Improving diagnostics and statistical information relating to energy consumption in buildings in Spain.

Carrying out the following (in coordination with MITMA, MITERD and IDAE):

- Surveys that allow data to be obtained regarding heating, cooling and DHW systems (sources of energy used, performance, types of distribution system, etc.), as well as the state of the building envelopes, including buildings in the tertiary sector, making it possible to direct the measures established in the strategy in a precise manner.
- A study on real energy consumption in buildings in Spain, at a minimum according to type and climatic zone. Inclusion in the National Statistical Plan of a periodic statistic on energy consumption in buildings.
- An economic analysis of the savings generated for users and also the saving as regards emissions at the macro level, which would involve ceasing to distribute certain types of energy, resulting from the energy savings generated or from changing the type of energy.

Coordination with the National Statistical Institute (INE) regarding energy-related matters in the statistics that already exist (Continuous Household Survey, Family Budget Survey, etc.).

In relation to paragraph 6b of Article 10 of Directive 2010/31/EU, coordination with energy suppliers in order to make anonymised consumption data, aggregated by region and appropriately segmented, available for the purposes of designing public policy and market orientation.

Measure 11.2. Research into comfort conditions and monitoring of the impact of renovation measures on buildings.

It is necessary to carry our more detailed research - using modelling, but also monitoring - into the comfort conditions of Spanish homes (temperature, interior air quality, etc.), and also into the real results (change in comfort conditions, evaluation of energy savings, etc.) obtained after carrying out renovation measures.

Measure 11.3. Improving statistics relating to renovation.

Improving renovation statistics of the Ministry of Transport, Mobility and the Urban Agenda (based on municipal planning consents).

Measure 11.4. Coordination of portals displaying data and information.

Starting with the existing tools (Urban Vulnerability Observatory or similar observatories at the level of the Autonomous Communities, housing renovation observatories), developing regionalised instruments for analysis (with disaggregation at census subdivision level or its equivalent), with specific indicators (poverty, housing characteristics, etc.) for the design of renovation plans at local and regional levels. (Measure 1.4)

Coordination of portals displaying Energy Performance Certificates and Building Assessment Reports.

Examination of the possibility of creating a portal displaying energy consumption data based on data from the suppliers (Measures 7.1 and 11.1).

Measure 11.5. Monitoring and follow-up of publicly financed actions.

It is essential that any new public support that is designed incorporates a precise system of indicators for monitoring the actions (savings achieved, investment, etc.) that allows for the analysis of aggregated data and the subsequent evaluation of public policies. (Measure 4.6).

Measure 11.6. Creation of the Centralised Administrative Register of Energy Assessment Reports.

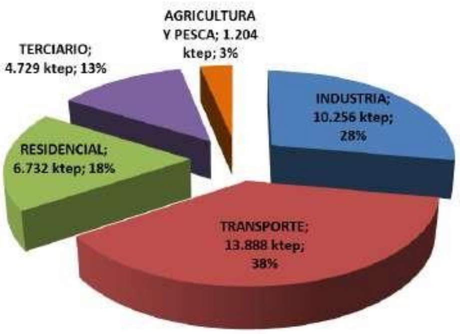
The creation of this centralised register of XML files of energy certificates, to which the registers of the Autonomous Communities must send an extract of all of the XML files registered in them, is set out in the royal decree that is currently going through the approval process and which will replace Royal Decree 235/2013, approving the basic procedure for the energy efficiency certification of buildings. This register could be a very powerful source of information for designing policies aimed at improving the energy efficiency of buildings.

CHAPTER 11. INDICATIVE MILESTONES AND INDICATORS FOR MONITORING.

11.1. INDICATIVE MILESTONES FOR 2030.

The milestones presented in this ERESEE are set within the general targets established for the residential sector by the PNIEC, which are as follows:

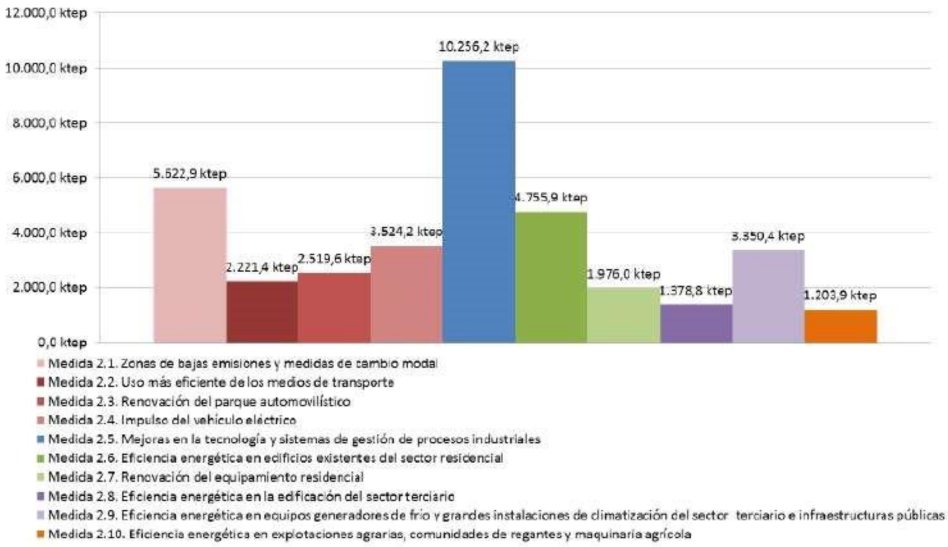
Figure 11.1. Cumulative final energy saving by Sector in Spain 2021-2030 (ktoe)[177]



	TERTIARY; 4 729 ktoe; 13%
	AGRICULTURE AND FISHERIES; 1 204 ktoe; 3%
	RESIDENTIAL; 6 732 ktoe; 18%
	INDUSTRY; 10 256 ktoe; 28%
	TRANSPORT; 13 888 ktoe; 38%

Source: PNIEC, p. 134, version of 20 January 2020.

Figure 11.2. Cumulative final energy saving by measure in Spain 2021-2030 (ktoe).



	12 000.0 ktoe
	Measure 2.1. Low emission zones and modal shift measures
	Measure 2.2. More efficient use of means of transport
	Measure 2.3. Renewal of the motor vehicle fleet
	Measure 2.4. Promotion of electric vehicles

[177] This quantification of the savings includes those necessary to ensure compliance with the binding saving target of Article 7 of the Energy Efficiency Directive, formulated in terms of the cumulative final energy saving from 1 January 2021 to 31 December 2030.

	Measure 2.5. Improvements in the technology and management systems of industrial processes
	Measure 2.6. Energy efficiency in existing buildings in the residential sector
	Measure 2.7. Renewal of residential equipment
	Measure 2.8. Energy efficiency in buildings in the tertiary sector.
	Measure 2.9. Energy efficiency in cooling equipment and major heating and cooling installations in the tertiary sector and public infrastructure
	Measure 2.10. Energy efficiency on farms, irrigation communities and agricultural machinery

Source: PNIEC, p. 134, version of 20 January 2020.

11.2. INDICATIVE MILESTONES FOR 2050.

Figure 11.3. Final energy consumption and savings in the residential sector (excluding non-energy uses) for the LTS 2050 target scenario (GWh).

Final energy consumption in the residential sector (excluding non-energy uses) for the LTS target scenario (GWh)				
	2 020	2 030	2 040	2 050
Fossil fuels	72 448	47 465	21 995	-
Electricity	68 823	64 403	78 561	88 110
Renewable energy	31 148	34 157	23 627	20 155
Total	**172 419**	**146 025**	**124 172**	**108 264**

Source: MITMA, based on the LTS 2050 (Long-term Strategy for a Modern, Competitive and Climate-Neutral Spanish Economy in 2050).

Figure 11.4. Final energy consumption and reduction in consumption in the tertiary sector for the LTS 2050 target scenario (GWh).

(GWh)	2020	2030	2040	2050
Fósiles	53.763	37.572	8.385	0
Electricidad	75.379	72.201	76.987	77.306
Energías renovables	2.715	5.016	6.331	7.157
TOTAL	**131.858**	**114.788**	**91.703**	**84.463**

	(GWh)
	Fossil fuels
	Electricity
	Renewable energy
	TOTAL

Source: MITMA, based on the LTS 2050 (Long-term Strategy for a Modern, Competitive and Climate-Neutral Spanish Economy in 2050).

Figure 11.5. Projected CO2 emissions in the LTS 2050 target scenario.

Projected emissions in the LTS scenario (Units:							
Year	2020	2025	2030	2035	2040	2045	2050
Residential	16 874	13 913	10 619	8 986	4 807	1 780	199
Commercial and institutional	11 544	9 994	7 939	5 657	1 774	359	13

Source: LTS 2050 (Long-term Strategy for a Modern, Competitive and Climate-Neutral Spanish Economy in 2050).

11.3. INDICATORS FOR MONITORING.

11.3.1. Indicators for monitoring in the residential sector.

	Number of dwellings	Number of buildings	Total floor area	Age	Total budget (with/without VAT)	Public financing	Initial consumption	Initial EPC rating	Estimated final consumption	Final EPC rating	Estimated savings
Single-family dwellings undergoing extensive renovation actions (envelope)											
Multi-family dwellings undergoing extensive renovation actions (envelope)											
Single-family dwellings undergoing moderate or minor renovation actions (others)											
Multi-family dwellings undergoing moderate or minor renovation actions (others)											
New-build single-family dwellings											
New-build multi-family dwellings											
Single-family dwellings renewed by demolition											
Multi-family dwellings renewed by demolition											

11.3.2. Indicators for monitoring in the tertiary sector.

	Number of buildings	Total floor area	Age	Total budget (with/without VAT)	Public financing	Initial consumption	Initial EPC rating	Estimated final consumption	Final EPC rating	Estimated savings	
Tertiary sector buildings (by use) undergoing extensive renovation actions (envelope)											
New-build tertiary sector buildings (by use)											
Tertiary sector buildings (by use) renewed by demolition											

11.2.3. Indicators for monitoring in public authority buildings.

	Number of buildings	Total floor area	Age	Total budget (with/without VAT)	Public financing	Initial consumption	Initial EPC rating	Estimated final consumption	Final EPC rating	Estimated savings	
Public authority buildings (by use) undergoing extensive renovation actions (envelope)											
New-build public authority buildings (by use)											
Public authority buildings (by use) renewed by demolition											

11.2.4. Indicators for monitoring the investments of the Central State Administration.

	Millions of €	Initial consumption	Estimated final consumption	Estimated savings
Annual investment by the Central State Administration in renovating homes (envelope)				
Annual investment by the Central State Administration in renovating domestic heating and DHW installations				
Annual investment by the Central State Administration in other domestic energy efficiency actions				
Annual investment by the Central State Administration in renovation in the tertiary sector (envelope)				
Annual investment by the Central State Administration in renovating heating and DHW installations in the tertiary sector				
Annual investment by the Central State Administration in other energy efficiency actions in the tertiary sector				

11.2.4. Indicators for monitoring in relation to energy poverty.

For these indicators, the 2020 ERESEE refers to the 2019-2024 National Strategy to combat Energy Poverty.

11.2.5. Other monitoring indicators.

	Millions of €
Budget of national research programmes relating to the energy efficiency of buildings (€M PER YEAR).	

ANNEXES

A. TECHNICAL ANNEXES:

ANNEX A.1. GEOMETRIC CHARACTERISTICS OF THE HOUSING CLUSTERS CONSIDERED IN THE 2020 ERESEE.

ANNEX A.2. CLASSIFICATION OF DWELLINGS AND CONSUMPTION BY PROVINCE AND CTE CLIMATIC ZONE.

ANNEX A.3. CRITERIA FOR THE DESIGN OF THE MATRICES FOR CHANGES OF INTALLATIONS.

ANNEX A.4. PERFORMANCE OF INSTALLATIONS.

ANNEX A.5. RENOVATION MENUS IN CASES OF ENERGY POVERTY.

ANNEX A.6. CRITERIA FOR PRORITISING ACTIONS IN CASES OF ENERGY POVERTY.

ANEXO 7. DESCRIPTION OF THE ‘DENIO’ MODEL USED IN THE MACROECONOMIC ANALYSIS.

B. GLOSSARY OF ABBREVIATIONS AND INITIALISMS USED.

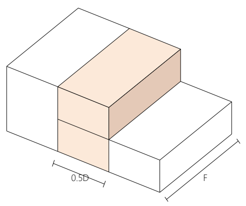
C. NOTE ON PARTICIPATION.

D. NOTE ON COMPLIANCE: COMPLIANCE WITH ARTICLE 2A OF DIRECTIVE 2010/31/EU.

ANNEX A.1. GEOMETRIC CHARACTERISTICS OF THE HOUSING CLUSTERS CONSIDERED IN THE 2020 ERESEE.

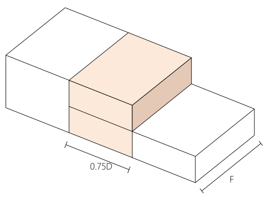
Figure A.1.1. Values of the geometric characteristics of single-family housing clusters (Uu).

Uu <40



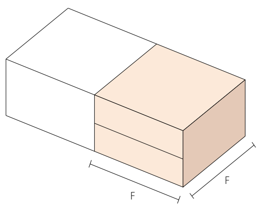
Average floor area of typical	113.31	Envelope surfaces	Per dwelling	Per 100 m2
No of storeys in building	2	m2 façade	185.22	163.46
No of dwellings per building (single-family)	1	m2 façade SOLID	77.31	68.23
Front/depth ratio (typical building)	0.50	m2 façade OPENINGS	15.30	13.50
Front/depth ratio (typical dwelling)	0.50	m2 adiabatic party wall	92.61	81.73
Front (typical building) (m)	5.32	m2 roof	56.66	50.00
% of party walls in contact with exterior	25	m2 plinth	56.66	50.00

Uu 41-60



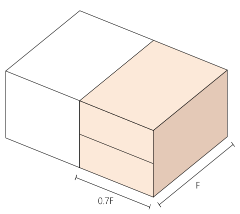
Average floor area of typical	104.20	Envelope surfaces	Per dwelling	Per 100 m2
No of storeys in building	2	m2 façade	169.19	162.38
No of dwellings per building (single-family)	1	m2 façade SOLID	82.61	79.29
Front/depth ratio (typical building)	0.75	m2 façade OPENINGS	14.07	13.50
Front/depth ratio (typical dwelling)	0.75	m2 adiabatic party wall	72.51	69.59
Front (typical building) (m)	6.25	m2 roof	52.10	50.00
% of party walls in contact with exterior	25	m2 plinth	52.10	50.00

Uu 61-80



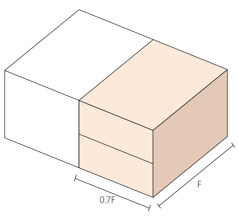
Average floor area of typical	112.81	Envelope surfaces	Per dwelling	Per 100 m2
No of storeys in building	2	m2 façade	174.24	154.45
No of dwellings per building (single-family)	1	m2 façade SOLID	115.45	102.34
Front/depth ratio (typical building)	1.00	m2 façade OPENINGS	15.23	13.50
Front/depth ratio (typical dwelling)	1.00	m2 adiabatic party wall	43.56	38.61
Front (typical building) (m)	7.51	m2 roof	56.41	50.00
% of party walls in contact with exterior	50	m2 plinth	56.41	50.00

Uu 81-07



Average floor area of typical	129.51	Envelope surfaces	Per dwelling	Per 100 m2
No of storeys in building	2	m2 façade	189.67	146.45
No of dwellings per building (single-family)	1	m2 façade SOLID	116.40	89.88
Front/depth ratio (typical building)	0.70	m2 façade OPENINGS	17.48	13.50
Front/depth ratio (typical dwelling)	0.70	m2 adiabatic party wall	55.78	43.07
Front (typical building) (m)	6.73	m2 roof	64.75	50.00
% of party walls in contact with exterior	50	m2 plinth	64.75	50.00

Uu 08-11

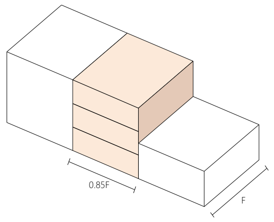


Average floor area of typical	137.42	Envelope surfaces	Per dwelling	Per 100 m2
No of storeys in building	2	m2 façade	195.38	142.17
No of dwellings per building (single-family)	1	m2 façade SOLID	119.36	86.86
Front/depth ratio (typical building)	0.70	m2 façade OPENINGS	18.55	13.50
Front/depth ratio (typical dwelling)	0.70	m2 adiabatic party wall	57.46	41.82
Front (typical building) (m)	6.94	m2 roof	68.71	50.00
% of party walls in contact with exterior	50	m2 plinth	68.71	50.00

Source: MITMA. (2019) 'Segmentation of the residential stock in Spain into type clusters'. Study (01) for the 2020 ERESEE.

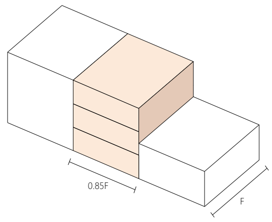
Figure A.1.2. Values of the geometric characteristics of multi-family housing clusters in buildings with up to three storeys (Cc).

Cc <40



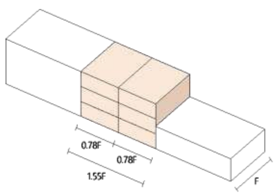
Average floor area of typical	97.86	Envelope surfaces	Per dwelling	Per 100 m2
No of storeys in building	3	m2 façade	115.13	117.65
No of dwellings per storey	1	m2 façade SOLID	55.24	56.45
Front/depth ratio (typical building)	0.85	m2 façade OPENINGS	13.21	13.50
Front/depth ratio (typical dwelling)	0.85	m2 adiabatic party wall	46.67	47.70
Front (typical building) (m)	9.12	m2 roof	32.62	33.33
% of party walls in contact with exterior	25	m2 plinth	32.62	33.33

Cc 41-60



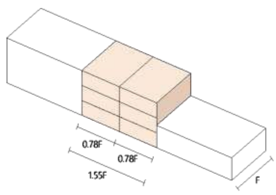
Average floor area of typical	92.35	Envelope surfaces	Per dwelling	Per 100 m2
No of storeys in building	3	m2 façade	111.84	121.11
No of dwellings per storey	1	m2 façade SOLID	54.03	58.51
Front/depth ratio (typical building)	0.85	m2 façade OPENINGS	12.47	13.50
Front/depth ratio (typical dwelling)	0.85	m2 adiabatic party wall	45.34	49.10
Front (typical building) (m)	8.86	m2 roof	30.78	33.33
% of party walls in contact with exterior	25	m2 plinth	30.78	33.33

Cc 61-80



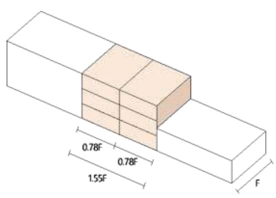
Average floor area of typical	94.78	Envelope surfaces	Per dwelling	Per 100 m2
No of storeys in building	3	m2 façade	81.80	86.31
No of dwellings per storey	2	m2 façade SOLID	44.98	47.46
Front/depth ratio (typical building)	1.55	m2 façade OPENINGS	12.79	13.50
Front/depth ratio (typical dwelling)	0.78	m2 adiabatic party wall	24.03	25.35
Front (typical building) (m)	17.16	m2 roof	31.59	33.33
% of party walls in contact with exterior	25	m2 plinth	31.59	33.33

Cc 81-07



Average floor area of typical	99.62	Envelope surfaces	Per dwelling	Per 100 m2
No of storeys in building	3	m2 façade	83.86	84.18
No of dwellings per storey	2	m2 façade SOLID	45.78	45.96
Front/depth ratio (typical building)	1.55	m2 façade OPENINGS	13.45	13.50
Front/depth ratio (typical dwelling)	0.78	m2 adiabatic party wall	24.63	24.73
Front (typical building) (m)	17.59	m2 roof	33.21	33.33
% of party walls in contact with exterior	25	m2 plinth	33.21	33.33

Cc 08-11

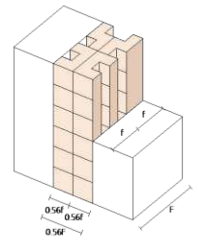


Average floor area of typical	101.80	Envelope surfaces	Per dwelling	Per 100 m2
No of storeys in building	3	m2 façade	84.77	83.28
No of dwellings per storey	2	m2 façade SOLID	46.13	45.32
Front/depth ratio (typical building)	1.55	m2 façade OPENINGS	13.74	13.50
Front/depth ratio (typical dwelling)	0.78	m2 adiabatic party wall	24.90	24.46
Front (typical building) (m)	17.78	m2 roof	33.93	33.33
% of party walls in contact with exterior	25	m2 plinth	33.93	33.33

MITMA. (2019) ‘Segmentation of the residential stock in Spain into type clusters’. Study (01) for the 2020 ERESEE.

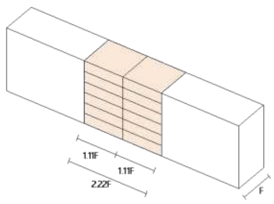
Figure A.1.3. Values of the geometric characteristics of multi-family housing clusters in buildings with more than three storeys (Bb).

Bb <40



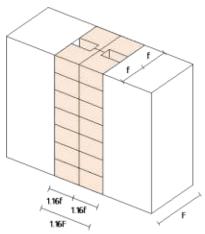
Average floor area of typical	94.23	Envelope surfaces	Per dwelling	Per 100 m2
No of storeys in building	6	m^2 façade	81.46	86.44
No of dwellings per storey	4	m^2 façade SOLID	41.31	43.84
Front/depth ratio (typical building)	0.56	m^2 façade OPENINGS	12.72	13.50
Dwelling front/depth (f) ratio (typical dwelling)	0.56	m^2 adiabatic party wall	27.43	29.10
Front (typical building) (m)	15.36	m^2 roof	15.71	16.67
% of party walls in contact with exterior	25	m^2 plinth	15.71	16.67

Bb 41-60



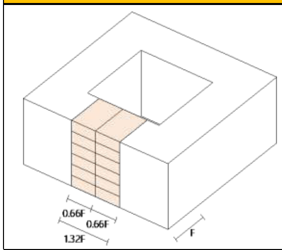
Average floor area of typical	90.75	Envelope surfaces	Per dwelling	Per 100 m2
No of storeys in building	6	m^2 façade	84.41	93.01
No of dwellings per storey	2	m^2 façade SOLID	45.92	50.60
Front/depth ratio (typical building)	2.22	m^2 façade OPENINGS	12.25	13.50
Front/depth ratio (typical dwelling)	1.11	m^2 adiabatic party wall	26.24	28.92
Front (typical building) (m)	20.06	m^2 roof	15.13	16.67
% of party walls in contact with exterior	-	m^2 plinth	15.13	16.67

Bb 61-80



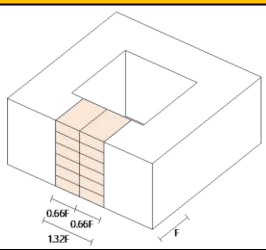
Average floor area of typical	93.66	Envelope surfaces	Per dwelling	Per 100 m2
No of storeys in building	7	m^2 façade	86.47	92.33
No of dwellings per storey	4	m^2 façade SOLID	47.74	50.98
Front/depth ratio (typical building)	1.16	m^2 façade OPENINGS	12.64	13.50
Dwelling front/depth (f) ratio (typical dwelling)	1.16	m^2 adiabatic party wall	26.09	27.85
Front (typical building) (m)	20.82	m^2 roof	13.38	14.29
% of party walls in contact with exterior	-	m^2 plinth	13.38	14.29

Bb 81-07



Average floor area of typical	99.50	Envelope surfaces	Per dwelling	Per 100 m2
No of storeys in building	6	m^2 façade	82.62	83.03
No of dwellings per storey	2	m^2 façade SOLID	33.60	33.77
Front/depth ratio (typical building)	1.32	m^2 façade OPENINGS	13.43	13.50
Front/depth ratio (typical dwelling)	0.66	m^2 adiabatic party wall	35.58	35.76
Front (typical building) (m)	16.22	m^2 roof	16.58	16.67
% of party walls in contact with exterior	-	m^2 plinth	16.58	16.67

Bb 08-11



Average floor area of typical	101.52	Envelope surfaces	Per dwelling	Per 100 m2
No of storeys in building	6	m^2 façade	83.45	82.20
No of dwellings per storey	2	m^2 façade SOLID	33.80	33.30
Front/depth ratio (typical building)	1.32	m^2 façade OPENINGS	13.70	13.50
Front/depth ratio (typical dwelling)	0.66	m^2 adiabatic party wall	35.94	35.41
Front (typical building) (m)	16.38	m^2 roof	16.92	16.67
% of party walls in contact with exterior	-	m^2 plinth	16.92	16.67

MITMA. (2019) 'Segmentation of the residential stock in Spain into type clusters'. Study (01) for the 2020 ERESEE.

ANNEX A.2. CLASSIFICATION OF DWELLINGS AND CONSUMPTION BY PROVINCE AND CTE CLIMATIC ZONE.

Figure A.2.1 Classification of dwellings and consumption by province and CTE climatic zone.

			Viviendas Totales INE	Viviendas Principales consideradas	Consumo total GWh·año	Consumo vivienda kWh/viv·año
			18.771.653	**16.598.127**	**77.966**	**4.697**
Zona A			**2.292.397**	**1.373.589**	**3.178**	**2.314**
P04	A4	Almería	268.210	263.182	443	1.682
P11	A3	Cádiz	471.168	462.335	837	1.810
P29	A3	Málaga	660.471	648.072	1.899	2.930
P35	A3	Palmas, Las	443.177	0	0	0
P38	A3	Santa Cruz de Tenerife	422.159	0	0	0
P52	A3	Melilla	27.212	0	0	0
Zona B			**4.621.559**	**4.464.174**	**12.540**	**2.809**
P03	B4	Alicante/Alacant	760.112	734.244	1.805	2.459
P07	B3	Balears, Illes	465.251	453.211	1.544	3.407
P12	B3	Castellón/Castelló	230.467	222.613	661	2.968
P14	B4	Córdoba	304.322	298.618	1.083	3.627
P21	B4	Huelva	198.523	194.796	523	2.683
P30	B3	Murcia	549.473	536.172	1.207	2.251
P41	B4	Sevilla	737.815	723.969	1.961	2.709
P43	B3	Tarragona	321.158	309.411	1.296	4.188
P46	B3	Valencia/València	1.026.107	991.140	2.460	2.482
P51	B3	Ceuta	28.331	0	0	0
Zona C			**6.295.313**	**5.837.386**	**27.194**	**4.659**
P06	C4	Badajoz	265.655	237.425	1.089	4.588
P08	C2	Barcelona	2.278.865	2.195.512	10.986	5.004
P10	C4	Cáceres	163.984	146.555	694	4.733
P15	C1	Coruña, A	450.752	401.641	1.622	4.038
P17	C2	Girona	295.480	284.673	1.651	5.798
P18	C3	Granada	369.269	362.343	2.205	6.086
P20	C1	Gipuzkoa	287.801	253.011	749	2.960
P23	C4	Jaén	243.903	239.330	1.127	4.707
P32	C2	Ourense	131.629	117.288	802	6.839
P33	C1	Asturias	453.269	399.909	1.509	3.773
P36	C1	Pontevedra	368.919	328.725	1.354	4.118
P39	C1	Cantabria	241.496	214.256	784	3.659
P45	C4	Toledo	260.786	231.670	1.465	6.324
P48	C1	Bizkaia	483.505	425.048	1.159	2.726
Zona D			**5.111.104**	**4.519.052**	**30.406**	**6.728**
P01	D1	Araba/Álava	141.360	124.262	957	7.704
P02	D3	Albacete	151.047	134.185	1.082	8.066
P13	D3	Ciudad Real	193.041	171.490	1.142	6.658
P16	D2	Cuenca	78.514	69.745	646	9.257
P19	D3	Guadalajara	100.312	89.110	735	8.252
P22	D2	Huesca	88.535	78.345	615	7.856
P25	D3	Lleida	179.469	158.702	994	6.265
P26	D2	Rioja, La	129.841	114.653	834	7.274
P27	D1	Lugo	135.412	120.659	774	6.413
P28	D3	Madrid	2.641.725	2.326.409	12.750	5.480
P31	D1	Navarra	258.222	228.791	2.001	8.745
P34	D1	Palencia	66.428	59.463	716	12.037
P37	D2	Salamanca	140.818	126.047	1.375	10.910
P40	D2	Segovia	61.616	55.148	610	11.059
P44	D2	Teruel	53.436	47.288	408	8.629
P47	D2	Valladolid	218.616	195.684	2.311	11.811
P49	D2	Zamora	74.685	66.850	598	8.939
P50	D3	Zaragoza	398.027	352.221	1.858	5.276
Zona E			**451.285**	**403.926**	**4.647**	**11.505**
P05	E1	Ávila	65.465	58.596	548	9.360
P09	E1	Burgos	149.673	133.966	1.547	11.550
P24	E1	León	198.825	177.963	2.129	11.965
P42	E1	Soria	37.322	33.401	422	12.634

	Total dwellings (INE)
	Main dwellings considered

	Total consumption in GWh/year
	Consumption per dwelling kWh/dwelling/year
	Zone
	18 771 653
	268 210
	27 212
	Almería
	Cádiz
	Malaga
	Palmas, Las
	Santa Cruz de Tenerife
	Melilla
	Alicante
	Balearic Islands
	Castellón/Castelló
	Córdoba
	Huelva
	Murcia
	Sevilla
	Tarragona
	Valencia
	Ceuta
	Badajoz
	Barcelona
	Cáceres
	A Coruña
	Girona
	Granada
	Gipuzkoa
	Jaén
	Ourense
	Asturias
	Pontevedra
	Cantabria
	Toledo
	Bizkaia
	Araba/Álava
	Albacete
	Ciudad Real
	Cuenca
	Guadalajara
	Huesca
	Lleida
	Rioja
	Lugo
	Madrid
	Navarre
	Palencia
	Salamanca
	Segovia
	Teruel
	Valladolid
	Zamora
	Zaragoza
	Ávila
	Burgos
	León
	Soria

Source: Cyclical, for MITMA.

ANNEX A.3. CRITERIA FOR THE DESIGN OF THE MATRICES FOR CHANGES OF INTALLATIONS.

In selecting the criteria to be used in the matrices for changes of installations, the starting point was the study carried out by the Spanish Technical Association for Climate Control and Refrigeration (ATECYR) for MITMA in 2019, as part of the preparatory work for the 2020 ERESEE: *'Report on the prospects and future development of heating and cooling and DHW systems in residential buildings.'*

In that work, each installation is classified with three codes separated by an underscore. Thus, most commonly, we find nomenclature of the kind ξ_σ_β where:

- ξ indicates the type of thermal installation. It can have only one of the following letters:
  - I - individual installation
  - C - collective installation
- σ expresses the service covered by the installation. It can have one or any of the following letters. If there are various, it indicates that the installation supplies more than one service.
  - C - heating (***c**alefacción*)
  - A - domestic hot water (***a**gua caliente sanitaria*)
  - R - cooling (***r**efrigeración)*
- β defines the type of equipment of which the thermal installation is made up. It can have one of the following letters:
  - UT - terminal unit (***u**nidad **t**erminal*) of the heating service (heater); the installation is made up of one heating terminal unit (for example, an electric radiator, a catalytic gas or liquid heater, a biomass stove, etc.).
  - A - the generating and emitting equipment that make up the thermal installation are connected by means of distribution using water as the heat-transfer fluid (for example, boiler and radiators). If it is an individual installation and the DHW service is covered by the same generator (I_CA_A), the generator in question is a mixed boiler; if, on the other hand, it is a collective installation and the DHW service is supplied by the same generator (C_CA_A), the generator is one or more boilers for the two services.
  - R - the thermal installation is connected by means of distribution using a coolant as the heat-transfer fluid - for example, a split or multi-split system - or with air distribution (duct distribution) and the thermal production is obtained by the expansion or condensation of a coolant. When the service is DHW (σ=A), the generator will be a heat pump. It services both heating and DHW.
  - CL is used to indicate a heater that is exclusively for DHW, whether it is an electric or gas heater.

For example:

I_C_R indicates that the thermal installation is an individual installation that only provides heating and that the system uses coolant (for example, a multi-split or single-split system or a refrigerating machine that cools the air by direct expansion, with the air then being distributed to each zone by means of vents and ducts).

C_CA_A indicates that the installation in question is a collective installation that supplies the needs of both heating and DHW and consists of a water-based system, the generator for which is a boiler that covers both services.

I_A_CL refers to an individual installation for DHW with an electric or other water heater.

With this nomenclature, an initial matrix was produced classifying the most common installations existing according to the different climatic zones:

Figure A.3.1. Likely situations with regard to installations in the existing building stock.

TIPOS DE INSTALACIONES HABITUALES EN EDIFICACIÓN EXISTENTE			VIVIENDA			BLOQUE DE VIVIENDAS					
			INSTALACIÓN INDIVIDUAL			INSTALACIÓN INDIVIDUAL			INSTALACIÓN COLECTIVA		
			SERVICIO			SERVICIO			SERVICIO		
ZC	REF	EQUIPOS	CLF	ACS	CLF + ACS	CLF	ACS	CLF + ACS	CLF	ACS	CLF + ACS
α	1	Calentador o Termo		I_A_CL			I_A_CL				
A y B	1	Calentador o Termo		I_A_CL			I_A_CL				
	2	Calefactor + Calentador o Termo	I_C_UT	I_A_CL		I_C_UT	I_A_CL				
	3	SPLIT (Clima) + Calentador o Termo	I_C_R	I_A_CL		I_C_R	I_A_CL				
	4	Caldera Mixta			I_CA_A			I_CA_A			
C	2	Calefactor + Calentador o Termo	I_C_UT	I_A_CL		I_C_UT	I_A_CL				
	3	SPLIT (Clima) + Calentador o Termo	I_C_R	I_A_CL		I_C_R	I_A_CL				
	4	Caldera Mixta			I_CA_A			I_CA_A			
	5	Caldera Sólo Calefacción + Calentador o Termo					I_A_CL		C_C_A		
	6	Caldera dos servicios									C_CA_A
D y E	2	Calefactor + Calentador o Termo	I_C_UT	I_A_CL							
	4	Caldera Mixta			I_CA_A			I_CA_A			
	5	Caldera Sólo Calefacción + Calentador o Termo					I_A_CL		C_C_A		
	6	Caldera dos servicios									C_CA_A

	USUAL TYPES OF INSTALLATIONS IN EXISTING BUILDINGS
	ZC:
	REF:
	EQUIPMENT
	DWELLING
	INDIVIDUAL INSTALLATION
	SERVICE
	BLOCK OF DWELLINGS
	INDIVIDUAL INSTALLATION
	SERVICE
	CLF:
	DHW
	HEAT + DHW
	COLLECTIVE INSTALLATION
	Electric or other water heater
	Heater + Electric or other water heater
	SPLIT (Climate) + Electric or other water heater
	Mixed boiler
	Heating-only boiler + Electric or other water heater
	Two-service boiler

Source: Spanish Technical Association for Climate Control and Refrigeration, for MITMA. ATECYR (2019) 'Report on the prospects and future development of heating and cooling and DHW systems in residential buildings'.

To make it easier to interpret the matrix, the six types of installation that appear in it are discussed below, justifying their use in each climatic zone in which they usually occur.

1. (I_A_CL) electric or other DHW heater: This relates to dwellings where there is only the DHW service, they are always individual solutions and they are only found in zones with very mild winters; it is, therefore, the typical installation in zone alpha and possible in zones A and B; in those zones, there are also installations with split systems for cooling, which are not considered here, as the study is confined to heating and DHW installations.

2. (I_C_UT + I_A_CL) heater plus electric or other DHW heater: In zones with very low heating demands and where this service is used for very few hours, it is very typical to provide it with unitary equipment on each premises; the DHW is provided with an electric or other water heater; its scope of application is limited to climatic zones A and B. It is only applicable to individual installations.

3. (I_C_R + I_A_CL) split system plus electric or other DHW heater: With cooling, split or multi-split systems are used and, very often, with ducts; almost always involving a reversible heat pump and, therefore, as well as cooling, it provides heating, and the installation is supplemented with an electric or other heater for the DHW; it is a typical solution in zones with mild winters, but with hotter summers (zones A, B and C); in zone alpha, it is very typical, but with cooling-only equipment, which is, therefore, not included in this study.

4. (I_CA_A) mixed boiler: In zones where heating is required, both in single-family dwellings and in blocks, mixed boilers are used for heating and DHW services; it is a very widespread installation type in zones C, D and E and, to a lesser extent, in zones A and B.

5. (C_C_A + I_A_CL) boiler (heating only) and electric or other DHW heater: This combination is typical for block-type buildings in cold climatic zones, where the boiler is part of a collective heating installation and the DHW for each dwelling is provided individually with electric or other water heaters.

6. It is a solution that was used frequently in boiler rooms with coal-fired boilers, in which, when the fuel was changed, typically to natural gas, the individual production of DHW was maintained.

7. (C_CA_A) collective boiler: Collective heating and DHW installations are more widespread the colder the climatic zone in winter, i.e. zones C, D and E.

Based on these hypotheses regarding the initial situation, matrices were produced with the changes proposed for each climatic zone. In each table, the boxes can have three different background colours:

- o Red entails a change of system and, therefore, as well as replacing the production equipment, other alterations must be made to the installations (removing or changing the radiators, installing a distribution circuit and radiators, etc.).
- o Yellow indicates that the type of installation - individual or collective - proposed retains the existing system and, therefore, the refurbishment is based on improving the production equipment (for example, simply changing the boiler).
- o Green indicates that only general improvements are proposed, such as changing thermostatic valves, etc.

Figure A.3.2. Matrix of solutions for winter climatic zone α.

Zona Climática α		Equipos propuestos para la Rehabilitación	VIVIENDA UNIFAMILIAR			BLOQUE DE VIVIENDAS					
			INSTALACIÓN INDIVIDUAL			INSTALACIÓN INDIVIDUAL			INSTALACIÓN COLECTIVA		
			SERVICIO			SERVICIO			SERVICIO		
REF	EQUIPO INICIAL		CLF	ACS	CLF + ACS	CLF	ACS	CLF + ACS	CLF	ACS	CLF + ACS
1 (*)	Calentador	Calentador Condensación (**)		I_A_CL			I_A_CL				
	Termo	Termo Smart + Energía Solar (***)		I_A_CL			I_A_CL				
	Calentador o Termo	Bomba de Calor		I_A_R			I_A_R				

(*) Siempre se debe analizar si resulta técnica y económicamene rentable la integración de energía solar térmica para ACS
(**) Si existe posibilidad de conexión a red de gas natural será este el combustible preferente
(***) Siempre que haya termos eléctricos se debe contemplar la instalación de energía solar térmica para el 70% del consumo de ACS

	Climatic Zone
	REF:
	ORIGINAL EQUIPMENT
	Heater
	Electric Heater
	Electric or other water heater
	Equipment proposed
	Condensing Heater (**)
	Smart Electric Heater + Solar Energy (***)

	Heat Pump
	SINGLE-FAMILY DWELLING
	INDIVIDUAL INSTALLATION
	SERVICE
	BLOCK OF DWELLINGS
	COLLECTIVE INSTALLATION
	SERVICE
	CLF:
	DHW
	HEAT + DHW
	(*) Whether it is technically and financially feasible to integrate solar thermal energy for DHW must always be analysed.
	(**) If it is possible to connect to the natural gas network, that will be the preferred fuel.
	(***) Wherever there are electric water heaters, installing solar thermal energy for 70% of the DHW consumption must be considered.

Source: Spanish Technical Association for Climate Control and Refrigeration, for MITMA. ATECYR (2019) 'Report on the prospects and future development of heating and cooling and DHW systems in residential buildings'.

Figure A.3.3. Matrix of solutions for winter climatic zones A and B.

Zonas Climáticas A y B		Equipos propuestos para la Rehabilitación	VIVIENDA UNIFAMILIAR INSTALACIÓN INDIVIDUAL SERVICIO			BLOQUE DE VIVIENDAS INSTALACIÓN INDIVIDUAL SERVICIO			BLOQUE DE VIVIENDAS INSTALACIÓN COLECTIVA SERVICIO		
REF	EQUIPO INICIAL		CLF	ACS	CLF + ACS	CLF	ACS	CLF + ACS	CLF	ACS	CLF + ACS
1 (*)	Calentador	Calentador Condensación (**)		I_A_CL			I_A_CL				
	Termo	Termo Smart + Energía Solar (***)		I_A_CL			I_A_CL				
	Calentador o Termo	Bomba de Calor		I_A_R			I_A_R				
2 (*)	Calefactor + Calentador	Calentador Condensación (**)	I_C_UT	I_A_CL		I_C_UT	I_A_CL				
	Calefactor + Termo	Termo Smart + Energía Solar (***)	I_C_UT	I_A_CL		I_C_UT	I_A_CL				
	Calefactor + Calentador o Termo	Bomba de Calor	I_C_UT	I_A_R		I_C_UT	I_A_R				
	Calefactor + Calentador	Split + Calentador Condensación (**)	I_C_R	I_A_CL		I_C_R	I_A_CL				
	Calefactor + Termo	Split + Termo Smart + Energía Solar (***)	I_C_R	I_A_CL		I_C_R	I_A_CL				
	Calefactor + Calentador o Termo	Bomba de Calor			I_CA_R			I_CA_R			
3 (*)	Split (Clima) + Calentador	Split + Calentador Condensación (**)	I_C_R	I_A_CL		I_C_R	I_A_CL				
	Split (Clima) + Termo	Split + Termo Smart + Energía Solar (***)	I_C_R	I_A_CL		I_C_R	I_A_CL				
	Split (Clima) + Calentador o Termo	Split (Clima) + Bomba de Calor	I_C_R	I_A_R		I_C_R	I_A_R				
	Split (Clima) + Calentador o Termo	Bomba de Calor			I_CA_R			I_CA_R			
4 (*)	Caldera Mixta	Caldera Mixta Condensación (**)			I_CA_A			I_CA_A			
		Caldera Mixta Biomasa (****)			I_CA_A						
		Bomba de Calor			I_CA_R			I_CA_R			

(*) Siempre se debe analizar si resulta técnica y económicamene rentable la alternativa de energía solar térmica para ACS
(**) Si existe posibilidad de conexión a red de gas natural se debe cambiar a este combustible
(***) Siempre que haya termos eléctricos se debe contemplar la instalación de energía solar térmica para el 70% del consumo de ACS
(****) Sólo para edificios residenciales unifamiliares en poblaciones de menos de 20.000 habitantes

	Climatic Zones
	Equipment proposed
	SINGLE-FAMILY DWELLING
	INDIVIDUAL INSTALLATION
	SERVICE
	BLOCK OF DWELLINGS
	COLLECTIVE INSTALLATION
	SERVICE
	CLF:
	DHW
	HEAT + DHW
	Heater

	Electric Heater
	Heater + Water Heater
	Heater + Electric Water Heater
	Heater + Electric or other water heater
	Split (Climate) + Water Heater
	Split (Climate) + Electric Water Heater
	Split (Climate) + Electric or Other Water Heater
	Mixed boiler
	Condensing Heater (**)
	Smart Electric Heater + Solar Energy (***)
	Heat Pump
	Split + Condensation Heater (**)
	Split + Smart Electric Heater + Solar Energy (***)
	Heat Pump
	Mixed Condensing Boiler (**)
	Mixed Biomass Boiler (****)
	Heat Pump
	(*) Whether the alternative of solar thermal energy for DHW is technically and financially feasible must always be analysed.
	(**) If it is possible to connect to the natural gas network, it is necessary to change to that fuel.
	(***) Wherever there are electric water heaters, installing solar thermal energy for 70% of the DHW consumption must be considered.
	(****) Only for single-family residential buildings in towns with fewer than 20 000 inhabitants.

Source: Spanish Technical Association for Climate Control and Refrigeration, for MITMA. ATECYR (2019) 'Report on the prospects and future development of heating and cooling and DHW systems in residential buildings'.

Figure A.3.4. Matrix of solutions for winter climatic zone C.

Zona Climática C		Equipos propuestos para la Rehabilitación	VIVIENDA UNIFAMILIAR			BLOQUE DE VIVIENDAS					
			INSTALACIÓN INDIVIDUAL			INSTALACIÓN INDIVIDUAL			INSTALACIÓN COLECTIVA		
			SERVICIO			SERVICIO			SERVICIO		
REF	EQUIPO INICIAL		CLF	ACS	CLF + ACS	CLF	ACS	CLF + ACS	CLF	ACS	CLF + ACS
2 (*)	Calefactor + Calentador o Termo	Caldera Mixta Condensación (**)			I_CA_A			I_CA_A			
		Bomba de Calor			I_CA_R			I_CA_R			
	Calefactor + Calentador	Split + Calentador Condensación (**)	I_C_R	I_A_CL		I_C_R	I_A_CL				
	Calefactor + Termo	Split + Termo Smart + Energía Solar (***)	I_C_R	I_A_CL		I_C_R	I_A_CL				
3 (*)	Split (Clima) + Calentador	Split + Calentador Condensación (**)	I_C_R	I_A_CL		I_C_R	I_A_CL				
	Split (Clima) + Termo	Split + Termo Smart + Energía Solar (***)	I_C_R	I_A_CL		I_C_R	I_A_CL				
	Split (Clima) + Calentador o Termo	Split (Clima) + Bomba de Calor	I_C_R	I_A_R		I_C_R	I_A_R				
	Split (Clima) + Calentador o Termo	Bomba de Calor			I_CA_R			I_CA_R			
4 (*)	Caldera Mixta	Caldera Mixta Condensación (**)			I_CA_A			I_CA_A			
		Caldera Mixta Biomasa (****)			I_CA_A						
		Bomba de Calor			I_CA_R			I_CA_R			
5 (*)	Caldera Sólo Calefacción + Calentador o Termo	Caldera + Calentador Ambos Condensación (**)					I_A_CL		C_C_A		
		Caldera Condensación (**) + Bomba de Calor					I_A_R		C_C_A		
6 (*)	Caldera dos servicios	Caldera dos servicios Condensación (**)									C_CA_A
		Bomba de Calor + Caldera Condensación									C_CA_R
(*) Siempre se debe analizar si resulta técnica y económicamene rentable la alternativa de energía solar térmica para ACS											
(**) Si existe posibilidad de conexión a red de gas natural se debe cambiar a este combustible											
(***) Siempre que haya termos eléctricos se debe contemplar la instalación de energía solar térmica para el 70% del consumo de ACS											
(****) Sólo para edificios residenciales unifamiliares en poblaciones de menos de 20.000 habitantes											

	Climatic Zone C
	Equipment proposed for the renovation.
	ORIGINAL EQUIPMENT
	SINGLE-FAMILY DWELLING
	INDIVIDUAL INSTALLATION
	SERVICE
	BLOCK OF DWELLINGS
	COLLECTIVE INSTALLATION
	SERVICE
	CLF:
	DHW
	HEAT + DHW
	Heater + Water Heater
	Heater + Electric Water Heater
	Heater + Electric or other water heater
	Split (Climate) + Water Heater
	Split (Climate) + Electric Water Heater
	Split (Climate) + Electric or Other Water Heater
	Mixed boiler
	Heating-Only Boiler
	Two-Service Boiler
	Condensing Heater (**)
	Smart Electric Heater + Solar Energy (***)
	Heat Pump
	Split + Condensation Heater (**)
	Split + Smart Electric Heater + Solar Energy (***)
	Heat Pump
	Mixed Condensing Boiler (**)
	Mixed Biomass Boiler (****)
	Heat Pump
	Boiler + Water Heater Both
	Condensing (**)

	Two-Service Condensing Boiler (**)
	(*) Whether the alternative of solar thermal energy for DHW is technically and financially feasible must always be analysed.
	(**) If it is possible to connect to the natural gas network, it is necessary to change to that fuel.
	(***) Wherever there are electric water heaters, installing solar thermal energy for 70% of the DHW consumption must be considered.
	(****) Only for single-family residential buildings in towns with fewer than 20 000 inhabitants.

Source: Spanish Technical Association for Climate Control and Refrigeration, for MITMA. ATECYR (2019) 'Report on the prospects and future development of heating and cooling and DHW systems in residential buildings'.

Figure A.3.5. Matrix of solutions for winter climatic zones D and E.

Zonas Climáticas D y E		Equipos propuestos para la Rehabilitación	VIVIENDA UNIFAMILIAR			BLOQUE DE VIVIENDAS					
			INSTALACIÓN INDIVIDUAL			INSTALACIÓN INDIVIDUAL			INSTALACIÓN COLECTIVA		
			SERVICIO			SERVICIO			SERVICIO		
REF	EQUIPO INICIAL		CLF	ACS	CLF + ACS	CLF	ACS	CLF + ACS	CLF	ACS	CLF + ACS
2 (*)	Calefactor + Calentador o Termo	Caldera Mixta Condensación (**)			I_CA_A			I_CA_A			
4 (*)	Caldera Mixta	Caldera Mixta Condensación (**)			I_CA_A			I_CA_A			
		Caldera Mixta Biomasa (****)			I_CA_A						
5 (*)	Caldera Solo Calefacción + Calentador o Termo	Caldera + Calentador Ambos Condensación (**)					I_A_CL		C_C_A		
6 (*)	Caldera dos servicios	Caldera dos servicios Condensación (**)									C_CA_A
(*) Siempre se debe analizar si resulta técnica y económicamene rentable la alternativa de energía solar térmica para ACS											
(**) Si existe posibilidad de conexión a red de gas natural se debe cambiar a este combustible											
(****) Sólo para edificios residenciales unifamiliares en poblaciones de menos de 20.000 habitantes											

	Climatic Zones D and E
	Equipment proposed for the renovation.
	SINGLE-FAMILY DWELLING
	INDIVIDUAL INSTALLATION
	SERVICE
	BLOCK OF DWELLINGS
	COLLECTIVE INSTALLATION
	CLF:
	DHW
	HEAT + DHW
	ORIGINAL Equipment
	Heater + Electric or other water heater
	Mixed boiler
	Heating-Only Boiler + Electric or Other Water Heater
	Two-service boiler
	Mixed Condensing Boiler (**)
	Mixed Biomass Boiler (**)
	Boiler + Water Heater Both Condensing (**)
	(*) Whether the alternative of solar thermal energy for DHW is technically and financially feasible must always be analysed.
	(**) If it is possible to connect to the natural gas network, it is necessary to change to that fuel.
	(****) Only for single-family residential buildings in towns with fewer than 20 000 inhabitants.

Source: Spanish Technical Association for Climate Control and Refrigeration, for MITMA. ATECYR (2019) 'Report on the prospects and future development of heating and cooling and DHW systems in residential buildings'.

ANNEX A.4. PERFORMANCE OF INSTALLATIONS.

The performance of the installations considered is as follows:

Figure A.4.1. Performance table for DHW.

Single-family dwelling	Efficiency of equipment before 2015	Efficiency of equipment 2015	Efficiency of equipment 2017
Coal-fired DHW heater	0.30		
Butane/propane-fired DHW heater	0.30	0.36	0.36
Oil-fired DHW heater	0.30	0.34	0.35
Natural gas-fired DHW heater	0.30	0.38	0.38
Solar panels	0.40	0.40	0.40
Biomass-fired DHW heater	0.22		
Electric DHW heater (electric water heater or electric boiler)	0.30	0.33	0.33
Butane/propane-fired mixed boiler	0.30	0.36	0.36
Oil-fired mixed boiler	0.30	0.34	0.35
Natural gas-fired mixed boiler	0.30	0.38	0.38
Biomass-fired mixed boiler (solid biomass other than pellets and briquettes)	0.22		
Mixed boiler running on pellets and briquettes	0.34	0.34	0.34
Direct-use geothermal energy	0.40	0.40	0.40
Electric mixed boiler	0.40	0.40	0.40

Single-family dwelling	Efficiency of equipment 2020	Efficiency of equipment 2025	Efficiency of equipment 2030
Butane/propane-fired DHW heater	0.37	0.37	0.38
Oil-fired DHW heater	0.35	0.36	0.37
Natural gas-fired DHW heater	0.39	0.40	0.40
Solar panels	0.40	0.40	0.40
Electric DHW heater (electric water heater or electric boiler)	0.37	0.37	0.38
Butane/propane-fired mixed boiler	0.37	0.37	0.38
Oil-fired mixed boiler	0.35	0.36	0.37
Natural gas-fired mixed boiler	0.39	0.40	0.40
Mixed boiler running on pellets and briquettes	0.35	0.35	0.36
Direct-use geothermal energy	0.40	0.40	0.40
Electric mixed boiler	0.40	0.40	0.40

Multi-family dwellings with collective systems	Efficiency of equipment before 2015	Efficiency of equipment 2015	Efficiency of equipment 2017
Coal-fired DHW heater	0.30		
Butane/propane-fired DHW heater	0.30	0.36	0.36
Oil-fired DHW heater	0.30	0.34	0.35
Natural gas-fired DHW heater	0.30	0.38	0.38
Solar panels	0.40	0.40	0.40
Electric DHW heater (electric water heater or electric boiler)	0.30	0.33	0.33

Multi-family dwellings with collective systems	Efficiency of equipment 2020	Efficiency of equipment 2025	Efficiency of equipment 2030
Butane/propane-fired DHW heater	0.37	0.37	0.38
Oil-fired DHW heater	0.35	0.36	0.37
Natural gas-fired DHW heater	0.39	0.40	0.40
Solar panels	0.40	0.40	0.40
Electric DHW heater (electric water heater or electric boiler)	0.34	0.34	0.35

Multi-family dwellings with individual systems	Efficiency of equipment before 2015	Efficiency of equipment 2015	Efficiency of equipment 2017
Coal-fired DHW heater	0.30		
Butane/propane-fired DHW heater	0.30	0.36	0.36
Oil-fired DHW heater	0.30	0.34	0.35
Natural gas-fired DHW heater	0.30	0.38	0.38
Electric DHW heater (electric water heater or electric boiler)	0.30	0.33	0.33
Butane/propane-fired mixed boiler	0.30	0.36	0.36
Oil-fired mixed boiler	0.30	0.34	0.35
Natural gas-fired mixed boiler	0.30	0.38	0.38
Electric mixed boiler	0.30	0.33	0.33

Multi-family dwellings with individual systems	Efficiency of equipment 2020	Efficiency of equipment 2025	Efficiency of equipment 2030
Butane/propane-fired DHW heater	0.37	0.37	0.38
Oil-fired DHW heater	0.35	0.36	0.37
Natural gas-fired DHW heater	0.39	0.40	0.40
Electric DHW heater	0.34	0.34	0.35
Butane/propane-fired mixed boiler	0.37	0.37	0.38
Oil-fired mixed boiler	0.35	0.36	0.37
Natural gas-fired mixed boiler	0.39	0.40	0.40
Electric mixed boiler	0.34	0.34	0.35

Source: CSIC-Instituto de Ciencias de la Construcción Eduardo Torroja [Eduardo Torroja Institute for Construction Science] (Construction Quality Unit).

Figure A.4.2. Performance table for heating.

Single-family dwelling	Efficiency of equipment before 2015	Efficiency of equipment 2015	Efficiency of equipment 2017
Coal boiler	0.73	0.00	0.00
Oil boiler	0.75	0.86	0.87
LPG boiler	0.75	0.90	0.91
NG boiler	0.85	0.95	0.96
Biomass boiler	0.56	0.85	0.86
Biomass fire or stove	0.30		
LPG stove	0.78		
Joule effect boiler/radiator	1.00	1.00	1.00
NG convectors	0.78		
Solar heat	0.00	1.00	1.00
Stove and other equipment running on coal	0.78		
Butane/propane-fired stove	0.78		
Heat pump (heat)	2.20	3.20	3.32
Reversible non-renewable aerothermal heat pump	2.20		
Reversible renewable aerothermal heat pump	2.90	3.20	3.32

Single-family dwelling	Efficiency of equipment 2020	Efficiency of equipment 2025	Efficiency of equipment 2030
Oil boiler	0.88	0.90	0.91
LPG boiler	0.92	0.94	0.96
NG boiler	0.97	0.99	1.01
Biomass boiler	0.87	0.89	0.90
Joule effect boiler/radiator	1.00	1.00	1.00
Solar heat	1.00	1.00	1.00
Heat pump (heat)	3.50	3.90	4.40
Reversible renewable aerothermal heat pump	3.50	3.90	4.40

Multi-family dwellings with collective systems	Efficiency of equipment before 2015	Efficiency of equipment 2015	Efficiency of equipment 2017
Coal boiler	0.73		
Oil boiler	0.75	0.87	0.88
LPG boiler	0.75	0.90	0.91
NG boiler	0.85	0.95	0.96

Existing multi-family dwelling with collective equipment	Efficiency of equipment 2020	Efficiency of equipment 2025	Efficiency of equipment 2030
Oil boiler	0.90	0.91	0.91
LPG boiler	0.92	0.94	0.96
NG boiler	0.97	0.99	1.01

Multi-family dwellings with individual systems	Efficiency of equipment before 2015	Efficiency of equipment 2015	Efficiency of equipment 2017
Coal boiler	0.73		
Oil boiler	0.75	0.86	0.87
LPG boiler	0.75	0.90	0.91
NG boiler	0.85	0.95	0.96
LPG stove	0.78	1.00	1.00
Joule effect boiler/radiator	1.00		
NG convectors	0.78		
Stove and other equipment running on coal	0.78		
Stove and other equipment running on butane/propane	0.78		
Heat pump (heat)	2.20	3.20	3.32
Reversible non-renewable aerothermal heat pump	2.20		
Reversible renewable aerothermal heat pump	2.90	3.20	3.32

Existing multi-family dwelling with individual equipment	Efficiency of equipment 2020	Efficiency of equipment 2025	Efficiency of equipment 2030
Oil boiler	0.88	0.90	0.91
LPG boiler	0.92	0.94	0.96
NG boiler	0.97	0.99	1.01
Joule effect boiler/radiator	1.00	1.00	1.00
Heat pump (heat)	3.50	3.90	4.40
Reversible renewable aerothermal heat pump	3.50	3.90	4.40

Source: CSIC-Instituto de Ciencias de la Construcción Eduardo Torroja [Eduardo Torroja Institute for Construction Science] (Construction Quality Unit).

ANNEX A.5. RENOVATION MENUS IN CASES OF ENERGY POVERTY.

Menu for external intervention on multi-family buildings
Interventions on the outside of the building envelope for multi-family buildings.
This is considered the main intervention menu for urban environments, where energy poverty is concentrated in multi-family buildings in vulnerable neighbourhoods.

Intervention		*Unit cost:*
ETIS in walls		€54.26/m^2
Roof insulation		€70.42/m^2
ERESEE plinth		€41.95/m^2
External secondary glazing		€270.48/unit
Canopies to the south	Applies to mainland and Mediterranean	€300.00/unit

	Cost per dwelling:
Price range:	€6 608 - €10 592
Average price:	€8 856

Menu for internal intervention on multi-family buildings
Interventions on the inside of the building envelope for multi-family buildings.
This is considered the main intervention menu for rural settings, where energy poverty occurs in some dwellings in the building and not in others.

Intervention		*Unit cost:*
Internal lining with EPS, without cavity		€37.25/m^2
Internal lining of ceiling with EPS		€42.65/m^2
Replacement of aluminium joinery 4-15-6be		€370.00/unit
Canopies to the south	Applies to mainland and Mediterranean	€300.00/unit

	Cost per dwelling:
Price range:	€4 086 - €6 294
Average price:	€5 301

Menu for partial intervention on single-family buildings
Partial interventions on the outside of the building envelope for multi-family buildings.
The aim is to treat the main rooms of the dwellings (living room and bedrooms). This is considered the main intervention menu for single-family dwellings.

Intervention		*Unit cost:*
Internal lining with EPS, without cavity	Applied to 30% of the surface area	€37.25/m^2
Internal lining of ceiling with EPS	Applied to 30% of the surface area	€42.65/m^2
Replacement of aluminium joinery 4-15-6be	Applied to 30% of the openings	€370.00/unit
Canopies to the south	Applies to mainland and Mediterranean	€300.00/unit

	Cost per dwelling:
Price range:	€1 888 - €3 563
Average price:	€2 836

Menu for complete intervention on single-family buildings
Interventions on the outside of the building envelope for multi-family buildings.
In any event, this is considered a complementary menu, in both rural and urban contexts, as it is advisable in large households that use the entire dwelling.

Intervention		*Unit cost:*
EPS ETIS in walls		€75.62/m^2
Internal lining of ceiling with EPS		€42.65/m^2
Replacement of aluminium joinery 4-15-6be		€370.00/unit
Canopies to the south	Applies to mainland and Mediterranean	€300.00/unit

	Cost per dwelling:
Price range:	€8 812 - €16 628
Average price:	€13 282

ANNEX A.6. CRITERIA FOR PRORITISING ACTIONS IN CASES OF ENERGY POVERTY.

Figure A.6.1. General criteria.

Criterion 1: Stock to be renovated (2050)	
Dwellings, envelope to be renovated	**0.5**
Dwellings in poor condition	**0.1**
Other actions	**0.4**
Criterion 2: Distribution by decade	
2020-30	**0.3333333**
2030-40	**0.3333333**
2040-50	**0.3333333**
Criterion 3: Prioritisation of menus	
Priority menu	**0.75**
Secondary menu	**0.25**
Criterion 4: Prioritisation of Autonomous Community with	
>15%	**1**
<15%	**0.75**
Criterion 5: Prioritisation winter climate severity	
A	**0.7**
B	**0.8**
C	**0.9**
D	**1**
E	**1**

Source: MITMA.

Figure A.6.2. Application of the criteria by Autonomous Community.

		Urban municipalities						Rural municipalities							
		Multi-family buildings			Single-family buildings			Multi-family buildings			Single-family buildings				
		1. MF external menu	2. MF internal menu	No intervention	3. SF complete menu	4. SF partial menu	No intervention	1. MF external menu	2. MF internal menu	No intervention	3. SF complete menu	4. SF partial menu	5. Emergency kit	No intervention	
CA01	Andalusia	8%	3%	89%	3%	8%	89%	3%	8%	89%	3%	8%	0%	89%	
CA02	Aragon	10%	3%	86%	3%	10%	86%	3%	10%	86%	3%	10%	0%	86%	
CA03	Asturias	10%	3%	86%	3%	10%	86%	3%	10%	86%	3%	10%	0%	86%	
CA04	Balearic Islands	8%	3%	90%	3%	8%	90%	3%	8%	90%	3%	8%	0%	90%	
CA05	Canary Islands	9%	3%	88%	3%	9%	88%	3%	9%	88%	3%	9%	0%	88%	
CA06	Cantabria	10%	3%	87%	3%	10%	87%	3%	10%	87%	3%	10%	0%	87%	
CA07	Castile and Leon	11%	4%	85%	4%	11%	85%	4%	11%	85%	4%	11%	0%	85%	
CA08	Castile-La Mancha	12%	4%	84%	4%	12%	84%	4%	12%	84%	4%	12%	0%	84%	
CA09	Catalonia	10%	3%	87%	3%	10%	87%	3%	10%	87%	3%	10%	0%	87%	
CA10	Valencia	8%	3%	89%	3%	8%	89%	3%	8%	89%	3%	8%	0%	89%	
CA11	Extremadura	10%	3%	86%	3%	10%	86%	3%	10%	86%	3%	10%	0%	86%	
CA12	Galicia	9%	3%	87%	3%	9%	87%	3%	9%	87%	3%	9%	0%	87%	
CA13	Madrid	11%	4%	85%	4%	11%	85%	4%	11%	85%	4%	11%	0%	85%	
CA14	Murcia	8%	3%	89%	3%	8%	89%	3%	8%	89%	3%	8%	0%	89%	
CA15	Navarre	10%	3%	86%	3%	10%	86%	3%	10%	86%	3%	10%	0%	86%	
CA16	Basque Country	9%	3%	88%	3%	9%	88%	3%	9%	88%	3%	9%	0%	88%	
CA17	Rioja	11%	4%	85%	4%	11%	85%	4%	11%	85%	4%	11%	0%	85%	

Source: GBCe for MITMA.

ANNEX A.7. DESCRIPTION OF THE 'DENIO' MODEL USED IN THE MACROECONOMIC ANALYSIS.

The DENIO model is used in this study to analyse the economic impact of the different measures and scenarios of the PNIEC. DENIO (*Dinámico Econométrico Neokeynesiano Input-Output*) is a dynamic econometric neo-Keynesian model and represents a hybrid between an input-output econometric model and a computable general equilibrium (CGE) model. It is characterised by the integration of the institutional rigidities and frictions that mean that fiscal policies and interventions have a different impact in the short term and in the long term. In the long term, the economy always converges towards an equilibrium of full employment and, in that phase of equilibrium, the model works in a similar manner to a CGE model. Unlike a CGE model, DENIO explicitly describes an adjustment path towards that equilibrium.
DENIO is a disaggregated model, detailing 74 sectors, 88 products, 22 000 types of household and 16 categories of consumption. The equations are based on econometric estimation work, using data from the Spanish National Statistical Institute (Instituto Nacional de Estadística: INE), the Bank of Spain and EUROSTAT. The model is calibrated for the base year 2014. DENIO is inspired by the FIDELIO (Fully Interregional Dynamic Econometric Long-term Input-Output Model) model of the European Commission (Kratena et al., 2013, Kratena et al. 2017). The FIDELIO model has been used by the European Commission to analyse the economic impact of the Clean Air Package (Arto et al., 2015). A model with similar characteristics (DERIO: Dynamic Econometric Regional Input-Output model)[178] has also been used in the Basque Country to analyse the economic impact of the Basque Country's 2050 Climate Change Strategy.

Economic growth in DENIO is determined, in the long-term, by the growth in the total productivity of the factors (total factor productivity: TFP), associated with which is a price trajectory and, therefore, a trajectory in terms of the competitiveness of exports. Exports, which are, therefore, exogenous, are adjusted in the base scenario to the GDP growth trajectory, provided by other sources. Imports are endogenous and there is no equilibrium condition relating to the balance of trade.

There are two mechanisms acting in DENIO, which determine the Keynesian nature of the model in the short term and its CGE nature in the long term: (i) the heterogeneity of the marginal propensity to consume in relation to disposable income, depending on the state of the financial sector; and (ii) the effect on salaries/prices when the economy is at or below the equilibrium unemployment rate (Non-accelerating Inflation Rate of Unemployment: NAIRU). The marginal propensity to consume also varies by income group. The current version of DENIO simply assumes that that propensity is zero in quintiles 4 and 5 of the disposable income distribution.

That assumption has been derived from estimates of the long-term sensitivity of consumption to income (Kratena, et al., 2017). The Spanish economy, which came out of the eurozone crisis (2010-2012) with an unemployment rate of 20% and over-indebted households, is characterised, in the medium term, by debt deleveraging and falling unemployment. In this period, additional investment by the private sector (driven by political measures) or the public sector generates Keynesian multiplier effects. When the economy reaches the equilibrium of full employment and financial balance sheets are balanced, those multiplier effects disappear.
The household demand sub-model includes three levels. At the first level, the demand for durable goods (homes, vehicles) and the total demand for non-durables is derived. The second level links energy demand (in monetary and physical units) to the stock of durable goods (homes, vehicles, electrical appliances), taking into account the energy performance of the stock. At the third level, eight categories of demand for non-durable consumer goods (excluding energy) are determined in a flexible demand system (Almost Ideal Demand System), which are then divided into the 88 products of the production model. The model is estimated using microdata from the Family Budget Survey and the Living Conditions Survey prepared by the INE.

The input-output core of the model is based on supply and use tables from 2014 (latest available) prepared by the INE. The production model links the production structures (Leontief technologies) of the 74 sectors and 88 products to a translog model with four production factors (capital, labour, energy and the rest of the intermediate inputs). The demand for the energy factor is divided into 25 types, which, in turn, are linked to the model in physical units (terajoules and tonnes of CO2). All of the energy categories in the energy substitution model are linked directly to two parts of the model: (i) EUROSTAT's physical calculations (terajoules) of energy by industry (74 + households) and energy type (25); and (ii) the energy products and industries from the supply and use tables in monetary units. For that, a series of implicit prices are used that link energy uses/production in physical units (TJ) and in monetary terms. The high level of detail of the energy model makes it possible to link the DENIO model with bottom-up models of the energy/electricity sector (TIMES SINERGIA).

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[178] https://info.bc3research.org/es/2016/11/21/bc3-models-tools-derio-modelo-dinamico-econometrico-regional-inputoutput-del-pais-vasco/

The labour market is specified through wage curves, where wage increases by industry depend on productivity, the consumer price index and the distance from full employment. The demand for intermediate inputs is modelled in three steps. First, the translog model estimates the total demand for intermediates for each productive sector. Second, that demand is disaggregated using the productive structures from the supply table of the input-output framework. Finally, the intermediate demand is divided into domestic and imported products. Capital formation is also endogenous and is derived from the demand for capital by sector of the translog model, applying the product/sector capital formation matrix. The model is closed by means of the endogenisation of parts of public expenditure and investment in order to comply with the medium-term stability programme for the public finances. That mechanism for closing the model forms part of the public sector module. That module contains various endogenous income components (income taxes, wealth taxes, VAT, social security payments). Among the expenditure, transfers are endogenous and grow at the same rate as GDP. Interest payments on public debt are also endogenous and depend on the trajectory for public debt. Public consumption and investment are endogenous on account of model closure described above.

For the simulations of the PNIEC and the ERESEE, the DENIO model has been used in combination with the bottom-up TIMES SINERGIA model. Specifically, data such as the energy and electricity mix, intensity and energy efficiency by sector, prices and investments are taken from that model in order to analyse the economic impact on key variables such as employment, GDP, trade balance, income distribution, inflation, etc.

B. GLOSSARY OF ABBREVIATIONS AND INITIALISMS USED.

DHW: Domestic Hot Water.
BEI: European Investment Bank.
BPIE: Buildings Performance Institute Europe.
CEE: Energy Certification of Buildings.
CTE: Building Technical Code.
DB-He: Building Technical Code Basic Document on Energy Saving.
DEE: Energy Efficiency Directive.
ENPE: National Strategy for Preventing and Combating Poverty and Social Exclusion 2019-2023.
ENPEn:
EPOV: EU Energy Poverty Observatory
EDUSI: Sustainable and Integrated Urban Development Strategies.
LTS 2050: Long-term Strategy for a Modern, Competitive and Climate-Neutral Spanish Economy in 2050.
ESCOs: Energy service companies.
FEMP: Spanish Federation of Municipalities and Provinces.
GEI: Greenhouse gases.
GBCe: Green Building Council España.
GTR: Working group on renovation, coordinated by the GBCe and the CONAMA Foundation.
IDAE: Institute for Energy Diversification and Saving.
IBI: Immovable property tax.
ICO: Instituto de Crédito Oficial.
IEE: Building Assessment Report.
IDAE: Institute for Energy Diversification and Saving. INE:
Spanish National Statistical Institute.
IPREM: Multi-purpose Public Income Indicator. Ktoe:
kilotonnes of oil equivalent.
LOE: Building Regulations Act.
MAGRAMA: Ministry of Agriculture, Food and the Environment.
MAPAMA: Ministry of Agriculture and Fisheries, Food and the Environment.
MINETUR: Ministry of Industry, Energy and Tourism.
MINETAD: Ministry of Energy, Tourism and the Digital Agenda.
MITECO: Ministry for the Ecological Transition.
NBE: Basic Standard for Building.
OECC: Spanish Office for Climate Change.
PNAEE: National Saving and Energy Efficiency Plan.
PNIEC: Integrated National Energy and Climate Plan.
PAREER: IDAE's programme of support for comprehensive saving and energy efficiency projects in residential buildings.
PVPC: Voluntary Price for Small Consumers.
UE: European Union.

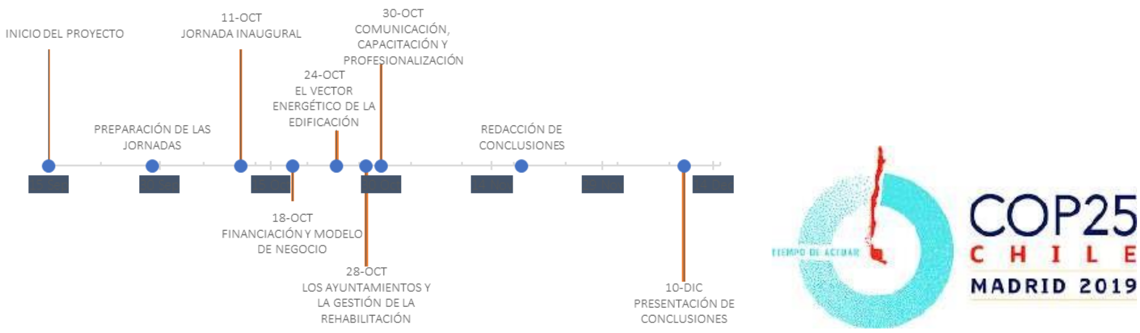
C. NOTE ON PARTICIPATION.

The public participation process to review the 2020 ERESEE was led by the Ministry of Transport, Mobility and the Urban Agenda (MITMA), the coordinator for drafting the strategy, and took place between September and December 2019, with GBCe acting as session coordinator and facilitator.

The process used the working methodology developed as part of the European BUILD UPON project, also coordinated by GBCe, and aimed to coordinate and support the drafting of the revisions to the 2017 Long-Term Renovation Strategies in 13 European countries. The starting point of this process was the results already obtained by that project.

Firstly, the actors involved in renovation in Spain were identified in a map of actors, and the resulting knowledge and initiatives that could enhance the strategy revision were set out.

Subsequently, a debate and collective design process was launched through a series of dynamic discussion roundtables in which all participants could share and compare their opinions. Six sessions were held on the topics identified as being key to the success of the strategy and the final results presentation session took place as part of the COP25.



	PROJECT LAUNCH

	11-OCT OPENING SESSION
	30-OCT COMMUNICATION, UPSKILLING AND PROFESSIONALISATION
	PREPARATION FOR THE SESSIONS
	24-OCT THE ENERGY VECTOR IN THE BUILDING STOCK
	DRAFTING OF CONCLUSIONS
	18-OCT FUNDING AND BUSINESS MODEL
	28-OCT MUNICIPAL COUNCILS AND RENOVATION MANAGEMENT
	10-DEC PRESENTATION OF CONCLUSIONS
	COP25
	CHILE:
	MADRID 2019
	TIME FOR ACTION

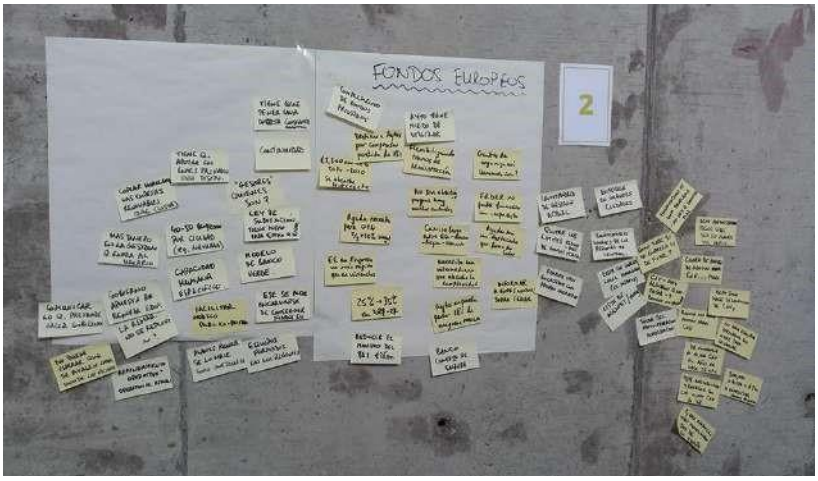
In total, more than 200 agents representing the entire renovation value chain participated in these debates, which were also attended by representatives of the public authorities involved in drafting and implementing the strategy.

This process went beyond simply collecting opinions from civil organisations and served as a meeting point for the various renovation actors, with a view to seeking joint solutions and creating a dialogue community, which offered to continue working to facilitate the implementation of the strategy.

In this way, a dual objective was achieved: gathering the knowledge and opinion of the sector so as to review the strategy and boosting the synergies between the various actors involved so as to improve collaboration. All this took place with the ultimate objective of reviewing, improving and adapting the strategy to the reality of the Spanish building stock.

The results obtained and suggestions made as part of this process were compiled into the Observations and Suggestions Document and were submitted to the Ministry of Transport, Mobility and the Urban Agenda for consideration in the Strategy.

The participation process and the methodology used are described in detail in the Public participation process report and the rest of the resources generated (summary videos of the sessions, map of actors, map of initiatives, etc.) have been published on the GBCe website: https://gbce.es/eresee-2020/



D. NOTE ON COMPLIANCE: COMPLIANCE WITH THE DIRECTIVE.

This annex details, in red, the compliance with Article 2a of Directive 2010/31/EU on the energy performance of buildings, as amended by Directive (EU) 2018/844 of the European Parliament and of the Council of 30 May 2018, amending Directive 2010/31/EU on the energy performance of buildings and Directive 2012/27/EU on energy efficiency.

Article 2a. Long-term renovation strategy

1. Each Member State shall establish a long-term renovation strategy to support the renovation of the national stock of residential and non-residential buildings, both public and private, into a highly energy efficient and decarbonised building stock by 2050, facilitating the cost-effective transformation of existing buildings into nearly zero-energy buildings. Each long-term renovation strategy shall be submitted in accordance with the applicable planning and reporting obligations and shall encompass:

a) an overview of the national building stock, based, as appropriate, on statistical sampling and expected share of renovated buildings in 2020; (2020 ERESEE Chapter 1)

b) the identification of cost-effective approaches to renovation relevant to the building type and climatic zone, considering potential relevant trigger points, where applicable, in the life-cycle of the building; (2020 ERESEE Chapters 7 and 8)

c) policies and actions to stimulate cost-effective deep renovation of buildings, including staged deep renovation, and to support targeted cost-effective measures and renovation for example by introducing an optional scheme for building renovation passports; (2020 ERESEE Chapters 4, 7, 8, 9 and 10) *d) an overview of policies and actions to target the worst performing segments of the national building stock, split-incentive dilemmas and market failures, and an outline of relevant national actions that contribute to the alleviation of energy poverty;* (2020 ERESEE Chapter 10)

e) policies and actions to target all public buildings; (ERESEE Chapters 4 and 10)

f) an overview of national initiatives to promote smart technologies and well-connected buildings and communities, as well as skills and education in the construction and energy efficiency sectors; and (ERESEE Chapters 4 and 10)

g) an evidence-based estimate of expected energy savings and wider benefits, such as those related to health, safety and air quality. (ERESEE Chapter 9)

2. In its long-term renovation strategy, each Member State shall set out a roadmap with measures and domestically established measurable progress indicators, with a view to the long-term 2050 goal of reducing greenhouse gas emissions in the Union by 80-95% compared to 1990, in order to ensure a highly energy efficient and decarbonised national building stock and in order to facilitate the cost-effective transformation of existing buildings into nearly zero-energy buildings. The roadmap shall include indicative milestones for 2030, 2040 and 2050, and specify how they contribute to achieving the Union's energy efficiency targets in accordance with Directive 2012/27/EU. (ERESEE Chapter 9)

3. To support the mobilisation of investments into the renovation needed to achieve the goals referred to in paragraph 1, Member States shall facilitate access to appropriate mechanisms for: (2020 ERESEE Chapters 4 and 10)
a) the aggregation of projects, including by investment platforms or groups, and by consortia of small and medium-sized enterprises, to enable investor access as well as packaged solutions for potential clients;

b) the reduction of the perceived risk of energy efficiency operations for investors and the private sector;

c) the use of public funding to leverage additional private-sector investment or address specific market failures;

d) guiding investments into an energy efficient public building stock, in line with Eurostat guidance; and

e) accessible and transparent advisory tools, such as one-stop-shops for consumers and energy advisory services, on relevant energy efficiency renovations and financing instruments.

4. The Commission shall collect and disseminate, at least to public authorities, best practices on successful public and private financing schemes for energy efficiency renovation as well as information on schemes for the aggregation of small-scale energy efficiency renovation projects. The Commission shall identify and disseminate best practices on financial incentives to renovate from a consumer perspective taking into account cost-efficiency differences between Member States.

5. To support the development of its long-term renovation strategy, each Member State shall carry out a public consultation on its long-term renovation strategy prior to submitting it to the Commission. Each Member State shall annex a summary of the results of its public consultation to its long-term renovation strategy. (2020 ERESEE Annex)
Each Member State shall establish the modalities for consultation in an inclusive way during the implementation of its long-term renovation strategy.

6. Each Member State shall annex the details of the implementation of its most recent long-term renovation strategy to its long-term renovation strategy, including on the planned policies and actions.
(ERESEE Chapters 9 and 10)

7. Each Member State may use its long-term renovation strategy to address fire safety and risks related to intense seismic activity affecting energy efficiency renovations and the lifetime of buildings.

(ERESEE Chapter 7)