LONG-TERM STRATEGY FOR ENERGY RENOVATION IN THE BUILDING SECTOR IN SPAIN PURSUANT TO ARTICLE 4 OF DIRECTIVE 2012/27/UE.

June 2014

CONTENTS:

GLOSSARY

DHW: Domestic Hot Water
EIB: European Investment Bank
BPIE: Buildings Performance Institute Europe
EC: European Community
CTE: Technical Building Code [Código Técnico de la Edificación]
EED: Energy Efficiency Directive
ESCos: Energy service companies
GHG: Greenhouse Gases
GBCe: Green Building Council España
GTR: Renovation Working Group [Grupo de Trabajo para la rehabilitación], coordinated by GBCe and the CONAMA Foundation
IDAE: Institute for Energy Diversification and Saving
IPT: Immovable Property Tax
BAR: Building Assessment Report
INE: Spanish National Statistical Institute
ktoe: kilotonne of oil equivalent
LOE: Building Planning Law
MAGRAMA: Ministry of Agriculture, Food and Environment
MINETUR: Ministry of Industry, Energy and Tourism
NBE: Basic Building Standard [Norma Básica de la Edificación]
PAEE: Energy Efficiency and Savings Plan
PAREER: IDAE aid programme for integral energy efficiency and savings projects in residential buildings
EU: European Union

I.1. DIRECTIVE 27/2012/EU ON ENERGY EFFICIENCY.

Directive 2012/27/EU of the European Parliament and of the Council of 25 October 2012 on energy efficiency (EED), amending Directives 2009/125/EC and 2010/30/EU and repealing Directives 2004/8/EC and 2006/32/EC is fundamentally aimed at establishing a common framework of measures for the promotion of energy efficiency within the Union in order to ensure the achievement of the Union's 2020 20% headline target on energy efficiency and to pave the way for further energy efficiency improvements beyond that date.

It also seeks to remove barriers in the energy market and overcome market failures that impede efficiency in the supply and use of energy, and to provide for the establishment of indicative national energy efficiency targets for 2020. It additionally has the ambitious aim of setting specific energy efficiency targets, strategically promoting building renovation, achieving the exemplary role of buildings for public bodies and ensuring that their purchases of products, services and buildings are energy efficient, establishing an energy efficiency obligation scheme for energy companies to achieve a cumulative savings target, carry out energy audits and establish energy management systems, billing and measurement of consumption, information for consumers, etc.

I.2. ARTICLE 4 OF DIRECTIVE 27/2012/EU AS FRAMEWORK OF THE STRATEGY FOR ENERGY RENOVATION IN THE BUILDING SECTOR IN SPAIN.

Buildings represent 40% of the Union's final energy consumption, hence Article 4 obliges Member States to create a long-term strategy beyond 2020 for mobilising investment in the renovation of residential and commercial buildings with a view to improving the energy performance of the building stock. The strategy should address cost-effective deep renovations which will lead to a refurbishment that reduces both the delivered and the final energy consumption of a building by a significant percentage compared with the pre-renovation levels, resulting in strong energy performance. Such deep renovations could also be carried out in stages.

This Strategy responds to the abovementioned obligation and includes the following elements:

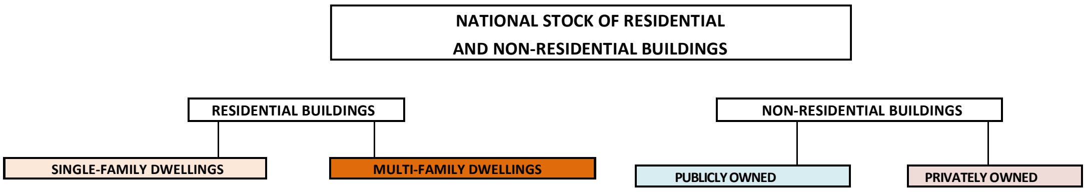
a) an overview of the national building stock based, as appropriate, on statistical sampling;
b) identification of cost-effective approaches to renovations relevant to the building type and climatic zone;
c) policies and measures to stimulate cost-effective deep renovations of buildings, including staged deep renovations;
d) a forward-looking perspective to guide investment decisions of individuals, the construction industry and financial institutions;
e) an evidence-based estimate of expected energy savings and wider benefits.

This Strategy has been prepared by the Ministry of Development's Directorate General for Architecture, Housing and Land, in collaboration with the other ministerial departments involved, as well as taking into account contributions from the various working groups set up to develop it, other public administrations and the main actors in the sector.

II.1. ANALYSIS OF THE BUILDING STOCK.

The analysis and segmentation of the Spanish building stock outlined below has been carried out based on the intersection of two criteria: use (differentiated between residential buildings and the non-residential sector) and ownership, as these are the two variables that fundamentally define how action will be taken with regard to the existing building stock, determining the way in which both decision-making regarding the renovation as well as funding will take place.

In terms of ownership, a distinction is made between single-family dwellings (one owner) and multi-family dwellings under a horizontal property regime (primarily as homeowners association schemes) for residential stock, and between public ownership (buildings for the various administrations: central government, regional government and municipalities) and private ownership for the non-residential stock.



This segmentation is consistent with the information sources used, as the 2011 Building and Housing Census only makes it possible to analyse the residential stock, whereas it is necessary to exploit the land register database (as at 2013) to analyse the non-residential sector.

The present Strategy deals with all of the above segments, addressing each one on its own merits and paying special attention to the most complex case with the greatest social impact, which is the case of homeowners associations in residential (or predominantly residential) buildings with several dwellings.

II.1.1. RESIDENTIAL SECTOR.

II.1.1.2. Detailed analysis of the Spanish residential stock.

The next section provides a comprehensive analysis of the Spanish residential stock, including the following aspects:

- analysis of the Spanish residential stock according to occupation: main, secondary and empty 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;
- analysis of energy performance. Characteristics of energy performance and availability of means of heating or heating installations in Spanish main dwellings.

Finally, and in the light of the above analysis, this residential stock is segmented into clusters that will be used throughout the entire document 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.

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

There are a total of 25.2 million existing dwellings in Spain, distributed as follows, according to the 2011 census: 71.5% main dwellings (17 528 518 dwellings), 14.8% secondary dwellings (3 616 695) and 13.8% empty and other dwellings (3 374 291).

The distribution at general level of 68.6% of dwellings as multi-family (17 250 759 dwellings) and 31.4% as single-family (7 709 272 dwellings), is qualified differently according to the use. Thus, multi-family dwellings have greater weight among main dwellings (71.8% compared to 28.2% of single-family dwellings), while the opposite occurs 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 is practically similar to the distribution for the total (68.4% multi-family and 31.6% single-family dwellings).

b) Analysis of the type and size of dwellings in Spain.

Of the more than 18 million Spanish main dwellings, nearly half fall between 61 m^2 and 90 m^2 in size; 29.6% (5 354 920 dwellings) are between 76 m^2 and 90 m^2 and 18.6% (3 360 925) are between 61 m^2 and 75 m^2.

Exploiting the land register information as at 2013 makes it possible to differentiate the following dwelling types based on the use of the dwelling: shared (multi-family) in a block or open building, which accounts 24.1% of the total national dwellings, shared (multi-family) in perimeter blocks, which accounts for 46.3% and, within single-family dwellings, detached and semi-detached homes, which account for 10% of the total stock, and terraced single-family dwellings or dwellings in a perimeter block (in a traditional urban area or a recent low-density development), which amount to 19.6% of the total.

c) Analysis of the distribution of dwellings according to municipality size.

Of the total 25.2 million existing dwellings in Spain, nearly half (47.6%: 11 987 675) are in urban municipalities with over 50 000 inhabitants, with the remaining half distributed as follows: 15.7% in municipalities with 20 001–50 000 inhabitants (3 969 298 dwellings), 20% in municipalities with between 5 001–20 000 inhabitants (5 029 342 dwellings) and another 16.7% in municipalities with fewer than 5 000 inhabitants (4 222 297 dwellings).

d) Analysis of the tenure status of households in Spain.

According to the data from the 2011 census, among main dwellings, over three-quarters (78.9%) are owned, while just 13.5% (2 438 575) are rented and 7.6% are made available free of charge or in another way.

e) Analysis of energy performance. Characteristics of energy performance and availability of means of heating or heating installations in Spanish main dwellings.

According to the 2011 census data, of the total 17.5 million existing main dwellings in Spain, 9 933 123 (56.7%) have heating installed (8 079 032 dwellings, 46.09%, with individual installation and 1 854 091, 10.6%, with shared installation). The breakdown of dwellings with shared installation indicates that 113 721 correspond to single-family dwellings built between 1981 and 2007; 831 523 to multi-family dwellings from the period 1961–1980; 543 255 to multi-family dwellings from 1981–2007; 121 382 to multi-family dwellings from 1941–1960 and 92 038 to more recent multi-family dwellings, later than 2008. Of the other main dwellings, 5 198 644 (29.7%) do not have heating installed, but they do have means or appliances for heating, and 2 396 751 (13.7%) do not have any heating system.

Fig. 1. Analysis of the residential stock in Spain according to the 2011 census. Availability of means of heating in main dwellings.

Type	Construction period	No of floors	Cluster	No record	Total Main	M with shared or central heating	M with individual heating	M without heating installed, but with some kind of heating appliance	M with no heating
Single family	Total single family	Total single family			4 948 039	214 687	2 239 056	1 665 570	828 726
Multi-family	Total multi-family	Total multi-family		440 327	12 580 479	1 639 404	5 839 976	3 533 074	1 568 025
Overall total	Overall total	Overall total		688 908	17 528 518	1 854 091	8 079 032	5 198 644	2 396 751

Source: Prepared by the Ministry of Development, using data from the 2011 census. (INE).

By type, among the main single-family dwellings, nearly half (49.6%) have some heating system (primarily individual, as out of all of them only 8.7% have some kind of shared system), 33.7% do not have heating installed but do have appliances to heat the dwelling and 16.8% do not have any means of heating. Among main multi-family dwellings, a higher percentage of them have some heating system, totalling 59.5% (with 21.9% having shared heating systems), while 28.1% only have heating appliances but no specific installation and 12.5% do not have any means of heating.

It is also of interest to note the breakdown of heating installation availability according to municipality size, as this makes it possible to make the analysis more specific. Among single-family dwellings, the greatest deviations from the average distribution indicate that the percentage of main single-family dwellings with individual heating systems is greater in municipalities with fewer than 5 000 inhabitants (50.3%). Among main multi-family dwellings, shared installations are most prominent in cities with over 50 000 inhabitants (where they reach up to 15.4%), compared to the higher weight of individual boilers in smaller municipalities (54.4% among multi-family dwellings in municipalities with under 5 000 inhabitants).

Fig. 2. Percentage distribution of means of heating in main dwellings. (2011 census).

Type	Municipality size (number of inhabitants)	M with shared or central heating	M with individual heating	M without heating installed, but with some kind of heating appliance	Main with no heating	Total main (100%)
Single family	Under 5 000	4.17	50.30	30.64	14.89	1 651 452
Single family	Between 5 001 and 20 000	4.75	45.57	33.75	15.94	1 477 315
Single family	Between 20 001 and 50 000	4.68	38.01	37.53	19.77	797 821
Single family	Over 50 000	3.76	42.29	35.39	18.56	1 021 451
Total single family		4.34	45.25	33.66	16.75	4 948 039
Multi-family	Under 5 000	8.40	54.40	27.37	9.83	660 587
Multi-family	Between 5 001 and 20 000	9.02	51.06	27.96	11.96	1 844 315
Multi-family	Between 20 001 and 50 000	7.74	42.92	33.97	15.37	1 959 051
Multi-family	Over 50 000	15.41	45.98	26.56	12.06	8 469 375
Total multi-family		12.98	46.67	27.92	12.43	12 933 328
Total (blank)		8.54	48.33	26.51	16.61	202 297
Overall total		10.56	46.30	29.48	13.66	18 083 664

Source: Prepared by the Ministry of Development, using data from the 2011 census (INE).

II.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 packages – 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. 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.

- Voluntary improvements in the energy efficiency of the building.

These three types of problems are unrelated and can crop up separately – although there may be a higher prevalence of problems among older buildings compared to newer ones – and therefore it is necessary to segment the stock in a differentiated way. These problems also require different interventions to solve them, which does not prevent synergies from taking place, especially between conservation and energy efficiency, that should be taken into account in setting out the renovation strategy.

The basic information source available for making these segmentations, considering the overall national dwelling stock, was the 2011 census from the Spanish National Statistical Institute (INE). The segmentations must be made based on the information available from this source, or from other sources provided that they can be cross-checked with it, which limits the quality of the segmentation to issues that may be established based on this information. Thus, the factors that determine the energy performance of a dwelling must be interpreted from the information available in the census, which means making simplifications, such as assigning certain construction characteristics to the building – information that is not collected by the census – based on the year of its construction, which is included in this source.

a) Periodisation according to technical regulations.

Considering that the main construction characteristics of the stock fundamentally depend on the technical regulations in force at the time when the buildings were constructed, we have begun by carrying out a periodisation according to these regulations.

The first technical standards that generally regulated 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 [*Ministerio de Vivienda*], 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.

However, in 1969, the provisional ordinances approved by Order of the Ministry of Housing regulated certain characteristics for subsidised housing, 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 limit the thermal transmittance (then called conductivity) of roofs and façades. The maximum limits were 1.2 and 1.6 kcal/m^2°C, which meant that including an air gap was enough to achieve that transmittance. The standard envelope of a façade became a six-inch brick wall, cavity and a thin or thick interior partition wall.

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 NBE. The first of these basic standards, issued as a result of the second energy crisis in 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 characterised by day degrees, as well as maximum transmittances for the various envelopes to ensure a minimum thermal comfort and the absence of surface condensation. With these requirements, in force from 1980 until 2006, the six-inch brick, cavity and thin wall solutions were not enough, and thermal insulation in façade and roof gaps became standard.

Later, in 1999, Law 38/1999 of 5 November 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 by means of Royal Decree that would set out the requirements that must be met by buildings in relation to the basic requirements of safety and habitability.

The legislator addressed the drafting of 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, the Basic Document DB HE set out requirements on limiting energy demand (which mean improving the passive aspects of the building), and also on improving the efficiency of the heating and lighting installations as well as the provision of a minimum 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 advance estimated at between a 25% and 35% improvement in demand, and therefore in insulation.

b) Segmentation of the Spanish residential stock into clusters.

To exploit the INE database that holds the information from the 2011 census, there was a dynamic table that made it possible to obtain the information by cross-checking the following data:

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

- the 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;

- the year of construction, within the specific periods listed above (before 1940, 1941–1960, 1961–1980, 1981–2007, 2008–2011), 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 that required a minimum of thermal insulation in envelopes), 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 extent to which the envelopes are insulated;

- the classification into single-family or multi-family buildings, which makes it possible to consider the renovation management unit (individual or homeowners association);

- the number of floors in the building and presence of a lift, which makes it possible to determine – together with the previous segmentation – the volume of the building and consequently its aspect ratio, and thus the relative quantity of the different types of enclosure;

- the state of conservation of the building, which tells us the necessity and depth of the actions on the building's construction systems and installations;

- the heating system of the dwellings, which both indicates the presence of some type of heating and makes it possible to identify those with shared and individual systems;

- main, secondary and empty dwellings.

These data have been used to select the clusters that are significant from the perspective of the energy efficiency of the dwellings, understanding that building types are grouped together that are going to have common action menus with a view to improving their energy efficiency:

Fig. 3. Definition of Clusters. Number of dwellings according to year of construction (rows) and number of dwellings in the building and floors above ground (columns).

Year of construction	Single family		Multi-family		No data	TOTAL	No of dwellings in the building / No of floors above ground
	1 - 3	≥ 4	1 - 3	≥ 4			
< 1940	1.305.885	7.304	423.780	650.418			A - G
1941 - 1960	1.042.011	2.656	492.944	1.127.383			B - H
1961 - 1980	1.815.875	3.906	1.121.936	5.642.801			C - E - I
1981 - 2007	3.139.296	10.215	1.913.055	4.498.101			D - F - J
2008 - 2011	380.834	1.290	235.117	704.897			
No data			170.727		518.181		
TOTAL						25.208.612	

Clústers 22.311.240 (88,5%)

Source: Prepared by GTR for the Ministry of Development, based on the 2011 census (INE).

Nevertheless, the segmentation recognises and is aimed at main dwellings, given that the Strategy will be applied to main dwellings since their increased use is what makes it possible to assume – compared to secondary dwellings – that it is going to be possible to make the energy reform operations cost effective and eligible for aid to improve accessibility or state of conservation.

Fig. 4. Definition of Clusters. Number of Main Dwellings according to year of construction (rows) and number of dwellings in the building and floors above ground (columns).

Year of construction	Single family		Multi-family		No data	TOTAL	No of dwellings in the building / No of floors above ground
	1 - 3	≥ 4	1 - 3	≥ 4			
< 1940	680.683	3.687	272.852	489.329			A - G
1941 - 1960	624.646	1.457	346.055	889.611			B - H
1961 - 1980	1.156.215	2.388	781.206	4.483.759			C - E - I
1981 - 2007	2.236.882	7.774	1.312.285	3.444.532			D - F - J
2008 - 2011	233.647	660	122.404	438.446			
Sin datos			130.073		425.073		
TOTAL						18.083.664	

Clústers 16.099.148 (89%)

Source: Prepared by GTR for the Ministry of Development, based on the 2011 census (INE).

Clusters A, B, C and D include main single-family dwellings, while clusters E, F, G, H, I and J include the dwellings located in multi-family buildings. All together, the clusters account for 89% of the 18 million main dwellings – excluding buildings constructed in the period from 2008 onwards when the CTE had already established significant energy efficiency conditions – that include nearly all the dwellings that should be targeted for energy renovation.

Clusters A, B, C and D include main single-family dwellings with fewer than three floors, and may be detached or terraced – one-third of the stock in the first case, and two-thirds in the second – meaning there are configurations with a very varied relationship between the volume of the dwelling and envelopes that enclose it.

The dwellings included in clusters A and B were built before 1960, and therefore with 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 cavities in these walls are 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 in these buildings, but a tiled roof over a ventilated attic has been considered as standard. The floor is built directly onto compacted earth.

Cluster C includes single-family dwellings constructed after 1960, and takes into account changes in the construction systems with regard to the preceding clusters, with a predominance of double leaf brick walls with an intermediate air gap as envelope wall, in addition to the existence of a pitched tiled roof but without ventilated loft or chamber, transforming 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. The floor remains slabs placed over a floor lying on compacted earth or with a gravel sub-base.

Cluster D includes dwellings built between 1980 – therefore after NBE-CT/79 – and before 2007 – therefore, before the compulsory application of the CTE – thus it is assumed that they have thermal insulation in the walls that is integrated within the cavity of the external wall and insulation under the roof; aluminium frames start to dominate with thicker and double glazing with a gap, thus improving their thermal insulation. Suspended floors with an air space separating the bottom floor from the ground become widespread.

The clusters that include dwellings in multi-family buildings follow the same construction patterns as regards walls and cavities as single-family dwellings from the same periods – G and H like A and B; E like C; F and J like D – although it is considered that in terms of roofs, flat roofs predominate (with insulation from 1980 onwards) as well as floors or ground floor business premises in contact with the ground.

The table with the distribution by clusters according to the means of heating is as follows:

Fig. 5. Number of main dwellings with heating (units) according to year of construction (rows) and number of dwellings in the building and floors above ground in the building (columns)

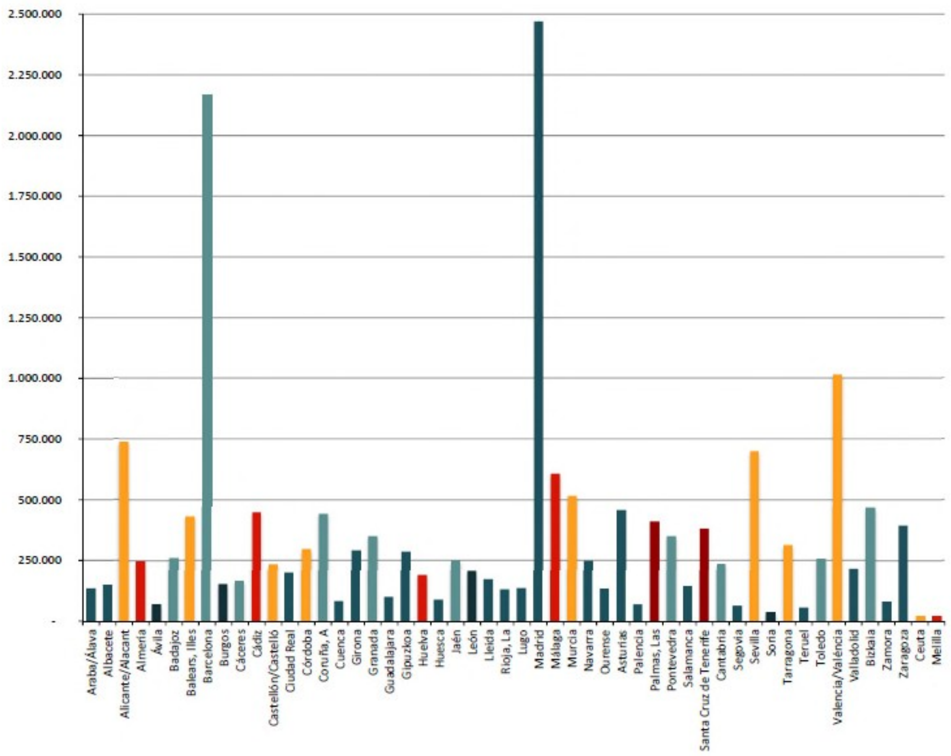
Year of construction	Single family 1–3	Single family ≥ 4	Multi-family 1–3	Multi-family ≥ 4	No data	TOTAL	No of dwellings in the building / No of floors above ground
< 1940	**538,772**	3,236	226,318	**430,613**			A - G
1941–1960	**492,852**	1,222	283,589	**781,860**			B - H
1961–1980	**924,347**	1,896	**630,968**	**3,950,334**			C - E - I
1981–2007	**1,943,533**	7,097	**1,083,598**	**3,120,483**			D - F - J
2008–2011	205,741	617	102,311	402,380			
No data			112,353		369,561		
TOTAL						**15,613,681**	

Clusters
16 099 148
(89%)

Source: Prepared by GTR for the Ministry of Development, based on the 2011 census (INE).

The exploitation of the census data makes it possible to characterise the clusters according to factors that do not appear in these tables but that are significant for the calculations made in the present Strategy, such as distribution of the stock by province.

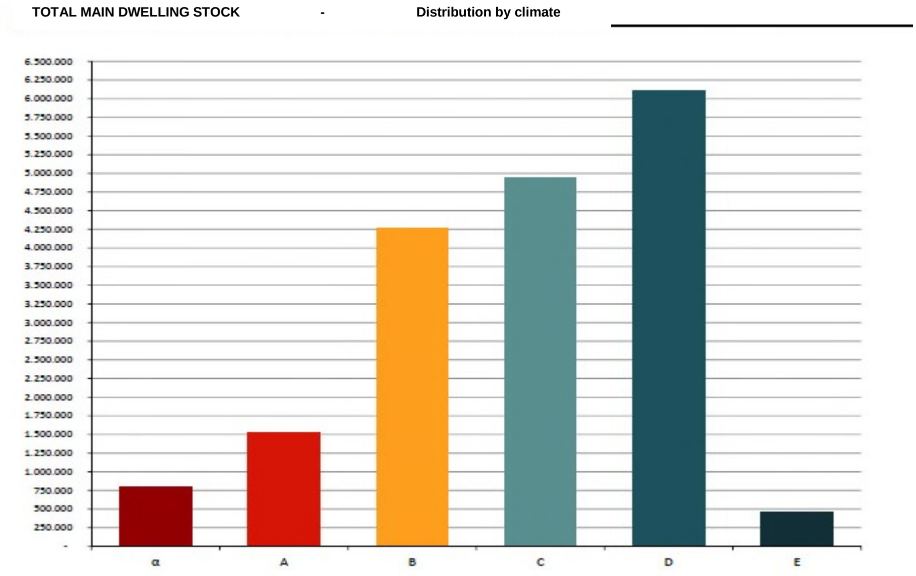
Fig. 6. Distribution of Main Dwelling stock by province.



Source: Prepared by GTR for the Ministry of Development, based on the 2011 census (INE).

Based on the distribution by province as above (assimilating the climatic zone of the entire province to that of the capital), the distribution of main dwellings can be determined according to the different climatic zones into which Spain is divided by the CTE.

Fig. 7. Distribution of Main Dwelling stock according to CTE climatic zones.



Source: Prepared by GTR for the Ministry of Development, based on the 2011 census (INE).

II.1.2. NON-RESIDENTIAL SECTOR.

II.1.2.1. Detailed analysis of the Spanish non-residential stock.

Characterising the construction in the non-residential sector is much more complex than for the residential sector, for several reasons:

-the types of uses are much more varied, and therefore there are many more building types;
- the typological diversity of the buildings within each use is also very extensive for the majority of uses, and it is almost unmanageable to form clusters that include groups from the stock that are significant;
- the construction characteristics of the buildings are also very variable due to the very different requirements necessitated by each type of use;
- the information available for this stock is sectoral and, in general, not very homogeneous 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 about 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 features like 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 that might make it possible to provide support for the approaches in the Strategy that are intended to be implemented. On the other hand, this situation leaves energy efficiency as the fundamental objective to be addressed by the Renovation Strategy.

To address the characterisation of the non-residential sector of the building stock, it has been decided to consider one last differentiation as key vis-à-vis the dwelling stock: energy use largely depends on the activities accommodated by these buildings, and since the types of activities are so variable, it is impossible to assume that there is a common benchmark pattern as there may be in residential buildings – in spite of the undeniable variety that exists among dwellings – and therefore it is considered decisive to form the segmentation of the non-residential buildings based on differentiation by types of use.

To do this, the data provided by the Directorate General of the Land Registry of the Ministry of Finance and Public Administrations have been used, for all national territory except the autonomous communities of the Basque Country and Navarre (referring to the month of September 2013), which makes it possible to differentiate by uses and even by date of construction – which in later, more detailed work may make it possible to propose a segmentation based on construction systems – and provides information both on the number of properties as well as their area. Obviously, the characterisation of the types of use is simplified and brings together very different types of use under each description, but this is an initial approach that should make it possible to outline an initial Renovation Strategy.

Fig. 8. Number of properties by uses and decades of construction according to the land register.

	NO OF PROPERTIES BY USES AND DECADE OF CONSTRUCTION												
	Before 1900	1900–1920	1921–1940	1941–1950	1951–1960	1961–1970	1971–1980	1981–1990	1991–2001	2002–2011	Since 2012 (*)	Other (**)	TOTAL
RESIDENTIAL													***23 142 267***
V - Residential	437 912	1 237 387	944 525	661 857	1 278 305	3 123 052	4 185 544	2 938 095	3 728 153	4 419 507	76 738	111 192	23 142 267
NON-RESIDENTIAL													***11 894 635***
TERTIARY, SERVICES AND PUBLIC FACILITIES													***1 967 237***
O - Offices	1 999	5 898	5 981	5 590	10 328	36 178	51 190	36 706	56 613	71 932	593	344	283 352
C - Commercial	13 401	36 134	35 686	25 735	59 062	211 028	280 036	213 446	235 776	181 623	2 356	1 076	1 295 359
K - Sports	177	704	597	823	1 779	5 872	12 874	13 846	11 620	8 777	240	617	57 926
T - Entertainment	147	433	380	303	425	666	904	765	707	380	10	183	5 303
G - Leisure and Hospitality	1 598	4 340	3 019	2 076	4 418	17 556	45 028	64 020	28 005	24 475	172	2 161	196 868
Y - Health and Charitable	424	1 147	1 137	958	1 506	3 993	8 346	7 886	6 483	5 133	117	252	37 382
E - Cultural	1 151	2 853	3 131	2 820	4 965	8 269	9 315	5 843	4 305	4 139	96	695	47 582
R - Religious	11 605	14 788	2 958	2 025	1 848	2 392	2 561	1 464	1 166	974	86	1 598	43 465
INDUSTRIAL													***1 703 522***
I - Industrial	106 613	272 072	120 087	80 468	90 744	152 938	231 222	202 719	207 094	155 928	2 149	81 488	1 703 522
WAREHOUSE - PARKING													***7 984 295***
A - Warehouse - Parking	24 156	74 466	46 550	33 266	61 810	263 439	1 005 188	1 166 184	2 159 091	3 092 778	49 344	8 023	7 984 295
OTHER													***239 581***
M - Urban design and gardening	3 205	9 213	3 349	2 037	2 004	3 878	35 541	6 130	10 975	30 064	922	39 771	147 089
P - Singular building	1 216	2 535	1 642	1 313	1 430	1 775	3 319	2 443	6 978	2 086	46	483	25 266
B - Agricultural warehouse	281	863	593	458	735	949	1 884	1 176	717	969	5	170	8 800
J - Agricultural Industrial	2 273	7 840	4 906	3 939	4 101	5 731	12 753	8 043	5 031	2 316	12	1 481	58 426
Z - Agricultural													

(*) Includes properties whose year of construction is 2012 or 2013.

(**) Any properties whose year of construction is zero, or after 2013.

NB: The data refer to the month of September 2013 and are those provided by the Ministry of Finance and Public Administrations (Directorate General of the Land Registry) for all national territory, except the autonomous communities of the Basque Country and Navarre.

Source: Prepared by the Ministry of Development, based on the Directorate General of the Land Registry.

Fig. 9. Total area of properties by uses and decades of construction according to the land register.

	TOTAL AREA OF PROPERTIES BY USES AND DECADE OF CONSTRUCTION												
	Before 1900	1900–1920	1921–1940	1941–1950	1951–1960	1961–1970	1971–1980	1981–1990	1991–2001	2002–2011	Since 2012 (*)	Other (**)	TOTAL
RESIDENTIAL													***3 283 305 198***
V - Residential	95 641 467	232 368 161	162 768 092	112 633 414	171 118 502	351 283 958	519 393 590	416 779 847	552 369 707	636 420 425	13 115 736	19 412 299	3 283 305 198
NON-RESIDENTIAL													***1 992 915 303***
TERTIARY, SERVICES AND PUBLIC FACILITIES													***825 585 829***
O - Offices	933 429	2 196 443	2 255 814	2 261 444	3 311 727	9 398 951	16 948 099	12 095 266	25 661 331	35 350 391	761 313	117 228	111 291 436
C - Commercial	1 731 072	4 900 501	4 839 248	3 605 743	7 371 186	25 391 430	37 034 399	30 293 606	48 285 915	57 588 864	2 224 986	274 761	223 541 711
K - Sports	645 624	2 154 375	1 381 860	2 208 430	9 681 970	16 739 944	25 746 395	31 954 726	57 436 525	49 575 087	3 064 330	415 177	201 004 443
T - Entertainment	140 476	405 788	360 694	249 003	360 137	551 356	828 287	663 479	2 512 020	1 694 595	41 535	278 386	8 085 756
G - Leisure and Hospitality	1 052 336	2 257 499	1 843 106	1 235 534	3 830 906	13 879 749	16 973 921	19 426 949	22 701 321	21 667 250	1 375 757	1 237 116	107 481 444
Y - Health and Charitable	661 849	1 538 747	1 707 308	1 926 984	2 931 571	4 080 888	7 987 640	5 358 000	7 730 524	13 775 331	228 533	204 597	48 131 972
E - Cultural	2 387 605	3 976 671	4 369 558	3 718 098	7 936 223	15 420 511	20 147 724	13 494 276	13 263 870	11 589 485	349 396	414 552	97 067 969
R - Religious	6 132 005	8 631 210	3 100 559	1 724 544	1 545 160	1 676 250	1 611 449	1 057 482	2 049 203	900 559	48 560	504 117	28 981 098
INDUSTRIAL													***704 912 001***
I - Industrial	17 323 488	37 910 600	23 518 988	21 194 673	34 054 056	81 031 926	127 376 064	84 414 671	128 095 848	138 366 661	2 691 221	8 933 805	704 912 001
WAREHOUSE-PARKING													***345 084 908***
A - Warehouse - Parking	2 152 140	6 830 004	4 449 097	3 245 855	5 538 600	18 461 615	47 154 722	49 514 779	92 677 169	112 642 473	1 808 729	609 725	345 084 908
OTHER													***117 332 565***
M - Urban design and gardening works,	1 025 091	2 094 942	1 086 389	584 783	1 697 876	4 139 426	4 201 986	2 402 618	7 509 297	7 484 575	305 896	2 398 792	34 931 671
P - Singular building	1 723 968	3 717 351	2 883 505	2 916 047	2 551 657	2 187 536	4 272 021	4 112 510	5 761 938	4 646 045	331 635	240 707	35 344 920
B - Agricultural warehouse	29 242	113 833	60 776	56 951	363 509	191 158	429 612	879 909	513 579	1 617 516	729	68 623	4 325 437
J - Agricultural Industrial	275 649	1 124 103	1 295 398	860 469	1 584 219	4 461 986	9 861 286	6 122 215	8 756 482	6 122 312	11 642	2 254 776	42 730 537
Z - Agricultural													0

(*) Includes properties whose year of construction is 2012 or 2013.

(**) Any properties whose year of construction is zero, or after 2013.

NB: The data refer to the month of September 2013 and are those provided by the Directorate General of the Land Registry of the Ministry of Finance and Public Administrations for all national territory, except the autonomous communities of the Basque Country and Navarre.

Source: Prepared by the Ministry of Development, based on the Directorate General of the Land Registry.

The land register data also make it possible to locate the properties and the surface areas in the different provinces, which in turn allows us to determine, with some approximation, the climatic demands they need to face.

From reading the tables, it follows that, after discounting the residential use examined above, the most significant uses of the non-residential building stock by surface area are industrial, warehouse/parking, commercial, sports, office, leisure and hospitality and cultural uses. Discounting the first two due to their special characteristics in the use of energy in industrial buildings – related to the production processes they accommodate – and the low intensity of energy use in warehouse and parking, and adding the buildings for health use precisely due to the energy intensity that causes it to be used intensively, the following use segments are those of more interest due to being the clusters to which attention should be paid by the Strategy:

-commercial, with 26% of the area and 65% of the number of buildings;
-sports, with 23% of the area and 3% of the buildings;
-offices, with 13% of the area and 14% of the buildings;
-hospitality, with 12% of the area and 10% of the buildings;
-cultural and educational, with 11% of the area and 2% of the buildings;
-health, with 6% of the area and 2% of the buildings.

Between them, they thus cover 91% of the area (and 96% of the buildings) of the non-residential stock, excluding industrial buildings, warehouses and parking:

Furthermore, information must also be added, taken from the land register as well as provided by IDAE, which will allow for subsequent cross-checking with energy consumption data, in addition to making particular reference to the area occupied by premises attached to the central State administration.

The IDAE data make it possible to segregate:
- in the commercial sector, the area dedicated to large shopping centres, thus making it possible to estimate the area used for small businesses;
- hotels in leisure and hospitality;
- hospitals and health centres in health and charitable;
- schools, state schools and universities from other cultural public facilities.

A segmentation is thus defined based on the uses that are most significant in terms of energy, which account for 80% of the area considered above.

Fig. 10. Area and percentage of property area according to use with regard to the total considered

	LAND REGISTER		IDAE data	
	m^2	%	m^2	%
A - Warehouse - Parking	345 084 908			
V - Residential	3 283 305 198			
I - Industrial	704 912 001			
O - Offices	111 291 436	13%	95 000 000	14%
C - Commercial	223 541 711	26%		
small businesses			200 000 000	29%
shopping centres			20 000 000	3%
K - Sports	201 004 443	23%	200 000 000	29%
T - Entertainment	8 085 756	1%		
G - Leisure and Hospitality	107 481 444	12%	48 000 000	7%
Y - Health and Charitable	48 131 972	6%	25 000 000	4%
E - Cultural	97 067 969	11%	91 000 000	13%
R - Religious	28 981 098	3%		
M - Urban design and gardening works, unbuilt land	34 931 671			
P - Singular building	35 344 920	4%		
B - Agricultural warehouse	4 325 437			
J - Agricultural Industrial	42 730 537			
Z - Agricultural	0			
total	860 930 749		679 000 000	
central administration	11 200 244	1.3%	11 200 244	2%

Source: Ministry of Finance and Public Administrations (Directorate General of the Land Registry) and IDAE.

II.2. ANALYSIS OF CONSUMPTION IN THE BUILDING SECTOR.

II.2.1. ANALYSIS OF CONSUMPTION IN THE RESIDENTIAL SECTOR IN SPAIN.

To determine the effect of energy renovation interventions on the building stock in Spain, a segmentation has been carried out for domestic energy consumption in climate control based on the segmentation of the stock carried out in the previous section.

The table below shows the final energy consumption of buildings (residential and non-residential) in relation to other uses.

Fig. 11. Final energy consumption in Spain according to sectors (2011).

FINAL ENERGY CONSUMPTION (ktoe)	COAL	PETROLEUM PRODUCTS	GAS	RENEWABLE ENERGY SOURCES	ELECTRIC POWER	TOTAL
INDUSTRY	**1 717**	**4 356**	**7 697**	**1 256**	**6 317**	**21 344**
TRANSPORT	**0**	**33 696**	**83**	**1 721**	**388**	**35 889**
MIXED USE	**198**	**5 779**	**6 220**	**2 838**	**14 237**	**29 272**
Agriculture	0	1 518	466	70	349	2 404
Fishing activities	0	0	0	0	0	0
Business, Services and Public	**0**	**1 355**	**1 755**	**104**	**6 992**	**10 206**
Residential	**122**	**2 906**	**3 411**	**2 647**	**6 545**	**15 631**
Other unspecified	76	0	587	17	351	1 031
FINAL ENERGY CONSUMPTION	**1 915**	**43 832**	**14 001**	**5 815**	**20 942**	**86 505**

Source: IDAE.

The data on household energy consumption in Spain, provided by the Ministry of Industry and the Institute for Energy Diversification and Saving (IDAE) in the *Informe anual de consumos energéticos. Año 2011* [*Annual Report on Energy Consumption. 2011], has been used as reference.* This report shows the annual domestic consumption distributed by energy sources and disaggregated by energy uses in the home – including climate control and DHW – which are summarised in the following table:

Fig. 12. Final energy consumption in the residential sector in Spain according to types of use (2011).

Type of Use	Coal	Petroleum Products			Gas	Renewables				Electric Power	TOTAL
		LPG	Liquid Fuels	TOTAL		Biomass	Solar	Geothermal	TOTAL		
	ktoe	ktoe	ktoe	ktoe	ktoe	ktoe	ktoe	ktoe	ktoe	ktoe	ktoe
Heating	12	388	2 033	2 421	1 695	2 368	10	6	2 384	380	6 892
DHW	1	459	183	642	1 566	50	129	3	182	385	2 776
Cooking	2	185	-	185	399	26	-	-	26	479	1 091
Lighting	-	-	-	-	-	-	-	-	-	606	606
Air conditioning	-	-	-	-	-	-	-	3	3	120	123
Electrical household	-	-	-	-	-	-	-	-	-	3 188	3 188
TOTAL	15	1 032	2 216	3 248	3 660	2 444	139	12	2 595	5 158	14 676

Source: IDAE.

The objective of this Strategy does not so much require an exact segmentation of household consumption – which would obviously be optimal – as an approximation that is sufficient to verify the costs and effects of a generalised intervention on the building stock aimed at improving its energy efficiency and reducing its emissions. To do this, the following considerations have been made in the segmentation:

- Energy consumption for heating is considered key for establishing energy consumption in climate control, since energy consumption for cooling is marginal (accounts for less than 2% of energy consumption for climate control). The majority of the actions proposed improve energy efficiency both in terms of heating as well as cooling; however, in any case, additional awareness-raising, fiscal and industrial measures should be developed that will regulate the spread of home cooling systems and prevent the boundless increase of energy consumption that is largely avoidable and, in any case, should be realised, whenever necessary, with efficient equipment.

- Energy consumption for heating non-main dwellings is considered residual compared to main residences, in that the consumption of days of winter use by secondary dwellings would practically never justify a deep energy efficiency renovation intervention (although partial measures are justified in some cases, such as switching boilers).

- Since the aim is to act, first and foremost, on dwellings that are the largest energy consumers – where it will be possible to amortize investments in efficiency more quickly – and, gradually, to progress with the remaining dwellings as the increase in energy prices makes it cost-effective to act on them, it is especially necessary to determine the order of intervention according to the known variables that influence this consumption, leaving the discovery or homogenization of other factors that influence consumption and that are not determined by the statistical information available, to intervention with additional mechanisms.

- Although the present Strategy focuses on main dwellings, these have different degrees of occupation: daily, weekly and seasonal. Likewise, heating consumption depends on the occupants' income levels, both in terms the comfort levels obtained as well as the efficiency in use and management. The dispersion both factors generate in heating consumption cannot be determined using the statistical data available. All the same, and as has been determined in the paragraph above, there must to be – alongside the actions that make deep energy renovation interventions possible – the right measures that combat energy wastefulness in building use and management and that identify situations of energy shortages, both of which are situations that distort effective action in terms of energy efficiency and that, in this case, also contribute to reducing the dispersion of the results from the consumption segmentation based on the data available.

With these considerations, the segmentation for heating consumption is carried out based on consumption data from 2010, in proportion to the demand from the main dwellings considered in the 2011 census (knowing their area, location and type).

A weighted average heating energy demand value per dwelling has been determined for each province (both for single-family and multi-family dwellings), according to the climatic conditions of the same (assimilating the climatic zone of each province to that of its respective provincial capital) and the construction characteristics of each chronological period into which the building stock has been segmented.

In order to evaluate the savings potential, the study published by WWF[1] in 2011 on the emissions savings potential of the Spanish dwelling stock has been used as baseline. This study includes demand values for each dwelling type, while the estimation made at that time has been improved by considering the day degrees for each climatic zone set out in the CTE. These simplifications mean that the different modes of occupation of the dwellings are not assessed, nor are the comfort demands of their users or the efficiency of their use and management, considering that these factors are homogeneous for the entire dwelling stock.

Based on the weighted average heating energy demand values per dwelling and the data on the territorial distribution of main dwellings from the 2011 census, the heating demand was lastly estimated in the different provinces, disaggregating the data by location, into rural and urban.

[1] WWF (2010) '*Informe 2010. Potencial de ahorro energético y reducción de emisiones de CO^2 del parque residencial existente en España en 2020' [Report 2010. Energy saving and CO_2 emission reduction potential of the existing residential stock in Spain in 2020].*

Fig. 13. Estimated heating demand in Single-family dwellings by province, according to rural/urban.

SINGLE-FAMILY DWELLINGS					
Province	Heating demand estimated		Province	Heating demand estimated	
	Rural	Urban		Rural	Urban
Araba/Álava	239 497	47 044	Lugo	842 032	84 884
Albacete	423 911	185 667	Madrid	1 805 567	2 849 218
Alicante/Alacant	404 158	372 291	Málaga	156 013	293 590
Almería	125 892	93 441	Murcia	242 707	777 929
Ávila	511 247	66 302	Navarre	1 146 631	59 701
Badajoz	722 809	270 772	Ourense	425 301	33 379
Balearic Islands	469 388	441 102	Asturias	552 411	314 380
Barcelona	1 331 313	844 903	Palencia	441 112	37 020
Burgos	807 032	121 029	Las Palmas	0	0
Cáceres	663 082	125 935	Pontevedra	606 365	391 515
Cádiz	77 683	227 995	Salamanca	632 205	33 332
Castellón/Castelló	210 166	165 278	Santa Cruz de Tenerife	0	0
Ciudad Real	856 018	377 037	Cantabria	316 126	113 442
Córdoba	465 396	347 268	Segovia	474 590	34 558
A Coruña	743 993	340 184	Seville	690 196	683 451
Cuenca	327 317	14 939	Soria	247 573	17 123
Girona	796 640	217 337	Tarragona	566 999	224 239
Granada	1 065 335	277 154	Teruel	409 572	32 912
Guadalajara	518 888	107 796	Toledo	1 863 241	185 744
Gipuzkoa	127 352	60 023	Valencia/Valéncia	836 879	508 825
Huelva	238 934	76 090	Valladolid	767 707	220 623
Huesca	413 903	9 052	Bizkaia	217 564	54 079
Jaén	730 799	235 187	Zamora	462 281	34 843
León	1 487 904	213 454	Zaragoza	617 425	162 050
Lleida	651 378	47 303	Ceuta	0	6 643
La Rioja	263 817	20 530	Melilla	0	7 008

Source: Prepared by GTR for the Ministry of Development.

Fig. 14. Estimated heating demand in Multi-family dwellings by province, according to rural/urban.

MULTI-FAMILY DWELLINGS					
Province	Heating demand		Province	Heating demand	
	Rural	Urban		Rural	Urban
Araba/Álava	150 559	730 363	Lugo	367 794	332 201
Albacete	127 905	516 127	Madrid	688 531	12 774 414
Alicante/Alacant	180 171	881 313	Málaga	33 858	457 297
Almería	33 157	87 854	Murcia	96 012	640 311
Ávila	172 308	185 417	Navarre	658 438	798 174
Badajoz	164 768	342 963	Ourense	123 499	180 572
Balearic Islands	194 523	759 003	Asturias	392 379	1 607 824
Barcelona	711 048	4 146 294	Palencia	120 599	274 901
Burgos	158 694	984 495	Las Palmas	0	0
Cáceres	194 746	244 119	Pontevedra	220 063	703 870
Cádiz	27 554	244 116	Salamanca	212 340	439 020
Castellón/Castelló	111 204	346 295	Santa Cruz de Tenerife	0	0
Ciudad Real	231 302	358 528	Cantabria	210 173	392 366
Córdoba	146 793	516 142	Segovia	122 747	169 580
A Coruña	253 179	835 636	Seville	130 885	825 543
Cuenca	63 307	69 526	Soria	89 522	151 878
Girona	366 525	434 342	Tarragona	254 093	562 631
Granada	227 844	572 343	Teruel	159 229	96 183
Guadalajara	81 462	249 772	Toledo	334 495	406 220
Gipuzkoa	570 365	632 506	Valencia/Valéncia	583 685	2 088 851
Huelva	70 420	156 000	Valladolid	163 356	1 023 830
Huesca	242 352	126 477	Bizkaia	461 283	1 311 505
Jaén	209 625	390 781	Zamora	78 392	159 443
León	442 237	1 017 768	Zaragoza	259 607	1 309 182
Lleida	382 765	307 482	Ceuta	0	20 397
La Rioja	251 544	458 961	Melilla	0	14 268

Source: Prepared by GTR for the Ministry of Development.

The actual heating energy consumption of the total of all the dwellings in Spain, distributed according to energy sources, has been obtained from the MINETUR/IDAE data, discounting the consumption corresponding to coal, the consumption corresponding to second residences and consumption by dwellings for which there are no data in the 2011 census, distributed based on dwelling type (single family and multi-family), climatic conditions and fuel type. For the distribution, the different provinces have been grouped into three differentiated areas: Continental, Atlantic and Mediterranean, as indicated on the map below. This distribution is the one used in the *SECH-SPAHOUSEC PROJECT*.

Analysis of energy consumption by the residential sector in Spain[2], which has been taken into account in the disaggregation of consumption.

Fig. 15. Climatic zoning considered in the SECH-SPAHOUSEC Project.

Green: North Atlantic ZONE. Orange: Continental Zone. Yellow: Mediterranean Zone.
Source: IDAE (2011). SECH-SPAHOUSEC PROJECT. Analysis of energy consumption by the residential sector in Spain.

The results obtained are as follows:

Fig. 16. Distribution of consumption according to final energy fuels in heating by SEC-SPAHOUSEC climatic zones and dwelling type (single family/multi-family).

DISTRIBUTION ACCORDING TO FINAL ENERGY FUEL IN HEATING	Dwelling type	
	Single family	Multi-family
NORTH ATLANTIC ZONE	MWh	MWh
TOTAL PETROLEUM PRODUCT HEATING	2 145 662	862 921
TOTAL GAS HEATING	291 781	1 595 117
TOTAL RENEWABLES HEATING	2 526 742	2 835
TOTAL ELECTRICITY HEATING	137 152	539 250
TOTAL	5 101 336	3 000 123
CONTINENTAL ZONE		
TOTAL PETROLEUM PRODUCT HEATING	8 145 127	8 950 298
TOTAL GAS HEATING	2 601 256	7 221 319
TOTAL RENEWABLES HEATING	10 806 596	4 427
TOTAL ELECTRICITY HEATING	480 435	1 181 465
TOTAL	22 033 413	17 357 508
MEDITERRANEAN ZONE		
TOTAL PETROLEUM PRODUCT HEATING	5 977 658	1 480 953
TOTAL GAS HEATING	2 099 425	5 491 210
TOTAL RENEWABLES HEATING	13 627 833	1 847
TOTAL ELECTRICITY HEATING	594 419	1 392 030
TOTAL	22 299 335	8 366 040
TOTAL	49 434 085	28 723 671

Source: Prepared by GTR for the Ministry of Development.

The heating energy demand covered has been determined based on the distribution of actual heating consumption, with a disaggregation according to fuel type, dwelling type (single family and multi-family), location (rural or urban) and climatic area, as shown in the table below:

[2] IDAE (2011). '*PROYECTO SECH-SPAHOUSEC. Análisis del consumo energético del sector residencial en España*'. http://www.idae.es/index.php/mod.documentos/mem.descarga?file=/documentos_Informe_SPAHOUSEC_ACC_f68291a3. pdf

Fig. 17. Satisfied energy demand by SEC-SPAHOUSEC climatic zones and dwelling type (single family/multi-family) and location in rural/urban environment.

SATISFIED ENERGY DEMAND	Dwelling type					
	Single family			Multi-family		
	Total	Rural	Urban	Total	Rural	Urban
NORTH ATLANTIC ZONE	MWh			MWh		
TOTAL PETROLEUM PRODUCT HEATING	1 716 530	66.5%	33.5%	690 337	60.8%	39.2%
TOTAL GAS HEATING	233 424	0.0%	100.0%	1 276 094	0.0%	100.0%
TOTAL RENEWABLES HEATING	908 900	100.0%	0.0%	1 020	100.0%	0.0%
TOTAL ELECTRICITY HEATING	137 152	66.5%	33.5%	539 250	60.8%	39.2%
TOTAL	2 996 006	71.5%	28.5%	2 506 700	29.9%	70.1%
CONTINENTAL ZONE						
TOTAL PETROLEUM PRODUCT HEATING	6 516 102	86.0%	14.0%	7 160 238	33.0%	67.0%
TOTAL GAS HEATING	2 081 004	0.0%	100.0%	5 777 055	0.0%	100.0%
TOTAL RENEWABLES HEATING	3 887 265	100.0%	0.0%	1 592	100.0%	0.0%
TOTAL ELECTRICITY HEATING	480 435	86.0%	14.0%	1 181 465	33.0%	67.0%
TOTAL	12 964 806	76.4%	23.6%	14 120 351	19.5%	80.5%
MEDITERRANEAN ZONE						
TOTAL PETROLEUM PRODUCT HEATING	4 782 126	40.4%	59.6%	1 184 763	55.3%	44.7%
TOTAL GAS HEATING	1 679 540	0.0%	100.0%	4 392 968	0.0%	100.0%
TOTAL RENEWABLES HEATING	4 902 098	100.0%	0.0%	664	100.0%	0.0%
TOTAL ELECTRICITY HEATING	594 419	40.4%	59.6%	1 392 030	55.3%	44.7%
TOTAL	11 958 184	59.2%	40.8%	6 970 425	20.4%	79.6%
TOTAL	27 918 995			23 597 475		

Source: Prepared by GTR for the Ministry of Development.

The actual heating energy consumption distribution has been determined based on these data, for each of the type clusters into which the residential stock has been segmented, considering that the actual heating energy consumption should be maintained for each fuel type.

Thus, the organisation of main dwellings from higher to lower consumption depends on their type and the climatic zone where they are located. The result of the segmentation by type clusters is summarised in the following tables:

Fig. 18. Heating energy consumption by main dwellings with heating (MWh) according to year of construction (rows) and number of dwellings in the building and floors above ground (columns).

Year of construction	Single family		Multi-family			No data	TOTAL	No of dwellings in the building / No of floors above ground
	1–3	≥ 4	1–3	≥ 4	No data			
< 1940	7 747 276	-	-	1 297 460				A - G
1941–1960	6 236 436	-	-	2 477 278				B - H
1961–1980	10 824 845	-	1 965 768	12 430 112				C - E - I
1981–2007	19 494 919	-	3 015 281	8 889 929				D - F - J
2008–2011	-	-	-	-				
No data			-		-	-		
TOTAL							79,011,424	

Clusters
74 379 303
(94.1%)

Source: Prepared by GTR for the Ministry of Development, based on the Population and Housing Census 2011 (INE, 2014), Population and Housing Census 2001 (INE, 2004), Handbook of air conditioning system design (Carrier Air Conditioning Company, 1970), Potencial de ahorro energético y de reducción de emisiones de CO_2 del parque residencial existente en España en 2020 (WWF, 2010), SECH SPAHOUSEC PROJECT Analysis of energy consumption by the residential sector in Spain (IDAE, 2011), Monthly bulletin of electrical indicators [Boletín mensual de indicadores eléctricos], January 2014 (CNMC, 2014).

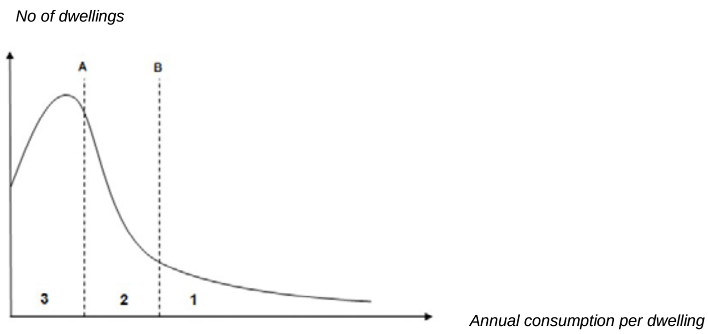
Fig. 19. Heating energy consumption by main dwellings with heating (kWh/main dwelling) according to year of construction (rows) and number of dwellings in the building and floors above ground (columns).

	1		≥ 2		No data	TOTAL	No of dwellings
	1–3	≥ 4	1–3	≥ 4			Municipality size
< 1940	14 380	0	0	3 013			A - G
1941–1960	12 654	0	0	3 168			B - H
1961–1980	11 711	0	3 115	3 147			C - E - I
1981–2007	12 982	0	2 783	2 849			D - F - J
2008–2011	0	0	0	0			
No data			0		0		
TOTAL						5,060	

Source: Prepared by GTR for the Ministry of Development.

Moreover, this segmentation that has been carried out for the residential stock makes it possible to find out the distribution according to the fuel used for heating in the dwelling and the distribution of consumption into the following bands:

- Band 1, which includes dwellings that between them account for 50% of the cluster's consumption;
- Band 2, which includes all other dwellings consuming above the median average for the cluster;
- Band 3, which includes the 50% of dwellings remaining, which have the least consumption in the cluster.



The content of the final tables obtained this way makes it possible to consider, for each segment selected (i.e. for each cluster), whether there is a specific heating installation and which fuel is used to heat the dwelling. This makes it possible to find out the GHG emissions generated by this consumption, as well as the potential for switching fuel when this solution means an improvement in efficiency in emissions due to climate control in the dwelling.

II.2.2. ANALYSIS OF CONSUMPTION IN THE NON-RESIDENTIAL SECTOR IN SPAIN.

The buildings in the non-residential sector in Spain have a very significant savings potential, although they require a different approach to the one used for dwellings. Despite having fewer buildings than the residential sector (with less area), the tertiary sector accounts for 35% of the country's energy consumption that includes buildings.

The managers of the non-residential sector are, on the whole, receptive to interventions regarding energy efficiency – given the attractive profitability of the investments – although implementing energy renovation projects is still currently 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.

Nevertheless, energy services companies (ESCos) have begun working in the sector, as many of them are operators or take responsibility for maintaining the buildings, hence their energy efficiency work can be combined with other services and be amortised through long-term contracts. Energy performance contracts would thus be combined with energy supply and maintenance contracts.

Unlike the residential sector, the tertiary sector is much more familiar with measures related to energy efficiency and, in turn, the administrators of large commercial properties are already implementing these kinds of measures outside Spain and importing this knowledge into our country.

Investments in energy efficiency in the non-residential sector currently seek an almost immediate return, which is responsible for the fact that they are not very deep. Thanks to the volatility of the business climate in general and to the desire to achieve the maximum return on investments, the majority of those that are made with regard to efficiency in non-residential buildings have been focused on replacing equipment and lighting. It can be said that many of the barriers that are currently preventing an optimal approach in the buildings of the Spanish residential sector also crop up in the non-residential sector. Nevertheless, the tertiary sector requires a methodological approach that differs from the residential approach, in order to determine the long-term efficiency parameters, as well as to implement the passive measures that have longer-term returns.

Furthermore, the non-residential sector includes buildings with very different uses, whose energy consumption responds to very different patterns, making it difficult to consider the same actions with the same savings performances. It is necessary to address this by means of sectoral strategies that take account of this variety 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, as well as exploitation of the land register and other sources to determine the area and uses covered by the sector.

Using consumption data from IDAE, the following table shows information on the consumption by different uses in relation to the headings that determine the different uses in the land register. The information on consumption has been limited to those uses with significant consumption that are not fundamentally associated with the industrial activities that they may include (for which improvement in energy efficiency is not included in this Strategy). Likewise, the consumption of buildings attached to the central State administration is differentiated from other uses, owing to its special relationship with the specific requirements set out in the Energy Efficiency Directive:

Fig. 20. Final energy consumption in the non-residential sector according to the segmentation by uses carried out based on the land register.

USES ACCORDING TO LAND REGISTER		Final energy
		ktoe
A - Warehouse - Parking		
V -Residential		
I - Industrial		
O - Offices		2 000
C - Commercial	small businesses	4 800
	shopping centres	1 000
K - Sports		200
T - Entertainment		
G - Leisure and Hospitality		1 000
Y - Health and Charitable		500
E - Cultural		400
R - Religious		
M - Urban design and gardening works, unbuilt land		
P - Singular building		
B - Agricultural warehouse		
J - Agricultural Industrial		
Z - Agricultural		
	TOTAL	10 000

Source: Prepared by GTR for the Ministry of Development.

As a supplement to this consumption, and with information taken from the 2014 GTR[3] report (prepared in collaboration with energy services companies), the following disaggregation of consumption into different energy uses is used as the model for this Strategy, for the most significant uses by the non-residential sector in Spain:

Fig. 21. Distribution in % of consumption in the non-residential sector according to the segmentation by uses carried out based on the land register.

USES		DISTRIBUTION OF CONSUMPTION (in %)				
		Climate	Cooling*	Lighting	DHW	Equipment and other
Offices (private)		55	25	20	5	20
Commercial	Small businesses	40	20	20	5	15
	Shopping centres	40		45		15
Hotels		45		15	23	17
Sports centres		36	10	19	6	39
Hospitals		40		35	20	5
Public administration		55	25	20	5	20
Public primary/secondary schools		75		20		5
State secondary schools		70		20		10
Universities		40	10	30		30

*Cooling is a separate quantity of Climate and should not be considered in the sum of percentages

Source: Prepared by GTR for the Ministry of Development.

II.3. LIST OF MEASURES APPROVED RECENTLY OR IN PROGRESS.

II.3.1. APPROVED REGULATORY MEASURES.

The Council of Ministers of 5 April 2013 approved a 'Comprehensive Housing and Land Plan'[4], with regulatory and development measures, whose fundamental objectives are focused on facilitating access to housing for more disadvantaged people, assisting with rent, promoting renovation and improving the energy efficiency of buildings.

Against this backdrop, and in terms of specific measures related to renovation and energy efficiency in buildings, the following laws have recently been passed:

Law 8/2013 on Urban Renovation, Regeneration and Renewal.

This law, together with Law 4/2013 of 4 June on measures to develop and make the house rental market more flexible (*Official State Gazette* of 5 June 2013), forms the keystone of the abovementioned 'Comprehensive Housing and Land Plan'. The draft law was sent to the lower house of parliament on 5 April 2013, and was passed on 26 June (*Official State Gazette* of 27 June 2013).

The purpose of the law is to regulate the basic conditions that will ensure sustainable, competitive and efficient development of the urban environment, by means of driving and promoting actions that will lead to the renovation of buildings and the regeneration and renewal of the existing urban fabric, where necessary, to ensure a suitable quality of life for citizens and the effectiveness of their right to enjoy decent and adequate housing, focusing on the following aspects in particular:

❑ Regulation to improve the state of conservation of buildings.
❑ Regulation to ensure universal accessibility and non-discrimination against persons with disabilities.
❑ Regulation to make it possible, on a voluntary basis, to improve the energy efficiency of

[3] GTR: *Renovation Working Group coordinated by Green Building Council España (GBCe) and the CONAMA Foundation*
[4] http://www.lamoncloa.gob.es/docs/refc/pdf/refc20130405e_1.pdf

existing buildings.

- Legislative amendments to remove obstacles and make the current arrangements more flexible. Basically by amending the Land Law, Horizontal Property Law and Building Planning Law + Technical Building Code
- New mechanisms for funding and public-private partnership.

Specifically, the measures included in the abovementioned national law to improve energy efficiency in buildings can be summarised as follows:

a) making it possible to occupy open space or public domain areas to do thermal insulation work from outside the building, install solar collectors on the roof and centralise energy installations, where there is no other technically viable option. It also makes it possible to close off terraces and balconies, in a uniform way and for the entire building, provided that this achieves energy savings of more than 30%;

b) encouraging methods to fund works that will be added to traditional public subsidies and owner contributions. To that end, economies of scale are sought, as well as a suitable design for building renovation actions and for urban regeneration and renewal, that may allow for the operations to be cost-effective, generate their own resources and will make it possible to attract private capital. Construction companies and energy services companies will be able to enter into these operations, providing own capital in exchange for new possibilities to build or density and making changes in use profitable, or by means of mixed coordination schemes with owners; and

c) promoting public-private partnership between the acting public administrations and those responsible for management (owners or companies previously contracted by owners for that purpose).

Royal Decree 235/2013 approving the basic procedure to certify the energy efficiency of buildings (*Official State Gazette* of 13 April 2013).

This law partially transposes Directive 2010/31/EU of the European Parliament and of the Council of 19 May 2010 as regards certifying the energy efficiency of buildings, recasting Royal Decree 47/2007 of 19 January with the incorporation of the basic procedure for certifying the energy efficiency of existing buildings, also taking into consideration the experience of applying this law over the past five years.

The Royal Decree sets out the obligation to provide the buyers or users of buildings with an energy efficiency certificate that must include objective information about the energy efficiency of a building and reference values such as minimum energy efficiency requirements, so that the owners or tenants of the building or unit within it can compare and evaluate its energy efficiency.

There is a basic procedure in place that must be followed by the method for calculating the energy efficiency rating, considering any factors that have the most impact on the energy consumption, as well as the technical and administrative conditions for building energy efficiency certifications.

Royal Decree 238/2013 of 5 April 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).

This amendment of Royal Decree 1027/2007 of 20 July arises from the need to transpose Directive 2010/31/EU of the European Parliament and of the Council of 19 May 2010 on the energy performance of buildings into the Spanish legal system and the requirement set out in the Second Final Provision of the abovementioned Royal Decree 1027/2007 to carry out a periodic review at intervals not exceeding five years to keep it in line with the progress of technology and Community legislation.

The Royal Decree regulates the energy efficiency and safety requirements that must be met by heating installations in buildings in order to address the requirements of personal well-being and hygiene. This law sets out requirements related to general energy efficiency, correct installation and sizing, appropriate control and adjustment of the installations that are present in existing buildings. Moreover, it establishes the inspections that must be carried out periodically on the accessible parts of climate control installations throughout their useful lives, in order to verify compliance with the energy efficiency requirement.

Order FOM/1635/2013 of 10 September updating the Basic Document DB-HE 'Energy Saving', from the Technical Building Code, approved by Royal Decree 314/2006 of 17 March (*Official State Gazette* of 12 September 2013).

This order updates the Basic Document concerning energy saving and partially transposes into the Spanish legal system Directive 2010/31/EU of the European Parliament and of the Council of 19 May 2010, as regards the energy efficiency requirements of buildings set out in Articles 3, 4, 5, 6 and 7 thereof, as well as Directive 2009/28/EC of the European Parliament and of the Council of 23 April 2009 as regards the requirement of minimum levels of energy from renewable sources in buildings, set out in Article 13 thereof.

In this sense, the update of the Basic Document on Energy Saving and the requirements set out therein form the first phase of moving towards the objective of getting buildings with nearly zero energy consumption before 31 December 2020 (2018 in public authority buildings), and it represents a considerable step forwards in terms of the requirements regarding energy efficiency of buildings that were in force up to that point.

II.3.2 APPROVED DEVELOPMENT MEASURES.

II.3.2.1. Approved development measures specifically aimed at the residential sector.

Royal Decree 233/2013 of 5 April regulating the State Plan to promote rental housing, building renovation and urban regeneration and renewal, 2013–2016. (*Official State Gazette* of 10 April 2013).

Royal Decree 233/2013, which implements the new State Plan 2013–2016, contains incentive measures on the new rental and building renovation, urban regeneration and renewal policies.

More information is available at:
http://www.fomento.gob.es/MFOM/LANG_CASTELLANO/DIRECCIONES_GENERALES/ARQ_VIVIENDA/APOYO_EMANCIPACION/ and https://www.boe.es/diario_boe/txt.php?id=BOE-A-2013-3780

ICO [Official Credit Institute] Line for the 'Renovation of dwellings and buildings' 2013 and 2014, within the line 'ICO businesses and entrepreneurs' 2013 and 2014.

The line 'ICO businesses and entrepreneurs 2014' provides funding aimed at the self-employed, businesses and public and private entities, both Spanish and foreign, that make productive investments within Spain. The portion associated with renovation is aimed

at addressing the funding requirements of individuals and homeowners associations, in order to undertake renovation or refurbishment projects on their homes and buildings, common elements and homes. The transactions are processed directly through the credit institutions.

Information is available at: http://www.ico.es/web/ico/ico-empresas-y-emprendedores/-/lineasICO/view?tab=general

Institute for Energy Diversification and Saving (IDAE) PAREER Programme: 'Aid programme for integral energy efficiency and saving projects in residential buildings'.

The IDAE's PAREER Programme came about in order to encourage the implementation of integral energy efficiency saving and improvement actions, as well as the use of renewable energy sources, such as the renovation of windows, façades, roofs, boilers, air conditioning equipment, the incorporation of equipment to individually measure heating and domestic hot water consumption, replacing conventional energy with biomass or geothermal energy, etc. The legislation regulating this aid is set out in Decision of 25 September 2013 of the State Secretariat for Energy of MINETUR published the Decision of 25 June 2013 of IDAE specifically establishing the regulatory bases and organising the programme of aid for the energy renovation of existing buildings in the residential sector (both for housing and hotel use).

More information may be found at: http://www.boe.es/boe/dias/2013/10/01/pdfs/BOE-A-2013-10201.pdf y http://www.idae.es/index.php/id.745/mod.pags/mem.detalle

II.3.2.2. Approved development measures with an impact on the residential and non-residential sectors.

JESSICA-FIDAE Fund Investment fund to finance energy efficiency and renewable energy projects.

The FIDAE Investment Fund is aimed at funding sustainable urban development projects that will improve energy efficiency, use renewable energies and that are developed by energy services companies (ESCos) or other private companies.

It is a fund that is co-financed by ERDF and IDAE and operated by the European Investment Bank (EIB). This fund will finance all investments that are directly related to increasing energy efficiency and the use of renewable energies in urban environments, and it is compatible with other sources of public or private funding, as well as subsidies that may be co-financed by ERDF.

More information may be found at:
http://www.idae.es/uploads/documentos/documentos_Guia_elegiblidad_v16_56e2ca80.pdf

MAGRAMA Clima Project.

The Clima Project seeks to promote a low-carbon economy. The 2014 call for Clima Projects was launched on 15 February 2014 by opening the period for submitting proposals for projects that should be operational no later than 2015. This aid instrument is designed to redirect economic activity towards low-carbon models at the same as contributing to meeting the international targets assumed by Spain concerning reducing greenhouse gas emissions.

More information may be found at: http://www.boe.es/boe/dias/2011/11/09/pdfs/BOE-A-2011-17631.pdf and http://www.magrama.gob.es/es/cambio-climatico/temas/fondo-carbono/Convocatoria-2014-proyectos-clima.aspx

II.3.2.3. Approved development measures specifically aimed at the non-residential sector.

PIMA SOL Plan. Royal Decree 635/2013 of 2 August in implementation of the 'PIMA Sol Plan to Promote the Environment in the hotel sector'.

The PIMA SOL Plant to Promote the Environment is an initiative aimed at reducing greenhouse gas (GHG) emissions by the Spanish tourism sector. Specifically, it promotes the reduction of direct emissions of GHGs at hotel facilities, achieved by means of the energy renovation of these facilities.

Information is available at: http://www.boe.es/boe/dias/2011/11/09/pdfs/BOE-A-2011-17631.pdf

II.3.3. REGULATORY AND DEVELOPMENT MEASURES IN THE PROCESS OF IMPLEMENTATION.

II.3.3.1. Energy efficiency in the Building Sector in the National Energy Efficiency Action Plan 2014–2020.

As proof of the firm commitment to improve energy efficiency, on 30 April 2014, Spain submitted the National Energy Efficiency Action Plan 2014–2020. This Plan also responds to a requirement of the Directive, which requires national plans to be submitted every three years, continuing on from the previous Energy Efficiency Action Plan 2011–2020.

In terms of the building sector, the National Energy Efficiency Action Plan 2014–2020 includes an entire complete specific section.

II.3.3.2. Energy efficiency obligation schemes and alternative policy measures (Article 7 of Directive 27/2012/EU, Annex XIV, Part 2, 3.2).

a) Energy efficiency obligation scheme.

In order to comply with the target in Article 7 of Directive 27/2012/EU and in accordance with the provisions of paragraph 1 of this Article, Spain shall adopt an energy efficiency obligation scheme that will be applied based on a standardised negotiable energy savings certificate scheme that is flexible and straightforward enough to ensure that there is not a high administrative burden is for either the obligated parties in the scheme or for the regulatory body, which is expected to be fully operational in 2015–2016.

For more information, please see the National Energy Efficiency Action Plan 2014–2020.

b) Energy Efficiency National Fund.

Making use of the power set out in Article 20(4) of Directive 27/2012/EU, Spain has created an Energy Efficiency National Fund to support the obligation scheme and to ensure fulfilment of the energy efficiency targets, by means of Royal Decree-Law 8/2014 of 4 July approving urgent measures for growth, competitiveness and efficiency. This law sets out the lines for developing the fund, in coordination with what has already been established on the matter in the National Energy Efficiency Action Plan 2014–2020.

II.3.3.3. Metering and billing information (Articles 9, 10 and 11 of Directive 27/2012/EC)

For more information, please see the National Energy Efficiency Action Plan 2014–2020.

II.3.3.4. Exemplary role of public bodies' buildings in compliance with Article 5 of Directive 2012/27/EU.

The National Energy Efficiency Action Plan 2014–2020 develops all matters concerning the buildings of the central administrations and other public bodies (Article 5 of Directive 27/2012/EU).

II.3.3.5. Measures for development with European Funds associated with the new programming period 2014–2020.

As set out by Regulation (EU) No 1303/2013 of the Parliament and of the Council laying down common provisions on the ERDF, Cohesion Fund, EAFRD and EMFF for the period 2014–2020, the Spanish draft Partnership Agreement 2014–2020 was sent to the European Commission on 22 April

2014. Next, a negotiation period is initiated with the European Commission until the Partnership Agreement is finally approved, over a maximum period of four months.

All the information concerning the same can be found at:
http://www.dgfc.sgpg.meh.es/sitios/dgfc/es-ES/ipr/fcp1420/p/pa/Paginas/inicio.aspx

II.3.4. FISCAL MEASURES.

Value Added Tax (VAT)[5].

Royal Decree-Law 20/2012 of 13 July on measures to ensure budgetary stability and promote competitiveness sets out the option to apply the reduced VAT rate to certain refurbishment, renovation and repair works.

Personal Income Tax. (IRPF)[6].

The current national regulations on personal income tax do not envisage the possibility of applying any kind of deduction for refurbishment, renovation or improvement works for dwellings built after 31 December 2012. Nevertheless, there are still deductions in some autonomous communities related to refurbishment works carried out on main dwellings.

[5] Link to legislation: http://www.boe.es/boe/dias/2012/07/14/pdfs/BOE-A-2012-9364.pdf
[6] Link to legislation: http://www.boe.es/boe/dias/2011/05/06/pdfs/BOE-A-2011-7972.pdf.

II.4. OPPORTUNITIES FOR ENERGY RENOVATION IN THE BUILDING SECTOR

The analysis preceding this heading shows that renovation in Spain represents a strategic opportunity. Beyond the statistical data, other elements show the opportunities of all kinds that go along with it:

II.4.1. OPPORTUNITIES IN THE LEGISLATION THAT FACILITATE ENERGY RENOVATION IN THE BUILDING SECTOR

- European legislation: Existence of clear European guidelines aimed at strengthening energy efficiency and saving emissions. Intention of the European Union (Directives, European funds) and of the central State administration to improve energy efficiency and, in general, the Spanish residential stock.
- The potentialities of Law 8/2013 on urban renovation, regeneration and renewal and its positive assessment by players in the sector.
- Building Assessment Reports: Existence of a BER Model Ordinance model, which has already been approved and is proving to be very useful for numerous city councils.
- The positive assessment of Energy Certification and the classification or energy label in the price of properties.
- The positive assessment of the amendments to Law 38/1999 on Building Planning and RD 314/2006 on the Technical Building Code (CTE), as well as the increased flexibility of the Horizontal Property Law by means of Law 8/2013.

II.4.2. ADMINISTRATIVE OPPORTUNITIES TO FACILITATE ENERGY RENOVATION IN THE BUILDING SECTOR

- Consolidated experience and the existence of successful models of inter-administrative coordination.
- Consolidated experience in managing renovation actions in historical areas.

II.4.3. OPPORTUNITIES FOR FUNDING AND THE DEVELOPMENT OF OPERATIONS.

- Opportunities from the macroeconomic point of view: Renovation during times of crisis has an anti-cyclical effect on the economy, contributing to improving the economy as a whole by energising the local economy.
- The link between promoting renovation and reactivating the economy, encouraging employment and strengthening the business of small- and medium-sized building firms, allowing them to find new business niches and work for their staff.
- The high percentage of returns on public investment, due to an increase in revenue via taxes (permits, VAT, immovable property tax, etc.) and reduction in unemployment benefits.
- Energy renovation results in energy saving, which means less energy consumption, both at national level (contributing to reducing Spain's energy dependence) as well as for owners (those who better thermally insulate now will have a competitive advantage when the cost of energy shoots up in the years to come).
- The strong interest in reducing consumption of resources and increasing the ability to anticipate, reducing the uncertainty entailed by dependence on fossil fuels, due to shortages and/or increased prices that are expected based on having to extract these fuels. The need to move closer to energy self-sufficiency with renewable and local resources and to carbon neutrality, reducing polluting emissions. Promoting and developing new energy sources.
- Reducing energy demand may make the system more stable, helping to strengthen it and becoming an ally of energy policies.
- Advantages for employment. Renovation has great ability to generate employment, much more so than building large infrastructures or new buildings, and encourages the

development of companies associated with the region where it is carried out. Furthermore, the kind of employment generated is more specialised and stable.
- By establishing a population in renovated areas, renovation will make existing infrastructures and facilities cost-effective, in addition to extending the useful life of dwellings and the consequent revitalisation of the environment in run-down neighbourhoods. This benefit extends to the majority of society, not just owners.
- Reducing the black economy through specialisation of the professionals in the sector.
- Subsidies through Royal Decree 233/2013 of 5 April regulating the State Plan to promote rental housing, building renovation and urban regeneration and renewal, 2013–2016.
- The opportunity to establish new lines of public aid with European funds.
- The opportunity to design new specific products aimed at funding renovation. The existence of previous European experiences with funding models.
- The possibility of having loans through the ICO-R3E line for homeowners associations.
- Private funding opportunities through public-private partnership arrangements.
- The possibility of energy services companies (ESCos) funding part of the renovation work. Energy companies must get involved in these processes and facilitate any changes that will improve the energy efficiency of buildings.

II.4.4. OPPORTUNITIES FOR BUILDING ENERGY RENOVATION PROCESSES IN RELATION TO SOCIAL AND ENVIRONMENTAL ASPECTS

- Promoting environmental sustainability and sustainable urban development. Reducing the ecological footprint and improving the environment in general, by reducing the generation of waste, and reducing the material and energy resources used for new construction.
- Renovating buildings and dwellings and regenerating neighbourhoods is outlined as the most sustainable solution in the medium and long term, compared to building new dwellings occupying new land. Promoting a more sustainable urban model that improves quality of life in cities and means less pressure on property and land.
- Overcoming the competitive strategies between regions based on consumption of resources, dematerialisation of the economy and the decoupling of economic growth and consumption of resources.
- Extending the useful life of buildings and revaluing building heritage. Possibility of improving the aesthetics of buildings, neighbourhoods, their environmental quality and reviving socially run-down areas.
- Compliance with legislation on building conservation and universal accessibility.
- Visibility and the snowball effect of actions: Replicability.
- Renovating energy equipment in cities, buildings and dwellings. Improving electricity and gas infrastructures during urban regeneration and renewal actions. Organised introduction of smart systems to measure and manage energy consumption. Eliminating equipment that uses the most contaminating fossil energy sources such as fuel oil or coal.
- The option of driving R&D&I related to renovation. Advances in research on new materials and development of more efficient appliances (boilers, air conditioners, lighting, etc.).
- The appearance of new technologies, especially in energy efficiency, that can provide fresh impetus to the renovation sector. Generating new profiles of experts specialising in REE.
- Industrialising construction by developing new building systems adapted to renovation.

II.4.5. BUSINESS OPPORTUNITIES IN THE SECTOR TOWARDS ENERGY RENOVATION IN BUILDINGS.

- The option of creating a multidisciplinary group to design business strategies.
- The opportunity to create and consolidate an energy renovation market and market for developing new contracting models.
- The right time to reorganise the range of services and companies.
- Spain has a very large construction industry, with extensive experience and a global vision of

the market. There are products, technical solutions and mature, proven technological solutions.

- The public's perception of the construction industry as a driver of the economy. Significant job niche for local companies, especially for SMEs, encouraging the legal economy.
- The experience in renovation accumulated by the players involved: administrations, experts and companies. In particular, the experience generated via the Integral Renovation Area Programme and Urban Renovation Areas and the local and regional programmes to promote renovation.
- The accumulated experience in Technical Building Inspection.
- The availability of labour specialising in construction, refurbishment and renovation. The existence of a multitude of suppliers. Strong fabric of SMEs in the renovation sector.
- Royal Decree-Law 6/2010 includes measures on driving economic recovery for energy services companies, which gives them legal basis.
- The existence of ESCos with extensive experience in energy services, with multi-sectoral capacity and, via appropriate financial tools, with scope for all kinds of customers, including residents associations. Great capacity for investment and to generate wealth.

PART III. TARGETS, STRATEGIC SCENARIOS AND MEASURES.

III.1. TARGETS OF THE STRATEGY.

The specific targets of this Strategy are in line with those set out by the Energy Efficiency Directive. Thus, below is an analysis of the relevant European context to that end and the national and environmental targets that are in existence or are planned to be drawn up, with which there will necessarily have to be coordination.

III.1.1. EUROPEAN CONTEXT. CURRENT POLICIES AND STRATEGIES IN FORCE IN EUROPE. THE ENERGY AND CLIMATE CHANGE PACKAGE. 20-20-20. ROADMAP FOR MOVING TO A LOW-CARBON ECONOMY IN 2050.

Starting in 2008, the 20-20-20 targets were defined in the European Union through the Energy and Climate Change Package, focusing on reducing greenhouse gas emissions, improving energy efficiency and increasing the proportion of renewable energy sources, objectives intended to be achieved on the 2020 horizon by means of various European legislation.

III.1.1.1 Long-term horizon: 2050.

Having known for some time that climate change represents one of the long-term key factors that requires cohesive action, and with an eye on the horizon further ahead, in March 2011 the Communication from the Commission to the European Parliament, to the Council, to the European Economic and Social Committee and to the Committee of the Regions called *'Roadmap to a competitive low-carbon economy in 2050'* was published. This roadmap provides EU Member States with a long-term general framework for addressing the problem of sustainability and the cross-border effects of phenomena that cannot be solved just at national level.

III.1.1.2. Short-term horizon: 2020.

Meanwhile, the 'Europe 2020' strategy for smart, sustainable and inclusive growth has included five main targets that illustrate the ideal situation for the EU in 2020. One of these refers to climate and energy: Member States have undertaken to reduce greenhouse gases (GHG) by 20%, increase the proportion of renewable energy sources in the EU energy mix by 20% and achieve the target of a 20% increase in energy efficiency between now and 2020. At the moment, the EU recognises that two of these targets are on track for being met; however, the energy efficiency target will not be achieved unless more effort is made. Therefore, the priority continues to be to accomplish all the targets set for 2020.

III.1.1.3. Extended horizon: 2030

This year in Europe, the need has arisen to make a change based on what has been learned from the earlier stage and to formulate a proposal in order for its policies to encompass a broader horizon, extending to 2030. In that regard, the Commission wants to make more intense progress towards ambitious climate and energy targets for 2030, and to do this it has been taking preliminary steps, such as launching the Green Paper[7] published in 2013, which kicked off a public consultation in this field across all sectors.

Consequently, on 22 January 2014, Communication COM(2014) 15 final to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions was published, titled *'A policy framework for climate and energy in the period from 2020 to 2030'*.

[7] Green Paper COM/2013/0169 final 2030 'A framework for climate and energy policies'.

To implement this 2030 framework, the Commission has indicated that a system of European governance is required that respects the flexibility Member States that must have to choose policies that are best suited to their national energy mix and preferences, while also being compatible with further market integration, increased competition and the attainment of Union-level climate and energy objectives.

Through this Communication, the Commission invites the Council and the European Parliament to agree by the end of 2014, that the EU should pledge a greenhouse gas emissions reduction of 40% by early 2015 as part of the negotiations that conclude in Paris in December 2015. The Union should also be prepared to contribute positively to the summit hosted by the UN Secretary General in September 2014.

Likewise, the Commission also seeks the endorsement of an EU-level target of at least 27% as the share of renewable energy to be consumed in the EU by 2030 to be delivered through clear commitments decided by the Member States themselves, supported by strengthened EU level delivery mechanisms and indicators.

Finally, the Commission also invites the Council and the European Parliament to endorse its approach and proposal to establish an effective governance system for the delivery of climate and energy objectives.

III.1.2. NATIONAL CONTEXT: NATIONAL TARGETS PROPOSED BY THE VARIOUS DEPARTMENTS.

As a response to national requirements, and also to fulfil the obligations that fundamentally stem from the European Union, Spain has been adopting measures and policies that must also be taken into account in considering the specific targets of this Strategic Plan.

III.1.2.1. Energy targets.

Of these obligations, mention must be made of the Report on the National Energy Efficiency Target, dated 17 May 2013[8], sent to the Commission pursuant to the provisions of Article 3(1) of Directive 2012/27/EU, which sets out that each Member State must set an indicative national energy efficiency target, based on either primary or final energy consumption, primary or final energy savings, or energy intensity, which must be notified to the European Commission in accordance with Article 24(1). The abovementioned report aims to update and complete the notification of the indicative target set by Spain for the 2020 horizon, in order to comply with the requirements of Article 3(1) as above, taking into account the binding targets (in terms of final energy) that arise from the adoption of Directive 2012/27/EU in Article 7 thereof.

In accordance with this Article, each Member State must achieve an cumulative energy savings target before 31 December 2020, equivalent to achieving new savings each year (from 1 January 2014 to 31 December 2020) of 1.5% of the annual energy sales to final customers of all energy distributors or all retail energy sales companies by volume, averaged over the most recent three-year period prior to 1 January 2013.

In December 2013, the Secretariat of State for Energy of the Ministry of Industry, Energy and Tourism submitted the Report[9] on Energy efficiency and savings policy measures pursuant to Article 7 of Directive 2012/27/EU of the European Parliament and of the Council of 25 October 2012 on energy efficiency.

This report breaks down final energy consumption in three sectors (industry, transport and residential, services and other) in ktoe for 2010, 2011 and 2012, and their average as well as the

[8] http://ec.europa.eu/energy/efficiency/eed/doc/reporting/2013/es_2013report_es.pdf
[9] http://ec.europa.eu/energy/efficiency/eed/doc/article7/2013_es_edd_article7_es.pdf

savings targets in final energy of the 1.5% cumulative average. The total savings target for the period 2014–2020 for Spain – excluding the transport sector to calculate this – reaches the 21 305 ktoe and for the residential, services and other sector is 12 432 ktoe. In accordance with the possibility set out in Article 7(2) and (3) of the Directive, the cumulative savings target is reduced from 21 305 ktoe to 15 979 ktoe for the entire period between 1 January 2014 and 31 December 2020[10].

This report proposes policy measures that are pending development by MINETUR, such as the energy efficiency obligation scheme that will be applied based on a standardised system of negotiable energy efficiency certificates that is sufficiently flexible and simple so as to limit the administrative burden both for the parties bound by the scheme and for the managing body, which is expected to be fully operational in 2015–2016. In that same regard, the report announces the creation of the Energy Efficiency National Fund pursuant to Article 20 of Directive 2012/27/EU. This Fund has been created, de facto, by means of Royal Decree-Law 8/2014 of 4 July approving urgent measures for growth, competitiveness and efficiency.

The measures that are given in a preliminary table of actions to be implemented as part of the energy efficiency obligation scheme include 10 measures relating to buildings and the equipment, which are explained below:

1. Energy renovation of the thermal envelope of existing buildings
2. Improving the energy efficiency of heating installations in existing buildings
3. Improving the energy efficiency of interior lighting installations in existing buildings
4. Construction of new buildings and renovation of existing buildings with a high energy rating
5. Improving the energy efficiency of commercial and industrial cooling installations
6. Improving the energy efficiency of existing lift installations in buildings
7. Improving energy efficiency in existing data centres
8. Improving the energy efficiency of electrical household appliances
9. Improving energy efficiency through home automation and smart management systems
10. Improving energy efficiency through district heating and cooling networks.

From this list of measures, it is clear that all of them, except numbers 5, 6 and 9, are included as potential measures in this Strategic Plan.

III.1.2.2. Environmental targets.

The ‘Europe 2020’ strategy for smart, sustainable and inclusive growth includes five main targets that illustrate the ideal situation of the EU in 2020. One of these refers to climate and energy, which has been specified into 20-20-20: reducing greenhouse gases (GHG) by 20%, increasing the proportion of renewable energy sources in the EU energy mix by 20% and achieving the target of a 20% increase in energy efficiency between now and 2020. In terms of the targets assumed by Spain, the commitment translates into the need to reduce the emissions associated with diffuse sectors by 10% in relation to their 2005 level.

The Secretariat of State for Environment has announced that its department is working on a roadmap to 2020 to reduce emissions in the diffuse sectors. This will make it possible to address Spain’s climate targets with a view to the 2020 horizon, as part of the European Energy and Climate Change Package. The essential elements of this roadmap include preparing the 2020 national projections, which are the responsibility of the Spanish Office for Climate Change and the Directorate General for Environmental and Natural Environment Quality and Assessment, and which forms part of the obligations arising from the commitments to the European Commission, to whom these projections are submitted on a yearly basis. The roadmap provides the keys for implementing

[10] Prior to 5 June 2014, the Commission will be notified of the flexibility elements that will be taken into account to determine the final target, although the energy efficiency obligation scheme and the supplementary measures that will be implemented will be designed starting from 1 January 2014, on the basis that Spain will be able to reduce the target from Article 7(1) by the 25% maximum allowed by the Directive in paragraph 3 of this same Article.

measures to meet the targets in a way that is consistent with the economic situation, seeking synergies in generating employment and economic activity.

The Roadmap 2020 for the diffuse sectors will consider the measures that in the building sector entail a high savings potential, and where energy renovation involves a high degree of mitigation in the reduction of greenhouse gas (GHG) emissions. The actions in the building sector that are relevant to the targets of this Roadmap will be set out once the planning proposals of this strategic plan are known.

III.1.3. SPECIFIC TARGETS OF THE STRATEGY.

III.1.3.1. Specific quantitative targets in this Strategy.

Three different final energy consumption savings scenarios have been established for residential buildings and two scenarios for non-residential buildings.

a) Residential buildings:

a.1) Scenario 1. HIGH RESIDENTIAL: Savings on the cumulative final energy consumption for thermal uses (heating, cooling and DHW) for the period 2014–2020 equal to 32% of the average total final energy consumption for the years 2010–2012.

a.2) Scenario 2. AVERAGE RESIDENTIAL: Savings on the cumulative final energy consumption for thermal uses (heating, cooling and DHW) for the period 2014–2020 equal to 26% of the average total final energy consumption for the years 2010–2012.

a.3) Scenario 3. BASIC RESIDENTIAL: Savings on the cumulative final energy consumption for thermal uses (heating, cooling and DHW) for the period 2014–2020 equal to 7% of the average total final energy consumption for the years 2010–2012. This scenario for the residential sector would arise from extending, between 2014 and 2020, approximately, the direct subsidies already committed for improving energy efficiency in the building sector in the various plans and programmes already in force, in addition to also considering the application of an estimated percentage of new European funds 2014–2020 for subsidies for energy efficiency in the building sector.

Fig. 22. Final energy savings targets (ktoe) in residential building scenarios.

Residential buildings	Final energy CONSUMPTION (ktoe)				Cumulative Savings 2014–2020	
	2010	2011	2012	AVERAGE	ktoe	%
Scenario 1. HIGH RESIDENTIAL	16 924	15 648	15 512	16 028	5 077	32
Scenario 2. AVERAGE RESIDENTIAL					4 088	26
Scenario 3. BASIC RESIDENTIAL					1 044	7

Source: Prepared by the Ministry of Development.

b) Non-residential buildings:

b.1) Scenario 1. HIGH NON-RESIDENTIAL: Cumulative savings for the period 2014–2020 equal to 20% of the average total final energy consumption for the years 2010–2012 (including both thermal and non-thermal uses).

b.2) Scenario 2. BASIC NON-RESIDENTIAL: Cumulative savings for the period 2014–2020 equal to 16% of the average total final energy consumption for the years 2010–2012 (including both thermal and non-thermal uses).

Fig. 23. Final energy savings targets (ktoe) in non-residential building scenarios.

Non-residential buildings	Final energy CONSUMPTION (ktoe)				Cumulative Savings 2014–	
	2010	2011	2012	AVERAGE	ktoe	%
Scenario 1. HIGH NON-RESIDENTIAL	9 801	10 255	10 098	10 051	2 010	20
Scenario 2. BASIC NON-RESIDENTIAL					1 608	16

Source: Prepared by the Ministry of Development.

The figure below shows the savings corresponding to the different combinations of the scenarios defined for residential and non-residential buildings, in absolute and percentage terms.

Fig. 24. Final energy savings targets (ktoe) combining scenarios (residential and non-residential buildings).

Combination of scenarios		Final Energy Consumption (ktoe)	Cumulative Savings 2014–2020	
			ktoe	%
Residential	Scenario 1. HIGH RESIDENTIAL	16 028	5,077	32
Non-residential	Scenario 1. HIGH NON-RESIDENTIAL	10 051	2,010	20
		TOTAL	7,087	27
Residential	Scenario 1. HIGH RESIDENTIAL	16 028	5,077	32
Non-residential	Scenario 2. BASIC NON-RESIDENTIAL	10 051	1,608	16
		TOTAL	6,685	26
Residential	Scenario 2. AVERAGE RESIDENTIAL	16 028	4,088	26
Non-residential	Scenario 1. HIGH NON-RESIDENTIAL	10 051	2,010	20
		TOTAL	6,098	23
Residential	Scenario 2. AVERAGE RESIDENTIAL	16 028	4,088	26
Non-residential	Scenario 2. BASIC NON-RESIDENTIAL	10 051	1,608	16
		TOTAL	5,696	22
Residential	Scenario 3. BASIC residential	16 028	1,044	7
Non-residential	Scenario 1. HIGH NON-RESIDENTIAL	10 051	2,010	16
		TOTAL	3,054	12
Residential	Scenario 3. BASIC residential	16 028	1,044	7
Non-residential	Scenario 2. BASIC NON-RESIDENTIAL	10 051	1,608	16
		TOTAL	2 652	10

Source: Prepared by the Ministry of Development.

III.1.3.2. Specific qualitative targets in this Strategy.

Taking account of the provisions of Article 4 of Directive 2012/27/EU, this Strategy seeks to mobilise investment in the renovation of the national stock of residential and commercial buildings, both public and private.

In that same regard, Law 8/2013 on urban renovation, regeneration and renewal sets out the triple objective of encouraging building renovation and urban regeneration and renewal, eliminating existing obstacles and creating specific mechanisms that will make it viable and possible; providing a suitable regulatory framework for making it possible to restructure and reactivate the construction sector, finding new fields of activity, specifically, in energy renovation and urban regeneration and renewal; and finally, promoting quality, sustainability and competitiveness, both in buildings as well as in land, bringing the Spanish regulatory framework into line with the European framework, especially in relation to the energy savings and efficiency targets.

This Strategy thus outlines the scenarios that seek to encourage the achievement of these targets, as recognised by Law 8/2013 in the Explanatory Memorandum thereof, where it is set out that opportunities for growth and employment will also be created in the construction sector, by means of a strategy of exhaustive, cost-effective renovations that will reduce the energy consumption of buildings by significant proportions with respect to the levels prior to the renovation.

Highlights of the present Strategy in terms of specific transversal objectives include:

- Providing a suitable regulatory framework for making building renovation, urban regeneration and renewal technically, legally and economically viable.

- Contributing to achieving a higher quality of life and comfort in homes.
- Generating a culture and awareness in favour of maintenance, urban renovation, regeneration and renewal as activities that contribute in a particularly positive way in aspects that directly affect the private sphere of their owners, in addition to generating a very positive impact on the entire city as a whole.
- Making it easier for owners to fulfil the duty of building conservation, seeking synergies with energy renovation, contributing to adapting the building stock to the requirements that arise over time. Furthermore, a well-conserved home substantially increases the value of the property itself, value that its owner directly recapitalises, in addition to contributing to a better urban image and efficiency.
- Contributing to the integration of persons with disabilities and to compliance with current legislation on ‘reasonable accommodation’ concerning accessibility, seeking synergies with energy renovation work.
- Reducing the energy bills of families and the country as a whole, as well as dependence on foreign energy.
- Contributing to improving the acoustic performance of dwellings – one of the big comfort issues in Spanish cities – through existing synergies between improving energy efficiency and improving acoustics.
- Committing to ‘integrated’ urban regeneration, defined as regeneration that develops not only technical-urban measures, but also social, economic and environmental measures in the pertinent field of activity.
- Reactivating the real estate and construction sectors and their ancillary industries, providing new opportunities for development. This economic aim means that one of the competences used by the State legislator to set the basic rules on this matter may be, precisely, Article 149(1)(13) of the Spanish Constitution, i.e. the article that grants exclusive competence to the State to establish the basic rules and coordinate general economic planning. Law 8/2013 has been passed in a context of economic crisis, where coming out of this crisis largely depends on the recovery and reactivation of the real estate and construction sectors, which have very significant weight in the national economy. The new law provides opportunities to all sectors that are most directly involved in the processes it regulates. As has been said, to owners first of all, because they will be able to conserve and renovate their dwellings with less financial sacrifice. To city councils, because creating new opportunities that facilitate renovation will solve the serious problem of dwellings in a poor state that cost more to repair than the limit that may be required of owners. Finally, to businesses, because new mechanisms are established to encourage them to be able to enter into renovation operations or by means of mixed coordination schemes with owners. Thus, the way is paved for activity and generation of employment, as well as new approaches to public-private partnership.

The objectives indicated in the above paragraphs are in line with Directives 2010/31/EU and

2012/27/EU insofar as they seek to promote energy efficiency and address the challenges brought about by climate change. To do this, there is recognition of the opportunity that is offered by transforming the production model towards parameters of environmental, social and economic sustainability, with the creation of employment associated with the environment, so-called green jobs, specifically, those associated with renewable energy sources and renovation and energy saving policies.

III.2. DEFINING STRATEGIC SCENARIOS.

III.2.1. DEFINING COST-EFFECTIVE APPROACHES TO RENOVATION AND ECONOMIC ASSESSMENT OF RENOVATION OPTIONS.

III.2.1.1. Macroeconomic analysis of the cost-effectiveness of renovation.

A macroeconomic analysis of the cost-effectiveness of renovation is proposed below, to justify the appropriateness of investing public resources in this activity.

At a time of macroeconomic uncertainty when priorities are fundamentally focused on reducing public administration deficit, investment in energy renovation in buildings can not only contribute to generating a significant volume of employment, reducing the energy bill of the country and the public, it can also have a positive impact on public finances.

The cost-effectiveness of this investment from the point of view of the fiscal returns – added to the possibility it offers with regard to energising the economy, creating jobs, as well as reducing energy dependence on energy sources from oil (the price of which is expected to continue rising) – turn renovating the dwelling stock into a strategic opportunity.

Despite the limitations of the macroeconomic studies available, investing public resources in renovation – and particularly in energy renovation in the residential sector – has two major benefits:

- It generates a significant volume of employment, estimated at 18 jobs for each million euros of total investment, or between 54.3 or 56.5 jobs for every million euros of public investment (assuming that 25% of the total investment is subsidised, so that the other 75% would correspond to private investment). At present, reducing unemployment is undoubtedly a notable factor to be considered.
- It generates returns for the public coffers that can be estimated to be at least (just considering the VAT and the reduction in unemployment costs) equivalent to the volume of public investment.

As will be seen further on, the public investment considered by the calculation model used to design the scenarios takes the traditional form of direct subsidies. With regard to subsidies, from the scenarios analysed, it follows that they would only be necessary during the initial years to kick-start the market (in the basic hypothesis for designing the scenarios, they are estimated to be 25% of the total for the energy renovation) and that they would be reduced gradually to the extent that the micro cost-effectiveness itself of the investments (thanks to the energy savings that can be obtained) also covered this percentage. In any case, it is necessary to recall that the urban dividends made available to fund the renovation operations is a supplementary instrument whose progressive consolidation can either replace the need to make direct public subsidies or, and in combination with these subsidies, result in reducing the final outlay that must be made by owners. In that regard, it should be remembered that Law 8/2013 has opened up the possibility of developing additional work funding schemes that come in addition to traditional public subsidies and contributions from owners. To that end, economies of scale can be sought, as well as an appropriate design for building renovation actions and for urban regeneration and renewal, which may allow for the operations to be more cost-effective, generate their own resources and make it possible to attract private capital. Construction companies and energy services companies will be able to enter into these operations, providing own capital in exchange for new opportunities to build or density, and making changes in use profitable, or by means of mixed coordination schemes with owners.

To multiply the potentialities of the renovation, it would be desirable to have a suitable funding framework that includes reduced interest rates and long terms. 20-year credits and 5% interest are considered conditions that are sufficiently attractive for owners.

III.2.1.2. Cost-effective approaches and economic assessment of the renovation options in the residential sector.

As has been mentioned, for each of the clusters into which the Spanish residential stock has been divided, the most appropriate intervention menu has been designed for each of the construction types, in such a way that a deep intervention will be possible in the dwellings, obtaining a reduction in their heating energy consumption between 60% and 90% and achieving an input, through solar energy, of 50% of the energy necessary for domestic hot water (DHW).

The main argument presented to propose a deep intervention in the energy renovation of dwellings, and to intervene only when it is economically viable to carry out this deep intervention (compared to smaller, more diffuse interventions that may make it possible to accumulate more immediate savings and that are quicker to amortise), is that the latter strategy may eat up a good portion of future savings and leave them outside the reach of successive interventions. This has to do with the various sources of residential energy consumption and their interrelationship.

Effectively, household energy consumption is spread between climate control, DHW, electrical household appliances and lighting, with climate control having a very decisive weight, which, on average and according to IDAE, accounts for 47% of consumption, and that these thermal uses account for 64% when DHW is added. Electrical household appliance equipment and lighting both generate consumption that is directly linked to the number of hours each item of equipment or light is used, and to the specific efficiency of this equipment. Thus, improving efficiency includes improving use – in the event it is not optimal – and replacing equipment with more efficient equipment, without this having more significant consequences on the consumption of other equipment or lights or on other electrical consumption beyond the input as heat, which, ultimately, any consumption of this kind generates.

Replacing one piece of equipment with another more efficient one is going to be an operation that should take place according to the amortisation of the investment made compared to the energy savings that it is going to generate, and considering the amortisation that is still pending from the investment in the existing equipment. In general, and for equipment with an amortisation period of 10 years or fewer that can be replaced with equipment that is much more efficient – as has happened in recent years with electrical household appliances and lighting – renovation is very viable and has fast returns on the investment, and, as a last resort, waiting for the end of their useful life only serves to increase the viability of replacing them with more efficient equipment whose savings no longer need to cover the amortisation of equipment that is still in use. Furthermore, renewing this equipment – precisely due to taking place in such relatively short periods of time – does not require complex operations to intervene in the constructive configuration of the dwelling and, usually, it is resolved with simple operations to disconnect and connect to supplies and sewage systems (where necessary).

Compared to this, the systems and elements associated with climate control and DHW consumption not only have much longer amortisation periods – around 35 to 40 years for the constructive elements of the envelopes; 30 years for centralised installations with programmed and continuous maintenance, or 20 years for mechanical elements in single-family installations – and are more firmly and permanently fastened to the building structure, they also have an interrelationship in their performances that must be duly considered when carrying out an energy renovation.

Furthermore, if, eventually and over a long period but clearly shorter than the amortisation of the building and its main elements, the aim is to obtain significant reductions in a home's energy consumption in terms of climate control, the priority intervention dynamic for the elements that obtain a greater return on the investment in the short term with the savings obtained may be counter-productive in the long term. For example, in certain climatic zones with high heating consumption, an investment that may be amortised over a short period of time – such as switching to a more efficient boiler, but not in coordination with other constructive actions – may have the undesired effect that the reduction in the consumption bill achieved through this initial intervention – for example, by 20–25% – makes other investments in energy efficiency with longer amortisation periods – such as improving the envelope – less viable now, since they must be amortised based on an already reduced energy bill. In general, first investing in actions with a faster return only makes subsequent actions more difficult, up to the point of making many of them unviable and, therefore, making it difficult to obtain reductions in consumption above 50% when all is said and done as regards potential investments.

If the aim is to obtain economically viable but strongly significant reductions that will make it possible to achieve the targets that guarantee fulfilment of our international commitments, actions that can be amortised more quickly are needed to make those where the investment is recouped more slowly (in a deep renovation) viable, as well as to enable them to be included in financial products with return periods similar to investment in real estate.

The proposed target of reductions around 70–80% of the energy consumption of dwellings is based, precisely, on the verification that this percentage of reduction is the figure that can be obtained with logical, organised and decisive intervention menus for the factors involved in the consumption of existing buildings – as confirmed further on – through investments that can be amortised with the savings on energy bills for the most likely future energy price scenarios and with the appropriate aid and funding frameworks. Moreover, these reductions would bring climate control consumption into line with the values defined by European references on energy efficiency in buildings – such as the German Passivhaus – or with the European proposals being debated concerning policies on energy efficiency in buildings, such as the requirement of nearly zero-energy buildings or the proposal of the European Parliament's Industry, Research and Energy (ITRE) Committee from February 2012, calling for Member States to prepare specific plans to obtain energy savings of 80% in buildings in 2050.

These considerations reveal the contradictions of some forms of intervention in energy renovation based on gradually changing elements and systems as the investments needed to do so may be amortised in a short period of time and, as a result, their short-term economic viability is beyond doubt. To a large extent, this vision advocates an economic rationality that is indisputable in many sectors, but in the case of the energy renovation of the residential sector, it may even end up discouraging other investments in deep renovation, whose amortisation period is much longer and without which a significant reduction in demand cannot be achieved.

a) Factors that determine the interventions.

In order to work with these reduction targets, it is necessary to recognise the functional logic in the factors that determine climate control energy consumption in buildings. The factors that determine climate control consumption in a building are:

- The use and management of the building and of its elements and systems;
- The energy demand, considering the energy losses due to transmission and the energy losses due to ventilation separately, if desired;
- The efficiency of the climate installations that satisfy the comfort demand;
- The source of the energy that is supplied to the building.

The rational order of intervention in case of separate actions over time is precisely the order in which they have been presented in the list:

1. Rationalising the use and management of the building is the first adjustment that must be made with a view to energy efficiency, since the other systems are defined precisely for a particular use and management. For example, it does not make sense to invest in an efficient boiler, and then to improve the use and management, causing a slight reduction in the demand so the new boiler ends up being oversized, and consequently loses its efficiency.

2. The energy demand is the exact heating or cooling demand at any time so as to deal with each space in the building according to the use that occupies it. These demands are determined by the conditions of the outdoor climate and the characteristics of the building envelope: the amount of it in relation to the volume enclosed, its overall thermal conductivity and the thermal conductivity of the different elements and systems that make it up, its orientation, etc., as well as the demand for conditioning the air that is replaced inside the building to maintain its quality. It is generally expressed as total annual heating and cooling demand, either by dwelling or by m^2 of building or dwelling. Once again, the boiler example shows us that getting a more efficient one, to only then intervene on the building envelope, reducing the conductivity of its walls or windows, will make the boiler end up being oversized.

3. Efficiency of the installations: it only makes sense to address improving the efficiency of the installations that collect, transport, conduct and deliver the heating or cooling required at any time and in each location to satisfy the demand, when this demand has been rationalised as much as possible.

4. Improving the energy source used for climate control: it does not make sense to cover the roof of a building with solar collectors without first having made the use, management, envelope and installations efficient, although equally, it is possible that changing the fuel or energy source is economically viable in an inefficient dwelling and is much more difficult to set up in an efficient dwelling, in that it will be more difficult to amortise and additional aid will probably be claimed if the change means a very high cost.

An organised catalogue of actions to improve the energy efficiency of existing buildings is thus proposed, which includes the list of basic actions and the conditions for implementing them in the different stock segments (clusters), showing how they contribute to energy saving and considering their economic costs, the energy involved in their manufacture and in the emissions generated by this manufacture. This catalogue of actions is organised based on the list of factors that influence the building's consumption – which have been outlined above – so that the most reasonable and widespread intervention options are covered in each factor, as well as – according to the order of the factors in the list – the priority their implementation would require with regard to the actions that influence other factors.

The list of actions does not seek to be exhaustive so much as to cover, with reasonable actions, the scope of the possible interventions in each of the factors. Obviously, the list can end up becoming extremely long and, for a dwelling in particular, possibilities may be found for different actions and with greater economic efficiency for the same environmental benefit. In fact, it is about attempting to propose a catalogue of actions that, by default, represent a reasonable minimum that may be considered as potential interventions on the factors that affect the heating consumption in any dwelling, and also that any specific study on a specific dwelling only – in the vast majority of cases – finds even more efficient actions.

The actions that are listed within each factor are intended, in general, as alternatives for one another, as a range where the most appropriate one can be selected according to the characteristics of each dwelling – of the dwellings in each cluster – that will make it possible to adopt certain actions and not others, and that in any case will be shown to be most efficient from among the potential actions.

The potential actions are outlined below for each of the factors that influence a building's consumption, listed according to the priority of intervention in each.

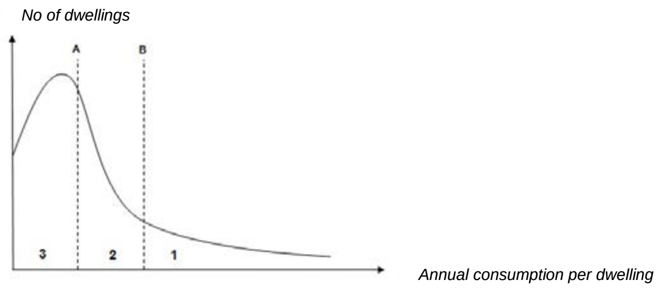
a.1) Use and management

Use and management are considered to be the prime factor to be taken into account in an overall intervention in the reduction of consumption aimed at having efficient performance in the use of energy and in the emissions associated with it. It represents the key factor in the energy demand in that it determines this demand in a decisive way and, in this sense, the efficiency of any reduction in any of the other factors is contingent on subsequent reductions provided by improving use and management. Sidelined by the majority of legislation – with the exception of RITE – which always consider standard and efficient use and management, respectively, of the building and its installations, this factor does not affect the building's constructive elements or installations, and therefore the tools for acting on use and management are not – with the exception of smart management systems – specific technical applications. This factor may be reduced by means of stimuli that lead the user to be more efficient, and training and awareness-raising actions can be combined with actions regarding the cost of energy that harshly and exponentially penalise excessive consumption. They must involve the shift from user management towards maximum efficiency at the time when the other measures are introduced and, therefore, their aim should be, for each stock segment, for users to get on board with the lowest consumption possible, or they will have to pay additional energy and emissions costs that will make it possible to amortise the investment in efficiency, subsidise the purchase of energy to make up for cases of shortages, as well as to subsidise the purchase of their additional emissions.

Furthermore, efficient building use strategies must be developed, such as, for example, the case of going back to use and management strategies linked to heritage buildings, provided that it is possible to adapt them to current requirements. One case to particularly take into account in our country is to consider adaptive comfort during periods in which natural ventilation is possible, which has an impact on a wider range of comfort temperatures and a significant reduction on the cooling demand during warmer months.

The proposed intervention menus do not consider smart management systems for installations and constructive elements – for ventilation, climate control appliances, blinds, etc. – due to their high initial cost, although the installation of these systems could be considered starting from a certain level of energy costs, as an additional action that can be carried out at any time that may be cost-effective, by means of replacement or making the conscious action of the user more convenient.

The dispersion of consumption for the average household consumption value would form a distribution curve that becomes flatter along its right end the fewer restrictions there are on consumption:



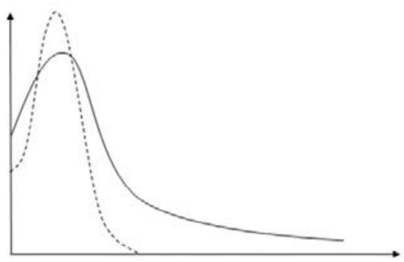
The graph shows three bands – 1, 2 and 3 – delimited by line A, which establishes the median consumption value by household (50% of homes – main dwellings – on either side of the line) and by line B, which establishes half the consumption (50% of consumption on either side of the line). Band 1 includes the most consuming households, which between them account for 50% of the total consumption. Of the other 50% of consumption, band 2 includes any households that are above the median, and band 3 includes 50% of the least consuming households (or, in other words, 50% of main dwellings). If the graph is separated into dwelling type and climatic zone, band 3 would undoubtedly include the homes that have energy shortages – but also those that are simply in the south of Spain – and they could be defined if those values were cross checked with information about income: consumption in band 3 and low income would mean a real possibility of there being an energy shortage, taking into account geographical position as well.

Unfortunately, specific information for dwellings that may allow us to adequately assess how much final consumption can be reduced by acting on use and management has not been found. Data from some studies prepared by GTR on administrative and educational buildings indicate that a minimum value of 10% of consumption should be considered as varying subject to use and management, but this can even commonly represent values around 30% of consumption, thus the scope for improvement would be 20% if action were taken on use and management to improve the building's energy efficiency.

If we shifted these values to the dwelling, we must consider that there is an opportunity to recover consumption along the right side of the graph, and a need for energy investment along the left side. Depending on the compensation mechanisms that were put in place – for example taxing high consumption and supporting households with energy shortages – the graph would get narrower in a way similar to the way shown by the dashed line in the figure overleaf:

MINISTERIO DE FOMENTO

SECRETARIA DE ESTADO DE INFRAESTRUCTURAS, TRANSPORTE Y VIVIENDA



In this Strategy, we will consider that the gains through improvements in use and management, generated by the mechanisms that can be established for this purpose, are going to be used to compensate for the social requirements of additional energy consumption and for supporting investments in energy efficiency to make up for energy shortages, and therefore, despite being a priority and key factor, the Strategy is going to consider the balance from reducing consumption and energy, which may be achieved with the decisive action regarding this factor, as ultimately neutral or zero-sum.

a.2) Reduction of demand through actions on the building skin

After efficient use and management, the next factor that determines energy consumption is the building's demand, i.e. the energy requirements – heating or cooling – that are needed to achieve comfort. The demand depends on the climate, orientation, relationship between the amount of area and the volume of the building – all given factors – and on the building envelopes, which is the feature where intervention action can be taken. The intervention considered here is on the elements that form the building envelopes, improving their thermal insulation.

The following four fields of action are distinguished:

1. Vertical envelopes – walls that separate the interior from the exterior of the building – where it is proposed to increase the thermal insulation up to the maximum possible efficiency (where increasing the insulation no longer produces a noticeable improvement in the overall losses) based on two baseline options:

-Insulation on the inside, maintaining the external appearance of the façade:

a- by means of filling the cavity, where there is an air gap inside the envelope that can be filled with an insulating material. There are different filling procedures and techniques that are more than viable;

b- by means of attaching an internal lining system and an internal finish, 'doubling' the envelope so as to attach an insulating layer to it.

-Insulation on the outside, intervening on the outer face of the wall and transforming its initial appearance to give it continuous insulation as well as, necessarily, new waterproofing through externally attached insulation and finished on the outside with mortar. Compared to doubling on the inside, this doubling on the outside makes it easily possible to noticeably improve the effects of thermal bridging (blind housings, slab edges and supports, jambs, etc.).

2 Windows, where it is proposed to improve the thermal insulation and tightness against leakage, as well as the solar protection of the apertures. It is proposed to replace the window in the aperture with a frame with double glazing with thermal break or to add a new window with double glazing and thermal break to the aperture of the existing window. Adding the double window is the preferred action vis-à-vis replacement, since it makes it possible to considerably increase the thermal resistance of the aperture, although its constructive configuration does not always allow this. Finally, adding a workable solar shading system (blind, awning, shutter, etc.) should also be considered, where there is not one already.

3 Roofs, where it is proposed to increase the thermal insulation up to the maximum possible efficiency (where increasing the insulation no longer produces a noticeable improvement in the overall losses) based on two baseline options:

For pitched roofs:

a- where there is no ventilated chamber under the waterproofing, by means of replacing the existing waterproofing – considered to be tiled – and attaching thermal insulation and a new upper layer of waterproofing;

b- where there is a ventilated chamber and it is accessible, by means of adding thermal insulation to the partition between the habitable space and the ventilated chamber.

For flat roofs, by means of adding a layer of thermal insulation and a trafficable upper protection.

4 Floors, where it is proposed to increase the thermal insulation up to the maximum possible efficiency by means of:

a- attaching thermal insulation to the existing slabs and a new layer of lightweight flooring, with a total thickness of less than 7 cm.

b- for suspended floors, by means of placing the thermal insulation in the gap.

a.3) Ventilation control

Once adequate use and management has been achieved and there are envelopes with maximum insulation and air tightness, ventilation becomes the key factor in the building's energy demand. Controlling ventilation when there is a slight thermal difference between the outdoor air temperature and the indoor air temperature, using a mechanical system, is an action that significantly limits energy consumption.

It is proposed to have a controlled ventilation system that acts automatically when the concentration of CO_2 in the indoor air exceeds a certain level. This way, the replacement of air is strictly adjusted to the indoor air quality demand – the CO_2 acts as benchmark for this quality – and it prevents unnecessary ventilation when the building is unoccupied. Naturally, in our country and in many climatic zones, for a good part of the year there are only small fluctuations in the outdoor air temperature and, although during some hours they may be outside the comfort temperature we require for indoors, the thermal inertia of the construction elements and adequate natural ventilation by managing the opening of windows should allow for adequate indoor air conditions without using climate control systems.

a.4) Improving the efficiency of heating installations

After significantly limiting the energy demand, achieved through the sum of the above measures, the availability of efficient installations to convert, transmit and transfer energy is the next step to reduce consumption, in addition to the use of renewable energy. Naturally, the possible combinations of heating and cooling systems and renewable or non-renewable energy sources but with different costs and GHG emissions is very considerable, and the study carried out for the present Strategy only seeks to consider the options that, being most common, are considered to be most reasonable, most viable economically and with a greater environmental improvement.

In any case, opting for deep energy renovation means that acting on the efficiency of installations must necessarily take place as the last step in a set of prior interventions, and therefore – if we were to consider it individually and for a dwelling that had already been subject to intervention for the other factors – its impact on the increase in efficiency would already be relatively reduced. That is why, despite being one of the actions with a faster return on the investment if we consider all of them individually, certain actions such as switching fuel, installing radiators and even installing certain elements that allow for input from renewables – such as a biomass boiler – are not as convincing if long-term economic analysis is carried out, since consumption has already been reduced previously with other measures for around 70%, and therefore, with bills that are already so greatly reduced, it becomes more difficult to amortise any significant change in the dwelling's heating installations.

Thus, and depending on the different fuels used and a reasonable substitution of those with a higher cost and, also, the highest emissions, the following changes are suggested:

- Dwellings with heating installations using natural gas: replacing boilers with high efficiency boilers.
- Dwellings with electric heating installations using night tariffs: keeping the heating system, since replacing it with another climate system is not considered to be competitive.
- Dwellings using electricity for heating via plates or radiators without use of night-time electricity tariff: installing natural gas or biomass heating depending on whether they are in a rural or urban environment.
- Dwellings using fuel oil for heating: replacement with high efficiency gas boilers where there is a natural gas grid.
- Dwellings using liquefied petroleum gas stoves for heating: installing gas central heating with high efficiency boiler.
- Biomass boilers are gradually being installed in single-family dwellings in rural environments.

In cases of installations with boilers, it is suggested that the change entail installing a centralised boiler when dealing with multi-family buildings.

Finally, in all cases in which biomass is not used as an energy source, a minimum coverage of 50% of DHW with solar thermal panels is also considered.

b) Defining the intervention menus.

The intervention 'menus' are intended to provide packages of energy renovation actions that can be applied to different segments of the existing residential stock, which have been called 'clusters', according to which the Spanish residential stock has been divided. They are used to show the possibility of gaining reductions in consumption of around 80% due to climate control in dwellings. They are also for showing the potential 'market' for the different menus by being expressed in terms of the dwelling stock, thus making it possible to define business strategies to implement them.

The menus comprise actions organised around the logical axis of decisions that makes it possible to intervene on the factors that determine energy consumption, in the appropriate order. Each menu is set up through a connected series of actions that follow this logical axis, setting out a comprehensive intervention option according to the opportunities and restrictions presented by the buildings in each 'cluster'. The aim is to have a benchmark 'menu' that applies to each of the different 'clusters', taking into account the energy source that supplies the dwelling.

The 'intervention menus' represent a strong contribution in the field of renovation as they propose model solutions to be applied in the different 'clusters' and, therefore, they should help to establish market sizes for the different solutions, thus driving the capacity for innovation and technological development and the consequent reduction of costs; fields of competence among the different materials and technologies involved; strategic alliances between the various product manufacturers, installers, construction companies, etc. that provide the different 'menus' to the market and their possible alternatives; as well as – and linked to these alliances – funding 'menus' that may consider the energy and emissions savings, and the contractual figures to guarantee them. All of this will determine the optimal size of the interventions and will help shape a business model and a solvent market.

Even so, the 'intervention menus' are not the only solutions, nor do they aim to be. They simply open up the scope for defining new 'menus' that represent – in each case, and being adjusted to local conditions (types, climatic and constructive) – particular solutions for increased efficiency and/or less expense, making it so that the costs considered in this study may be rationalised even further.

The intervention 'menus' that are proposed for each of the 'clusters' are determined according to the assumption of a basic case that represents the type of envelopes, proportions between them, areas, annual consumption, etc., which essentially determine their profile. The most energy and economically efficient actions are proposed for implementation based on these basic cases, which are the following:

Cluster A, defined as single-family dwellings built before 1940, with one to three storeys: they are considered to be buildings constructed with traditional systems of solid, thick walls, with a predominance of pitched roofs with ventilated chambers, as well as a floor that lies directly on the ground. The intervention 'menu' proposes insulating using an internal double layer (with the persistence involved in heat bridges), adding a window with low air permeability, insulating the roof chamber and insulating the floor using screed with insulation and heavy flooring. As in all the clusters, a particular type of action is proposed for the installation depending on the energy source that supplies the heating; moreover, as in all the clusters, it is proposed to introduce a ventilation system with CO_2 regulation.

Cluster B, defined as single-family dwellings built between 1941 and 1960, with one to three storeys: they are also considered to be buildings constructed with traditional systems of solid, thick walls, with a predominance of pitched roofs with ventilated chambers, as well as a floor that lies directly on the ground. The intervention 'menu' proposes insulating using an internal double layer (with the persistence involved in heat bridges), adding a window with low air permeability, insulating the roof chamber and insulating the floor using screed with insulation and heavy flooring.

Cluster C, defined by single-family dwellings built between 1961 and 1980, with one to three storeys, generally built with cavity walls, a pitched roof with no air chamber and suspended floor: The intervention 'menu' considers filling the air gap with insulation (thus maintaining the thermal bridges), adding a window with low air permeability, replacing the roof by placing thermal insulation underneath the tiles and placing insulation in the underfloor void.

Cluster D, which includes single-family dwellings built between 1981 and 2007 – therefore when technical standard NBE-CT 79 was already in effect – with one to three storeys: It is assumed that they have been built with cavity walls with integrated insulation, a pitched roof with no air chamber and suspended floor. It is not proposed to intervene on the walls beyond filling the cavity with batt, adding windows with low air permeability, replacing the roof by placing extra thermal insulation underneath the tiles and filling the underfloor void with insulation.

Cluster E, defined by multi-family dwellings built between 1961 and 1980, with one to three storeys, considered to have been built with cavity walls, a flat roof and suspended floor: It is also proposed to fill the cavity in the walls with insulation, adding windows with low air permeability, intervention with insulation and layer of protection for the roof and filling the underfloor void or ceiling of the business premises with insulation.

Cluster F, defined as multi-family dwellings built between 1981 and 2007, with one to three storeys: They are considered to have been built with cavity walls with thermal insulation, flat roofs and suspended floor. Therefore the intervention proposal suggests additionally filling the cavity with batt, adding windows with low air permeability, intervention with the addition of extra insulation and layer of protection for the roof, and filling the underfloor void with insulation or insulating the ceiling of the business premises.

Cluster G, defined as multi-family dwellings built before 1940, with four or more storeys: The construction systems continue to be solid walls, the roof is flat, and there is an underfloor void or business premises on the ground floor. The proposed intervention 'menu' considers doubling on the inside, adding a window with low air permeability, intervention with insulation and layer of protection for the roof, and insulating the underfloor void or ceiling of the business premises.

Cluster H, defined as multi-family dwellings built between 1941 and 1960, with four or more storeys: The construction systems continue to be solid walls, the roof is flat, and there is an underfloor void or business premises on the ground floor. The proposed intervention ‘menu’ considers doubling on the outside, adding a window with low air permeability, intervention with insulation and layer of protection for the roof, and insulating the underfloor void or ceiling of the business premises.

Cluster I, defined as multi-family dwellings built between 1961 and 1980, with four or more storeys, considered to have been built with cavity walls, a flat roof and suspended floor: It is also proposed to fill the wall cavity with insulation, to add windows with low air permeability, intervention with insulation and layer of protection for the roof, and insulating the underfloor void or the ceiling of the business premises.

Cluster J includes the multi-family dwellings built between 1981 and 2007, with four or more storeys, that are considered to have been built with thermally insulated cavity walls, flat roof and suspended floor. The proposal for these dwellings is extra filling for the cavity using batt, adding windows with low air permeability, intervention with extra insulation and layer of protection for the roof, and insulating the underfloor void or ceiling of the business premises.

In all the clusters, a particular type of action is proposed for the installation depending on the energy source that supplies the heating; moreover, in all the clusters, it is proposed to introduce a ventilation system with CO_2 regulation. In Clusters G, H, I and J, when the boiler is changed it is assumed that a shared boiler is installed.

Fig. 25. Summary table. Construction characterisation by cluster (previous situation).

Previous situation	Cluster									
	A	B	C	D	E	F	G	H	I	J
Façade										
Thick solid wall										
Cavity wall										
Insulated cavity wall										
Roof										
Pitched with ventilated chamber										
Pitched without chamber										
Flat										
Contact with the ground										
Floor										
Underfloor void or business premises										

Source: Prepared by GTR for the Ministry of Development.

Fig. 26. Summary table. Characterisation of the intervention menus by cluster.

Intervention proposals	Cluster									
	A	B	C	D	E	F	G	H	I	J
Façade										
Insulation with interior doubling	■	■					■			
Insulation with exterior doubling								■		
Cavity filling			■		■				■	
Cavity filling with batt				■		■				■
Window with low permeability	■	■	■	■	■	■	■	■	■	■
Roof										
Roof chamber insulation	■	■								
Insulation under tiles and replacement			■	■						
Insulation and roof protection layer					■	■	■	■	■	■
Contact with the ground										
Insulation through screed	■	■								
Cavity filling insulation			■	■						
Cavity filling or business premises insulation					■	■	■	■	■	■
Ventilation										
Ventilation system with CO_2	■	■	■	■	■	■	■	■	■	■
Climate control system										
Natural gas → efficient gas boiler	■	■	■	■	■	■	■	■	■	■
Fuel oil → efficient gas boiler (city)	■	■	■	■	■	■	C	C	C	C
Fuel oil → biomass boiler (rural)	■	■	■	■	■	■	C	C	C	C
Electric panel → natural gas heating (city)	■	■	■	■	■	■	C	C	C	C
Electric panel → biomass heating (rural)	■	■	■	■	■	■	C	C	C	C
LPG cylinder → natural gas heating (city)	■	■	■	■	■	■	C	C	C	C
LPG cylinder → biomass heating (rural)	■	■	■	■	■	■	C	C	C	C
Biomass → biomass heating	■	■	■	■						
DHW										
Solar installation covering 50% demand	■	■	■	■	■	■	■	■	■	■

NB: C: Change from individual boiler to shared. Source: Prepared by GTR for the Ministry of Development.

c) Calculation methodology applied to the 'clusters'.

In order to ensure that the 'menu' proposed for each 'cluster' reduces the dwelling's energy consumption by a significant percentage, as close as possible to 80% of the original consumption, an exercise is carried out first of all to distribute the current consumption according to the two determining factors in the building's energy demand: the transmission of heat through the building's envelopes and losses due to ventilation. This is an exercise to make a distribution among factors with varying proportions, and requires making some considerations to guarantee that the actions generate, as minimum, the savings indicated.

Losses due to ventilation are an important factor in existing buildings, since frames with low air permeability have only been acquired very recently in our usual construction, and therefore a large part of the built heritage suffers from windows that have very high air permeability. These losses, moreover, are very difficult to quantify for each dwelling. Because the air permeability of the windows is radically improved in all the intervention 'menus' and there is a ventilation control system, achieving total control of losses due to ventilation and making it possible to comply with the CTE, in order to prevent the efficiency measures applied to the envelope from being exaggerated by considering greater losses due to ventilation than those that actually occur, it is considered in the assessment of the improvement 'menu' that the replacement of air that occurs now in the dwellings to receive interventions, is already the minimum ventilation for replacement per hour. This measure guarantees that the consumption savings that are proposed by controlling the ventilation and exchanging the heat between the exhaust air and new air will be the minimum savings, since the reduction of the leakages resulting from adding windows with low air permeability is not considered.

Discounting losses due to ventilation, it should be considered that the dwelling's heating consumption is also lower than the demand due to internal loads and sun exposure, which represent – like the occupation itself – energy inputs that reduce the need for additional energy to heat the home. Occupation has not been discounted since the people will continue living in the home but sun exposure has, so that once again the reduction in consumption is not inflated due to increasing the efficiency of the building envelope. The input from electrical household appliances has been considered, because it is assumed that, during the amortisation period for the investments in efficiency in the building's constructive elements and installations, campaigns are going to be rolled out that will allow homes to have electrical household appliances classified as 'A' today. Therefore (in other words, because not considering this reduction could once again increase the effect of improving efficiency in the building's envelopes), this heat input has been considered both in the current situation as well as in the situation after applying the intervention menu.

The losses due to transmission are distributed according to the existing envelopes in the built stock, their thermal conductivity and the area of each with regard to the total envelope, thus obtaining a distribution of energy consumption for heating. From this point onwards, the above information is supplemented by adding a new column, 'Renovation Data', corresponding to the resultant data after having applied the actions from the intervention menu proposed for each case. An example of one of these tables, for a specific cluster, is as follows:

Fig. 27. Example of complete appearance of the Calculation table for the intervention menus.

HEATING														**CLUSTER**	**F**
Elements that determine consumption			**CURRENT DATA**				**RENOVATION DATA**								
			Characteristics		W/K m² dwelling area	kWh/m² dwelling area year	2. DEMAND					3. VENTILATION		4. INSTALLATIONS	
			Values	Units			Characteristics: Values	Characteristics: Units	W/K m² dwelling area	Heterogeneity coefficient	kWh/m² dwelling area	saving heat exchanger	kWh/m² dwelling area	action saving (%)	kWh/m² dwelling area
Losses	Transmission	walls	1.0	W/m² K	0.63	12.1	0.4	W/m² K	0.22	1.00	4.2				
		window	4.2	W/m² K	0.54	10.4	1.7	W/m² K	0.22		4.2				
		roof	0.7	W/m² K	0.35	6.8	0.3	W/m² K	0.13		2.4				
		floor	1.2	W/m² K	0.30	5.8	0.4	W/m² K	0.10		2.0				
		Total			**1.82**	**35.2**			0.67		**12.9**		**12.9**		
	Ventilation		1.2	renov hour	**1.03**	**19.8**	0.4	renov hour	0.34		**6.6**		**6.61**		
	Total				**2.85**	**55.0**			1.01		**19.5**		**19.5**		**19.5**
Gains	Appliances		9	kWh/m² (1)			5.6	kWh/m² (2)							
	Radiation		not considered				not considered								
Heating demand (losses + gains)						**55**					**19.5**		**19.5**		**19.5**
Heating CONSUMPTION						**46**					**13.9**		**13.9**	**20.0**	**11.11**
% Heating CONSUMPTION after each action						**100**					**30.2**		**30.2**		**24.2**
% CONSUMPTION REDUCTION after each action						**0**					**69.8**		**69.8**		**75.8**

Source: Prepared by GTR for the Ministry of Development.

The changes that will be generated in the consumption by implementing the intervention 'menu' are evaluated by applying the reduction corresponding to each value of kWh/m² of dwelling area and year for each envelope – considering the reduction in the thermal conductivity value W/m²K for each one – thus generating a change in the consumption value attributable to the heading 'Total' in the section 'Losses' in the table above.

These changes are reflected in the box 'Renovation Data' within the columns corresponding to '2. Demand'. One of the columns that appears contains the 'heterogeneity coefficient', which takes into consideration the existence of thermal bridges in the renovation solution, and changes the total thermal conductivity of the envelope. Next, the savings are considered that are due to the recovery of heat from the forced ventilation system, if there is one. As has already been stated, it is also considered that an improvement has been achieved in the air permeability of the windows. These results are shown in the column '3. Ventilation'. Finally, the efficiency improvements in the climate control systems are considered – in this case, the efficiency of the boiler in producing heat from the fuel – and the results due to these are located in the column '4. Installation' in the box 'Renovation Data'.

Finally, the bottom row of the table, highlighted in grey, shows the reductions in the initial consumption of the dwelling after each of the improvements through each of the actions carried out, until obtaining the final consumption reduction percentage value that is recorded in the lower right box.

d) Final results of applying the intervention menus by 'cluster': savings obtained and costs.

The final results, in terms of costs and savings obtained through the intervention menus in each cluster, according to the changes in energy source, are as follows:

Fig. 28. Final results of applying the intervention menus by 'cluster': savings obtained and costs.

NATURAL GAS → NATURAL GAS	Cost	Saving
Cluster A	€ 18 989.00	68.8%
Cluster B	€ 18 585.00	69.5%
Cluster C	€ 25 714.00	80.9%
Cluster D	€ 20 763.00	72.5%
Cluster E	€ 19 283.00	83.5%
Cluster F	€ 19 482.00	76.7%
Cluster G	€ 13 508.00	82.5%
Cluster H	€ 16 647.00	82.8%
Cluster I	€ 12 873.00	80.2%
Cluster J	€ 12 955.00	76.0%

OIL → NATURAL GAS	Cost	Saving
Cluster A	€ 18 989.00	68.8%
Cluster B	€ 18 585.00	69.5%
Cluster C	€ 25 714.00	80.9%
Cluster D	€ 20 763.00	72.5%
Cluster E	€ 19 283.00	83.5%
Cluster F	€ 19 482.00	76.7%
Cluster G	€ 13 508.00	82.5%
Cluster H	€ 16 647.00	82.8%
Cluster I	€ 12 873.00	80.2%
Cluster J	€ 12 955.00	76.0%

ELECTRIC STOVE → NATURAL GAS	Cost	Saving
Cluster A	€ 23 574.00	61.0%
Cluster B	€ 23 169.00	61.9%
Cluster C	€ 30 298.00	76.1%
Cluster D	€ 31 647.00	65.6%
Cluster E	€ 23 868.00	79.4%
Cluster F	€ 24 066.00	70.9%
Cluster G	€ 17 196.00	78.1%
Cluster H	€ 20 335.00	78.6%
Cluster I	€ 16 561.00	75.3%
Cluster J	€ 16 643.00	69.9%

ELECTRIC STOVE → BIOMASS	Cost	Saving
Cluster A	€ 32 403.00	61.0%
Cluster B	€ 31 999.00	61.9%
Cluster C	€ 39 128.00	76.1%
Cluster D	€ 40 476.00	65.6%
Cluster E	€ 32 697.00	79.4%
Cluster F	€ 32 896.00	70.9%
Cluster G	€ 21 675.00	78.1%
Cluster H	€ 24 814.00	78.6%
Cluster I	€ 21 040.00	75.3%
Cluster J	€ 21 112.00	69.9%

WOOD → BIOMASS	Cost		Saving
Cluster A	€	32 403.00	78.5%
Cluster B	€	31 999.00	79.0%
Cluster C	€	39 128.00	86.8%
Cluster D	€	40 476.00	81.1%
Cluster E		-	-
Cluster F		-	-
Cluster G		-	-
Cluster H		-	-
Cluster I		-	-
Cluster J		-	-

NIGHT-TIME ELECTRICITY → NIGHT-TIME	Cost		Saving
Cluster A	€	10 826.00	62.3%
Cluster B	€	10 420.00	63.5%
Cluster C	€	17 561.00	79.1%
Cluster D	€	18 912.00	68.2%
Cluster E	€	11 120.00	91.7%
Cluster F	€	11 319.00	81.8%
Cluster G	€	8 161.00	85.7%
Cluster H	€	11 305.00	86.0%
Cluster I	€	7 525.00	83.0%
Cluster J	€	7 607.00	77.5%

Source: Prepared by GTR for the Ministry of Development.

III.2.1.2. Cost-effective approaches and economic assessment of the renovation options in the non-residential sector.

Investments in energy efficiency in the non-residential sector currently seek an almost immediate return, which is responsible for the fact that they are not very deep. Thanks to the volatility of the business climate in general and to the desire to achieve the maximum return on investments, the majority of actions that are carried out regarding efficiency in non-residential buildings have been focused towards replacing equipment and lighting. The tertiary sector requires a methodological approach that differs from the residential approach, in order to determine the long-term efficiency parameters, as well as to implement the passive measures that have slower returns.

Furthermore, the non-residential sector means considering buildings with very different uses, whose energy consumption responds to very different patterns that make it difficult to consider the same actions with the same savings performances. It is necessary to address this by means of sectoral strategies that take account of this variety of uses.

As an initial approach to show the savings possibilities presented today by the non-residential sector, and that could be addressed in an economically viable way with very fast returns – under eight years – shown below are some improvement menus, created based on actual experiences, which are grouped into sectoral strategies according to the different uses of the buildings.

The menus are focused towards the following actions:

- Climate control
- Lighting
- Equipment
- DHW (when this is significant)

Likewise, these menus include the use and maintenance of the installations, equipment and the building in itself. It should be emphasised that there is not much information available and it is difficult to generalise for a sector with such different uses and types, and therefore these data should be taken as an initial approximation.

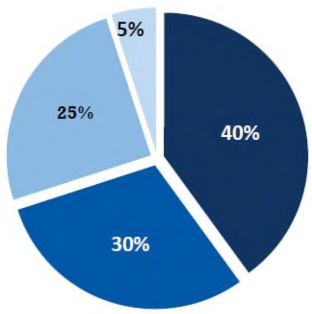
a) Action menu for Offices and estimated savings:

The actions proposed for Offices are the following:

Lighting and equipment	Estimated savings (%)
• Using and purchasing efficient lighting equipment with energy saving mode	50
• Exploiting natural light and rational use of lighting	35
• Installing a centralised system for control, zoning, luminaire regulation, timer switches, presence detectors, etc.	25
Climate control	**Estimated savings (%)**
• Using large boilers has a lower energy consumption per unit of heat produced	20
• Replacing chillers with different ones with superior cooling performance	22
• Incorporating non-outdoor air in the air conditioners	5
• Appropriately regulating the climate control temperature	10
• Using free cooling	15
• Appropriately maintaining the climate control system	10
DHW	**Estimated savings (%)**
• Reviewing the installation's insulation and regulating the DHW temperatures	6
• Reducing the temperature for storing and distributing DHW	2
Insulation	**Estimated savings (%)**
• Improving the insulation of walls, floors and façade of the building	40
• Improving the building's glazing, reducing air leakages	45

The savings results that could be obtained are:

Distribution of the total energy consumption
Total consumption 2010 (ktoe): 2 156
Consumption with measures (ktoe): 987



	Initial consumption in ktoe	Potential saving	Amortisation period (years)
Lighting & equipment	362	76%	4-5
Heating	347	40%	4-5
Cooling	539	46%	3-4
DHW	108	6%	3-4

Source: A. Cuchí and P. Sweatman (2014). Informe GTR 2014. Claves para transformar el sector de la edificación en España [GTR Report 2014. Keys for transforming the building sector in Spain]. p, 32.

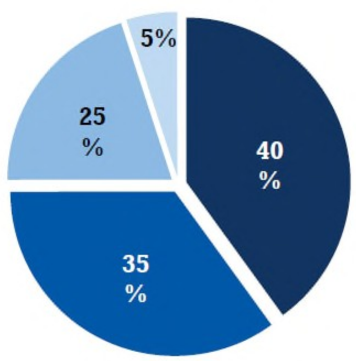
b) Action menu for the Hospital sector and estimated savings:

The actions proposed for the hospital sector are the following:

Climate control	Estimated savings (%)
• Optimising boiler combustion and exploiting heat, through flue gas analysis	30
• Optimising the performance of the distribution network by insulating and descaling pipes	Unsatis. build. 30 / Avg. building 10
• Installing a system for centralised control, zoning, temperature regulation, etc.	15
Lighting	**Estimated savings (%)**
• Replacing conventional lamps with energy-saving lamps	40
• Installing a system for centralised control, zoning, luminaire regulation, timer switches, presence detectors, etc.	15
Other	**Estimated savings (%)**
• Replacing obsolete elements	
Burner (older than 8 years)	7
Boiler (older than 12 years)	20
• Installing thermostatic valves to limit and regulate DHW temperature	10
• Adequately insulating piping systems and storage tanks	5
• Installing thermal solar energy to produce DHW	10
DHW	**Estimated savings (%)**
• Optimising water consumption endpoints and humidifiers	15

The savings results that could be obtained are:

Distribution of the total energy consumption
Total consumption 2010 (ktoe): 553
Consumption with measures (ktoe): 245



	Initial consumption in ktoe	Potential saving	Amortisation period (years)
Climate control	221	46%	<3
Lighting	194	70%	<3
DHW	111	38%	4-5
Other	28	15%	<3

Source: A. Cuchí and P. Sweatman (2014). Informe GTR 2014. Claves para transformar el sector de la edificación en España [GTR Report 2014. Keys for transforming the building sector in Spain]. p, 33.

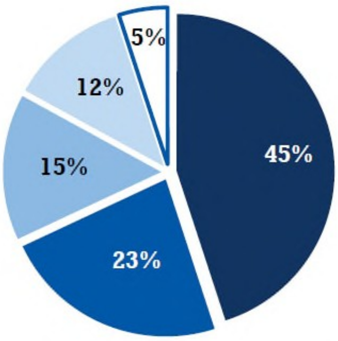
c) <u>Action menu for Hotels and estimated savings:</u>

The actions proposed for the hotel sector are the following:

Climate control	Estimated savings (%)
• Using speed variators in the recirculation pumps of the thermal distribution circuits	15
• Regulating the speed of the fan coil unit fans, as well as installing thermostatic heads on radiators	12
• Establishing a maximum and minimum temperature policy	10
• Reusing heat for climate control	5
DHW	**Estimated savings (%)**
• Control system for recirculating hot water	10
• Minimising DHW consumption at the point of final consumption	20
• Reusing heat for DHW	10
Lighting	**Estimated savings (%)**
• Replacing electromagnetic auxiliary equipment with electronic ones	15
• Limiting and optimising on times	20
• Installing a system for centralised control, zoning, luminaire regulation, timer switches, presence detectors, etc.	25
Laundry and cooking	**Estimated savings (%)**
• Using washing machines and dryers at nominal load, and never half loaded	10
• Adjusting the size of pots and pans to the hob used	5
• Monitoring the opening and closing of cold rooms	15
Other	**Estimated savings (%)**
• Avoiding heating water in dishwashers, using water from heat exchangers	10

The savings results that could be obtained are:

Distribution of the total energy consumption
Total consumption 2010 (ktoe): 985
Consumption with measures (ktoe): 649



	Initial consumption in ktoe	Potential saving	Amortisation period (years)
Climate control	443	36%	<3
DHW	227	28%	<3
Lighting	148	49%	3-5
Laundry and cooking	118	30%	<3
Other	49	10%	<3

Source: A. Cuchí and P. Sweatman (2014). Informe GTR 2014. Claves para transformar el sector de la edificación en España [GTR Report 2014. Keys for transforming the building sector in Spain]. p, 34.

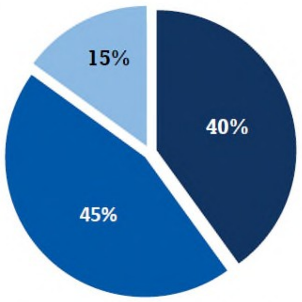
<u>d) Action menu for Shopping Centres and estimated savings:</u>

The actions proposed for the shopping centre sector are the following:

Climate control	Estimated savings (%)
• Correctly estimating the climate control demand	10
• Improving insulation combined with suitable ventilation	20
• Installing climate control support systems based on renewables	10
Lighting	**Estimated savings (%)**
• Better exploitation of natural light	30
• Installing a system for centralised control, zoning, luminaire regulation, timer switches, etc.	15

The savings results that could be obtained are:

Distribution of the total energy consumption
Total consumption 2010 (ktoe): 1 010
Consumption with measures (ktoe): 684



	Initial consumption in ktoe	Potential saving	Amortisation period (years)
Climate control	404	35%	10-12
Lighting	455	41%	3-5
Other	152	n/a	

Source: A. Cuchí and P. Sweatman (2014). Informe GTR 2014. Claves para transformar el sector de la edificación en España [GTR Report 2014. Keys for transforming the building sector in Spain]. p, 35.

Although these intervention menus cannot be generalised as well as those for the residential sector, as the non-residential sector particularly requires a 'made-to-measure approach for each building', their application to the different types of use in non-residential buildings shows that it would be possible to obtain reductions of between 35% and 50% of the energy consumption in this sector, by means of investments that can be amortised over relatively short periods, generally under 10 years.

Given that the tertiary sector's capacity for investment is much higher than the residential sector's, that – also unlike the residential sector – there is already an ESCo market operating in this sector, as well as that the proposed measures have relatively short amortisation periods, the energy renovation market in the non-residential sector could start up immediately if the barriers were overcome that are currently preventing the widespread implementation of these intervention menus.

It is clear that passive measures are critical for getting tertiary buildings to obtain substantial energy reductions. In some segments, such as offices, hospitals and hotels, where heating and cooling represent a large proportion of the total energy demand, passive measures are fundamental for carrying out deep renovations that will make it possible to achieve decisive savings.

Finally, it must be considered that unlike the residential sector, offices, hotels and shopping centres have a renovation rate for equipment and even constructive elements – such as façades, due to their image value – that is much higher than in the residential sector. The fact that non-residential buildings are often subject to extensive façade and interior refurbishment work – with relative independence of their state of conservation and due to questions of corporate image or refurbishment – represents a significant opportunity to improve their energy efficiency, since the additional cost of introducing insulation and other energy efficiency measures is very small compared to the total costs of the operation.

III.2.2. DEVELOPING LONG-TERM STRATEGIC SCENARIOS AND OVERALL QUANTIFICATION OF THE ANTICIPATED RESULTS.

Based on the building stock segmentation data and consumption data, and after having defined the possibilities and investment costs needed to reduce this energy consumption according to each of the building types, the Strategy sets out the organisation of intervention scenarios defined by the variation of the factors that determine the scope of the consumption reductions over time, always considering that the investments to be made must be cost effective or have a return in the form of future energy cost savings.

In order to provide these scenarios with a benchmark that will make it possible to compare them and take decisions on their appropriateness in a uniform way, the following scenarios are considered, whose results in terms of energy savings have been outlined in the corresponding tables included under heading III.1.3.1:

a) <u>Residential buildings</u>:

a.1) BASIC RESIDENTIAL scenario: Savings on the cumulative final energy consumption for thermal uses (heating, cooling and DHW) for the period 2014–2020 equal to 7% of the average total final energy consumption for the years 2010–2012. This scenario for the residential sector would arise from extending, between 2014 and 2020, approximately, the direct subsidies already committed for improving energy efficiency in the building sector in the various plans and programmes already in force, in addition to also considering the application of an estimated percentage of new European funds 2014–2020 for subsidies for energy efficiency in the building sector.

a.2) AVERAGE RESIDENTIAL scenario: Savings on the cumulative final energy consumption for thermal uses (heating, cooling and DHW) for the period 2014–2020 equal to 26% of the average total final energy consumption for the years 2010–2012.

a.3) HIGH RESIDENTIAL scenario: Savings on the cumulative final energy consumption for thermal uses (heating, cooling and DHW) for the period 2014–2020 equal to 32% of the average total final energy consumption for the years 2010–2012.

b) <u>Non-domestic buildings</u>:

b.1) BASIC NON-RESIDENTIAL scenario: Cumulative savings for the period 2014–2020 equal to 16% of the average total final energy consumption for the years 2010–2012 (including both thermal and non-thermal uses).

b.2) HIGH NON-RESIDENTIAL scenario: Cumulative savings for the period 2014–2020 equal to 20% of the average total final energy consumption for the years 2010–2012 (including both thermal and non-thermal uses).

Based on these savings, the scenarios corresponding both to the residential sector as well as the non-residential sector have been set out, considering for each the stock segmentation presented above and the consumption segmentation that has been outlined in the previous sections. In both cases, and to calculate the investments and returns, the models designed by the GTR Renovation Working

Group are used to define the different scenarios by means of their input variables.

III.2.2.1. Developing long-term strategic scenarios and overall quantification for the residential Sector.

Calculation model: variables, fixed data considered and outputs.

The design of the scenarios for the residential sector, presented below, is based on a calculation model prepared by GTR for the Ministry of Development, whose input variables – based on whose definition the different scenarios considered are established – are as follows:

1) Percentage of public aid in the form of subsidies out of the total cost of renovating the dwellings.
2) Interest rates on the loans required to fund the remaining cost of renovation.
3) Loan return period.
4) Future energy price scenario.
5) Additional percentage of private investment in alterations or voluntary improvements that are not related to energy efficiency.
6) Percentage of annual interventions in accordance with new regulatory requirements and start date for these.

The calculation model of the scenarios includes the different clusters into which the dwelling stock has been segmented according to the methodology presented in the pertinent section, including the distribution thereof into three bands according to their consumption level (band 1, which includes dwellings that cover 50% of consumption; band 2, which covers 50% of the total number of dwellings, and band 3, which includes the rest) and the type of energy used for heating; the intervention menu with the reduction of consumption – which includes the measures selected to reduce energy consumption between 60% and 90%, as the case may be, and obtain 50% of DHW via renewable energy sources – that will occur by implementing it and the costs of renovating the dwellings, all by cluster, climatic zone and consumption band.

Likewise, the model contains other hypotheses and fixed data that are considered sufficiently accepted and agreed upon in the specialist literature so as to be able to enter them as constants to create the scenarios, which are:

1) The percentage of public aid as direct subsidies to the owner for renovation will be reduced gradually until disappearing in 10 years, once the market is up and running, i.e. the energy savings are such that they make it possible to fully fund the cost of the proposed renovation measures.

2) The average inflation in the period considered will be around 2%.

3) There is going to be a technological learning curve that will make it possible to annually reduce by 1% above inflation the amount for the necessary renovation measures, inasmuch as the increase in the renovation demand is going to shape the appearance of new technologies in the market, which will reduce the costs of the intervention menus to obtain the reductions envisaged in household consumption.

4) 18 direct jobs are generated in the sector for every million euros invested.

5) There will be certain limitations, both in the market's capacity to immediately tackle the renovation demands of each cluster and each band, as well as in owners activating the demand (as a result of the difficulties in reaching agreements, accessing funding, etc.), and therefore it is assumed that it will take between at least eight and 15 years – depending on the cluster and the band – to complete the renovation of each cluster and each band, once

their renovation begins to be cost effective in market terms. This also makes it possible to consider that the model works with representative values for each cluster and each band, and therefore taking each band into account to be renovated will also actually take place in a gradual way.

6) The calculation model does not currently include the possibility of capitalising on the CO_2 emissions savings in the residential sector. The implementation of tools that may enable this possibility in future will have a favourable impact on the scenarios, reducing funding needs.

7) It is estimated that works will also be undertaken annually to improve the state of conservation in a given number of dwellings. To formulate a hypothesis on the subject, it is necessary to work from the number of dwellings in an unsatisfactory and poor state according to the data on state of conservation set out in the 2011 census (it is assumed that the dwellings the census categorises as being in a dilapidated state will be demolished and replaced by new builds, or subjected to a deep renovation process outside the scope of this Strategy). Next, an average cost per dwelling is estimated to resolve the corresponding construction issues that will make it possible to go from a poor or unsatisfactory state to a good state, and this estimation is applied according to an average of dwellings renovated annually, which may establish a regular pace for renovations between 2014 and 2050, so that in 2050 64% of the stock that is currently in an unsatisfactory or poor state will have been renovated (it is assumed that the remainder, up to 100%, would be combined with synergistic energy renovation actions). The following table summarises these costs and scopes:

Fig. 29. Conservation Works Hypothesis.

	Unsatisfactory state	Poor state	Total
No of dwellings	1 404 247	271 787	1 676 034

Cost of conservation works (€)	Shift from unsatis. to good	Shift from poor to good	Total
Total per dwelling (€)	20 000	30 000	
Total required (millions of €)	28 085	8 154	36 239

Scope of Conservation Works	2014–2020	2020–2030	2030–2050
No dwellings Conservation works/year	25 770	28 228	23 787
Cumulative % of dwellings Conservation works	16%	37%	64%

Source: Prepared by GTR for the Ministry of Development.

According to these fixed data and the value of the input variables explained above, 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. Thus, the baseline outputs for the model are:

1) Number of annual dwellings renovated.
2) Energy and emissions saved by renovating these dwellings.
3) Public and private investment requirements to renovate these dwellings.
4) Jobs generated or maintained by renovating these homes.

Moreover, the calculation model also makes it possible to obtain all the above dimensions on an aggregate basis, taken from these outputs over the course of the period considered. As immediate reference, the model works with the 2020 scenario, although it allows for extending its results to 2030 and 2050 to allow for an approximation of what its results might be in the longer term.

Scenario 1 or 'Basic Residential' scenario: Cumulative savings by 2020: 1 044 ktoe.

The value each of the variables considered by this Scenario 1 or 'Basic Residential' is:

1) Percentage of public aid in the form of subsidies out of the total cost of renovating the dwellings: This scenario would arise from extending, between 2014 and 2020, approximately, the direct subsidies already established for improving energy efficiency in the residential building sector in the various plans and programmes already in force, as well as also formulating the hypothesis that approximately another 855 million euros in new European funds 2014–2020 could ultimately be applied to subsidies for energy efficiency in the building sector. Public investment in the form of subsidies estimated only for energy efficiency up to 2020 stands at around 1 491.5 million euros. An additional 811.7 million euros would have to be added to this amount up to 2020, for conservation and accessibility. It is assumed that these subsidies in energy efficiency and in habitability cover 35% of the total investments needed.

2) Interest rates on the loans required to fund the remaining cost of renovation: The average current rate is considered to be 8.2%.

3) Loan return period: The loan return period is considered to be 20 years.

4) Future energy price scenario: The energy price trend is considered to correspond to the High scenario out of those presented by Spain in the Optimal Cost Studies set out in Directive 31/2010/EU.

5) Additional percentage of private investment in alterations or voluntary improvements that are not related to energy efficiency: it is considered that these only account for 10% of the investment in energy efficiency.

6) Percentage of annual interventions in accordance with new regulatory requirements and start date for these: 2% yearly from 2030 (i.e. is not considered within the period analysed).

With these values in the input variables, the output data in **Scenario 1 (‘Basic Residential’)** are the following:

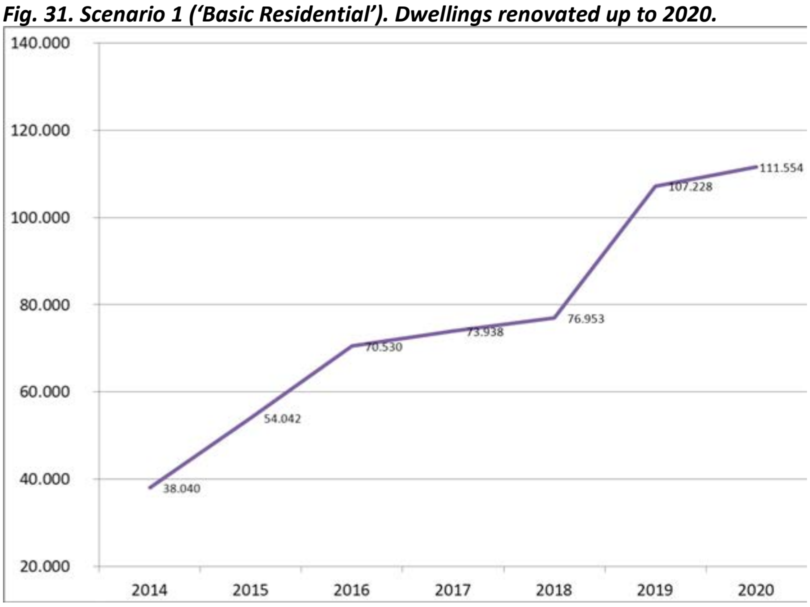
Fig. 30. Scenario 1 (‘Basic Residential’). Main dimensions up to 2020.

TOTAL NO DWELLINGS RENOVATED 2014–2020	357 285
SUBSIDIES FOR ENERGY EFFICIENCY (€M)	1 491.5
SUBSIDIES FOR CONSERVATION (€M)	811.7
DROP IN INTEREST RATE TO 5% (€M)	-
TOTAL PUBLIC INVESTMENT (€M)	2 303.3
PRIVATE INVESTMENT IN ENER. EFF. (€M)	5 265.8
PRIVATE INVESTMENT FOR CONSERVATION (€M)	1 507.5
INDUCED PRIVATE INVESTMENT (€M)	675.7
TOTAL PRIVATE INVESTMENT (€M)	7 449.1
TOTAL INVESTMENT (€M)	9 752.4
ENERGY SAVINGS (ktoe)	1 044
EMISSIONS SAVINGS (tonnes)	2 606 990

EMPLOYMENT CREATION: **22 117** (yearly average)	**DWELLINGS RENOVATED:** **51 040** (yearly average)

Source: Prepared by GTR for the Ministry of Development.

Fig. 31. Scenario 1 ('Basic Residential'). Dwellings renovated up to 2020.



Source: Prepared by GTR for the Ministry of Development.

As a variation of this scenario, another is presented with an identical volume of subsidies: 2 303.3 million euros (1 491.5 million euros for energy efficiency and 811.7 million euros for conservation), to which the cost of the differential between the current interest rates and the rate of 5% considered optimal would be added, which would total a volume of 2 514.9 million euros for the period 2014–2020. In this new scenario, it is assumed that subsidies cover 25% in energy efficiency and 35% in conservation, and the rest private investment. Furthermore, the hypothesis is considered that the private investment will generate an induced effect of 50% of the investment in energy efficiency, due to its greater pulling capacity.

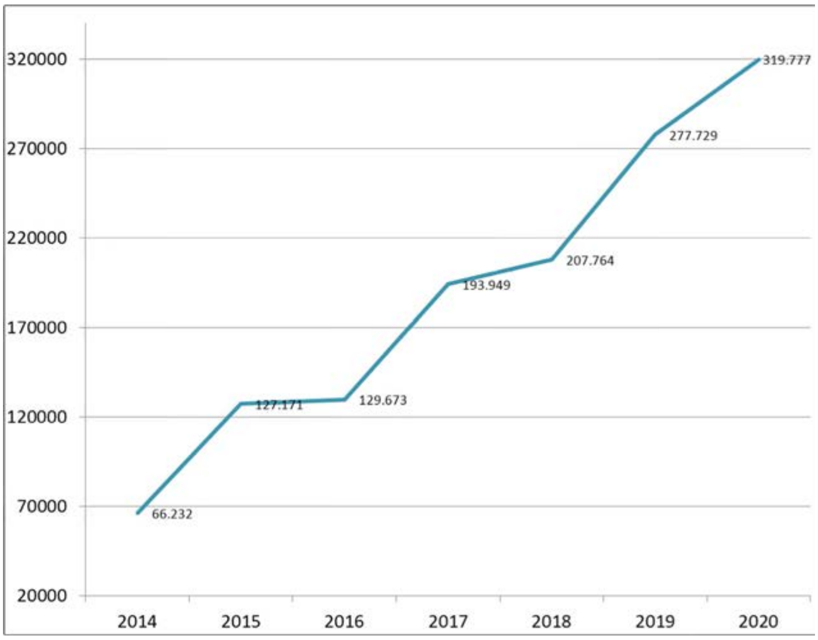
In this case the results are:

Fig. 32. Scenario 1 ('Basic Residential with rate aid'). Main dimensions up to 2020.

TOTAL NO DWELLINGS RENOVATED 2014–2020	1 147 295
SUBSIDIES FOR ENERGY EFFICIENCY (€M)	1 491.5
SUBSIDIES FOR CONSERVATION (€M)	811.7
DROP IN INTEREST RATE TO 5% (€M)	2 514.9
TOTAL PUBLIC INVESTMENT (€M)	4 818.1
PRIVATE INVESTMENT IN ENER. EFF. (€M)	20 849.6
PRIVATE INVESTMENT FOR CONSERVATION (€M)	3 697.9
INDUCED PRIVATE INVESTMENT (€M)	11 157.7
TOTAL PRIVATE INVESTMENT (€M)	35 705.2
TOTAL INVESTMENT (€M)	40 523.4
ENERGY SAVINGS (ktoe)	3 468
EMISSIONS SAVINGS (tonnes)	8 381 362

EMPLOYMENT CREATION:	**DWELLINGS RENOVATED:**
96 842 (yearly average)	**163 899** (yearly average)

Source: Prepared by GTR for the Ministry of Development.



Source: Prepared by GTR for the Ministry of Development.

Scenario 2 or 'Average Residential' scenario: Cumulative savings by 2020: 4 088 ktoe.

The value each of the variables considered by this Scenario 2 or 'Average Residential' is:

1) Percentage of public aid in the form of subsidies out of the total cost of renovating the dwellings: The estimated public investment in the form of subsidies just for energy efficiency up to 2020 is around 2 681 million euros, which accounts for approximately a percentage of 16% subsidy out of the volume of dwellings that work is carried out on. In addition, a further 1 578 million euros would be required for subsidies in conservation actions.

2) Interest rates on the loans required to fund the remaining cost of renovation: 5%. This would mean a differential of around 3 094 million euros to lower the funding cost from the current rates to the 5% rate considered optimal.

3) Loan return period: 20 years.

4) Future energy price scenario: The energy price trend is considered to correspond to the High scenario out of those presented by Spain in the Optimal Cost Studies set out in Directive 31/2010/EU.

5) Additional percentage of private investment in alterations or voluntary improvements that are not related to energy efficiency: 50%.

6) Percentage of annual interventions in accordance with new regulatory requirements and start date for these: 2% yearly from 2028.

With these values in the input variables, the output data in Scenario 2 ('Average Residential') are the following:

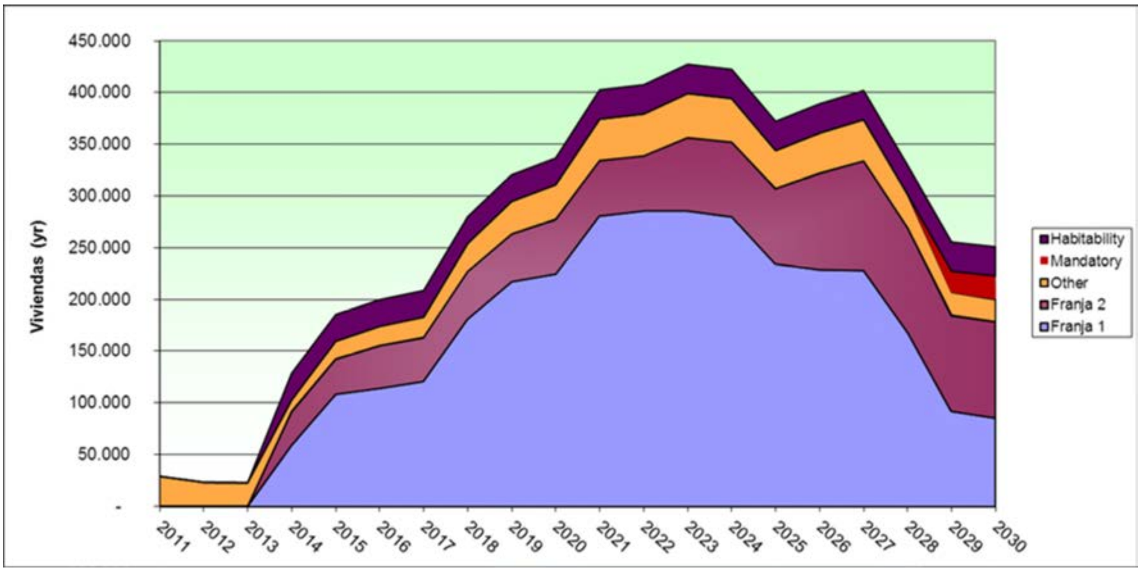
SCENARIO 2 'AVERAGE RESIDENTIAL'				
Basic hypotheses				
(1) Subsidies (% of costs covered by subsidies	16%	of the total cost of energy efficiency actions		
(2) Interest rate on the loans	5.00%	vs. average ICO rate	8.20%	
(3) Loan return period:	20	years		
(4) Future energy price scenario	1	(1="HIGH"; 2="LOW")		
(5) additional % of private investment in improvements or	50%	additional out of the expenditure on energy efficiency		
(6) yearly % of obligatory interventions	2%	from the year	2028	

Summary of Results 2014–2020	**SCENARIO 2 'AVERAGE RESIDENTIAL'**			
Total no of dwellings renovated (2014–2020)	1,427,183	**dwellings**		
Total Public Investment in Energy Efficiency (EE)				**Yearly average**
Direct subsidies	€2,681,647	thousands of €		€383 092
Difference real funding cost and 20-year funding at 5%	€3 094 521	thousands of €		€442 074
TOTAL	€5 776 168	thousands of €		
TOTAL per renovated dwelling =	€4 047	*per renovated dwelling (including subsidies and interest rate differential)*		
	16%			
Total Private Investment related to Energy Efficiency				**Yearly average**
Energy renovation	€23 517 972	thousands of €		€3 359 710
Voluntary improvements or refurbishment (50% extra)	€13 099 809	thousands of €		€1 871 401
TOTAL	€36 617 781	thousands of €		€5 231 112
TOTAL per renovated dwelling =	€25 657	*per renovated dwelling (including energy renovation and voluntary*		
Total Investment in Conservation and Accessibility				**Yearly average**
Direct subsidies	€1 578 390	thousands of €		€225 484
Private investment	€2 931 296	thousands of €		€418 757
TOTAL	€4 509 686	thousands of €		€644 241
TOTAL per renovated dwelling =	€25 000	*per renovated dwelling*		

Benefits for Employment, Energy Saving and CO_2.	**SCENARIO 2 'AVERAGE RESIDENTIAL'**			
Total energy saved 2014–2020	47 543 203	MWh		
Total energy saved 2014–2020	4 088	ktoe		
	26%	of the target from Article 3 of Directive 2012/27/EU		
Total energy saved during the useful life of the measures	266 725 049	MWh		
	22 934	ktoe		
Total CO_2 emission savings 2014–2020	10 792 893	Tonnes	1,541,842	Tonnes/year
Total CO_2 emission savings during the useful life of the	62 935 513	Tonnes	7%	Diffuse emissions 2
Jobs created or maintained 2014–2020	111 824	Average over the period		

NB: The figures for results in this table are rounded, to make them easier to read.

Fig. 34. Scenario 2 ('Average Residential'). Results: Graph 1: General trend up to 2030.



Key:
Vivienda = dwelling
Franja = band

Source: Prepared by GTR for the Ministry of Development.

Scenario 3 or 'High Residential' scenario: Cumulative savings by 2020: 5 077 ktoe.

Scenario 3 or 'High Residential' has been defined as any scenario that enables a reduction of consumption of up to 32%. The value each of the variables considered by this Scenario 3 or 'High Residential' is:

1) Percentage of public aid in the form of subsidies out of the total cost of renovating the dwellings: It is assumed that there is a 25% percentage of public aid in the form of subsidies out of the total cost of energy renovation for the dwellings. Public investment in the form of subsidies estimated only for energy efficiency up to 2020 stands at around 5 455 million euros, to which an additional 1 578 million euros would have to be added for subsidies in conservation actions (these subsidies at 35%). With these values, jointly with the other variables for this scenario, the return on the public investment is consolidated in the period 2014–2020, which includes both this value of the aid as well as the value estimated to cover the differential of the interest rates needed to assume – from the current rates of 8.2% – the optimal interest rate of 5% considered by this scenario, as well as the 35% aid for renovation for any buildings that may have issues in terms of a poor state of conservation or accessibility and that end up applying for the aid.

2) Interest rates on the loans required to fund the remaining cost of renovation. 5% is considered an optimal funding cost. As has been mentioned in the paragraph above, this value requires measures to reduce the current average interest rate value of 8.2% for renovation. These mechanisms to lower the interest rates must be undertaken for the loan return period in order to invest in renovation. The total volume required would amount to 4 068 million euros.

3) Loan return period: The loan return period is considered to be 20 years.

4) Future energy price scenario. The energy price trend is considered to correspond to the High scenario out of those presented by Spain in the Optimal Cost Studies set out in Directive 31/2010/EU.

5) Additional percentage of private investment in alterations or voluntary improvements that are not related to energy efficiency. Taking into account data from other countries and energy renovation actions carried out in Spain, in this case it is considered an expenditure in addition to the investment in energy efficiency – equivalent to 50% of the value of this – that the owner is going to make in other improvements to the dwelling by taking advantage, in part, of the reduction in the transaction costs represented by professional fees, licences, site installations, etc., as well as the increase in the value of their property, estimated at around 10%. This is a separate variable, since because these are completely voluntary works, these costs are exclusively attributable to owners and are not eligible for aid of any kind, and in the model they only have an influence – as will be seen later – on the generation of employment.

6) Percentage of annual interventions in accordance with new regulatory requirements and start date for these. In Scenario 3, it is considered that, from 2020 onwards when the renovation sector is already mature and fully operation, it could be assumed that in up to 2% of the residential stock of main dwellings – if not reached by itself under the market conditions – energy renovation interventions would occur as a result of complying with new regulatory requirements.

With these values in the input variables, the output data in **Scenario 3 ('High Residential')** are the following:

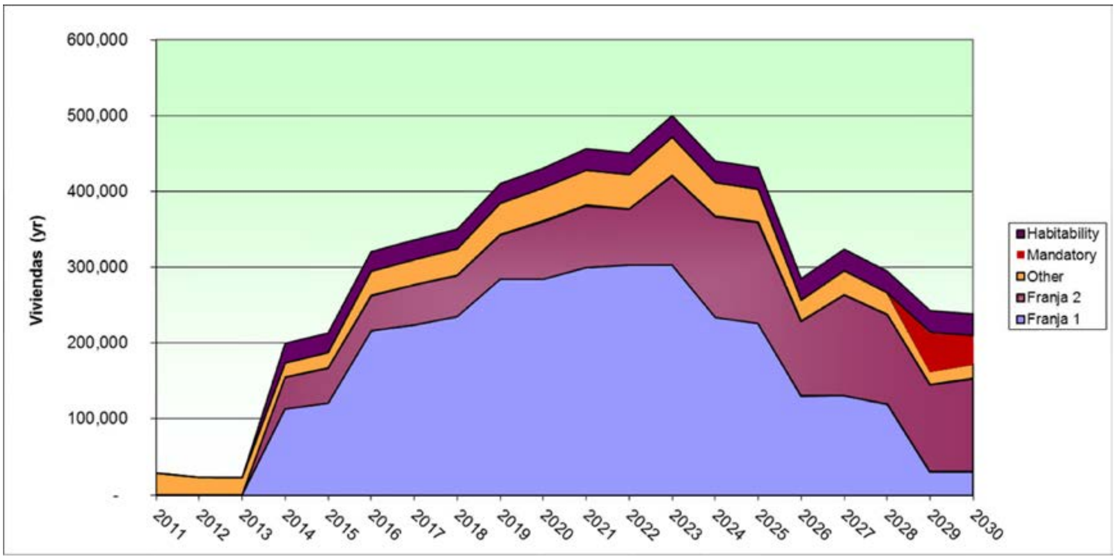
'HIGH RESIDENTIAL' SCENARIO				
Basic hypotheses				
(1) Subsidies (% of costs covered by public subsidies)	25%	of the total cost of energy efficiency actions		
(2) Interest rate on the loans	5%	vs. average ICO	8.2%	
(3) Loan return period:	20	years		
(4) Future energy price scenario	1	(1="HIGH"; 2="LOW")		
(5) additional % of private investment in voluntary improvements or	50%	additional out of the expenditure on energy		
(6) yearly % of obligatory interventions	2%	since the year 2020		

Summary of Results 2014–2020	**'HIGH RESIDENTIAL' SCENARIO**			
Total no of dwellings renovated (2014–2020)	**1,993,321**	**dwellings**		
Total Public Investment in Energy Efficiency (EE)				**Yearly average**
Direct subsidies	€5 455 824	thousands of €		€779 403
Difference real funding cost and 20-year funding at 5%	€4 068 764	thousands of €		€581 252
TOTAL	**€9 524 588**	thousands of €		
TOTAL per renovated dwelling =	*€4 778*	*per renovated dwelling (including subsidies and interest rate differential)*		
	33%			
Total Private Investment related to Energy Efficiency (EE)				**Yearly average**
Energy renovation	€28 448 403	thousands of €		€4 064 058
Voluntary improvements or refurbishments (50% extra)	€16 952 114	thousands of €		€2 421 731
TOTAL	**€45 400 517**	thousands of €		€6 485 788
TOTAL per renovated dwelling =	*€22 776*	*per renovated dwelling (including energy renovation and voluntary improvements)*		
Total Investment in Conservation and Accessibility Actions				**Yearly average**
Direct subsidies	€1 578 390	thousands of €		€225 484
Private investment	€2 931 296	thousands of €		€418 757
TOTAL	**€4 509 686**	thousands of €		€644 241
TOTAL per renovated dwelling =	€25 000	*per renovated dwelling*		

Benefits for Employment, Energy Saving and CO_2.	**'HIGH RESIDENTIAL' SCENARIO**			
Total energy saved 2014–2020	59 043 616	MWh		
Total energy saved 2014–2020	5 077	ktoe		
	32%	of the target from Article 3 of Directive 2012/27/EU		
Total energy saved during the useful life of the measures	326 953 229	MWh		
	28 113	ktoe		
Total CO_2 emission savings 2014–2020	14 695 912	Tonnes	2,099,416	Tonnes/year
Total CO_2 emission savings during the useful life of the measures	83 030 761	Tonnes	10%	Diffuse emissions 2005
Jobs created or maintained 2014–2020	141 541	Average over the period		

NB: The figures for results in this table are rounded, to make them easier to read.

Fig. 35. Scenario 1 ('High Residential'). Results: Graph 1: General trend up to 2030.



Key:
Vivienda = dwelling
Franja = band

Source: Prepared by GTR for the Ministry of Development.

III.2.2.2. Developing long-term strategic scenarios and overall quantification for the Non-Residential Sector.

For the non-residential sector building stock, as mentioned in earlier sections, the problem does not fundamentally lie in funding the interventions to improve energy efficiency, since today, at the current price of energy, interventions can be carried out that – in the sector as a whole – can end up totalling savings between 35% and 50% of the energy consumed. The need in this sector is to set forth the policies that will break down the barriers to action for ESCos to make it possible to invest in these buildings in the most efficient way.

Definition of scenarios. Calculation method

The design of the scenarios for the residential sector, presented below, is based on a calculation model prepared by GTR for the Ministry of Development. Two scenarios have been defined in which the overall target set out is a reduction of 20% (Scenario 1) and 16% (Scenario 2), respectively, as a proportionate share of the fulfilment of the Spanish commitment in Article 3 of Directive 27/2012/EU.

The following hypotheses have been considered in the calculation model:

- The saving is determined as the sum of two differentiated savings: a saving out of the building's total final energy consumption due to modifications in the installations that improve energy efficiency and an additional saving related to the energy consumption used in the building's climate control resulting from renovating the building envelope (façades and roofs). Both savings have been considered separately since the amortisation periods and the consumption band they have an impact on are different.

- the intervention period for the envelopes – façades and roofs – between 20 and 30 years depending on the building's type of use (for construction or commercial reasons, the intervention on roofs and façades can be considered to be much more frequent than on residential buildings, and therefore measures must be developed so that strict energy efficiency criteria are met in these renovations that will update these buildings). Thus, we should assume that before 2050, all non-residential buildings will have had their envelopes updated, deeply affecting their energy efficiency, so that we might assume a minimum savings of 30% on their climate control needs.

To understand the point to which energy efficiency policies should be guaranteed for buildings from the non-residential stock, three energy savings hypotheses have been considered within each scenario – low, average and high – that, combined with the intervention on the building skin as this is updated for functional or aesthetic reasons, must achieve the reduction target (20% or 16%, in each case) of the stock's energy consumption.

For each hypothesis, there is a need to determine the average annual percentage of buildings that must be worked on in order to achieve the overall reduction target. To define these hypotheses, it has been considered that the same average percentage of buildings is required, regardless of their type of use, although in this estimation it would be possible to differentiate by type of use if additional information is available that may determine greater benefits by doing it that way. Likewise, it has been considered that central government buildings also require this same percentage, which, in all cases, exceeds the 3% required by the EED, and therefore it is understood that the exemplary role of the administration must be greater in this case. The various hypotheses have been determined on these bases, as outlined below:

- For the 'Low' hypothesis, for each type of use, the most conservative value out of the possible energy savings that can be obtained in an economically viable way today has been considered, and therefore it is necessary to mobilise a higher percentage of buildings: 10% per year. This would mean a full renovation of the stock in 10 years, around 2025. This is a realistic scenario in terms of obtaining the savings in each building, but a very ambitious one in what it means for extending it to the stock (average intervention percentage), so it would require policies focused on mobilising the highest number of entities and companies in the investment in energy efficiency.

- For the 'High' hypothesis, the upper limit of the estimation of possible savings in each type of use has been considered. To achieve the proposed targets, it would be necessary to mobilise an annual average percentage of 6% of buildings and premises, which would mean a full energy renovation of the stock in a period of 16 years, around 2030. This scenario is very demanding both as regards the savings in each building as well as in terms of extending it to the stock. Therefore, it also requires policies that will mobilise the energy renovation of the stock, but especially taking full advantage of the energy saving opportunities in each of the interventions.
- For the 'Average' hypothesis, average energy savings attainment values are used and, naturally, it requires an intermediate annual average percentage with regard to the other two, namely 7%, which means the full energy renovation of the stock in under 15 years.

Naturally, there are many intermediate scenarios that are possible, meaning that the savings demand or required annual average percentage of renovated buildings for each type of use is variable, or even that this average percentage evolves over time, being lower at the start and increasing with the passage of time. In any case, all the scenarios require the same promotional actions to break down the barriers that are preventing the energy renovation of these kinds of buildings from being a growing reality at present, as well as assuring that the energy renovation covers all consumption whose amortisation does not exceed 8–10 years. It is precisely because of this high degree of cost effectiveness that in this sector there is not considered to be any need for public financial support that will speed up economic viability, and it is understood that the promotional actions should seek other methods to encourage companies and institutions.

Scenario 1. 'High Non-Residential'. Cumulative savings by 2020: 20%.

The table below sets out the evolution of the consumption of the different types of use in this scenario.

Fig. 36. Broken down results Scenario 1 HIGH for Non-Residential Sector.

SCENARIO 1. HIGH. Cumulative savings by 2020: 20%.									
Savings HYPOTHESIS									
LOW									
	ktoe	Buildings		2015	2016	2017	2018	2019	2020
	consumption	% annual	% saving						
central administration	100	10%	45%	99	94	90	86	82	78
private offices	2 000	10%	45%	1 973	1 884	1 799	1 718	1,641	1,567
small businesses	4 800	10%	30%	4 757	4 614	4 476	4 341	4,211	4,085
shopping centres	1 000	10%	30%	991	961	932	904	877	851
hotels	1 000	10%	30%	991	961	932	904	877	851
sports centres	200	10%	30%	198	192	186	181	175	170
hospitals	500	10%	45%	493	471	450	430	410	392
education	400	10%	15%	398	392	386	381	375	369
total	10 000			9 900	9 571	9 253	8 946	8 650	8 364
				99%	96%	93%	89%	86%	84%
AVERAGE									
	ktoe	Buildings		2015	2016	2017	2018	2019	2020
	consumption	% annual	% saving						
central administration	100	7%	50%	97	93	90	86	83	79
private offices	2 000	7%	50%	1 930	1 862	1 792	1 722	1,652	1,582
small businesses	4 800	7%	40%	4 666	4 535	4 401	4 266	4,132	3,997
shopping centres	1 000	7%	30%	979	958	937	916	895	874
hotels	1 000	7%	30%	979	958	937	916	895	874
sports centres	200	7%	40%	194	189	183	178	172	167
hospitals	500	7%	50%	483	466	448	431	413	396
education	400	7%	25%	393	386	379	372	365	358
total	10 000			9 720	9 448	9 168	8 888	8 608	8 328
				97%	94%	92%	89%	86%	83%

HIGH									
	ktoe	Buildings		2015	2016	2017	2018	2019	2020
	consumption	% annual	% saving						
central administration	100	6.0%	55%	98	95	92	88	85	82
private offices	2 000	6.0%	55%	1 945	1 879	1 813	1 747	1 681	1,615
small businesses	4 800	6.0%	50%	4 680	4 536	4 392	4 248	4 104	3,960
shopping centres	1 000	6.0%	35%	983	962	941	920	899	878
hotels	1 000	6.0%	35%	983	962	941	920	899	878
sports centres	200	6.0%	50%	195	189	183	177	171	165
hospitals	500	6.0%	55%	486	470	453	437	420	404
education	400	6.0%	30%	394	387	380	372	365	358
total	10 000			9 764	9 479	9 194	8 909	8 624	8 339
				98%	95%	92%	89%	86%	83%
SKIN: FACADES + ROOFS									
	ktoe	Buildings		2015	2016	2017	2018	2019	2020
	consumption	% annual	% saving						
central administration	55	3%	30%	54	54	53	53	52	52
private offices	1 100	5%	30%	1 078	1 062	1 045	1 029	1 012	996
small businesses	1 440	5%	30%	1 411	1 390	1 368	1 346	1 325	1,303
shopping centres	450	5%	30%	441	434	428	421	414	407
hotels	450	5%	30%	441	434	428	421	414	407
sports centres	80	5%	30%	78	77	76	75	74	72
hospitals	200	3%	30%	196	194	192	191	189	187
education	160	3%	30%	157	155	154	152	151	150
total	3 935			3 857	3 800	3 744	3 687	3 631	3 574
TOTAL									
				2015	2016	2017	2018	2019	2020
LOW				9 822	9 436	9 061	8 698	8 345	8 003
				98%	94%	91%	87%	83%	80%
AVERAGE				9 642	9 313	8 977	8 640	8 304	7 967
				96%	93%	90%	86%	83%	80%
HIGH				9 685	9 344	9 002	8 661	8 319	7 978
				97%	93%	90%	87%	83%	80%

Source: Prepared by GTR for the Ministry of Development.

As regards the values for economic savings, energy and emissions savings, the cumulative totals would be:

Fig. 37. Summary of results Scenario 1 HIGH for Non-Residential Sector.

	2015	2016	2017	2018	2019	2020
k€ saving	633 253	1 320 592	2 007 932	2 695 271	3 382 610	4 069 949
GWh saving	3 619	7 546	11 474	15 402	19 329	23 257
TCO_2 saving	969 782	2 022 393	3 075 004	4 127 615	5 180 226	6 232 836

Source: Prepared by GTR for the Ministry of Development.

Nevertheless, the reduction demands of 20% for this scenario are to a large extent very demanding, since they require high rates of intervention in non-residential buildings, and this means quickly and effectively breaking down the barriers that are currently preventing these investments.

Scenario 2. 'Basic Non-Residential'. Cumulative savings by 2020: 16%.

The table below sets out the evolution of the consumption of the different types of use in this scenario.

Fig. 38. Broken down results 'Basic Non-Residential' Scenario.

SCENARIO 1. BASIC NON-RESIDENTIAL. Cumulative savings by 2020: 20%.									
Savings HYPOTHESIS									
LOW									
	ktoe	Buildings		2015	2016	2017	2018	2019	2020
	consumption	% annual	% saving						
central administration	100	7%	45%	99	96	93	90	87	84
private offices	2 000	7%	45%	1 973	1 911	1 851	1 792	1,736	1,681
small businesses	4 800	7%	30%	4 757	4 657	4 559	4 463	4,370	4,278
shopping centres	1 000	7%	30%	991	970	950	930	910	891
hotels	1 000	7%	30%	991	970	950	930	910	891
sports centres	200	7%	30%	198	194	190	186	182	178
hospitals	500	7%	45%	493	478	463	448	434	420
education	400	7%	15%	398	394	390	386	382	378
total	10 000			9 900	9 669	9 444	9 225	9 011	8 802
				99%	97%	94%	92%	90%	88%
AVERAGE									
	ktoe	Buildings		2015	2016	2017	2018	2019	2020
	consumption	% annual	% saving						
central administration	100	5%	50%	98	95	93	90	88	85
private offices	2 000	5%	50%	1 950	1 901	1 851	1 801	1,751	1,701
small businesses	4 800	5%	40%	4 704	4 610	4 514	4 418	4,322	4,226
shopping centres	1 000	5%	30%	985	970	955	940	925	910
hotels	1 000	5%	30%	985	970	955	940	925	910
sports centres	200	5%	40%	196	192	188	184	180	176
hospitals	500	5%	50%	488	475	463	450	438	425
education	400	5%	25%	395	390	385	380	375	370
total	10 000			9 800	9 604	9 404	9 204	9 004	8 804
				98%	96%	94%	92%	90%	88%
HIGH									
	ktoe	Buildings		2015	2016	2017	2018	2019	2020
	consumption	% annual	% saving						
central administration	100	4.0%	55%	98	96	94	92	90	87
private offices	2 000	4.0%	55%	1 945	1 901	1 857	1 813	1,769	1,725
small businesses	4 800	4.0%	50%	4 680	4 584	4 488	4 392	4,296	4,200
shopping centres	1 000	4.0%	35%	983	969	955	941	927	913
hotels	1 000	4.0%	35%	983	969	955	941	927	913
sports centres	200	4.0%	50%	195	191	187	183	179	175
hospitals	500	4.0%	55%	486	475	464	453	442	431
education	400	4.0%	30%	394	389	384	380	375	370
total	10 000			9 764	9 574	9 384	9 194	9 004	8 814
				98%	96%	94%	92%	90%	88%
SKIN: FACADES + ROOFS									
	ktoe	Buildings		2015	2016	2017	2018	2019	2020
	consumption	% annual	% saving						
central administration	55	3%	30%	54	54	53	53	52	52
private offices	1 100	5%	30%	1 078	1 062	1 045	1 029	1,012	996
small businesses	1 440	5%	30%	1 411	1 390	1 368	1 346	1,325	1,303
shopping centres	450	5%	30%	441	434	428	421	414	407
hotels	450	5%	30%	441	434	428	421	414	407
sports centres	80	5%	30%	78	77	76	75	74	72
hospitals	200	3%	30%	196	194	192	191	189	187
education	160	3%	30%	157	155	154	152	151	150
total	3 935			3 857	3 800	3 744	3 687	3 631	3 574
TOTAL									
				2015	2016	2017	2018	2019	2020
LOW				9 822	9 535	9 253	8 977	8 706	8 441
				98%	95%	93%	90%	87%	84%
AVERAGE				9 722	9 469	9 213	8 956	8 700	8 443
				97%	95%	92%	90%	87%	84%
HIGH				9 685	9 439	9 192	8 946	8 699	8 453
				97%	94%	92%	89%	87%	85%

Source: Prepared by GTR for the Ministry of Development.

As regards the values for economic savings, energy and emissions savings, the cumulative totals would be:

	2015	2016	2017	2018	2019	2020
k€ saving	633 253	1 129 405	1 625 557	2 121 708	2 617 860	3 114 012
GWh saving	3 619	6 454	9 289	12 124	14 959	17 794
TCO_2 saving	969 782	1 729 603	2 489 424	3 249 245	4 009 066	4 768 886

Source: Prepared by GTR for the Ministry of Development.

III.3. MEASURES TO DRIVE DIFFERENT SCENARIOS.

As has already been explained, the Strategy contains *'a forward-looking perspective to guide investment decisions of individuals, the construction industry and financial institutions'* as well as *'Developing long-term Strategic Scenarios'* with the *'Overall quantification of the anticipated results'*. A particular saving in energy consumption, a particular number of dwelling renovations and particular opportunities for growth and generation of employment in the construction sector are attributed to each of these Scenarios.

The step from one scenario to another is linked to the measures that are adopted, which may be very diverse in nature. Some of these will be necessary in the short term, while others will have different horizons. In any case, any that may require public funds must be in line with the country's overall economic policy.

Measures that need to be undertaken in the short term unquestionably include any that aim to **RAISE AWARENESS AND CREATE A PRO-RENOVATION CULTURE** and, in particular, create a positive impression of the energy renovation of the building stock.

Any basic scenario could noticeably improve if the public were aware of renovation's potential in the improvement of their homes and dwellings, their quality of life, the energy bills they pay and in the revaluation of properties for their owners. At present, the current lines of public aid are not providing the right response, largely due to this lack of awareness and culture, which does already exist in other European countries.

The measures listed below would fall into this category of measures:

a) Designing and carrying out publicity and awareness-raising campaigns.
b) Launching specific training and participation days of a technical nature, as well as information days more focused on users and residents associations.
c) Preparing and disseminating explanatory guides.
d) Developing websites, as portals for information and assistance.
e) Spreading good practices, pilot projects and model examples.
f) Incorporating renovation and energy efficiency into training plans in university activity related to intervention techniques in the consolidated city and in existing buildings.
g) Vocational training should also be adapted so as to train the workforce and specialist craftsmen that are required by intervention in existing buildings.

Alongside these measures are others that would allow the business sector **TO DEVELOP BUSINESS STRATEGIES** with particular focus on the needs of homeowners associations. This would mean facilitating the restructuring of development/construction companies with a view to a new role as integral managers of renovation processes and changing the model of energy suppliers by influencing new emerging values.

Just by extending the economic scenario that renovation is currently experiencing up to 2020 – if it so happened – could improve the expected results with the adoption of measures that are unrelated to the existing lines of public aid themselves. Of these, specific mention must be made of those of a **REGULATORY** and administrative **NATURE**.

Starting with the first, the following would have to be highlighted:

a) Promoting the regional and municipal regulatory development of the potentialities of Law 8/2013 of 26 June on urban renovation, regeneration and renewal. To do this, and particularly in the municipal sphere, a model ordinance on energy efficiency and renovation should be created that offers standardised solutions for this kind of action.
b) Achieving the necessary flexibility in the application of the Technical Building Code to renovation works. To do this, a Ministry of Development Order similar to the one that has already been passed in relation to the Basic Document on Energy Saving would be sufficient.
c) Popularising Building Assessment Reports as a tool to measure the situation of the Spanish building stock and to inform homeowners of the extent to which their property could be improved.
d) Strengthening the ability of programmes for the energy certification of existing buildings to make it possible to assess different options to improve energy efficiency.
e) Creating the 'Building Record for existing buildings' as a continuously updated set of documentation on all the actions, reports (including the BAR), certificates, reviews, works, etc. that are carried out on each building.

In terms of the **ADMINISTRATIVE MEASURES**, they are logically associated with improving coordination between the three levels of public administration: State, regional and municipal. They are all involved in these policies and in the processes to implement the same, in different ways, but the objectives are shared. The coordination must prevent, as far as possible, any duplications or contradictions that could arise.

The current coexistence of different State, regional and local aid programmes for conservation, integral renovation and sustainability actions, aimed at similar or complementary actions, is sometimes confusing and creates compatibility issues. Solving these issues is therefore a priority. To do this, some appropriate measures would be:

a) Simplifying, standardising and reducing time in administrative procedures. Procedures for licences and authorisations should be sped up and use should be made of electronic administration platforms.
b) Promoting 'Local Agencies or Municipal Services for Building Renovation, Urban Regeneration and Renewal' in order to inform private actors, guide developers throughout the renovation process, mediate in any conflicts that arise, prepare intervention programmes, draw up regulations on renovation aid (renovation ordinances) and the terms for organising subsidies, etc. This measure would also include management and information through so-called 'one-stop shops'.
c) Introducing relaxation criteria in processes to authorise works, which are approved in relation to applying the Technical Building Code.

One of the most significant Scenario leaps in the Strategy is the one that allows homeowners, in addition to homeowners associations, to obtain suitable funding, which has been estimated in the access to low-interest (less than or equal to 5%), long-term (20-year) loans. Nevertheless, the **MEASURES THAT WOULD IMPROVE FUNDING** these operations are varied and would not only include those measures aimed at guaranteeing such objectives.

The State Plan to promote rental housing, building renovation and urban regeneration and renewal 2013–2016, as well as the IDAE's PAREER Programme and the new European cohesion funds aimed at renovation are designed to contribute to launching this Strategy as a fundamental driver for implementing it. Nevertheless, certain sectors (particularly estate managers and the banking sector) have highlighted some weaknesses of the outright grant model, including: the extensive processing period, or the fact that they are always collected after the fact, once the works have been completed. This causes owners to have to deal with a large initial outlay and receive the subsidy after the works are completed, all with a certain reasonable margin of uncertainty.

Therefore, from the economic point of view, it seems that both in the short, medium and long term, other mechanisms should be devised that will go beyond traditional subsidies, or the subsidisations of loans, or at least they will be able to be in line with these. These would include the following:

a) Channelling resources from the Energy Efficiency National Fund (from contributions, *inter alia*, from obligated companies and from ERDF funds from *'Thematic Objective 4: Towards a Low-Carbon Economy'*) towards building energy renovation actions, due to their particular contribution to energy savings in the long term and their potential to reduce families' and business' energy bills, as well as their contribution to the competitiveness of the economy and the reactivation of economic activity.
b) Working with the European Investment Bank (EIB) to design programmes to support the funding of building renovation, particularly energy renovation. This would make it possible to inject liquidity from the European Central Bank to our banks. An example could be the JESSICA-FIDAE Sustainable Development Urban Fund managed by IDAE, which uses the EIB JESSICA financial instrument to promote urban energy renovation actions.
c) Making it possible for energy services companies, construction companies or renovation management companies to receive aid from public administrations, with explicit consent from the client.
d) Reinforcing the ICO line for homeowners associations that it has been doing since 2013, seeking to improve two aspects as far as possible: making it cheaper to raise funds on the capital markets and obtaining 'soft' funding from international financial institutions (or institutions such as KfW, CEB, etc.).
e) Supporting financial entities in designing specific products to fund renovation. One of the measures to take into account would be the one that would provide guarantees to these entities against loan defaults by homeowners associations (which banks identify as 'high risk'). From this point of view, a 'limited guarantee fund' or some method of guarantee that would make it possible to partially cover the risk of residual late payment that could possibly occur, would be measures to examine. There are already some models in this regard, in other sectors, such as 'SAECA'[11] or the 'Loan Coverage' model.

[11] SAECA is a Spanish public company whose shareholders are SEPI (State industrial holding company), with 80% of the capital and the Spanish Agricultural Guarantee Fund (FEGA) with 20% of the remaining capital, with MAGRAMA as the supervising ministry. SAECA provides guarantees and bonds to facilitate access to funding for the whole of the primary sector.