RENONBILL

THE RESIDENTIAL BUILDING RENOVATION MARKET IN GERMANY, ITALY, LITHUANIA AND SPAIN

2020

MAY

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 847056.

Project Acronym	RenOnBill
Project Name	Residential building energy rENovations with ON-BILL Financing
Project Coordinator	Paolo Michele Sonvilla Senior Manager Creara pms@creara.es Marqués de Ahumada 5, 3rd Floor 28028 – Madrid (Spain)
Project Duration	2019 - 2022
Website	www.renonbill.eu

Deliverable No.	D2.2
Dissemination Level	Public
Work Package	WP 2
Lead beneficiary	Creara
Contributing beneficiary(ies)	All partners
Author(s)	**Creara**: Andrea Real Ruiz and Adriana Villoslada Prado **adelphi**: Leonie Ederli Fickinger, Peter Ewald and Sophia Stock. **BPIE**: Ivan Jankovic **UNIGE**: Vincenzo Bianco, Federico Scarpa, Annalisa Marchitto and Luca Tagliafico. **LEI**: Ramunas Gautatis
Co-author(s)	
Reviewed by	**Creara**: Paolo Michele Sonvilla, Adriana Villoslada Prado
Date	6 April 2020
File Name	200406_ROB_WP2_D2.2_Combined_v20_FINAL

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 847056.

Legal Notice

TABLE OF CONTENTS

1 INTRODUCTION

Buildings play a fundamental role in our daily lives; on average, each of us spends 90% of their time indoors (BPIE, 2017). Furthermore, buildings represent an integral component of the energy sector, as they account for 40% of Europe's total energy use, and 36% of CO_2 emissions (BPIE, 2018). Making the existing building stock more energy efficient is essential not only to achieve climate targets, but also to increase individual wellbeing.

The **Energy Performance of Buildings Directive (EPBD)** is the central European legislation addressing energy performance and energy renovation of residential buildings. In addition to the EPBD, the **Renewable Energy Directive (RED)** and the **Energy Efficiency Directive (EED)** contain important policies affecting the residential building market.

These directives are supported by the larger **Clean Energy for All Europeans Package**, which establishes the main 2030/2050 energy targets, including:

- The entire building stock (including residential) must be decarbonised by 2050;
- Energy efficiency should increase by 32.5% by 2030 compared to 1990 levels (EED);
- Renewable energy must exceed 32% of energy demand by 2030 (RED);
- CO_2 emissions should be reduced by 40% by 2030 compared to 1990 levels (EED);
- Member States must develop long-term renovation strategies (previously regulated under the EED and now moved to the EPBD) that contain an overview of the national building stock (identifying main building categories).

In December 2019, the European Commission presented the **European Green Deal**. Aiming at becoming the world's first climate-neutral continent by 2050, the European Green Deal set a more ambitious target: an overall 50% reduction of CO_2 emissions by 2030 compared to 1990 levels.

Other aspects of the Green Deal that are directly related to the energy renovations sector are:

- Inclusion of an open platform bringing together the buildings and construction sector; architects and engineers and local authorities to address the barriers to renovation. This initiative will also include innovative financing schemes under InvestEU[1].
- Particular attention to the renovation of social housing to help households who struggle to pay their energy bills.

Financing residential building renovation

The revised EPBD requires Member States to establish and report sound renovation strategies and financial instruments that will be used for supporting the renovation of the national

[1] The InvestEU Programme builds on the Investment Plan for Europe, the Juncker Plan. Triggering at least €650 billion in additional investment, the Programme aims to give an additional boost to investment, innovation and job creation in Europe (for additional information see https://ec.europa.eu/commission/priorities/jobs-growth-and-investment/investment-plan-europe-juncker-plan/whats-next-investeu-programme-2021-2027_en).

building stock. Achieving efficient and decarbonised national building stocks by 2050 is the cornerstone of this regulation. In summary, the requirements include:

- **Project aggregation** (Article 2a) – Since energy efficiency projects are often small in scale (i.e. an individual home or apartment renovation), emphasis should be made on ways for countries to aggregate small-scale projects in order to obtain access to financing;
- **Addressing perceived risk** (Article 2a) – Given the long payback periods (5+ years) of energy efficiency measures, the risk of savings underperforming is perceived as high. Member States should look for ways to encourage potential investors;
- **Leveraging public funds** (Article 2a) – A growing amount of public funding has become available for energy efficiency and renovation projects (in large part thanks to the policy focus in energy efficiency). However, neither governments nor international financial institutions may have enough funds to reach the level of renovation needed to meet European energy targets. In this sense, significant contribution from the private investments will be needed. As the Article 2 of the newly published EPBD foresees, private financing should be encouraged as much as possible;
- **Investment in public buildings** (Article 2a) – Public building renovations should be used to guide the energy efficiency investments by providing leading examples of energy and wider benefits to potential investors;
- **Advisory tools** (Article 2a) – National and local governments should invest in establishing advisory tools and one-stop-shops to inform and facilitate energy efficiency and renovation projects, providing information on available technologies, financial instruments and contractors (to name a few);
- **List of current financial instruments** (Article 10) – Member States are required to submit an updated list of available financial instruments to the European Commission every three years. Member States should link the identified financial instruments to their specific energy savings targets.

Overview of the current situation of the residential building renovation in Europe

In order to meet the overall EU target of a decarbonised building stock by 2050, the vast majority of buildings will need to be highly energy efficient, compliant with an Energy Performance Certificate (EPC) label A. A study of national EPC label data conducted by BPIE (BPIE, 2017) shows the following:

- An analysis of different EU regions covering 66% of the total EU floor area shows that 97% of the building stock should be renovated to achieve the 2050 vision. Figure 1.1 depicts this situation by country[2].
- Although building performance is constantly improving in the EU, only after 2010 average buildings began to be constructed according to efficient standards (average building envelope U-value of around 0.49 W/m²K). However, these efficient buildings amount to only around 3% of the total building stock in Europe.
- Different analyses show that there must be a gap between the level of energy use stated by the EPC label and actual energy use of the building. In practice this means that the transition to a highly efficient building stock to meet the Paris Agreement targets could be tougher than expected.

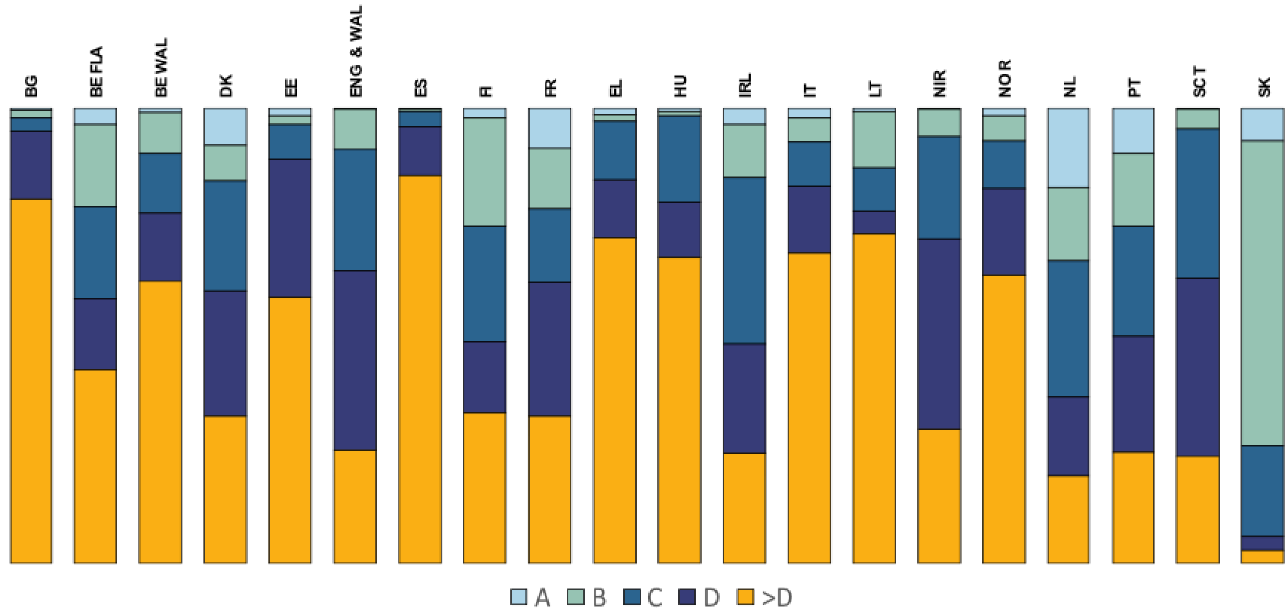


Figure 1.1 - Distribution of the building stock in the EU per EPC class (BPIE, 2017)

[2] A few countries were excluded from the analysis due to the either lack of a central EPC database (e.g. Germany) or impossible extrapolation from limited/skewed EPC population (e.g. Romania)

Content and objectives of this study

This report provides a detailed analysis of the main data, drivers and challenges involved in the energy renovation of residential buildings in four focus countries: Germany, Italy, Lithuania and Spain. Each country section includes five sub-sections:

- **Executive summary** — The main points that are developed in the following subchapters are summarised in these first paragraphs;
- **Residential building sector** – Definition and quantification of the relevant building stock in the country. A common segmentation differentiates between single family houses, multifamily buildings, and social housing, while other criteria may play a part in national contexts;
- **Residential building renovation market** – Main trends on the renovation sector (current growth rate and expected evolution), exhaustive list of the regulatory framework (policy instruments and regulation) at national level;
- **Potential impact of building energy renovation in the market** – The potential of savings is estimated as the gap between the current energy performance and the projected consumption if energy targets are achieved. In addition, other effects are commented (non-energy benefits to the extent that they have a special relevance in each country);
- **Financing the energy renovation of buildings** – Financing schemes available at national level. They include various public support programmes providing grants, (soft) loans, tax incentives, and other similar instruments for building renovations. In addition, an overview of other sources of financing (own funds, private, ESCOs) is provided.

In addition, two non-country specific sections conclude the document:

- **Multiple benefits of energy renovations** – Additional impacts that building renovations and linked energy efficiency investments can have. Among them, the most important for individuals are the increased value of the dwelling, the improvements in comfort and the creation of a healthy indoor environment. Additional benefits at a macro level are also commented (improved energy security and job creation among others);
- **Key challenges to energy efficiency renovations** – Including different structural issues, financial constraints, social resistance and legal barriers that hamper the energy efficiency potential in the residential sector.

Findings and next steps: the potential of renovation

The analysis presented in this report lays the foundation for the work to be carried out in RenOnBill, primarily the replication analysis of on-bill schemes and the development of pilot projects.

Table 1.1 summarises the potential for energy renovation in the focus countries. At first glance, the potential in terms of the total number of buildings that may be subject to renovation largely depends on the size of the building stock, being much smaller in Lithuania (which is also a smaller country).

Country	Germany	Italy	Lithuania	Spain
Total number of residential buildings	**18.8 million** (3.2 million multi-family buildings)	**12 million** (9 million multi-family buildings)	**0.58 million** (44.000 multi-family buildings)	**10 million** (2 million multi-family buildings)
Total number of dwellings	**40.3 million** (21.5 million in multi-family buildings)	**35 million** (31.9 million in multi-family buildings)	**1.5 million** (0.85 million in multi-family buildings)	**25 million**
Main current energy uses	Space heating and hot water	Space heating	Space heating	Space heating and electrical appliances
Turning point	**1977** (First Ordinance on Thermal Insulation)	**1976** (First Thermal Insulation Ordinance)	**1992** (Stricter regulation came into force)	**1980** (Basic Building Standard)
% of the building stock that should be renovated	**84%**	**46%**	**50%**	**49%**
Target segments for renovation	Buildings between 1950-1970 Bi-family houses built before 1979	Buildings in North West/North East Buildings built before 1960	Soviet -type multi-apartment buildings built before 1992	Buildings built before 1980
Potential (number of buildings that should be renovated)	**7.9 million buildings**	**5.5 million buildings**	**0.3 million buildings**	**4.8 million buildings**
Corresponding achievable yearly energy savings from 2030	**42 TWh/year**	**67 TWh/year**	**5 TWh/year**	**38 TWh/year**

Table 1.1 - Comparative chart of the potential for energy renovation in each focus country. RenOnBill consortium analysis.

As it can be noticed in the table, a few trends are shared by all countries. Regarding energy use, space heating is the first source of consumption, and therefore an appealing area of intervention. On the other hand, in each country a regulatory turning point can be found, normally coinciding with the issuance of a stricter regulation since when buildings started to be more efficient. This turning point helps to better define the target for renovation based on the age of the buildings in each country.

As for the achievable energy savings, Germany seems to show a lower level savings with respect to Italy and Spain. Actually, the savings reported in **Table 1.1** are calculated with respect to the baseline, and the German baseline, differently from Italian and Spanish one, shows a decreasing trend due to aggressive policies already in place. If the impact of the current and foreseen policies is summed up, a saving of about 100 TWh/year is estimated[3].

[3] The estimation is developed by assuming that energy consumption in the period 2019-2030 is constant and equal to the 2016 level (last historical datum available in Eurostat). This value is compared with the baseline value and a saving of ~60 TWh/year is obtained. By adding more energy efficiency policies on top of those considered in the baseline an additional saving of ~40 TWh/year is achievable.

2 GERMANY

2.1 Executive Summary

The German **construction sector accounts for approximately 5.3% of the national economy's gross value added and has been growing continuously over the past years**. This also holds for the building construction sector; in particular, between 2013 and 2017 the number of building construction companies increased from approximately 14,500 to more than 15,700.

The sector is in a good position to support the promotion of residential building renovation in Germany. The German residential building stock is comprised of approximately 18.8 million buildings, with **the large majority (83%) being single and two-family buildings and only 17% being multi-family buildings.** However, more residential units are located in multi-family buildings (21.5 million) than in single and two-family houses (18.8 million). Ownership structures of residential buildings are relatively diverse, ranging from private owners to owner associations, municipal housing companies and private housing companies. Approximately 47% of Germany's residential units are occupied by the owners while **renting is quite popular all across the country.**

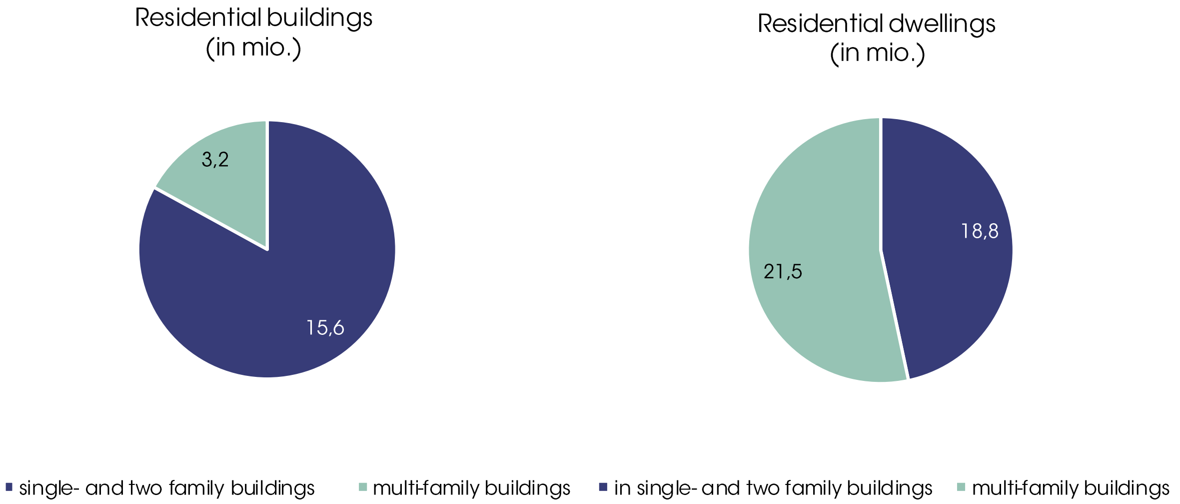


Figure 2.1 - German residential building sector (dena , 2018)

Nonetheless, almost **two thirds of the living area of today's building stock have been constructed in the 1970s or earlier**, i.e. before the first Thermal Insulation Ordinance came into effect. For these buildings, annual energy demand levels are significantly higher than for the remaining building stock. Thus, the energy savings potential for this segment is particularly high.

There are four large energy suppliers operating supra-regionally that are privately owned. The majority of German energy suppliers, however, are small and medium-sized municipal enterprises, which supply two-thirds of the total electricity. In addition, there are private medium-sized and small energy suppliers, whose number has grown faster than the number of public suppliers in the last decade (DIW, 2016).

The regulation of the residential building renovation market dates back to the 1970s, with the First Thermal Insulation Ordinance being adopted in 1977. Since then, the **regulatory framework has continuously become more comprehensive**, including for instance the Renewable Energies Act (2009) and the Energy Saving Ordinance (2014/2019). Recently, these regulations have been merged in the Building Energy Act (2019).

Germany's overall long-term **political goals include the reduction of greenhouse gas emissions by 55% until 2030 and by 80% until 2050**. The buildings sector is considered key for this development and shall be almost climate-neutral by 2050.

In order to reach these targets, German policy makers have created a landscape of **public funding schemes that is backed by more than €300 million per year**. These schemes finance approximately 9,000 different energy efficiency measures. The most prominent ones are the **CO_2 Building Renovation Support Programme offered by the German development bank (KfW)** and the Market Incentive Programme for Renewable Energies. Besides energy counselling and planning services, these programmes also offer grants and soft loans. At regional and local level, many additional support schemes are offered.

Property owners that implement energy renovation measures are **legally allowed to apportion a certain percentage of the renovation costs to their tenants**. This practice is very common across Germany but – in light of increasingly tense housing markets – also highly debated.

2.2 The Residential Building Sector

Introduction

Germany is the largest European country in terms of population with 83 million inhabitants in the year 2019. It is also the fifth highest in terms of population density with an urbanisation rate in 2018 of around 77% (Statista). The majority of the building stock consists of residential buildings; in 2017, only 2.7 million were non-residential buildings, excluding industry buildings (dena , 2018).

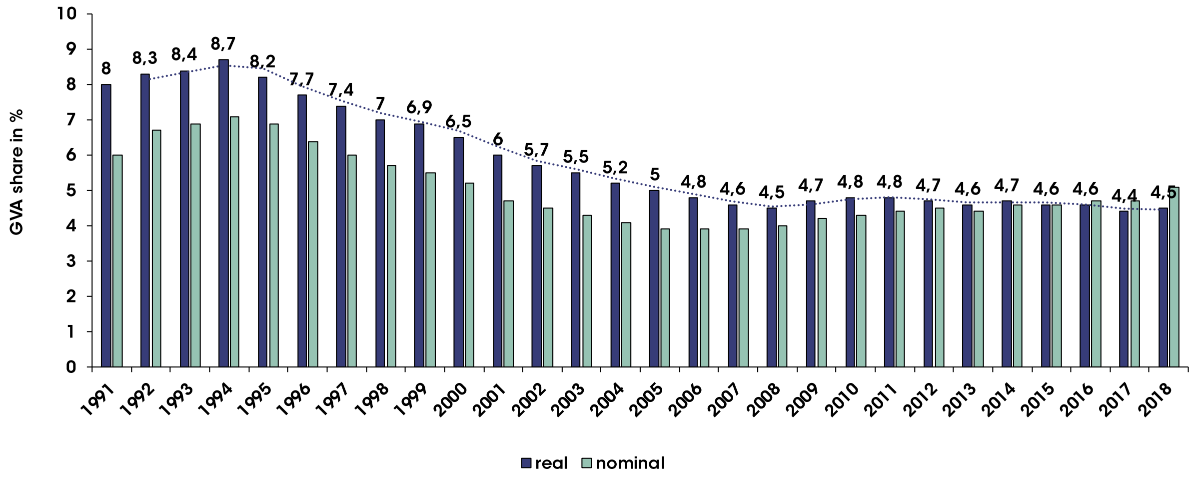


Figure 2.2 - Gross value added of the construction industry as a percentage of total economic gross value added (Bauindustrie, 2019)

The Gross Value Added of the German construction sector is depicted in Figure 2.2. From 1994 on, values decreased, hitting the lowest point during the financial crisis in 2008. Since 2009, values have increased and since 2011 values have oscillated within the range of 4.8% and 4.4% (real values).

Residential buildings

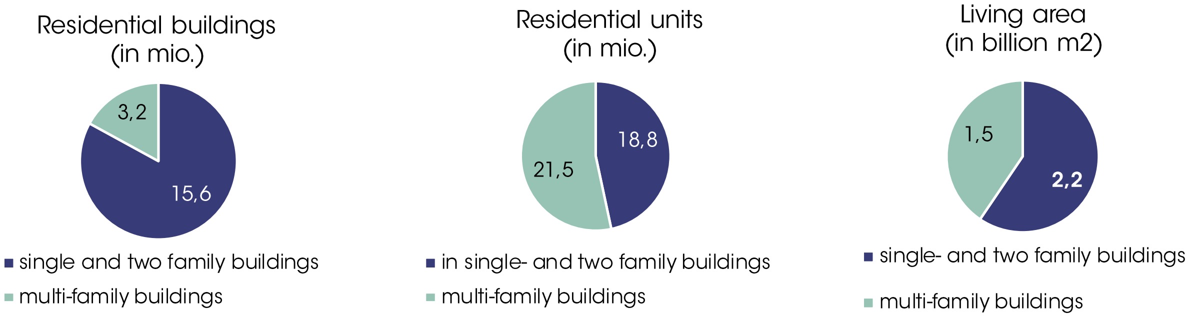


Figure 2.3 - Residential building stock in Germany: buildings, units and living area (dena , 2018)

As of 2017, around 18.8 million residential buildings existed in Germany, of which the large majority (15.6 million; approximately 83%) are single and two-family buildings and only 17% (3.2 million) are multifamily buildings. Living space (in m^2) per unit is smaller in multifamily buildings (a total of 1.5 billion m^2 of living space) compared to single and two-family buildings (2.2 billion m^2). From the 40.3 million residential units, around 53% exist in multi-family buildings (21.5 million) and 18.8 million in single and two-family buildings (dena , 2018).

Figure 2.4 provides an overview of the evolution of the residential building stock in Germany for the period 2000 to 2018. It is important to note that almost two thirds of the residential buildings (currently around 63% of existent living space) in Germany were built before 1979 – i.e. before the first Thermal Insulation Ordinance entered into force. For these buildings, annual energy demand levels are notably higher (see Figure 2.4 and Table 2.1); accordingly, energy saving potentials for these buildings are particularly high (dena, 2016), (dena , 2018).

Construction period	Building type	Annual energy demand for space heating and hot water [TWh]
before 1978	Multi-family buildings	146
1979 - 1994	Multi-family buildings	32
1995 - 2009	Multi-family buildings	14
before 1978	Single family buildings	264
1979 - 1994	Single family buildings	61
1995 - 2014	Single family buildings	45

Table 2.1- Annual energy demands for residential buildings in Germany (BPIE, 2015)

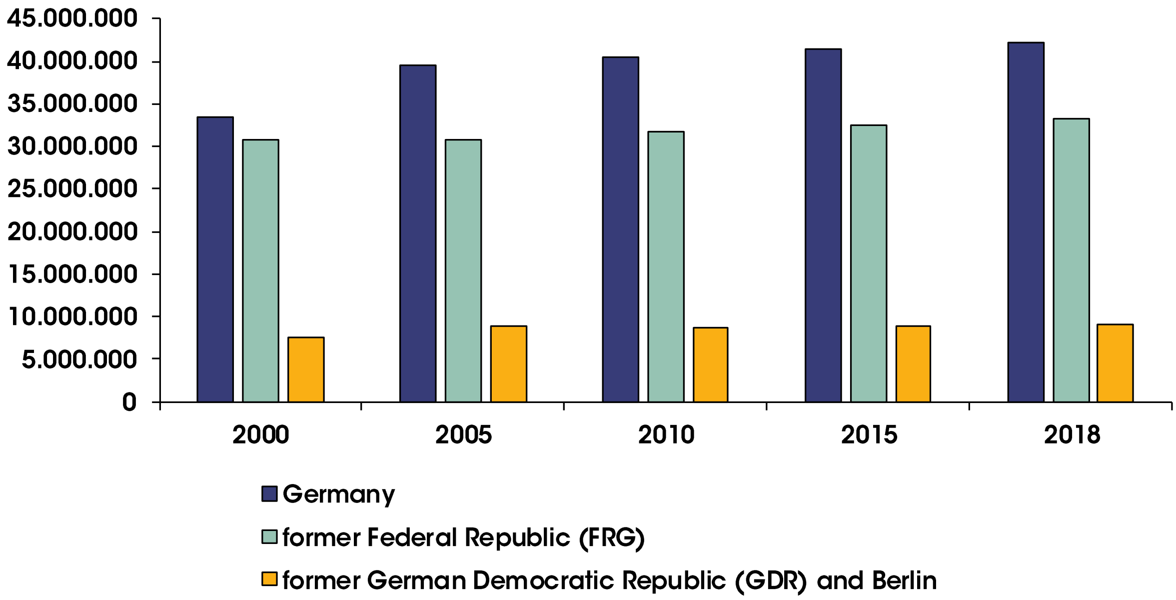


Figure 2.4- Evolution of the residential building stock in Germany, 2000-2018 (Destatis, 2018a)

Today (2018), the share of energy consumption of residential buildings accounts for 64% of total building energy consumption (dena, 2019).

Energy labels have been compulsory in the German real estate market since May 2014. There are two types of energy labels: first, energy labels based on actual energy consumption levels ("Verbrauchsausweis")[4] and second, energy labels based on estimated energy demand levels ("Bedarfsausweis")[5]. Usually, labels based on estimated demands lead to a less accurate rating, because they assume a constant heating energy demand to reach 19°C for the entire heated floor space. However, tenants usually regulate their heating according to personal demands (e.g. absences on weekdays and/or over the weekend). These behavioural factors are hardly taken into account in energy labels based on demand estimates.

As of 2014, only about 10% of the building stock are rated A/A+/B (best categories), regardless of which type of energy label is considered. Approximately 20% of all labels based on consumption are rated G/H, representing the worst categories, and around 40% of all labels based on demand are rated G/H (see Figure 2.6).

[4] These labels consider the building consumption values of the past years and therefore depend strongly on residents' behaviour or usage type.
[5] These labels estimate a building's energy demand based on its construction characteristics (e.g. condition of the building fabric, installed heating system) and with that independently of the residents' behaviour.

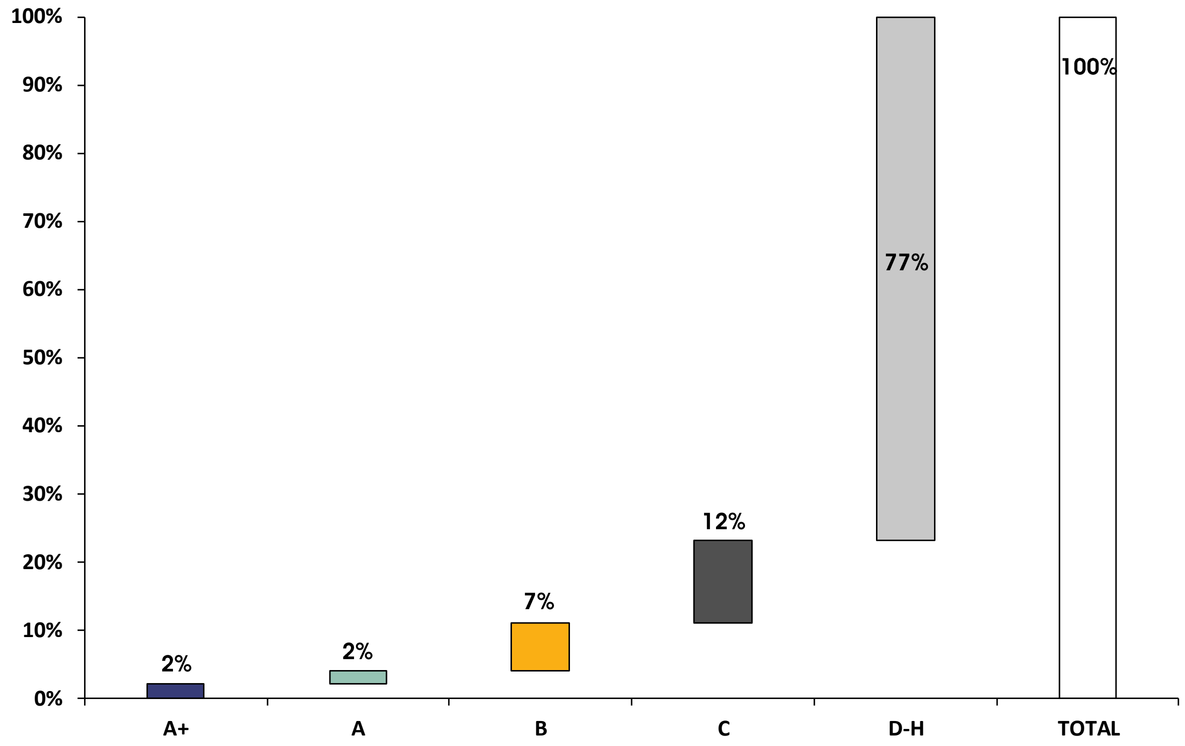


Figure 2.5 - Distribution of Germany's building stock per energy label and consumption (dena, 2016)

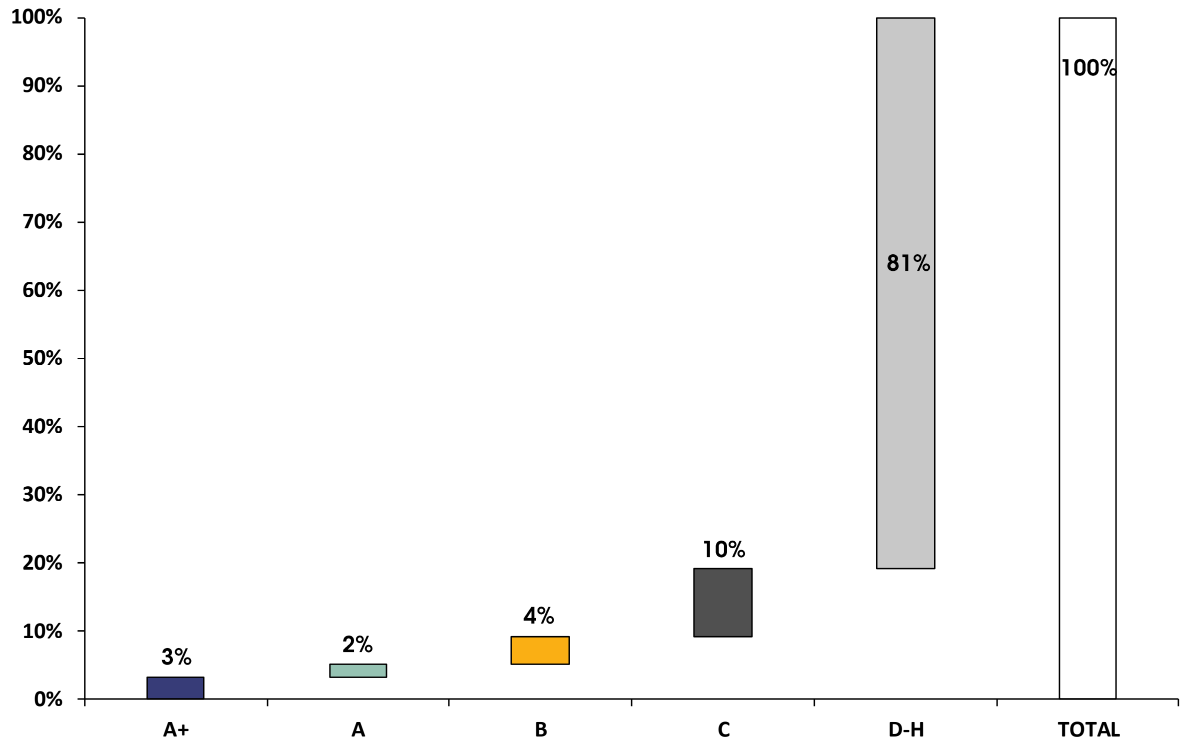


Figure 2.6 - Distribution of Germany's building stock per energy label and demand. (dena, 2016)

Residential ownership models and affordability of energy bills

In 2018, around 46.5% of Germany's residential units were occupied by the owners themselves (Destatis, 2019b); estimations expect only a slight increase to around 47% by 2030 (KfWResearch, 2017). Looking at the evolution over time (Table 2.2), geographical differences can be observed: ownership rates in the former Federal Republic ("Western Germany") tended to steadily increase while in the federate states of the former German Democratic Republic ("Eastern Germany") rates oscillated and only increased during the last decade. Looking on the individual federate state level, the state of Saarland currently records the highest ownership rate (64.7%), followed by Lower Saxony (54.2%) and Schleswig-Holstein (53.3%), while the capital Berlin has the lowest ownership rate (17.4%), followed by Hamburg (23.9%) and Saxony (34.6%) (Destatis, 2019b).

	1998	2002	2006	2010	2014	2018
Germany (united)	40.9	42.6	41.6	45.7	45.5	46.5
Former Federal Republic ("West")[6]	43.1	44.6	44.6	48.8	48.4	49.2
Former German Democratic Republic ("East")[7]	31.2	34.2	30.6	34.4	34.4	36.2

Table 2.2 – Ownership of residential units in Germany (Destatis, 2019b)

Households with more than one adult person tend to own their primary residence, whereas single households or households of single parents tend to rent (Destatis, 2014).

As presented in Table 2.3, in 2011, private individuals are the category owning most residential units (around 22.85 million), followed by associations of condominium owners.

Owner	Number of buildings	Number of residential units
Association of condominium owners	1,689,623	8,689,427
Private individual(s)	15,487,234	22,845,055
Housing associations[8]	287,729	2,082,475
Municipality or municipal housing company	306,489	2,253,450
Private housing company	304,777	2,142,167
Other private company	92,587	590,287
Federate state or "Länder"	40,959	292,715
Non-profit organisation (e.g. church)	49,962	274,791

Table 2.3 – Ownership types of residential buildings in Germany (Zensus, 2011)

[6] Data for 2006, 2010 and 2014: excluding Berlin.
[7] Data for 1998 and 2002: including only East Berlin. Data for 2006, 2010 and 2014: including Berlin.
[8] All housing companies that have the legal form of a cooperative

Utility bills

In Germany, gas prices currently (2019) amount to 6.34 cts/kWh, and electricity prices to 30.85 cts/kWh. (Bundesnetzagentur, 2019a) and (Bundesnetzagentur, 2019b). As of 2013, mean total electricity expenditures of private households account for 2.4% of a household net income. Yet, share values differ strongly between income groups and vary between 7.9% (poor households) and 1% accordingly (rich households) (DIW, 2018). Taxes on electricity consumption amount to an average of 0.9% of a net household income and vary between 2.8% and 0.4% dependent on income group (DIW, 2018).

The evolution of electricity costs (as share of net income) is presented in Table 2.4. It is to note that the burden is higher for the poorer households than for the wealthier ones (BMWI, 2018) and higher for East-German consumers than for West-German consumers. In single households (both with and without children), housing costs represent a bigger share of household income than in two person households; in "dink"-households ("double income, no kids") housing costs represent a smaller share of household income than on average (Destatis, 2019b)

	2012	2014	2015	2016	2017
Share of housing, energy and maintenance of the dwelling costs of net household income	25.9%	27.2%	26.7%	26.5%	26.4%
Share of housing, energy and maintenance of the dwelling costs of overall private consumption expenditure	34.5%	36%	35.9%	35.3%	35.6%

Table 2.4 – Shares of housing, energy and maintenance cost evolution in Germany (Destatis, 2017), (Destatis, 2019b)

Moreover, in 2018, German private households spent again more on heating costs – due to higher consumption (exceeding 2010 values) and due to rising production costs for heating oil; gas costs remained stable (dena, 2019).

2.3 The Residential Building Renovation Market

Introduction

The main regulatory framework determining energy efficiency and consumption requirements for residential buildings is the newly adopted Building Energy Act (GEG 2019). It implements the EU requirements on building efficiency by stipulating energy requirement levels for new and existing buildings in Germany (to be reviewed in 2023) and regulates the installation of oil heaters from 2026 onwards. Moreover, it mandates the inclusion of energy counselling when selling or renovating one - or two-family houses, a service offered for free by the consumer advice centres.

Although new residential constructions will be critical to meet the high and increasing demand for housing, it is the existent residential building stock that must be addressed in order to meet long-term energy goals. The existent stock holds the highest energy saving potential, especially because the largest part of today's residential buildings was constructed before the first Thermal Insulation Ordinance came into force. Those buildings account for two thirds of total heat consumption.

The Building Energy Act, which includes the former EnEV (Energy Savings Ordinance), stipulates the allowed heat transmission coefficients and primary energy consumption levels (§50 I GEG) for existent buildings after modification. Reference houses and standards of energy consumption levels build the basis for the understanding of such requirements. In order to allow a common understanding and facilitate the design of public support schemes, the Kreditanstalt für Wiederaufbau (KfW) developed the standard-set KfW Energy-Efficiency Houses (KfW Effizienzhaus). They are categorised according to the criteria "annual primary energy consumption" and "transmission heat loss" of the building.[9]

Regulatory framework

Table 5 presents the main legislative references that regulate energy efficiency requirements for buildings. Until recently, the valid standard for energy-efficient refurbishments of existent buildings was stipulated by the Energy Saving Ordinance (EnEV 2014). Since October 2019, these requirements have been mandated by the Buildings Energy Act, however without containing any major material change to EnEV 2014.

German regulation	Explanation
Thermal Insulation Ordinance (1977)	Introduction of minimum standards for thermal insulation in external building components, seals around windows and joints in new buildings (dena , 2018).
Heating Cost Ordinance (1981; last amendment 2009)	Governs the allocation of costs for heating and hot water production in centrally supplied buildings with two or more units (excluding buildings with just two dwellings, one of which is occupied by the owner himself). • Overall goal: to encourage energy savings • Obligation to carry out metering

Renewable Energies Heat Act (2009)	Obligation to use renewable energies in new buildings and for major renovations of public sector buildings
	• For all buildings with a floor space > 50 m²: energy demand for heating/ cooling purposes must be partially met by renewable energies
	• Percentage of renewable energy depends on energy source used:
	  – Solar thermal plant: 15%
	  – Use of biomass: 50%
	  – Use of geothermal energy: 50%

Energy Saving Act (last amendment 2013)	Introduction of a nearly zero-energy standard for new buildings that applies to all new public buildings from 2019 onwards and to all other new buildings as of 2021

[9] The standards KfW energy-efficiency house 40 and 40 plus refer to new constructions, while KfW energy-efficiency house 70, 85, 100, 115 and the KfW listed building cover existent buildings; KfW energy-efficiency house 55 is applicable to both categories. The smaller the number, the lower the energy requirement of the property.

German regulation	Explanation
Energy Saving Ordinance (2014; last amendment 2016) (EnEV)	Stipulates energy requirements[10] in existing buildings when external components of the building envelope are modified or when the heated or cooled usable area is extended. It moreover dictates: • Increased energy efficiency standards for new buildings: reduction of approximately 25% in terms of primary energy consumption and approximately 20% in terms of heat transfer loss • Obligation to disclose key energy figures in real estate advertisements, including energy performance certificates • Obligation to document efficiency classes in energy performance certificates for residential buildings • Obligation to decommission temperature boilers installed before 1985
Building Energy Act (GEG 2019)	The Building Energy Act (GEG) merges the Energy Saving act, the Energy saving Ordinance and the Renewable Energies Heat Act into one law (GEG) without significant material changes. The draft law was passed by the Federal Cabinet on 23 October 2019.
Climate Protection Package (September 2019)	Agreed plans and action points related to energy renovation for residential buildings: • Tax incentives for energy refurbishment measures for owner-occupiers (in form of a deduction from tax duty) • Replacement subsidy for oil heaters (additional federal-state subsidy of up to 40%) • Bundesförderung für effiziente Gebäude (BEG): newly conceived federal support programme for efficient buildings to bundle the existing investment grant programmes in the building sector into a single, comprehensive, optimised and modernised subsidy offer (e.g. stronger target towards more ambitious measures, simplification of the application procedure and the extension of addressees to housing cooperatives, housing companies with high losses and persons with little assessed tax liability such as pensioners among others) and higher financial allocation (i.e. increase by 10 percentage points for comprehensive refurbishments to an efficiency house level) • Promotion of serial renovation • Further development of the energy standard (after an assessment that will be conducted in 2023) • Extension of the subsidy for energy counselling services (e.g. grant increase up to 80 %)

Table 2.5 - Relevant German regulation regarding energy efficiency (dena , 2018), (BMWi, 2019)

Potential

Germany's residential building stock is distributed among 16 federate states, with the largest states counting the most residential buildings (see Figure 2.7). On a city-state level, Berlin has the highest number of residential buildings. In all federate states the number of residential buildings in 2018 increased compared to 2010. In fact, 2011 represents the start of an increasing building stock, after the steady decline between 2002 and 2010. That decline was

---

[10] Allowed heat transmission coefficients and primary energy consumption levels do not exceed by more than 40% the figures of the respective reference buildings.

influenced by the elimination of the home ownership subsidy in 2006; higher numbers before 2002 are furthermore related to the reunification owed construction boom (dena, 2019).

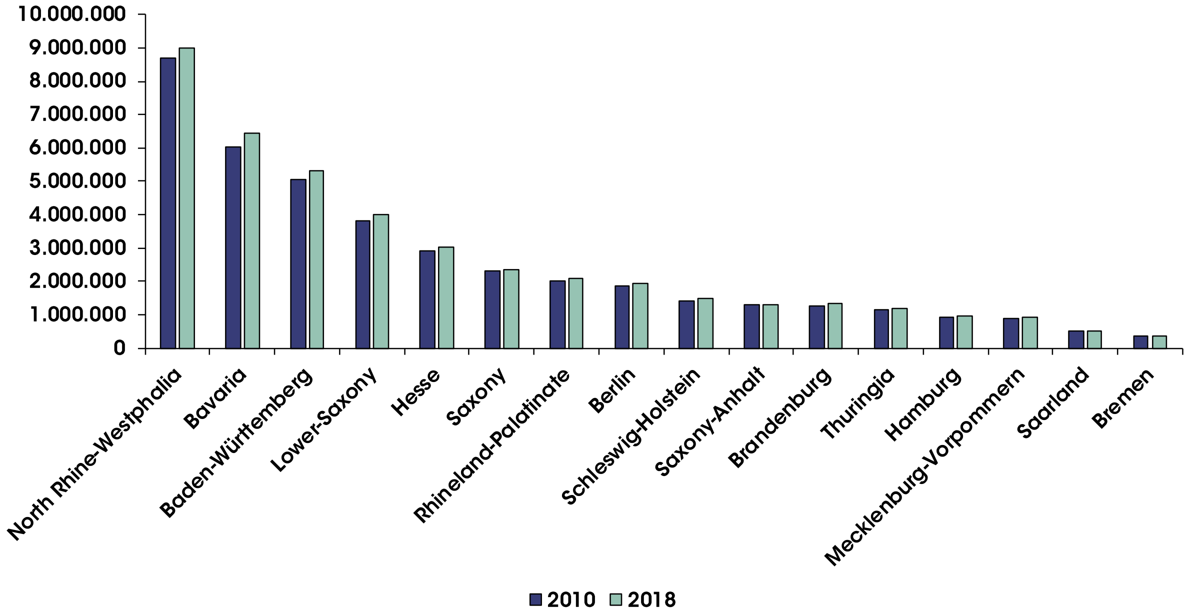


Figure 2.7 - Comparison of the residential building stock in Germany's federate states in 2010 and 2018 (Source: Destatis, 2018a)

Population growth until 2030 is expected in most municipalities in Southern Germany, while in the northern and eastern parts of the country population is expected to decline. This partly reflects in projections about future demand for self-owned residential units (i.e. one and two family houses) which until 2030 are expected to grow in almost all parts of Western Germany, and only in some parts of Eastern Germany – especially in growing cities such as Berlin, Dresden, and Leipzig. Demand for rented apartments will particularly increase in big urban centres (KfWResearch, 2017).

In fact, urbanisation has been a continuous trend in Germany for more than 10 years and is likely to continue in the future (KfWResearch, 2017). As a result, cities are challenged to meet the increasing demand for residential space. In cities like Berlin, Hamburg, Munich, Frankfurt, Cologne, Stuttgart and Düsseldorf – the German cities with the largest population – the demand for residential units already exceeds by far the supply (ZIA, 2019). This trend is further exacerbated by the ongoing trend to form single households (KfWResearch, 2017). Consequently, people start moving to the outskirts of the city where prices for renting and buying a house are significantly lower (ZIA, 2019). However, this phenomenon started to increase prices also in these suburban areas which partly begin to see even more dynamic price increases than the cities themselves (ZIA, 2019).

According to KfW studies, in order to meet the increasing demand for residential units, approximately 4.4 million new residential units need to be constructed until 2030, with around 50% to be met by one- and two-family houses (KfW, 2019a). The federal government's goal of building up to 400,000 apartments per year to address the current housing shortage has not been achieved in 2018 (dena, 2019).

Evolution of the sector

Over the past years, the number of construction companies increased steadily – from 12,702 companies in 2008 to 15,783 in 2017. Looking at the architectural or engineering sector, in 2016 around 119,800 companies or institutions with an economic focus on architectural and engineering activities were active (Destatis, 2016). While the number of companies decreased compared to the year before (-2.3%) the number of employees increased (+7%).

	2013	2014	2015	2016	2017
Number of companies (companies with 20 or more employees)	14,577	14,702	14,857	15,456	15,783

Table 2.6 - Number of building construction companies, 2013-2017 (Destatis, 2019b)

Employment

In 2017, around 165,000 people were employed in the construction of buildings in Germany. The total number of people employed (excluding self-employed persons) in the German construction industry in the same year was around 856.000 (Destatis, 2019c).

Closely linked to the construction industry is the labour market for architects and civil engineers: low interest rates stimulate and its positive impact on residential construction rates and therefore reflect in a steadily rising employment rate for architects and civil engineers, reaching a new 10-year high in 2018. The year before Germany counted around 239,000 employed civil engineers and 140,000 architects (BA, 2019). However, especially in the construction sector, the notable lack of skilled workers and rising wage costs is becoming an increasing challenge for construction companies (dena, 2019)

Contribution to GDP

In 2018, the gross value added of the construction industry in Germany accounted for around 5.3% of the gross value added of the German economy (Statista, 2019d). Compared to the previous year, this represents an increase of 3.6% (Destatis, 2019c). In that context it is to note that, lately, residential real estate is becoming more expensive[11] because of steadily increasing land prices (dena, 2019). Architecture and engineering firms (as of 2016) generated a total turnover of €68.7 billion (+4.4% compared to 2015). Around 84.1% of this was accounted for by engineering firms (€57.8 billion) (Destatis, 2016).

[11] Rising land prices, especially in growth regions, increase residential construction costs significantly – ultimately making residential real estate more expensive. Since 2000, the average price per m² of building land has risen by 46% and in the past five years, total prices for building land have risen by an average of around 5% per year. The house price index rose by 22.1% between 2011 and 2016, the building land price index even by 27% (dena, 2019b, p.12).

Utility companies

The Energy Industry Act (EnWG) separates energy supply[12] from grid operation; both are hence seen as two different energy market domains. Energy utilities in Germany are subject to special public control and regulation. They have to pay grid fees for distributing their products over electricity and gas grids and have to meet special legal requirements to sell energy to households.

Since market liberalisation (1998) enabled a large number of energy suppliers to enter the market, there has been great fluctuation among market participants. Many customers have switched to cheaper or green power rates. The number of customers switching to another provider is also growing steadily. Since market liberalisation, more than 40% of electricity customers and more than 35% of gas customers have switched providers at least once, but many have also done so several times (BDEW, 2019). One third of household customers is not supplied by their local default supplier (Bundesnetzagentur, 2019c).

In the entire value chain from generation to supply there are about 2,200 companies on the German energy market. By European standards, Germany has the highest number of energy suppliers. Viewed separately, there are approximately 1,300 electricity suppliers, 1,000 gas suppliers, and 600 district heating suppliers. Many of these companies also overlap with producers and network operators and are active in multiple sectors (BDEW, 2019).

There are four large energy suppliers operating supra-regionally that are privately owned: E.ON, RWE, EnBW and Vattenfall. The majority of German energy suppliers, however, are small and medium-sized municipal enterprises, which supply two-thirds of the total electricity. These are predominantly public or semi-public companies providing, among other things, the basic (default) energy supply (BDEW, 2019), (Lünendonk GmbH, DETECON Consulting, GISA, & m3 management consulting, 2014). In addition, there are private medium-sized and small energy suppliers, whose number has grown faster than the number of public suppliers in the last decade (DIW, 2016).

Looking at the product level, many utilities on the electricity market offer green electricity, but only a few suppliers are specialised on green electricity and purchase their electricity independently from conventional electricity suppliers. Some of these promote the expansion of green electricity generation facilities or even operate their own. In gas supply, on the other hand, only a few pure eco-gas rates are offered, since normally only a portion of biogas is fed into the grid.

In the private customer segment, energy suppliers typically offer a wide range of products for natural gas, electricity and district heating, and often also water (BDEW, 2019). Municipal and private energy suppliers are increasingly developing energy efficiency services beyond their

[12] Even if fuel oil has still a share of 25.9 % of the heating systems in German households (as of 2018), the purchase of fuel oil is not considered under energy supply here. Likewise, the growing but still very small shares of renewable heating energy sources such as wood pellets or heat energy, which is generated by heat pumps, is not considered. Coal with a share of approximately 1% nowadays is negligible. Only the supply of energy through distribution networks (electricity, natural gas and district heating) is taken into account here; this refers to the supply of almost 70% of heating systems in German households (BDEW, 2019).

core business. Most municipal companies already offer energy management services such as energy audits or energy controlling. To a lesser extent they also offer contracting solutions such as Energy Performance Contracting or lease models (e.g. for photovoltaic modules) for customers from the public sector as well as the commercial, trade and services sectors. In addition, there is an increasing trend to offer (mostly regional) innovative products like smart home, e-mobility solutions or virtual power plants (VKU & ASEW , 2016), (Lünendonk GmbH, DETECON Consulting, GISA, & m3 management consulting, 2014).

Around 45.5 million customers were supplied with electricity in 2018, only slightly less than ten years before. The number of homes that were supplied with natural gas heating in the same year was 20.7 million, about 7% more than in 2008. The number of households supplied by district heating has been increasing by 16% since 2008 and counted 5.8 million in 2018 (BDEW, 2019).

Energy renovations in residential buildings

The high energy saving potentials of buildings constructed before 1978 reflect a higher annual renovation rate (1.1%) compared to the rest of residential buildings (dena, 2016). During the period 2005-2008 the overall annual renovation rate amounted to only 0.8% for the German residential building stock[13] (dena, 2016), whereby roof insulation (1.5%) was the most common energy renovation measure undertaken, followed by exterior wall insulation (0.8%) and floor insulation measures (0.3%) (dena, 2016). These figures are basically equal for single- and multi-family houses but differ between regions[14].

Even though the concept of energy transition and the relevance of building performance is generally acknowledged among the German public and the political spectrum, obstacles remain (BPIE, 2015) – e.g. only every third renovation undertaken in Germany results in the implementation of energy saving measures and most measures do not meet the optimum renovation depth.

Identified measures for residential building renovations

List of the main measures for residential building renovations

As space heating and hot water account for the largest share of final energy consumption in residential buildings (98%), the transition to more efficient heating systems, thermal insulation of the building envelope and the use of renewable energies are the measures with the greatest potential to reduce energy demand (dena, 2016).

Typical measures offered on the German renovation market are listed below. These measures concern the building envelope, i.e. renewal of the windows or thermal insulation of the roof, the exterior walls, or the basement ceiling, and on the other hand, renewing of the heating system (dena, 2016).

---

[13] This calculation is based on renovation data for the following four components: exterior walls, roof, floor, windows (dena, 2016).

[14] In Northern Germany, renovation rates of exterior walls and roofs are slightly above average; in Southern Germany, renovation rate of exterior walls, floor and roofs are slightly below average and in Eastern Germany, renovation rate for floor insulation is slightly above average.

Common energy renovation measures in Germany (dena, 2016).

- Optimisation of the heating system
- Replacement of the heating system
- Ventilation system
- Thermal insulation of the basement ceiling
- Replacement of windows
- Thermal insulation of the roof
- Thermal insulation of exterior walls

2.4 Potential Impact of Building Energy Renovations

National energy consumption

Figure 2.8 shows the evolution of the energy consumption in the residential buildings sector compared to the evolution of the overall final energy consumption in Germany.

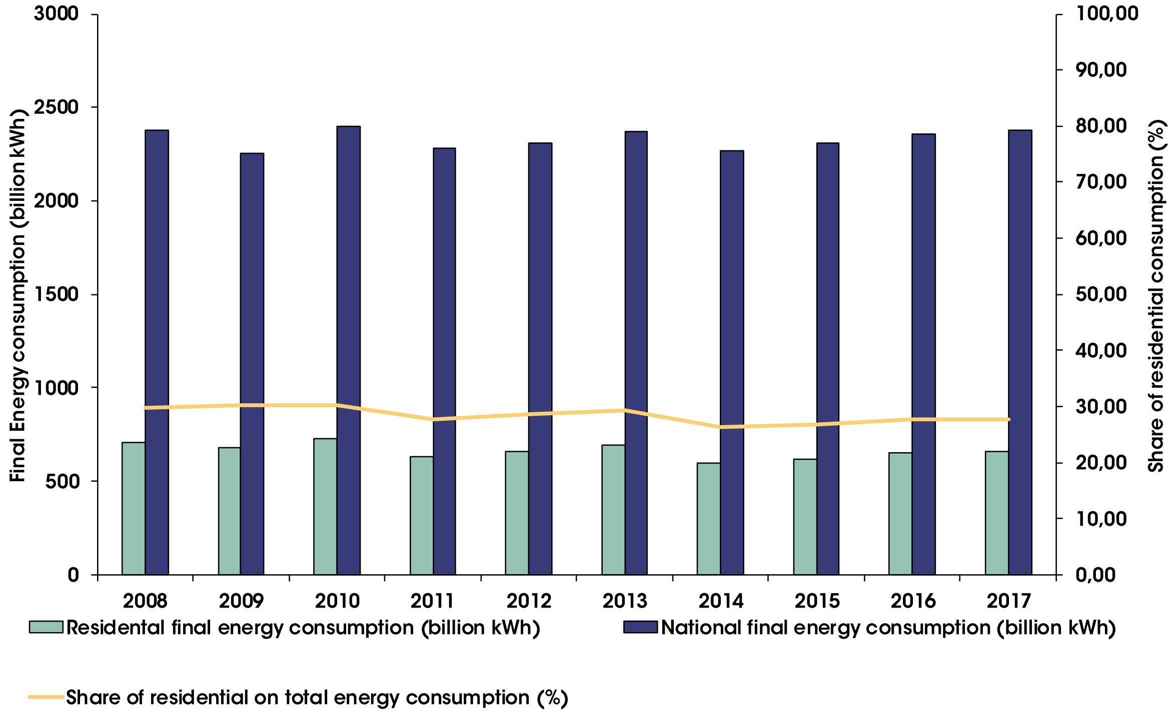


Figure 2.8 - Evolution of national and residential buildings' final energy consumption in Germany (Eurostat, 2018), (Eurostat, 2019)

The residential building sector's final energy consumption varies significantly from year to year depending on the weather conditions. Thus, it is not possible to evaluate the possible impact of energy efficiency measures here. The share of residential buildings energy consumption on total consumption follows the demand for energy needed to heat a building year after year very well.

The weather-adjusted energy consumption of the residential building sector is shown in Figure 2.9 differentiated by heating sources. The entire final energy in German households is used for space heating, hot water, lighting or electrical appliances, but space heating and hot water make up the largest share of residential energy consumption with approximately 98% (dena, 2016).

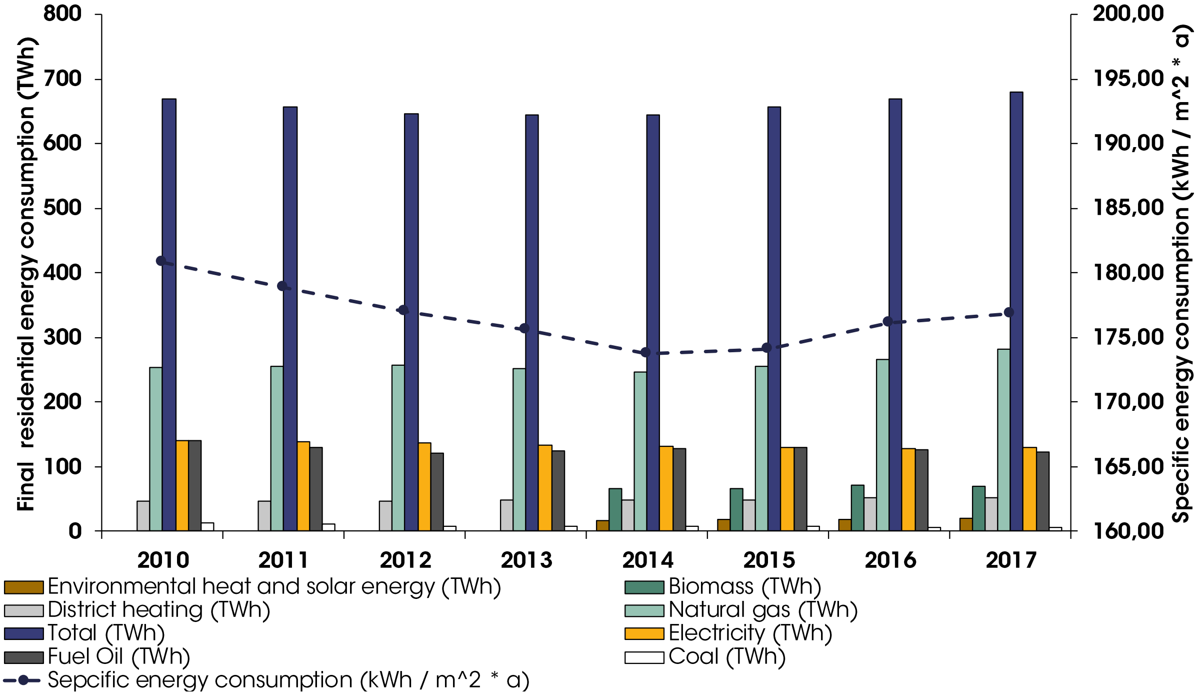


Figure 2.9 - Evolution of the weather adjusted final energy consumption in the German residential sector by fuel type and specific energy consumption (Destatis, 2019d) (Destatis, 2019e)

The significant decline in fuel oil consumption and simultaneous increase of natural gas consumption in the period 2010 to 2017 (Destatis, 2019e) may be explained by the replacement of energy inefficient heating systems – e.g. substitution of oil boilers with more efficient and less pollutant natural gas boilers.

Also noteworthy is the first decline in renewable energies (mainly in biomass: wood and wood pellets) from 2016 to 2017. Over a longer period of time, however, the share of renewable energies has grown 16.7 % since 2010. The use of environmental heat (e.g. electric heat pumps) and solar thermal energy has grown rapidly in recent years (Destatis, 2018b).

Between 2000 and 2014, the total energy consumption of households fell significantly, but since 2014 there has been a steady increase again. Since 2010, the share of heating energy in the residential sector has risen by 2.1% and that of hot water by as much as 12.1%. This can be explained by a population increase of 3% in the same period (Destatis, 2018b).

Looking at the specific heating energy demand of households in Figure 2.9 i.e. the final energy demand per year and square metre of living space, there also is a decline until 2014. This, too, is only a continuation of a long-term trend with a significant decline since approximately 2000. Since 2014, however, square metre-based consumption has risen again. This is mainly due to the proportionate increase in single and two-family households, which have a higher energy requirement per area than multi-family households (Destatis, 2018b) (dena, 2016).

Potential of energy savings

The potential for energy savings is defined as the gap between the current and required energy performance of the buildings (that must be achieved during the building renovation).

Due to the relatively low construction rate, however, new buildings play only a minor role in reducing energy consumption in the entire building stock. Also, energy renovations in buildings constructed after 1995 (in accordance with the Third Thermal Insulation Ordinance or the Energy Saving Ordinance from 2002) play a minor role as they are relatively low both in numbers and in energy consumption. Thus, the savings potential lies in energy renovations of existing buildings constructed before 1995 (approximately 84% of the total housing stock), whose final energy demand is up to three times higher than the current minimum standard for new buildings (BMWi, 2014).

The largest savings potential lies in buildings built before 1977 and thus before the First Ordinance on Thermal Insulation came into force. These buildings account for two thirds of the total heat consumption of residential buildings. Renovated buildings from this period, on the other hand, achieve consumption values that are almost at the level of new buildings (dena, 2017). Particularly, buildings built between the 1950s and the 1970s, which account for 42% of all dwellings, are often not considered historically valuable and are therefore not particularly in need of conservation, which is why they offer great and cost-effective energy-saving potentials. The relatively high final energy demands averaging over 240 kilowatt hours per square metre per year of the buildings constructed before 1948 also offer the potential for high energy savings. However, extensive energy renovation is not always possible or only at significantly higher costs due to restrictions, especially for listed buildings (IW Köln, 2017b).

All in all, only slightly more than 10% of the residential building stock is at least as energy efficient as a current new building according to the valid limits until 2015 (EnEV 2009, (dena, 2016). Thus, less than 10% comply with standards according to the energy savings ordinance EnEV 2014.

On average, the energy demand for one- and two-family houses is higher than for multi-family houses. This applies in particular to pre-1979 buildings. The average energy consumption values for one- and two-family houses and multi-family houses converge and are practically the same for residential buildings built after 2001. Therefore, one- and two-family houses built before 1979 offer a particularly high energy saving potential (dena, 2016).

The German long-term goals are to reduce greenhouse gas emission by 55% until 2030 and by 80% until 2050 (Climate Protection Plan of 2016). Buildings, as integral part of the climate protection strategy, shall be almost climate-neutral by 2050 (BMU, 2016), (BMWi, 2015)– with the interim goal of a reduction by 66 to 67% of greenhouse gas emissions by 2030 (equivalent to 70-72 million tonnes of CO_2 equivalents). This shall be achieved through a mix of energy efficiency increase and the integration and expansion of renewable energies; new building standards, long-term renovation strategies and a step-by-step abandonment of fossil heating systems accompany the strategy (BMU, 2016), (BMWI, 2018).

In terms of primary energy demand of residential building a reduction by 80% to approximately 40 kilowatt hours per square metre and year until 2050 is envisaged. Thus, in 2050, the average primary energy demand on the national level has to be 70% of today's minimum standard for new buildings and energy-efficient renovations.

The German energy targets for the residential building sector can be met if a renovation rate of 1.4% to 2% is achieved. This, however, seems rather unrealistic as renovation rates during the last years stagnated between 0.8% and just over 1% (dena, 2019) (DMB, GdW, DV, 2019). Even reaching an annual renovation rate of 1.4% is considered a significant challenge. As of 2018, the majority of the existent 42 million residential units is still lacking renewable heat supply and the heating replacement rate for all buildings is less than the required 3.5 % per year (dena, 2019) (DMB, GdW, DV, 2019).

The graph below shows the projected developments of energy consumption in the building sector from 2018 onwards based on the GDP, the number of heating days per year, and the previous developments of energy consumption since 2000 (blue line).

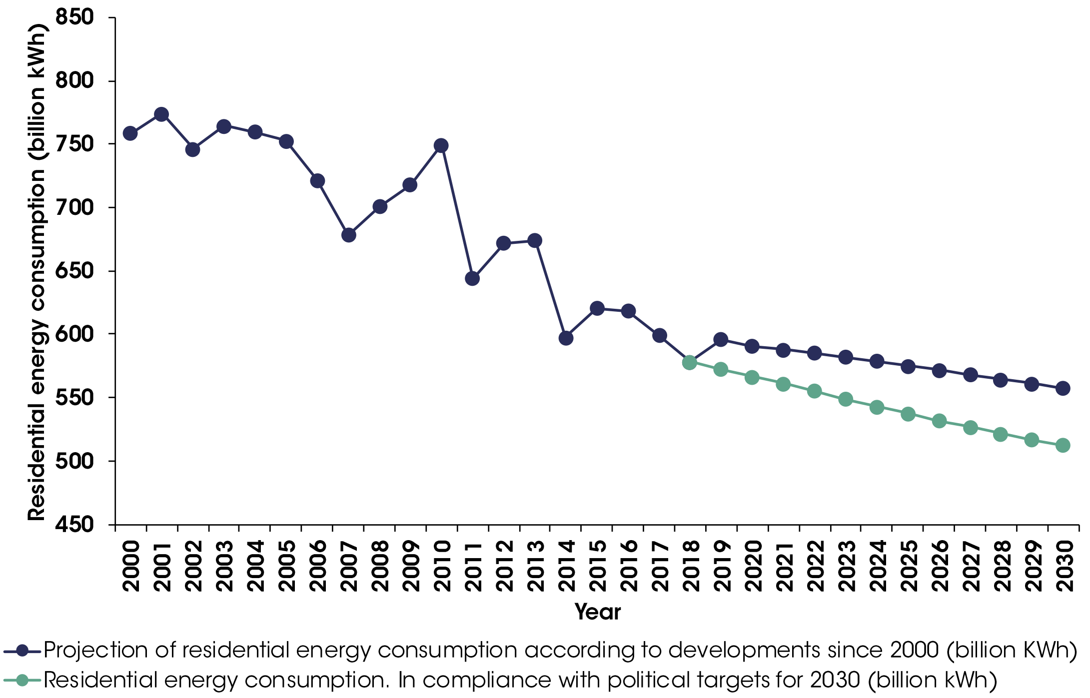


Figure 2.10 - Evolution of energy consumption in the residential buildings sector since 2000 (Federal Ministry for Economic Affairs and Energy, 2019) (Eurostat, 2020) (World Bank, n.d.)

The lighter line in Figure 2.10 shows the development projections of energy consumption in the residential building sector, which results if the national energy efficiency policies, measures and programmes envisaged for meeting the political energy savings targets for the year 2030 are continued (e.g. Energy Efficiency Strategy for Buildings, National Energy Efficiency Action Plan) (Federal Ministry for Economic Affairs and Energy, 2019).

In order to achieve the national climate targets, heating requirements between 2008 and 2020 have to be reduced by 20% for residential buildings – i.e. reductions of an average of 1.7% per year (dena, 2016), which is in line with the predicted developments in Figure 2.10

(light blue line). Looking at the previous actual final energy consumption, the decline between 2020 and 2008 (assuming a constant average reduction as between 2008 and 2017 onwards), has only reduced by 1.2% per year, or 14% overall (dena, 2016), (dena , 2018) (Urtasun & Alves, 2019) (own calculations). Due to lower energy prices and thus reduced heating replacement and refurbishment rates, the developments described deviated significantly from the targets set for residential buildings (in terms of reduction of energy consumption for heating and hot water).

Potential market impact

Investment potential

According to estimations (GdW, DMB, DV., 2019), for rented apartments a minimum of €6 billion annually and for residential buildings in general at least €14 billion annually are needed to finance the energy renovation measures needed to meet Germany's climate targets in the buildings sector. Against this background, the number of providers and programmes promoting energy efficient measures has grown over the past years.

Overall market impact

Under the target scenario of a 2% energy renovation rate of residential buildings in Germany, projections estimate annual additional investment costs of €9 billion in 2030 and €14 billion in 2050, which are contrasted by energy costs savings for residential buildings of €11.1 billion in 2030 and of €32 billion by 2050 (DIW, 2014).

On a macroeconomic level, these energy cost savings allow for higher consumption capacities for end users, resulting in a higher demand for production goods and positive gross value-added effects (Prognos, 2013). Overall, energy efficiency measures in the residential sector can have a positive impact on income, domestic demand and potentially significant positive employment effects; including also on other sectors (i.e. non-residential sector), energy efficiency measures may increase GDP about one percent p.a. by 2050 and – depending on labour mobility and increased productivity – create between 66.000 and 250.000 new jobs by 2030 (DIW, 2014).

2.5 Financing the Energy Renovation of Buildings

Introduction

Homeowners that decide to undertake energy efficient renovation at their residential unit(s) are confronted with a large and ramified public funding landscape, offering a total of approximately 3,350 single and supplementary support schemes that promote around 9,000 different energy efficiency measures (IW Köln, 2017a).

The most prominent national support programmes in the energy renovation context are:

- The CO_2 Building Renovation Support Programme[15] offered by the German development bank "Kreditanstalt für Wiederaufbau" (KfW) and existent since 2006; and
- The Market Incentive Programme – Renewable Energies offered by the Federal Office of Economics and Export Control (BAFA) and the KfW.

Together these programmes subsidise energy counselling and planning services and offer grants and soft loans (partly with amortisation bonuses) for single measures as well as for comprehensive energetic renovation projects. While the CO2 Building Renovation Support Programme aims in particular at energy efficiency measures for new and existing buildings, the Market Incentive Programme focuses on the use of renewable energies in buildings' heating systems.

In order to sustain both support schemes, the federal government provides €2 billion (KfW) and €300 million (BAFA) annually from the federal Energy and Climate Fund (IW Köln, 2017a). The newly adopted Climate Protection Package (September 2019) is planning to expand support programmes: an increase by 10% for support schemes promoting the KfW efficiency house[16], targeted subsidies for low-income tenant areas and the promotion of serial refurbishment – among others – are being discussed (Bundesregierung, 2019).

On the regional and local level, federal states, municipalities, districts and municipal energy utilities offer own support programmes, some of which can be combined with each other and/or with national support schemes.

On the private side, financing support to homeowners can be obtained through conventional bank loans. Yet, a survey showed that lower-investment measures tend to be financed by the owners themselves, without seeking external financial support (dena, 2016).

Public support programmes

In Germany, public financing schemes are accessible only for property owners (from individual to corporate owners), as they are the only ones legally allowed to decide whether or not to conduct energy renovations in their property. The only exception is the BAFA energy consulting support programme that is accessible also for tenants (DMB, 2019).

[15] The programme contains support programmes for homeowners, condominium owners' associations, housing companies and cooperatives, property developers, municipalities, non-profit organisations and trade and industry and with that aims at increasing the energy efficiency of residential and commercial properties as well as of public non-residential buildings (BMWi, 2014). The support schemes presented in this report exclude public and industry buildings, and instead target private (individual to corporate) residential buildings and units.

[16] The KfW-Efficiency-House describes the energy efficiency status of a building. It draws on the reference values primary energy demand and transmission heat loss. The figures 55, 70, 85, 100 and 115 indicate the percentage of the required energy compared to the reference KfW-Efficiency-House 100.

Grants and loans

Public grants for energy renovation of residential buildings are mainly provided by the KfW CO2 Building Renovation Programme via the following programme numbers:

- Programme 151: comprehensive refurbishment to KfW efficiency house
- Programme 152: single measures
- Programme 430: energy efficiency single measures or package

While programme number 430 offers direct investment grants for selected energy renovation measures, KfW-programmes number 151 and 152 constitute low-interest loans, for which grants are given as repayment bonuses. In all programmes the underlying principle is that the higher the achieved energy efficiency level, the higher the grant or repayment bonus. Energy efficiency levels are generally measured in reference to the KfW Efficiency House levels.

Via the Market Incentive Programme (MAP) the Federal Office of Economics and Export Control (BAFA) offers investment grants and soft loans for the integration of renewable energies in heating systems. The related Energy Efficiency Incentive Programme (APEE) offers special investment grants for fuel cell systems (KfW programme 433)[17].

Besides energy renovation projects and measures, BAFA and KfW also support energy renovation counselling services through direct grants. BAFA supports on-site energy consultation for complete refurbishments or customised step-by-step renovations and the KfW programme number 431 supports construction supervision services.

Federal soft loans can cover up to 100% of the investment costs and grants up to 30% of the eligible costs; maximum amounts limiting grant amounts are usually determined. Many national support programmes can be combined with each other or with available support programmes of the federal states, municipalities or energy suppliers.

Financing institution	Financial instrument	Support programme name	Explanation
Only existing building stock			
KfW – CO_2 Building Renovation Programme	Soft loan (with amortisation bonus)	"Energieeffizient Sanieren – Kredit (151) "[18]	• **target:** comprehensive refurbishment to a KfW efficiency house, including monument renovation • **interest rate:** reduced federal interest rates • **loan amount:** maximum €100,000, • **repayment period:** maximum 30 years • **amortisation bonus**: maximum 27,5 % of loan

[17] In all national support programmes, additional building costs that come along with renovation measures and are needed for the orderly completion and functioning of the building, e.g. replacement of window sills, testing of airtightness are generally included (DDIV, 2017), (KfW, 2019b).

[18] Translation: „Energy-efficient renovation- loan 151"

Financing institution	Financial instrument	Support programme name	Explanation
KfW – CO2 Building Renovation Programme	Soft loan (with amortisation bonus)	"Energieeffizient Sanieren – Kredit (152) "[19]	• **target**: single measures (e.g. window replacement, roof insulation) • **interest rate**: reduced federal interest rates • **loan amount**: maximum €50,000 • **repayment period**: maximum 30 years • **amortisation bonus**: maximum 7,5 % of loan; maximum €6,250 for heating- and ventilation package
KfW – CO2 Building Renovation Programme	Grant	"Energieeffizient Sanieren - Investitionszuschuss (430)"[20]	• **target**: private homeowners who are renovating or buying energetically renovated living space • **grant amount**: depending on the measure – maximum €30,000 (for comprehensive refurbishment to KfW-Efficiency-House); maximum €5,000 (for single measures); maximum €7,500 if combined with heating- and ventilation package
BAFA	Grant	Energieberatung für Wohngebäude[21]	Energy consulting for complete refurbishments or step-by-step refurbishment schedules, eligible for homeowners and tenants
New buildings and existing building stock			
KfW – CO2 Building Renovation Programme	Grant	Energieeffizient Bauen und Sanieren – Baubegleitung (431)[22]	Specialist construction and energy planning supervision by an independent energy efficiency expert
BAFA, KfW	Grants and soft loans (with amortisation bonuses)	Market incentive programme (MAP) & Energy Efficiency Incentive Programme (APEE)	MAP promoting the generation and use of renewable energies in the heating sector, with APEE as an additional support programme for replacing inefficient heating systems through modern energy efficient systems using renewable energies Example grant: „Energieeffizient Bauen und Sanieren - Zuschuss für Brennstoffzellen (433)" for fuel cell systems

Table 2.7 - Overview of national public support schemes relevant in the context of energy renovation of residential buildings (KfW, 2019b) (KfW, 2019c)

In most cases, the consultation of an energy efficiency expert[23] is required within the loan or grant application process. Moreover, eligible buildings are the ones that submitted the building application or notification of the residential units and buildings (including listed

[19] Translation: „Energy-efficient renovation- loan 152"
[20] Translation: „Energy-efficient – investment grant 430"
[21] Translation: "Energy consulting for residential buildings"
[22] Translation: "Energy-efficient construction and renovation - construction supervision (431)"
[23] These experts must be selected from a list accessible under www.energie-effizienz-experten.de.

buildings) before the 1st of February 2002 and are predominantly used residentially. For the KfW soft loans, usual bank securities are required as collateral; the specific form and scope of collateralisation is agreed during credit negotiations between the borrower and his financial institution (KfW, 2019b). Moreover, reduced federal interest rates are guaranteed for 10 years (KfW, 2019b).

Depending on whether grants are given in from of direct investment grants or repayment bonuses, the cost alleviation will be effective after completed renovation (direct grants) or after completed repayment (repayment bonuses). Reduced interest rates (of the KfW loan programmes) on the other side reduce financing costs.

Regional level

Over the last decade, the number of regional energy renovation support programmes and providers has grown resulting in a complex funding landscape that varies across federate states. As of 2017, a total of 137 support schemes was provided by the federate states ("Länder"), with the Eastern states offering less programmes than the Western states. Whereas grant conditions can vary, these programmes primarily target the thermal insulation of facades, roofs and windows and secondarily heating systems (IW Köln, 2017a).

Existent federate schemes include but are not limited to supplementary grant programmes (to national KfW programmes), special guarantees from the federal states, or grants and loans from regional banks ("Landesbanken"). Besides that, energy utilities started offering energy renovation support programmes, too. The latter mainly focus on consultation services and heating systems – i.e. conversion from fossil heating systems to systems integrating renewable energies or district heating (IW Köln, 2017a).

Local level

Around one third of all support schemes is offered on the district and municipal level; most of them are offered in Bavaria and Baden-Württemberg. Target areas and grant conditions vary and often differ from those of the federal state programmes (IW Köln, 2017a).

Tax depreciation

Up to now, there is no targeted tax depreciation for energy renovation measures. Current related options exist in the following: landlords can claim full maintenance costs over 2 to 5 years; and production costs can be depreciated annually with 2% distributed over 50 years. These options do only hold for landlords, not for owner-occupiers (FÖS, 2014). Moreover, German tax law allows tax reductions (20% of labour costs; maximum €12,000) for craftsman services for maintenance or renovation works (§ 35a EStG).

However, after many years of debate, the recently adopted Climate Protection Package (September 2019) decided to introduce "attractive, simple and technology open" tax incentives for energy renovation measures (Bundesregierung, 2019) by 2020 – specifically in form of a deduction from the tax obligation in order to ensure benefits for owners of all income classes (tax bonus). The envisaged tax incentive shall apply (for now) only to selected single measures (which also KfW classified as eligible; e.g. heating installation, window replacement, roof insulation) and only for owner-occupied properties. The figures under discussion are 20% or a maximum of €40,000 of the renovation costs that shall be deductible from the tax debt, spread over 3 years (Bundesregierung, 2019)[24]. Moreover, just recently (December 2019), a new amendment was presented, which foresees to consider costs for energy consultants as expenses for energy measures; this soon and likely to be adopted amendment would mean that energy counselling costs can benefit from the possibility of tax liability deduction as well.

Incentives

Private appropriation (to occupant)

German tenancy law (§559 BGB, Tenancy Law Adjustment Act 2019) allows to apportion part of the renovation costs (in form of a levy) to the renter[25]: the landlord can increase the annual rent by 8% (before 2019: 11%) of the pure refurbishment expenses[26]. Yet, there is a six-year valid cap limit according to which the rent cannot increase by more than 3€/m^2 of living space or by more than 2€/m^2, if the rent before the refurbishment was less than 7€/m^2. Further rent increases are forbidden for the following five years, unless refurbishments are due to legal obligations or condominium decisions. This (i.e. cap limit and blocking period) and local comparative rents (that generally determine the maximum rent increase) may challenge the incentive effect of this apportionment possibility.

CO_2- Price

The planned and politically agreed levies on fossil energy consumption (i.e. CO_2 pricing) might increase the competitiveness of energy efficiency measures and renewable heat and power applications and by that incentivise energy-efficiency refurbishments (DV, 2019).

Impact of public support programmes[27]

From 2005 until 2016, the refurbishment of around 2,595,000 dwellings was supported through the KfW CO_2 Building Renovation Programme in Germany. Although uptake rates of the "energy-efficient renovation" programme have fluctuated, steady growth has been recorded since 2015 (as of 2017) and led to more than €73 billion invested over the past 12 years (IWU & Fraunhofer IFAM, 2018). Compared to grants given for new constructions, however, refurbishment support schemes seem to perform less (dena, 2016)

In the same period (2005-2017), the refurbishments supported by the "energy-efficient renovation" programme led to the reduction of 7,534,000 tCO2e/a and to final energy savings of 20,360 GWh/a. The most used energy renovation measures of this programme refer to thermal insulation (IWU & Fraunhofer IFAM, 2018). Overall, the cumulative impact on

[24] A decision on this is expected until the end of 2019.
[25] For refurbishments up to 10,000 € per residential unit, landlords can calculate the rent increase in the simplified procedure: a lump sum of 30% for maintenance costs has to be deducted and the rest can be considered as modernisation costs (BGB). Yet, eligible renovation measures include also non-energetic refurbishments.
[26] Refurbishment measures eligible in this context are defined as changes that increase the residential value or that were necessary without the landlord having any influence (§555b BGB). This means that mixed forms of refurbishment works are allowed and with that renovation measures entailing no energetic optimisation of the building (e.g. installation of elevators), too.
[27] This section focusses on the evaluation of the national CO_2 Building Renovation Programme of KfW, acknowledging that there are a large number of local and regional support schemes available.

employment since 2005 is estimated at around 962 person-years (i.e. employment of a person for one year with the average weekly working time of the respective industry) (IWU & Fraunhofer IFAM, 2018).

However, a survey of the German energy agency "dena" (as of 2015) investigating on the financing behaviour of building owners regarding energy renovation of the building envelope and heating system showed that only 27% of the respondents made use of public support programmes. In those cases, direct grants (15%) were preferred over loans (8%) or a mix (4%) (dena, 2016). From the 73% not taking advantage from the public support programmes, 45% were aware about them (dena, 2016). Disincentives often mentioned are the complex bureaucratic requirements of public support schemes (as against bank requirements for conventional credits) combined with the current low-interest rate environment.

Private financing schemes

Looking at private financing options, homeowners seem to use own resources for energy renovation measures that are less cost intensive. An indicative reference value of measures up to €200,000 is provided by the survey (2015) of the German energy agency (dena, 2016). Alternatively, conventional (house) bank loans are available, too. Given the current low-interest rate environment, commercial bank loans may gain attention.

3 ITALY

3.1 Executive Summary

Residential buildings represent the 89% of the total Italian building stock. Building distribution is not homogeneous within the country´s territory and **approximately 40% is concentrated in the northern part of Italy**. The distribution of dwellings is substantially proportional to the population. The large majority of residential buildings is represented by multifamily houses as shown in Figure 3.1, with an average surface of 115 m^2 per dwelling, whereas single family houses have a surface of approximately 160 m^2. The number of buildings grew at a pace of 0.7% in the period 2008-2017.

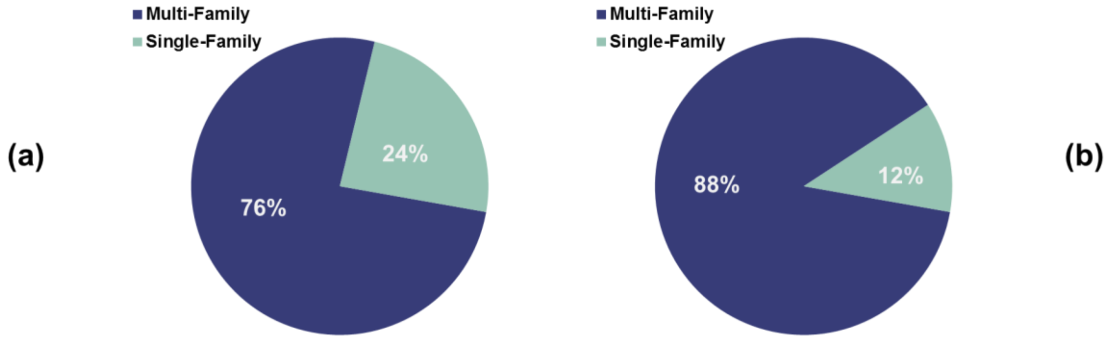


Figure 3.1 - Typology of buildings in the residential stock: (a) number of buildings; (b) share of surfaces. UNIGE estimation based on ISTAT data (ISTAT, n.d.)

Predominant ownership structures are tenancy and ownership. Social houses represent a special category since they are rented under special conditions to residents with specific needs. Approximately **70% of Italian population lives in owned dwelling, yet big cities present a much higher share of rented dwellings than the country´s average.**

The real estate market contributes to approximately **14% to the GDP**. Traditionally, earnings from other activities are invested in real estate which makes this sector is largely exposed to economic cycles.

The specific energy consumption showed a reduction trend in the period 2008-2017, partially due to the energy efficiency policies promoted by the Italian government. Despite the global economic downturn contributed to reduce the consumption, residential customers are captive, and therefore their reaction to economic factors (e.g. energy prices or income variations) is limited with respect to others, such as the climatic conditions.

The **Italian utility market is quite dynamic, populated by a large number of retailer**s. The high level of competition leads to a reduction of the volumes supplied by each company in the last years. Furthermore, customer churn rates show values between 6% and 10% both in the electricity and natural gas markets.

The regulation of the residential building renovation market dates back to the 1970s, with the **First Thermal Insulation Ordinance being adopted in 1976**. Since then, the regulatory framework has progressively become more comprehensive, including for instance the Renewable Energies Act (2011) and the Energy Saving Decree (2014). On the other hand, **most of the Italian buildings were built during the '60s (prior to the first energy efficiency regulation)** constituting for this reason a relevant potential market for the implementation of energy efficiency measures.

Italy's **long-term political goals include the reduction of greenhouse gas emissions by 40% until 2030** with respect to 1990 levels. In this context, the role of the buildings sector is considered pivotal. Different measures are currently in place to support the energy refurbishment of existing buildings in order to fulfill the EU commitment level in terms of energy efficiency and carbon emissions abatement. The most popular are **tax rebates, white certificates and others.**

3.2 The Residential Building Sector

Introduction

Italy is the fourth largest EU country in terms of population (approximately 60 million people) after Germany, France and United Kingdom, and fifth in terms of population density (approximately 200 people/km^2). Thus, Italy is characterized by a high urbanisation rate and the building sector has developed accordingly.

Figure 3.2 below portrays the composition of the Italian building stock. The fact that the large majority (89%) is represented by residential buildings stands out.

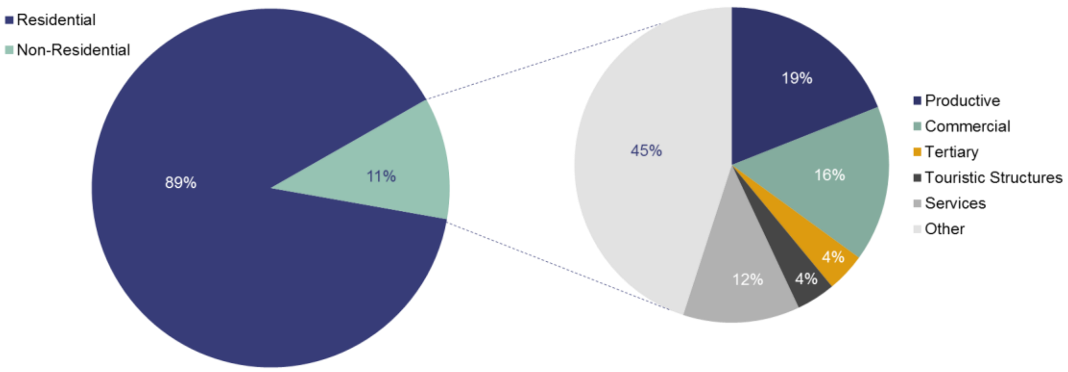


Figure 3.2 - Composition of the current building stock (Italian Institute of Statistics, 2011)

Non-residential buildings account for 11% of the stock (Italian Institute of Statistics, 2011), represented by productive activities, services, commercial & business buildings, touristic structures and others (e.g. sport facilities, churches, etc.).

The structure of the stock has remained stable over the years, since Italy is a developed country and the current challenge is on the retrofitting and maintenance, rather than on new constructions.

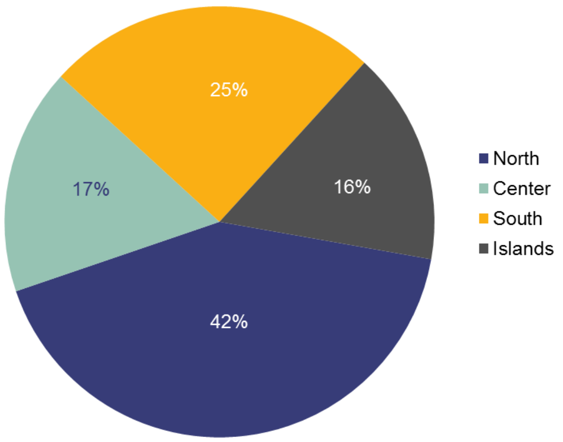


Figure 3.3 - Geographical distribution of the building stock (Italian Institute of Statistics, 2011)

The distribution of the buildings across the territory is not homogeneous. As depicted by Figure 3.4, 42% is concentrated in the northern part of the country where most of the economic activities are located. Southern Italy accounts for 25% of the total, whereas central Italy and the islands represent 17% and 16% respectively (Italian Institute of Statistics, 2011). The share of residential buildings is similar among regions and aligned with the country-based value.

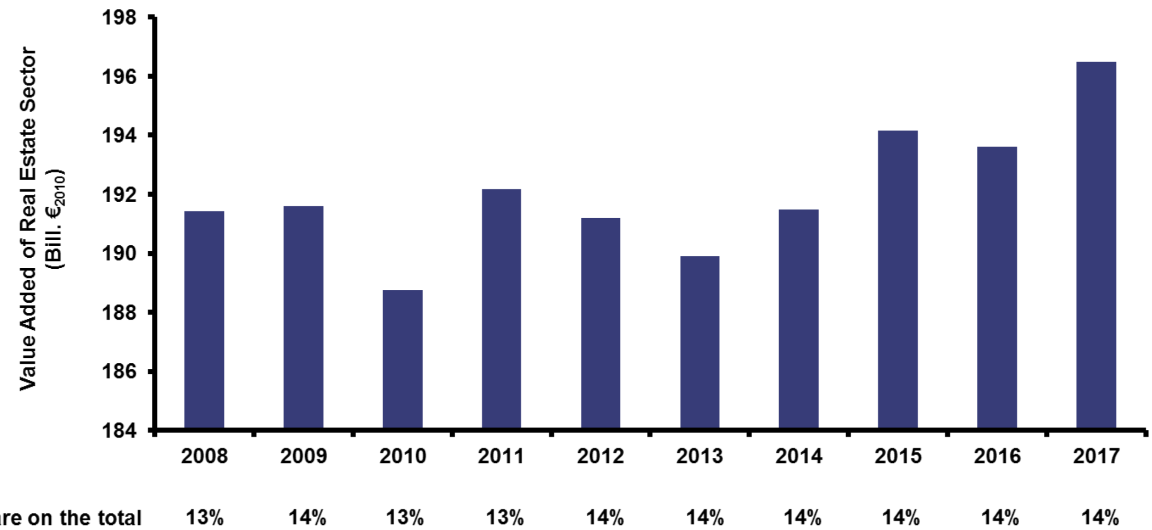


Figure 3.4 - Value added of the real estate sector in Italy (Italian Institute of Statistics, 2019)

The Value Added of the Italian real estate sector is depicted in Figure 3.4. An oscillating trend in the period 2008-2013 can be observed due to the economic downturn. In particular, the minimum value of activity is registered in 2010. On the contrary, from 2013 onward, the sector experienced an upward trend.

Figure 3.4 also demonstrates the fact that the real estate market is tightly connected with the performance of the Italian economy. In fact, its share on the total value added of the country is mostly constant. This trend is also consequence of the fact that the real estate sector is often considered an effective way to invest earnings from other activities.

Residential buildings

Most of the Italian building stock is concentrated in the northern part of the country. Figure 3.5 shows the level of correlation between the number of dwellings per region and the corresponding population. Lombardia, Lazio and Campania are the top three regions in terms of inhabitants. They represent the 40% of the total of population and the 30% in terms of dwellings (Italian Institute of Statistics, 2011).

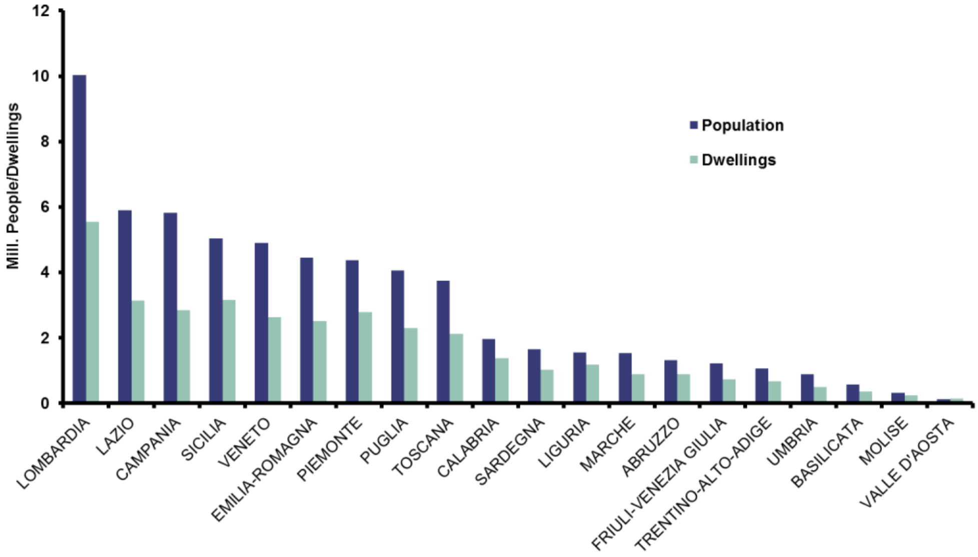


Figure 3.5 - Population vs. dwellings per region in 2017 (Italian Territorial Agency, n.d.)

If the most industrialized regions (Lombardia, Piemonte, Veneto and Emilia Romagna) are considered, they account for 40% of population and 40% of the dwellings (Italian Territorial Agency, n.d.). On the contrary, except for the Lazio, all the regions located in the central part of Italy are characterized by low density of population and dwellings.

Figure 3.6 shows the average number of people living in a dwelling which stood at 1.73 persons per dwelling in 2017. This graph denotes relevant differences among the regions. In particular, small regions such as Molise, Basilicata and Val d'Aosta are characterized by values under the average, whereas, the most populous regions show occupancy rates higher than the country´s average.

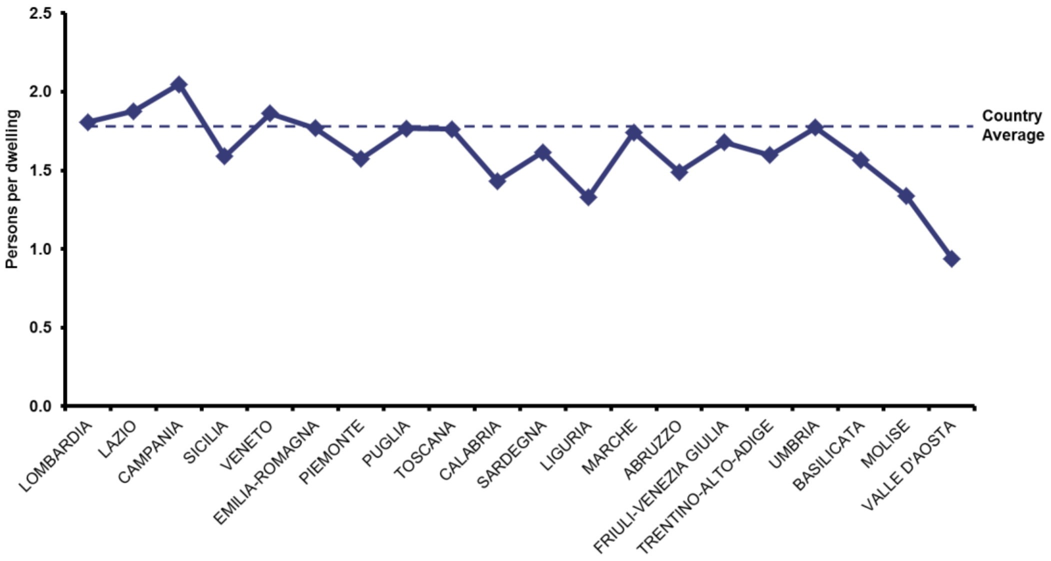


Figure 3.6 - Occupancy rate per region (Italian Territorial Agency, n.d.)

According to the Italian regulation, buildings are classified in six categories or dwelling type according to their quality, as depicted in the table below:

Category	Definition	Description
A1	Luxury	Dwellings with luxury finishes, also included in historical contexts
A2	Ordinary	Usual dwellings with standard quality of finishes
A3	Cheap	Dwellings built with affordable finishes in terms of quality and materials. They are also smaller compared to the standard
A4	Modest	Modest dwellings in terms of finishes and dimension and with limited presence of HVAC systems
A5	Very Modest	Dwellings belonging to buildings of very low quality without the presence of any service
A6	Rural	Dwellings connected to agricultural activities
A7	Detached/Semi Detached Houses	Independent dwellings with private garden or external space
A8	Villa	Luxury dwellings with very high-level finishes and services, and a private garden/park.
A9	Historical Buildings	Dwellings located in historical buildings of artistic relevance
A11	Local Buildings	Regional houses (e.g. Trulli in Apulia Region)

Table 3.1 – Italian dwelling categories (Agenzia dell'Entrate, n.d.)

The evolution of the dwelling stock is represented in Figure 3.7. The share of predominant dwelling categories is also depicted, showing that categories A3 (cheap) and A2 (ordinary) represent most of the stock.

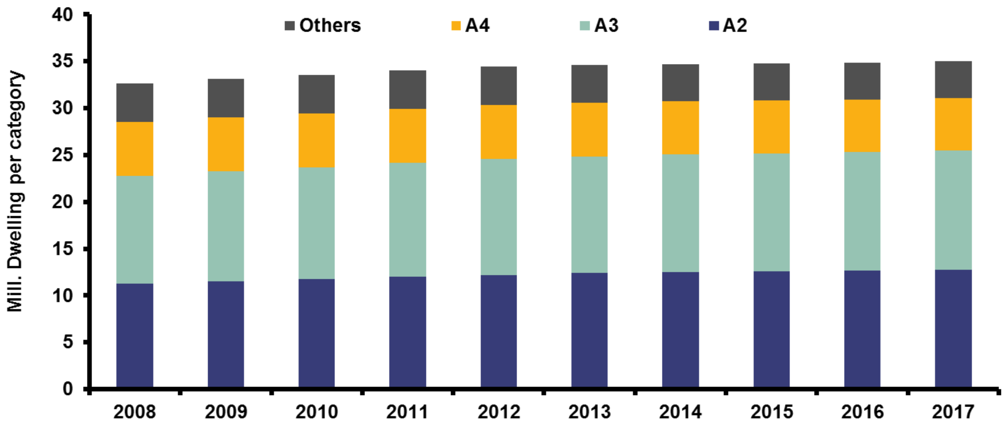


Figure 3.7 - Evolution of the dwelling stock (Italian Territorial Agency, n.d.)

The Italian dwelling stock in 2017 stood at 35 million with an increase of 2.4 million with respect to 2008. A2 and A3 categories steadily represent 70% of the total dwelling stock and they increased 2.7 million between 2008 and 2017.

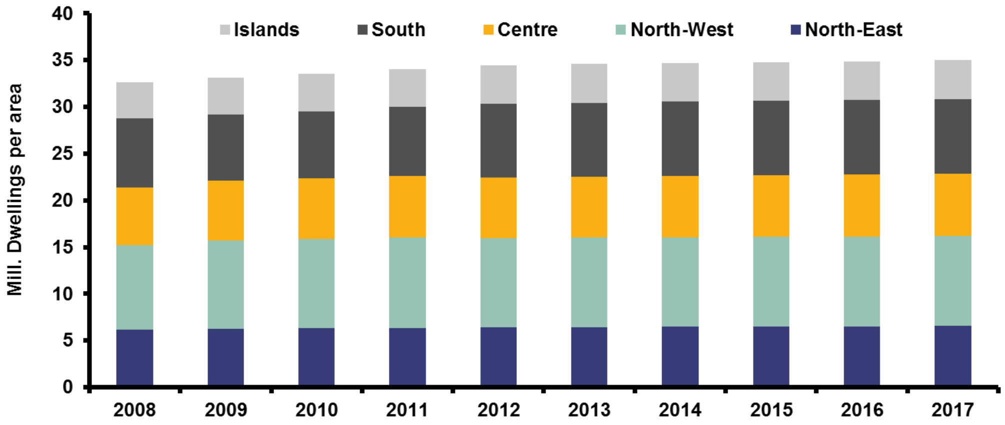
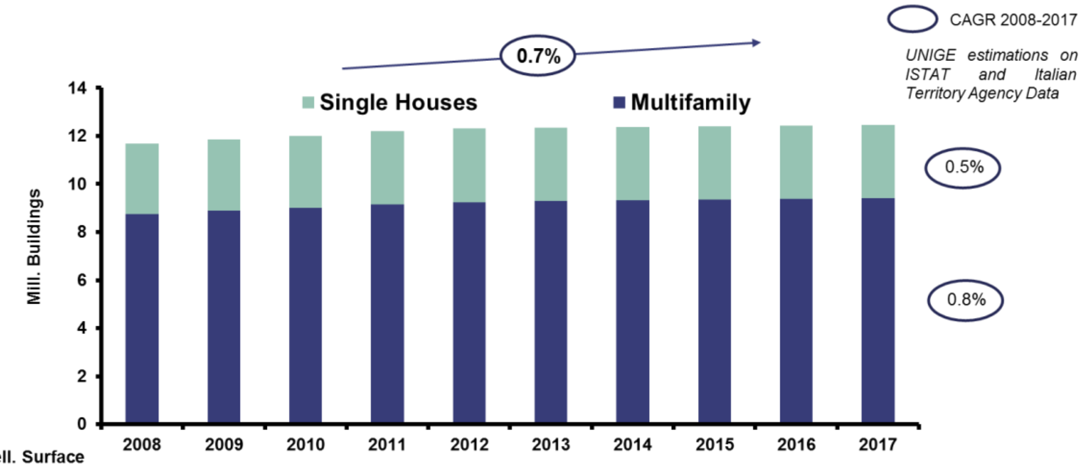


Figure 3.8 - Evolution of the dwelling stock per area (Italian Territorial Agency, n.d.)

The evolution of the dwelling stock in each macro-region, that is North-West, North-East, Centre, South and Islands, is depicted in Figure 3.8. The North-West region accounts for most of the building stock (28%), followed by South Italy with 23%. The shares of the considered macro-regions are quite stable during the period 2008-2017. This means that the increase of dwellings between 2008 and 2017 has been proportional in all the areas, without concentration phenomena.

The evolution of the residential building stock is illustrated in Figure 3.9. Single family and multifamily buildings account for 75% of the total, and their weight is stable over the period of time considered.



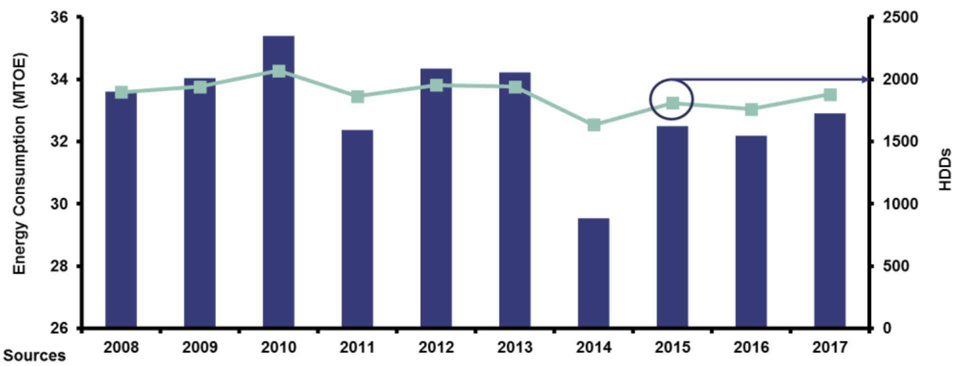
Avg. Dwell. Surface (m^2)	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Single Houses	153	156	157	158	159	160	162	163	164	164
Multifamily	111	111	112	112	112	112	112	112	112	115

Figure 3.9 - Evolution of the residential building stock (Italian Institute of Statistics, ISTAT, 2018), (Italian Territory Agency, 2018). UNIGE analysis.

The total amount of residential buildings has reached approximately 12 million with an average yearly increase of 0.7% between 2008 and 20017. Multifamily buildings showed a higher growth rate of 0.8%, with respect to single houses which average yearly increase was 0.5%.

Single-family houses are characterized by a larger surface compared to dwellings in multifamily houses. Figure 3.10 highlights a trend of increasing internal surface for both single and multifamily houses, which went from an average of 153 m^2 to 164 m^2 and from 111 m^2 to 115 m^2 in the period 2008-2017, respectively. On average, in 2017, single houses had a surface 1.4 times larger than dwellings in multifamily buildings. This ratio is likely to influence energy consumption for both winter heating and summer air conditioning.

The energy consumption is depicted in Figure 3.10. The contribution of the main sources of energy: electricity, natural gas and fuel oil is depicted (Eurostat, n.d.).



Energy Sources	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Fuel Oil (MTOE)	3.8	3.6	3.2	2.9	2.7	2.6	2.1	2.3	2.2	2.0
Natural Gas (MTOE)	17.8	18.7	20.8	20.0	20.1	20.1	16.8	18.9	19.0	19.2
Electricity (TWh)	68.4	68.9	69.6	70.1	69.5	67.0	64.3	66.2	64.3	65.5

Figure 3.10 - Evolution of energy consumption in the Italian residential sector (Eurostat, n.d.)

Energy consumption presents an irregular pattern; therefore, it is not possible to identify a specific trend which would allow the evaluation of the possible impact of energy efficiency measures.

Fluctuations in energy consumption can be largely ascribed to weather fluctuations, since a large share of energy is used for heating, especially natural gas. This is confirmed by the Heating Degree Days (HDDs) trend reported in Figure 3.11. It can be observed that, in general, the increase of HDDs (i.e. cold year) matches a growth of energy consumption, whereas a decrease of HDDs (i.e. warm year) is followed by a reduction of energy consumption. The match is confirmed quantitatively by a correlation coefficient of 0.97. In order to compensate for the climatic effect, it is necessary to implement a weather adjusted procedure (Bianco, Scarpa, & Tagliafico, Analysis and future outlook of natural gas consumption in the Italian Analysis and future outlook of natural gas consumption in the Italian residential sector, 2014).

Figure 3.11, highlights also that the consumption of fuel oil, mainly used for heating, experienced a relevant reduction in the period 2008-2017. In most cases it was substituted with natural gas due to the substitution of older equipment with more efficient and less pollutant ones.

The weather adjusted procedure results in a more regular pattern which marks a clearer trend, as shown in Figure 3.11. In particular, a decrease in energy consumption in the period 2008-2010 can be observed, probably due to the global economic downturn. In the following years (2011-2017), probably due to the increase of the average dwelling surface, a slight increase is registered. To assess the progress in terms of energy efficiency, the specific consumption is estimated in Figure 3.11.

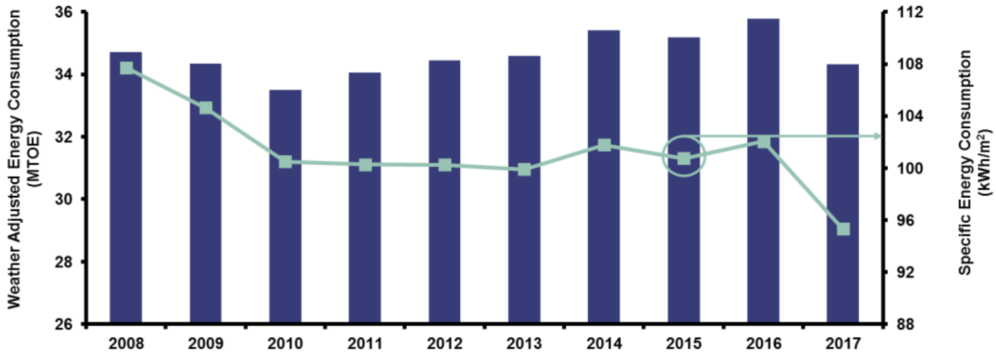


Figure 3.11 - Evolution of weather adjusted energy consumption

Figure 3.11 shows a decreasing trend in energy consumption per square meter which could mean that energy efficiency measures are under implementation. These measures affect both, to new construction and to the refurbishment of existing buildings pushed by different support schemes and energy policies launched during the reference period. It is, however, difficult to estimate the weight of each contribution.

Residential ownership models and affordability of energy bills

The current Italian population is approximately 60 million with a slight average increase of 0.3% per year, in the period 2008-2017. There are two ownership models that are predominant in Italy: via tenancy and via ownership.

Figure 3.12 shows the share of population living in rented and owned dwellings, which have remained stable for the period 2008-2017. On average, 72% of the population (43 million people) live in owned dwellings and the remaining part (28% equal to 17 million people) live in rented dwellings.

Approximately 20 million dwellings (approximately 60%) are occupied by owners, whereas 3 million dwellings (approximately 10%) are rented, and the remaining part, 10 million (approximately 30%), is dedicated to other uses (e.g. holiday houses, on gratuitous loan, etc.).

Furthermore, the number of people living in the same dwelling is decreasing probably due to social changes which have resulted in a decrease in the number of people per family as well as an increase in the number of people living alone. The increase of people living alone is partially explained by the fact that a substantial number of people have moved for working reasons from one part of the country, usually South Italy, to another part, mainly North of Italy.

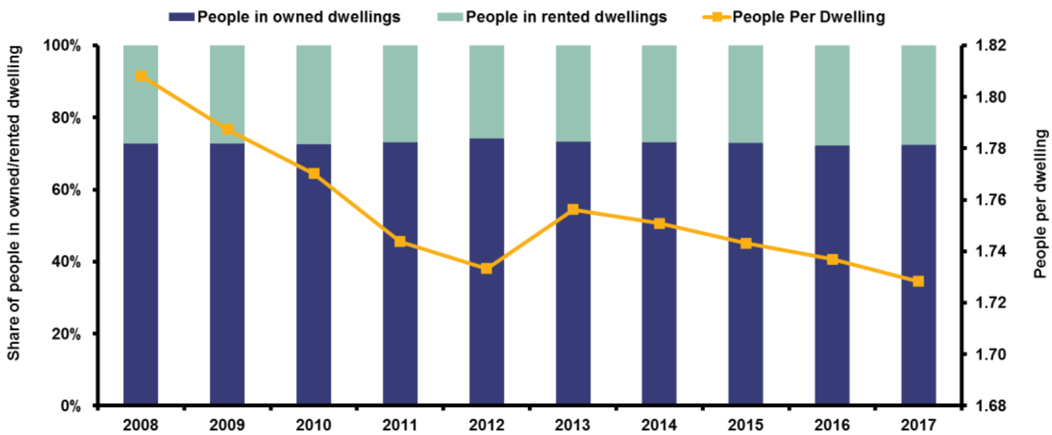


Figure 3.12 - Distribution of people in dwellings per ownership model (Eurostat, n.d.)

The number of available/holiday dwellings is high in Italy. In many cases these dwellings are family houses located in rural areas which have been left by people who moved to cities for working reasons. These houses are then used as vacation homes.

It is important to stress that these numbers represent the country's average and this representation can be noticeably different among regions.

For example, if the business areas of Milan and Rome are analysed it is possible to see relevant variations in terms of share of people living in owned/rented dwellings, with a likely increase of the rented quota. On the contrary, if rural areas of southern or central Italy are considered an increase of the owned quota would be observed.

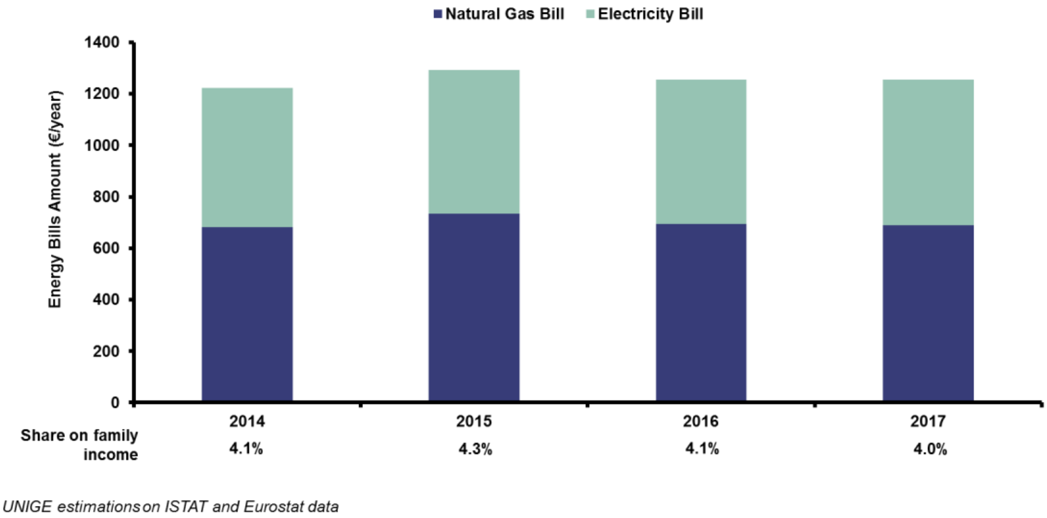


Figure 3.13 - Expenses for energy bills in Italian dwellings, (ISTAT, n.d.), (Eurostat, n.d.)

The average energy bill per dwelling is 1,200 €/year representing, on average, 4% of family income. It is important to observe that these average values may vary consistently if different areas of the countries are considered.

In fact, energy consumption, especially natural gas, is strongly correlated with climatic conditions (i.e. a correlation coefficient of 0.92 is determined between natural gas consumption and HDDs in the period 2008-2017).

If geographical differences are considered, the average energy bill varies from approximately 1,500 €/month in the northern part of the country to approximately 950 €/year in the Islands.

3.3 The Residential Building Renovation Market

Introduction

Most of Italian buildings were built during the 1960s, therefore they need deep structural, service and energy maintenance and refurbishment. The issue is well known by policy makers, who have tried to develop adequate regulation to support interventions on the Italian residential buildings stock.

Since 1998 different measures have been introduced to push structural and energy retrofitting of existing buildings in the form of tax discounts. The original system has been modified over the years in order to meet the changing needs of the market. Over the years, different categories of buildings were added to those benefiting from the incentives, and the amount of the tax discount was modified according to selected parameters.

In recent years, regulators and policy makers tried to stimulate the joint implementation of structural and energy retrofitting, since it is considered more efficient. In fact, once the decision to implement structural refurbishment is made, the additional effort needed for the implementation of energy efficiency measures is considerable reduced.

To further promote support to integrated structural-energy interventions, the services for ordinary and extra-ordinary maintenance also benefit from a reduced value added tax.

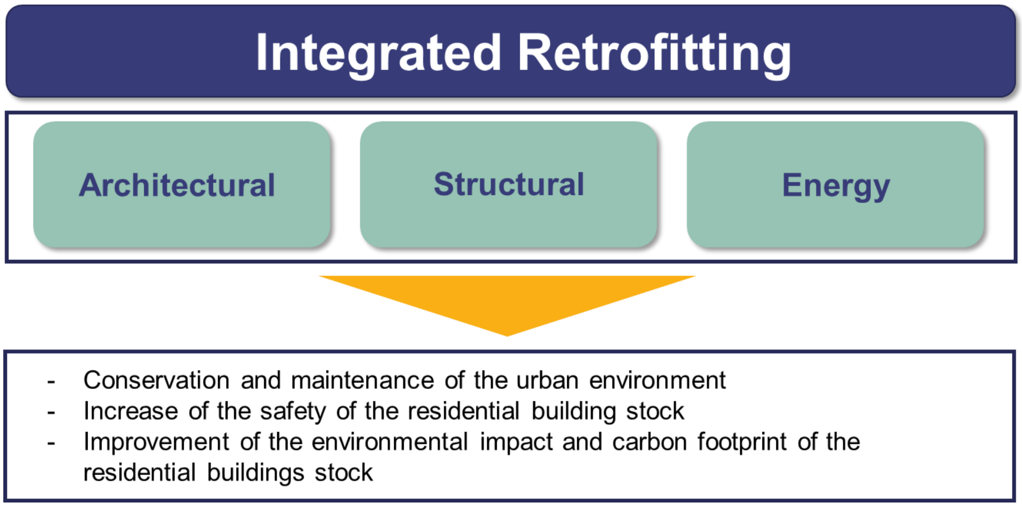


Figure 3.14 - Dimensions of integrated retrofitting interventions. UNIGE analysis.

Regulatory framework

At country level, Italy started to approach the issue of energy efficiency in buildings in 1976 with a Ministerial Decree focused on regulation for the limitation of energy consumption in buildings. This decree has its roots in the energy crisis at the beginning of '70s, particularly sever for Italy due to the scarcity of primary energy sources on its territory. In this context, the first option to improve security of energy supply was to reduce the internal consumption by implementing energy efficiency actions.

Table 3.2 contains the main legislative references which regulate energy efficiency in buildings. The focus is on national and EU regulatory frameworks (RSE, 2015), (CTI, n.d.). In addition, each region can set stronger requirements in terms of energy efficiency.

Italian regulation	Explanation
Decreto Legislativo 192/2005	Implementation of EU Directive 2002/91/CE focused in energy efficiency in the construction sector
Decreto Legislativo 112/2008	Implementation of the EU Directive 2006/32/CE in the efficiency of final energy uses and on energy services
Decreto Ministeriale 26/06/2009	Guidelines for the energy certification of buildings with the definition of the methodology for the release of the energy efficiency certification
Decreto Legislativo 28/2011	Implementation of the EU Directive 2009/28/CE on the promotion of renewables
Decreto Presidente della Repubblica 74/2013	Definition of the general criteria for the operation, control and maintenance of thermal plants for winter and summer air-conditioning and for the generation of sanitary hot water
Decreto Legislativo 102/2014	Implementation of the EU Directive 2012/27/CE on energy efficiency. The decree highlights a set of measures to support energy efficiency in order to satisfy the 20-20-20 targets
Decreto Interministeriale 26/06/2015	Definition of the calculation methodologies for energy performance in buildings and definition of the minimum requirements for buildings.

Table 3.2 – Relevant Italian regulation (RSE, 2015) (CTI, n.d.)

The aim of these regulations is twofold: to align the national regulation framework to the EU directives and to push energy efficiency interventions in buildings in order to improve the carbon footprint as well as to support the construction and renovation sector after a period of noticeable stagnation.

Depending on the depth of the energy renovation measures (e.g. substitution of windows or installation of external insulation), the intervention may be subject to building permits and other legal requirements stipulated by regulation in force at national, regional and city administration level.

The Inter-Ministerial Decree 26/06/2015 sets the performance requirements for building elements (i.e. U values, of the building envelope), according to climatic zones.

Table 3.3 reports a synthesis of these technical prescriptions with references to the mandatory values for energy renovations of buildings from 2021 onward.

Climatic Zone	HDDs	External Walls (W/m^2K)	Roof (W/m^2K)	Floor (W/m^2K)	Windows (W/m^2K)
A-B	0-900	0.40	0.32	0.42	3.00
C	901-1,400	0.36	0.32	0.38	2.00
D	1,401-2,100	0.32	0.26	0.32	1.80
E	2,101-3,000	0.28	0.24	0.29	1.40
F	>3,001	0.26	0.22	0.28	1.00

Table 3.3 – Minimum requirements for energy renovation of buildings from 2021 onward from DI 26/06/2015

The Decree also sets minimum requirements for heat pumps. In particular for an air-air heat pump the minimum coefficient of performance (COP) is 3.5 (by considering dry air internal and external temperature respectively equal to 7 and 20 ℃), whilst for a water-water heat pump the minimum COP is 4.2 (by considering water internal and external temperature respectively equal to 10 and 30℃).

Table 3.3 presents the climatic zones of the country, ranging from Alpine conditions in the northern part to Mediterranean in South Italy. In between, several intermediate conditions can be found.

Both technical requirements and efficiency targets need to be adapted to the specific climate conditions of each region.

Potential

The Italian territory can be divided in five macro-areas which share geographical, climatic, cultural and economic conditions: North West, North East, Centre, South and Islands. This geographical segmentation can be used to analyse the residential renovation market. A first driver to consider for the evaluation of the market´s potential is the number of dwellings in each geographical area, depicted in Figure 3.15.

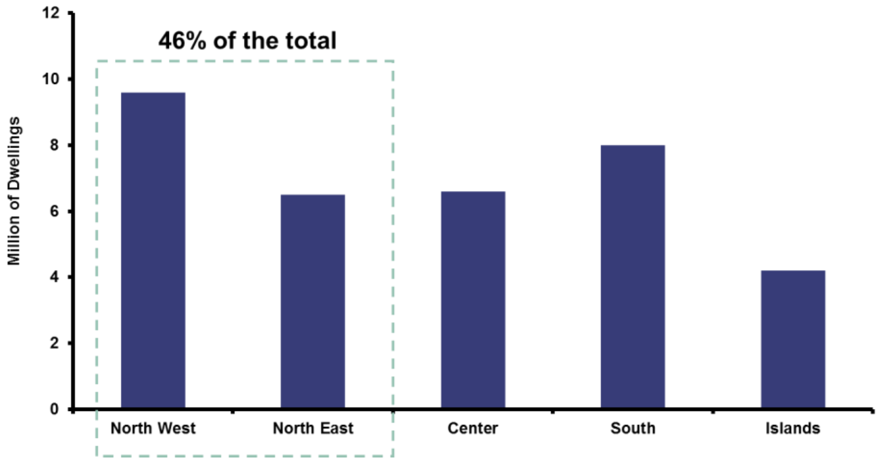


Figure 3.15 - Distribution of the dwelling stock in 2017 (Italian Territorial Agency, n.d.)

The North West and North East of the country gathers 46% of the building stock. This is of fundamental importance, since climatic conditions in the northern part of the country are much more severe, therefore generating a larger focus on achieving energy savings over winter.

Figure 3.16 shows that similar numbers can be observed in terms of population distribution within the country. In fact, 46% of the population is concentrated in the northern part of Italy.

This phenomenon is due to the fact that most of the productive activities and businesses are concentrated there, which caused an internal migration from other parts of the country.

In terms of critical mass of people to reach, market size (e.g. number of dwellings) and market features (e.g. high cost for winter heating), North Italy represents the most attractive macro-area for companies interested in developing energy efficiency services for the residential market.

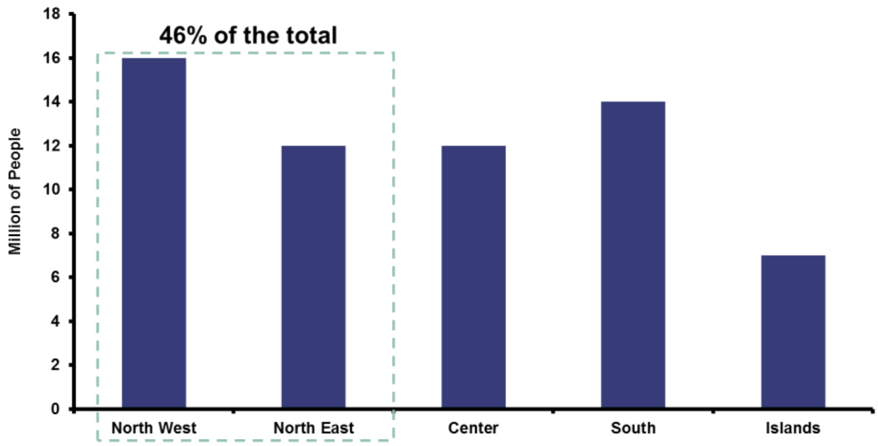


Figure 3.16 - Territorial distribution of the population in 2017 (ISTAT, n.d.)

The third variable to consider when assessing the market potential for renovation is the spending capacity of families. Figure 3.17 indicates that the average earnings in the North-West and North-East Italy is 10% higher than the country average and 30% higher than in Southern Italy.

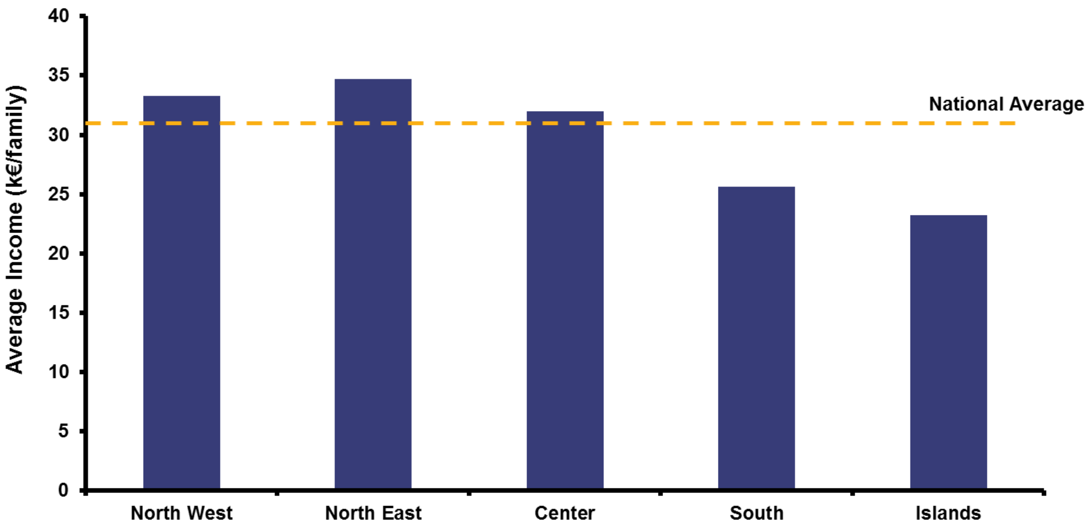


Figure 3.17 - Distribution of the average family income (Source: ISTAT)

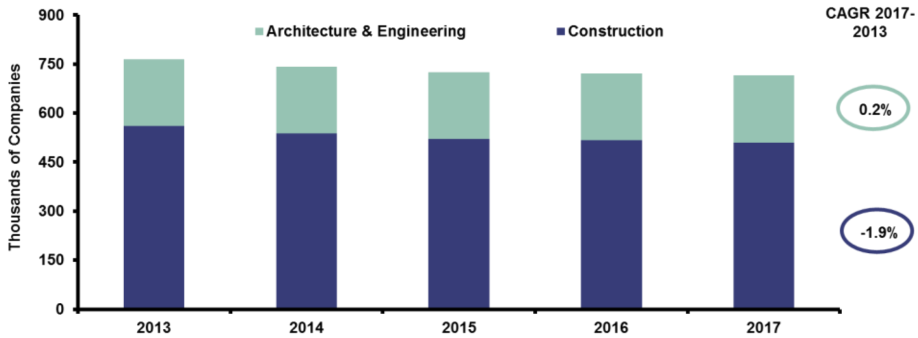
The analysis of the dwelling stock, population, climatic conditions and average income distribution highlights that the northern part of Italy is the most attractive macro-area for the development of energy efficiency services in the residential sector. As a result, there is room to develop and propose innovative energy efficiency services, from both technical and financial point of views.

Evolution of the sector

Companies involved in the energy renovation can have very different nature, but two main categories can be identified: construction companies and architecture & engineering firms.

Construction companies perform building retrofitting including the building envelope, as well as HVAC systems. Architecture & Engineering firms, on the other hand, provide the identification and design of the interventions.

Figure 3.18 illustrates the trend in the number of companies in the period 2013-2017 which is approximately 750k.



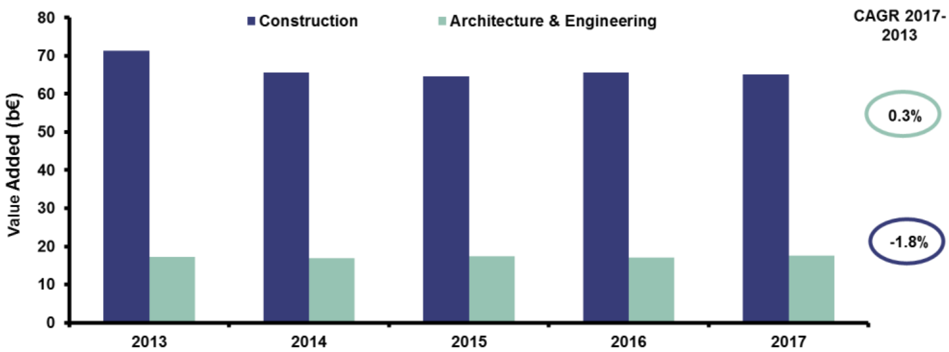
Employees per company	2013	2014	2015	2016	2017
Construction	2.6	2.5	2.6	2.6	2.6
Architecture & Engineering	1.4	1.4	1.4	1.4	1.4

Figure 3.18 - Evolution of companies involved in the retrofitting business (Eurostat, n.d.)

The decreasing trend is associated to the average decrease of 1.9% per year of construction companies. This negative performance is due to the economic downturn which affected the construction sector during the last years, particularly severe for new construction.

On the contrary, Architecture and Engineering firms show an upward trend with a slight increase in number of companies of 0.2% per year. This is attributable to a higher degree of flexibility with respect to construction companies.

Furthermore, it can be observed that the average size of both construction and Architecture & Engineering companies is quite small. In fact, construction companies employ, on average, a little over 2 people, while Architecture and Construction companies employ 1.4. Hence, the number of one-person companies is high.



Share on the total VA	2013	2014	2015	2016	2017
Construction	4.9%	4.5%	4.3%	4.3%	4.2%
Architecture & Engineering	1.2%	1.2%	1.2%	1.1%	1.1%

Figure 3.19 - Economics of companies involved in the retrofitting business (Eurostat, n.d.)

The trend illustrated by the number of companies goes hand in hand with the evolution of the economy. In fact, a reduction on the added value of construction companies is observed with an average yearly rate of -1.8%.

On the contrary, Architecture & Engineering firms show an average increase of the value added of 0.3% between 2013 and 2017.

These values should be compared with the average growth rate of the total national added value, which is equal to 1.8% per year. Based on this, it can be said that construction sector was particularly affected by the economic crisis; even though the impact on the architecture & engineering firms was much lower, they underperform with respect to the Italian economy.

This is confirmed by the fact that in 2013 the added value of the construction sector represented approximately 5% of the total, whereas in the 2017 this share was reduced to around 4%. The share on the total of engineering and construction companies remained relatively constant over the reported period.

Utility companies

According to EU regulation, the Italian utility market is a completely liberalized and customers can freely choose their supplier. This has allowed many companies to enter the market, offering different levels of service.

Furthermore, it is supposed that during the next years there will be a trend towards the *"servicitacion"*[28] of the energy supply (Bianco, 2018). Hence, the services connected with the energy supply, (e.g. electricity, natural gas, heat) such as energy efficiency, will become more and more central.

Over the last five years (2013-2017) the number of retailers working in the Italian electricity and natural gas sector increased (ARERA, n.d.).

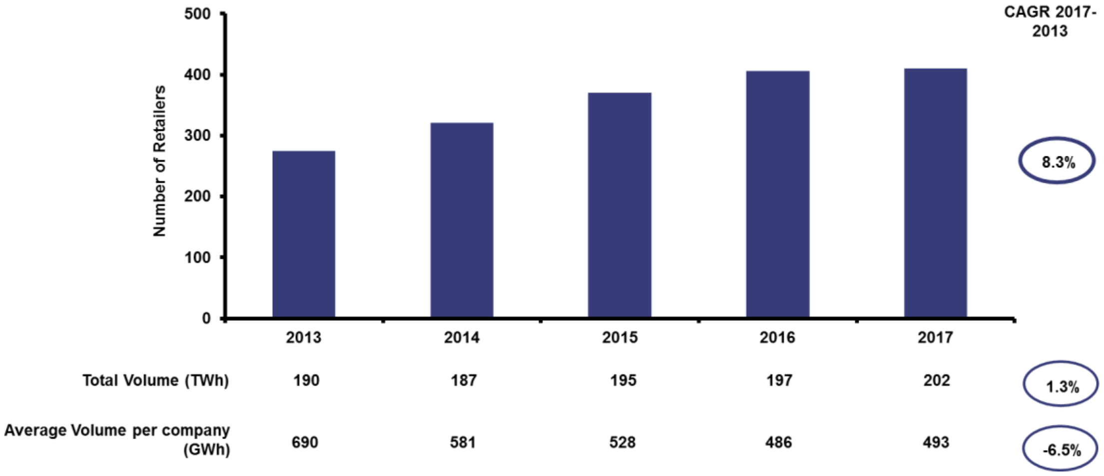


Figure 3.20 - Evolution of electricity retailers (Source: ARERA)

The number of electricity retailers increased at a pace of 8.3% per year in the period 2013-2017 as shown in Figure 3.20. The marketed volume of energy experienced and average increase over the same period of 1.3%.

On the other hand, the market became much more competitive, as there was a reduction of 6.5% per year of the volume supplied per company. This means that the increase in the number of companies is greater than the market expansion. Therefore, the concurrency to obtain clients is very aggressive. In this situation, one of the main line of actions is the proposition of different Value-Added Energy Services (VAES) in conjunction with energy supply.

A similar situation is observed in the natural gas market, where the number of retailers over the last five years (2013-2017) increased at a pace of 7.3% per year, as illustrated in the Figure 3.21.

[28] *Servicitacion* can be defined as the tendency to develop energy supply as a service not only linked with the selling of commodities (e.g. electricity, natural gas, heat, etc.), but also with more value-added services such energy storage, electric cars, energy efficiency, etc.

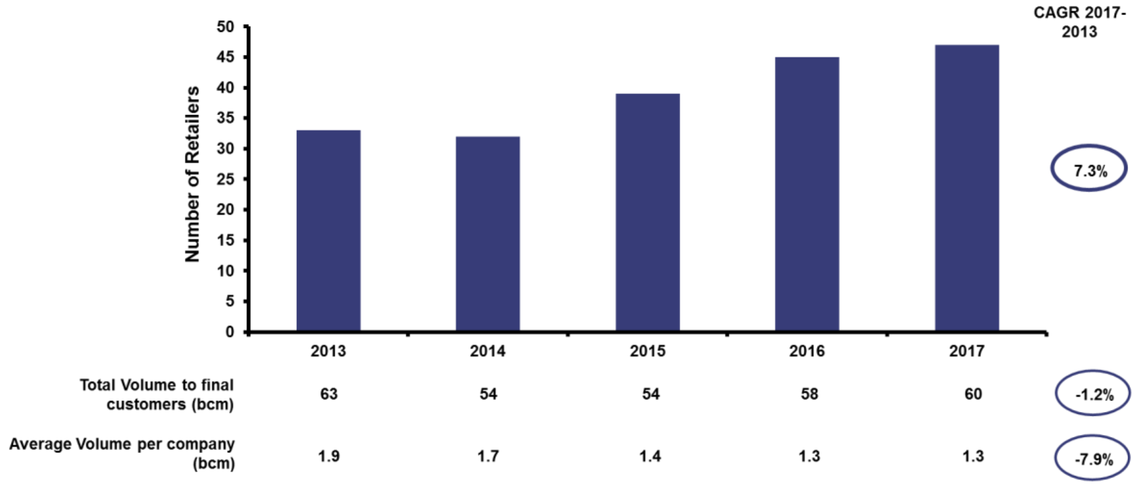


Figure 3.21 - Evolution of the natural gas retailers (ARERA, n.d.)

Figure 3.21 also highlights the relevant average reduction (7.9% per year) of companies' traded volumes. This trend can be explained by the reduction on natural gas consumption and the increase in the number of retailers.

Reduction of consumption is mainly due to the energy efficiency measures pushed during the last few years by EU and Italian energy policies, as well as to the switching of a share of the consumption from natural gas to the electricity market. For example, winter heating can be partially provided with electric heat pumps, especially in areas with mild winter conditions.

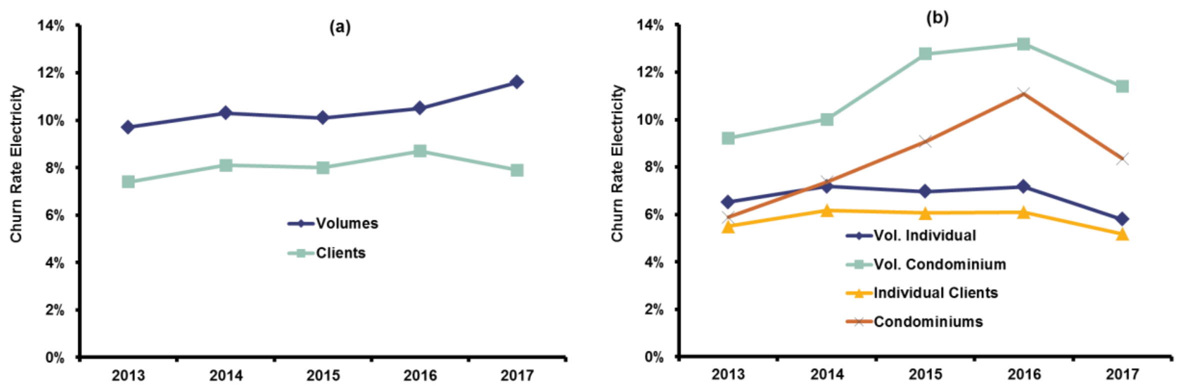


Figure 3.22 - Churn rates in electricity (a) and natural gas (b) market (ARERA, n.d.)

Values of churn rates for electricity and natural gas supply for residential customers, shown in Figure 3.22, demonstrate the relevant level of concurrence of the sector.

In general, the churn rate calculated in terms of volumes is higher than the one measured in terms of clients. This means that clients with a high level of consumption are much more sensitive to commercial incentives and prompt to change. This is true for both the electricity (a), and natural gas (b) markets.

For the natural gas market, churn rates of condominiums are higher than those of individual customers. This behaviour might be explained because condominiums are administrated by professionals, who extensively scrutinize the best available commercial offers year by year which are then presented to the condominium owners. This process leads to higher churn rates. The trend is particular of the natural gas sector, since in the presence of central heating, the natural gas bill for the condominium during the winter season can be very expensive, especially if it is located in areas characterized by harsh winters (e.g. North-East or North-West Italy).

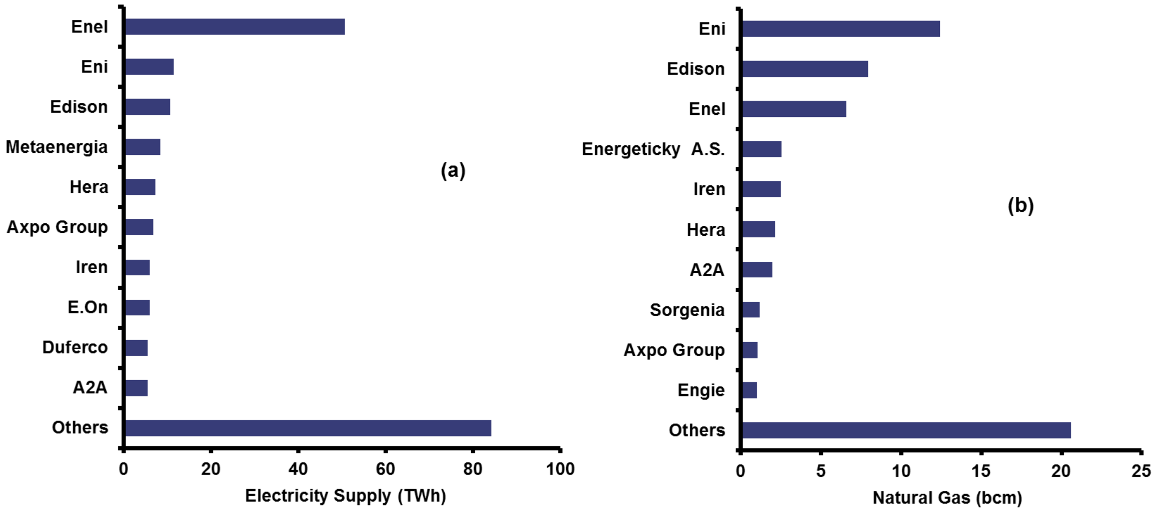


Figure 3.23 - Energy supply from the main retailers in 2017. Electricity (a) and natural gas (b). (ARERA, n.d.)

Finally, Figure 3.23 represents the first ten retailers for the electricity (a), and natural gas (b), operating in the Italian market. Most of the companies are fully private, whereas some of them, e.g. Hera, Iren, A2A, etc. have a minor public participation. Other operators of the market such as Enel and Eni, which were the two former monopolies in the electricity and natural gas market respectively, are characterized by an indirect state participation by means of stakes owned by the national bank of investments, i.e. Cassa Depositi e Prestiti.

Both markets are typified by the presence of many small operators, which are often active on a local basis. On the other hand, it can be observed that in 2017 the first ten operators represent 58% of the volume of the electricity market and 66% of the natural gas market.

The dominant position of the incumbent utility, i.e. ENEL, persists on the electricity market at national level. At local level, there are some "local incumbents", e.g. IREN in Piemonte and Liguria regions, A2A in Milan and Brescia areas, Hera in Emilia Romagna region, etc. The same observations can be made for very small operators at city municipality level.

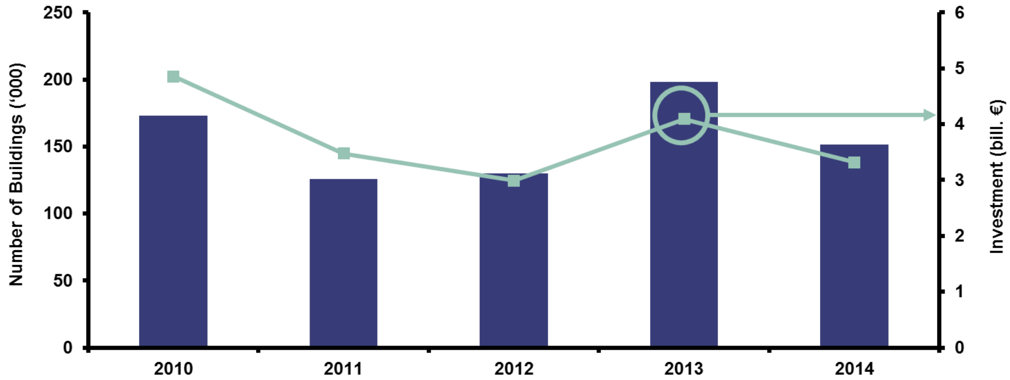
The presence of the incumbent, Eni, is also detected in the natural gas market, but its position in terms of volume is less dominant if compared with the incumbent in the electricity market.

Energy renovations in residential buildings

Italian governments have paid considerable attention to the issue of energy renovation of existing buildings, and incentives for the retrofitting have been in place for many years.

The main instrument to support retrofitting is via tax discounts. Through this, the amount of money invested in energy retrofitting of a residential building (in total or in part) can be deducted from the yearly taxable income. Regulations for such mechanism have changed over the years, but the principle remained the same.

It can be safely assumed that most investments in energy retrofitting went through this mechanism, which enables to track them. There will be with some delay though, as taxes are paid one year later, and some additional time is spent in processing the data.



	2010	2011	2012	2013	2014
Total Tax Discount (M€)	534	191	165	256	215
Unitary Investment (€/m²)	72	70	59	52	55

Figure 3.24 - Investments in energy renovation of buildings (Italian Territorial Agency, n.d.)

Figure 3.24 reflects the fact that between 100,000 and 200,000 buildings per year have been renovated in Italy in the period 2010-2014, with a variable investment between €3 and €5 billion per year. In total, about 2.6 million interventions were executed in the period 2010-2014 corresponding to approximately 300 million m^2 and referred to a total of approximately 780.000 buildings.

The tax discount represented just 5%-10% of the invested amount. This shows that with a little stimulus is possible to mobilize relevant amount of capital to invest in energy retrofitting.

These figures highlight the potential of the residential buildings' energy renovation market and the consequent advantages to be obtained in terms of energy efficiency, carbon footprint, but also urban regeneration and general well-being.

3.4 Potential Impact of Building Energy Renovations

National energy consumption

Italy is one of the largest energy consumers within the EU, ranking fourth after Germany, France and UK. Italy is poor in primary energy sources, therefore most of them, especially oil, natural gas and coal, are imported from other countries.

In particular, a wide natural gas network is present in the country both at distribution level as well as connection via pipeline with producing countries.

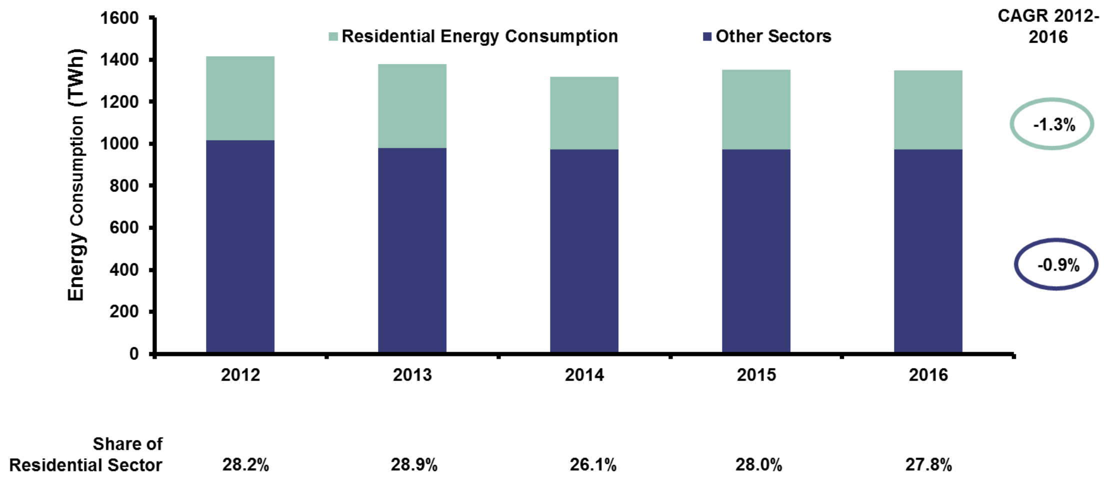


Figure 3.25 - Energy consumption (Eurostat, n.d.)

Over the period 2012-2016, a reduction on consumption was registered. In particular, the residential sector showed a decrease at an average yearly pace of 1.3%, whereas the other sectors decreased the consumption at an average rate of 0.9%.

This negative trend is caused by the joint effect of different factors: economic downturn, climatic factors and the implementation of energy efficiency measures.

Representing about one third of total energy consumption, residential sector is crucial to implement effective energy efficiency policies, as it offers untapped potential to exploit.

Potential of energy savings

The estimated baseline for Italy foresees an increase of consumption of 66 TWh between 2016 and 2030, growing at an average pace of 1.2% per year. Two main factors are responsible for this increase, rise of the total dwelling surfaces and growth of the economy which fosters consumption.

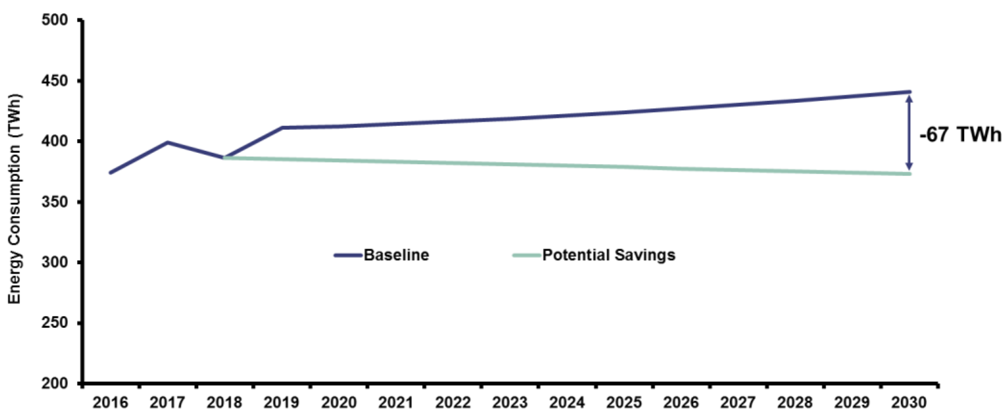


Figure 3.26 - Estimation of the baseline and of the potential savings (Eurostat, 2020) (World Bank, n.d.)

According to the Italian Integrated National Energy and Climate Plan (MISE, MATTM, & MIT, 2018), average savings of 0.3% per year can be achieved through the implementation of targeted policies aiming at supporting the renovation of residential buildings, starting from 2019. In particular, the following actions will be implemented: tax rebates, white certificates and energy accounting.

The implementation of these measures is expected to generate savings up to 67 TWh (i.e. 15%, in 2030 with respect to the baseline scenario). This target seems credible, even prudential, since deep renovation of buildings are expected to obtain 60% of savings. Moreover, In the northern part of the country, this level of savings is relatively easy to achieve if old buildings are renovated.

As shown in Figure 3.26, the trend of residential energy consumption in the 2012-2016 period seems to be in line with set targets. The key-role will be played by the supporting measures to energy efficiency, especially tax discount. If support to energy efficiency interventions is lightened the target´s achievement will be at risk.

Data on the Italian tax rebate programme (see next section 2.5) demonstrate that small stimulus can provoke a relevant market reaction with a multiplier in terms of investment volume equal to 15 (e.g. ratio between final investments and incentives given in the form of tax rebates). This demonstrates that the market is quite sensitive to appropriate support mechanisms, which are necessary.

The introduction of other financing/support may also help speed up the trajectory towards the accomplishment of the targets.

Potential market impact

To reach the expected energy efficiency target, it is necessary to mobilize an appropriate amount of capital to invest in related energy efficiency measures.

The estimation of the total amount of capital is complex given the heterogeneity of the efficiency measures (ranging from installation of new boilers or heat pumps to the refurbishment of buildings envelope by adding an insulation layer).

A top down approach to provide a rough estimation of the total capital that needs to be mobilized can be done considering the value of white certificates, which are awarded for each toe of saved energy.

On the Italian market, the initial value of the white certificate was set at 100 €/toe (AEEG, 2006), which approximately corresponds to 8.6 €/MWh. It can be assumed that the value of the white certificate represents a good proxy of the necessary capital to obtain an energy saving of 1 toe.

On the basis of this assumption, the total necessary capital to obtain an energy saving equal to 67 TWh in 2030 is €580 million in 2018. If the investments start in 2019, it is necessary to mobilize an amount of approximately €50 million per year for the next 12 years, according to trend shown in Figure 3.27.

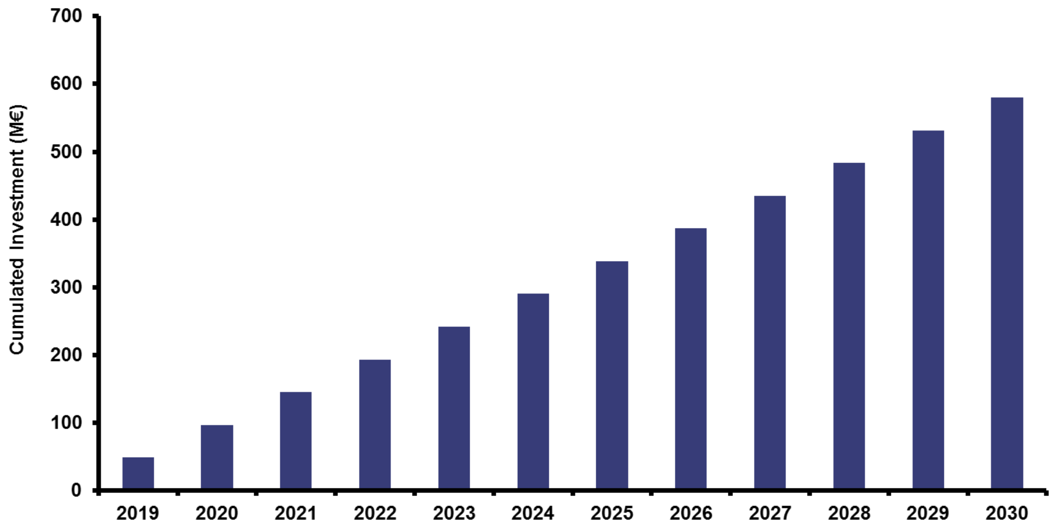


Figure 3.27 - Estimation of necessary investment volume. UNIGE analysis

A rough estimation of the impact of this volume of investment in the job market can be obtained by considering that the value added per employee in the construction and engineering sector ranges between 49 k€/head and 59 k€/head. Therefore, if an investment of €50 million per year is foreseen, it is possible to say that approximately 1,000 jobs will be created.

This estimation is quite coarse but provides the order of magnitude of the expected impact in terms of new jobs. Other variables to take into account are all the activities related to maintenance of the energy efficiency interventions, as well as the negative impact for utilities reducing the amount of energy sold.

Other possible effects are due to the reduced environmental impact as consequence of the implementation of the energy saving measures. In particular, it is possible to estimate the amount of equivalent saved carbon emissions and the corresponding externality costs saved (Friedman, Becker, & Erell, 2014), as shown in Figure 3.28.

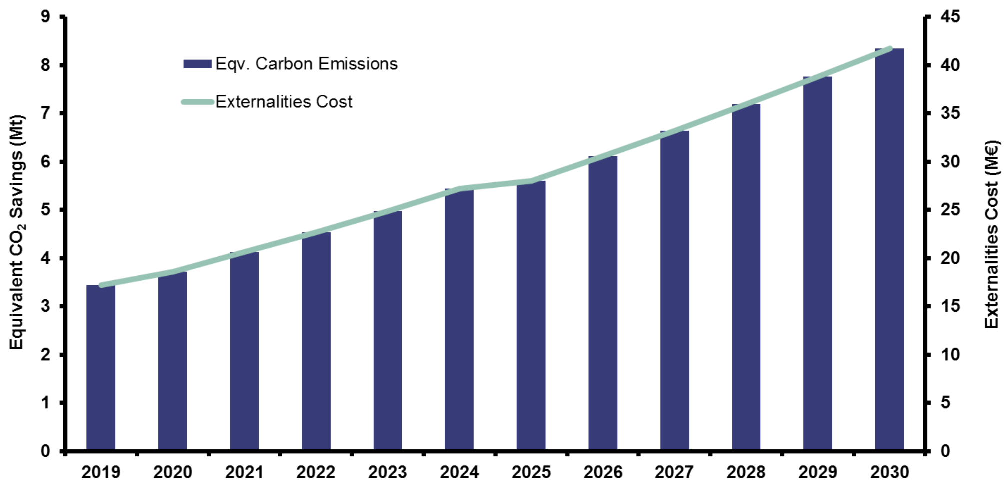


Figure 3.28 - Saved carbon emissions and externalities

Figure 3.28 highlights the relevant social value that energy efficiency investments have , which can be estimated in approximately €40 millions of savings in externalities in 2030 (e.g. reduction of sanitary expenses for reduced pollution, etc.). These savings are obtained from the state budget and can be invested in other initiatives of social interest.

3.5 Financing the Energy Renovation of Buildings

Introduction

Private financing market is not yet well developed and classical instruments, such as loans, are typically supporting energy efficiency interventions. Depending on the specific bank or financial institution, loan products may exist for energy renovation. Usually, they are connected with targeted financing lines available on secondary markets and provided by supra-national institutions, such as the European Investment Bank.

Another form of financing energy efficiency intervention is through ESCOs that provide energy services to final clients, e.g. implementation of energy saving measures in condominiums by Energy Service Agreements (ESAs). By these means, banks or financial institutions have a relationship with the ESCOs and only indirectly with the final clients.

Currently, it seems that in Italy the most consolidated approach to finance energy efficiency measures are the public incentives complemented with own resources or by traditional loans. This is especially true for single interventions, such as windows substitutions, installation of efficient boilers or heat pumps.

At condominiums level, the measures (e.g. installation of insulators on the external envelope), are often implemented with the support of an ESCO.

This analysis highlights the lack of a structured presence of the financial sector in the energy renovation business. This is mainly due to the fragmentation of the market which is represented by a large amount of small investments which are complicated and expensive to manage by banks. Thus, cooperation between energy operators (e.g. utilities, ESCOs, etc.) and financial institutions appears fundamental to promote energy renovation in the Italian residential sector.

Public support Programmes

Governments play a crucial role in promoting energy efficiency and leveraging more investments in the building sector. The Italian government promotes them with several incentive tools (MISE, MATTM, & MIT, 2018):

- Grants at regional (Programma Operativo Regionale - POR) or national level (Programma Operativo Nazionale - PON) mainly financed by European funds;
- Tax incentives in forms of tax deductions;
- Energy accounting for supporting generation of renewable thermal energy, as well as energy efficiency improvements in public buildings;
- Italian national fund for energy efficiency.

Grants

Grants for the implementation of energy efficiency measures in buildings are available at regional level in the framework of the Operating Regional Programmes (Programma Operativo Regionale - POR) or at national level within the National Operating Programme (Programma Operativo Nazionale - PON).

Each regional authority sets the priorities regarding energy efficiency measures to be included in the POR.

If included in the POR, the financing measures are accessible by submitting a project proposal which is then evaluated by regional commissions. Selected projects are financed or co-financed (around 50%-60% of the investment cost).

PON financing is not intended to support energy renovation on large scale, but to stimulate the development of pilot sites which can act as demonstrators for implementing innovative measures which, for example, are not cost effective at the moment.

Similar to POR, pilot projects for residential need to apply to the Programme, usually submitting a project proposal on behalf of a consortium with companies, universities, etc.

Altogether, POR-PON Programmes represent only a residual part of the energy renovations financed with public support.

Tax rebates/ incentives

Tax deductions for energy efficiency renovation of buildings were introduced for the first time in Italy in 2007. This measure was proven to be very successful with 2.9 million of interventions implemented till the end of 2016, with end-use energy savings amounting 1Mtoe/year and an equivalent amount of avoided carbon emissions corresponding to 2Mt/year.

Individuals, companies and professionals can benefit from the tax deduction if energy efficiency measures for improving energy performance of buildings are implemented.

The measures supported by tax deductions include the improvement of thermal insulation of the buildings envelope (i.e. walls, floor, roofs and windows), installation of solar thermal panels, improvement of the winter heating system, installation of heat pumps and installation of buildings automation systems.

The deduction adds up to 50% for installation of new windows and high-performance boilers, 65% for installation of heat pumps, building automation, thermal solar panels, wall insulation. The level of deduction increases at 75% if the interventions are implemented at condominium level.

Those who are not subjected to income tax can transfer their deduction to another, including banks and financial intermediaries. This serves to increase the involvement of private operators, which, in such a way, may enter the energy renovation market.

The tax deductions are expected to contribute to the 2030 target for energy efficiency in buildings in the amount of 18.15 Mtoe.

Energy Accounting

Energy Accounting 2.0 is a policy measure aiming to support the development of thermal energy generation from renewable sources and energy efficiency renovation in public buildings. Social cooperatives and entirely public companies can obtain the same energy accounting treatment reserved for public administrations.

The scheme is conceived to stimulate interventions in the civil sector, which includes residential, tertiary and public sub-sectors.

The incentives are aimed at substituting and replacing old inefficient devices for heating and lighting, improving the building envelope performances and increasing automation systems within the buildings. Furthermore, the installation of solar thermal panels is supported.

Incentives are given in the form of repayment up to 40% for thermal insulation expenditure, up to 65% for taxes and equal to 100% for energy certification of public administration buildings.

This measure is supposed to contribute to the 2030 target for energy efficiency in buildings for an amount of 3.85 Mtoe.

Italian National Fund for Energy Efficiency

This fund aims at stimulating investment on energy efficiency implemented by companies and public administrations. The promotion of cooperation with financial institutions and private investors on the basis of an equal sharing of the risks is also supported.

Measures supported by this fund include energy efficiency of industrial processes, expansion of district heating/cooling networks, public lighting and energy retrofitting of buildings.

The funds are accessible to companies, including ESCOs, which can implement the interventions. The incentive is given in the form of loans at reduced rates with respect to market prices. Loans can be also provided with the intermediation of financial institutions.

The goal of this measure is double, to support energy efficiency interventions and to promote the involvement of financial institutions in the energy retrofitting market, in order to increase the private initiatives.

This measure is supposed to contribute to the 2030 target for energy efficiency in buildings for an amount of 2.75 Mtoe.

Impact of public support Programmes

Public support Programmes demonstrated to be quite effective in the Italian renovation market. Especially, tax incentives had a relevant success also because they can be combined with incentives for structural retrofitting in seismic areas.

According to the Italian Integrated National Energy and Climate Plan (MISE, MATTM, & MIT, 2018) objectives, a relevant share of energy efficiency in buildings will be obtained by the implementation of public support Programmes.

The main obstacle to the successful implementation of public support mechanism is the excess of bureaucracy and administrative duties which prevent final users from applying to these Programmes.

This is especially true for individuals who often need the assistance of private consultants to apply for incentives. This creates a barrier to access the support mechanisms, which, in practice, have an access cost.

When the mechanism is conceived in a smooth way, as is the case of tax discount, the response from the market is quite positive.

Private financing schemes

The drive for energy efficiency is about attracting private capital. Public financing may provide the ground for initial investments, but a well-developed, specialized market for financing energy renovations is still necessary. Despite that Italy has not achieved that level yet, there are some private financing initiatives that will be analyzed below.

White Certificates

White certificates represent mandatory energy saving schemes for all electricity and natural gas distributors with more than 50,000 customers. The certificates are tradable assets which accredit the reduction of final energy consumption as the results of the implementation of energy efficiency measures (MISE, MATTM, & MIT, 2018).

The economic value of the white certificate was originally fixed at 100 €/Toe, but then changed according to market developments. The obligated parties must deliver a number of certificates according to the energy savings targets every year (MISE, MATTM, & MIT, 2018).

These certificates can also be issued to ESCOs or other accredited companies. These entities may obtain an extra-advantage by selling white certificates on top of the energy savings (MISE, MATTM, & MIT, 2018).

Own Resources

As commented before, most of the incentives given by the Italian government only cover part of the investment costs. Due to this, other sources of financing become necessary to support energy efficiency investments. People willing to invest in energy efficiency understands that public incentives will not be enough, and the most common options to finance the remaining part are own resources and traditional bank loans.

Individuals often decide to use their own resources to avoid any kind of constraints and obligations towards third parties, also because the cost of financing can be considerable high, especially if added to other loans, such as mortgages.

Loans

Traditional bank loans represent the most common source of financing after own resources. Most of the banks do not offer dedicated instruments for implementing energy efficiency solutions, because this business sector is often perceived as a high-risk business. Financial institutions are not really interested in its development, especially when the counterpart is a private client.

Traditional loans can be obtained for energy renovation of dwellings and usual warranties are required, such the dwelling itself, other assets, insurance instruments, etc.

4 LITHUANIA

4.1 Executive Summary

According to official statistics (Lithuania Department of Statistics, 2019) in 2018 there were 1,451,500 dwellings in Lithuania; 97.9 % of which were privately owned and 2.1% owned by the Government or the municipalities. **Slightly more than half (59%) of the country's population lived in multi-apartment buildings and 41% in one-dwelling houses**. 75 % of dwellings were constructed in the period before 1991 according to the Soviet-era building codes. All these buildings are low energy efficiency class (E, F class) due to the fact that it was in 1992 when a new, stricter regulation for construction was implemented**.** Later, the requirements for energy performance of new homes were further tightened to comply with the ones introduced by EU directives.

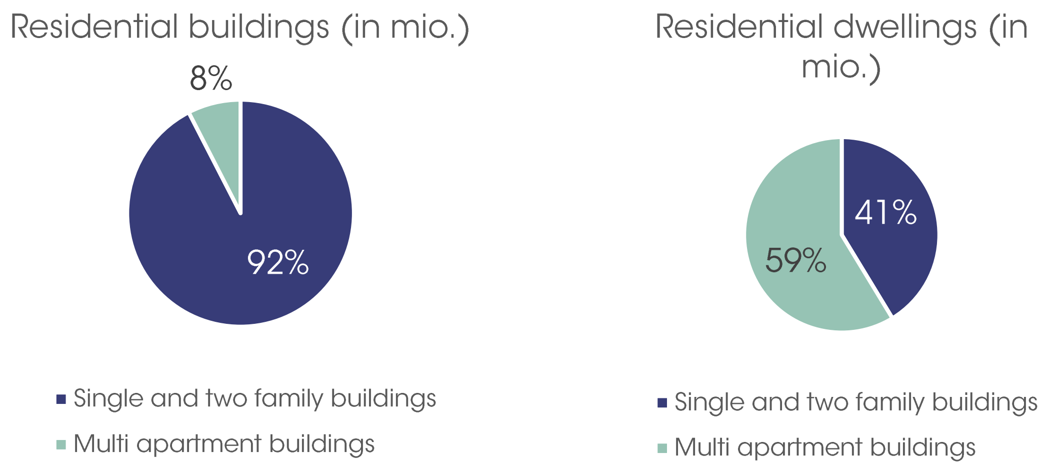


Figure 4.1 - Residential buildings (left) and residential dwellings (right). Lithuanian residential building sector (Lithuania Department of Statistics, 2019)

Most publicly available information about the Lithuanian residential sector is related to multi-apartment houses. Heat demand in these buildings typically decreases between 50 and 60% after renovation. The multi-apartment buildings built before 1992 hold the greatest potential to reduce energy consumption and increase energy efficiency to reach European targets.

Regulatory and policy instruments such as the **National Energy Strategy and Government Programme for multi-apartment building renovation** consider renovation as a driver to increase energy efficiency in residential buildings. The Government encourages deep renovation (including new envelop and new engineering systems) so that maximum efficiency is achieved. By the summer of 2020, a **national long-term building renovation strategy** should come to light.

Young, average-income families prefer new houses in the suburbs. This fact raises new urbanistic challenges since these areas are usually not well developed in terms of services and infrastructures (public transportation, kindergartens and schools etc.). Upgrading the city´s apartment buildings can help to reverse this trend. In smaller cities, assuming a positive trend in job creation, this may prevent young people from migrating to major cities or to Western European countries.

District heating (DH) and natural gas networks are consolidated markets in Lithuania. Pilot projects for renovation at district level, which involves comprehensive renovation of the city infrastructure (engineering networks), are in progress. By law, district heating companies are only allowed to provide heat supply (additional services such as energy management create a conflict of interest).

National funding programmes for multi-apartment buildings offers subsidies for project development and soft loans for construction works, as well as grants for low income earners. Under these programmes Lithuania´s Government intends to **deeply renovate 500 apartment buildings** every year, which is still a low rate considering the large amount of apartment buildings in need of major overhaul regarding their energy-efficiency measures. Nothing similar exist at municipal level. There is a single-family building renovation support programme, however, its budget is quite limited.

Government support for apartment renovation projects, currently covering about 30% of construction works and loan repayments for low-income citizens, is a crucial factor for apartment owners when deciding if a deep apartment renovation project should be started. Given that there are about 44,000 apartment buildings in Lithuania and at least 75 % need renovation, the renovation rate still insufficient.

4.2 The Residential Building Sector

Introduction

Lithuania has 2.8 million inhabitants, density equals to 42.8 people/km^2 (Lithuanian Department of Statistics, 2020). Being a small country, with a 65,286 km^2 territory, climatic differences are negligible. However, density in urban and rural areas is quite different, as 67 % of population live in cities and 33 % in rural areas.

Currently reliable statistics related to buildings are scarce. As a matter of fact, the Ministry of Environment has recently launched a public tender to develop a long-term strategy for building renovation, being the collection and analysis of data on existing buildings one of the main tasks. This task is planned to be accomplished by May 2020.

Years	Thousands of dwellings	%
Before 1919	55,9	4,1
1919 - 1945	29,6	2,2
1946 - 1960	96	7,1
1961 - 1970	300,9	22,3
1971 - 1980	311,6	23,1
1981 - 1990	237,1	17,6
1991 - 2000	132,5	9,8
2001 - 2005	139,5	10,3

Table 4.1 - Dwellings by period of construction in Lithuania in 2011 (Lithuanian Population and Housing Census, 2011)

The latest available data in terms of buildings was published by the Lithuanian Population and Housing Census of 2011, published in 2013. The table above provides data on the construction distribution of residential buildings.

Residential buildings

By 2011, slightly more than half (59%) of the country's population lived in multi-apartment buildings and 41% - in one-dwelling houses in Lithuania (Lithuanian Population and Housing Census, 2011).

Figure 4.2 - Residential buildings (left) and residential dwellings (right). Lithuanian residential building sector (Lithuania Department of Statistics, 2019)

The government programmes are primarily focused on the renovation of Soviet-type multi-apartment blocks built before 1992, which have a very low energy efficiency classification (E, F class).

When renovating apartment buildings in Lithuania, it is mandatory to achieve at least a C energy label. As a result, even the homes that have been renovated in the last 10 years are C-class. Since 2018, the Lithuanian government has been promoting Class B renovations, which has led to an increased number of B-class buildings, but this is not mandatory. Therefore, there currently are different requirements for newly built homes (A +) and renovated homes (C).

Residential ownership models and affordability of energy bills

The ownership situation of the apartment buildings in Lithuania was greatly influenced by the fact that, during the Soviet era, the State was the owner of the apartments. After Lithuania regained its independence, it was decided to allow the privatisation of the apartments, and the people living in the apartment had priority to ownership. Since then, the "one apartment – one owner" policy was implemented. On the one hand, this means that the state does no longer have the obligation to oversee a huge apartment building sector, and apartment owners have a far more effective handle over their property. On the other hand, having a large number of apartment owners means that agreeing on home maintenance or renovation interventions constitutes a long and difficult process.

There is no specific law on rentals in Lithuania and apartment owners often do not register their contracts when renting apartments, in a manoeuvre to avoid taxes. Therefore, there are no reliable statistics on the number of rented apartments.

For the homeowners connected to the DH network, the main energy bills are from DH and electricity suppliers. Expenses for heating very much depend on the house´s condition. For single-family houses, heat is usually produced with solid fuels (wood, coal) or natural gas. Homes built in the last decade have usually been equipped with natural gas heating systems or heat pumps, which are easier to maintain and provide greater comfort. In smaller cities, citizens with lower incomes are keener to save on their energy bill so they opt for firewood, as it is the cheapest fuel (not taking into account the time needed to operate heating appliances, that requires a lot of handmade work). Electric heating is rare because the cost per kWh is several times higher than other heating alternatives.

The volume of municipal (social) housing in Lithuania is quite low. Municipalities in most cases purchase separate flats in the multi-apartment houses and hand them over to low-income population. Public authorities try to avoid the concentration of social houses since that may cause quick depreciation of their real estate assets.

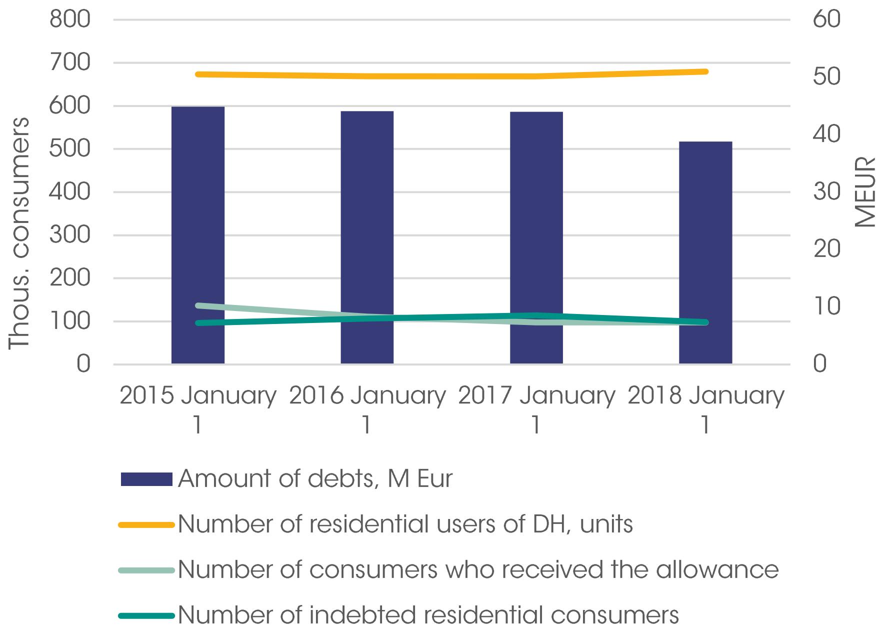


Figure 4.3- Debts for heat provided for DH consumers in Lithuania (The Lithuanian District Heating Association (LDHA), 2018)

Consumers' ability to pay their energy bills can be assessed by statistics on the highest bill by energy use; referring to the heat bill (heating and hot tap water). Statistics on residential consumers of DH and their debt to DH companies are shown in Figure 4.3 (The Lithuanian District Heating Association (LDHA), 2018). The graph depicts the number of DH residential customers that receive a state allowance to pay for their bill. As shown in the figure, the amount of accumulated consumers debt is gradually decreasing. This is related to the improving economic surge and the increase in consumer’s income.

4.3 The Residential Building Renovation Market

Introduction

Several factors substantiate the need for multi-apartment house renovations in Lithuania.

The first one being the high level of energy consumption for space heating. Between 1965 and 1990, when most apartment buildings in Lithuania were designed and built, the regulatory requirements for the thermal resistance of buildings envelop were much laxer. An annual building heat consumption of 180-200 kWh/m^2 was considered normal. District heating networks capacities were designed according to that demand. After Lithuania regained its independence in 1991 and changed its economic model towards a free market, energy prices increased dramatically. High heat prices, combined with high heat consumption, led to high energy bills. Even though some families tried to adjust by reducing their use of heating at the expense of comfort or installing new plastic windows, which increases the indoor temperature by 2-3 Celsius degrees, these measures were not enough to offset the price´s increase. Specially because heat loses through poorly insulated walls and roof remained untouched. Currently the average non-renovated apartment building consumes 130 – 150 kWh/m^2 per year. The only way to significantly reduce heat consumption is with the installation of a modern thermal envelope through a complex apartment renovation.

Due to the aforementioned factors, the technical condition of a large part of the building stock is such that renovation becomes necessary. As explained before, most of the apartment buildings in Lithuania were built during the Soviet era, when not only the technical requirements for buildings were softer but also the quality of materials and finishings was less demanding. On top of that, the so-called GOST (Technical standards issued by the Euro-Asian Council for Standardisation, Metrology and Certification) imposed by the Soviet Union, which mandated that apartment buildings must undergo major refurbishment every 25 years were not respected. As a result, the current average age of Lithuanian apartment buildings without overhaul which are still in use is 45 years.

The conclusion is that all homes built before 1992, require deep renovation, upgrading all building engineering systems and installing a new thermal envelope.

The Ministry of Environment, after having conducted expert's consultations, concluded that renovation of individual buildings is inadequate to achieve long-term sustainable urban development, so district perspective is necessary. This approach will allow to undertake deeper renovations, comprising urban engineering systems, including energy supply systems (district heating, electricity, gas networks).

Regulatory framework

Lithuanian regulation	Explanation
Resolution of the Parliament on the approval of a National Energy Independence Strategy (July 2012, last amendment June 2018)	Defines the vision of the Lithuanian energy sector, its implementation principles, strategic directions, goals and objectives. One of the goals is to promote a deep renovation of residential multi-apartment and public buildings (giving priority to the renovation by cities blocks).
Housing Strategy of Lithuania (January 2004 – March 2017)	Taking into account the current housing situation in Lithuania and the principles of housing policy in the European Union, as well as the State Long-term Development Strategy, this strategy sets long-term housing policy objectives and priorities for improving housing legislation, programmes and measures for development and renovation, as well as financial and social assistance for the population. The implementation period for this Strategy end by 2020.
Lithuanian government decree on Renovation programme (September 2004, last amendment January 2019)	Intends to encourage and facilitate the owners of multi-apartment buildings, built in accordance with the technical standards of construction prior to 1993, to renovate multi-apartment buildings in order to increase their energy efficiency.
The Act on Associations of Multi-apartment Homes Owners (March 1995, last amendment January 2017)	Establishes management procedures for the joint ownership of multi-apartment houses, comprehending the establishment, management, operation, reorganisation and liquidation of the homeowner´s association and the rights and duties of the association.
The Act on State Aid for the Renovation of Apartment Houses (July 1992, last amendment January 2020)	Establishes conditions, methods and procedures for the provision of state support for the renovation (modernisation) of apartment buildings.
The Act on Cash Social Assistance for Poor Families and Single Residents (January 2012)	Establishes the principles, sources of financing, rights and obligations of persons receiving social assistance (monetary subsidies). If the multi-apartment house owners have implemented a project to renovate the multi-apartment building, the low-income apartment owner will receive state support to repay the loan.
The Programme of the Government of the Republic of Lithuania (March 2017, last amendment September 2019)	Contains commitments to improve Energy Efficiency. The implementation of at least 500 multi-apartment building renovation each year is foreseen.
Technical Regulation of Construction STR 2.01.02: 2016 "Design and certification of energy performance of buildings" (January 2017, last amendment November 2019)	Applies to the design of heating in residential and non-residential buildings, energy efficiency, the energy performance certification of buildings and the calculation of the capacity of heating system.

Lithuanian regulation	Explanation
Lithuanian Government Decree on the rules for providing state support for renovation of multi-apartment houses (December 2009, last amendment June 2019)	Establishes conditions and procedures for the supervision of the implementation of multi-apartment building renovation projects, state support to apartment owners for the renovation of multi-apartment houses, as well as expenses payment for preparation of the multi-apartment building renovation project.
Description of the procedure for the preparation of multi-apartment building renovation project (November 2009, last amendment January 2020)	Sets out the requirements for content and preparation of apartment building renovation projects.
Lithuanian Government Decree approving the Description of the procedure for the development and implementation of district energy efficiency programmes (June 2016)	Helps select districts within the municipality for preparation, implementation and financing of energy efficiency improvement Programmes within deep renovation projects (to increase the energy efficiency of its buildings and associated infrastructure)

Table 4.2. Relevant Lithuanian regulation regarding building renovation (Legislative register, n.d.)

Potential

Most of the buildings built during the Soviet era can fit in technical projects with shared characteristics. In theory, this would mean that deep renovation projects can be designed levering on economies of scale. However, even apartment buildings built by the same construction project, in the same year, by the same construction company may be in different technical conditions nowadays, depending on how well they have been maintained over decades of operation.

The urban development in Lithuania presents several trends that constitute a quite complex framework. Small towns (1,000 to 10,000 inhabitants) are experiencing a decrease in population as there are no well-paid jobs and young people tend to migrate to larger cities or to Western European countries. In Lithuania, it is usual, for those who can afford it, to purchase their homes rather than rent them. In large cities (Vilnius, Kaunas, Klaipėda) single-family houses are being built in areas near major cities.

Renovated multi-apartment homes in Lithuania are relatively rare. Non renovated soviet-type apartment dwellings have poor quality, but they tend to be located in cities with already developed infrastructure (streets, kindergartens, shopping malls). Out-of-town homes are more recent, but often with very underdeveloped infrastructure - streets are not always paved, lack of kindergartens, schools, public transport, etc. Despite of that, young solvent professionals in the three major cities of Lithuania (Vilnius, Kaunas, Klaipėda) are moving out of the city centre. Presumably, massive a high-quality renovation of Soviet-type apartment blocks would help to reverse this trend.

The Lithuanian Statistic Department indicates that the average disposable income per household in 2018 was 1063 EUR/month. Lithuania is a small country with no significant differences among its territory. When assessing the income gap, attention must be drawn to the differences between large cities, small towns and rural population. In 2018, the average disposable income per household in large cities was 1.299 EUR/month, 897 EUR/month in small towns and 906 EUR/month in rural eras.

On the other hand, many apartment buildings in Lithuania have a rather heterogeneous social composition and usually some of the apartment´s owners have no financial means to afford the cost of deep renovations. This motivated the Lithuanian government to launch a multi-apartment renovation support Programme. The Programme established that, after deep renovation is implemented, all homeowners will receive 30% of the construction work support. Moreover, if an apartment owner in a renovated home can prove that the family's income is insufficient to afford the monthly building renovation bill, it will be paid by the Government.

Evolution of the sector

The Lithuanian construction sector plays an important role in the national economy. However, as illustrated in Figure 4.4, the global economic crisis of 2009 has had a major impact on the construction sector and its contribution to the national economy has fallen from 10 % in 2008 to 5.9 % in 2009.

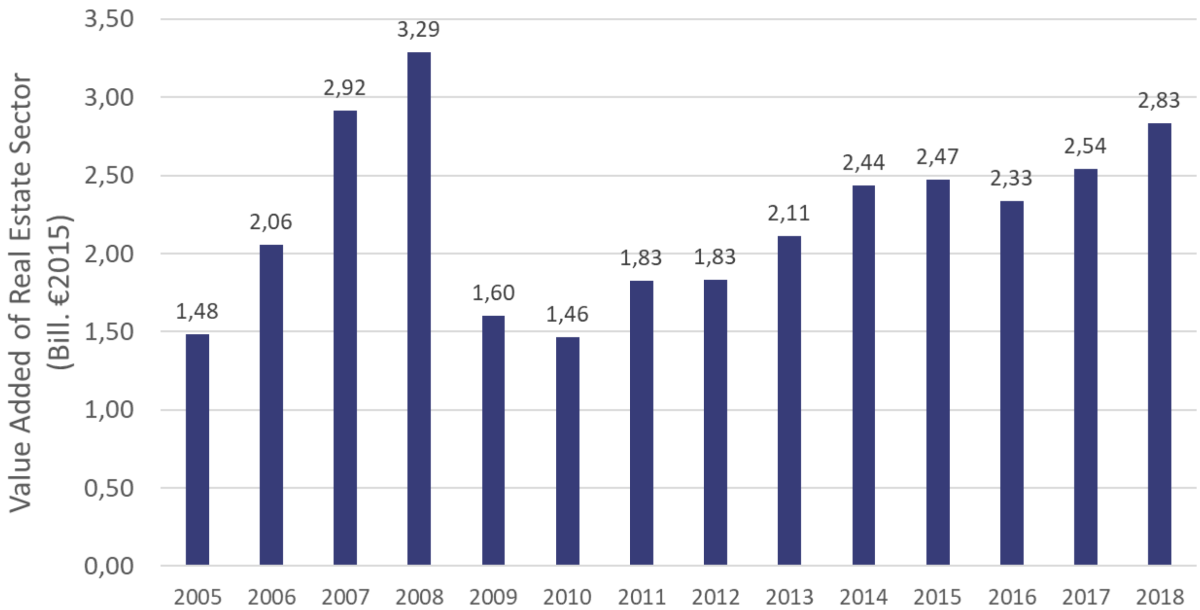


Figure 4.4. - Contribution of the Real Estate Sector to the Country Value Added in Lithuania (Lithuania Department of Statistics, 2019)

Year	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
%	7,0	8,5	10,0	10,0	5,9	5,2	5,8	5,5	6.0	6,7	6,6	6,0	6,0	6,3

Table 4.3. Share in % of the Real Estate Sector to the total Country Value Added in Lithuania (Lithuania Department of Statistics, 2019)

Large construction companies are reluctant to participate in residential building renovation projects due to lengthy bureaucratic public procurement procedures, unfavourable lowest-price criterion and the lack of a stable framework of funding for renovation projects.

Utility companies

Energy demand from the Lithuanian residential sector can be served by district heating, natural gas and/or electricity, oil being a rarely used alternative in residential buildings. Some of the buildings, especially in the suburbs of towns or villages, are heated with biomass or coal.

The logic contradiction between the core activities of energy utilities and energy efficiency may have consequences in Lithuania. Utilities are interested in selling more energy and the renovation of buildings in Lithuania leads to a 50-60 % reduction in heat demand. With lower sales, the income of the utilities would be reduced, but the cost of maintaining the grid would still be the same, so companies are not interested in high-quality renovations that lead to dramatic drops in energy consumption.

In major cities of Lithuania, district heating companies are not allowed to provide additional services to multi-apartment buildings (e.g., maintenance of heating systems, energy management services), only the heat supply is legal. This is because policy makers believe that monopolistic companies may abuse and improperly force their services on customers or maliciously adjust the technical parameters of building's heat systems to increase energy consumption and monthly payments.

Fulfilling the requirements of the Directive 2012/27/ES, utilities have signed agreements with the Ministry of Energy to promote energy efficiency at the consumers end. In practice, their services to consumers are limited and they only provide general information on the best way to save energy through energy renovation.

At present, for dwellings participating in the Government's renovation support Programme, the final repayment per apartment ranges between 50-100 euros per month.

District heating utilities

DH systems are highly developed in Lithuania as all cities have their own. Cities' DH systems cover, on average, approximately 60% of city buildings and 70% of heat demand. There are 60 municipalities and 50 DH companies in Lithuania. In many cases, the municipality is the main shareholder of the DH company. Sometimes the same DH company serves several municipalities. While in small towns, the DH company manages both heat production and transmission networks, in major cities, DH companies operate the transmission network and part of the heat production sources, while part of the heat is produced and supplied to the network by independent heat producers. Some municipalities have long term contracts with private operators for the operation of DH systems.

According to the Lithuanian Civil Code, energy supply companies should submit the energy bill directly to the apartment owner, not to the building manager, thus DH companies have large billing departments. For example, Kaunas District Heating company supplies heat to 2,500 buildings, adding up to 120,000 final customers.

The heat supplier is responsible for supplying heat to end users at the appropriate technical parameters. All buildings connected to DH system in Lithuania must have a heat meter at the house entrance. This meter also acts as the boundary between the building´s ownership and the DH company. All heat supplied to the building, and thus measured by this meter, must be paid by the owners. The maintenance of in-house heating systems is carried out by a separate company hired by the dwelling managers.

Prices (EUR / kWh) of heat supplied by DH in Lithuania change every month, and each of the 50 DH companies in the country have different tariffs. Heat prices in cities vary depending on the size of the DH system, its efficiency (network losses), the fuel used (biomass, natural gas, fuel oil) or the heat production technologies used (heat boiler, Combined Heat and Power). Heat prices are set by every DH company once a month and they tend to fluctuate during the season.

DH bills are the largest in the family's budget among all energy supplies, particularly if the house has not been renovated. Theoretically, DH would be the first choice when considering OBS schemes.

In an effort to foster apartment buildings renovation, the Housing Energy Efficiency Agency (BETA) has tried to relate the attractiveness of apartment renovation to the potential monetary savings. When natural gas prices were high (2009-2012), DH heat tariffs were also high, so heat savings achieved through renovation were not only obvious but also economically attractive. However, DH companies have invested in new effective biomass boilers, while in major cities in Lithuania competition between heat producers increased, which has ultimately led to a significant drop in heat production prices. Nowadays, DH heat tariffs are so low that the monetary incentive for renovation is hardly perceived. Currently, the main driving force behind the multi-apartment building renovation is to deep-renovate a building so that it can offer a comfortable living conduction (allowing the adjustment of the temperature in each of the room, good quality ventilation, refurbishing the engineering systems of the house).

Natural gas supply utility

Natural gas networks are also well developed in Lithuania. Many multi-apartment buildings, even when equipped with district heating, use natural gas for cooking. If gas use is reduced only to the kitchen, monthly bills are still low (3-6 m^3/month). In such case, the application of OBS schemes will not be appealing due to the disproportion between the renovating cost and the savings´ small scale. If the house also uses gas for space heating, OBS schemes may have a larger potential.

Electricity supply

Electricity is supplied to all houses in Lithuania but is rarely used for space heating. Standard monthly electricity consumption for an apartment is 100-150 kWh, while single family houses consume 200-400 kWh/month.

The largest residential electricity utility is the state-owned company (ESO). In 2016, state-owned electricity and gas retail companies were merged into one. Despite that reducing the share of the state-owned company in the electricity market is among the planned measures of the Ministry of Energy, so far private utilities prices in the residential sector have not been competitive, compared to the ones of the state-owned company.

Energy renovations in residential buildings

The greatest potential for reducing inefficient energy consumption in Lithuania is the renovation of apartment buildings built before 1992. As stated before, the reason is that stricter building regulation for buildings envelope thermal resistance was implemented after that year.

Until 2004, the rate of renovation for multi-apartment buildings was very small due to the intricacies of the economic transition from the planned Soviet economy to a free market economy. The average income of the Lithuanian population at that time was too low for major dwelling renovation projects and government support mechanisms were not in place yet.

In 2004, the Lithuanian Government adopted the Housing Strategy of Lithuania and the National Programme for multi-apartment buildings renovation. In 2007, the Housing and Urban Development Agency (BETA) was established under the Ministry of the Environment with 10 regional offices at a district level. The agency was responsible for implementing a multi-apartment building renovation Programme, providing technical and financial assistance as well as advice to apartment owners.

The Lithuanian Government has made efforts to speed up the pace of apartment renovation by amending a number of laws (Act on Associations of Multi-apartment Homes, Act on State Aid for Apartment Renovations, Act on Social Cash Assistance for Poor Families and Single Residents among others). In 2017, the Lithuanian government set a target to renovate 500 apartment buildings each year. However, the progress of the apartment building renovation programme still unable to fulfil the targets set. By 2014, only approximately 1,000 buildings had been renovated.

The progress of the multi-apartment renovation is shown in Figure 4.5 below.

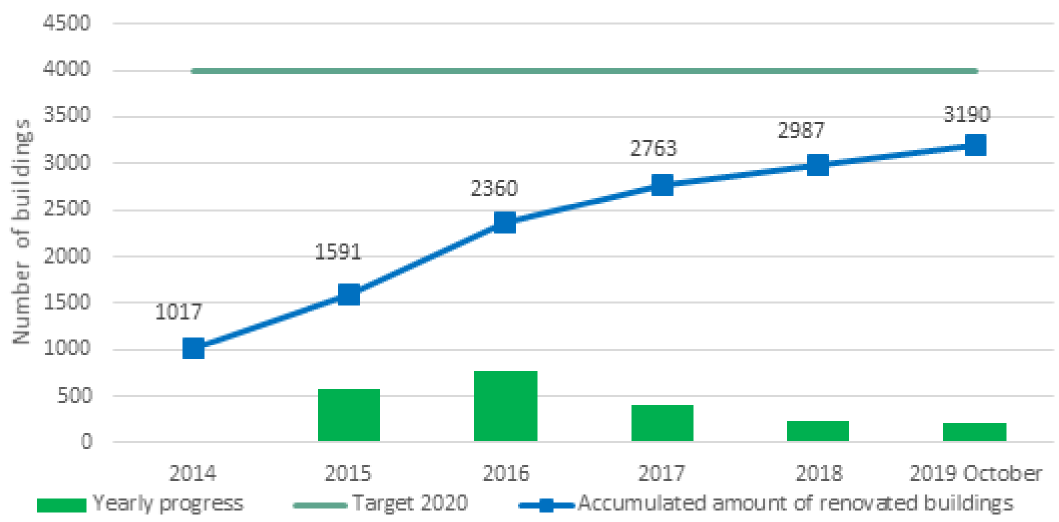


Figure 4.5 - Progress of multi-apartment renovation in Lithuania (Ministry of Environment of Lithuania, 2019)

Given that there are about 32,000 apartment buildings in Lithuania and at least 75 % need renovation, the renovation rate is still insufficient.

Identified measures for residential building renovations

Technically, renovations of residential multi-apartment buildings in Lithuania may include the following measures:

- Envelop (roof, walls, foundations, windows, outdoors, balcony glazing)
- Space heating systems, hot tap water system
- Ventilation
- General room for electrical installation (cables, metering, stair and basement lighting, sometimes patio lighting)
- Elevators
- Renovation of other engineering systems of the building (rainwater, domestic wastewater, drainage)

However, performing deep renovations while the residents are still living there is burdensome, since all the engineering systems of the building (e.g. electricity, water, sewage, etc.) must be operational in order to keep providing services to the consumers. In practice, that means that there is no possibility to change the windows, but also that the in-house engineering system renovation alternatives are minimal.

Experience on Lithuanian apartment buildings renovation shows that isolated measures are unsustainable. One example of this issue would be the replacement of Soviet-type windows into modern PVC windows with double glazing. On one hand, this measure raises the indoor temperature by 2-4 degrees which can cause overheating in apartments lacking individual dimmers. On the other hand, this measure damages the cycles of natural ventilation, causing mould to grow in the apartments.

In Lithuania attempts were made to renovate apartment buildings in phases; for instance, one year the roof is refurbished, the next year the new windows for the patio are installed, later the heating system improved, and so on. However, this tactic was often unsuccessful because of the poor initial conditions of the house. Problem occurs due to incompatibilities between the renovation measures. For example, wall insulation keeping old windows does not have a large impact in the overall energy efficiency of the building. Aware of that, Lithuanian government encourages complex renovation of apartment buildings, including engineering systems and envelope. In addition, at least energy class C must be achieved, and also a minimum 40% of the energy used for the heating must be saved.

Since multi-apartment buildings in Lithuania tend to share the engineering systems (heating, hot and cold water, electricity, natural gas), renovations are performed without breaking down into blocks or staircases (for example, if a house has three staircases with 15 flats each, renovation is done for all three staircases). On average, as a result of multi-apartment building renovations, heating consumption is usually halved. Indoor heating and ventilation costs typically decrease by 50-60% after renovation (if the house was very inefficient before the renovation, heating energy consumption for heating after renovation can be reduced by up to 3-5 times). The heat consumed to produce hot water does not decrease significantly. Only by improving the house's pipeline insulation for the hot water system could relevant savings be achieved.

Heat loss through the ventilation system can be greatly reduced, but it is highly dependent on the technical solutions for the ventilation renovation. Currently, ventilation ducts are required to be cleaned in a renovated apartment building, but there is no obligation to install recovery or high efficiency units. As a result, only few apartment buildings invest in good, efficient ventilation system causing energy savings due to ventilation system renovations in Lithuania not to be significant.

The in-house electrical installation is the sole responsibility of the apartment´s owner, therefore it is not included in the building renovation project. There are no statistics about significant reduction in electricity consumption in a renovated apartment building in Lithuania, however, the reliability and safety of electricity supply is improved.

Renovation prices depend on the number of measures installed and the selected equipment (e.g. façade plastered or ventilated). Preliminary building renovation costs are calculated according to the price list for construction works, which is updated biannually (Sistela, n.d.). The set price is divided between apartments' owners according to the floor area of their dwellings.

Measure	Explanation
Thermal insulation of the roof	Roof construction arrangement, thermal insulation, all roof elements replacement (rain drainage system, lightning conductors). Average investment varies from 75 to 112 EUR/m² without VAT.
Thermal insulation of the walls and basement ceiling	Full facade´s thermal insulation including balconies, windowsills, plinth. Two options are popular: insulated with polystyrene foam and plastered (cost varies 80-114 EUR/m²), or ventilated facade with stone wool and cladding panels (cost varies106 – 133 EUR/m²)
Thermal insulation of the ground floor	Thermal insulation panels are used to insulate the ground floor from the basement. Cost varies 19 – 37 EUR/m²
Replacement of windows	Replacement of windows in apartments, stairwells, basement. 1.3> U> 0.7 W / (m2 * K). Cost 143 – 339 EUR/m².
The replacement of the outer door in staircases	New insulated doors: door of entry to staircase, tambour door (the second door in the entry to staircase), roof entry door, door to the basement. 1.9> U> 1.4 W / (m2 * K). Cost 291 - 392 EUR/m²
Renovation of space heating system	New two-pipe heating system, radiators capacity selected for reduced heating requirements due to new envelope, thermostatic valves on each radiator, new risers, new mainlines in basement, new automated electric system.
Renovation of Hot water supply systems	The hot water system supplies water to the bathroom and to the kitchen. The system includes towel radiators in the bathroom. Upgrading the hot water system includes new basement pipelines, risers, automatic riser valves, towel radiators. The amount of investment depends on the length of pipelines and the number of equipment (radiators, valves)
Ventilation system upgrade	Non-renovated apartment buildings have natural ventilation systems. A renovated ventilation system can range from natural ventilation (purifying

	ventilation ducts only) to efficient recuperation systems. The investment´s size depends on the technical solution chosen.
Electricity supply installation upgrade	Installation of new building's electrical inlet panel/switchboards, power cables from the inlet panel to the power distribution panels in the stairwells on each floor, changing panel equipment. Also, the electrical installation of staircase lighting, yard lighting, basement lighting is being updated. Renovated building's electrical system does not have a high energy saving effect, but greatly increases the reliability of power supply (old electrical installations could trigger the start of fires).
New elevators	The elevators are completely refurbished as it is a hazard facility. Renovated elevator cabin, access to elevator on each floor, full renovation of equipment in the engine room. New lifts are quieter and typically use about 30 percent less electricity than old lifts. Cost vary between 25000-50000 EUR/elevator depending on the number of floors and its capacity.
Other common measures: cold water system, domestic sewage system, drainage, stair painting	Renovation of building's cold-water supply system includes coupling point into the building, pipes in basement, risers. All apartments in Lithuania have a separate cold-water metering device. Renovation of water domestic sewage system includes risers, pipes in basement, pipe outlet to a city-owned sewage well in the yard. If needed, the drainage system of the building´s area can be renovated. At the request of residents, the project may include staircase repairs: painted ceilings, walls, floors, handrails. These works do not save energy and are not subject for governmental support but are needed to make the building comfortable and safe.

Table 4.4. Prices for the implementation of renovation measures (Public procurement electronic system, 2019)

The presented renovation measures' implementation prices were taken from the public procurement electronic system and were in force in summer 2019.

4.4 Potential Impact of Buildings Energy Renovation

National energy consumption

The year by year energy demand fluctuation in buildings is mostly due to seasonal differences in weather conditions. Figure 4.6 shows the evolution of the energy consumption in the residential buildings sector compared to the evolution of the overall final energy consumption in Lithuania.

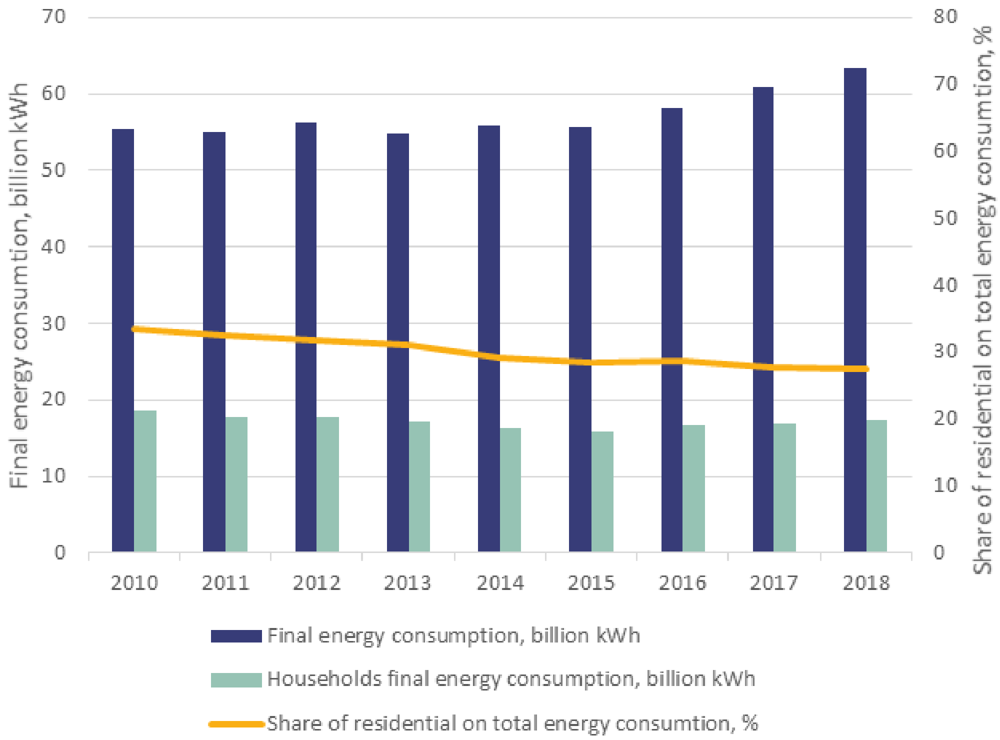


Figure 4.6 - Energy consumption in total and in residential buildings' in Lithuania (Eurostat, 2020)

According to Eurostat data (Eurostat, 2020) energy consumption in residential buildings is slowly decreasing, with an average annual decrease of 0.6% between 2010 and 2018. The main reason for the energy consumption decrease in residential buildings is the introduction of energy saving measures in existing buildings and the construction of cost-effective new residential buildings. Energy consumption in other sectors of the Lithuanian economy (transport, industry) is slowly increasing, therefore the relative share of the buildings sector is decreasing.

According to the National Energy Strategy, adopted in 2018, Lithuanian district heating systems supply heat to 53% of Lithuanian buildings and this rate rises in cities (76% of the buildings). The main users of district heating services are residents of multi-apartment buildings. In 2016, out of 27,359 buildings supplied by district heating systems, 17,840 (about 700,000 apartments) were apartment buildings, representing 72.6% of the total heat served. The remaining users are public buildings (14%) and business organisations (13.9%).

In 2016, a total heat of 8.9 TWh was supplied through district heating networks in Lithuania. With the expansion of district heating and the rapid investment in a more efficient energy use, it is foreseen that district heating systems will deliver 8.9 TWh of heat in 2020, 8.5 TWh of heat in 2030 and 8.0 TWh of heat energy in 2050. The changes in the structure of the primary fuel mix in the Lithuanian District Heating sector are shown in Figure 4.7 - Structure of primary fuel in Lithuanian District Heating sector 1997 - 2017

The National Energy Strategy aims at renovating multi-apartment residential and public buildings (prioritizing district level) to save between 2.6-3 TWh of energy in the renovated multi-apartment and public buildings by 2020, and up to 5-6 TWh of energy by 2030.

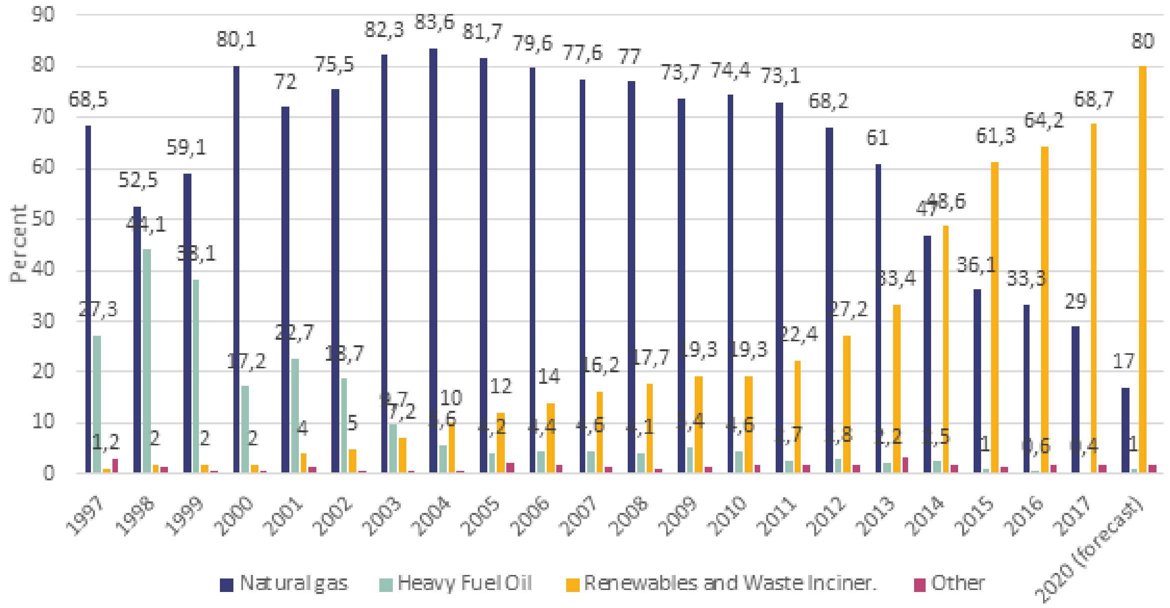


Figure 4.7 - Structure of primary fuel in Lithuanian District Heating sector 1997 - 2017 (The Lithuanian District Heating Association (LDHA), 2018)

Energy savings potential

The potential for energy savings via building renovation is limited. With regards to the technical potential, experience shows that apartment buildings with energy class E or F can reach a C class after renovation, reducing heating consumption by 40 to 60%. Still, in practice this will not be achieved due to the course of population trends (e.g. former Kolkhoz settlements where the number of inhabitants has fallen significantly, and it is not likely to increase). In addition, for this segment of buildings, the next deep renovation will be no earlier than in 20 to 30 years, constituting in practice a barrier for renovation. Besides that, some of those apartment buildings are completely worn out or have a very uncomfortable layout, which makes it unattractive for investing, as their renovation costs are higher than the market price.

Buildings built before World War II have serious constrains; some of them are already in very poor technical conditions which make them economically unreasonable to renovate, while others are subject to heritage regulation that sets restrictions to renovations (especially façade insulation, which can be specifically banned). Interior insulation in such buildings is allowed, but it involves even higher costs than standard renovation. Therefore, renovation of such buildings is infrequent. Sometimes municipalities have programmes to encourage the renovation of the façades of heritage buildings. For example, Kaunas City Municipality provided financial support for the façade maintenance of heritage conservation buildings constructed in the main pedestrian street on Laisvės avenue in the centre of the city. However, this support was limited to façade repainting and not to energy renovation measures.

Further, the Ministry of Environment is currently launching a public tender for a "*Study to prepare a long-term renovation strategy for Lithuania*". The aim of this study is setting out the guidelines for building renovation, including actions associated to measurable indicators of progress. The study is aligned to the EU objective of reducing carbon emissions by 80-95% by

2050 (below 1990 levels). Ultimately, the strategy seeks to ensure that the national building economy is highly energy efficient and fossil fuel independent and to facilitate the conversion of buildings into nearly zero-energy buildings. The roadmap also sets indicative targets for 2030, 2040 and 2050 and intermediate targets along with the projected contribution of Lithuania to achieve Union's energy efficiency targets under Directive 2012/27/EU. The study is expected to be ready by June 1, 2020.

According to Lithuania's National Energy and Climate Plan (NECP), adopted by the Lithuanian Government on 30 December 2019, there is an overall objective to promote the renovation of 50% of the national public and residential building stock by 2030, involving 0.3 million residential buildings. The NECP also foresees that the measures supporting the deep renovation volume of 500 apartment buildings per year will be maintained, and the annual additional energy savings due to the implementation of the apartment building renovation program will be 28 GWh/year.

These energy savings were calculated based on the open data of the Lithuanian District Heating Association (Lithuanian District Heating Association, n.d.) related to the actual amount of heat supplied to the multi-apartment buildings connected to district heating networks, taking into account the average floor area of multi-apartment buildings and the average specific building heat consumption, assuming that after deep renovation buildings will consume at least 50% less energy.

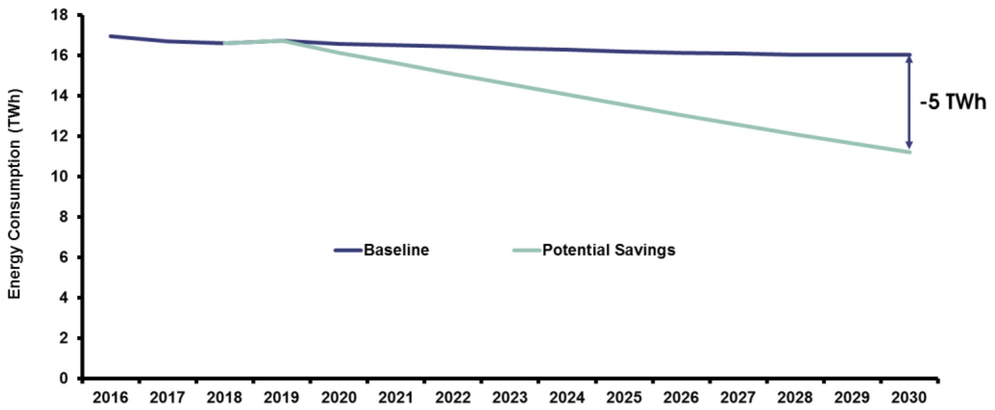


Figure 4.8 - Estimation of baseline and potential savings (Eurostat, 2020) and ROB consortium analysis

However, by considering the implementation of energy efficiency measures on 0.3 million of residential buildings, a 30% decrease of the energy intensity per capita in 2030 is estimated, i.e. from ~0.6 kTOE per capita to ~0.4 kTOE per capita[29]. Therefore, the total yearly energy savings achievable from 2030 will be 5 TWh/year as presented in Figure 4.8.

It is assumed that once the long-term renovation strategy is adopted, the target it sets will not be less ambitious than the one provided here.

Potential market impact

As part of the programme to renovate 500 apartment-building per year, the Lithuanian government has launched several calls for building renovation applications over the last 3 years. The programme provides soft loans amounting 150 million euros per year. In addition, 50 million euros are spared to cover energy efficiency measures.

Experience shows that this investment volume can meet the needs for deep renovation of about 350 apartment buildings. The number of applications is increasing every year: there were 550 applications in 2018, 770 applications in 2019, and it is foreseen that for the spring 2020 period there will be even more, according to expert´s estimates. Since long-term stable financing schemes for renovations have not been developed yet, government financial support will be essential.

4.5 Financing the Energy Renovation of Buildings

Introduction

Deep renovation of buildings requires considerable financial resources. High income owners, which can afford buying a single house, either renovate the building using their own resources or borrow money from the bank on similar terms to real estate loans.

Owners of multi-apartment flats on average have lower incomes so, without government support, deep renovation will not happen. In the best cases, only certain measures may be adopted (such as replacing windows in the staircase), which can be covered by the maintenance budget provided by homeowners. Bank loans are granted only in exceptional circumstances, such as in the event of an accident and in the absence of other financial resources to repair the consequences of an accident (for example, in the event of a breakdown of a building heat station).

Financial support for apartment building renovation is granted exclusively to homeowners and is not available to tenants (the latest represent just 10 % of the population).

Public support programmes

Public support for building renovation in Lithuania comes from national programmes and funds. Only in exceptional cases, municipalities might provide support for deep renovations.

State support for multi-apartment buildings

The apartment building renovation programme began in 2005 and, since then, the programme´s terms and conditions have been revised and updated in order to foster participation. Only multi-apartment buildings are eligible for the programme. In this context, an apartment building is a dwelling of three or more apartments, which may include non-residential premises - commercial, administrative, catering, etc.

The apartment building must be built according to the regulation valid until 1993. The support consists in:

- 100% for the preparation of the project or part thereof, including supervision of the execution of the renovation project and the auditing of the renovation technical project by the independent experts, when required by the Construction Law.
- 100% of project administration and construction maintenance costs
- 30% of the investment for energy efficiency improvement measures set by the Government (applicable to projects selected under Order No. D1-803 of October 2, 2017 of the Minister of Environment of the Republic of Lithuania On the Call for Applications for Renovation / Modernisation of Apartment Houses);
- 10 % of additional state support (from the price of the implementation of the measures mentioned below) when the renovation project installs a separate heating substation or modernises an existing non-automated one, installs automatic valves for raisers and / or rebuilds or replaces the heating system, heat metering devices or individual meters and / or thermostatic valves (applicable to projects selected in accordance with Order No D1-803 of the Minister of Environment of the Republic of Lithuania of 2 October 2017 on the call for applications for the renovation / modernisation of apartment buildings);
- 100% of renovation´s preparation costs, including the project´s execution supervision and expertise (when required by the Construction Law), the administration of its implementation, construction maintenance, credit insurance premium, monthly credit and interest payments;
- There is also a soft credit with 3% annual interest for the first five years. The annual interest rate of this credit, which exceeds 3 percent, is paid by the government for five years from the date of the first repayment of the credit. In the sixth year and beyond, the apartment owner pays 3% annual interest plus the Euribor rate for 6 months (in case the Euribor is negative, the interest equals to zero).

State-supported apartment building include the following renovation measures:

- Conversion or replacement of heating and hot water systems:
- Replacement or conversion of heating systems or individual boilers and hot water heater, including the installation of renewable energy sources (solar, wind, geothermal, biofuel, etc.); Installation of balancing automatic valves on risers; Improvement of thermal insulation of pipelines; Replacement of heating appliances and pipelines; Installation of individual heat metering devices or individual meters and / or thermostatic valves in flats and other premises.
- Conversion, replacement or installation of ventilation and recovery systems.
- Roof insulation, including the installation of new coverings or new pitched roofs (other than sheds) and / or roofing under ventilated pitched roofs, and / or the installation of stairs to new pitched roofs for the operation of energy efficiency improvement equipment, if elements of energy efficiency measures are installed in the shelter.
- Insulation of facade walls (including plinth), including removal of defects in the construction of walls (plinth);

- Glazing of balconies or loggias, including reinforcement of existing balcony or loggias and / or installation of new glazing structures.
- Replacement of stairway exterior doors and tambour doors, including related finishing work, repair of entrance stairs, and adaptation to the needs of the disabled.
- Replacement apartment´s windows and other premises with lower heat transmission windows.
- Basement ceiling insulation.
- Elevator renewal – replacement of lifts with more energy efficient ones, including accessibility for the disabled.
- Other measures for home renovation: Replacement or modification of other engineering systems for general use in the building (sewage systems, including house-based local installations, electrical installations, fire protection installations, drinking water pipelines and installations, drainage).

Government support for single-family houses

The Environmental Projects Management Agency under the Ministry of Environment of the Republic of Lithuania provides support to projects for the renovation of one or two family dwellings, that achieve at least class B energy efficiency and reduce thermal energy costs by at least 40% compared to the calculated thermal energy costs before the implementation of the refurbishment project. Funding for this programme is 3,000,000 euros per year.

The programme funds the following energy efficiency improvement measures:

- Roof insulation without covering/roof replacement.
- Roof insulation with covering/roof replacement.
- Ground-floor insulation;
- Floors insulation above basements;
- Wall and plinth insulation;
- Underfloor heating installation;
- Installation of radiators;
- Modification of existing windows;
- Replacement of existing exterior doors and / or gates;
- Heat recovery with heat exchanger;
- Energy certification of buildings (energy performance certificate of the building and certificate of reduction of energy consumption);
- Costs of construction waste removal and handover from the project´s site to disposal companies.

The maximum compensation per project may not exceed 14,500 euros.

Tax rebates/ incentives

The Governmental Tax Inspectorate of Lithuania (GTI) informed that starting from January 1, 2019, residents are able to recover a portion of the Personal Income Tax (PIT) on services or works performed for their own benefit or that of their spouse regarding decoration and any repairs to buildings and other structures.

The benefit is granted if works and services are performed by a resident or company registered in Lithuania and the buyer has the documents proving the provision of the works, services and payment. Reports of incurred expenses with documents proving the provision of the service and payment can be submitted only electronically via the GTI Electronic Declaration Information System.

The GTI underlines that the maximum amount of expenses from which part of the PIT for the services can be recovered is EUR 2,000. The maximum amount that can be recovered by a single person is 400 EUR, if the income was taxed at 20% PIT rate. This amount is too low to incentivize deep renovation loans for the dwelling´s owner.

Impact of public support programmes

The Government support programme for apartment buildings renovation is crucial. Despite the target of 500 renovated apartment buildings per year is low compared to the country's need, stopping the programmes would halt deep renovation processes. The trend over the past 3 years has been the increase in the number of applications for an apartment building renovation programme, and the Ministry of Environment is seeking funds to cover them.

The Ministry of Environment and the Housing Energy Conservation Agency have decided to renovate apartment blocks in all Lithuanian cities, which will act as pilot projects. This will increase the interest and confidence of the residents in the renovation programme. Currently, the Ministry of Environment has begun to promote the idea of district level renovation, where apartment blocks and their surroundings (streets, lighting, sidewalks, greenery, etc.) are managed as a whole. The advantages of this approach are that it improves the comfort of residents and increases the property´s value. First district renovation projects are already underway and, so far, they had a positive demonstration role for other city dwellers. Nationally, this could become significant as it improves efficiency not only for the end-user but also for the energy supply network.

Private financing schemes

Private financing for renovation of multi-dwelling houses is practically excluded in Lithuania. The biggest problem is the need for the multi-apartment co-owners to agree on the loan and to provide the loan repayment guarantees.

In fact, ESCO operates in Lithuania on a very small scale due to the uncertainty of the legal framework. In 2016, EBRD took the initiative and led the legislation needed for ESCO model implementation. The plan is to use ESCO model for the renovation of government-owned buildings. Although the model's implementation has been accomplished it has not led to a renovation's expansion through ESCO schemes.

There are reports that municipalities are updating street lighting systems on an ESCO basis (Baltic News Service news, n.d.). Also, the ESCO model principle is offered by several large facility management companies in Lithuania but most of the customers are commercial buildings.

5 SPAIN

5.1 Executive Summary

The construction sector in Spain has played a very important role in the national economy, especially in the last years before the 2008 financial crisis. As a result of it, the sector suffered a sharp fall in demand and prices, from which it only started recovering in 2014. A proof of this is the fact that **the sector's weight in the economy went from accounting for 9.4% in 2006 to 5.5% in 2018.** According to the European Commission's Construction Sector Observatory, the revival of the industry will mostly rely on housing renovation, availability of trainings to cover lack of skills, and sustainable construction, as supported by several policy schemes and dedicated programmes.

In Spain, although the **majority of the population lives in multi-family houses**, the residential building stock is mostly made up of single-family houses, as reflected in Figure 5.1. The number of dwellings, however, is largely multi-family. In terms of ownership models, **Spain has traditionally been an "owners" country**, but sociological factors have switched the trend and the weight of rental households went from 19.4% in 2005 to 23.9% in 2018. The proportion of owner-occupied homes without outstanding mortgages stood at 46.9% in 2018, just below the 50.2% EU average.

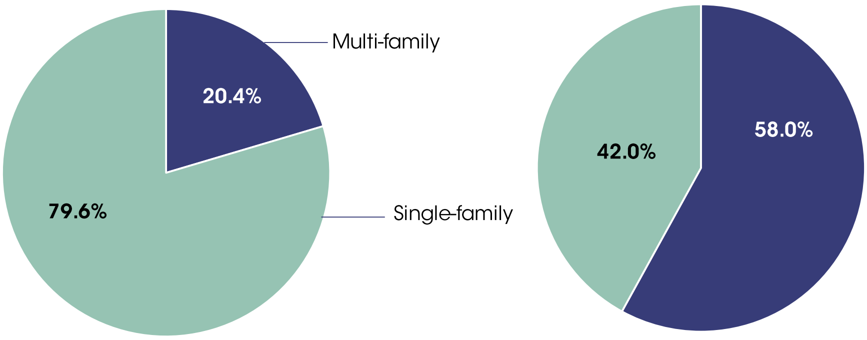


Figure 5.1 – Segmentation of the Spanish building stock by number of buildings (1) and floor area (2). (Ministerio de Fomento, 2016)

The Spanish building stock is quite aged, as **56.3% of the country's buildings were built prior to 1980**. This is accentuated by the fact that the largest number of buildings in poor condition were built prior to 1900, followed by those built over the 1941-1950 decade. It is relevant to highlight that the Spanish stock ages[30] at a rate of 3.3% each year, which has a direct impact on the state of buildings and emphasises the potential for energy efficiency renovations.

Of the more than 25 million homes in Spain, approximately 90% precede the Technical Building Code (approved in 2006) and 60% were built without any energy efficiency regulations. Because of this, several measures aimed at improving the energy performance

[30] The obsolescence of a building depends on different factors: from the off-plan approach, plastering materials and interior finishes, up to the structure or the aggressiveness of the environment.

of Spanish buildings have been approved, in line with the provisions of Directive 2010/31/EU. The Directive sets out the minimum energy performance requirements to be met by both new and existing buildings in which it intervenes, the procedure for their energy certification and for carrying out periodic energy performance inspections, as well as the construction of buildings with almost no energy consumption.

Residential sector buildings built prior to 1980 (56.3% of the total stock) should serve as the target for the implementation of a comprehensive rehabilitation action with the objective of ensuring that energy efficiency targets are met.

The Spanish electricity and natural gas market utilities have 29 million customers of which 18 million are free market consumers. **Five companies hold 75% market shares in volume and 93% in consumers** (Naturgy, Iberdrola, Viesgo, Endesa, EDP), but lately smaller companies have been attracting clients from the incumbent ones.

In order to finance energy efficiency renovation across the residential sector, a wide range of **public grants and subsidies are available, as well as more "traditional" private financing schemes**. A survey conducted by the Ministry of Development enquiring participants about the most occurring financing methods used for energy renovation showed that the majority of them were done via extraordinary expenses from multi-family building community owners. Another relevant source is personal savings and public subsidies (19.9% and 6.8% respectively).

5.2 The Residential Building Sector

Introduction

Over the last ten years, the evolution of the residential building sector in Spain has been highly conditioned by the 2008 financial crisis, which burst the real estate bubble the country had experienced since the late 1980s. As a result, the sector suffered a sharp fall in demand and prices, from which the country only started recovering in 2014.

Nonetheless, within this improvement trend the investment linked to construction has registered a less dynamic evolution than the rest of the Spanish economy. This performance reflects how the sector has maintained a reduced weight in recent years, after a decade of continued losses, going from accounting for 9.4% of the GDP in 2006 to 5.5% in 2018 (Urtasun & Alves, 2019).

As reflected by Figure 5.2, and as is the case with most European economies, the contribution of the tertiary sector to the national GDP is significantly higher than that of other sectors. Construction-related GDP holds the third spot in significance in Spain (excluding taxes), only followed by agriculture and fishery.

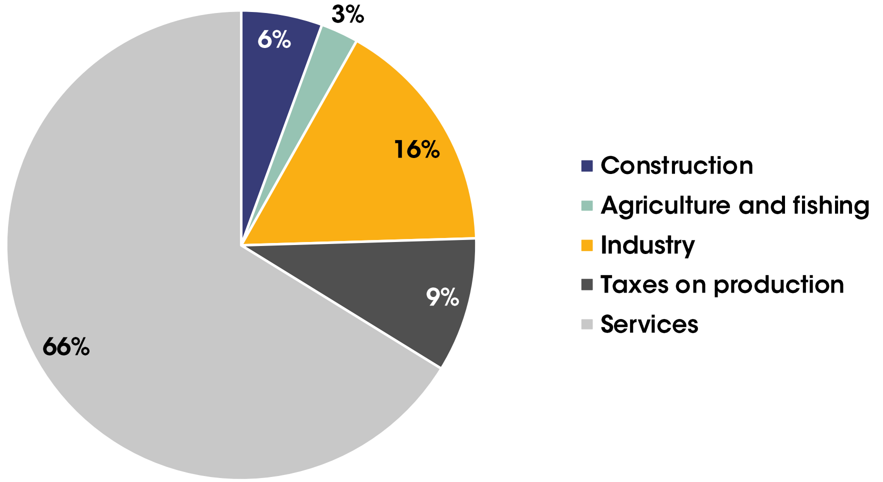


Figure 5.2 – GDP distribution by sector, 2018. (Instituto Nacional de Estadística, 2018)

Figure 5.3 reflects the evolution of the construction sector in terms of the Industrial Production Index (IPI), as well as the expected evolution up to 2021. The IPI is a short-term indicator that measures the evolution of the industrial branches´ productive activity. The objective of the index is to measure the evolution of the gross added value´s volume generated by industrial branches, in this case, construction. It therefore measures changes in industrial production without the effect of prices.

It can be observed that the economic activity within the construction sector that has slowed down the most over the past five years is civil engineering. Large civil engineering firms have reduced their business in Spain in recent years so that it now accounts for 10% of total turnover in the construction sector, compared to 90% in 2007, the year prior to the onset of the crisis.

In recent years, there has been intense activity in residential construction, where production had to be accelerated to fill the supply gaps that had been neglected during the crisis. At the present time the market has once again been reasonably supplied, so Spanish housing developers are wondering whether the time has come to retreat again.

Non-residential construction is going through a somewhat ambiguous moment. On one hand, macroeconomic deterioration is already a reality in certain sectors such as industry. On the other hand, the non-residential real estate market continues to be very active, attracting domestic investors who continue to finance themselves at good prices and foreign investors who do not even need to finance themselves. However, this demand seems to have been met by the existing stock, without the need to acquire new buildings.

Even though the renovation sector does not show a complete recovery, professionals are optimistic after years of sustained growth. Furthermore, if the obsolete Spanish housing stock is considered, the potential of this activity is unquestionable. Since the construction sector as a whole bottomed out in 2014, rehabilitation has recorded a growth between 3% and 4% for three consecutive years, which would be considered a success in mature markets (ITeC, 2019).

According to the European Construction Sector Observatory, carried out by the European Commission, the revival of the industry will mostly rely on housing renovation, availability of trainings to cover lack of skills and sustainable construction, as supported by several policy schemes and dedicated programmes. In addition, if the political conflict in Spain persists, it could negatively affect the construction sector.

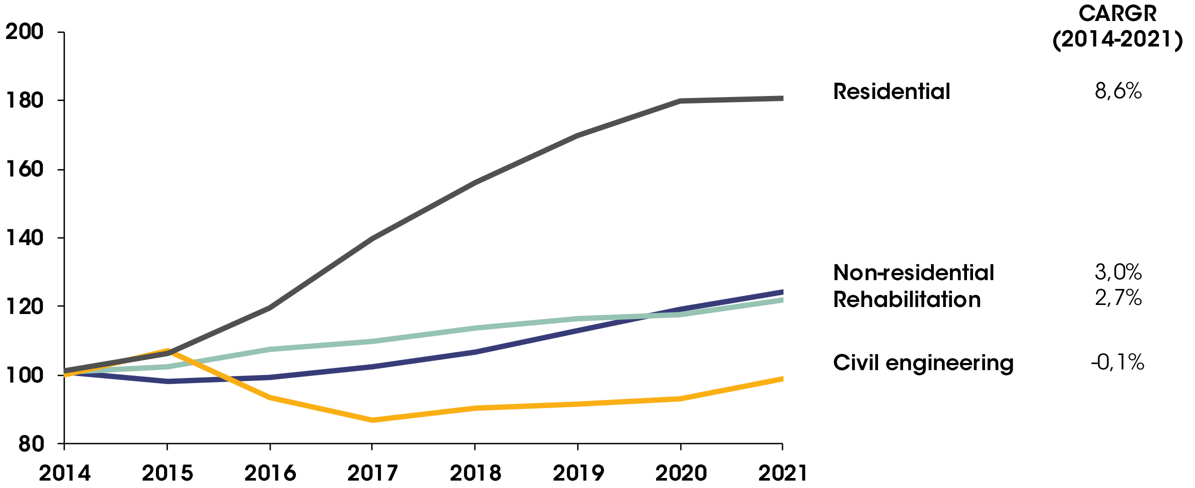


Figure 5.3 – Evolution of the construction sector in Spain 2014-2021 (Industrial Production Index (IPI) at constant prices, base 2014=100. (ITeC, 2019)

In terms of the evolution of the building stock in the country, Figure 5.4 reflects the number of dwellings by use and decade of construction which add up to a little over 34 million. Two thirds (or 66.1%) of the aforementioned amount correspond to the residential sector. It also reflects the fact that over half of the buildings in Spain were built before 1980, representing up to 51.5% of buildings in the residential sector, 61.9% of industrial-use properties, 51.0% of commercial-use properties and 41.4% of offices.

Of the total of 5,279 million m^2, residential properties represent an area of 3,283 million m^2, which is 62.2% of the total, slightly higher than the figure obtained in the analysis by number of buildings. The next use per area corresponds to the industrial sector, with 705 million m^2, and 13.4% of the building stock, followed by storage/parking, with 345 million m^2 and 6.5% of the stock.

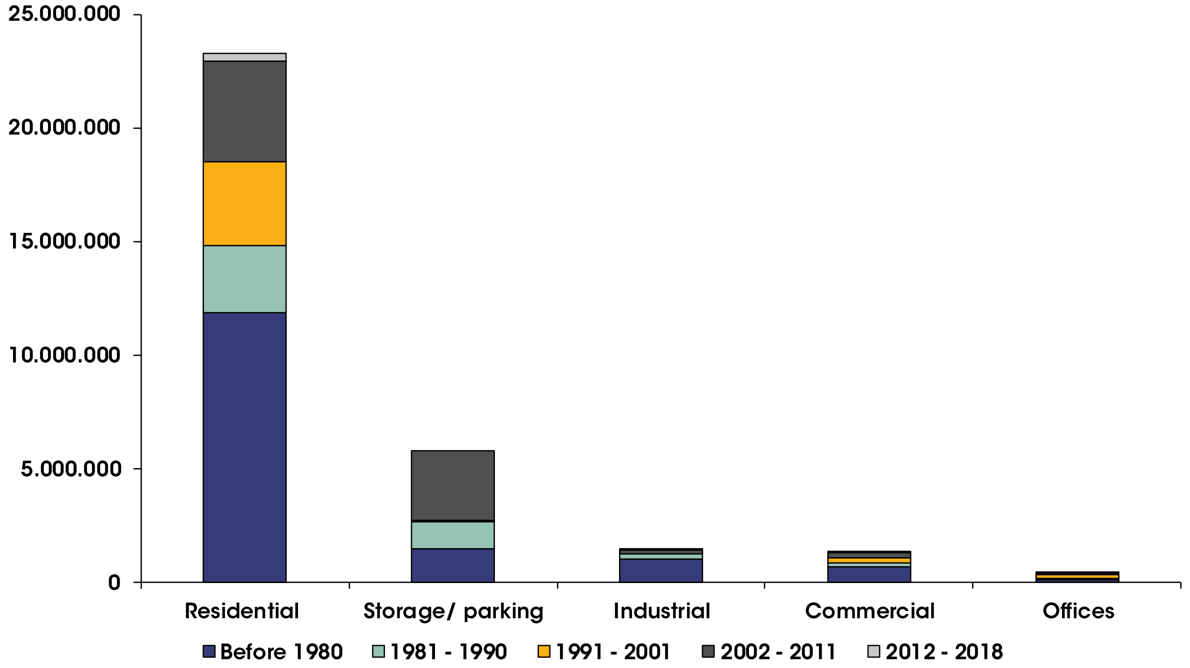


Figure 5.4 – Evolution of the dwelling stock in Spain. (Ministerio de Fomento, 2017)

In Spain, as illustrated in Figure 5.5, over 76% of buildings have an E energy label or worse causing buildings to currently be responsible for 31% of energy consumption. This is a fact that directly affects the pockets of Spaniards, as energy efficiency is closely linked to economic savings: an A label means spending up to 10 times less than a G label.

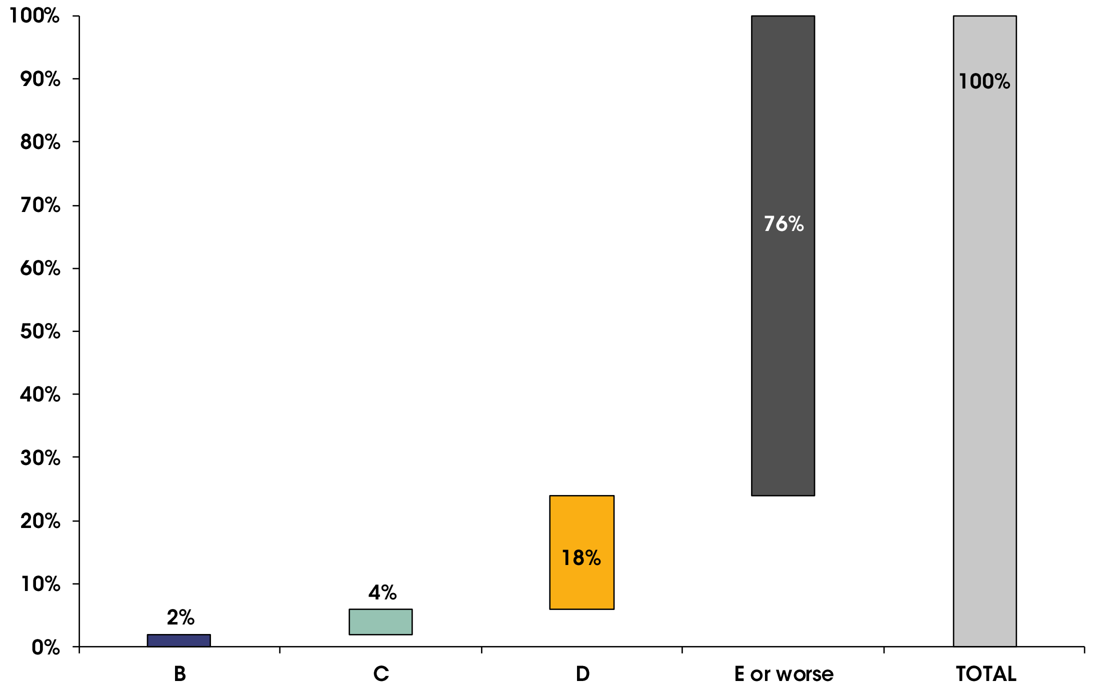


Figure 5.5 – Distribution of the building stock by energy label in Spain. (BPIE, 2017)

Residential buildings

The cumulative increase in real housing investment between Q4 2013 and Q4 2018 was 45%, compared with a rise of 15% in GDP in the same period. Other indicators also showed the cyclical improvement in this sector, such as transactions and prices. However, this sector is still highly diverse in terms of the properties´ location, type and size. The recent buoyancy seems to reflect, among other factors, positive labour market developments and the low cost of borrowing against a backdrop of gradual growth of loans for house purchase (Urtasun & Alves, 2019).

If the potential for renovation of residential buildings is analysed, based on the latest data from the Population and Housing Census of the National Statistics Institute, it could be seen that, during the 2012 to 2018 period, 1.5 million residential buildings were constructed, of which 82% were single family buildings. An analysis of the percentage of pre-1980 buildings shows that they represent 56.3% of the total stock.

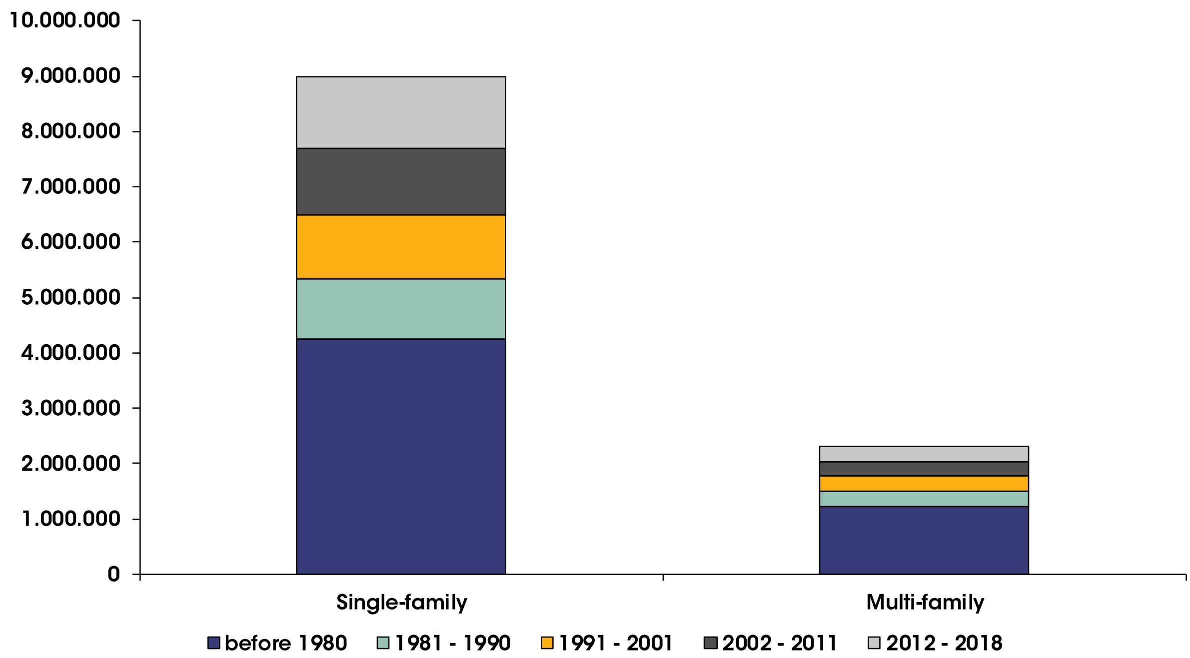


Figure 5.6 – Description of Spain's residential building stock. (Ministerio de Fomento, 2019)

In terms of size, 76.4% of residential buildings have an area between 61 and 120 m², distributed as follows: 18.7% and 2.6 million between 61 and 75 m², 29.4% and 4.1 million between 76 and 90 m², 25.3% and 3.6 million between 91 and 120 m². Homes larger than 120 m² represent 12.4% of the stock. The number of buildings under 30 m² are residual with 55,501 dwellings and 0.4% of the stock (Ministerio de Fomento, 2016).

The state of residential buildings, as a percentage of the total and according to year of construction is presented in Figure 5.7. The greatest number of buildings in poor condition (deficient, bad or ruinous) were built prior to 1900, with 250,825 buildings, followed by those built over the decade 1951-1960, in which 134,906 buildings were built which are in deficient, bad or ruinous condition. It is also important to point out that the building stock "ages" at a rate of 3.3% each year, which has a direct impact on the state of buildings.

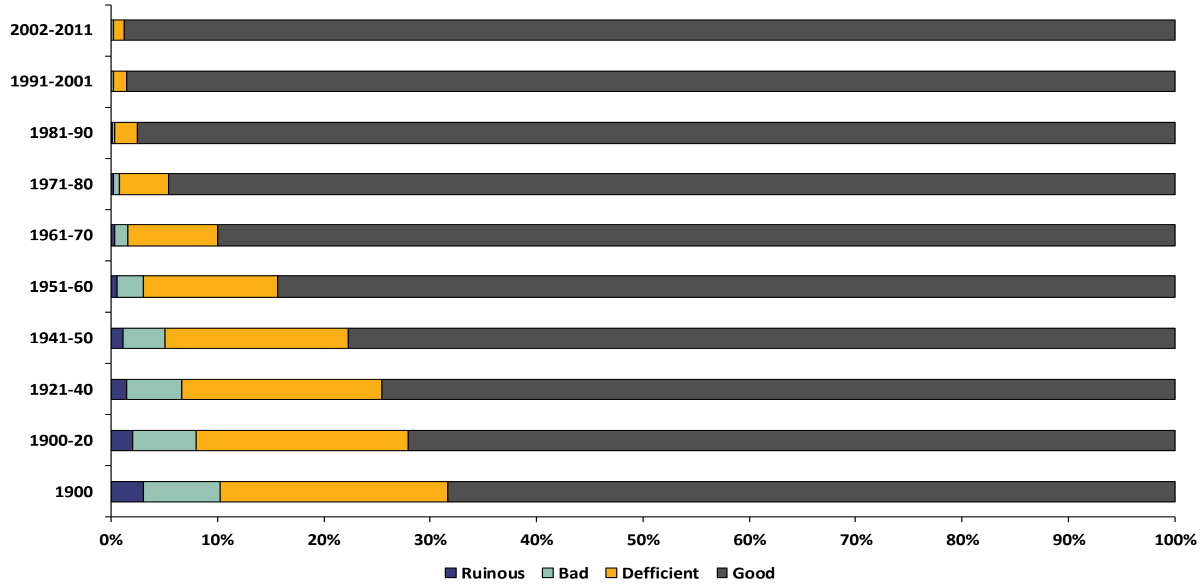


Figure 5.7- State of the Spanish residential building stock by decade of construction. Source (Ministerio de Fomento, 2019)

Figure 5.8 depicts the distribution of primary residences by Autonomous Community. The regions with the highest number of dwellings are *Andalucía* and *Cataluña*, with around 3 million dwellings, *Madrid*, with 2.4 million, *Comunidad Valenciana*, with around 2 million, and *Castilla y León* and *Galicia* with around 1 million primary-residency-dwellings.

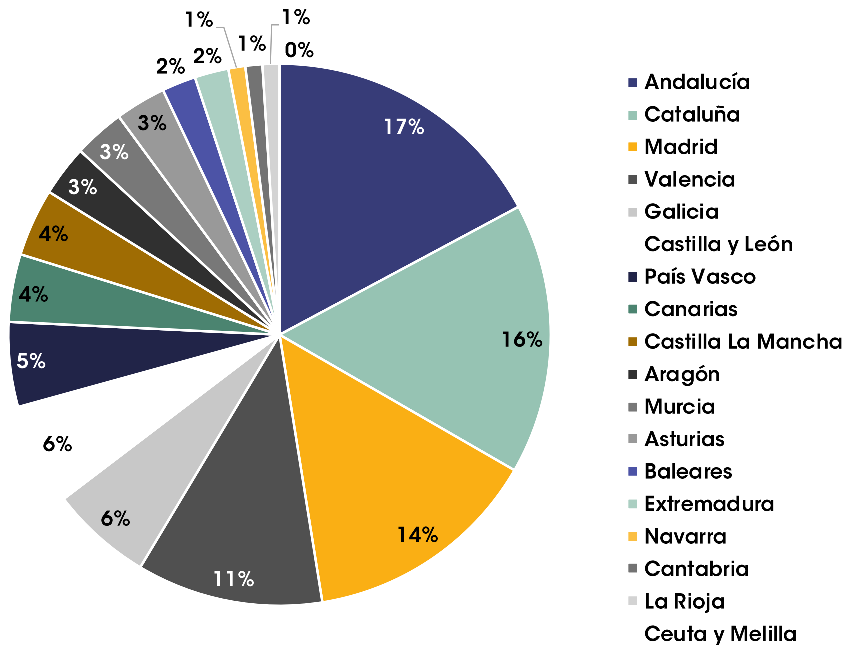


Figure 5.8 – Evolution of the building stock in Spain. (Ministerio de Fomento, 2019)

Six years after the implementation of energy certification for buildings, 47.50% of old residential buildings in Spain only get the E energy label, according to data provided by Certicalia, and 25% of residential buildings in the country have received a G rating. This is due to the fact that efficiency in the building stock has been conditioned by regulation that was "not very effective". This trend is expected to improve in the whole country once energy labels start being granted to constructions built under the new Technical Building Code, as new regulations are more oriented to energy saving, among other aspects.

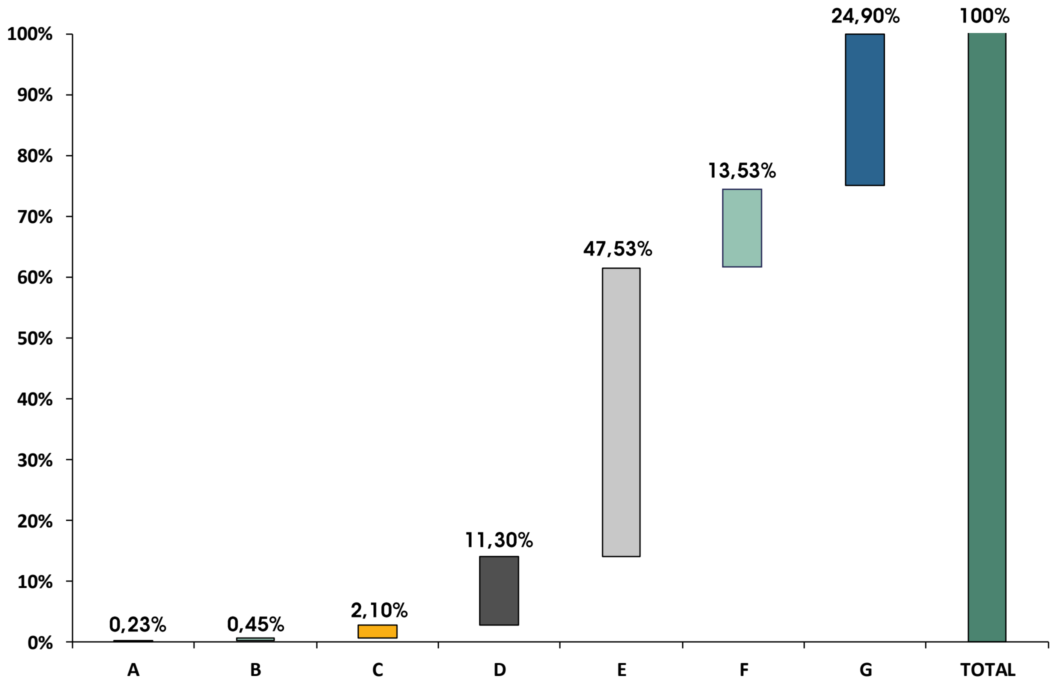


Figure 5.9 – Distribution of the residential building stock by energy label in Spain. (Certicalia, 2019)

Residential ownership models and affordability of energy bills

The proportion of the population living in non-owner-occupied housing stood at 23.7% in Spain in 2018, according to the European Survey on Income and Living Conditions (EU-SILC, Eurostat, 2018). At the same time, the relative weight of rentals at a reduced price stood at 10.7% (Banco de España, 2019).

This data reveals a lesser significance of residential rentals in Spain compared with the EU countries (Figure 5.10). Specifically, in 2017, 30.7% of the EU population, on average, lived in rental housing. These figures were prominent for Germany (48.6%), Austria (45%), Denmark (37.8%), France (35.6%) and the United Kingdom (35%).

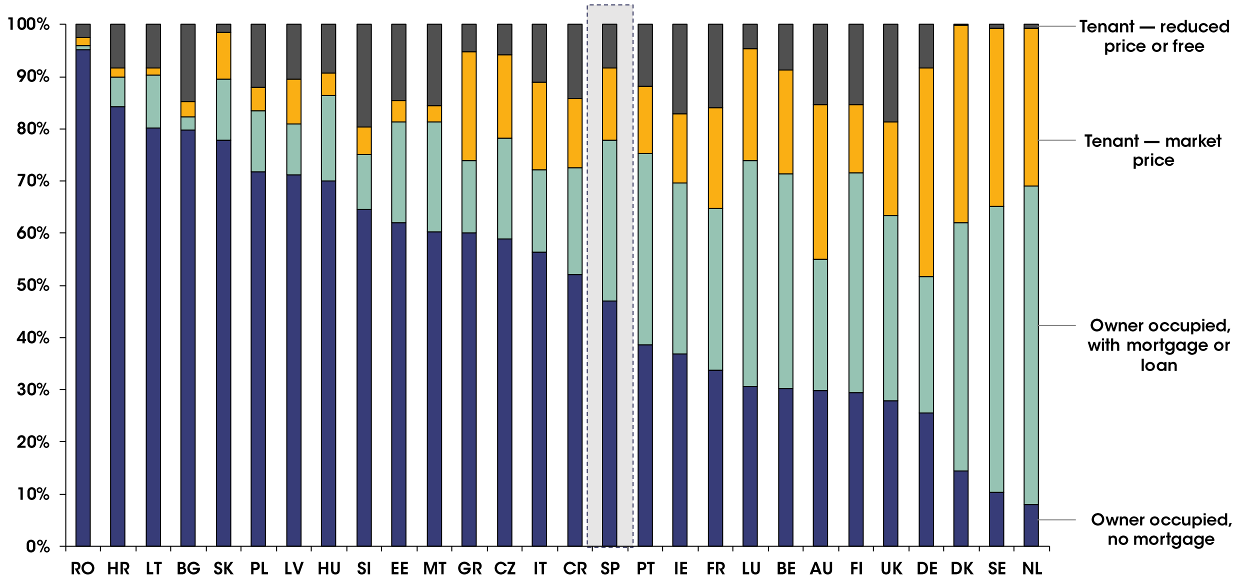


Figure 5.10 - Distribution of population by tenure status. (Banco de España, 2019)

The average energy demand of households has followed a downward trend since 2005, this was reinforced by the changes in the economic environment that began in 2008 and the loss in households' purchasing power (Figure 5.11). It was in this context that the households' lower spending power, as well as the effect induced by technological improvements in household equipment and facilities, contributed to decrease the level of power consumption per household. From 2014, the economic recovery, as well as the drop in oil prices, job creation and favourable financing conditions, has allowed an increase in the gross disposable income of households and their spending capacity. This may therefore explain the increase in energy demand from the aforementioned households in 2016, which has resulted in a 0.9% increase in energy intensity in the residential sector. This increase is mainly associated with household heating uses, in which energy demand has grown by 2.2%.

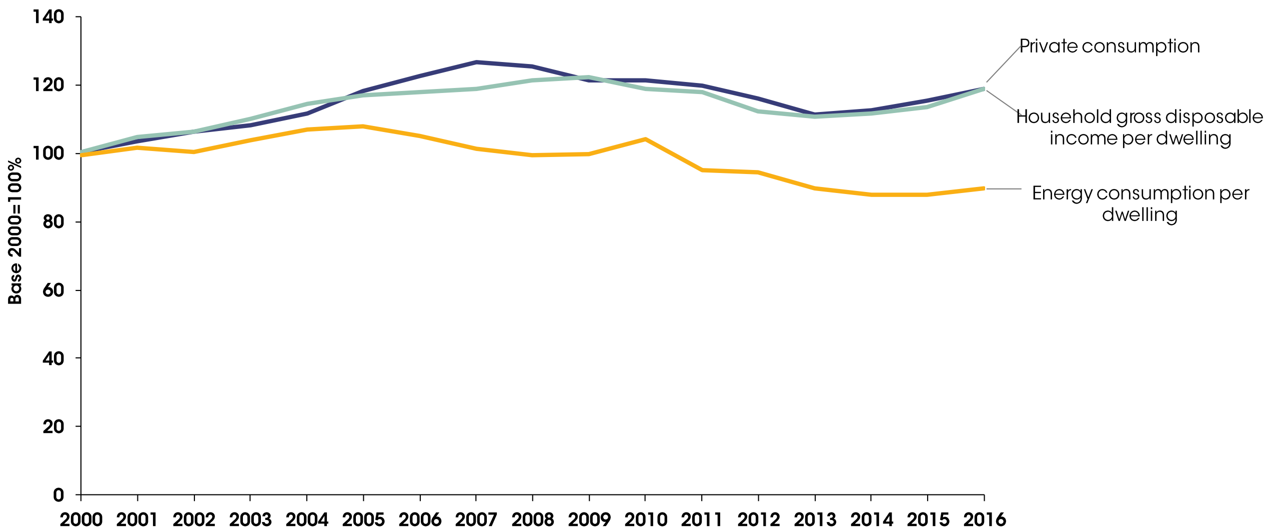


Figure 5.11 – Trends of income and energy consumption per dwelling in Spain. (ODYSSEE- MURE, 2016)

In terms of total energy spending depending on the energy label granted to each house, there may be a difference of up to 2,087 EUR/ year, as reflected by Figure 5.12, which reflects the importance and potential of energy efficiency renovations.

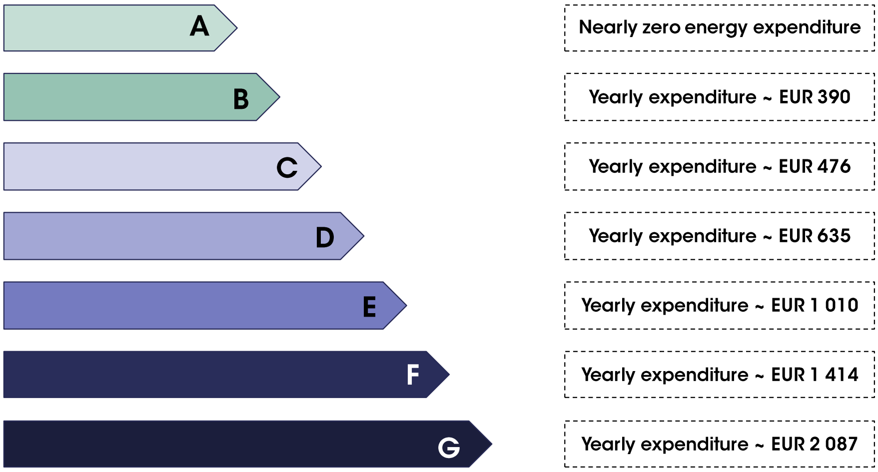


Figure 5.12 – House yearly energy expenditure by energy label. (Precio Viviendas, 2017)

5.3 The Residential Building Renovation Market

Introduction

Within the construction sector, experts consider that building renovations will continue to perform their usual stabilising function, thanks to their large market size combined with their low propensity to be affected by cycles.

Figure 5.13 represents the evolution of the number of licenses granted for renovations by municipalities, which reflects the steep fall in the market experienced when the crisis hit the Spanish economy. Since 2014, the segment has experienced a slight recovery.

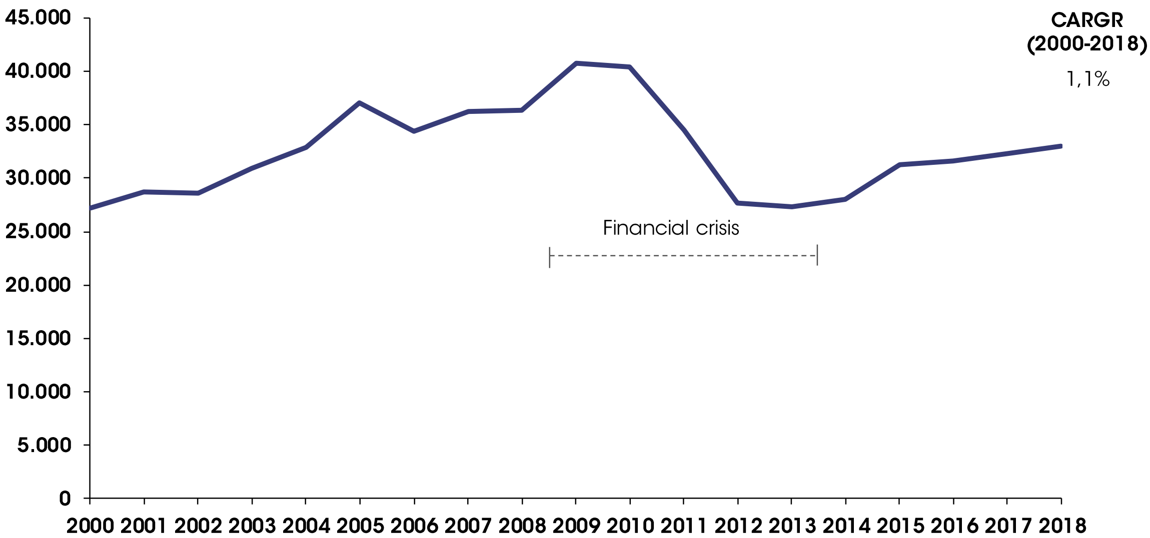


Figure 5.13 – Number of municipal licences granted for renovations across all sectors. (Ministerio de Fomento, 2019)

Considering the figures presented above, the number of buildings renovated as a percentage of total buildings stood, in 2017, at almost 1% of the total stock, with little difference in comparison to prior years. The general data on the evolution of the renovation´s number in the residential sector, renovated houses and budget for the material for the execution of the corresponding works, shows that the renovation sector has experienced sustained growth since 2014. In fact, the number of work permits granted for renovations and/or refurbishment increased by 14.8% between 2014 and 2018. For its part, the number of permits approved in the residential sector rose from 22,413 in 2014 to 25,963 in 2018, representing a 13.6%. increase.

Regulatory framework

The measures aimed at improving the energy performance of Spanish buildings are in line with the provisions of Directive 2010/31/EU on buildings energy performance. The Directive sets out the minimum energy performance requirements to be met by both new and existing buildings, the procedure for their energy certification and for carrying out periodic energy performance inspections, as well as the construction of buildings with almost no energy consumption.

This Directive has been transposed into Spanish law by means of the following Royal Decrees, which were updated to include the Directive:

1. Royal Decree 314/2006, approving the Technical Building Code (CTE, by its Spanish acronym), is the regulatory framework that establishes the requirements that buildings must meet in terms of safety and habitability, established in Law 38/1999. The CTE is made up of Basic Documents (DB), which are technical texts that set out the limits and basic requirements regarding structural safety, fire safety, safety in use, health, noise protection and energy saving. As for the Basic Energy Saving Document (DB HE), Order FOM/1635/2013, requirement levels for minimum energy efficiency were raised and are now being applied in new buildings, expansions and rehabilitation of existing ones, which have applied for building permits as of March 2014.

The DB HE in turn consists of six documents, the first four are oriented to energy efficiency and the last two to the incorporation of solar energy and renewable energy in buildings. Those relating to energy efficiency are as follows:

- **Document DB HE0 - Limitation of energy consumption**: limits the consumption of non-renewable primary energy used in new buildings with a private residential purpose.
- **Document DB HE1 - Limitation of energy demand**: hardens the insulation levels of facades, roofs and voids of the previous CTE and establishes criteria for interventions in existing buildings.
- **Document DB HE2 - Performance of Thermal Installations**: The basic HE 2 requirements are developed in the current Regulation on Thermal Installations in Buildings (RITE).
- **Document DB HE3 - Energy efficiency of lighting installations:** establishes mandatory compliance with an energy efficiency value of the lighting installation. It also incorporates obligations related to the regulation and lighting control , especially the use of natural light in perimeter areas of the building. The energy efficiency of a

lighting installation in an area will be determined by the energy efficiency value of the installation (VEEI); the electrical power installed in lighting is also limited.

Royal Decree 314/2006, in its last update in 2018, establishes the minimum requirements to be met by new builds and renovations, as reflected by Table 5.1.

Limits to non-renewable primary energy consumption (kWh/m²/year)						
Winter climatic zone	**α**	**A**	**B**	**C**	**D**	**E**
New buildings and extensions	**20**	**25**	**28**	**32**	**38**	**43**
Changes of use to private residential and renovations	**40**	**50**	**55**	**65**	**70**	**80**
In non-mainland territory, the values in the table are multiplied by 1,25						
Limits to primary energy consumption (kWh/m²/year)						
Winter climatic zone	**α**	**A**	**B**	**C**	**D**	**E**
New buildings and extensions	**40**	**50**	**56**	**64**	**76**	**86**
Changes of use to private residential and renovations	**55**	**75**	**80**	**90**	**105**	**115**
In non-mainland territory, the values in the table are multiplied by 1,25						

Table 5.1 - Minimum requirements for energy renovation of buildings. (Boletín Oficial del Estado, 2018)

2. Royal Decree 1027/2007, approving the Regulation on Thermal Installations in Buildings (RITE by its Spanish acronym) ,updated by Royal Decree 238/2013, modifying certain articles and technical instructions of the RITE: regulates the minimum performance requirements of thermal installations for heating, cooling, ventilation, production of domestic hot water and periodic inspection of energy efficiency, as well as design and sizing, assembly and maintenance.

3. Royal Decree 235/2013, approving the basic procedure for the certification of the energy performance of buildings: it establishes the obligation to make available to purchasers or users of buildings an energy performance certificate which must include objective information on the energy performance of a building and reference values such as minimum energy performance requirements so that the owners or tenants of the building or a building unit can compare and assess its energy performance. It also develops the methodology to be followed for calculating the energy performance rating, considering those factors that have the greatest impact on its energy consumption, as well as the technical and administrative conditions for buildings' energy performance certifications.

4. Law 8/2013, on urban rehabilitation, regeneration and renovation, subsequently amended by Royal Legislative Decree 7/2015, of 30 October, approving the consolidated text of the Land and Urban Rehabilitation Law. This law includes the obligation to have the Building Assessment Report, made up of three documents, one of them being the energy certificate of the building. Mandatory buildings are those of collective housing's residential type of that reach the age of 50 years, as well as the buildings whose owners intend to benefit from public aid. Therefore, and as a result of the application of this legislation, a significant part of the existing building stock will be obliged to carry out the energy certification of its buildings during the period 2014-2020, which will induce a part of them to carry out the energy efficiency improvement measures recommended in the energy certificate.

Directive 2010/31/EU makes it mandatory that by 31 December 2020 all new buildings have near zero energy consumption, and that by the end of 2018, new buildings that are occupied and owned by public authorities are also near zero energy buildings. Updating the Basic Energy Saving Document (DB-HE) and the requirements established therein is the first step towards the objective of achieving this type of buildings.

Potential

Buildings intended for housing built before 1979, date on which the Basic Building Standard on Thermal Conditions in Buildings (NBE-CT-79) came into force, do not present any type of insulation or constructive measure aimed at improving energy efficiency. Buildings constructed between 1980 and 2006 include certain measures that improve their thermal conditions, while buildings built after 2006 have been constructed following the Basic Document E of Energy Saving approved in the Technical Building Code (CTE-HE-06), so that conditioning and insulation have been taken into account, as well as some energy efficiency improvement measures which have been executed (Guillermo Arregui Portillo, 2010).

Residential sector buildings built prior to 1979 should serve as targets for the implementation of a comprehensive rehabilitation action with the objective of ensuring that energy efficiency targets are met. This would mean rehabilitating 48.5% of the total residential building stock.

The geographical distribution of the buildings built before 1980 is depicted in Figure 5.14. 58% of the residential stock is distributed in four Autonomous Communities (AA.CC), which in turn also house 59% of the Spanish population.

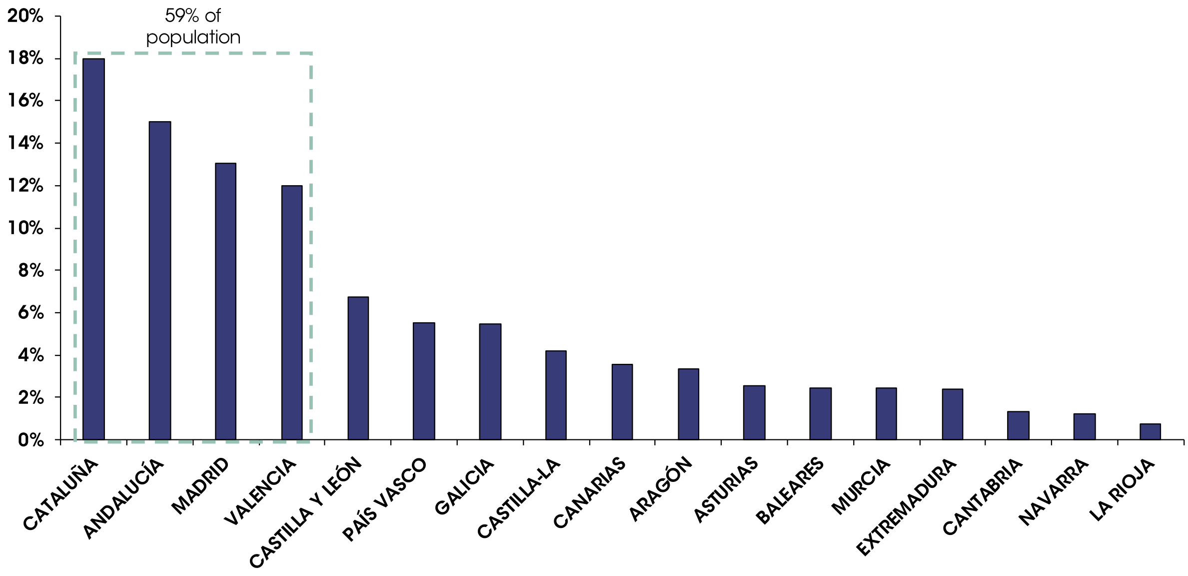


Figure 5.14 – Distribution of the residential building stock built before 1980 by AA.CC. Source (Ministerio de Fomento, 2017)

However, it is important to highlight that out of these four AA.CC, *Andalucía has a rate of almost 40% regarding the risk of social exclusion*, which could limit the available income to be destined to energy efficiency renovations. Furthermore, Communities like Canarias, Extremadura or the Autonomous City of Ceuta have rates ranging between 36% and 49%, which is especially concerning since one of the indicators used to calculate the rate is "severe material deprivation".

Severe material deprivation describes a household in which its members cannot afford at least four out of nine basic consumption concepts or items defined at the European level. One of said concepts is energy poverty, which is the situation where a household is unable to pay for enough energy to meet its domestic needs, or when it is forced to spend an excessive proportion of its income on paying the household's energy bill. This impacts the welfare of people who live there as it generates a lack of thermal comfort, reduced income available for other goods and services, poor habitability conditions, risk of non-payment and disconnection.

Figure 5.15 reflects the percentage of population in Spain, by AA.CC, that fall under the energy poverty line. This translates into 11% of Spanish households (equivalent to 5.1 million people) who declared themselves incapable of maintaining their dwelling at an adequate temperature during cold months. Furthermore 8% of Spanish households (equivalent to 4.2 million people) reported delays in the household bills' payment, including household energy bills, which would make it difficult for them to access on-bill financing for energy efficiency renovations (Asociación de Ciencias Ambientales, 2018).

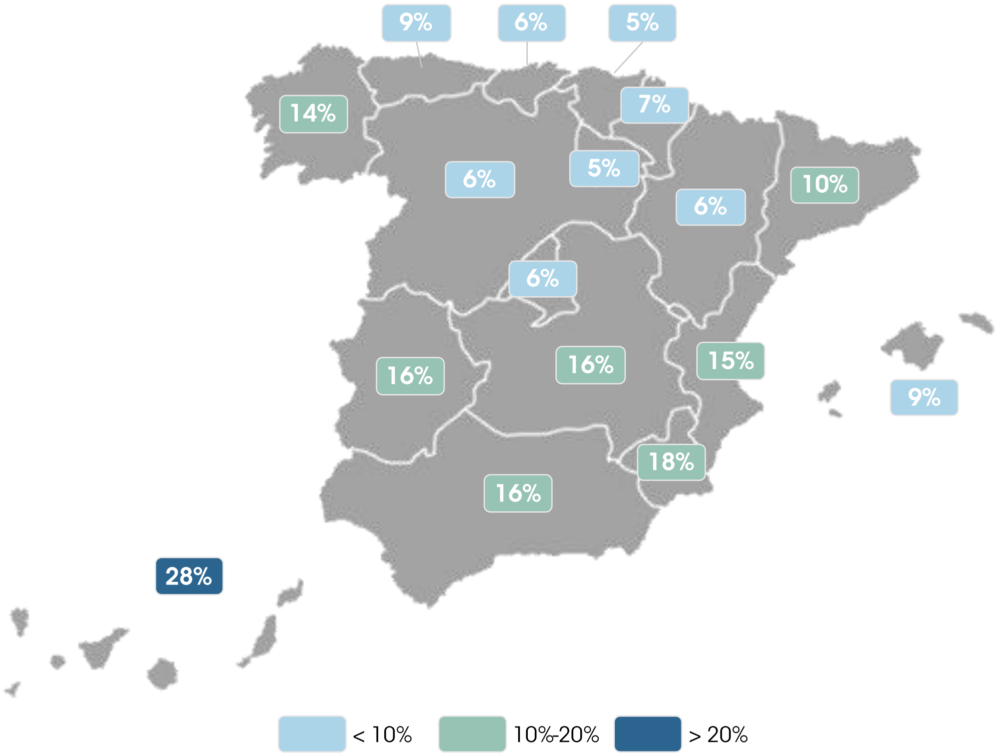


Figure 5.15 - Percentage of population at risk of energy poverty in Spain by Autonomous Communities. (Asociación de Ciencias Ambientales, 2018)

Evolution of the sector

In 2016, the total value added of the broad construction sector amounted €66.5 billion (Figure 5.16), with narrow[31] construction having the largest share (53.6%). The total value added of the broad construction sector was on decline until 2014, with a slow recovery until 2016, however it still was 3.7% lower than in 2010. The share of gross value added of the broad construction sector in the GDP decreased by 12.6% between 2010-2015, reaching in 17.1% in 2015, with real estate activities having the largest contribution (9.9%) (Figure 5.16).

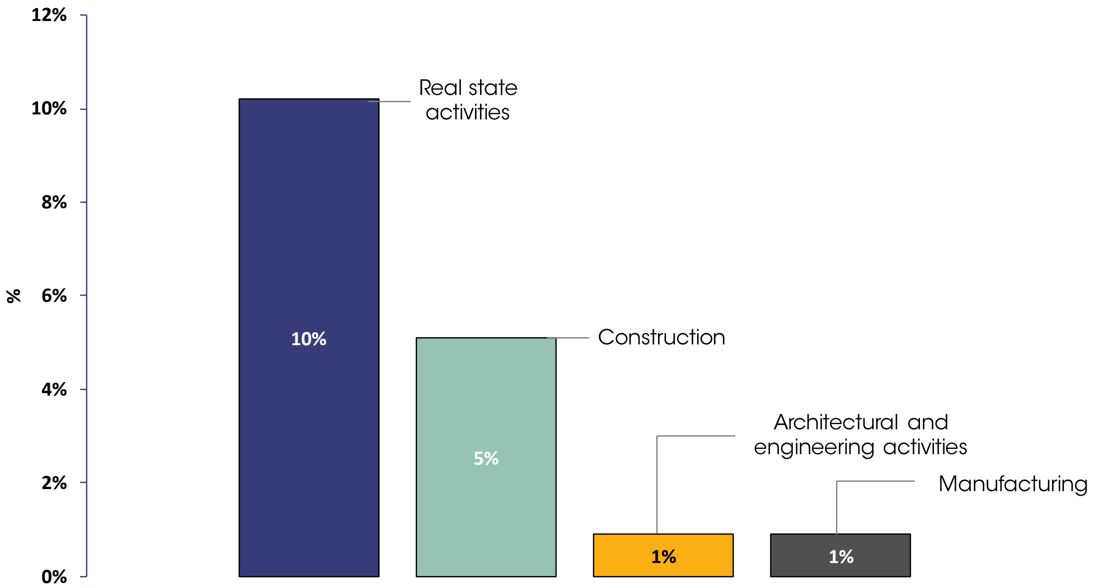


Figure 5.16 - Gross value added as share of GDP in the construction sector in Spain in 2016 (European Commission, 2018)

According to the Survey on the Structure of the Construction Industry of the Ministry of Development, business turnover in the renovation market reached €23,600 million in 2006, representing 15% of total investment. This participation, which came largely as a result of the drop in investment in new construction in recent years, increased from 15% to 62% of the total in 2015 and 55% in 2017. The turnover of residential construction in 2017 was €44,294 million, distributed as indicated earlier, 55% of which came from the renovation market and 45% from new construction.

[31] "Narrow" refers solely to on-site construction activity, and the "broad" encompasses the quarrying of construction materials, the manufacture of building materials, the sale of the final products and associated professional services such as facilities management (Andrew Foulkes, 2003)

Year	Total (€ million)	New build	Renovation
2002	90,120	73,335	16,785
2003	105,489	86,931	18,558
2004	112,579	93,420	19,159
2005	145,004	123,241	21,763
2006	157,184	133,572	23,611
2007	146,478	125,115	21,362
2008	112,352	88,090	24,261
2009	79,546	60,763	18,782
2010	62,198	40,408	21,789
2011	46,660	23,830	22,829
2012	38,479	17,369	21,109
2013	30,247	13,253	16,994
2014	29,573	13,026	16,547
2015	31,715	12,052	19,662
2016	34,734	13,931	20,802
2017	44,293	19,829	24,464

Table 5.2 - Turnover from residential construction sector. (Ministerio de Fomento, 2019)

The number of enterprises in the Spanish broad construction sector amounted to 653,117 in 2016. Companies in the narrow construction sector accounted for 60% of the total number of enterprises, followed by real estate activities (21.1%), architectural and engineering activities (13.8%) and manufacturing (5.2%). Spain experienced a sharp drop in the number of construction companies between 2010 and 2013 (-12.4%), but steady recovery in the following years (+16.9%) led to the 2.4% increase recorded in 2016 compared to 2010 values. The biggest increase since 2013 has been reported in narrow construction (22.4%), followed by real estate activities (18.9%), whereas the number of companies in the manufacturing sub-sector, and architectural and engineering activities only increased by 0.1% and 1.1% respectively (European Commission, 2018).

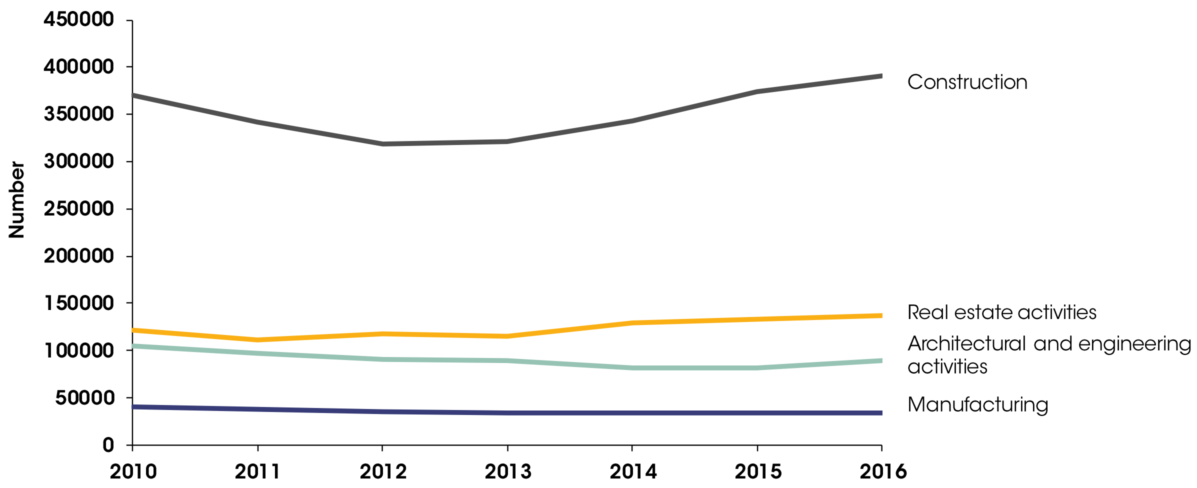


Figure 5.17 - Number of enterprises in the construction sector in Spain over 2010-2016. (European Commission, 2018)

After being the most damaged sector during the crisis the construction sector closed 2018 with a rate of job creation not seen since 2000: in the last quarter of the year full-time jobs increased by 12.3% (year-on-year), an increase that had not been seen in Spain for eighteen years.

The 2018 National Accounting statistics, released by the National Statistics Institute (INE, by its Spanish acronym), show that construction is the economic sector in which employment is created most rapidly, since both employment in general and full-time jobs or the number of paid hours reached their peaks last year. Construction is followed, quite a distance away, by a closely related sector: real estate activities, in which the number of employed grew by 7% year-on-year in the last quarter.

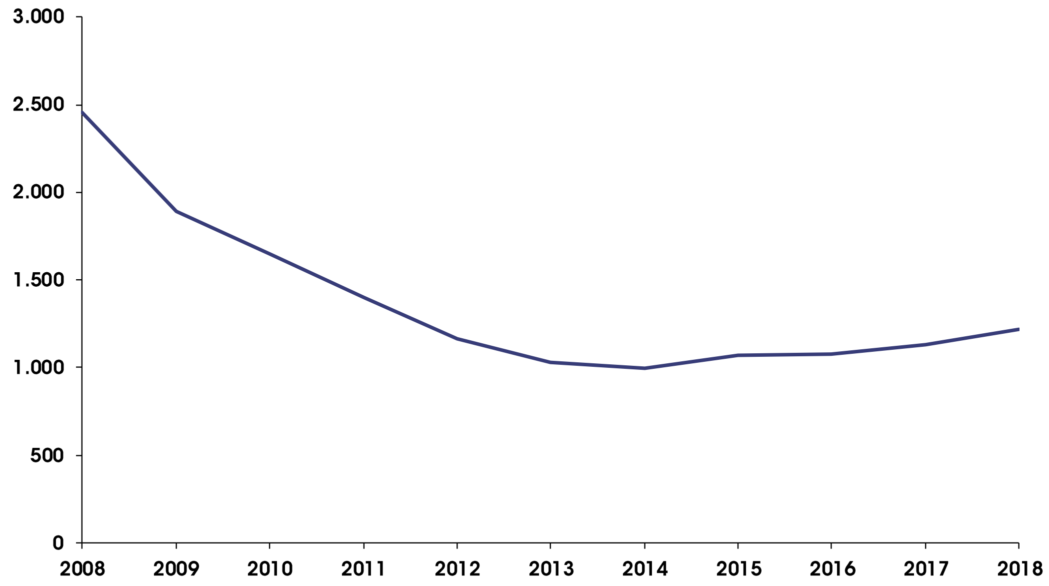


Figure 5.18 – Evolution of employment in the construction sector (thousands of people). (Instituto Nacional de Estadística, 2018)

Utility companies

The Spanish energy sector

Spain has 100 GW of installed power, which provided the network with almost 270 000 GWh of electricity over 2018. The main generation sources are nuclear plants, wind farms, coal and hydroelectric plants.

Generation

Provided by several private companies, Spain has an installed power capacity of 100 GW and generated 268,808 GWh of energy in 2018. The energy is generated by different technologies, being nuclear, renewable and hydraulic the most relevant. Spain is a net energy importer, it has very few reserves of fossil fuels, so their policy is to increase the participation of renewable energies in their power generation mix to become less energy dependent.

As reflected by Figure 5.19, the use of gas to produce electricity has decreased more than 50% since 2009. On the other hand, wind and solar energy have increased their share in the mix and coal, nuclear and hydro have remained stable.

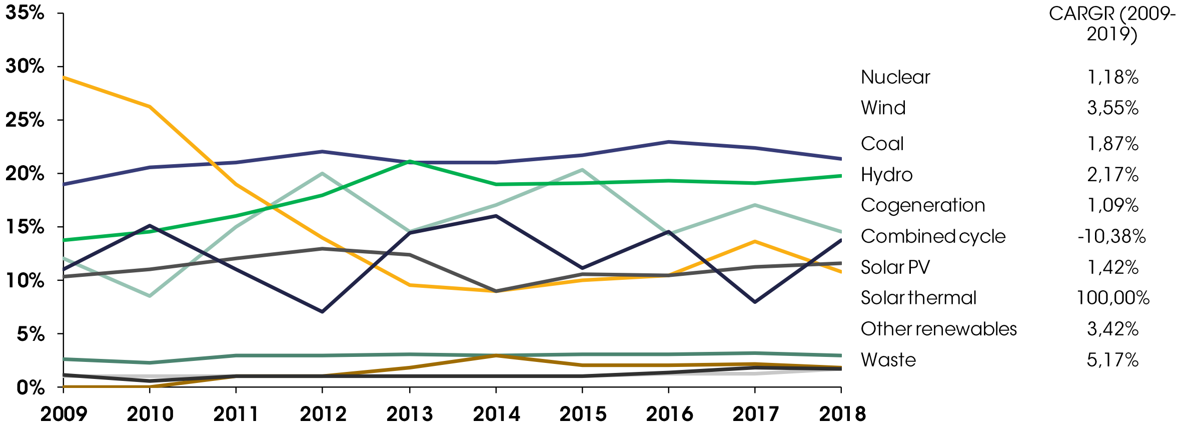


Figure 5.19– Generated energy in Spain in 2018 by technology. (REE, 2018)

Transportation

Provided by Red Eléctrica de España (REE), a public-private company which has the monopoly of the transportation and operation of the high voltage energy network. The state owns 20% of the company's stock, while the remaining 80% is privately owned. It has 1,700 employees and 42,000 kilometers of high voltage lines. It is in charge giving the permission to new projects of more than 1 MW of power inject energy into the system.

It is also in charge of operating the high voltage electric system. Its main goal is to secure the transportation from the power generators to the distribution network. REE is also in charge of matching the energy generated with the consumption so there are no frequency gaps.

Distribution

It is an oligopoly of five big utilities (Endesa, Iberdrola, EDP, Repsol (Viesgo) and Naturgy), who are in charge of distributing energy from the high voltage transportation lines to final consumers. The consumer cannot choose the distributor as each company has the monopoly of a specific area. Over the last four years, seven independent electricity companies have increased their share of the low-voltage market by 6%, reaching 9.6% in 2018, and exceeding 1.7 million customers.

Distribution Company	Market share (%)	Energy distributed 2018 (GWh)	Length of their distribution lines (Km)	Description
Endesa	42.7	117,029	319,613	It is the biggest Spanish utility with 74,193 GWh produced during 2018. It is also the biggest distributor. The Italian Enel is the controlling shareholder since 2009
Iberdrola	39.2	93,897	268,570	It is the world's biggest wind-power producer. Apart from energy generation it also has a company dedicated to distributing electricity and another one to commercialize it.
Naturgy	13.2	41,822	65,000	Formerly Gas Natural Fenosa its main business is in the gas sector, but also generates, distributes and commercialises electricity.
Viesgo	2.5	6,700	31,292	Owned by the German utility E.ON. Its core business is electricity distribution, but they also generate electricity with renewable sources and thermal plants.
EDP	2.4	9,360	20,709	It is the Spanish subsidiary of Portuguese EDP, the biggest utility in Portugal. It has almost 6 GW of installed power in Spain and they also commercialize and distribute electricity.

Table 5.3 - Spanish Electricity Distributors

Commercialisation

There are three types of contracts that can be offered to a customer. The first is called regulated market contract, the second is an annual contract with a fixed price and the third is the free market.

On the regulated market, the price varies according to supply and demand, and it is only available for customers with an installed power of 10 kW or less. The second type of contract is an annual contract where the customer pays a fixed price over the twelve months. The free market has a fixed price which is written down on a contract (it can be one price for day and other for the night, the same price all day long, or other kind of arrangements), so customers know how much they are going to pay for each kWh consumed.

The Spanish market has 29 million customers of which 18 million are free market consumers. Five companies have 75% market share in volume and 93% in consumers (Naturgy, Iberdrola, Viesgo, Endesa, EDP), but lately smaller companies have been attracting clients from them (see Figure 5.20). These five big companies also operate the gas market.

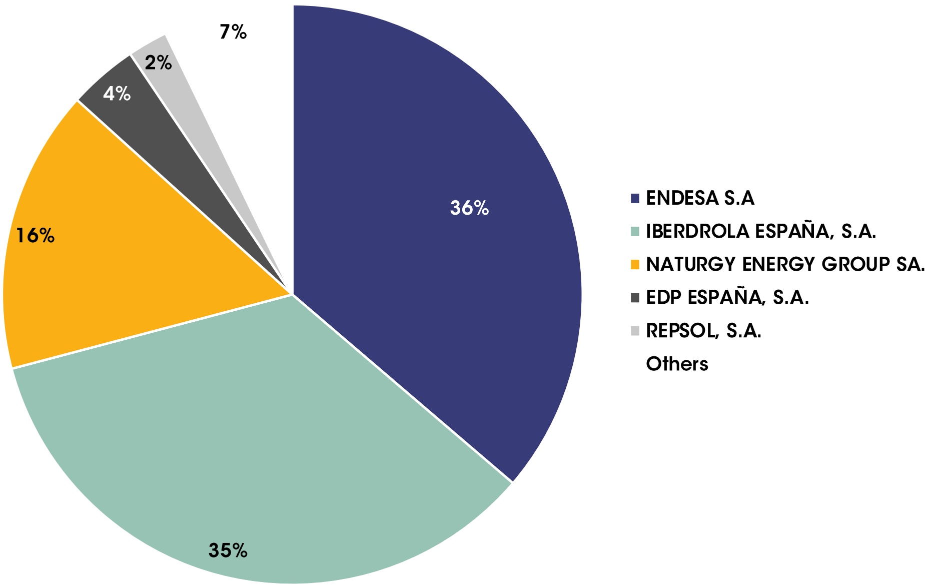


Figure 5.20 - Market share by consumers of the commercialisation. (CNMC, 2018)

Churn rates have seen an important decrease in the electricity sector since 2011. However, this has not been the case in the natural gas sector, as in 2016 almost 20% of customers decided to switch their provider. No clear trend has been identified which could justify this.

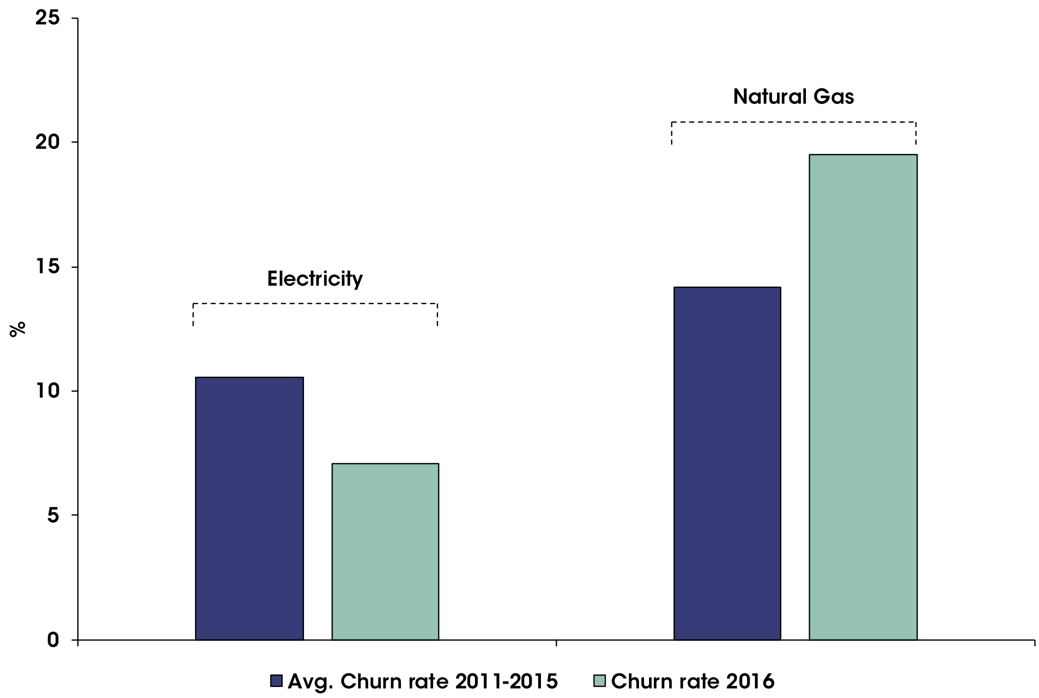


Figure 5.21 - Churn rates for electricity and gas household customers in 2016 and annual average 2011-2015 (%). (CEER, 2017)

Energy renovations in residential buildings

According to data by the Ministry of Development, over the past 4 years (2014-2018), around 60% of the renovations conducted in residential buildings had the implementation of energy efficient measures as an objective. Considering this, from the total of reforms presented in Figure 5.22, in 2018, about 16,000 of them targeted energy efficiency.

Statistics reveal that the maximum number of building renovations was reached in 2005, with a total of 45,931 permits granted. Thus, the 26,024 recorded last year represent 56.6% of that figure, just over half.

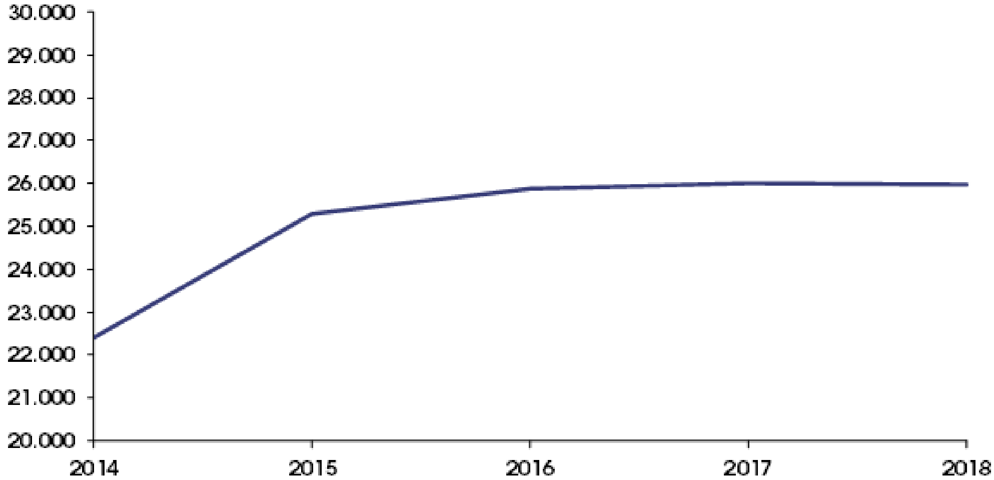


Figure 5.22 –Number of municipal licences granted for renovations in the residential sector. (Ministerio de Fomento, 2019)

Measures for residential building renovations

When it comes to the implementation of energy efficiency measures in the Spanish residential sector, the most implemented ones are window's replacement and substitution of existing hot water generators by more efficient installations.

Each building, depending on its characteristics, will have a potential for improvement; there are houses in which carrying out rehabilitation measures can achieve significant economic savings and windows are a key element in the insulation of a house. In Spain, because of weather conditions, sometimes it is enough to improve window sealing, where leaks often happen allowing the heat to escape, or insulate blind boxes for the same reason. Replacing hot water generators with more efficient ones is the second most recommended measure. There are houses with very old water heaters and the investment in a more efficient current equipment can achieve important savings.

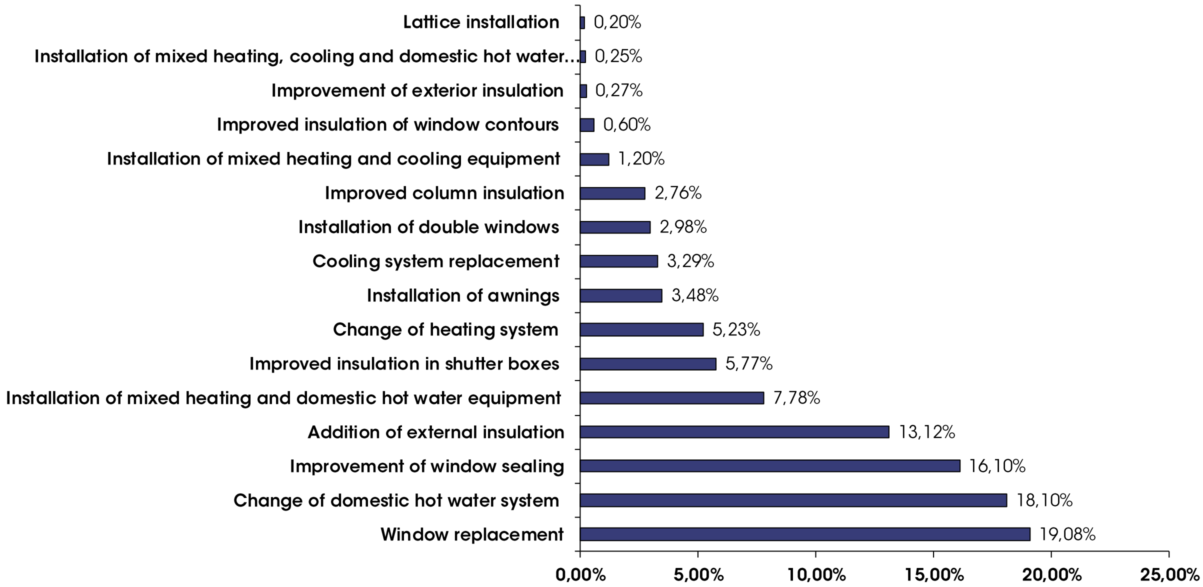


Figure 5.23 - Most common energy efficiency measures. (Ecobservatorio, 2018)

When it comes to savings generated, the World Wildlife Fund estimated the impact of energy improvement proposals on an average home in Spain in terms of final energy consumption, energy demand and CO_2 emissions. These results are reflected on Figure 5.24, taking into account five improvements for existing dwellings of different nature, which are:

- **E1 Trend**: initial situation of the building without renovation
- **E2 Insulation + (1st improvement insulation levels):** it considers an improvement of the maximum levels permitted under HE1 of the CTE for thermal transmittance parameters of soils, covers and facades as well as measures to improve treatment of cracks and thermal bridges
- **E3 Insulation ++ (2nd improvement insulation levels):** The improvements introduced in the E2 solution (Insulation+) are reinforced to incorporate criteria used in the PassivHaus standard: a highly isolated building envelope (maximum U-value of 0.15 W/ m2 K) and heat recovery for the air extracted from the house
- **E4 Renewables:** considers the incorporation of solar thermal energy to produce domestic hot water (coverage 60% - 70%, according to the climate zone) and photovoltaic solar energy for electricity consumption (10%)
- **E5 Renove Plan:** the impact on energy consumption of the existing residential buildings of the implementation of the Renove Plans for boilers and air conditioners are considered, according to the development they are experiencing in the different Autonomous Communities with the implementation of the Savings and Energy Efficiency Plan
- **E6 Mix:** the combined action of planned improvement on the insulation of the building under E3 (Insulation ++), E4 (Renewables) and E5 (Renove Plans) is analysed

Measures related to the improvement of insulation levels are the ones that offer the best results per house in terms of energy savings, reduction of emissions and economic profitability. With the modernisation of thermal equipment and the installation of solar energy systems, the average house consumption can be reduced between 12.4% and 23.2%, respectively, while increasing the levels of insulation of the building would bring much higher reductions, between 57% and 72%, depending on the depth of the improvements carried out.

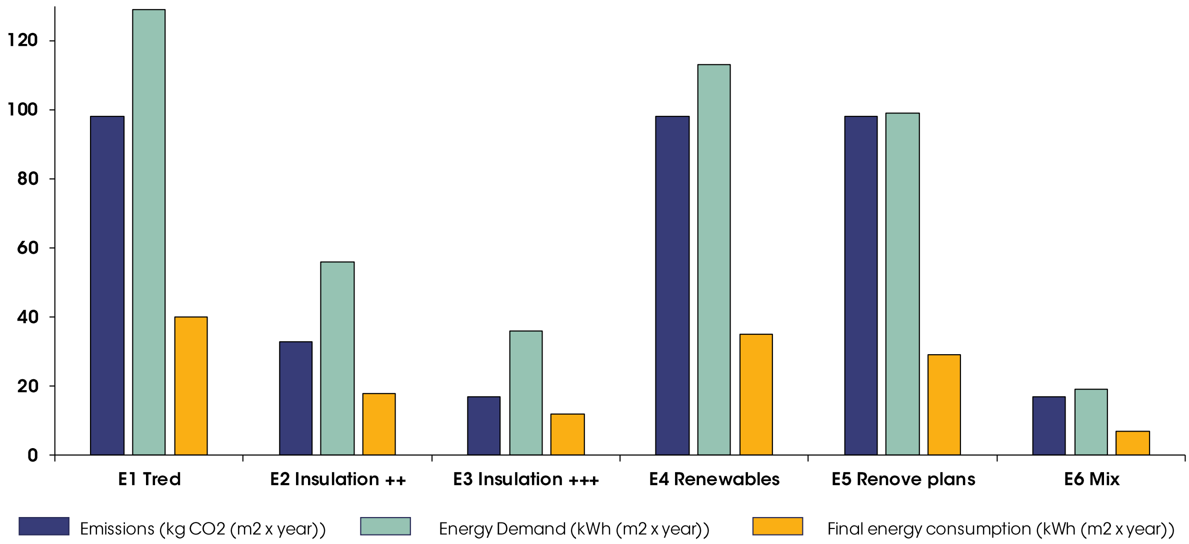


Figure 5.24 – Potential energy savings and CO_2 emission reduction in an average household from Spain's existing residential building stock. (Rincón, 2013)

The effect of incorporating more efficient equipment and solar installations, after having previously improved the insulation levels of the building with criteria close to that of passive homes, would further reduce energy consumption by more than 85% and CO_2 emissions per house by more than 82%, with respect to those the same building would have without the improvement (Rincón, 2013).

In terms of energy savings, Table 5.4 describes the estimated savings achieved by the implementation of the most relevant energy efficiency measures, where it can be observed that no measure generates energy savings under 40%.

Measure	Explanation
Substitution of lighting	Lighting represents the 12% of the total consumption within the residential sector. The substitution of conventional lighting by LED involves approximately a 90% of energy savings
Use of heat pumps	Heat pumps are used for heating and domestic hot water. Since the performance is greater than 300%, they can reduce a household's energy consumption by around 40%.
Replacement of windows	About 15% of energy losses come from old windows. Replacing them by new double-glazed windows could result in a reduction of energy losses of 40%-80%.
Substitution of appliances	Appliances consume over the 60% of the total electricity consumption in the residential sector, with refrigerators accounting for almost 20%. Replacing an old refrigerator with a G energy label by another one with an A energy label could save over the half of is consumption.
Enclosure	Approximately 75% of a home's energy losses occur through the exterior walls, roof and soil. Thermal insulation helps reduce losses.

Table 5.4 – Measures for residential buildings and estimated savings. (Ministerio de Fomento, 2014)

5.4 Potential Impact of Building Energy Renovation on the Spanish Market

National energy consumption

Energy consumption in the residential sector is relevant for the design of energy policies and strategies due to its weight in the final consumption. In Spain, for example, it accounts for 17% of final energy consumption and 25% of final electricity consumption, compared to 25% and 29%, respectively, for the European Union as a whole. The increase in the number of households and the improvement in equipment have influenced this sector's upward trend regarding energy consumption.

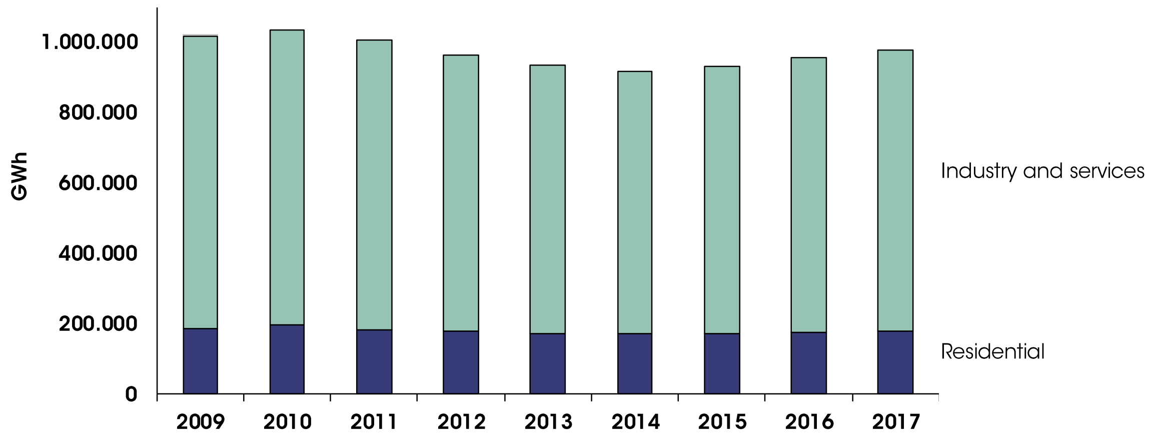


Figure 5.25 – Evolution of residential energy consumption in Spain. (IDAE, 2018)

As reflected by Figure 5.25 above, and as it is the case in most European countries, the energy consumption of the residential sector is relatively low in comparison to the total consumption of energy in Spain.

After a decrease in energy consumption from 2009 to 2013, due to the 2008 crisis, demand started recovering and growing constantly again. This growth relied on the reactivation of the economy for industrial and services consumption. On the other hand, residential consumption was driven by a slight recovery on residential building development. In 2018 energy consumption grew 1.8% but was not close to the world energy consumption growth which was 2.9%.

The average total annual energy consumption of Spanish households is 9,908 kWh, with an average annual electricity consumption per household of 3,487 kWh, and an average total energy expenditure of 990 EUR/year. On the other hand, the average consumption of households whose dwelling is a flat is 7,547 kWh, while households in single-family dwellings consume slightly more than double the energy (15,514 kWh). The geographical variation in consumption is also relevant: in the Atlantic climatic zone the average annual consumption per household is 9,292 kWh, compared with 8,361 kWh in the Mediterranean zone and 12,641 kWh in the continental zone.

In terms of the structure of consumption by energy source, the weight of electricity consumption stands out (35% of the total, on average), followed by consumption of natural gas (25%), oil derivatives (22%) and renewable energies (18%). On the other hand, heating is the service that consumes the most energy on average in Spanish households (47% of the total), while in terms of electricity consumption the consumption of electrical appliances stands out (55% of the total, with an equivalent average consumption of 655 kWh for refrigerators compared to 254 kWh for washing machines, 245 kWh for dishwashers, 145 kWh for computers or 119 kWh for television) (Energía y Sociedad, 2017).

Potential of energy savings

In line with the European objective, the Spanish National Action Plan for Energy Saving and Efficiency (PNAEE, by its Spanish acronym) 2017-2020, contemplates a series of actions aimed at reducing energy consumption and costs in all economic sectors by means of energy efficiency actions, with the aim of meeting Europe's objectives of 20% by 2020 and 27% by 2030.

The Spanish strategy presented by the Ministry of Development in 2017, in addition to fully satisfying all the requirements of the Directive, was an important starting point for the promotion of energy rehabilitation of the building sector in Spain, as well as a roadmap that allowed to guide the different agents involved in the rehabilitation processes, in their respective spheres of activity achieving the best valued strategy in the entire European Union.

The forecast primary energy consumption in 2020 is 122.6 Mtoe, which represents a reduction of 24.7% with respect to the reference or trend scenario, across all sectors. Based on this, estimations have been conducted by UNIGE which predict a cumulative energy consumption reduction in the residential sector from energy renovations between 2018 and 2030 of 14.4% (Figure 5.18).

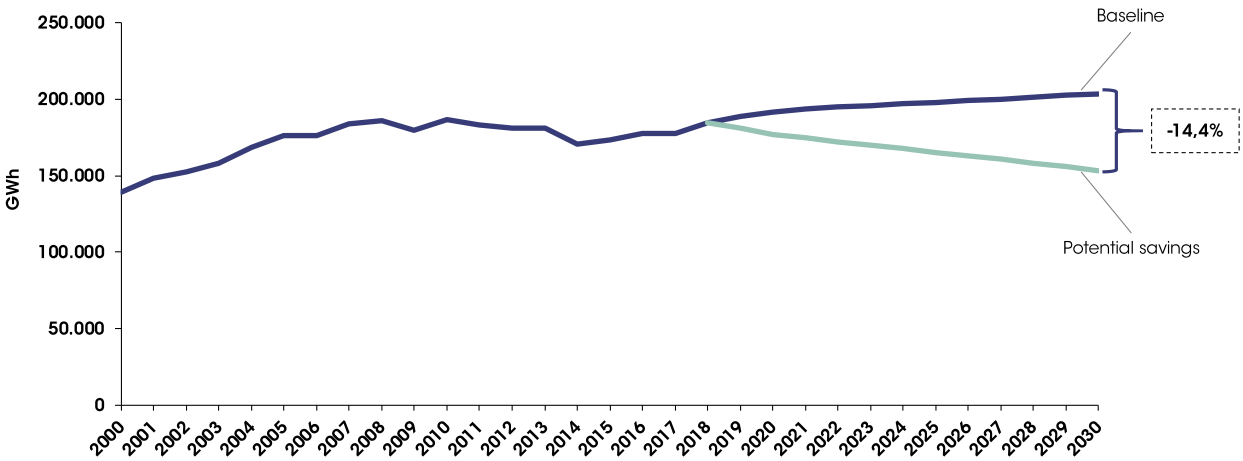


Figure 5.26 – Estimation of the baseline and potential savings (Eurostat, 2020) (World Bank, n.d.)

Potential market impact

The renovation segment, both of buildings and of dwellings, has recorded the smallest decrease in construction activity as a whole and is also among those with the greatest potential to reactivate activity in the sector, given the demographic evolution in Spain (mainly the move from rural areas to cities) and the need to adapt the housing and equipment stock to the new environmental, energy and social requirements.

Several variables fuel the expectations of a positive future development of the market for energy efficiency renovations in Spain in the upcoming years. On the one hand, although economic growth in the country has slowed down, it is still expected to grow at rates faster than other European economies, which results in financial stability and increase in consumption.

Another variable to be considered is the country's unemployment rate, which after peaking in 2013 at 27%, has experienced a constant decline since, reaching 14.5% in 2018. Much as economic growth, low unemployment rates reactivate the economy as income increases leading to higher rates of personal spending. If these numbers are analysed specifically for the construction sector, over 2019 it will experience an employment growth of 3.4%, ahead of industry (2.4%) and services (2%). This growth will continue in 2020 (although it will slow down) with at a rate of 1.5%, which translates into 60,000 jobs created.

Estimations conducted by ANDIMAC[32] predict an increase in spending on renovations in 2019 of up 4.4% over 2018. Average spending per household will stand at €681/ year, which adds up to €17,514 million. The disaggregated data by Autonomous Community is reflected in Figure 5.27, where the Baleares Islands stand out among other AA.CC with an average yearly spending of €840.

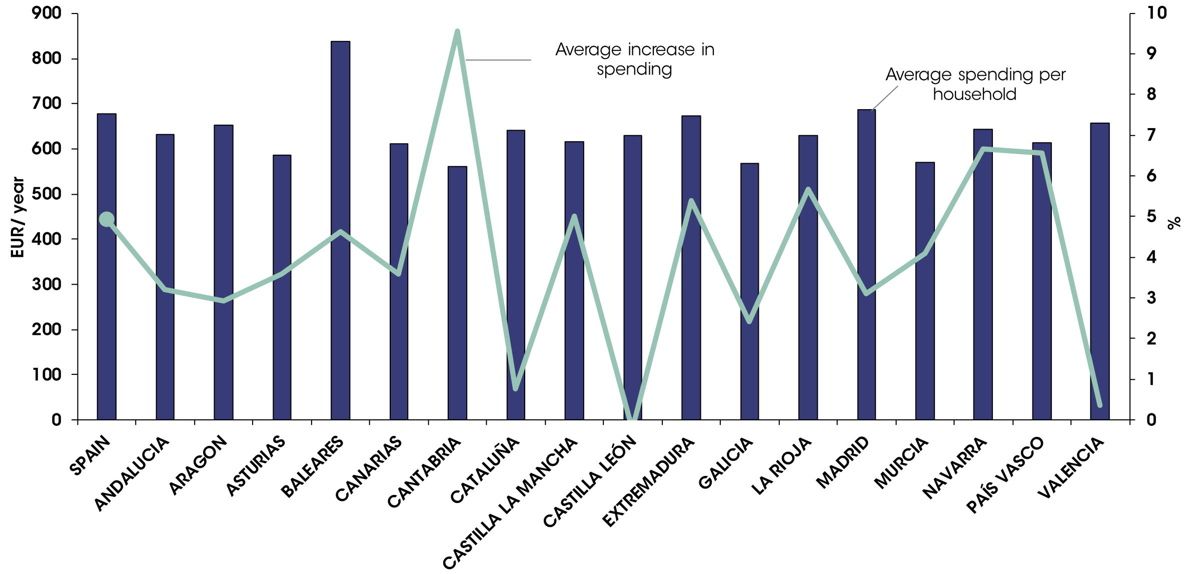


Figure 5.27 – Average annual spending on renovations per household and Autonomous Community and increase in spending in 2019. (ANDIMAC, 2018)

ANDIMAC's report highlights the launch of subsidies for renovations that now include work executed in the interior of the house as another boost for the sector, as 55% of the total residential building stock can benefit from them.

Another opportunity is present in the fact that Spain is undergoing a "renting boom". Because of this, landlords tend to invest in their properties as rent prices can be increased by up to

[32] National Association of Ceramics and Construction Materials

30% for renovated flats. This also applies for the sale of second-hand homes, 70% of which are renovated before or after the operation is closed.

In conclusion, the Spanish economic outlook together with the opportunities presented for landlords and by available subsidies predict a steady growth of the residential renovation sector.

5.5 Financing the Energy Renovation of Buildings

Introduction

In Spain, a wide range of official grants and subsidies are available to finance energy efficiency renovations in the residential sector, managed by the different Public Administrations, as well as tax deductions. In addition, many Autonomous Communities have plans for the renovation of windows and other building parts.

The adopted financial solution will depend on the type of dwelling and the particular circumstances of the property. In single-family houses the decision is simpler because there is no need for the inhabitants to reach consensus. The rehabilitation of collective properties forces the different neighbours to come to an agreement on how they wish to finance the renovation. For each case there are effective and profitable solutions, supported in many cases by financing plans and subsidies from the public administration.

In 2017, the Ministry of Development conducted a survey in which they enquired participants from the residential sector about the most occurring financing methods for energy renovations. As reflected by Figure 5.28, 58.7% of those surveyed stated that they are financed through extraordinary expenses from community owners, while 19.9% would do so through savings.

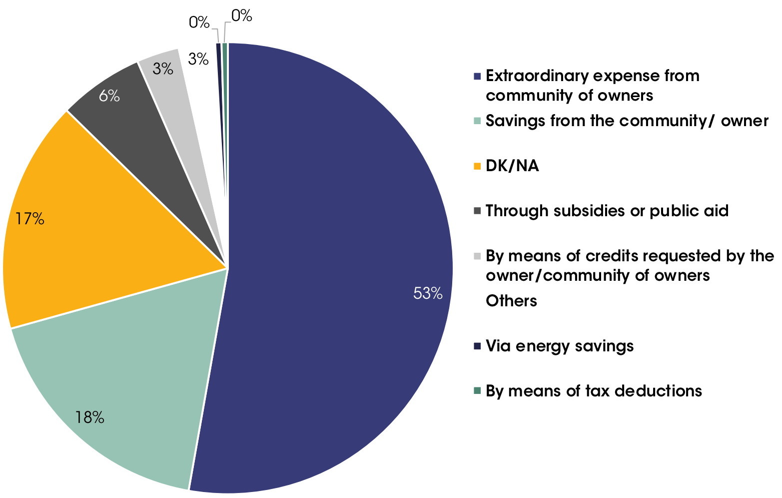


Figure 5.28 – Most common financing methods for energy efficiency renovations in Spain. Source (Ministerio de Fomento, 2017)[33]

[33] DK: Does not know
NA: no answer

Public support programmes

Grants, subsidies and credits

As mentioned above, the Spanish Government offers various schemes through which owners can benefit when conducting energy efficiency renovations in their buildings. In terms of subsidies and public financing, the main mechanisms are described below:

- **Plan de Vivienda 18-21 from the Ministry of Development**: the plan consists on subsidies for the renovation of residential buildings constructed before 1996. €1,443 million will be destined for this plan which foresees contributing to 557,000 subsidies. The amount of the subsidy will depend on the energy efficiency certification of the building and/or whether the beneficiary has a disability:
  - Up to 40% of the cost of the renovation or €12,000. In case the beneficiary has a disability, the amount subsidized can increase up to €24,000
- **Institute for the diversification and energy savings (IDAE, by its Spanish acronym)- Aid programme for the energy renovation of existing buildings (PAREER-CRECE):** IDAE will destine 200 MEUR/year to promote renovations through subsidies and low interest loans (Euribor + 0%)
  - The subsidies can cover up to 30% of the cost of the reform and the loans up to 70%
- **Official credit institute (ICO, by its Spanish acronym) loans to rehabilitate and improve the energy-efficiency of buildings and dwellings:** these are aimed at rehabilitating homes and buildings in order to improve energy efficiency and make responsible use of resources.
  - This funding can be applied for by individuals and communities of owners who want to carry out reforms to improve the quality of housing, residential buildings and their common areas. It is possible to refurbish both normal and second homes, as long as it is in the national territory, and tenants can also apply for this financing provided that their rental contract lasts at least the repayment term of the loan.
  - It is possible to finance up to 100% of the cost of the renovation project, including VAT, provided that the services are executed by an independent third party and proof of payment is provided. If the project is of great importance, it will be necessary to provide all the documentation accrediting the works to be carried out: project work, licenses and authorisations required for the execution of the works.
  - The only limitations to be considered are that the works must be executed within a maximum period of one year from the signing of the loan and the maximum amount that can be requested is €12.5 million. Repayment terms range from 12 months to 20 years.

Tax rebates and incentives

Value Added Tax

Royal Decree-Law 6/2010 of 9 April states that renovations that fall under the following categories will be subject to tax rebates:

"Those which have as their object the improvement of energy efficiency, hygiene, health and protection of the environment, the use of renewable energies, security and water tightness, and in particular the replacement of installations for electricity, water, gas or other supplies, or which favour accessibility to the building or dwellings, in the terms provided for in Royal Decree 2066/2008, of 12 December, regulating the 2009-2012 State Housing and Rehabilitation Plan, as well as the works to install telecommunications infrastructures carried out during that period that allow access to the Internet and digital television services in the taxpayer's primary residence."

Taking this into account, renovations conducted in common areas, such as swimming pools or sports facilities, as well as parking spaces, would be excluded from the tax rebates. The programme allows the deduction of up to 10% of the cost of the renovation or up to €7,000 from the VAT (Value Added Tax).

Property Tax

Another tax to which rebates can be made is the IBI tax (property tax, by its Spanish acronym). In order to qualify for this reduction, the building will need to have the highest energy efficiency certifications.

This type of reduction is carried out by municipalities; therefore, the application may vary depending on the municipality. However, all follow the same methodology, which is to grant the greatest rebates to house buildings with type A certifications and decrease as the efficiency of housing goes down.

Impact of public support programmes

The PAREER-CRECE programme registered as of 2017, 2,488 applications for subsidies representing €269 million of aid requested, exceeding the planned budget by 35%. Thus far, 1,010 applications have been favourably evaluated, representing €120.7 million in aid. The applications evaluated favourably so far involve improving the energy efficiency of 32,798 dwellings, 4,031 rooms in 28 hotels and 3.1 million m^2 total surface area conditioned.

The average investment ratio per application submitted is €200,000 and the average aid granted is €120,000/application. As for the type of grants, 48% of the aid corresponds to direct subsidies and the remaining 52% to reimbursable loans. Regarding the type of action carried out, of the four types of actions contemplated in the programme, the change of thermal insulation was the action that received the most economic support, with 86% of the aid, followed by the improvement of thermal and lighting installations (14%), the substitution of fossil fuels by biomass (3%) and, finally, the substitution of conventional thermal installations by geothermal energy, with 1% of the aid (Figure 5.29).

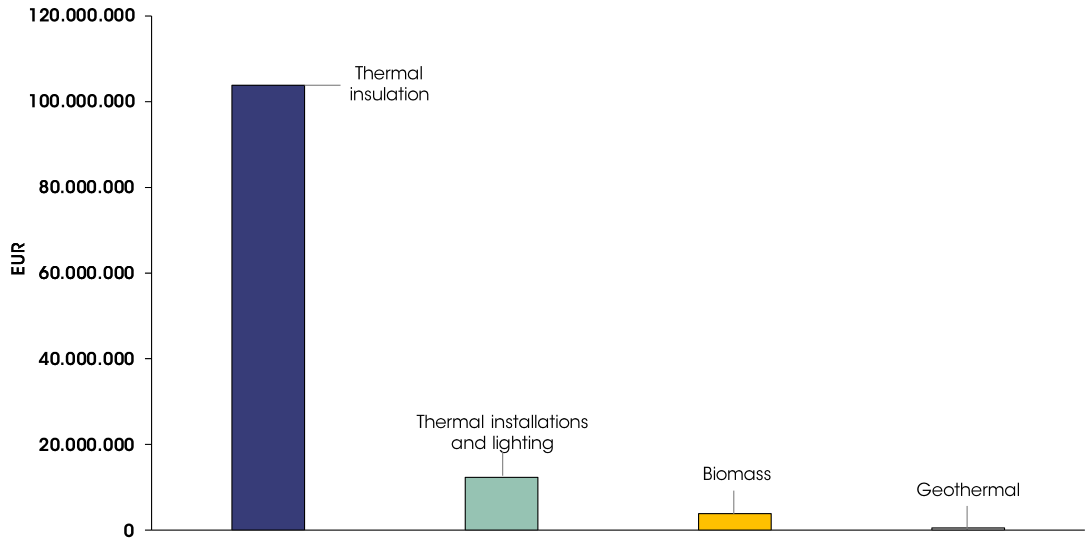


Figure 5.29 - Aid granted by type of action of the PAREER-CRECE Programme. (Ministerio de Energía, Turismo y Agenda Digital, 2017)

Private financing schemes

As reflected by Figure 5.28, renovations in Spain are mostly funded by **owner's own resources**, which is the first method to be considered. Financing projects using one's own funds is an alternative that must be considered either to finance the totality or to finance part of the project. Financing with private funds can not only help reduce financial costs, but also gives a freedom not enjoyed when using third-party financing.

It is very frequent that, even when the owner has the necessary funds to execute the work, external financing is requested, for diverse reasons such as:

- Financing is cheaper than what can be obtained for money in the market. This can happen in the case of subsidized loans, public credit lines, etc.
- Tax reasons, as with financing citizens can apply for rebates

Third-party financing

Loans

Many entities offer regular loans to finance renovations, but some maintain specific products in their portfolio. Bearing in mind that the final characteristics will depend on the profile of the applicant, in general terms interest rates tend to move around the 6% mark, although there are those that start at 4%.

The minimum financing usually starts at €3,000 and can be extended to €60,000, and the repayment terms move between five and ten years. Commissions depend on the policy of each entity and may or may not exist. If they exist, they are added when the loan is opened and do not exceed 1.0%.

The requirements to formalize a loan for renovations are no different from those of a consumer loan. Thus, the bank will study the credit profile of the applicant. An owner's habitual bank will tend to offer better financing conditions because they have access to all relevant information. However, before deciding on a product, it is advisable to analyse the different options offered by the market.

Mortgages

Applying for a mortgage loan for energy efficiency renovations is usually more profitable for the customer, since the interest rate is lower than a consumer loan and the period for repayment is longer, although the costs of formalisation are higher than those of a consumer loan. Mortgages are based on the appraised value of the property at that time and it is necessary to comply with the following requirements (according to Order ECO/805/2003, of 27 March, on rules for the valuation of assets):

- Have the pertinent real estate license
- Works are carried out in accordance with a project approved by the corresponding professional association.
- Altering or not its structural elements imply the conditioning of at least 50% of its built surface before the beginning of the works.
- The budgeted cost of the works reaches at least 50% of the gross replacement value of the building (excluding the value of the land).

6 MULTIPLE BENEFITS OF ENERGY RENOVATIONS

In recent years, energy efficiency has become a key issue for improving economic and social conditions in Europe. Understanding all the benefits beyond the traditional decrease of energy demand and GHG emissions reduction is paramount to correctly assess the impact of energy efficient renovation in buildings.

As a matter of fact, according to a survey conducted among more than 45 stakeholders from Germany, Italy, Lithuania and Spain, non-energy benefits are often very low in the ranking of priorities for end-users, constituting a challenge to the implementation of energy efficiency measures in buildings. Lack of awareness regarding these benefits makes people underestimate the advantages of investing in energy efficiency improvements.

Increase in dwelling value

Energy efficiency improvements have been claimed to result in greater tenant demand, leading to higher rents and making housing more attractive, as well as easier and quicker to rent out or sell (RICS, 2019). Evidence suggests that individuals and businesses are willing to pay a higher rent or sales premium for a property with improved energy performance. For example, prices of apartments in renovated buildings in major cities of Lithuania are around 20% higher than non-renovated ones.

Certain renovations (e.g.: glazing of balconies) increases the usable surface of the dwelling. In addition, conducting energy efficiency renovations can lead to opportunities to improve the aesthetics of the house.

The EU Directive mandate to advertise the energy performance in the process of selling the house has helped to reflect the increased value after the energy improvements.

Furthermore, an energy efficient building will normally reduce the costs incurred for heating, cooling, lighting and ventilation. In turn, this may lead to reduced operational costs and, potentially, reduced maintenance requirements (RICS, 2019).

Finally, improvements in the living conditions affect tenant satisfaction, which ultimately reduces vacancy and tenant turnover resulting in a net benefit for the landlord. That can help to overcome the "split incentive" that prevent landlords from investing in energy measures, since the tenant is not the only one benefiting from lower energy bills or greater comfort.

Healthy and comfortable indoor environment

Energy efficiency measures can lead to improvements in the thermal comfort parameters for building occupants, increased noise and light comfort, improved safety, security and health.

Keeping good air temperatures, humidity levels, noise levels, and air quality has an impact in people´s health. Moreover, according to IEA (International Energy Agency), chronic thermal discomfort and fuel poverty also have negative mental health impacts (anxiety, stress, and depression). Energy efficiency improvements targeting fuel poverty can therefore improve mental well-being.

According to the European Union´s Survey on Income and Living Conditions (EU SILC), 9.4% of the European Union's population is unable to keep their homes adequately warm and 15.2% lived in residential housing characterised by leaking roofs, damp walls, floors or foundation, and degraded window frames or floors (COMBI, 2015). According to IEA, the potential benefits of energy efficiency measures include improved physical health such as reduced symptoms of respiratory and cardiovascular conditions, rheumatism, arthritis and allergies, as well as fewer injuries. In cold climates, energy efficiency improvements can lower rates of excess winter mortality, while in hot climates they can reduce the risk of dehydration. Within the next 10 years, depending on the scenario, estimations on energy poverty public health and the impact of building refurbishments are as follows:

- 3,000–24,000 premature deaths can be avoided
- The associated economic value of avoided annual public health damage in 2030 ranges from 323 million to 2.5 billion EUR from premature mortality due to indoor cold; and from €338 million to of €2.9 billion EUR due to asthma provoked by indoor dampness

Improved community

Another indirect result of energy renovation is the homeowners' improvement as a community. Normally, neighbours interact minimally. However, in the context of a renovation project, apartment owners need to attend apartment owner meetings quite often and deal with various technical and organisational issues related to the renovation. By interacting more, neighbours create a practice of closer neighbourhood.

Increased disposable income

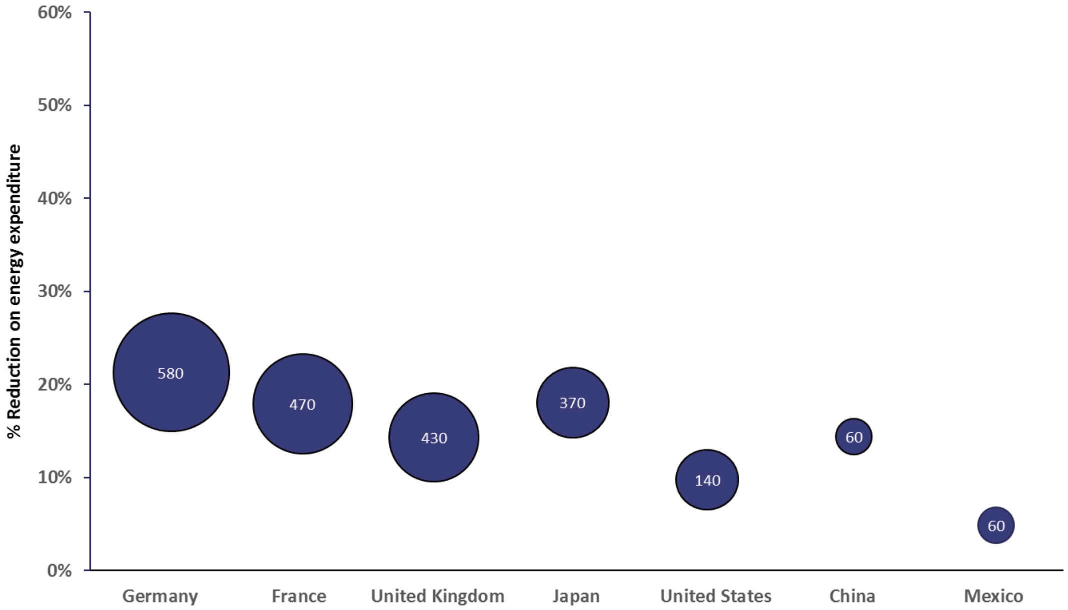


Figure 6.1 – Per capita reduction in household expenditure in 2016 due to efficiency gains (International Energy Agengy, 2019)

By the means of reducing the energy bill, energy efficiency increases the household savings. Energy efficiency improvements reduce operation and maintenance costs, generating disposable income. For example, when buying energy efficiency appliance, which often have an extended lifetime, maintenance and replacement become less costly.

Efficiency gains since 2000 have helped households in major economies save 10% to 30% of their annual home and travel energy costs (International Energy Agengy, 2019).

Improved energy security

Energy is one of the most important structural problems of the European economies, as most of the primary energy consumed is imported, making the EU region vulnerable to world conflicts. Energy efficiency can effectively decrease energy demand and, consequently, reduce reliance on import of gas and fossil fuel, strengthening EU energy security.

According to IEA (International Energy Agengy, 2019), in IEA countries[34] and other major economies, efficiency gains since 2000 avoided the need for over 20% more fossil fuel imports in 2017, of which avoided oil imports in IEA countries alone were worth over USD 30 billion.

The reduction of European gas imports is a good example of the positive consequences derived from energy efficiency measures. Energy efficiency gains since 2000 in Germany and the United Kingdom – the two largest EU gas markets – have been the main factor behind lower gas use and the reduced need for gas imports. Between 2000 and 2015, overall gas demand fell by 11% in Germany and 29% in the United Kingdom. This decline more than offsets the impact of factors that drove up gas demand, including increases in population, the number of households, economic growth and changes in the fuel mix.

In both countries, energy efficiency improvements in the residential sector played a major role, particularly in space heating. Between 2000 and 2015, the amount of gas needed for space heating per unit of floor area fell by 44% in Germany, and by 28% in the United Kingdom.

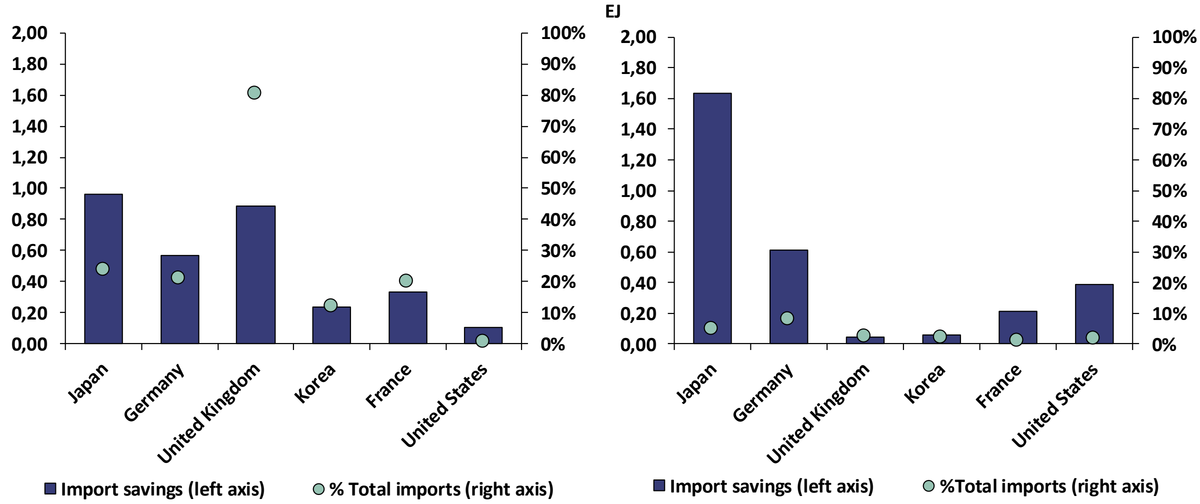


Figure 6.2 – Gas Imports (left) and oil imports (International Energy Agengy, 2019)

[34] IEA countries are all OECD member (except from Chile, Iceland, Israel, and Slovenia. Brazil, China, India, Indonesia). Morocco, Singapore and Thailand are the associate members of IEA.

Job creation

Promoting energy efficiency will create a new market in which new specialised jobs will emerge, reducing unemployment. Certain subsectors, such us the ESCO market, have a great potential to generate new and specialised jobs. ESCOS and energy utilities employ jointly more than 1 million people globally (and 100,000 in Europe) (International Energy Agengy, 2019).

Additional benefits at macro-economic level

Energy efficiency carries savings at the macroeconomic level; electricity network infrastructure will need less maintenance and lower energy imports will improve trade balance. Energy efficiency can also lead to gains in productivity at work; healthy home conditions may decrease absenteeism. Other related benefits are lower health expenses because of having cleaner air and lower unemployment subsidies due to an increase in job creation.

7 KEY CHALLENGES TO ENERGY RENOVATIONS

Despite the political and legislative momentum at the European level and the support instruments launched by member states, energy renovation is still progressing at very slow pace, hampered by different kind of challenges. Challenges can be split into four categories: structural, financial, social and legal. The content of this section has been enriched with the insights obtained from a series of interviews with different stakeholders (utilities, ESCOs, financers, policy actors, homeowners and tenants) from each focus country.

7.1 Structural challenges

Market fragmentation

One of the distinctive characteristics of the energy renovation sector is its fragmentation. Deep energy renovation calls for a set of skills that go from architectural/structural knowledge to energy engineering and technology capabilities, which are difficult to find altogether in a single provider. Standardised and comprehensive solutions that are able to harness the potential for energy savings are scarce in the market.

Under these circumstances, the learning process for investors to understand the market, hiring suppliers and negotiating prices may become an exhausting job. This is true especially for homeowners that are not always knowledgeable in these subjects. On top of that, the concurrence of many providers results in higher installation costs (each agent of the value chain adds its margin) and increases the risk of failure.

Ultimately, these barriers discourage potential investors in efficient renovation. The time and effort required to get enough information to make a decision, apply for a loan, and arrange for the work to be done may simply be perceived not to be worth the return in terms of energy savings (BPIE, 2010).

Lack of capacity

Parallel to market fragmentation, the lack of capacity emerges as a major challenge. As already explained, capturing entire building and system-wide savings involves complex and diverse skills. In view of currently existing capacities, it will be challenging to meet the potential demand in the period 2021-2030. Particularly, in Germany skilled labour shortage is likely to emerge, especially in the building technology sector (Deutscher Bundestag 2018).

Unfortunately, labour shortage is often covered by the black market, resulting in underperforming works that do not tap into the potential of energy savings and, in the worst cases, contribute to undermine the sector's reputation and the trust in energy efficiency solutions.

7.2 Economic and financial challenges

Small volume of projects

Not only the renovation market is fragmented, the building sector itself is quite spread out. Financial agents are not attracted by diffuse, small volume opportunities. Therefore, bundling projects becomes necessary in order to build economies of scale that offset the associated costs (i.e.: due diligences needed to approve a loan, bureaucratic burdens etc.).

Long payback periods

Many renovations carry lengthy economic recovery periods, constituting one of the major financial barriers. Users and owners are not likely to consider investments that do not pay for themselves within 3–7 years (D'Oca 1, et al., 2018). On the other hand, the maintenance costs avoided thanks to deep energy renovation may help to counterbalance this situation, especially when the economic savings are higher than repayment fees.

High up-front costs

Energy renovation often requires high upfront payments. This, coupled with the long payback periods and the technical intricacies, reinforce the perception of a high-risk investment.

Lack of funding instruments

The absence of financial instruments at acceptable terms – i.e. at moderate rates and attractive tenors - is one of the most cited challenges to investment in energy efficiency measures. Filling out the forms to receive the loan and other bureaucracy are also burdensome and discouraging for potential investors.

In some countries, the lack of a stable and reliable framework to develop financial schemes is often cited as a major barrier. That is for example the case of Lithuania, where hopefully the forthcoming apartment building renovation strategy (currently under preparation) will ensure long-term, non-disruptive financing for building renovation. From the private side, only one bank is financing the deep renovation of apartment buildings. Managers of other banks (mainly Scandinavian ones) see a lot of risk in financing this type of projects.

Owner-tenant dilemma

Homeowners and tenants are driven by very different interests. While tenants enjoy the benefits of energy renovations, they are reluctant to invest in a house that they do not own. Ultimately, homeowners postpone the renovations until it becomes unavoidable (for example to cope with legal obligations). Public subsidies or favourable loan terms may simply not have the expected impact because the time span for renovation is short and infrequent. In countries like Germany where most of the population live in rented homes, the owner-tenant dilemma is an important challenge.

7.3 Social challenges

Information and awareness

Homeowners and building managers have often little information and awareness of energy efficiency. The lack of awareness regarding comfort and other non-energy benefits factors was mentioned as a major challenge for the implementation of renovation projects by many stakeholders. Particularly, in mild climates as in Spain, owners and occupants (especially old generations) "got used" to some lack of comfort at home (e.g.: cold temperatures) and they do not mind adopting alternative measures (e.g.: using warm clothes) instead of investing in insulation technologies.

Other factors refer to the mistrust in energy professionals or in new technologies. Sometimes, end-users are also driven by fears towards new technologies, which are often at the heart of energy efficiency solutions. The lack of trained professionals (already mentioned among the structural challenges) does not contribute to improve this perception.

Economically irrational decisions

Extensive evidence has shown that individual decisions systematically deviate from rational choice assumptions and that cognitive capacity to make rational decisions can be impaired by situational factors. People often fail to assess the benefits of energy efficiency renovations, or decisions are affected by present bias, myopia or irrational fear of change. Contexts of scarcity trigger a tendency to prefer immediate smaller rewards to delayed larger ones. Also, reliance on wrong or invalid assumptions about individual behaviour undermines the efficacy of policy measures to promote energy efficiency (DellaValle, n.d.).

7.4 Legal challenges

Complex decision-making process

The decision to undertake energy efficiency measures often depends on several agents. In general, the bulk of the building stock that needs to be renovated is composed by multi-apartment buildings, in which achieving the qualified majorities needed to intervene is quite complex (depending on the case, even unanimity can be required). Another aspect jeopardising the consensus is the uneven distribution of benefits and costs of an energy retrofit to the individual apartments (D'Oca 1, et al., 2018). This is particularly relevant when heating supply is centralised. Then, some owners that enjoy from extra heating will not have the incentives for changing the situation, especially if they pay fixed fees depending on factors different from consumption (i.e.: surface of the house).

On top of that, certain measures (e.g. integration of renewables in buildings) and district heating contexts have a larger-than-building impact, often at district or even city scale. This escalates from a single stakeholder decision to a multi-stakeholder decision entailing additional challenges: integration and synergies, balancing and flexibility, long and short term storage, high upfront (shared) investments, cross-sector solutions, market structures and barriers, data and accounting, urban planning, policy and regulations at national and local level (EASME, 2016).

Other legal issues

In certain countries there are specific regulations that can act as barriers to energy efficiency renovation. In other cases, legislation launched to stimulate renovations has become quite unpopular. That is the case of the Tenancy Law in Germany, which allows to apportion part of the costs of the renovation to the tenant. The apportion-right of the owner relates to every renovation work regardless the presence of the energy efficiency component. Consequently, owners tend to renovate intensively, to increase the property value and ask for higher rent. Tenants face increasing rents for "luxury renovation" which end up undermining the reputation of these measures.

In other countries as in Spain, the Horizontal Property Law poses so many obstacles to provide loans to homeowners' communities that alternative figures such as cooperatives (which are subject to a more flexible regulation) have emerged.

ANNEXES

Methodological note on the estimation of energy consumption baseline in the residential sector of the target countries.

The estimation of the baseline residential energy consumption in the target countries, namely Italy, Spain, Germany and Lithuania, is developed by means of a *top-down* approach.

The approach consisted in the estimation of a regression equation which links the consumption to a set of explaining variables, namely HDDs, GDP per capita and one year lagged consumption in the present case. The mathematical representation can be given in the following form:

$$EC = HDDs^{\alpha} \cdot GDP_{PC}^{\beta} \cdot EC(-1)^{\gamma} \quad (1)$$

where EC is the energy consumption In the residential sector, HDDs are the heating degree days of the target country, GDP_PC Is the per capita GDP of the target country and EC(-1) represents the one year lagged energy consumption. a, b and c are the regression coefficients.

In order to have a better representation, a logarithmic transformation is applied to Eq. (1) and the following relation is obtained:

$$\log(EC) = \alpha \cdot \log(HDDs) + \beta \cdot \log(GDP_{PC}) + \gamma \cdot \log(EC(-1)) \quad (2)$$

with such a representation a and β represent the short run elasticity with respect to HDDs and GDP per capita[35], therefore they have a clear economic meaning.

To check the consistency of the equation, the visual inspection of the residuals is performed, in order to verify the absence of any trend and to confirm their random distribution. Furthermore, the R^2 value is determined to evaluate the accuracy of the model. For Italy, Germany and Spain, R^2 ranges between 0.85 and 0.91, which is considered acceptable for the scope of the current analysis. As for Lithuania, the value is lower and equal to 0.68, therefore the methodology cannot be applied. More details can be found in Bianco et al. (2020)[36]

Once obtained the baseline projection, by considering GDP forecasts given by World Bank, population outlook from Eurostat and an average value of HDDs, the energy efficiency scenario is determined by applying the savings foreseen by each country in their 2030 strategies[37].

---

[35] V. Bianco, O. Manca, S. Nardini. Electricity consumption forecasting in Italy using linear regression models. Energy 34 (2009) 1413-1421

[36] V. Bianco, A. Marchitto, F. Scarpa, L.A. Tagliafico. Forecasting Energy Consumption in the EU Residential Sector. International Journal of Environmental Research and Public Health 2020, 17(7), 2259; https://doi.org/10.3390/ijerph17072259

[37] https://ec.europa.eu/energy/en/topics/energy-strategy-and-energy-union/governance-energy-union/national-energy-climate-plans

Methodology for the estimation of energy consumption baseline and energy efficiency scenario in the Lithuanian residential sector

The estimation of the baseline residential energy consumption in Lithuania is developed by means of a *top-down* approach, but built in a different way with respect to Germany, Italy and Spain. This is due to the fact that Lithuania is substantially different in terms of dimension, i.e. much smaller country with much less population, and building stock structure, i.e. large presence of buildings built during the Soviet time with the corresponding standard.

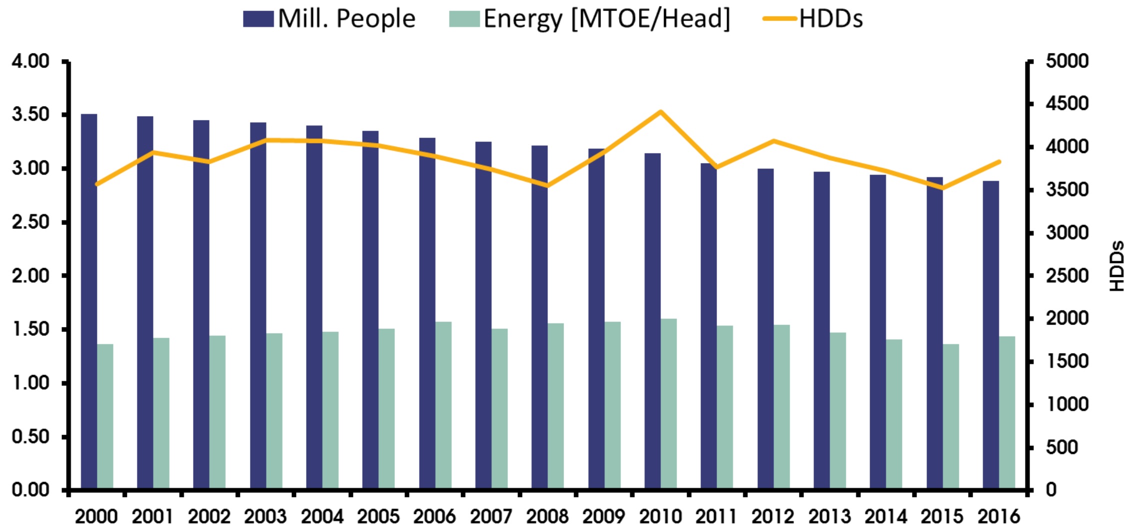


Figure A1. Population, energy consumption and HDDs evolution in Lithuania in the period 2000-2016 (Eurostat, 2020)

From the data reported in Figure A1 it Is possible to estimate the energy intensity with respect to the population, which is relevant to understand energy consumption trend in the residential sector. Furthermore, Figure A1 highlights the correlation between energy consumption and HDDs, therefore it is necessary to employ a weather adjusting procedure as highlighted in Bianco et al. (2014).

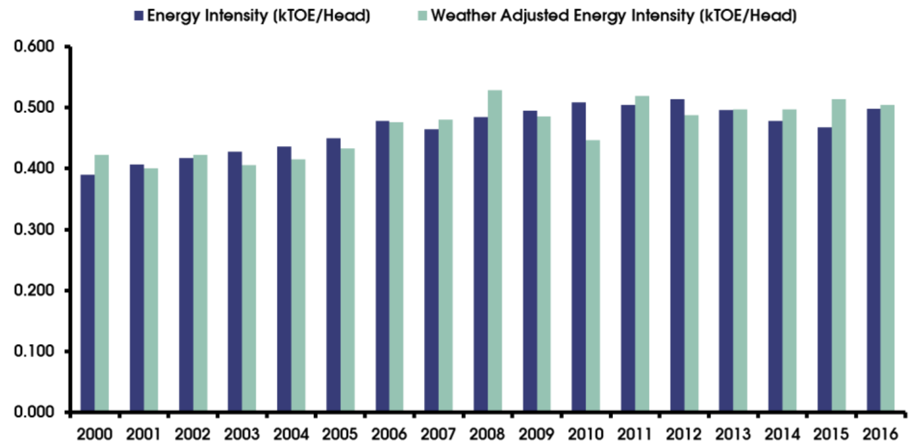


Figure A2. Energy Intensity per Capita evolution in Lithuania in the period 2000-2016

To determine the baseline of energy consumption In the Lithuanian residential sector, the average Weather Adjusted (WA) energy intensity in the period 2012-2016 (i.e. 0.5 kTOE/Head) is taken into account as well as its average yearly increase (i.e. 0.8%). Therefore from 2016 onward (namely the last available historical data) an energy intensity of 0.5 kTOE/head with an increase of 0.8% per year has been considered. Then these values are multiplied by the forecast of the population provided by Eurostat in order to have the baseline reported in Figure 4.8.

Furthermore, in order to reach in Lithuania an energy efficiency target comparable with the other target countries, e.g. Germany, Italy and Spain, a reduction of 30% of the energy intensity in 2030 is foreseen with respect to the baseline value and reached with a linear trend starting from 2020. This assumption leads to a yearly energy saving from 2030 onward of 5 TWh/year, as shown in Figure 4.8.

DEFINITIONS

Term	Definition
Heating Degree Days	Measurement to define the average winter climatic conditions of a location
Italian Territory Agency	National Agency in charge of the monitoring of the Italian building stock
Standard Revenue (Rendita Catastale)	Gross average revenue generated, in average, by a dwelling. It is a value determined by the Italian Territory Agency and used to calculate the tax rate to apply
Bundesnetzagentur	Federal Network Agency
Energy label	An energy label constitutes consumer information on the performance of a product (the building)
Energy Performance Contracting (EPC)	Energy performance contracting (EPC) is a mechanism for organising the energy efficiency financing. The EPC involves an Energy Service Company (ESCO) which provides various services, such as finances and guaranteed energy savings. The remuneration of the ESCO depends on the achievement of the guaranteed savings
Primary energy consumption	Measures the total energy demand of a country. It covers consumption of the energy sector itself, losses during transformation (for example, from oil or gas into electricity) and distribution of energy, and the final consumption by end users
Final energy consumption	Total energy consumed by end users, such as households, industry and agriculture
dena	The German Energy Agency is a federally owned German company and Germany's centre of expertise for energy efficiency, renewable energy sources and intelligent energy systems
Destatis	The Federal Statistical Office provides official data on society, the economy, the environment and the state. They provide neutral, objective and technically independent statistics
Statista	A leading provider of market and consumer data in Germany
Energy Saving Ordinance (EnEV)	German law determining minimum requirements of energy consumption of new and existing buildings. The last amendment increasing requirements was adopted in 2016.
Renewable Energies Heat Act (EEWärmeG)	German law that aims at promoting the integration of renewable energies in the heating and cooling sector of buildings. It introduces a nationwide obligation to integrate renewable energies in new buildings. The law is part of the 2007 Federal Integrated Energy and Climate Programme (IEKP)
Energy Saving Act (EnEG)	Enacted in 1976 to reduce the dependence on imported energy sources. The law authorises the Federal Government to enact regulations catered to set energy-related requirements on buildings and their system technology (e.g. the Heating Costs Ordinance, the Energy Saving Ordinance). The 2005 amendment facilitated the implementation of the European Directive on the Energy Performance of Buildings. A further amendment (2009) paved the way for the implementation of the Integrated Energy and Climate Programme (IEKP)
Climate Protection Package (September 2019)	Climate protection plan presented by the Climate Cabinet – a committee appointed by the German Federal Government in March 2019 to ensure that the Climate Protection Plan 2050 (of 2016) is implemented in Germany and that the climate protection targets for 2030 are met

Term	Definition
CO_2 Building Renovation Support Programme	Promotional programme launched by the German Federal Government in 2006 to support energy efficient new constructions and refurbishments through soft loans and grants
Market incentive programme (MAP)	Promotional programme of the German Federal Ministry of Economics and Energy providing incentives to Increase heat generation from renewable energies: government subsidises the replacement of old heating systems with an efficient solar thermal system, biomass system or heat pump as well as the construction of heating networks and storage tanks
Energy Efficiency Incentive Programme (APEE)	Support programme of BAFA, intended to support the modernisation of heating systems based on renewable energies. It is conceived as an additional grant programme to MAP, when the heating system replacement is envisaged in a more comprehensive manner (i.e. optimising the entire heating system including radiators and pipes)
Energy Industry Act (EnWG)	Also referred to as Electricity and Gas Supply Act, was last revised in 2005 and contains fundamental regulations concerning grid-bound energy
Thermal Insulation Ordinance	The "**Wärmeschutzverordnung**"(1977) pursued the reduction of energy consumption through construction measures in the light of rising energy prices. The Ordinance was amended twice (1984, 1995) before being replaced by the Energy Saving Ordinance (EnEV) in 2002, which merges the Thermal Insulation Ordinance with the Heating Systems Ordinance (HeizAnlV) into a combined set of regulations.
Building Energy Act (GEG)	The "**Gebäudeenergiegesetz**" (GEG) is anchored in the coalition agreement and merges (without material changes) the Energy Saving act, the Energy Saving Ordinance and the Renewable Energies Heat Act into one unified and coordinated set of rules (GEG) containing energy requirements for new buildings and requirements regarding the use of renewable energies in heating and cooling systems of buildings. The draft law was passed by the Federal Cabinet on 23 October 2019.
Default supplier	The supplier that is activated when the customer is passive or when the customer cannot find a supplier on the market. The term is not used in all countries (out of the ROB countries it exists in Germany, Spain or Lithuania but not in Italy). It is not unusual that the default supplier (also acts as the supplier of last resort, or vice versa.
Churn rate	Percentage of customers or subscribers who stop using the services offered by a business for a given period of time
KfW energy-efficiency house	Building that meets a certain standard in terms of energy efficiency. These standards were developed by the Kreditanstalt für Wiederaufbau (KfW). The most relevant criteria are the annual primary energy demand and the transmission heat loss of the building. These two values define the KfW efficiency house standards
Incumbent (utility)	The incumbent is the former monopolist company of the market which still occupies a dominant position, usually located in a former exclusive service territory

ACRONYMS AND ABBREVIATIONS

Abbreviation	Definition
BA	Federal Employment Agency
AA.CC	Autonomous Communities: Spanish territorial administrative entity which, within the state constitutional legal system, is endowed with certain legislative autonomy with its own representatives and with certain executive and administrative powers
BAFA	Federal Office of Economic and Export Control
BDEW	Federal Association of the German Energy and Water Industry
BGB	Civil code
BMU	Federal Minister for the Environment, Nature Conservation, and Nuclear Safety
BMWi	Federal Ministry of Economics and Technology
CAGR	Compound Annual Growth Rate
CTE	Technical Building Code, by its Spanish acronym
COP	Coefficient of performance
DIW	German Institute for Economic Research
DMB	German Tenants' Association
EU	European Union
FÖS	Forum Socio-Ecologic Market Economy
FRG	Former Federal Republic of Germany, also referred to as "Western Germany"
GDR	former German Democratic Republic, also referred to as "Eastern Germany"
GdW	Federal Association of German Housing and Real Estate Companies
GTI	Governmental Tax Inspectorate of Lithuania GTI
ICO	Official Credit Institute, by its Spanish acronym
HDD	Heating Degree Days
HVAC	Short for heating, ventilation, and air conditioning
IDAE	Institute for the diversification and energy savings, by its Spanish acronym
INE	National Institute of Statistics, by its Spanish acronym
ISTAT	Italian National Institute of Statistics
ITeC	Technological Construction Institute (Spain)
IW	Institute of the German Economy
IWU	Institute for Housing and the Environment

Abbreviation	Definition
MTOE	Megaton of oil equivalent
PNAEE	National Action Plan for Energy Saving and Efficiency, by its Spanish acronym
PON	Italian Operating National Plan, by its Italian acronym
POR	Italian Operating Regional Plan, by its Italian acronym
REE	Electricity Network of Spain, by its Spanish acronym
RITE	Regulation on the Thermal Installations of Buildings, by its Spanish acronym
ZIA	German Property Federation

LIST OF FIGURES

LIST OF TABLES

REFERENCES

Urtasun, & Alves, P. A. (2019). Recent housing market developments in Spain. *Economic Bulletin.*

ITeC. (2019, Junio 27). *INFORME DEL SECTOR DE LA CONSTRUCCIÓN EN ESPAÑA.* Tratto da https://itec.es/servicios/estudios-mercado/euroconstruct-sumario-ultimo-informe/

Ministerio de Fomento. (2016, January). *Fomento.* Tratto da https://www.fomento.es/recursos_mfom/pdf/9DFC55DD-B6F8-4C40-8634-8B199A6770A8/135887/INF_CARAC_EDIF_RESID_2001.pdf

Banco de España. (2019). Recent developments in the rental housing. *Economic Bulletin.*

European Commission. (2018). *European Construction Sector Observatory - Spain.*

Ministerio de Fomento. (2019, June). *Observatorio de Vivienda y Suelo 2018.* Tratto da https://apps.fomento.gob.es/CVP/handlers/pdfhandler.ashx?idpub=BAW062

Instituto Nacional de Estadística. (2018). *Contabilidad Nacional Trimestral de España.* Tratto da https://www.ine.es/jaxiT3/Tabla.htm?t=2492

Precio Viviendas. (2017, July 4). Tratto da https://www.precioviviendas.com/sala-de-prensa/blog/408-ahorra-comprando-una-vivienda-eficiente

Energía y Sociedad. (2017, June). *Energía y Sociedad.* Tratto da http://www.energiaysociedad.es/wp-content/uploads/pdf/Boletin_de_Energia_y_Sociedad-NUMERO_68.pdf

Andrew Foulkes, L. R. (2003). *Defining the scope of the construcion sector.* Salford: Salford Centre for Research and Innovation.

ANDIMAC. (2018, May). *ANDIMAC.* Tratto da http://www.ioncomunicacion.es/wp-content/uploads/Presentacion2018.pdf

Guillermo Arregui Portillo, C. A. (2010). *La generación de empleo en la rehabilitación y modernización energética de edificios y viviendas.* Fundación Conde del Valle de Salazar.

Ministerio de Fomento. (2017). *Observatorio de Vivienda y Suelo - Boletín Especial Sobre Rehabilitación.* Centro virtual de publicaciones del Ministerio de Fomento.

Asociación de Ciencias Ambientales. (2018). *Pobreza Energética en España.* Madrid: Asociación de Ciencias Ambientales.

COMBI. (2015). *COMBI Project.*

ODYSSEE- MURE. (2016). *Energy Efficiency Trends and Policies in Spain.* Madrid.

Ministerio de Energía, Turismo y Agenda Digital. (2017). *Plan Nacional de Acción de Eficiencia Energética 2017-2020.*

Boletín Oficial del Estado. (2018). *BOE.* Tratto da https://www.boe.es/boe/dias/2006/03/28/pdfs/A11816-11831.pdf

Certicalia. (2019). *Certicalia.* Tratto da https://www.certicalia.com/

RICS. (2019, March). *Energy efficiency and residential values: a changing European landscape.* Tratto da https://www.rics.org/globalassets/rics-website/media/knowledge/research/insights/energy-efficiency-and-residential-values.pdf

Bianco, V. (2018). The Future of the Italian Electricity Generation Sector. An Analysis of the Possible Strategic Models. *Foresight and STI Governance*, 20-28.

MISE, MATTM, & MIT. (2018). *Draft Integrated National Energy and Climate Plan.*

AEEG. (2006). *Primo rapporto annuale sul meccanismo dei titoli di efficienza energetica.*

Friedman, C., Becker, N., & Erell, E. (2014). Energy retrofit of residential building envelopes in Israel: A cost benefit analysis. *Energy, 77*, 183-193.

CEER. (2017, November 21). Tratto da CEER: https://www.ceer.eu/documents/104400/6122966/Retail+Market+Monitoring+Report/56216063-66c8-0469-7aa0-9f321b196f9f

IDAE. (2018). *Consumos del Sector Residencial en España.* Madrid.

BPIE. (2017). *Building 4 People: People-Centric Buildings for European Citizens.* Tratto da http://bpie.eu/wp-content/uploads/2017/12/White-Paper2017.pdf

BPIE. (2018). *Policy Innovation for Building Renovation.* Tratto da http://bpie.eu/wp-content/uploads/2019/01/BPIX-Briefing-_Final-1.pdf

BPIE. (2017). *97% of buildings in the EU need to be upgraded.* Tratto da http://bpie.eu/wp-content/uploads/2017/12/State-of-the-building-stock-briefing_Dic6.pdf

International Energy Agengy. (2019). *iea.* Tratto da Multiple Benefits of Energy Efficiency: https://www.iea.org/

BPIE. (2010). Tratto da http://www.bpie.eu/documents/BPIE/BPIE%20background%20paper.pdf

EASME. (2016). *Buiding Renovation Challenge.* Tratto da https://ec.europa.eu/easme/sites/easme-site/files/practical_approaches_to_the_buildings_renov_challenge.pdf

BPIE. (2017). *BPIE.* Tratto da http://bpie.eu/wp-content/uploads/2017/12/State-of-the-building-stock-briefing_Dic6.pdf

Ministerio de Fomento. (2014). *LONG-TERM STRATEGY FOR ENERGY RENOVATION IN THE BUILDING SECTOR IN SPAIN PURSUANT TO ARTICLE 4 OF DIRECTIVE 2012/27/UE.*

D'Oca 1, S., Ferrante , A., Ferrer, C., Pernetti , R., Gralka , A., Sebastian , R., & op 't Veld , P. (2018). Technical, Financial, and Social Barriers and Challenges in Deep Building Renovation: Integration of Lessons Learned from the H2020 Cluster Projects.

Lithuania Department of Statistics. (2019). Tratto da https://osp.stat.gov.lt/statistiniu-rodikliu-analize?indicator=S3R073#/

Lithuanian Department of Statistics. (2020). Tratto da https://osp.stat.gov.lt/statistiniu-rodikliu-analize?hash=103cad31-9227-4990-90b0-8991b58af8e7#/

Lithuanian Population and Housing Census. (2011). Tratto da Lithuanian Department of Statistics: https://osp.stat.gov.lt/statistiniu-rodikliu-analize?indicator=S3R073#/

The Lithuanian District Heating Association (LDHA). (2018). *Annual statistic of Lithuanian DH.*

Ministry of Environment of Lithuania. (2019).

Public procurement electronic system. (2019). Tratto da www.cpo.lt

Eurostat. (2020). Tratto da https://ec.europa.eu/eurostat/web/energy/data/energy-balances

Italian Institute of Statistics. (2011). Tratto da ISTAT: https://www.istat.it/

Italian Institute of Statistics. (2019).

Italian Territorial Agency. (n.d.). Retrieved from Agenzia delle Entrate: https://www.agenziaentrate.gov.it/portale/web/guest/schede/fabbricatiterreni/omi/pubblicazioni/statistiche-catastali

Italian Institute of Statistics, ISTAT. (2018).

Italian Territory Agency. (2018).

RSE. (2015). *Edifici Energeticamente Efficienti: un'opportunità.* Milano: Alkes.

Bauindustrie. (2019). *Anteil an der Wertschöpfung.* Tratto da https://www.bauindustrie.de/zahlen-fakten/statistik-anschaulich/bedeutung-der-bauwirtschaft/anteil-der-wertschopfung/

BPIE. (2015). *Renovating Germany's Building Stock. An economic appraisal from the investor's perspective.* Tratto da http://bpie.eu/wp-content/uploads/2016/02/BPIE_Renovating-Germany-s-Building-Stock-_EN_09.pdf

KfWResearch. (2017). *Es werden genug Wohnungen genehmigt. Sie müssen nur gebaut werden.* Tratto da https://www.kfw.de/PDF/Download-Center/Konzernthemen/Research/PDF-Dokumente-Fokus-Volkswirtschaft/Fokus-2017/Fokus-Nr.-188-November-2017-Wohnungsmarktst

Destatis. (2014). *Haushalte im selbst genutzten Eigentum und Mietwohnungen nach Haushaltstyp.* Tratto da https://www.destatis.de/DE/Themen/Gesellschaft-Umwelt/Wohnen/Tabellen/liste-haushaltsstruktur-wohnungen.html

Zensus. (2011). *Gebäude mit Wohnraum sowie Wohngebäude nach Eigentumsform des Gebäudes.* Tratto da https://ergebnisse.zensus2011.de/#StaticContent:00,GWZ_1_1_4,m,table

Bundesnetzagentur. (2019a). *Bundesnetzagentur.* Tratto da https://www.bundesnetzagentur.de/SharedDocs/Bilder/DE/Sachgebiete/Energie/Verbraucher/strompreiszusammen_2019.jpg;jsessionid=E4311BFB41CEB239526EC70396967288?__blob=poster&v=2

Bundesnetzagentur. (2019b). *Bundesnetzagentur.* Tratto da https://www.bundesnetzagentur.de/SharedDocs/Bilder/DE/Sachgebiete/Energie/Verbraucher/gaspreiszusammen_2019.jpg;jsessionid=E4311BFB41CEB239526EC70396967288?__blob=poster&v=2

DIW. (2018). *Verteilungswirkungen der Energiepolitik – Personelle Einkommensverteilung.* Tratto da https://www.bmwi.de/Redaktion/DE/Publikationen/Studien/verteilungswirkungen-der-energiepolitiken.pdf?__blob=publicationFile&v=8

Destatis. (2019b). *Anteil der Wohnkosten am verfügbaren Haushaltseinkommen* . Tratto da https://www.destatis.de/DE/Themen/Gesellschaft-Umwelt/Wohnen/Tabellen/eurostat-anteil-wohnkosten-haushaltseinkommen-silc.html

Destatis. (2017). *Income, receipts, expenditures.* . Tratto da https://www.destatis.de/EN/Themes/Society-Environment/Income-Consumption-Living-Conditions/Income-Receipts-Expenditure/Tables/income-expenditure-d-lwr.html

BMWi. (2019). *Energy Conservation Legislation.* Tratto da https://www.bmwi.de/Redaktion/EN/Artikel/Energy/energy-conservation-legislation.html

Destatis. (2019c). *Bruttoinlandsprodukt 2018 für Deutschland.* Tratto da https://www.destatis.de/DE/Presse/Pressekonferenzen/2019/BIP2018/pressebroschuere-bip.pdf?__blob=publicationFile

BA. (2019). *Berichte: Blickpunkt Arbeitsmarkt | April 2019. Akademikerinnen und Akademiker.* Tratto da https://www.bak.de/w/files/bak/07-daten-und-fakten/arbeitsmarkt/broschuere-akademiker-2019.pdf

BDEW. (2019). *Bundesverband der Energie- und Wasserwirtschaft e.V. (2019). Energy market Germany 2019.* Tratto da https://www.bdew.de/media/documents/Pub_20190603_Energy-Market-Germany-2019.pdf

Bundesnetzagentur. (2019c). *Bundesnetzagentur* . Tratto da https://www.bundesnetzagentur.de/SharedDocs/Downloads/DE/Allgemeines/Bundesnetzagentur/Publikationen/Berichte/2018/Monitoringbericht_Energie2018.pdf?__blob=publicationFile&v=3

Lünendonk GmbH, DETECON Consulting, GISA, & m3 management consulting. (2014). *Future Utility 2030. Energieversorger auf ihrem Weg in eine neue Zukunft.* Retrieved from https://publikation.msg.group/publikationsarchiv/studie/216-future-utility-2030-energiev

DIW. (2016). *Private versus kommunale Energieversorger: Kein genereller Trend zur Rekommunalisierung und keine Effizienzunterschiede.* Tratto da https://www.diw.de/de/diw_01.c.534047.de/themen_nachrichten/private_versus_kommunale_energieversorger_kein

VKU & ASEW . (2016). *Entwicklung eines Portfolios von Energieeffizienzdienstleistungen für kommunale EVU – Kurzfassung. .* Tratto da https://www.vku.de/fileadmin/user_upload/Verbandsseite/Publikationen/2016/VKU_ASEW_Broschuere-EDL-Studie_Web.pdf

dena. (2016). *Gebäudereport. Statistiken und Analysen zur Energieeffizienz im Gebäudebestand.* Tratto da DENA: https://www.dena.de/fileadmin/user_upload/8162_dena-Gebaeudereport.pdf

Eurostat. (2018). *Endenergieverbrauch in Haushalten nach Kraftstoffart.* Retrieved from https://ec.europa.eu/eurostat/tgm/refreshTableAction.do?tab=table&plugin=1&pcode=ten00125&language=de

Eurostat. (2019). *Heizgradtage und Kühlgradtage nach Land - jährliche Daten.* Tratto da https://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=nrg_chdd_a&lang=de

Destatis. (2019d). *Wirtschaftsrechnungen. Einkommens- und Verbrauchsstichprobe Wohnverhältnisse privater Haushalte.* Tratto da https://www.destatis.de/DE/Themen/Gesellschaft-Umwelt/Wohnen/Publikationen/Downloads-Wohnen/evs-wohnverhaeltnis-haushalte-21

Destatis. (2019e). *Material- und Energieflüsse Energieverbrauch der privaten Haushalte für Wohnen.* Tratto da https://www.destatis.de/DE/Themen/Gesellschaft-Umwelt/Umwelt/Materialfluesse-Energiefluesse/Tabellen/energieverbrauch-haushalte.html

Destatis. (2018b). *Energieverbrauch privater Haushalte für Wohnen 2017 erneut gestiegen. .* Tratto da https://www.destatis.de/DE/Presse/Pressemitteilungen/2018/10/PD18_378_85.html

BMWi. (2014). *CO2-Gebäudesanierungsprogramm: Gute Förderung noch besser machen.* Tratto da .https://www.bmwi.de/Redaktion/DE/Downloads/F/factsheet-02-co2-gebaeudesanierung.pdf?__blob=publicationFile&v=3

IW Köln. (2017b). *Energiewende im Gebäudesektor. Handlungsempfehlungen für mehr Investitionen in den Klimaschutz.* Tratto da https://www.iwkoeln.de/fileadmin/user_upload/Studien/IW-Analysen/PDF/2017/IW-Analyse_119-2017_Geb%C3%A4udesanierung.pdf

dena. (2017). *Pressemitteilung. dena-Gebäudereport: Sanierungsrate weiterhin viel zu gering.* Tratto da https://www.dena.de/newsroom/meldungen/2017/dena-gebaeudereport-sanierungsrate-weiterhin-viel-zu-gering/

BMU. (2016). *Bundesministerium für Umwelt, Naturschutz und nukleare Sicherheit (BMU), Klimaschutzplan 2050. Klimaschutzpolitische Grundsätze und Ziele der Bundesregierung.* Tratto da : https://www.bmu.de/fileadmin/Daten_BMU/Download_PDF/Klimaschutz/klim

BMWi. (2015). Tratto da https://www.bmwi.de/Redaktion/DE/Publikationen/Energie/energieeffizienzstrategie-gebaeude.pd

BMWI. (2018). *The Energy of the Future. Sixth "Energy Transition" Monitoring Report. Reporting Year 2016.* Tratto da https://www.bmwi.de/Redaktion/EN/Publikationen/Energie/sechster-monitoring-bericht-zur-energiewende-kurzfassung.pdf?__blob=pu

DMB, GdW, DV. (2019). *Wohngebäude: Klimaziele sozialverträglich erreichen. Retrieved from.* Tratto da https://www.energietage.de/fileadmin/user_upload/Bereich_C_365/Campaign_Soziale_Klimaziele/2019-09-09_Wohngebaeude._Klimaziele_sozialvertraeglich_erreichen.pdf

dena . (2018). *Concise building report. Energy efficiency in the building stock – statistics and analyses* . Tratto da https://www.dena.de/fileadmin/dena/Dokumente/Pdf/9268_dena_concise_2018_building_report.pdf

GdW, DMB, DV. (2019). *Pressemitteilung. Wohnungswirtschaft und Mietervertreter schlagen Alarm: Ohne eine massive Ausweitung der Förderung werden die Klimaziele unerreichbarhttps://www.energietage.de/fileadmin/user_upload/Bereich_C_365/Cam.* Tratto da https://www.energietage.de/fileadmin/user_upload/Bereich_C_365/Cam

DIW. (2014). *Steigerung der Energieeffizienz: ein Muss für die Energiewende, ein Wachstumsimpuls für die Wirtschaft.* Tratto da https://www.diw.de/documents/publikationen/73/diw_01.c.435700.de/14-4-1.pdf

Prognos. (2013). *Ermittlung der Wachstumswirkungen der KfW-Programme zum Energieeffizienten Bauen und Sanieren.* Tratto da https://www.kfw.de/Download-Center/Konzernthemen/Research/PDF-Dokumente-alle-Evaluationen/Wachstumseffekte-EBS-Endbericht.pdf

Bundesregierung. (2019). *Eckpunkte für das Klimaschutzprogramm 2030.* Tratto da https://www.bundesregierung.de/resource/blob/997532/1673502/768b67ba939c098c994b71c0b7d6e636/2019-09-20-klimaschutzprogramm-data.pdf?download=1

DMB. (2019). *Klimaschutz und energetische Gebäudesanierung - Positionspapier Deutscher Mieterbund (DMB)* . Tratto da https://www.energietage.de/fileadmin/user_upload/Bereich_C_365/Campaign_Soziale_Klimaziele/Anlage_4_DMB_Klimaschutz_und_energetische_Ge

DDIV. (2017). *DDIV-Kompendium Energieeffizienzmassnahmen in Wohnungseigentümergemeinschaften.* . Tratto da https://vdiv.de/download/d1kuijl9luv8es2fpfh43ia1e8/DDIV-Kompendium%202017_Webversion.pdf

KfW. (2019b). *Merkblatt Energieeffizient Sanieren – Kredit* . Tratto da https://www.kfw.de/PDF/Download-Center/F%C3%B6rderprogramme-(Inlandsf%C3%B6rderung)/PDF-Dokumente/6000003743_M_151_152_EES_Kredit_2018_04.pdf

FÖS. (2014). *Steuerliche Förderung von energetischen Sanierungen Perspektiven für eine ökologisch-soziale Ausgestaltung.* Tratto da http://www.foes.de/pdf/2014-09-Workshop_steuerliche_Foerderung%20_Programm_und_Thesen.pdf

IWU & Fraunhofer IFAM. (2018). *Monitoring der Programme „Energieeffizient Sanieren" und „Energieeffizient Bauen" 2017.* Tratto da https://www.kfw.de/PDF/Download-Center/Konzernthemen/Research/PDF-Dokumente-alle-Evaluationen/Monitoring-der-KfW-Programm

dena. (2019). *dena-Leitstudie Integrierte Energiewende: Impulse für die Gestaltung des Energiesystems bis 2050.* Tratto da https://www.dena.de/fileadmin/dena/Dokumente/Pdf/9261_dena-Leitstudie_Integrierte_Energiewende_lang.pdf

ZIA. (2019). *Frühjahrsgutachten Immobilienwirtschaft 2019 des Rates der Immobilienweisen Retrieved from* . Tratto da https://www.zia-deutschland.de/fileadmin/Redaktion/Meta_Service/PDF/Immoweisen_2019_web.pdf

KfW. (2019a). *Volle Auftragsbücher im Wohnungsbau.* Tratto da https://www.kfw.de/KfW-Konzern/KfW-Research/Wohnungsbau.html

Destatis. (2016). *Strukturerhebung im Dienstleistungsbereich Architektur- und Ingenieurbüros.* Tratto da https://www.destatis.de/DE/Themen/Branchen-Unternehmen/Dienstleistungen/Publikationen/Downloads-Dienstleistungen-Branchenberichte/architektur-inge

DV. (2019). *Kursbuch Klimaschutz im Gebäudebereich. Aktuelle Empfehlungen der AG Energie für wirksame, wirtschaftlich tragfähige und sozialverträgliche*

Klimaschutzmaßnahmen. Tratto da https://www.energietage.de/fileadmin/user_upload/Bereich_C_365/Cam

Federal Ministry for Economic Affairs and Energy. (2019). *Federal Ministry for Economic Affairs and Energy. Draft of the integrated national energy and climate plan*. Tratto da https://ec.europa.eu/energy/sites/ener/files/documents/ec_courtesy_translation_de_necp.pdf

Bianco, V., Scarpa, F., & Tagliafico, L. A. (2014). Analysis and future outlook of natural gas consumption in the Italian Analysis and future outlook of natural gas consumption in the Italian residential sector. *Energy Conversion and Management*, 754-764.

Destatis. (2018a). *Gebäude und Wohnungen*. Tratto da https://www.destatis.de/DE/Themen/Gesellschaft-Umwelt/Wohnen/Publikationen/Downloads-Wohnen/fortschreibung-wohnungsbestand-pdf-5312301.pdf?__blob=publicationFile

Destatis. (2019b). *Eigentümerquote nach Bundesländern*. Tratto da https://www.destatis.de/DE/Themen/Gesellschaft-Umwelt/Wohnen/Tabellen/entwicklung-eigentuemerquote.html

KfW. (2019c). *Merkblatt Energieeffizient Sanieren – Investitionszuschuss*. Tratto da https://www.kfw.de/PDF/Download-Center/F%C3%B6rderprogramme-(Inlandsf%C3%B6rderung)/PDF-Dokumente/6000004311_M_430_Zuschuss.pdf

REE. (2018, 10). *Red Eléctrica de España*. Tratto da https://www.ree.es/es/actividades/operacion-del-sistema-electrico

CNMC. (2018). *Ranking de las eléctricas en España.*

Ecobservatorio. (2018). Tratto da www.ecobservatorio.com

IW Köln. (2017a). *Die komplexe Förderlandschaft für energetische Gebäudesanierungen in Deutschland*. Tratto da https://www.iwkoeln.de/fileadmin/publikationen/2017/317876/IW-Gutachten_2017_Energetische_Foerderung.pdf

DellaValle, N. (n.d.). *Science Direct*. Retrieved from https://www.sciencedirect.com/science/article/pii/S0378778819305675

Agenzia dell'Entrate. (n.d.). *Agenzia dell'Entrate*. Retrieved from https://www.agenziaentrate.gov.it/portale/documents/20143/233848/Il+sistema+catastale+%28dati+2016%29_Il+Sistema+Catastale+2018+%28DATI+2017%29+20181210_stampa.pdf/b3b105f2-e48b-227e-31e7-969e5686e1ab

ARERA. (n.d.). Retrieved from Regulation Authority for Energy, Networks and Environment: https://www.arera.it/it/index.htm

Baltic News Service news. (n.d.). Retrieved from https://sc.bns.lt/view/item/310813

CTI. (n.d.). Retrieved from Comitato Termotecnico Italiano: https://www.cti2000.eu/legislazione-nazionale/

Eurostat. (n.d.). Retrieved from European Statistical Office: https://ec.europa.eu/eurostat

ISTAT. (n.d.).

Legislative register. (n.d.). Retrieved from www.e-tar.lt

Lithuanian Heat Supplier Association. (n.d.). Retrieved from https://lsta.lt/

Sistela. (n.d.). Retrieved from http://www.sistela.lt/apie-mus

Rincón, E. N. (2013). *Wold Wildlife Fund.* Retrieved from Evangelina Nucete and Manuel Romero Rincón

World Bank. (n.d.).

RENONBILL

www.renonbill.eu

@RenOnBill

RenOnBill H2020 – Residential Building Energy Renovations with On-Bill Financing

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 847056.