NOVA SCHOOL OF SCIENCE & TECHNOLOGY

DEPARTMENT OF ELECTRICAL AND COMPUTER ENGINEERING

MIGUEL PROJECTO MENDES

BSc in Environment and Sea Technologies

EXPLORING THE DEVELOPMENT OF AN ENERGY EFFICIENCY ONE-STOP SHOP

IN SETÚBAL, PORTUGAL

MASTER IN RENEWABLE ENERGY ENGINEERING

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ABSTRACT

Energy is an essential pillar for any economy. In Europe, energy consumption has been gaining prominence as energy costs increase, especially in the most consuming sectors such as transport, industry and buildings. With the residential sector accounting, on average, for more than a quarter of total final energy consumption, makes it a key sector for the energy transition. In line with several recent policies and strategies, many European countries have created methods to implement on-site measures that help the population and ensure a fair energy transition, encourage the improvement of energy performance on residential buildings and reduce the population's vulnerability to energy poverty. This thesis's objectives consist on developing a methodological approach to study the implementation of an energy efficiency One-Stop Shop to address energy poverty. This approach consists in implementing a mobile One-Stop Shop for Energy Efficiency in two locations in Setúbal, Portugal using twelve simple steps. This mobile unit, made from a used shipping container for portability, allows to concentrate all relevant information needed to help users reduce their energy bills and to improve energy efficiency at home. Approximately six months after the implementation and after analysing the data collected by the survey, it was possible to verify that users from the target group were the most difficult to reach. Was registered a higher incidence of middle-class users looking for public funding, instead of users in more severe energy poverty situations per se. The majority of the surveyed population had interest in renovating their homes to improve their energy efficiency but were looking for available governmental grants to help with investment costs.

Keywords: Energy efficiency, Energy Poverty, One-Stop-Shop, Local action, Buildings renovation

RESUMO

A energia é um pilar essencial para qualquer economia. Na Europa, o consumo de energia tem vindo a ganhar destaque à medida que os custos energéticos aumentam, especialmente nos sectores que mais consomem como os transportes, indústria e edifícios. Com o sector residencial a representar, em média, mais de um quarto do consumo final total de energia, torna-o um sector chave para a transição energética. Em linha com várias políticas e estratégias recentes, muitos países europeus criaram métodos para implementar medidas no local que ajudam a população e asseguram uma transição energética justa, promovem a melhoria do desempenho energético dos edifícios residenciais e reduzem a vulnerabilidade da população à pobreza energética. Os objetivos desta dissertação consistem em desenvolver uma abordagem metodológica para estudar a implementação de um *One-Stop Shop* de eficiência energética para combater a pobreza energética. Esta abordagem consiste na implementação de um *One-Stop Shop* móvel para Eficiência Energética em dois locais em Setúbal, Portugal, utilizando doze passos simples. Esta unidade móvel, feita a partir de um contentor marítimo usado para portabilidade, permite concentrar toda a informação relevante necessária para ajudar os utilizadores a reduzir as suas faturas de energia e a melhorar a eficiência energética em casa. Aproximadamente seis meses após a implementação e após análise dos dados recolhidos pelo inquérito, foi possível verificar que os utilizadores do público-alvo foram os mais difíceis de alcançar. Foi registada uma maior incidência de utilizadores de classe média à procura de financiamento público, em vez de utilizadores em situações mais graves de pobreza energética propriamente dita. A maioria da população inquirida tinha interesse em renovar as suas casas para melhorar a sua eficiência energética, mas procurava apoios públicos disponíveis para ajudá-los com os custos de investimento.

Palavras chave: Eficiência energética, Pobreza energética, *One-Stop-Shop*, Ação local, Renovação de edifícios

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ACRONYMS

bcm	Billion cubic Metres
CENSE	Center for Environmental and Sustainability Research
EE	Energy Efficiency
EES	Energy Efficiency Subscription
ENA	Agência de Energia e Ambiente da Arrábida
EP	Energy Poverty
EPAH	Energy Poverty Advisory Hub
EPB	Energy Performance of Building
EPVI	Energy Poverty Vulnerability Index
EU	European Union
EV	Efficiency Voucher
GHG	Greenhouse Gas
HDI	Human Development Index
Mtoe	Million tons of Oil Equivalent
OECD	Organization for Economic Cooperation and Development
OSS	One-Stop-Shop
TP	Transition Point

1 INTRODUCTION

1.1 Context and motivation

Energy is at the base of every country's economy and is essential to what we call everyday living nowadays. Since the first industrial revolution, energy use has soared severely as technology evolved until the present time. Energy resources have been taken for granted since then, and only recently, countries have started taking into consideration the (in)sustainability of their economic activities. With more than 80% of the world's primary energy consumption being fossil fuels (Smil, 2016), it is urgent to reduce the world's dependency on fossil fuels to maintain a liveable planet to future generations. With most of the primary energy consumed by industrial, buildings and transportation sectors, it is essential to research methods to reduce energy consumption and increase the efficiency of our activities in these key sectors. In Europe, the residential sector consumes 26.1% of the total final energy (Eurostat, 2020a), making it the second largest sector in terms of final energy consumption, just below the transportation sector. This makes the residential sector a key sector to achieve the targets set by the European Commission on decarbonization and energy transition.

Portugal is one of the countries with the highest levels of energy poverty in Europe. Even though Portugal is considered a developed country with an HDI of 0,847 (United Nations, 2018), It is estimated that between 1.9 to 3 million Portuguese are somehow affected by energy poverty. This is a significant share of the country's population; 20 to 30% of the citizens can not properly heat or cool their homes when needed. In most cases, this part of the Portuguese population is financially unable to maintain thermal comfort as it represents a significant part of the family's income. The Portuguese residential building stock is old, with 15% of the buildings dating back to 1945 or earlier (J. Gouveia & Palma, 2021a). Approximately 70% of the

country's dwellings are built before 1990 (INE, 2011a), a period without any regulation considering energy efficiency or thermal performance of new buildings. Every year, the inefficiency of Portuguese homes attracts mediatic attention as more inhabitants suffer from thermal discomfort and poor living conditions at home.

Fighting energy poverty and energy inefficiency in Portuguese homes is a challenging objective. With almost a third of the Portuguese population not having the possibility to maintain a comfortable temperature at home all year long, it requires an effective instrument capable of gradually reducing the vulnerability of that population to energy poverty. Improving the available housing stock is an effective way to increase dwelling efficiency. With most Portuguese homes not having suitable insulation methods to increase thermal comfort, it is essential to concentrate efforts to improve thermal performance in an alternative to produce energy from new or renewable sources right away. In this case, the main objective is to reduce the energy necessary to maintain thermal comfort using passive methods like exterior wall insulation, roof insulation and double-glazed windows. Only after ensuring appropriate insulation is it advised to implement active solutions to improve dwelling efficiency like photovoltaics. With electrical appliances and lighting representing 21.5% and cooking representing 34.6% (INE, 2021c) of the total energy consumed on a Portuguese dwelling, it is pertinent to consider the efficiency of new appliances and substitute inefficient ones when possible. In this way, it is possible to reduce consumption and the impact of energy costs on the household budget.

Portugal has been very receptive to energy transition and home renovations to improve efficiency. Since 2020, the Portuguese Government and community aid have opened three subsidy schemes to Portuguese homeowners to improve the energy efficiency of their homes, totalizing over 130 thousand applications in the last two years. This indicates that Portuguese citizens are receptive to change and are willing to invest in improving their living conditions. As 130 thousand families applied to receive a grant from the Portuguese environmental fund, it is feared that the remaining population has not applied because they are not owners of the home or did not have the economic capability to proceed with the intervention or do not have enough knowledge about the solutions and available grants. Other European countries are approaching this problem with the One-stop shop business model that consists in a physical or online platform that aggregates all the necessary information to advise the consumer.

1.2 Objectives

Considering the motivation of this thesis and the current energy problem for homeowners and tenants, it is relevant to develop a method to be in proximity to the most vulnerable. Inhabitants that are more vulnerable to energy poverty can be directly linked to low energy literacy and low income. To address this condition and reduce the vulnerability of these inhabitants, this thesis aims to explore the development of a pilot project to be in proximity to homeowners and were set the following objectives:

- Review energy efficiency One-stop shops across Europe and their activities on improving household efficiency and reducing the exposure of population to energy poverty.
- Characterize and identify best practices of similar European shops.
- Develop a methodological model to allow the implementation of similar one-stop shops in Portugal and other European countries.
- Apply the developed methodology to a pilot project and collect performance registries.
- Analyse and discuss results to identify improvement opportunities.

1.3 Thesis Organization

This thesis is divided into seven chapters; the first chapter introduces the developed work, main objectives, and motivation necessary to develop the methodology to implement a One Stop Shop for Energy Efficiency.

Chapter 2 presents the literature review on energy poverty, energy poverty indicators, and energy efficiency in residential buildings. In this chapter, are also mentioned the existing related EU a national policies and funding schemes.

Chapter 3 compiles relevant Energy efficiency One-stop Shops projects in European countries and their key characteristics.

Chapter 4 is dedicated to developing and describing the methodology used so that it could be used to replicate the work in other regions.

Chapter 5 aims to describe all the steps made during the development phase of the case study and the main results for each step.

Chapter 6 discusses and analyses the collected data from the survey conducted to the participants and that was explored using Power BI.

Finally, chapter 7 compiles relevant project conclusions and future work arising from this thesis.

2 LITERATURE REVIEW

2.1 Energy in the World

Energy users worldwide have been taking energy for granted, some using it like it was infinite and limitless. The problem with using energy irrationally is its impact on global natural resources and future generations. As energy is fundamental to create economic growth and more prosperous communities worldwide, some countries and regions have been using global resources to produce it in an unsustainable way in exchange for quick economic growth. This growth, mainly pursued by developing countries, was made possible by using fossil fuels – oil, natural gas, and coal, that are readily available and historically considered a cheap energy source.

With the start of the first oil crisis in 1973, it was necessary to rationalize energy consumption to save primary energy and reduce energy-related costs. During this period, the cost per barrel of oil was unsustainable to most economies and consumption habits (Bösch & Graf, 2014) (Gouveia et al., 2019). This crisis was a warning for the future and is still an important event that made the western world reduce its energy dependence and environmental impact and improve energy efficiency in all sectors.

It is with energy that all countries create and consume products from alimentary products to electronic goods. Without energy, the global economy would stop, and the wellbeing of the global population would be tremendously affected. With the not-so-new concerns about energy production and its impact on climate change, the energy sector has been selected as one of the most capable sectors of sustaining a significant reduction of energy-related carbon emissions.

A study conducted by EIA (2021b) assumes that most of the energy produced worldwide in 2019 (>80%) was produced using fossil fuels. Since the 70s, the world's energy production has grown over 240 percent in the last fifty years, increasing the demand for cheap and reliable

energy sources. Since the industrial revolution, most countries have used fossil fuels like oil and coal as an opportunity to produce more and boost their economy. Since then, the use of each fuel source has not changed much, but the amount of energy has more than duplicated. As this form of unsustainable energy production continues to increase, more countries and regions adopt measures to reduce their impact on the environment. Figure 1 exemplifies the evolution of the global energy supply by source from 1971 until 2019.

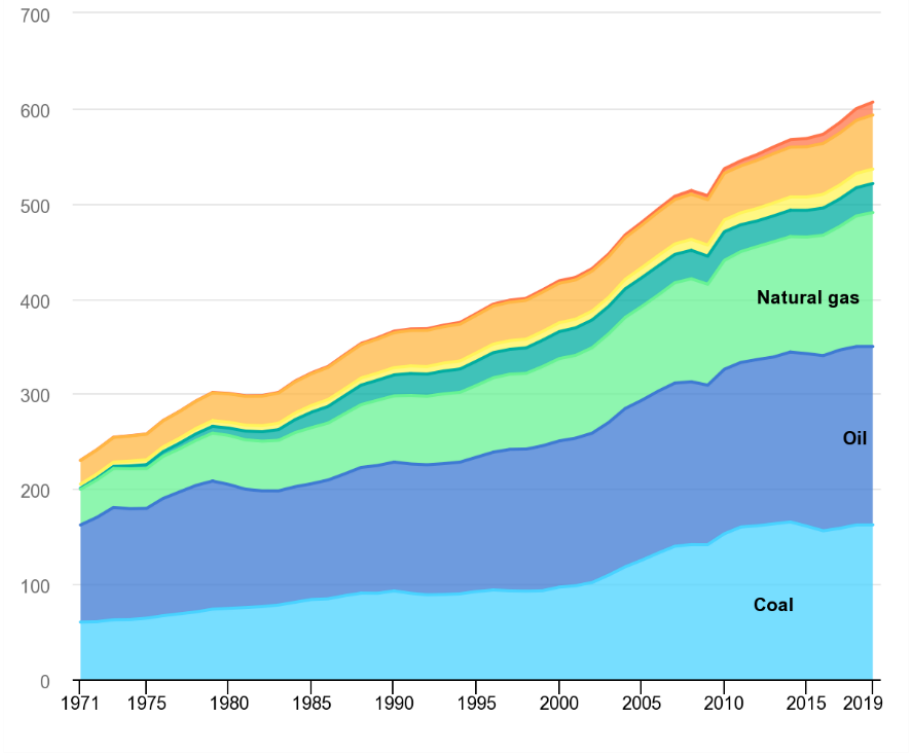


Figure 1: World total energy supply by source, 1971-2019 (IEA, 2021c)

2.2 Energy in Europe

In the International Energy Association (EIA), (IEA, 2019) has compiled the data of the total energy supply from 1990 to 2019 in Figure 2. Similarly, as the previous Figure, OECD as similar source distribution among the energy supply, with a much less significant growth on energy production in this timeframe. The small change on energy production since the 70s when comparing with the rest of the world, may relate to the outsourcing of several industries like electronics and clothing manufacture to Asian and African countries, consuming energy in those countries. In European countries, coal and oil are not as relevant as in other countries. Europe's electric energy comes mainly from renewables such as wind and hydroelectricity and from nuclear and natural gas. The increase in energy regulations to stimulate energy transition

in Europe and reduce carbon emissions was also noticeable after 2010 until the COVID-19 pandemic struck the world in March 2020.

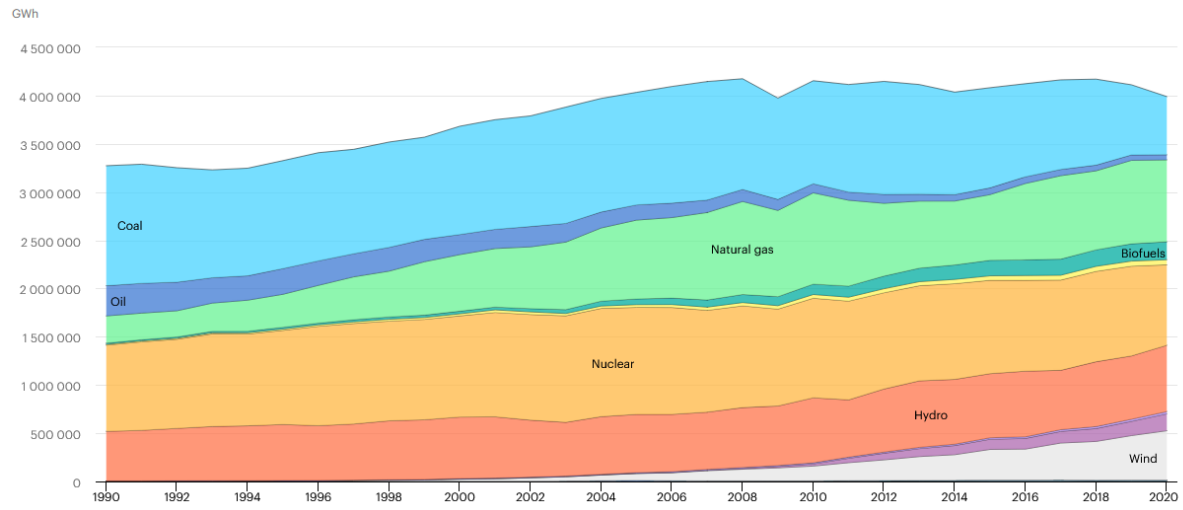


Figure 2: Europe's electricity generation by source, 1990-2019 (IEA, 2019)

In 2022, a new energy crisis has begun with most of the OECD, especially the European countries, population being somehow dependent on Russian energy sources like oil and gas to fuel their economies. Russian sanctions amid the Ukraine war have struck the world, especially the Europeans, with a big energy problem, energy dependency and security. In 2021, the EU imported approximately 155 billion cubic metres (bcm) of natural gas from Russia, representing around 40 percent of the EU's total gas consumption (Halm, 2022). This makes Russia the largest external supplier of natural gas to the EU. Due to the increased tensions between the East and the West, the EU is at risk of entering a major energy crisis for not diversifying its energy suppliers. A study conducted by (Ratner et al., 2012) back in 2012 indicated that EU countries had an old energy dependence on Russia, especially eastern and central Europe countries, as shown in Figure 3. The problems that some EU countries have been facing in 2022 are consequences of the past Russian influence in eastern countries like Lithuania and the proliferation of natural gas pipelines to supply central Europe countries with cheap and readily available natural gas. In the past decades and with the increase of stricter carbon regulations, most EU members felt the need to reduce energy carbon emissions. To achieve the goals of decarbonizing the economy and reach carbon neutrality by 2050, most countries were required to retrofit the existing power plants that used coal or oil to start using natural gas

instead. In 2010, the use of primary energy in the form of oil and coal began to diminish as natural gas started to be implemented in more industries.

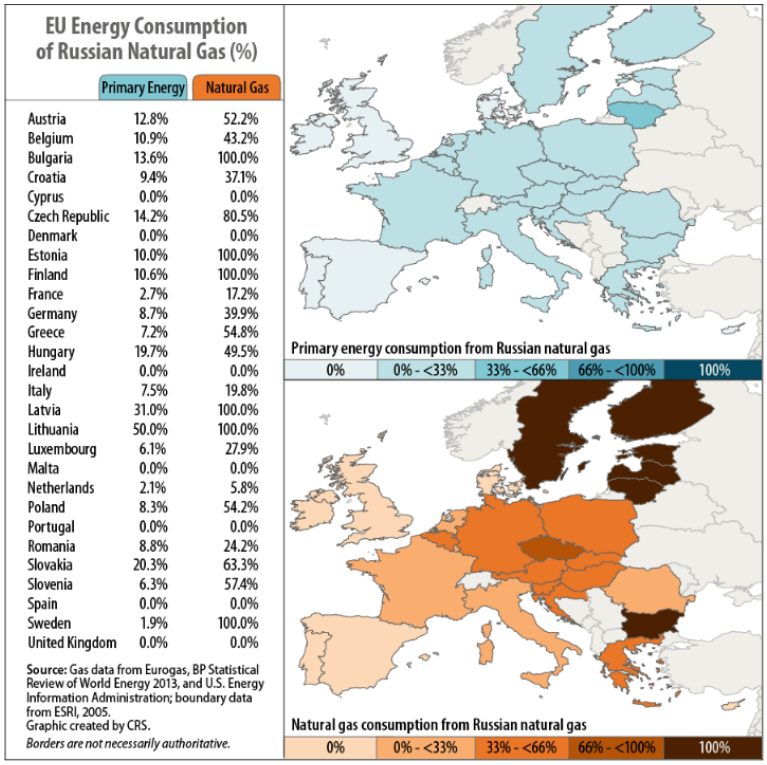


Figure 3: EU Dependence on Russian Natural Gas (Ratner et al., 2012)

As the EU is being affected by its energy dependence on imported primary energy, the European Commission has proposed a reduction in the demand for natural gas by 15% until spring of 2023 to protect itself from future restrictions in the supply (European Commission, 2022b).

2.3 Energy efficiency in the residential sector

Energy efficiency can be simply described as the means of using less energy to perform the same task. Turning something or some process more energy efficient is expected to consume less energy to maintain such activity. Linked with energy efficiency is the rational use of energy which consists of the behavioural aspect of the user.

With rising environmental concerns, energy efficiency is considered an effective instrument to reduce the consumption of primary energy. This way, it is possible to maintain a certain degree of comfort or economic growth while using less energy. This is, in most cases, the most cost-effective solution to reduce energy consumption. Using energy-efficient

technologies, like LEDs, uses less energy while providing similar or better light output (United Nations, 2022). Improving energy efficiency reduces energy intensity and therefore reduces the dependency on fossil fuels that are mostly imported. The International Energy Agency estimated there was potential to decrease energy intensity in Europe by at least 2.5% per annum between 2017 and 2030 (ECA, 2022). This target cannot be reached without making Europe's economy more energy efficient.

With the world's residential sector consuming 25.9% of the total electricity produced annually (Fatih Birol, 2020), which represents 36% of the greenhouse gas (GHG) emissions in the EU (Hermelink et al., 2019), makes building renovation an interesting method to assist the various initiatives already in progress to reach environmental objectives. The EU seeks to reduce greenhouse gas emissions by 55% by 2030 and reduce emissions needed to supply the residential sector by 60%. It is expected to reduce energy consumption by 14% for heating and 18% for cooling by 2030 of the total energy consumed for residential use (European Commission, 2020c). This makes the residential sector in Europe an important path to reduce the carbon footprint of European homes.

To meet the EU objective to be carbon-neutral by 2050, countries like Germany strongly invest in a more energy-efficient economy. In 2020, Germany spent 30 billion euros on efficient construction and renovation investments. Other countries like the United Kingdom and the Netherlands are encouraging homeowners to replace existing water heating solutions with more efficient heat pumps by ceasing to sell gas-fired boilers. In Ireland, new buildings will be forbidden to have oil-powered boilers by 2022 (IEA, 2021a). The discouragement of using water heaters powered by fossil fuels is being widely adopted across Europe; these policies effectively promote a positive evolution of dwelling efficiency by forcing homeowners to buy new methods to heat water for home use. Shifting to a carbon-neutral economy by improving existing buildings' performance is a relatively cheap way to improve the comfort and health of the inhabitants.

2.4 Energy consumption on European residential buildings

According to the data analysed by (Eurostat, 2020a) and exemplified in Figure 4, the residential sector is the second largest energy consumer in the EU, corresponding to 26.1% of

the total final energy, between the transportation sector with 30.5% and the industry sector representing 25.8% of the total energy consumed.

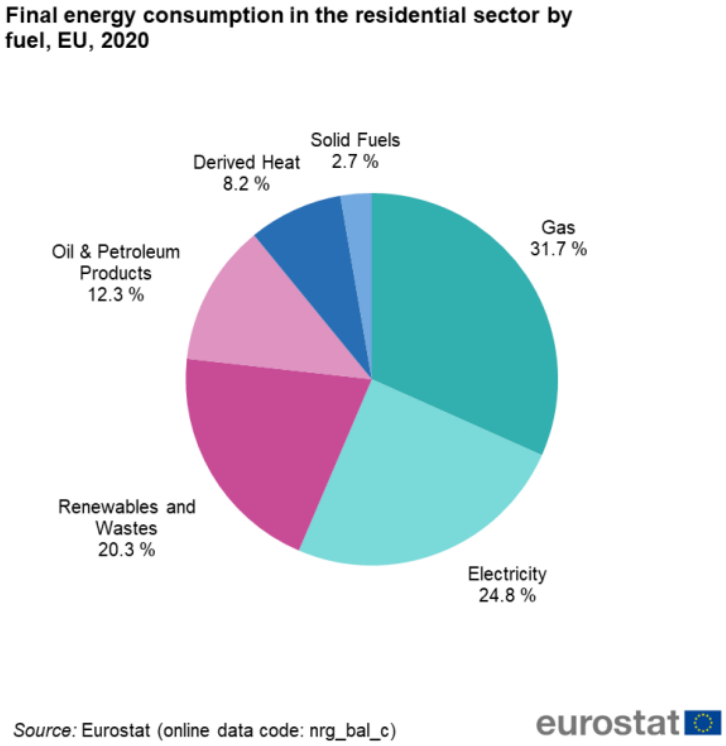


Figure 4: Final Energy consumption by sector in EU-27, 2020 (Eurostat, 2022)

In the EU, the primary use of energy by households is spent heating their homes, representing almost 2/3 of the total energy consumed, as exemplified in Figure 5. Electricity used for lighting and most electrical appliances represents 14.5%, excluding the electricity required for powering the main heating, cooling, or cooking systems. In contrast, the proportion used for water heating is slightly higher, representing 15.1 %. Main cooking devices require 6.1 % of the energy used by households, while space cooling and other end-uses cover 0.4 % and 1.0 %, respectively. Heating of space and water represents 77.9 % of the final energy consumed by households (Eurostat, 2022). With energy expenditure for space heating representing most of the energy consumed by average European households, it indicates that most residential buildings suffer from deficient energy efficiency, making homeowners and tenants spend more income to maintain a comfortable temperature at home. Also, most of the EU's population lives in regions with harsh winters, requiring active measures to sustain a comfortable temperature at home.

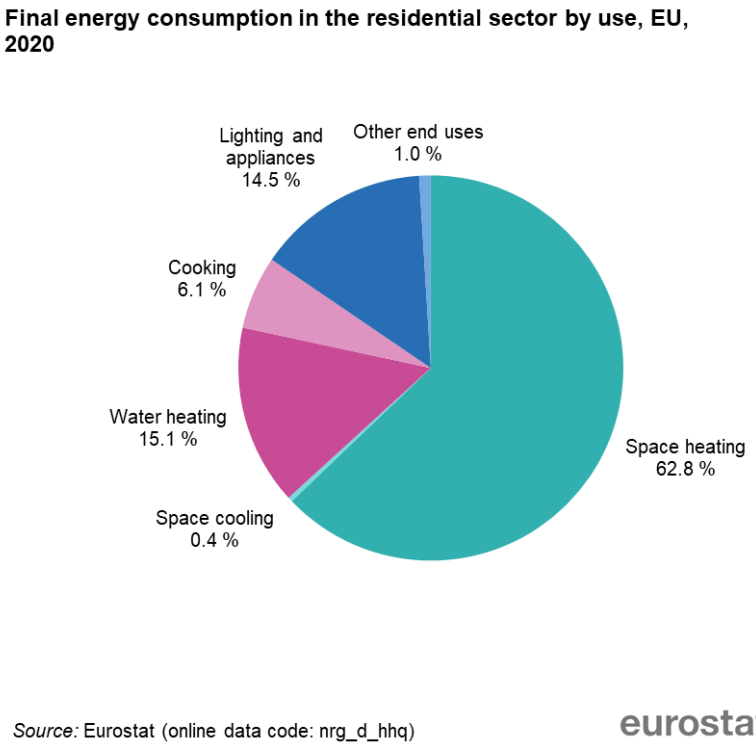


Figure 5: Final Energy consumption in the residential sector by use in the EU in 2020 (Eurostat, 2022)

Portugal, on the other hand, spends less than half of the average EU household on space heating (30.5%); this is not an indicator that Portuguese housing is more efficient than the average European homes; it indicates not only that Portuguese households spend less to heat their homes due to less rigorous winters when compared with countries from higher latitudes or central Europe, requiring less space heating during the colder months, but also widespread problems of underconsumption and lack of thermal comfort. In Table 1: Energy consumption in the residential sector by type of end use in the EU in 2020 (Eurostat, 2022) it is possible to compare the share of final energy consumption between European countries.

Table 1: Energy consumption in the residential sector by type of end use in the EU in 2020 (Eurostat, 2022)

Share of final energy consumption in the residential sector by type of end-use, 2020
(%)

	space heating	space cooling	water heating	cooking	lighting and electrical appliances	other end use
EU	**62.8**	**0.4**	**15.1**	**6.1**	**14.5**	**1.0**
Belgium	72.7	0.1	11.7	1.7	13.2	0.6
Bulgaria	54.5	0.5	17.1	8.3	19.7	:
Czechia	68.4	0.1	16.5	6.2	7.2	1.7
Denmark	58.3	:	22.7	1.8	16.7	0.5
Germany	67.1	0.2	16.7	5.9	9.0	1.1
Estonia	72.1	:	11.6	4.9	11.4	:
Ireland	60.8	:	19.7	2.2	16.4	0.9
Greece	57.1	4.2	13.9	8.0	16.7	:
Spain	40.7	:	19.4	7.8	32.1	0.0
France	62.9	0.6	12.0	5.9	18.6	:
Croatia	68.2	1.9	10.2	6.7	13.1	:
Italy	65.4	0.7	12.2	6.8	13.6	1.3
Cyprus	37.2	10.2	22.7	7.9	20.0	2.0
Latvia	64.2	0.0	18.8	7.2	9.1	0.6
Lithuania	69.0	:	9.2	6.4	15.4	:
Luxembourg	81.0	0.5	7.5	3.3	7.8	:
Hungary	63.7	0.2	16.3	6.7	13.2	:
Malta	19.4	12.3	25.1	13.1	29.2	0.8
Netherlands	60.9	0.3	17.4	2.1	19.2	0.1
Austria	69.8	0.0	14.3	2.6	10.2	3.1
Poland	63.3	0.0	17.2	8.6	10.9	:
Portugal	30.5	0.9	17.9	31.4	19.4	0.0
Romania	62.2	0.3	13.8	9.8	13.9	:
Slovenia	62.0	0.6	16.2	4.1	17.2	:
Slovakia	73.1	0.1	12.3	4.3	10.2	0.0
Finland	63.6	0.2	16.4	1.4	12.5	5.8
Sweden	55.6	:	14.1	1.6	20.5	8.2
Norway	65.2	0.1	13.4	1.6	18.9	0.8
North Macedonia	68.7	2.4	8.6	7.3	13.0	:
Albania	32.6	8.0	23.6	31.2	4.6	:
Serbia	66.3	0.4	11.8	7.1	14.4	:
Bosnia and Herzegovina	73.4	0.6	9.4	5.1	11.5	:
Kosovo*	67.8	4.0	7.6	8.4	10.9	1.3
Moldova	68.1	0.1	10.0	13.0	8.9	:
Georgia	56.8	0.3	13.7	17.5	11.7	:

(*)This designation is without prejudice to positions on status, and is in line with UNSCR 1244 and the ICJ Opinion on the Kosovo declaration of independence.

Source: Eurostat (online data code: nrg_d_hhq)

eurostat

2.5 Energy Consumption in Portuguese buildings

The residential sector in Portugal is the third largest energy consumer, with 19.5% in 2020. The largest energy consumer in 2020 was the transportation sector (32.7%), followed by the industrial sector with 31.1%, as shown in Figure 6. In 2020 was registered an increase in the total energy consumed by the residential sector was most definitely caused by the effect of the COVID-19 pandemic, which forced everyone to stay home. This increase of over 3 percentage points came from the transportation sector. Due to the pandemic, people were prevented from leaving their homes as much as possible, increasing energy consumption at home and thus, reducing energy consumption in transport.

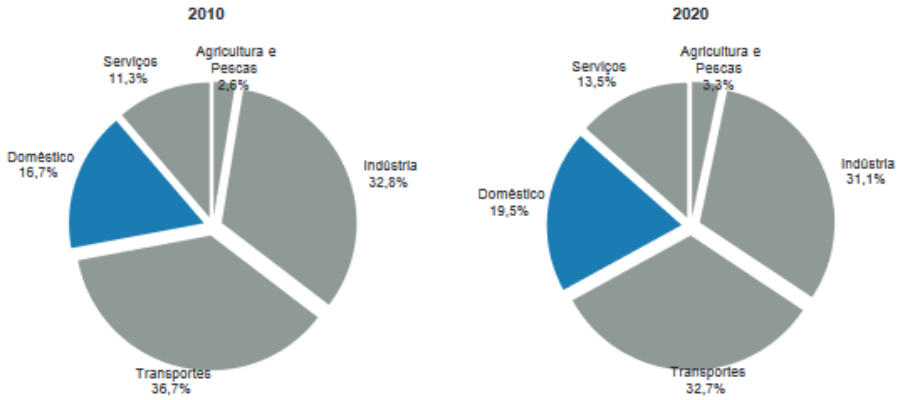


Figure 6: Energy consumption repartition by sector in 2010 (left) and 2020 (right) (INE, 2021b, 2021a)

According to INE (INE, 2021b, 2021c), the evolution of the weight of Portuguese households on the total energy consumption has fluctuated in the past two decades, reaching its maximum in 2020 and a minimum in 2010 due to the previous economic crisis as demonstrated in Figure 7.

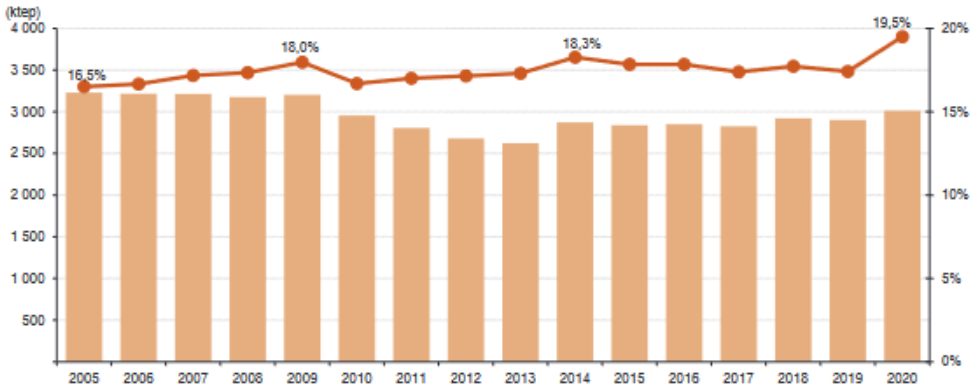
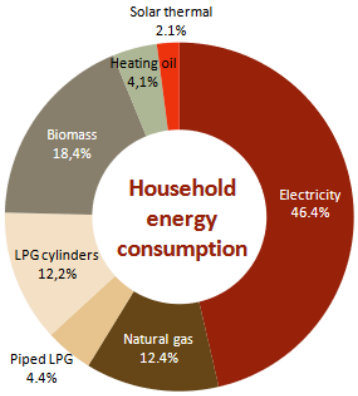


Figure 7: Evolution of the consumption of domestic sector 2005-2020 (INE, 2021c)

In 2020, the average energy consumption by household was 1.146 toe, equivalent to 1 925€ per year on total energy expenditure. Comparing with the data from 2010, the average Portuguese home consumed 1.501 toe, which equates to a total expenditure of 1 843€ (INE, 2021b). Portuguese homes have become significantly more efficient in ten years, with a reduction of near 0.4 toe per home. On the other hand, energy prices have increased, and the consumer paid more, even though less energy was consumed. (IEA, 2021b).

Electricity has remained the primary source of energy consumed by Portuguese households (excluding private transportation), with 46.4% in 2020, as indicated in Figure 8. Electricity is followed by biomass (18.4%), natural gas (12.4%), and LPG cylinders with (12.2%).



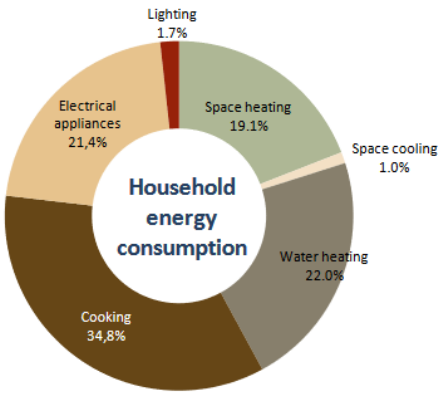
Source: INE/DGEG/ADENE - Survey on energy consumption in households (2020)

Figure 8: Type of energy consumed in Portuguese households in 2020

Gas distribution in Portugal is made in 3 forms, piped LPG, natural gas, and LPG cylinders. These three components represented 29% of the total energy consumed by households in 2020, making it the second largest energy source.

Electricity consumption has a very relevant role in the domestic sector, given that most of the appliances present in dwellings require this type of energy source, being clear the dependence on this energy source today. Electricity consumption will be directly associated with the increase in thermal comfort and the growth in the number of electrical appliances available, but also with the availability of more efficient equipment in consumption (INE, 2021b).

Most of the energy consumed by Portuguese households is used for cooking (34.8%), water heating (22%), electrical appliances (21.4%) a space heating (19.1%). These four components represent 97.3% of the total energy consumed by households, leaving only 1.7% for lighting and 1% for space cooling, as exemplified in Figure 9.



Source: INE/DGEG/ADENE - Survey on energy consumption in households (2020)

Figure 9: Energy use in Portuguese dwells in 2020

2.6 Portuguese residential buildings characteristics

There are about 3.5 million classic residential buildings and 5.9 million dwellings in Portugal (INE, 2011b). The Portuguese residential building stock is old, with 15% of the buildings dating back to 1945 or earlier. Approximately 70% were built before 1990 (INE, 2011b), when energy performance regulations for residential buildings were still not implemented in the country. Bearing structures are either stone or brick masonry (51%) or reinforced concrete (49%). Older buildings commonly have stone masonry and wooden roofs and floors (Magalhães & De Freitas, 2017). The use of reinforced concrete in the bearing structure is more recent and is a common practice nowadays (Gouveia & Palma, 2021a).

The Portuguese construction, mainly until the early 2000s, is known for its insufficient thermal insulation and lack of preparation for high-temperature amplitudes. In Portugal, buildings are mainly built from clay bricks and cement; some older buildings are made from stone. Although this contributes to increasing the building's thermal inertia, which can maintain the inside temperature stable for some time, it is just a matter of time until the materials that constitute the wall reach thermal equilibrium with the outside environment. This makes housing hard to cool in the summer and hard to heat in the winter because there is not enough time between heat cycles (days). Until 2006, when the Thermal Performance Buildings Characteristics Regulation (RCCTE) came into force, houses were built with little to no thought regarding thermal efficiency, walls with no insulation, windows only with single glazing, and window frames made from wood or aluminium that contributes to poor insulation and comfort.

In Portugal, buildings consumed 32.9% of the total produced energy in 2020, residential buildings consumed 19.4%, and the other 13.5% consumed the service sector (DGEG, 2021b). With more than 30% of the energy consumed by buildings, the building sector is as important as the transportation sector with 32.6%. With an old building stock and with the objective to improve the quality and comfort of home conditions, the communitarian directive 2010/31/EU was approved to regulate and incentivise building certification and energy performance (EED - Energy Efficiency Directive). This directive was later revised by the 2018/844 of the European Parliament and Council (DGEG, 2021b). This revision has come to implement and align Europe's trajectory to develop a sustainable energetic system and pursue the decarbonization required by imposing the reinforcement of strategies for a long-run rehabilitation (ADENE, 2022b).

2.7 Energy performance certification in Portuguese residential buildings

Like other European countries that have implemented the EU directive responsible for legislating building performance and certification, Portugal implemented a building certification system in 2007. Since then, over 1.7 million performance certificates have been emitted. The performance of the evaluated building can be classified into 8 classes ranging from F, the worst performing class, to A+, the best performing class. In 2009, it became mandatory for every new building or existing building (when sold or leased) to have an energy performance certificate. New buildings must have B- or better to comply with current regulations. The certificate can only be acquired after the building has been submitted to an evaluation conducted by a qualified expert certified by ADENE (ADENE, 2022a).

Most recent statistics show that the majority (over 67%) (ADENE, 2022c) of certified residential buildings have a performance score lower than the current standard (B-) defined for new buildings. Most Portuguese buildings were built before the implementation of any regulation and, in most cases, without any intentions of making houses more energy efficient. Figure 10 represents the distribution, by rate, of evaluated buildings.

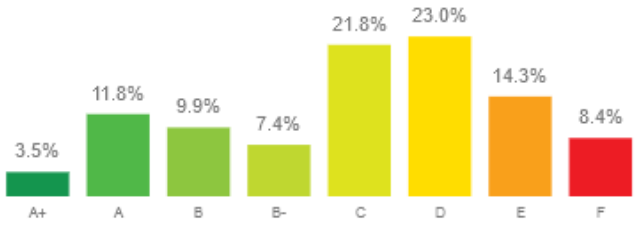


Figure 10: Score of Portuguese building certification (ADENE, 2022c)

A study made by ADENE, the national Portuguese energy agency, has researched the consumption of energy and energy efficiency of private housing and found that, on average, the Portuguese spend roughly 112 euros every month on utility bills. Between electricity, gas, and water usage, electricity is the most significant expense representing 51% of the total utility expense for the average Portuguese household, followed by gas and water. The same study also identified that 3 out of 4 people interviewed are sensitive about the subject and wish to reduce their energy costs and improve thermal comfort at home. The same citizens that have shown sensitivity to the previous concerns indicated that they do not have the knowledge or

been able to concretize efficient measures to reduce their energy consumption. (ADENE, 2017, 2022b).

Until 1990, Portuguese buildings were not constructed following energy efficiency guidelines or regulations. It was not until 1990 that the first energy performance of the building (EPB) was implemented. This EPB was the first legal instrument to define energy performance requirements for new and big retrofitting projects._This regulation was replaced by 2006's Thermal Performance Buildings Characteristics Regulation (RCCTE), stemming from the European Directive 2002/91/CE, which set more demanding requirements concerning the building's thermal performance and introduced the Energy Certification System (SCE). In 2013, a new directive on building energy performance was issued (Directive 2010/31/EU), resulting in two new revised building energy performance regulations in Portugal, Residential Buildings Energy Performance Regulation (REH) and Commercial and Service Buildings Energy Performance Regulation (RECS), as well as a revised SCE. (Gouveia & Palma, 2021a). Figure 11 represents the evolution of the Portuguese regulations concerning energy efficiency in residential buildings.

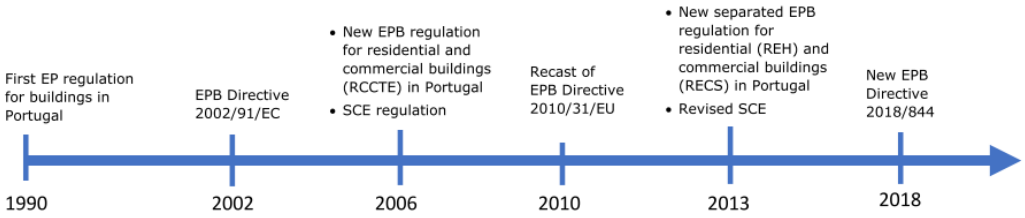


Figure 11:Portuguese energy efficiency regulation for residential buildings timeline. (J. P. Gouveia & Palma, 2021a)

2.8 Energy policies

2.8.1 European Green Deal

Europe is committed to becoming carbon neutral by 2050. To reach that goal, the European Green Deal aims to detach economic growth from resource use, setting a goal of achieving net-zero emission of greenhouse gases in 2050 while allowing the EU to become a fair and prosperous society with a modern resource-efficient and competitive economy (European Commission, 2019; Felix, 2021).

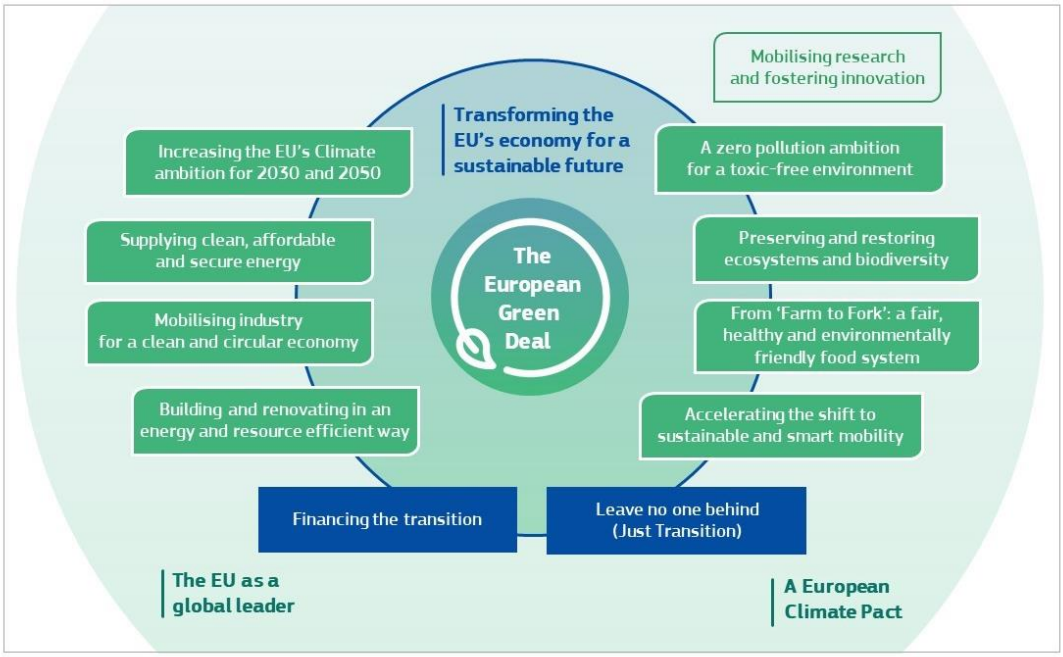


Figure 12: The European Green Deal (European Commission, 2019c)

The Green Deal emphasizes the need to rethink policies, increasing the value given to the protection of the natural ecosystems and the improvement of human health and wellbeing, through sustainable use of resources, for better integration of clean energy supply across all the economy, including the construction sector. With regards to the existing buildings stock, which is responsible for 40% of energy consumption, the strategy encourages the EU and the Member States to engage in a 'renovation wave' of public and private buildings in the challenge to achieve energy efficiency and affordability in the construction, use, and renovation of buildings (European Commission, 2019c). The increase in the annual renovation rate of the Member States' building stock, currently between 0.4 to 1.2%, is also vital in reaching the EU's energy efficiency and climate objectives (European Commission, 2019). Lowering energy bills and improving the quality of the construction – and consequently, the well-being of users – energy and resource-efficient renovations also can reduce energy poverty, assisting consumers who struggle to keep their homes at a comfortable temperature and other energy services at affordable costs. The design of new and renovated buildings is expected to align with the circular economy's needs, leading to a path of increased digitalization and climate-proofing of the building stock. On that goal, multiple efforts are in course to enforce the legislation related to the energy performance of buildings, including the 2020's assessment of Member States' national long-term renovation strategies under the Energy Performance of Buildings Directive,

initiatives related to relative pricing of different energy sources to encourage more energy-efficient alternatives, and the revision of the Construction Products Regulation to align the marketing of construction products with the aimed sustainability goals (European Commission, 2019; Felix, 2021).

To overcome existing barriers to renovation, the Commission also proposes an open platform, bringing together the buildings and construction sector, architects, engineers, and local authorities, with innovative financing schemes targeting housing associations and energy service companies that could contribute to the renovation catalysis. Rented and multi-ownership buildings are also targeted by the Commission, which aims to overcome national regulatory barriers to energy efficiency investments, with particular attention to the renovation of social housing and households with financial difficulties in paying energy bills (Felix, 2021).

2.8.2 Fit for 55

The Fit to 55 package (European Commission, 2021b) builds on EU policies and legislation, further supporting a fair shift to climate neutrality, presenting a comprehensive set of proposals on climate and energy, and setting the basis for a sustainable, resilient, and job-generative economy. A set of interconnected proposals driving towards the same goals of leading the EU to a fair, competitive, and green transition by 2030, the Fit for 55 package strengthens eight existing pieces of legislation. It presents five new initiatives on climate, energy and fuels, transport, buildings, land use, and forestry. It assumes the policy mix approach defended in the 2030 Climate Target Plan to balance the opportunities and costs involved in the green transition (European Commission, 2021b). Balancing between pricing, targets, standards, and support measures, the chosen policy mix aims to avoid the high economic burdens expected from an over-reliance on regulatory policies reinforcement and the inefficiency of overcoming market-related issues through carbon pricing interventions alone (European Commission, 2021b; Felix, 2021).

2.8.3 Renovation Wave

Pointing to buildings renovation as a double feature solution for climate neutrality and economic recovery post-COVID-19, the European Commission (European Commission, 2020a) developed the Renovation Wave strategy with the objective to "at least double the annual

energy renovation rate of residential and non-residential buildings by 2030" and the potential to promote the renovation of 35 million buildings units. Besides the guiding principle of energy efficiency, the strategy's highlights the affordability of energy-performing and sustainable buildings to lower-income and vulnerable people and areas, the focus on user's health and protection against climate-related hazards through the implementation of high health and environmental standards, the integration of energy systems to help the decarbonization and integration of renewables and heritage conservation based on the respect for aesthetics and architectural quality in its contribution to people's quality of life and sustainable development of cities and rural areas (European Commission, 2020a; Felix, 2021).

2.9 Portuguese Energy Efficiency Policies, Strategies, and Measures

2.9.1 Long-term Strategy for the Renovation of Buildings in Portugal [Estratégia de Longo Prazo para a Renovação dos Edifícios de Portugal]

The Long-Term Strategy for the Renewal of Buildings until 2050, developed in collaboration with ADENE and DGEG, was approved. It aims to promote the energy renovation of the national buildings park, to improve its energy performance and progressive decarbonization, contributing to the mitigation of energy poverty. This Strategy will strongly contribute to the national and European Union objectives of achieving carbon neutrality by 2050. The measures provided for in LTRS are grouped into seven lines of action: Building Renovation, Intelligent Buildings; Energy Certification; Training and Qualification; Fight against Energy Poverty; Information and Awareness, Monitoring (ADENE, 2021).

This strategy aims to provide an adequate response to this situation on the energy performance of buildings energy performance of buildings in which it is intended that this strategy facilitates access to mechanisms through smart financing, to support the mobilization of 13 investments to achieve a decarbonised and high-efficiency building stock by 2050 and to make buildings more cost-effective and with near-zero near zero energy buildings. LTSRB sets out a guide of improvement measures, progress indicators, and targets to be considered for 2030, 2040, and 2050 (Duarte, 2021).

2.9.2 National Long-term Strategy to Fight Energy Poverty [Estratégia Nacional de Longo Prazo para o Combate à Pobreza Energética]

In the context of the previous policies and strategies, Portugal, in its NECP 2030, establishes a line of action, "Fighting energy poverty and improving protection instruments for vulnerable consumers", which defines a set of action measures to tackle energy poverty, including the introduction of a Long-Term Strategy to Combat Energy Poverty.

Among the various factors that lead to a situation of energy poverty, Portugal considered three factors as most relevant: Income - low income and lack of monetary resources to meet energy costs; Energy - lack of access to adequate levels of energy services and low rate of equipment ownership; Housing - low energy performance, without the ability to provide adequate comfort and with high energy consumption needs (DGEG, 2021a).

Portugal's National Strategy to Fight Energy Poverty 2021-2050 (Ministério do Ambiente e Acção Climática, 2021) aims to obtain the characterization of the energy poverty issue in the country, and develop monitoring indicators and strategies, to set goals for reducing energy poverty in the medium and long term, at the regional and local scale, to propose specific measures to achieve these objectives and forms of financing for its mitigation. The strategy is the Government's first step in defining a strategic framework for combating energy poverty integrated into the broader approach to climate change, economic recovery, social equality, and improvement in the overall life of the Portuguese population. Acknowledging the importance of social inclusion in avoiding energy poverty exacerbation throughout the decarbonization and energy transition process, the strategy provides for a comprehensive and detailed understanding of the energy poverty reality in the country, identifying and highlighting potential energy poverty situations to propose concrete measures aimed at buildings renovation, energy efficiency promotion and the reduction of fossil fuel dependence. (Felix, 2021)

Adding to the potential benefits originated from this strategy, a set of goals for building renovation, within the scope of the Recovery and Resilience Program (PRR in Portuguese), Portugal will grant 300 of the 610 million euros over the next five years allocated to energy efficiency improvements and RES integration in the residential sector. Households of all types, with emphasis on low-income and energy-poor households, are included through support initiatives and efforts to tackle initial investments challenges related to energy renovation, such

as the Vale Eficiência program (Efficiency voucher) and Edificios + Sustentáveis (More sustainable buildings) Program (Felix, 2021).

2.9.3 National Plan for Energy and Climate 2030 [Plano Nacional de Energia e Clima 2030]

The National Plan for Energy and Climate is the main energy policy for 2021-2030, on the way to a carbon-neutral economy under the obligations established by the Regulation on the Governance of the Energy Union and Climate Action. This plan includes a characterization of the existing situation in terms of energy and climate, covering: decarbonization, energy efficiency, security of supply, innovation, and competitiveness. The NPEC establishes ambitious targets for 2030, such as the reduction of greenhouse gas emissions to 45-55% in relation to 2005 emissions, incorporation of renewable energy and energy efficiency for effective implementation of the Carbon Neutrality Roadmap for 2050 guidelines (APA, 2022)

Additionally, the NPEC 2030 establishes sectoral targets for the reduction of greenhouse gas emotions having 2005 emissions as a baseline: reduction of 70% in GHG in the service sector, 35% in the residential sector, 40% in the transport sector, 11% on agriculture and 30% on waste and wastewater sector (APA, 2022).

2.9.4 Efficiency Voucher [Vale Eficiência]

Vale Eficiência, or Efficiency Voucher (EV) in English, is a Portuguese program to address the problem of low energy efficiency in residential buildings and reduce the exposure to energy poverty. This allows homeowners to improve and renovate their homes. This program fits in the Recovery and Resilience Plan (RRP) being included in the investment TC-C13-i01 – Energy Efficiency in Residential Buildings of Component C13 – "Energy Efficiency in Buildings (Fundo Ambiental, 2021b).

This program aims to hand over 100.000 Efficiency Vouchers to economically vulnerable families until 2025 worth 1300 euros plus VAT each to improve the thermal comfort of their homes. This is a solution created by the Portuguese government through the Portuguese Environmental Fund (EF) to help families without the capability to pay for the improvements upfront. To be eligible to receive such a voucher, homeowners must be a social tariff beneficiary, be the property owner, and have not previously received a voucher from this program.

Eligible homeowners can use the voucher in four categories:

- 1-Efficient windows,
- 2-Roof and wall insulation,
- 3-AC, heat pumps, fireplaces, stoves, and solar for water heating,
- 4-Photovoltaic systems.

After selecting the category of interest, homeowners must choose a registered supplier to proceed with the renovation/installation; after the installation and after giving the registered supplier the details of the voucher, the supplier applies to redeem the voucher. This way, the voucher goes directly to the supplier and not from the EF to the homeowner to the supplier.

2.9.5 More Sustainable Buildings Program [Programa de Apoio a Edifícios + Sustentáveis II]

Funding for the More Sustainable Buildings Program is a Portuguese incentive to increase sustainability and efficiency of residential buildings. To have access to this funding, homeowners must conclude the installation/renovation of at least one of the six available categories (windows; roof and wall insulation; heat pumps, AC, fireplaces, and solar for water heating; photovoltaic panels; more efficient faucets; and the incorporation of biomaterials in facades and roofs. Homeowners can receive a reimbursement up to 4500€, in the case of wall insulation, or 85% of the total eligible expense (whichever comes first). Property owners can apply to several categories at the same time but can only benefit from 7500€ in reimbursements or 15 000€ in the case of multi-unit buildings. Beneficiaries must have their Social Security and taxes regularized and fill an online form with the relevant data to validate ownership and the intervention.

The application of this financing program promotes home retrofitting and decarbonization of the building sector and improves energy and environmental performance of residential buildings (Fundo Ambiental, 2021a). This fund has terminated in early May after receiving approximately 106 000 applications in less than a year. The evaluation process is currently ongoing.

2.10 Energy Poverty

Energy poverty in developed countries can be defined broadly as the inability to heat or cool a household at affordable costs. Energy poverty affects millions of people in the EU. Energy poverty results from a combination of low income, high expenditure of disposable income on energy and poor energy efficiency, especially as regards the performance of buildings(European Commission, 2022a; Gouveia et al., 2022). People that inhabit inefficient homes tend to be more exposed to temperature variations such as heat waves and cold periods aggravated by climate change. Recent statistics from (Eurostat, 2021d) indicate that at least 2 million people are vulnerable to energy poverty. The EU has recently made the prevention and reduction of energy poverty vulnerability a priority, as numbers have begun to rise and mediatic attention increased.

According to the description in recital 59 of the Directive (EU) 2019/944, households in energy poverty are unable to afford essential energy services to guarantee a decent standard of living and citizens' health, such as adequate warmth, cooling, lighting and the energy to power appliances, due to a combination of low income, high energy expenditure and poor energy efficiency of their homes (Barrella et al., 2022; European Commission, 2019a). A study made by EPOV indicated that Portugal has mixed performance indicators (EU Energy Poverty Observatory, 2019). Having one of the highest performances regarding the inability to keep Portuguese homes adequately warm and due to low incomes when compared with other European countries. Portugal has a similar high share of expenditure in income as the average of the EU; this is most likely caused because Portuguese families cannot afford to spend a higher amount of income on energy. This makes the inability to keep homes warm correlated with a high share of energy expenditure as consequence of low incomes. Figure 13 represents each country's inability to adequately warm their homes in the winter months in 2020. As contradictory as it seems, the southern countries like Portugal, Spain and Turkey have more

difficulties maintaining a comfortable temperature at home even though winters are less extreme when compared with countries like Finland and Norway.

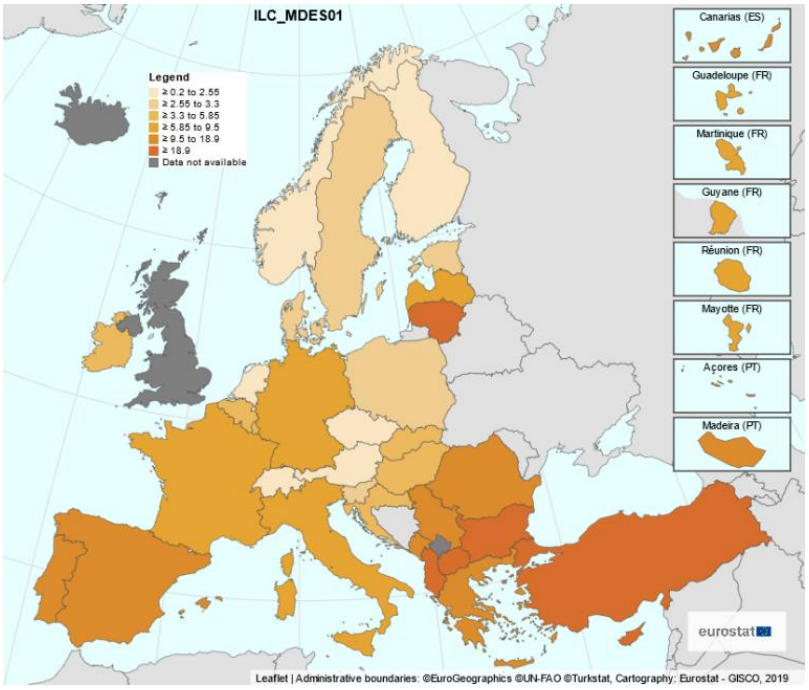


Figure 13: Inability to keep adequately warm in 2020 (Eurostat, 2020b)

Portugal, compared with the EU's average of 2018, has similar results in most indicators shown in Figure 14 except for the inability to keep the home adequately warm (7.3%), which is well under the EU average (19.4%).

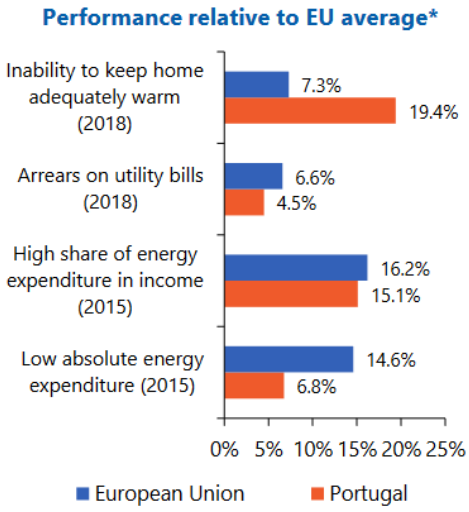


Figure 14: Portuguese energy poverty performance relative to EU in 2018 (European Commission, 2019b)

To help reduce the vulnerability to energy poverty, Portugal assists families financially using a social tariff that came into force in 2008. Since 2016 this aid has been awarded automatically to families that already benefit from statal aid. In Figure 15 is possible to visualize the

tendency from 2005 to 2018, with this figure it is possible to correlate the effect of the social tariff. This tariff consists in a lower cost per kWh and must use a contracted power equal or lower than 6.9 kVA. These families can also benefit from a social tariff for natural gas, which limits users to a maximum annual consumption of 500 m^3.

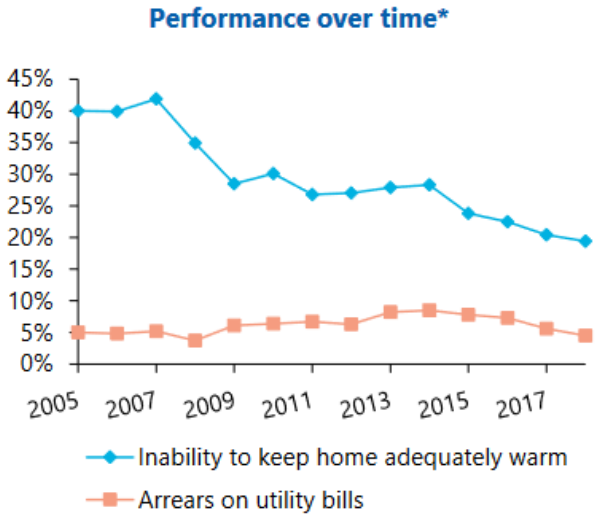


Figure 15: Percentage of families unable to keep their homes warm in 2018 (European Commission, 2019b)

Indicators

As problems like energy poverty become larger over the years, it is necessary to find metrics capable of categorizing and quantify citizens to the problem in study. Energy users vulnerable to energy poverty can be simplified in three common characteristics: low income, low household energy efficiency and low building performance, and high energy prices (European Commission, 2022d). These common causes of energy poverty are caused by different vulnerability factors such as sociodemographics, household composition, health, energy literacy and culture. An energy poverty indicator is an indicator that allows for the measuring and monitoring of energy poverty (Rademaekers et al., 2016).

Indicators can be divided into two categories, primary that categorize and secondary. In the case of energy poverty, the European Commission (European Commission, 2020b) has come up with four primary indicators such as: Arrears on utility bills; Low absolute energy expenditure; High share of energy expenditure; and Inability to keep home adequately warm. For this thesis, two secondary indicators of the 19 suggested by the EC were selected: Household electricity prices and at poverty risk. (European Commission, 2021a, 2022c, 2022d; Siksnelyte-Butkiene et al., 2021)

- ## Arrears on utility bills

Arrears on utility bills is often used as one of the main indicators to characterize countries or regions vulnerability to energy poverty. If a family cannot pay their energy bills, they most certainly cannot afford to spend more energy to heat or cool their home to a comfortable temperature during the year. This inability to pay energy bills can be related to the inability to afford more efficient heating equipment or perform home renovations to increase thermal comfort, creating a snowball effect that is hard to avoid. In Figure 16 is represented a table that indicates the share of the population with arrears on utility bills in each country European country(Eurostat, 2021a). Greece (23.6%), Bulgaria (19.1%), and Hungary (15.2%) are the countries with the highest percentage of the population with arrears on utility bills, as represented in Figure 16. Portugal is among the countries with the lowest share of the population with arrears on utility bills, only affecting 5.3% of the population in 2021.

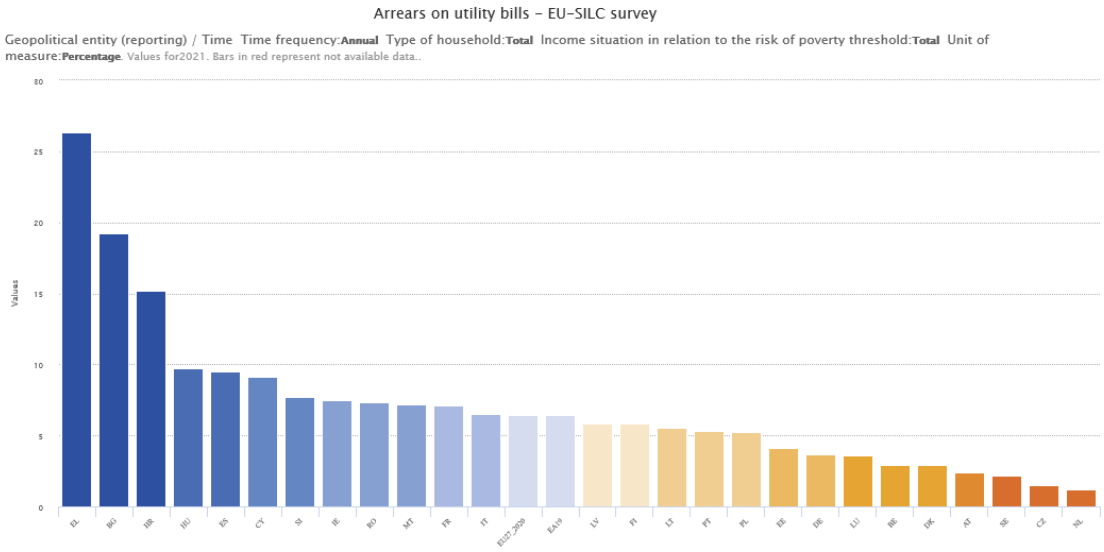


Figure 16: Arrears on utility bills by country in 2021 (Eurostat, 2021a)

- ## Low absolute energy expenditure

The Low absolute energy expenditure indicator presents the share of households whose absolute energy expenditure is below half the national median, or in other words, abnormally low. This could be due to high energy efficiency standards but may also be indicative of households' dangerously under-consuming energy (European Commission, 2020b). Austria (15%), Germany (17.4%), Estonia (18.9%), Finland (29.9%), France (19.5%), Malta (16.7%), Poland (19.5%), Romania (16.8%) and Sweden (24.3%) are the countries with the highest absolute

energy expenditure, being all above the average for the EU 14.6%). Portugal is among the countries with the lowest absolute energy expenditure, with only 6.8% of Portuguese households being below the national median. The country with the lowest absolute energy expenditure is The Netherlands, with only 4.4%. In Figure 17 is represented the EU's low absolute energy expenditure per country.

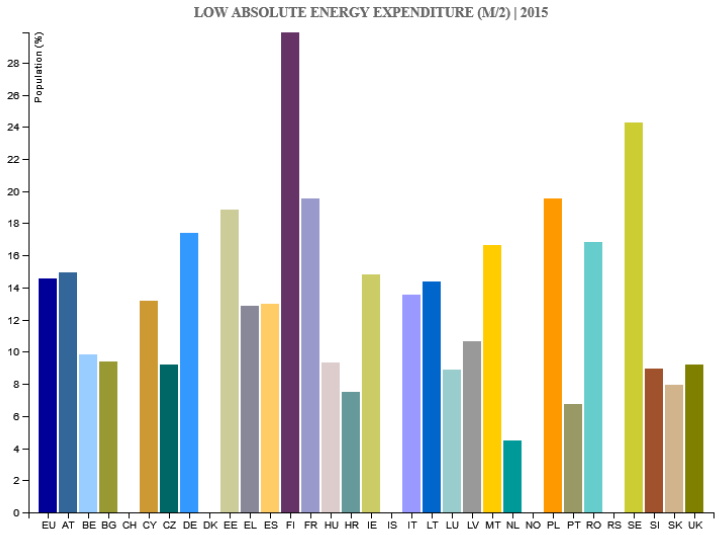


Figure 17: Low absolute energy expenditure 2015 (European Commission, 2020b)

- ## High share of energy expenditure in income

The High share of energy expenditure in income indicator presents the proportion of households whose share of energy expenditure in income is more than twice the national median share. High variance in energy/income shares can occur due to structural differences in energy expenditure between household groups and in situations where energy is often, but not exclusively, included in rent. (European Commission, 2020b). Germany (17.4%), Estonia (18.7%), Finland (22.3%), Ireland (17.6%), Malta (20.1%), Romania (16.9%), Sweden (28.7%) and the United Kingdom (18.8%) are the countries with the highest share of energy expenditure in income, above the EU's average of 16.2%. Portugal is below the EU average with only 15.1%, as seen in Figure 18.

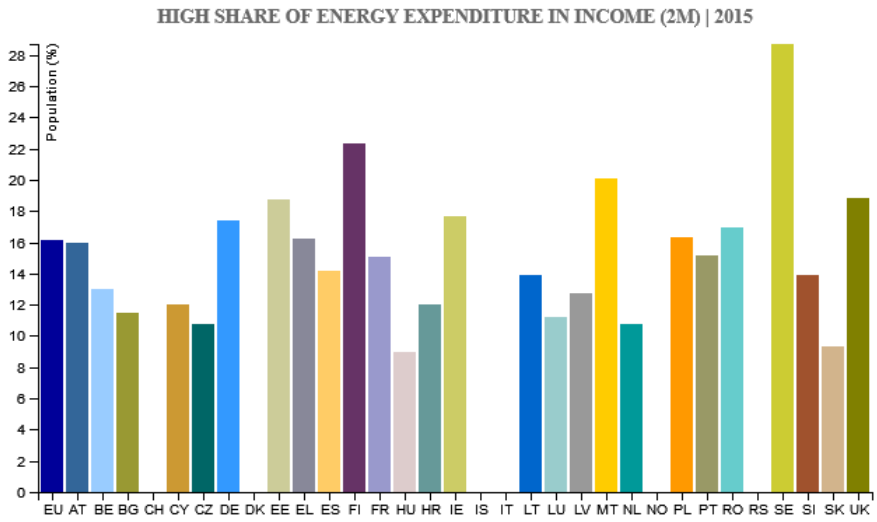


Figure 18: High share of energy expenditure in income in 2015 (European Commission, 2020b)

- ## Inability to keep home adequately warm

This indicator represents the share of (sub)population not able to keep their home adequately warm, based on question (Eurostat, 2021d). A significant portion of Bulgaria (23.7%), Lithuania (22.5%), Cyprus (19.4%), Greece (17.5%), Portugal with (16.4%) populations have not kept their home adequality warm as shown in Figure 19 . Most Countries of the EU have relatively low share of the population with difficulties keeping their home adequately warm as seen bellow, that might change significantly this winter related to natural gas prices and electricity increase.

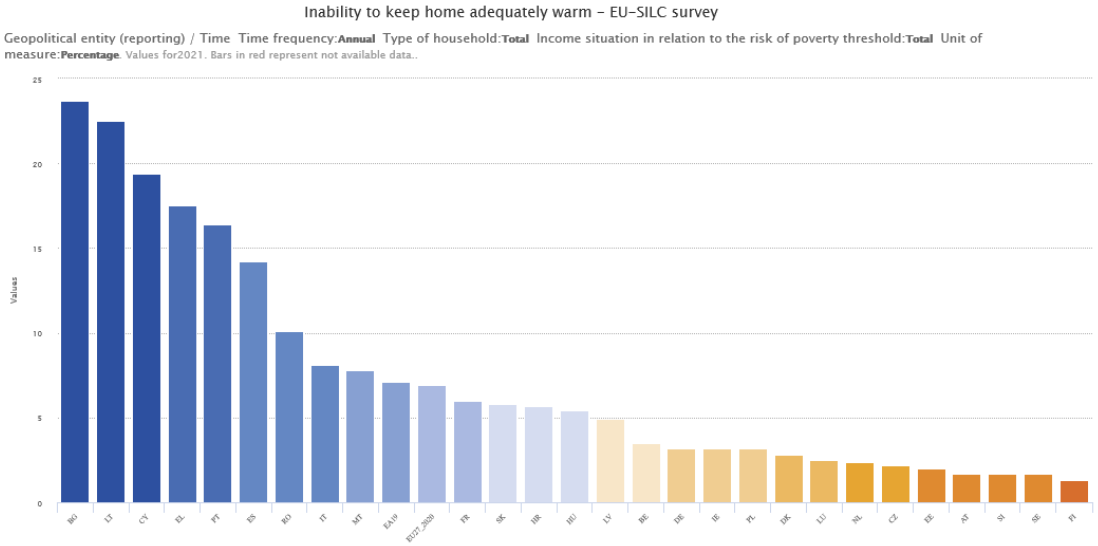


Figure 19: Inability to keep home adequately warm in 2018 (Eurostat, 2021d)

- ## Household electricity prices

Electricity prices for household consumers is a significant cause of energy poverty for some, as energy prices play a big role in total energy expenditure. Countries with high energy prices and low incomes have a high energy poverty vulnerability (Eurostat, 2021c). Countries like Germany (0.3193 €/kWh), Denmark (0.29 €/kWh), Belgium (0.2702 €/kWh) have the most expensive electricity costs in the EU. The countries with the lowest electricity costs are from Eastern Europe like Serbia (0.0791 €/kWh, Turkey (0.0834 €/kWh) and Bulgaria (0.1024 €/kWh) as shown in Figure 20 . With Eastern countries have a lower average income, the total share of income spent with energy makes them more vulnerable to energy poverty. Portugal is the 10th country with the highest electricity cost for residential consumers.

Figure 20: Household electricity prices 2021 in cents of euro per kWh (Eurostat, 2021c)

- ## At Poverty risk

The risk of social exclusion is also an indicator of energy poverty, leading to a marginalization of people with lower incomes, literacy, and habitability conditions. According to the European Commission, eastern Europe countries have a greater poverty risk when compared to western and central Europe. Cases like Latvia (23.4%), Romania (22.6%), Bulgaria (22.1%) has over a fifth of their population at risk of poverty. Poverty risk is an important indicator of energy poverty, allowing one to compare various economic and social indicators simultaneously. Czechia (8.6%), Finland (10.8%) and Slovenia (11.7%) have the lowest at poverty risk. Portugal

is the tenth country with the highest poverty risk with 18.4%. Figure 21 represents the risk of poverty in European countries in 2021.

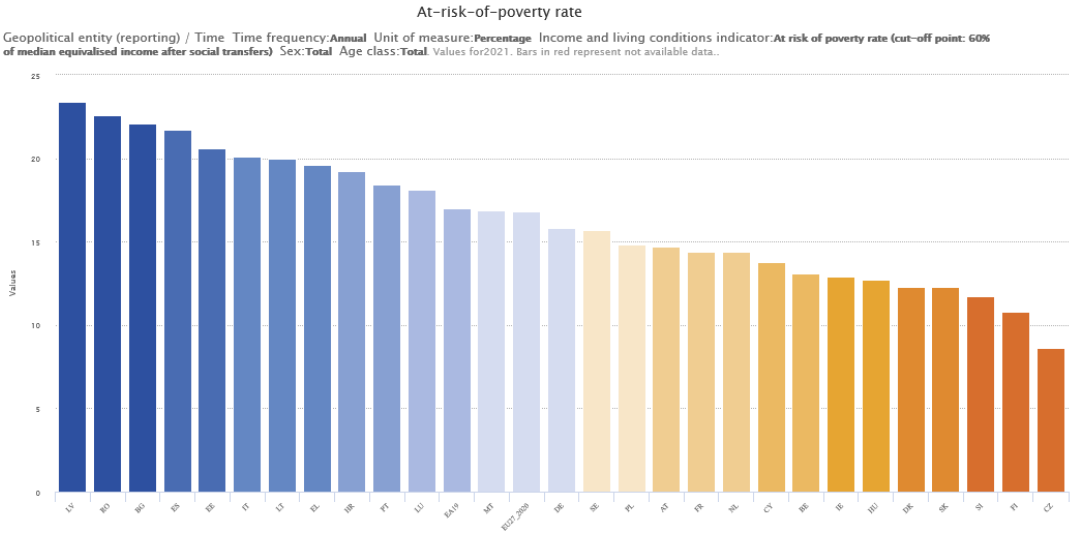


Figure 21: Poverty risk in 2021 (Eurostat, 2021b)

3 Energy Efficiency One-stop shops

The idea of an Energy Efficiency One-stop-shop is a business model meant to offer multiple services in just one place to its customers. Nowadays, with the amount of information that we have available, just a click away on our computers or smartphones can be mesmerizing and confusing to some. This way, the one-stop-shop model was created to organise the available information that is scattered across various places. The creation of the one-stop-shop business model came into force to simplify and aggregate all the relevant information to reach a specific objective. Instead of wasting time searching and filtering for relevant information for a set project, customers can collect all the necessary information and services and seek guidance from professionals to help with their needs. This way, customers can have a more informed decision and more satisfaction with their choices. They must be transparent, reliable, and accessible to everyone interested in the available products or services.

The role of a One-stop-shop to meet European deadlines for decarbonization and accelerate home renovation to improve thermal comfort and efficiency is substantial. With a single point where homeowners and citizens can receive all the necessary help and information regarding home renovation and energy efficiency. With an OSS, technicians can assist homeowners throughout the renovation project with higher performance and quality.

One-stop shops for energy efficiency can be defined as virtual or physical places where property owners can find information, services, and support to implement measures to increase energy efficiency. To achieve better energy efficiency at home, homeowners need a place to ask for advice and inform them of the available opportunities like government grants, loans with low interests for home renovations, and to help plan the renovation project. One-stop shops for energy efficiency can have different objectives depending on the target audience and the available resources; some shops can be set to reach consumers nationwide or on a local or regional scale.

One-stop shops have been used to advise energy consumers in several European countries. The European Commission is increasingly interested in the one-stop-shop business model to improve household efficiency. This model is used as a link to connect consumers and experts to help communities reduce their carbon footprint and energy costs. One-stop shops

are considered points where users can access transparent information and advisory tools to improve building efficiency (Bertoldi, 2018).

Advisory points are a great way to helping homeowners identify the most cost-efficient approach to reduce unnecessary consumption and improve comfort. These advising points can help homeowners on all steps of home renovation, from the first contact to the recommendation, to informing homeowners about the availability of governmental programs to support renovation costs, to the facilitation of getting a loan to finance the renovation, to contacting a professional capable of implementing the recommended improvements and to the last step of monitoring the effect of the installed solutions. One-stop shops do not need to cover all the previous steps; it depends on the objectives of the OSS; some can be more oriented towards counselling, and other more focussed on home renovations for energy efficiency. Regardless of the course of the OSS, they all share the same goal: improving dwelling efficiency and helping homeowners save on energy costs.

One-stop shops can be implemented in two formats: Online or physical or a conjunction of both. An office can be deployed to have more proximate action with the target audience. The online format can have a different impact than the physical format. When implementing an OSS, it is essential to define the target audience of the advice point in advance; this is because some users do not have a computer, or internet connection or know the existence of such aid. An online OSS can reach a more significant number of users and have a broader impact on the population, but it can also be more challenging for the consumer to receive personalized aid. Physical OSS are a better approach when the target audience is older or does not have access to a computer or the internet. Physical OSS can be placed near communities that could benefit from energy efficiency advisory.

Developing a physical One-Stop-Shop (OSS) for energy efficiency is advised to analyse several indicators beforehand. It is essential to characterise the population of the region of interest and gather the number of inhabitants that could benefit from the implementation of an OSS in their residential area. With this data, it is possible to decide where the OSS should have more impact on the desired population. It is essential to select an accessible location in relative proximity to households vulnerable to energy poverty.

There are several types of advisory points to improve energy efficiency, (Cicmanova et al., 2020) divided the OSS business model into three significant categories: facilitation,

coordination and all-inclusive points. The main purpose of the facilitation business model is to advise and raise awareness of homeowners related to energy poverty concerns. With this type of OSS, homeowners can get help to improve their energetic performance. On the Coordination method, homeowners can receive assistance with the renovation, access to attractive financing opportunities and advice and awareness of energy efficiency and energy poverty. All-inclusive OSS is a place where homeowners can ask for help if they want to improve the energy efficiency of their homes. On the all-inclusive type of OSS, the advisory point oversees planning, upgrading and ensuring the homeowner has the best service possible.

3.1 Energy Advice Points, Barcelona, Spain

Barcelona is the second-largest city in Spain and the capital of the autonomous region of Catalonia. In 2018, the population of Barcelona was 1 620 343 dispersed over 101.4km^2, corresponding to a population density of 15 987 per square kilometer. The city's population has remained stable, but suburbs continue to grow gradually. Barcelona's population comprises 53% female and 47% male, primarily distributed in the demographic bracket of 15-64. Only 62% of Barcelona's residents were born in Catalonia; the remaining 38% are from other regions of Spain and are immigrants.

Roughly 10% of the 1.6 million inhabitants live under conditions of energy poverty (Eumayors, 2018). These inhabitants are more susceptible to thermal discomfort at home because they are unable to afford heat or cool their homes efficiently. Houses with poor energy performance require more energy to maintain a comfortable inside temperature, therefore, requiring a larger amount of energy to reach a comfortable temperature. In most cases, homeowners cannot afford this additional expense because it represents a significant expense of their household income.

These Energy Advice Points started after two pilot projects. The first one, called Just Energy, consisted of training 100 vulnerable citizens to provide energy advice to the population. This project helped around 3,000 vulnerable households to reduce energy bills and implement cost-effective measures to improve the efficiency of their homes. Later, a second pilot project was developed called Punt's d'Atenció a la Pobresa Energètica (energy attention points), which consisted of creating four contact points spread across three districts of the city of Barcelona. Here homeowners could make an appointment to discuss changes to increase the energy

efficiency of their homes (Ecoserveis, 2022)[1]. Fighting energy poverty, guaranteeing the rights to energy as legislated, and improving the energy efficiency of homes, especially for the most vulnerable families, are the main objectives of these initiatives.

The Energy Advice Points have three pillars of action, ensuring the right of access to energy, energy efficiency and employing and training people to fight energy poverty in the region. Eleven Energy Advice Points have been installed throughout the city of Barcelona, where citizens can clarify any questions that they may have about reducing their energy and water bills. In this specific case, the agents of these advice points meet with citizens for approximately 20 minutes, where they try to absorb as much information as possible to verify the degree of energy poverty of that household. In this meeting, the agent must develop solutions to reduce exposure to energy poverty. The agents are trained to identify evidence of energy poverty that social welfare services cannot always identify. To develop and implement this project, Barcelona City Council has invested two million euros to date to reduce energy poverty in the region.

From 2017 to 2018, advice was given to approximately 50,000 habitants, and of these inhabitants, 1639 families vulnerable to energy poverty were identified, and 61 citizens were hired to participate in the project. This project improved the capacities of the contracted vulnerable citizens to find new job opportunities in the energy and energy efficiency (Eumayors, 2018). Figure 22 illustrates one of the several energy advisory offices in Barcelona.

Figure 22: Energy Advise Points, Barcelona. (Ajuntament de Barcelona, 2019)[2]

[1] Ecoserveis. (2022). Energy Advice Points (PAE). https://www.ecoserveis.net/en/donation/punts-dassessorament-energetic/

[2] Ajuntament de Barcelona. (2019). Energy advice points, one of the best initiatives to combat the climate emergency. Housing. https://www.barcelona.cat/infobarcelona/en/tema/housing/energy-advice-points-one-of-the-best-initiatives-to-combat-the-climate-emergency_860666.html

3.2 RenoWatt, Liège, Belgium

RenoWatt is a Belgium One-stop-shop created in 2014 with the goal of improving the efficiency of public buildings. This project was created by the Walloon Government and led by GRE-Liège, a non-profit organization with the aim of reducing energy consumption of public entities and meet community goals for 2030 and 2050.

RenoWatt OSS business model was tested with a pilot in the Liège region from 2014 to 2017; in 2017, RenoWatt was recognized as the best energy service in the European Union. RenoWatt assists local entities with the necessary expertise and logistics to renovate the selected buildings. The first phase of renovations involved 12 local organizations that totalized 136 renovations. RenoWatt affirms that with this project, it was possible to save 33% in energy savings (RenoWatt, 2017)[3]. This OSS provides a concrete and comprehensive approach to participating entities on how to implement the necessary improvements to reach sufficient energy savings (Figure 23).

Figure 23:RenoWatt's business model diagram. (RenoWatt, 2020)[4].

Local authorities can sign up for an Energy Performance Contract to reduce energy consumption; there are four building categories eligible for these contracts, which include schools, sports buildings like gyms and stadiums, hospitals, and other kinds of public equipment.

RenoWatt's services guarantee a significant reduction of energy bills (around 30%), and as a consequence, it reduces the carbon footprint of the intervened buildings. This OSS model

[3] RenoWatt. (2017). RenoWatt's History. https://renowatt.be/fr/notre-mission/

[4] RenoWatt. (2020). *RenoWatt, energy efficiency at the service of employment*. About RenoWatt. http://www.gre-liege.be/renowatt/25/renowatt.html

follows six simple steps to achieve its objectives; the first step is to select an applicable building from all the candidate entities that have significant energy-saving potential; after that initial selection, buildings are once again filtered based on the collected data like energy consumption, area, and other important data that is relevant to the following steps. The 3rd step consists of an energy audit on the selected buildings to detect unnecessary or abnormal consumption. After selecting the building to intervene in and collecting the necessary data, a financial analysis is made to calculate if there is an added benefit (economic and environmental) to the building retrofit. Since every building is unique, it is necessary to adapt the retrofit model to the building characteristics and use cost-effective techniques to reduce building energy consumption, which is taken into consideration in the 5th step. On the 6th and final step, RenoWatt launches a public contract to proceed with the planned retrofit.

RenoWatt by assisting public authorities in renovating their buildings, was possible to create 322 direct and 780 indirect jobs (RenoWatt, 2017). Not only is RenoWatt assisting public authorities and the environment by saving on energy costs, but it is also helping the community and the economy with jobs and better conditions for those who frequently make use of the retrofitted buildings.

3.3 Reimarkt, The Netherlands

Reimarkt was a concept created in 2013 after KAW, an architect cooperative, in conjunction with Innovate, a project with the goal to develop attractive energy retrofit packages for homeowners. For most homeowners, the retrofit process for energy efficiency is difficult and unclear. This pushes away citizens that need to improve their dwellings to save on energy bills and increase comfort. Innovate made a net of OSS that could be replicated across Europe to accelerate the renovation process, one of these offices was the Reimarkt in The Netherlands.

With the Dutch government willing to reach the goals imposed by 2030 and 2050, KOW got saw an opportunity to create an OSS to help homeowners in the renovation process and meet the imposed goals. By 2014 KAW launched the first OSS in Groningen offering energy renovations for single-family homes. In that year, similar shops in 6 Dutch cities were implemented where homeowners could visit and receive all the information they needed and receive a ready-made refurbishment package consisting of advisory, financing, and installation

services. Since the start of Reimarkt, over 2000 houses have been refurbished in The Netherlands (Innovate, 2019a[5]).

Reimarkt customers can be defined in two categories, direct and indirect. In the direct spectrum, clients can be the owners of the house, renters, or collectives that approaches individual residents. The indirect clients are social housing corporations and private investors. Reimarkt offers its customers financial solutions to proceed with home renovations and connects homeowners with partners to facilitate the process in a transparent way (Innovate, 2019b[6]). This is a viable solution to the hesitance of homeowners to renovate. (Innovate, 2019a, 2019c[7]). The following represents a mobile advice point of Reimarkt. This way, it is possible to increase the coverage area and be in proximity to the population.

Figure 24: Reimarkt One-stop Shop in Enschede. (Cities, 2016).

3.4 Aradippou, Cyprus

Aradippou municipality is in the suburbs of the third-largest city of Cyprus, with a population of 20 000 distributed across 173 km^2. This city consists mainly of single-storey buildings dispersed evenly across the territory. Aradippou has the ambition to become a "Net-Zero Energy Smart City", and it is aligned with the EU goal to become climate-neutral by 2050. The municipality plans to encourage homeowners to install solar panels on their roofs and invest in energy-efficient actions. The city plans to provide a local powered energy transition and a

[5] Innovate. (2019a). Innovate In a Nutshell. http://www.financingbuildingrenovation.eu/

[6] Innovate. (2019b). INNOVATE project WP2, D.2.3 Business Model KAW. http://www.financingbuildingrenovation.eu/wp-content/uploads/2017/09/Innovate_D2.3_BM_KAW.pdf

[7] Innovate. (2019c). Koöperatieve Architecten Werkplaats – KAW (The Netherlands). Innovate Cases. http://www.financingbuildingrenovation.eu/cases/kaw-the-netherlands/

well-established smart grid to connect Industries to residential areas to monitor energy and balance demand. The city plans to support the installation of solar panels in 2 000 homes to Increase renewable energy generation in the region (Cicmanova et al., 2020[8]).

Like many other European countries, the biggest obstacle for homeowners face when switching to renewable energy sources Is the significant upfront cost of this kind of technology. To meet this constraint, the municipality has negotiated interest rates on loans to encourage homeowners to invest in renewable energy and to improve household efficiency.

The Aradippou OSS started In June 2018 to create a link between construction companies and homeowners and inform them about the type of public Incentives available. Residents can apply for a bank loan with lower interest rates when retrofitting their homes. This OSS offers homeowners a municipal tax deduction and grant depending on the amount of CO_2 saved (Cicmanova et al., 2020). Homeowners can use two financial schemes; a soft loan to install a photovoltaic system on the building or a municipal grant according to the CO_2 emissions saved when retrofitting their homes.

3.5 POWERPOOR

POWERPOOR objective is to help energy-poor citizens and promote the use of alternative financing like energy communities and crowdfunding, facilitate expertise, and install renewable energy solutions with the active participation of citizens. (POWERPOOR, 2020). This project started as a pilot in 8 European countries: Bulgaria, Croatia, Estonia, Greece, Hungary, Latvia, Portugal, and Spain (POWERPOOR, 2021a[9]); these pilots were led by a network of energy supporters and community mentors. In these eight countries, were engaged projects like info days to inform the population about energy poverty and local energy poverty offices. (POWERPOOR, 2021b[10]).

In Portugal, POWERPOOR, the local offices were set in two locations, Ermesinde in the country's northern region and Mértola in the south-eastern region of Portugal near the border

[8] Cicmanova, J., Eisermann, M., & Maraquin, T. (2020). ONE-STOP-SHOP FOR INTEGRATED HOME. http://www.financingbuildingrenovation.eu/setting-up-a-one-stop-shop/

[9] POWERPOOR. (2021a). About POWERPOOR. https://www.powerpoor.eu/about/project

[10] POWERPOOR. (2021b). POWERPOOR Rollup. https://www.powerpoor.eu/sites/default/files/2021-05/rollup4_web.pdf

with Spain. A third office opened in Lisbon on February 1st of, 2022 with the objective to assist social tariff beneficiaries (POWERPOOR, 2022[11]).

POWERPOOR helps citizens in three main pillars, support, facilitate and promote. On the support pillar, the objective is to fight energy poverty while giving support with home interventions and other ways to ease the energy poverty of the population; the second consists in facilitating energy renovation by sharing knowledge and promoting engaging initiatives with citizens to address energy-poor communities. The third pillar consists in promoting more sustainable projects and alternative financing schemes to give opportunities to help energy-poor communities.

3.6 EPIU GETAFE - Energy Poverty Intelligence Unit

The Energy Poverty Intelligence unit, also known as EPIU, is a Spanish One-stop-shop situated in the Madrid metropolitan area in Getafe. Getafe is characterized as an industrial geographical zone that has witnessed exponential population growth since the 60s. This growth was caused by the increase of industries in the area, led to a large necessity to build fast and cheap housing due to the rise in population. With the urge to build homes for workers, houses were built inefficiently, resulting in an increase of citizens impacted by energy poverty at home.

EPIU was designed to fight Hidden Energy Poverty, also known as HEP, with a pilot that covers the two most vulnerable areas of Getafe: LAs Margaridas and La Alhóndiga. Together with the council of Getafe, universities, and other private organizations was possible to create an OSS to reduce the exposure to energy poverty. For that, EPIU was aligned to include four main goals: To improve the population's knowledge regarding energy poverty, design new mechanisms to subsidize energy to the most vulnerable using bonds and social tariffs, reduce energy poverty and increase rehabilitation and implement measures to protect customers and

[11] POWERPOOR. (2022). Primeiro Boletim Nacional - POWERPOOR. https://us3.campaign-archive.com/?u=446e6522d8372157e654e6b19&id=7c7f968578

social awareness (UIA, 2021[12]) (EPIU, 2019[13]). Figure 25 illustrates an office where EPIU consumers can receive energy counseling to improve energy efficiency at home.

Figure 25: EPIU Getafe office. (Marta García París, 2022)

This project has a budget of over 1 million euros to provide energy services to vulnerable groups of residents of the region. This project covers three scales, home, buildings, and neighbourhood. EPIU services include addressing problems related to cooling, heating, household appliances, indoor comfort, information and awareness, energy access, energy audits, energy efficiency and social support to vulnerable consumers (EPAH, 2019).

3.7 The EUROPA Project

EUROPA is a HORIZON 2020 project with the objective to create a simpler and better method to deep renovate residential buildings. This model guarantees energy saving as well as comfort (Europa, 2020[14]). This Project has nine partners (Figure 26) with five different pilots across five European countries. In conjunction with each country's regional energy agencies, Portugal, France, Italy, Germany, and Latvia were chosen to introduce the EUROPA business model to promote deep energy renovation in residential buildings.(EUROPA, 2020b[15], 2020a[16]).

[12] UIA. (2021). Journal 2: Energy Poverty Intelligence Unit (EPIU). https://www.uia-inittative.eu/en/news/journal-2-energy-poverty-intelligence-unit-epiu-2

[13] EPIU. (2019). Getafe EEPIU. https://hogaressaludables.getafe.es/contacto/

[14] EUROPA. (2020). Europa One Stop. Our Mission. https://europaonestop.eu/about/

[15] EUROPA. (2020a). EUROPA brochure. https://europaonestop.eu/wp-content/uploads/2021/02/Europa_Brochure_Online.pdf

[16] EUROPA. (2020b). EUROPA Brochure. Renovate Simplier, Better, Together. https://europaonestop.eu/wp-content/uploads/2022/05/EUROPA-Brochure_Online.pdf

Figure 26: EUROPA partners

The project to develop a chain of One-stop shops across several European countries stands in a business model that engages stakeholders during the renovation process. A EUROPA One-stop-shop aims to increase deep renovation in residential buildings and encourage Europeans to start a renovation wave by assisting property owners in all phases of renovation (planning, financing, and implementation). This renovation wave must be achieved to reach the agreed energy transition goals and building renovations. This OSS also has at the disposal of property owners, an Energy Efficiency Subscription (EES), which consists of the creation of standards along the investment chain. This EES aims to increase trust levels between property owners and financial institutions and offer a reliable assessment of the impact of the renovation measures and their energy-saving potential. (EUROPA, 2020b).

EUROPA's target audience is property owners of private or social housing and companies/property managers. This makes the EUROPA Project suitable for almost everyone who wants a partner with the expertise to assist in all steps of the deep renovation process. This project and the implementation of several OSSs across Europe will boost the local economy by increasing the demand for qualified professionals and the necessary materials to perform the renovations. Financial institutions will also play a significant role by facilitating loans to homeowners and property managers willing to renovate their dwellings.

The EUROPA project facilitates the process of replication in case new or existing partners want to develop an OSS in their region. For this, EUROPA has created a mentoring process between its regional partners to engage with the potential participants and address possible challenges on a regional scale. This learning program is six months long, and throughout the

mentoring program, they will have the opportunity to know the active pilots and their challenges. (EUROPA, 2020b) (Figure 27).

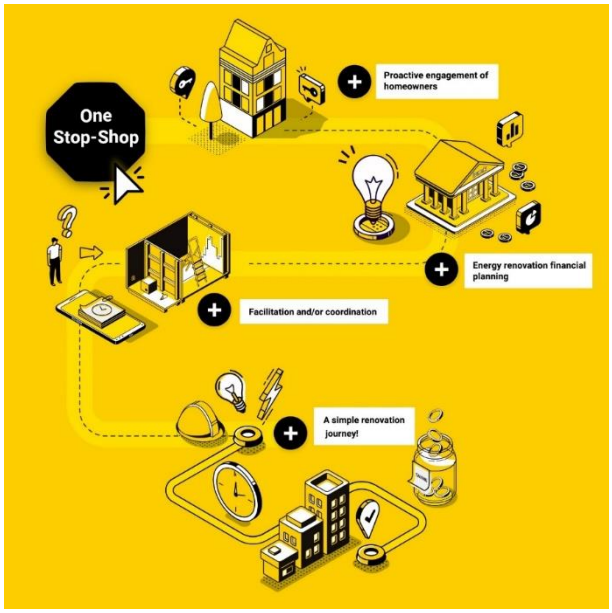


Figure 27: EUROPA one-stop shop process (Europa, 2020)

AREANATejo is the Portuguese representative of this project. AREANATejo region is a pilot of the Europa Project. This European project gathers 9 European partners to develop deep retrofits to residential buildings to guarantee residents' energy savings, thermal comfort, and health. Each country is responsible for its own pilot to create a renovation wave. AREANATejo is a regional energy agency that operates in the region of Alto Alentejo in Portugal, covering 15 counties of the Portalegre district. With this project, the goal is to implement a single desk (an OSS) to aid in implementing measures to improve comfort in the residential sector.

This OSS aims to assist homeowners and investors from the beginning of the decision-making process to the implementation of the solutions and performance assurance to ensure the reduction of energy consumption with endogenous solutions. This desk is available in both a virtual and physical strand, so homeowners can ask for personalized technical support to improve their homes (AREANATejo, 2020[17]).

The target audience of this advice point is the municipalities of the region that own social housing and are interested in retrofitting them, condominium managers, local and regional

[17] AREANATejo. (2020). *EUROPA – Subscrição de Eficiência Energética para Renovações Profundas com Garantia de Desempenho*. Europa Project. https://www.areanatejo.pt/europa-subscricao-de-eficiencia-energetica-para-renovacoes-profundas-com-garantia-de-desempenho/

entities, and owners of residential dwellings. The services of this OSS include the development of awareness programs to actively include homeowners in the renovation process, the development of a financial plan to convince investors to renovate, coordinate and facilitate the process of renovation with possibilities of financing the intervention to reach those who cannot afford major renovations and to follow the project even after renovations to guarantee the projected savings. With these services, it is possible to increase comfort and efficiency at home and help homeowners decide which solution is more adequate for their home. In Figure 28, it is possible to better understand the phases of the process and the objectives of this OSS project.

Figure 28: EUROPA brochure (AREANATejo, 2020)

The project develops in the following phases ():

1. Identification, collection, and data analysis
2. Measures identification
3. Planning of the intervention (articulated with the EUROAP web platform)
4. Financial mechanisms identification
5. Follow-up

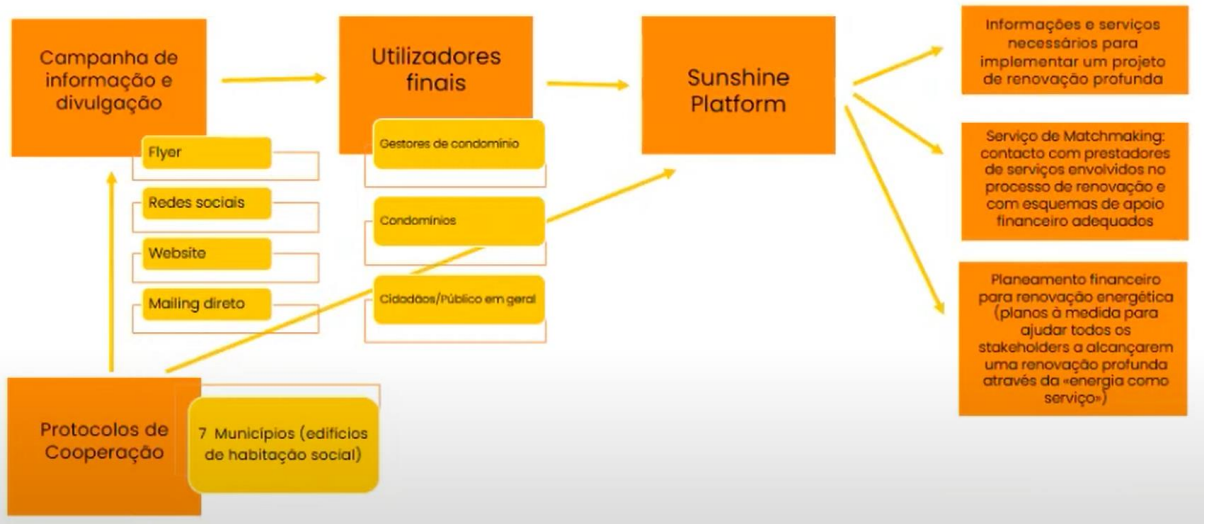


Figure 29: AREANATEJO One-Stop-Shop Flowchart (AREANATEJO, 2022)

3.8 ENSVET

Slovenia's Energy Advisory Network (ENSVET) offers consumers information on both renewable and energy efficiency investments. ENSVET was implemented by the Ministry of the Environment and Spatial Planning via Eco Fund, the Slovenian Environmental Public Fund, in 1991 and later updated to new standards in 2014. In 1992 the first six energy counseling offices were established, including the necessary training of the consultants. In the year 2000, ENSVET had 24 energy advisory offices and five subsidiaries established by municipalities. In 2010, it had 36 offices covering all Slovenia (OECD, 2012[18]). Today, in 2022, ENSVET has 60 consulting and advisory offices distributed across Slovenia (Ekosklad, 2022[19]).

ENSVET consists of an independent energy advisory network offering expert advice on energy efficiency and renewable energy for free to Slovenian households through local offices and home visits (ECSO, 2018[20]). ENSVET also promotes educational activities to create awareness of rational energy use and renewable energy in the communities and schools. ENSVET, with the help of the National Environmental Fund (ECO Fund), assists residents in accessing public funding to invest in energy-efficient solutions for their homes. This includes soft loans,

[18] OECD. (2012). OECD Environmental Performance Reviews: Slovenia 2012. https://books.google.pt/books?id=FOrUeREpU5IC&lpg=PA139&dq=ensvet slovenia&hl=pt-PT&pg=PA139#v=onepage&q=ensvet slovenia&f=false

[19] Ekosklad. (2022). ENSVET: Locations of consulting offices. Ensvet Counseling Center. https://www.ekosklad.si/prebivalstvo/ensvet/pisarna?stran=1

[20] ECSO. (2018). European Construction Sector Observatory 2020: Portugal. European Construction Sector Observatory, October, 1–32. http://ec.europa.eu/growth/sectors/construction/

and subsidies for residential buildings and apartment buildings. At ENSVET's offices, customers can receive counselling on ways to reduce their energy bills and increase dwelling comfort and efficiency. This counselling can include a home visit to assess each situation individually and personalize the solution, which can include a recommendation to replace older heating equipment for newer and more efficient equipment that translates into energy savings. (Slovenian Ministry of Infrastructure, 2018[21]).

ENSVET offices were implemented strategically to maintain offices close to the population, to achieve that goal, the nearest office could not be further than 20 kilometers from customers. With 60 active offices distributed across Slovenia, it indicates that most major cities and villages have an ENSVET office nearby, serving the population with their energy efficiency expertise. Figure 30. represents an example of an ENSVET advisory office; this figure demonstrates an interview between a citizen with some sort of energy-related questions and an expert.

Figure 30: ENSVET Office map. (Novo Mesto, 2022).

[21] Slovenian Ministry of Infrastructure. (2018). Supplement Long-term strategy for stimulating investment into energy renovation of buildings.

3.9 Advice.scot

Advice.scot is a Scottish advice platform that provides free services to Scottish residents. Advice.scot offers various types of divisional services such as debt advice, a benefits calculator, home heating, energy, social, and several other pieces of advice. The objective is to aggregate valuable information and share it with people who need it in a simpler way (Energy Saving Trust, 2018[22]).

This makes Advice.scot not only an OSS for energy-related challenges but also for other common issues. Residents can ask for advice via email, website form, phone, or visit Advice.scot office in central Glasgow. Advice.scot advises interested individuals on how to keep their homes at a comfortable temperature throughout the year and thus help reduce carbon emissions to the atmosphere. This OSS will also help customers with available grants or funding to renovate or substitute efficient appliances to save on energy bills (Scottish Government, 2022)

Advice.scot has created a simple tool that allows residents to calculate if they are intituled to receive government benefits to support energy costs. With three simple questions (household income, the number of adults and children living in the user's home, and ownership status (owner/renter), the tool estimates how much that household can receive (Energyadvice.scot, 2022[23]) (Figure 31).

[22] Energy Saving Trust. (2018). Home Energy Programmes Delivered By Energy Saving Trust On Behalf Of The Scottish Government. In Energy Saving Trust. https://energysavingtrust.org.uk/sites/default/files/EST Programmes In Scotland FINAL.pdf

[23] Energyadvice.scot. (2022). energyadvice.scot. Energy Advice. https://energyadvice.scot/

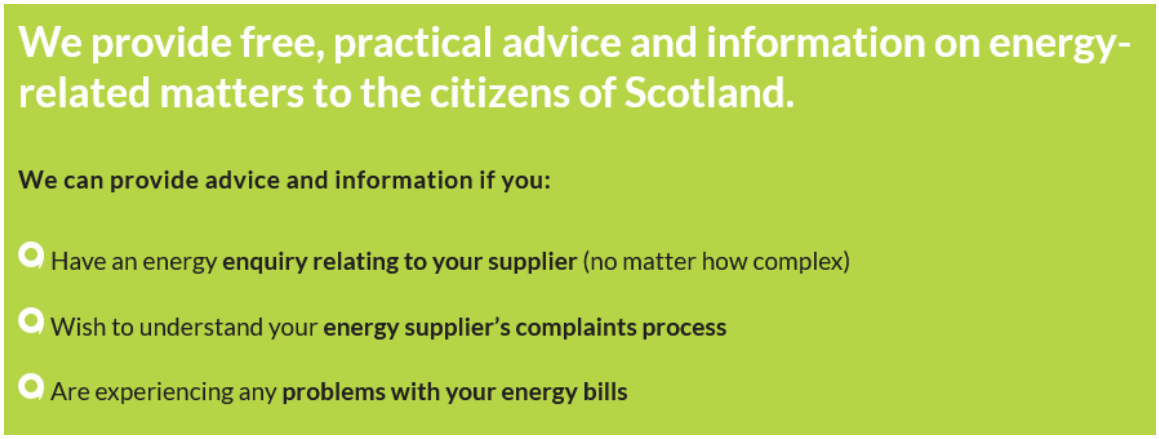


Figure 31: Energyadvice.scot advice services. (Energyadvice.scot, 2022)

3.10 The Green Menu

The Green Menu is an online platform developed by De Groene Grachten in 2014. It serves as a national knowledge platform to inspire and activate homeowners to renovate their buildings in a sustainable way (De Groene Grachten, 2020[24]). The Green Menu platform has been successful in the Netherlands by renovating century-old houses, farms, windmills, churches, fortresses, and manors. This project has shown a significant influence in the Netherlands so, two additional platforms were launched to expand the online platform and help a larger number of property owners; in December 2020, two additional platforms were launched. One in Slovenia with the collaboration of E-Zavod, Institute for Comprehensive Development Solutions, and one in Portugal with the collaboration of CENSE, FCT-NOVA. With this cooperative work, two new Green Menus were established to assist Slovenian homeowners with sustainable home renovations. For the Portuguese and Slovenian versions, the Green Menu has researched the most appropriate technical measures for retrofitting buildings in these very different countries. Users can find information for over 70 measures, from simpler to more complex interventions. Residents have access to information about financing schemes if necessary. The Portuguese version of the Green Menu will be addressed in more depth in the next section. The following Figure 32 consists of a diagram that represents the function of the

[24] De Groene Grachten. (2020). Launch of the international Green Menu. News. https://www.degroene-grachten.nl/launch-international-green-menu/

project, the client asks for advice; the Green Menu helps find a solution, and the client saves on energy bills with the implemented solution.

Figure 32: Green Menu diagram. (De Groene Grachten, 2020) (De Groene Grachten, 2020)

On this comprehensive online platform, until recently only available in the Netherlands, users can find all relevant information on how to make their homes more sustainable, including technical solutions, financial mechanisms, and regulations. Additionally, the visitor to the platform can use simple calculation tools and find other relevant tips (CENSE, 2020).

The Menu Renovação Verde[25], or in English Green Renovation Menu, is a Portuguese platform created in 2020 after the Dutch pilot (De Groene Grachten) where homeowners can increase their home sustainability, improve comfort, and reduce energy-related expenses. This platform offers homeowners a place where all the necessary information (technical, financial, and regulations) is accessible on one platform for free. On this platform, users can discover insulation, ventilation, renewable energy production, water heating, climatization, and water and vegetation possibilities. Users can also receive aid to ensure a well-succeeded installation, financial and fiscal benefits, and receive assistance on licensing, selection of contractors, and in monitorization.

This project received financial support from EIT Climate KIC in the summer of 2020 after being selected at a European contest for post-COVID-19 Regeneration Projects. This project is a collaboration between CENSE from NOVA School of Science and Technology, De Groene Grachten, the creator of the platform Green Menu dedicated to refurbishing and building sustainability and E-Zavod, a Slovenian institute focused on sustainability and promoting building carbon-neutrality. (CENSE, 2020, 2022; De Groene Grachten, 2020) (Figure 33).

[25] https://www.menurenovacaoverde.pt/pt/em-todo-o-pais/casas

Figure 33: Menu Renovação Verde (CENSE, 2020)

3.11 STEP

STEP is a European H2020 project made to answer Energy Poverty in European countries with the highest levels of energy poverty. To solve this issue common in several European countries, STEP has developed an innovative and easily replicable model that can be simply reproduced in other countries. Some of these countries already have a version of STEP implemented to help the population regarding energy poverty issues; countries like the United Kingdom, Belgium, Bulgaria, Cyprus, Portugal, Czech Republic, Poland, Latvia, Lithuania, and Slovakia have the highest levels of energy poverty among the population are being helped by this program.

STEP's objective is to attenuate the effects of energy poverty and incentivize residents to adapt their behaviour with energy efficiency advice. The three main pillars of STEP are energy advisory, energy-saving, and spreading best practices about energy poverty and energy efficiency at home (STEP, 2022[26])

DECO, the Portuguese consumer defence association, is developing the STEP project in Portugal. This project wants to promote local renovation programmes to improve the energy performance of social housing, the use of renewable energy and self-consumption solutions via energy communities, the adoption of self-consumption solutions in social housing and disadvantaged communities and building retrofit projects.

[26] STEP. (2022). *Sobre o projeto (STEP)*. https://www.stepenergy.eu/pt-pt/sobre-step/

This project has been done in coordination with the municipalities. This one-stop-stop shop will share information about energy poverty and energy efficiency solutions, consumer guidance, and renovation projects for vulnerable and low-income consumers. Évora Municipality is debating with DECO to create a one-stop-shop dedicated to multi-unit buildings and social housing to tackle energy poverty and governance of these kinds of buildings. Multi-unit buildings are often harder to renovate (Stepenergy, 2022).

3.12 Porto Energy Hub

Porto Energy Hub (PEH)[27] is a one-stop shop with the objective of assisting with energy efficiency and renewable energy projects. This Hub helps homeowners in the Porto Metropolitan area implement energy efficiency mechanisms to improve comfort. Porto's OSS provides free legal, financial, and technical support to anyone who needs to improve their habitability conditions.

This one-stop shop was created after the project Porto Energy ElevatoR (PEER) in the scope of the Horizon Program 2020 of the European Commission. Porto's Energy Agency led the European project financed by the Horizon 2020 program, a community project with the objective of innovation and research of methods to accelerate the development of new technologies. This project is aligned with the National Energy and Climate Plan 2030, Carbon Neutrality Guide 2050, and the Long-Term Strategy for Building Renovation.

At first, PEER focused on promoting energy efficiency and clean energy production in a small area of around three thousand homes in the northern region of the Porto Metropolitan Area. AdEPorto wants to test the possibility of financial solutions to accelerate home renovations in the covered area. On the Hub's webpage, there is a form users can answer so technicians can understand the current situation of each home (AdEPorto, 2021[28]; PEH, 2021).

[27] https://www.portoenergyhub.pt/

[28] AdEPorto. (2021). *Porto Energy Hub - AdEPorto*. https://www.adeporto.eu/pt/comunicacao/noticias/adeporto-e-lider-de-projeto-europeu-para-combater-pobreza-en

Table 2- One-stop shop comparison table

Title	Type	Starting date	Status	Country	Coverage	Number of OSS	Objectives	Target	Services	Funding	Partners
Energy Advice Points	Physical/ online	2018	Running	Spain	Local/regional	11	Address energy poverty and renovate residential buildings	Residents (owners and tenants)	Help reduce energy bills, assist with renovation plan	n/a	Barcelona City Council energy cooperative, social cooperative and NGOs
RenoWatt	Physical/ online	2014	Running	Belgium	Local/regional	1	Renovate public buildings	Municipality buildings	Information, audits and financing	5.2M €	CITYNVEST
Reimarkt	Physical/ online	2014	Running	The Netherlands	Municipal	6	Increase energy efficiency and reduce energy bills	Residents (owners and tenants)	Renovation and financing	n/a	Stadlander
Aradippou	Physical	2018	Running	Cyprus	Local/regional	1	Net-Zero Smart City	Renovate single family homes	Energy renovations, financial plans and affordable financing	n/a	Aradippou council
POWERPOOR	Online	2020	Running	International	Nationwide	8	Create a network to reduce energy poverty	Residents (owners and tenants)	Support citizens with financing schemes	226M€	Municipalities; Energy mentors
EPIU	Physical/ online	2019	Running	Spain	Local/regional	1	Increase energy efficiency and reduce energy bills	Residents (owners and tenants)	Energy renovations, finantial plans and affordable financing	6.242.850€	Getafe Council
EUROPA	Physical/ online	2020	Running	International	Local/regional	5	Deep renovations	Residents (owners and tenants)	Renovation plan, financial plans	n/a	Host country energy agencies
ENSVET	Physical/ online	1992	Running	Slovenia	Nationwide	60	Energy Advisory for energy efficiency and renewables	Renovate houses and offices	Energy awareness, energy advices, public funding	n/a	Slovenian public fund
Advice.scot	Physical/ online		Running	Scotland	Nationwide	1	Increase energy efficiency and reduce energy bills	Residents (owners and tenants)	Energy renovations, financial plans and affordable financing	n/a	De Groene Grechten and the Assossiation of Dutch Municipalities
Green Menu	Online		Running	International	Local/regional	3	Make homes and historic buildings more sustainable	Residents (owners and tenants)	Energy, financing, and technical advice	n/a	E-Zavod; CENSE

Table 3: Portuguese one-stop shops comparison table

Title	Type	Starting date	Status	Country	Coverage	Number of OSS	Objectives	Target	Services	Funding	Partners
Menu Renovação Verde	Online	2020	Running	Portugal	Nationwide	1	Make homes more sustainable	Residents (owners and tenants)	Energy, financing, and technical advice	n/a	CENSE and De Groene Grachten
STEP	Online	2019	Running	Portugal	Nationwide	10	Address Energy poverty	Residents (owners and tenants)	Energy advisory, energy saving and to spread best practices	n/a	Consumer organizations from the participating countries
Porto Energy Hub	Online	2021	Running	Portugal	Local/regional	1	Support project of renewable energy and efficiency	Residents (owners and tenants)	Energy, financing, and technical advice	n/a	ElevatoR
EUROPA (Portugal)	Physical/ online	2020	Running	Portugal	Local/regional	3	Deep renovations	Residents (owners and tenants)	Renovation plan, finantial plans	n/a	AERANATejo and EUROPA project

4 METHODOLOGY

The methodological approach used for this project followed a similar path as other European projects such as RenoWatt, ENSVET and Green Menu, it is also a combination of several studies held by CENSE, FCT-NOVA (J. Gouveia, 2017; Palma et al., 2019b; Sequeira & Gouveia, 2022) in conjunction with other partners' work in recent years. Many of the steps followed in this project, such as target audience, location and energy poverty vulnerability index, were previously studied by CENSE, FCT-NOVA and adapted to assist in decision making and path to follow. These studies were crucial for the monitoring team to decide and adapt to the population's needs with the available data. This project's methodological approach can be simplified into twelve steps, as represented in Figure 34.

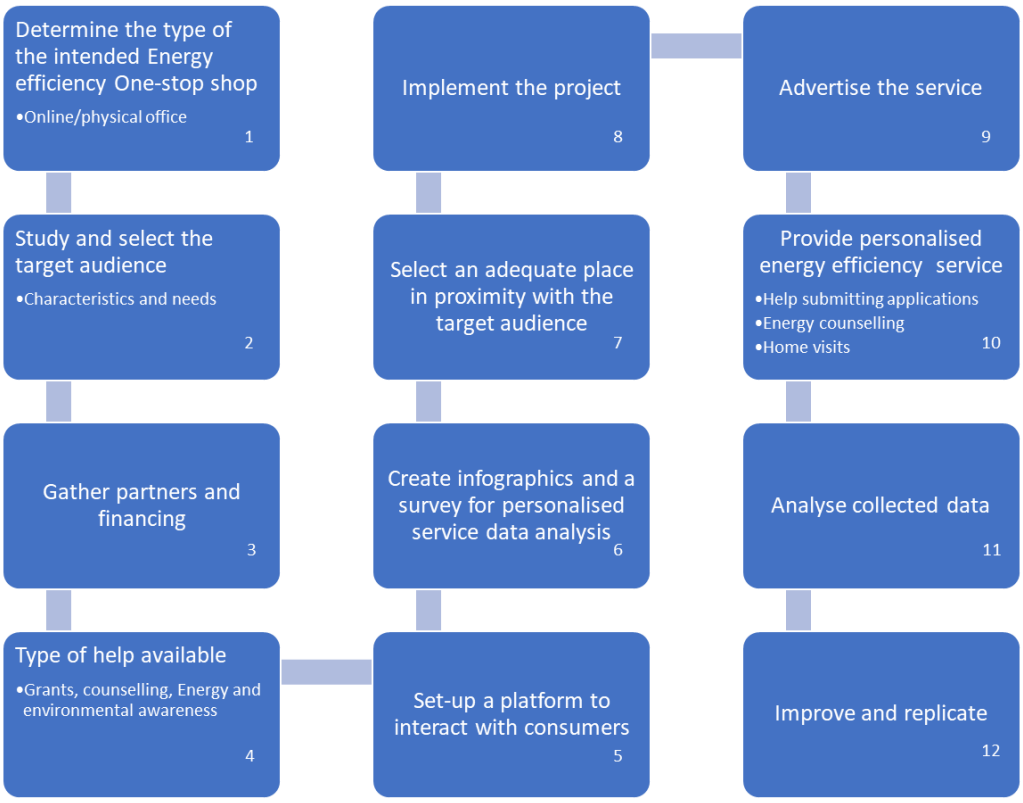


Figure 34: Methodological sequence

1. Gather partners and financing

To develop this model, it is essential to involve a network of strategic partners with know-how, knowledge of the territory, and proximity to the citizens. To test and implement the OSS model was proposed the use of a prefabricated unit that is easy to assemble, concentrating human and material resources on site, allowing the promotion of proximity actions with the most vulnerable households. This unit would have the support of a qualified team with the profile and skills to accompany the target public throughout the process.

For this pilot project, the partners could be divided into three classes; Energy agencies for onsite development and management, a team of experts from an university research centre for technical expertise in the field, and best approaches to reach the target audience and address the energy poor situations, and a team of project managers from a foundation with goals for sustainable development.

2. Study and select the target audience

Choosing the target audience for this project was possible with previous studies that allowed us to identify potential hotspots of inhabitants in energy poverty situations. The target audience selected were inhabitants vulnerable to energy poverty, such as social tariff beneficiaries and low-income households. This does not make this OSS model only available for this population previously mentioned; less vulnerable dwellers can also receive the available energy support.

3. Determine the type of the intended Energy efficiency One-stop shop

One-stop Shops for Energy Efficiency can have various types and objectives adapted to the target audience, such as a physical or online shop. In this thesis's case study, was developed a physical OSS to advise vulnerable inhabitants about energy poverty.

4. Type of help available

The available tools to help dwellers in energy poverty conditions were energy and climate awareness to reduce energy consumption and improve energy efficiency, and personalised energy counselling with the possibility of a home audit to identify the best solutions to apply. With the availability and demand of users for energy grants and due to the application's complexity, a service was developed to help whoever needed help to apply. All these services were made available free of charge to all users.

5. Set up a platform to interact with consumers

The platform used to draw the target audience was a shop made from a pre-fabricated unit made from a used shipping container to have the ability to be relocated to a different area. To facilitate contact with interested users, alternative means of communication like e-mail and a phone number were also made available publicly to allow dwellers to contact if needed.

6. Create infographics and a survey for personalised service and data analysis

With the format of the OSS was necessary to create a brand that users could trust and that would stimulate users to receive help. To do so, exterior and interior infographics were developed with users in mind, so it would not lead them to misinterpret the project's purpose. Infographics, especially those on the exterior, were designed with two concerns: avoid the term energy poverty and emphasise that all services were free. The first was to avoid labelling users as energy poor; this was to prevent users from thinking that this was only for the poorer or for those who do not know the concept of energy poverty in the first place. Second, emphasising that all services were free was to avoid the misconception of having any hidden cost for being affiliated with an energy supplier. Instead of using these terms that could be complicated or not so clear for some, simple messages related to energy poverty were used instead. In conjunction with simple and attractive messages, the mobile unit was painted with bright colours to be more eye-catching, making it stand out wherever it is.

A survey was developed to collect data for future analysis a monitoring; it was developed in cooperation with project partners. The survey is divided into three segments. The first, an introductory inquiry to identify and collect basic information about the surveyed individual, the second part is dedicated only if a domestic assessment is requested, and the last phase of the inquiry is used for monitoring and impact of the domestic assessment. It can also be divided into 9 categories:

- Identification of the applicant
- Identification of household and housing
- Construction characteristics
- Energy consumption
- Thermal comfort and energy poverty
- Appliances

- Problems (broken windows, mould, fissures, etc.)
- Home visits
- Impact assessment and monitoring

7. Select an adequate place in proximity to the target audience

The place of implementation was selected based on overlapping the results from previous studies with the area of action of project partners and energy poverty hotspots. This allowed stakeholders to manage the development and performance of the pilot. The exact place of implementation of the project has some requirements. Apart from being near the target population, the OSS needs to be placed in a levelled place with access to a point of connection with the electric grid for power and with a nearby restroom to guarantee appropriate work conditions for the expert. It is also recommended to implement the OSS in a busy place to attract more users and give more visibility to the project.

8. Implement the project

The implementation phase involves bringing resources to the field of action, combining all the previous steps into a real advisory service capable of advising the population. The project was implemented in two different parishes of Setúbal for three months each.

9. Advertise services

Advertisements are important to let users know about the available services at the OSS and attract new users to get help. Flyers, posters, outdoor billboards, and social media were the most used to advertise the project and its services, allowing more inhabitants to benefit from the available services. Local newspaper articles are also important to inform the public.

10. Provide personalised energy efficiency service.

In addition to the One-stop shop, a team of agents was proposed to conduct energy assessment visits to applicants' homes. These agents were recruited in the target neighborhoods of the project and had the mission to make counselling to the neighbours of the community. These agents will allow closer contact with residents, facilitating the necessary trust relationships to be established. Agents attended a training course that involved basic energy efficiency concepts in domestic environments and the methodology and diagnosis tools. Kits containing the tools required to evaluate the conditions of the applicant's home were made available to

all recruited agents. This kit comprises a tablet, energy meters, and an electric scooter to facilitate traveling between the OSS and houses to be evaluated. The main objective of these agents is to assess the conditions of users' homes and identify ways to improve thermal comfort and reduce vulnerability to energy poverty.

11. Analyse collected data

Data collected from surveying users that visited the project was saved on a database and analysed using Power BI, facilitating data processing and analysis.

12. Improve and replicate

This pilot project allows us to identify potential improvement strategies to address in the future. One of the objectives of this pilot project is to create a methodology capable of being implemented in other regions by the same or other stakeholders to reduce exposure to energy poverty and improve thermal comfort at home. This project's methodology approach was made as a real example for future replication.

5 CASE STUDY - TRANSITION POINT [PONTO DE TRANSIÇÃO]

To develop an effective model to fight energy poverty, it was necessary to involve a set of partners with know-how that enables them to get closer to the most vulnerable families. The Transition Point Project is an initiative of the Calouste Gulbenkian Foundation which, in partnership with the Arrábida Energy and Environment Agency (ENA), Center for Environmental and Sustainability Research (CENSE) of NOVA School of Science and Technology, RNAE (Association of Energy and Environment Agencies) and with the collaboration of Setúbal City Council and São Sebastião and Setúbal Parishes, has developed an intervention model like the Catalan that consists in a free advice point. This point follows the methodology of a one-stop shop (OSS) to minimize vulnerability to energy poverty.

The Transition Point is a mobile point to maximise the action and make it possible to relocate the advisory space to another location. This way, it is possible to have a larger coverage area and advise a larger number of citizens. To ensure the mobility of the Point, the physical shop was made using a used marine container to allow the OSS to be relocated to other areas in the Setúbal district or other cities.

In addition to implementing a free advice point on energy efficiency, a grant was created for the training of 4 Transition Agents who visit the homes of some citizens to carry out a more in-depth assessment. This evaluation identifies unnecessary consumption and possible improvements to minimise the energy consumption. The Transition Agents team comprises young adults over 18 years old with completed mandatory education and living in the proximities of the advice point. Transition Agents had basic training of approximately two days to learn several topics relevant to the visits. They have a checklist to collect data and help them decide how to improve that household; the agents will identify and advise residents on improving their energy performance and reducing energy expenditure.

A diagnostic support kit (a tablet and an energy meter) is available to the Transition Agents so that they can diagnose more effectively the needs of the visited house. This kit contains a tablet, a checklist, and a brief survey that will identify the best method to improve thermal comfort, reduce energy expenditure, and record data that will later be analysed. The kit is also composed of a set of energy meters to register the consumption of several appliances and an electric scooter to facilitate the Agents' journey between the Transition Point and the houses they will assess. Two kits are available whenever there are scheduled visits. The Transition Agents are remunerated when they make a scheduled visit. (Gulbenkian, 2021).

The pilot project was tested in two municipalities of the Lisbon Metropolitan Area with a higher vulnerability to energy poverty. Initially, the point was in the parish of São Sebastião in Setúbal from February 17th of 2022 to May 30th of 2022. After this period, the mobile unit was relocated to a different location in Setúbal city until the end of September 2022. At the end of September, the shop will be relocated to another municipality in the district of Setúbal, where the same methodology will be applied. In this way, it is possible to increase the project's area of action and help the largest number of families with difficulties keeping their homes in a mild climate. In this thesis, it only is considered and analysed the first two locations.

With the development of a pilot like the Transition Point that consists in helping others fight energy poverty by reducing energy consumption and improving energy efficiency at home, it is clear that it checks several Sustainable Development Goals, as shown in Figure 35. The Transition Point's project contributes to the first SDG to end poverty by helping dwellers reduce their energy bills. Contributes to the users' better health by increasing thermal comfort at home (3rd SDG). Promotes the installation and use of affordable clean energy, advising dwellers about financial incentives and programmes (7th SDG). Encourages economic growth by encouraging homeowners to renovate their homes to be more energy efficient (8th SDG). Reduce inequalities by supporting everyone in need of energy advisory for free (10th SDG). Promotes sustainable cities and communities by boosting the sustainability and the proximity of experts to the population (11th SDG). By promoting more sustainable ways of living in comfort at home, this project is participating in the climate action by reducing energy consumption, increasing local homes' energy efficiency, and assisting homeowners with energy renovation programs (13th SDG). This project contributes to the 17th sustainable development goal by

combining all the other SDGs in a single place, where users have relevant experts available to help with their energy needs. This project has several partners with the same goals, such as CENSE-FCT-NOVA, RNAE, ENA, and the Gulbenkian Foundation, therefore creating a net of partnerships for a more sustainable world.

Figure 35: Transition Point's Sustainable Development Goals

5.1 Target audience

With energy poverty affecting millions of Portuguese and being a complex problem, it is important to analyse the vulnerability of the population on a regional scale. With the studies made by (Palma, 2017; Palma et al., 2019b) was possible to map energy poverty on a regional and local scale, allowing to detect of social characteristics, household composition, climate, literacy and other injustices and inequalities on the access to energy. Situations like low education, ethnicity, pensioners, beneficiaries of social support and single-parent households can be directly linked to situations like energy poverty.

To address this situation and considering the objectives of this pilot project, CENSE-FCT NOVA has developed a territorial study, considering several important indicators, to assess the vulnerability of the population in the coverage area of ENA (Setúbal, Palmela and Sesimbra municipalities). Figure 36 shows the vulnerability of each parish council in the Setúbal region to energy poverty in summer (left) and winter (right) months, using the methodology developed by Gouveia et al. (2019).

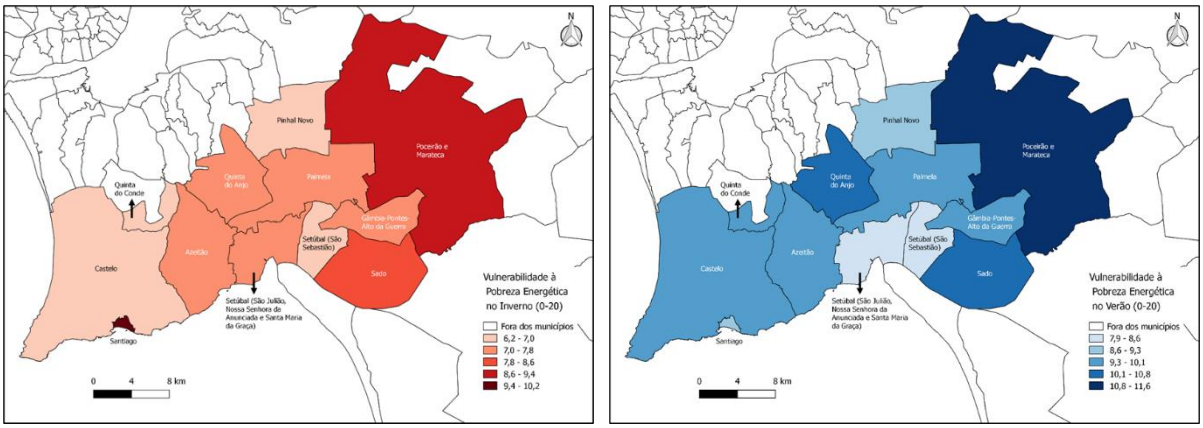


Figure 36: Vulnerability index of the Setúbal region (Gouveia et al., 2022)

With the data and results from this study, it was possible to select an appropriate place to be in proximity to the vulnerable population.

5.2 Location

Before the application of the project, it was necessary to select a location to deploy the mobile OSS in the study area. For this, it was necessary to select an area in relative proximity citizens in need of support to improve their comfort at home and to guarantee a greater involvement of the population.

Although Sesimbra, Setúbal and Palmela are among the least vulnerable municipalities in the country, respectively ranked #11, #14 and #28 out of 308 municipalities in the country. This is mainly due to some of the lowest gap percentages in the country, although adaptive capacity also shows favourable levels, above the national average. Regarding summer, vulnerability is higher due to lower consumption and higher energy gaps for cooling, although municipalities show index results still in the first half of the ranking of the least vulnerable. Setúbal is in #39 position, Sesimbra in #68 and Palmela in #86. Overall, the population of Sesimbra shows higher adaptive capacity, as it is a younger population, with lower percentage of elderly and higher income per household. It is important to highlight that lower EPVI values do not mean that there is no population suffering from energy poverty. It means that the indicators point in the direction of there being a smaller proportion of people in this situation (J. P. Gouveia et al., 2022).

At the parish level, the analysis is more detailed, and it is possible to identify focuses of vulnerability in municipalities that at first sight seem less vulnerable. In the heating season, the average EPVI of the parishes stands at 7.6. The average in the parishes of Sesimbra is slightly higher than the other municipalities (7.8), mainly due to the parish of Santiago. This is the most vulnerable of all the parishes in winter, presenting an index of 10.2. This higher value is due to a particularly high energy gap (86.4%), the highest of all the parishes, and a low adaptive capacity of the respective population, resulting from low proportions of the population owning their dwellings and with higher education. On the opposite side of the spectrum, the parish of Quinta do Conde in Sesimbra is the least vulnerable, presenting an index of 6.2 (J. P. Gouveia et al., 2022).

The selection of the location to implement the project also took into consideration the proximity and the field of action of project partners such as CENSE FCT-NOVA, ENA and Gulbenkian Foundation. This made adaptations easy

After the work made by Palma et al. (2019a) and by Gouveia & Palma (2021b) that studied the energy poverty vulnerability of the Portuguese population, they concluded for this analysis that the regions of Palmela, Setúbal and Sesimbra were ideal to municipalities to test the project for having a relatively high energy poverty vulnerability. The Palmela, Setúbal and Sesimbra regions have a high density of beneficiaries of social tariffs and housing. Inhabitants who benefit from social housing and energy tariffs are economically vulnerable to inefficiency and poor house conditions.

The key factors used to select the exact location were:

- A busy public place, near markets, bus stops and other public equipment that attract the public to that area.
- A place with high visibility with proximity to the public of interest (social housing and vulnerable residents).
- Near an electricity point.
- Near a public restroom where the expert could go if needed.

For the first 3 months (February to May), the Transition Point was placed near the 2 de Abril market in the place marked by the yellow circle in Figure 37. This place met all the requirements indicated above. The housing surrounding the market can be characterized as mainly composed of social housing and council rental properties with signs of degradation.

Most of the residents of these neighbourhoods have a precarious economic situation. In these circumstances, the project aims to help inhabitants in this situation reduce their energy bills and improve thermal comfort at home by using the available grants and government support schemes available.

Figure 37: Project's first location marked near Mercado 2 de Abril

During the 3 months, was verified that the user affluence was not as predicted, with interactions below expectations and unable to help the most needed due to lack of funding and inability to make significant changes to their homes for not being owners of the house, was necessary to change the initial approach and adapt it to the help as many people as possible. This decision was taken because most of the users in this area could not participate in the available funding from the Environmental Fund because they were not owners of the house they lived. This situation limited the action of the experts to just suggesting behavioural changes by creating awareness among users. Since the project did not have additional funding to intervene and improve energy efficiency and comfort, it was necessary to take advantage of the demand and availability of the available programs to improve energy efficiency. Allied to the fact that very few users were from the surrounding neighbourhoods, the idea of changing locations came to the surface. For the second location were applied mostly the same

requirements as the first location but instead of placing the refurbished marine container in a residential area with a high density of homes, it was placed in the busiest place possible in the city centre. The second location was on Luisa Todi Avenue, near banks, supermarkets, markets, and other important businesses that attract many people. This location, as represented by the yellow circumference in Figure 38, is a busy passageway with more visibility.

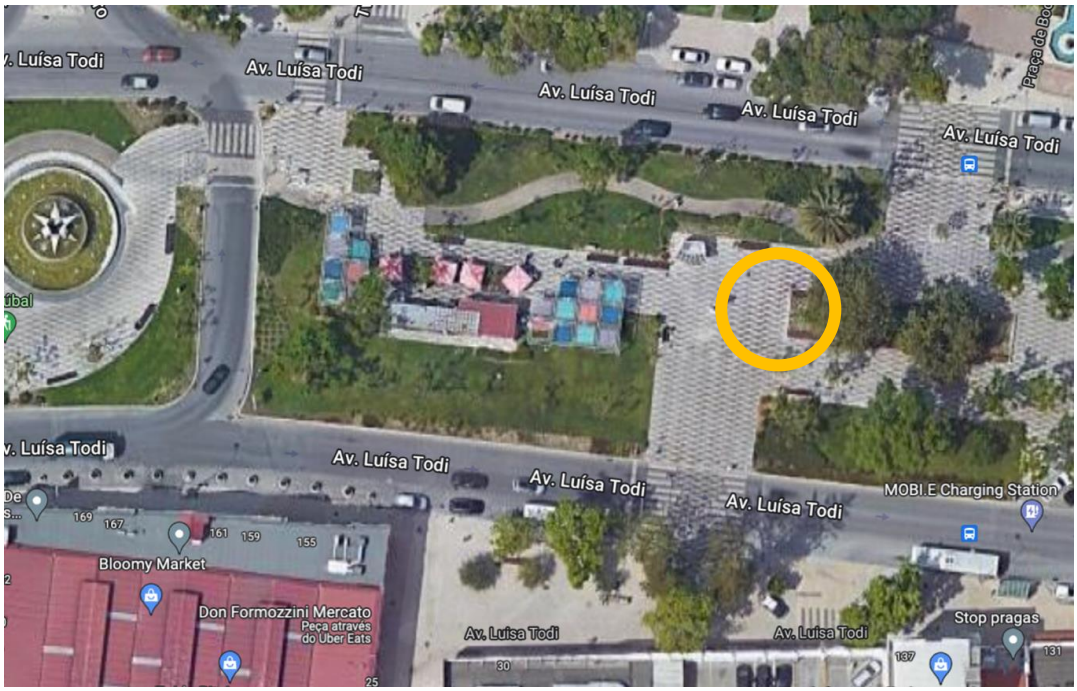


Figure 38: Second location, Luisa Todi Avenue in Setúbal

5.3 Survey

To characterize users and their needs and analyse the project's performance, it was necessary to develop a survey to collect relevant information about users to study it later. This survey was developed by the CENSE, FCT-NOVA team, in collaboration with ENA, based on recent studies made by (CENSE, 2020; J. Gouveia et al., 2018, 2019; Sequeira et al., 2021; Sequeira & Joanaz de Melo, 2020), energy poverty indicators under EU Energy Poverty Advisory Hub (EPAH) as well as other related projects. ENA also contributed to the elaboration of the survey that added some necessary inquiries and to protect consumers and comply with the data protection regulations of Portuguese law (DL nº 58/2019). The survey was divided into three sections, the first with general questions (name, age, nationality, etc.), the second with

data collection for domestic visits and the last for future monitorization of the impact of the implemented solution. The complete survey is attached to this document in Annex A. With the final version of the survey, ENA created a database capable of saving survey answers and creating automatic visit reports and consent forms as required per Portuguese law.

5.4 Communication channels

Since the beginning of the project, it was necessary to communicate and inform the population about the free energy advisory services available to Setúbal residents. To do so, it was important to create efficient ways to interact and reach the target audience. This task was led by the Calouste Gulbenkian Foundation marketing department that in cooperation with project partners, created several creative ways of reaching these users:

- **Outside messages**

Outside messages were developed to attract passing clients; these messages were placed on the outside of the refurbished shipping container used as a mobile office. The objective of this messages was to, simply and directly, inform inhabitants about the objectives and services available. The selected messages were carefully chosen to avoid confusing messages or labelling consumers as poor. These messages have been selected to be as simple and straightforward as possible to enable all inhabitants, regardless of age, to understand and not to link the project to any energy supplier or other paid business. Figure 39 represents the actual messages displayed on the exterior of the mobile unit.

Figure 39: Transition Point's exterior messages

- **Infographics**

Similar to the outside messages, infographics scattered inside the mobile office were carefully developed to be clear and informative and to avoid any misconceptions since the target audience does not have enough literacy to understand scientific concepts. Figure 40 demonstrates the layout disposition and the infographics developed by partners. Interested inhabitants are welcome to enter and read.

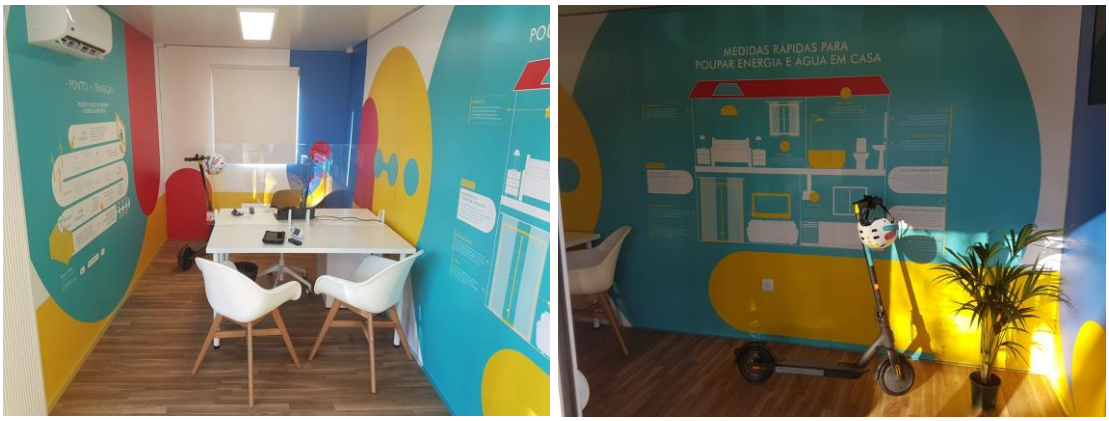


Figure 40: Interior infographics and layout

- **Advertisements/flyers**

Since the first weeks of deployment, the team of partners decided it was necessary to make the population aware of the available free energy services of the project to increase interactions. This way was used all the available strategies to increase visibility and interactions with energy poor inhabitants. Were used billboards, flyers, posters, and an easel in front of the entrance of the container to attract the public's attention. Figure 41 is an example of the various outdoor billboards used to promote the project.

Figure 41: Transition Point outdoor

The project was mentioned in four occasions in local newspapers, although this was not with the intent of advertising the project, it had increased significatively the visibility of the available services. The newspaper is still one of the most communication tools to reach vulnerable inhabitants such as the elderly or dwellers with difficulties using online services. Figure 42 represents one of the four newspaper articles since the inauguration of February.


8 LOCAL

Jornal da Câmara Municipal de Setúbal

AUTARQUIAS EXIGEM TRANSPORTES SEM FALHAS

Um projeto da Fundação Calouste Gulbenkian foi criado especificamente para ajudar no combate à pobreza energética. A população pode encontrar todas as informações no Ponto de Transição instalado na Avenida Luísa Todi até ao final de agosto

Técnicos ajudam a poupar energia e melhorar conforto térmico das habitações

PONTO DE TRANSIÇÃO ACONSELHA SOBRE EFICIÊNCIA ENERGÉTICA

Projeto melhora conforto e consumo de energia em casa

O Ponto de Transição, projeto da Fundação Calouste Gulbenkian a funcionar num contentor instalado na Avenida Luísa Todi, proporciona aconselhamento à população sobre formas de rentabilizar os consumos energéticos domésticos.

Inaugurado, a 17 de fevereiro, *junto do Mercado de 2 de Abril, o projeto mudou-se em junho para a praça central da principal avenida da cidade, perto do Mercado do Livramento, onde se mantém até final de agosto, disponível, de forma gratuita, para todos os munícipes.*

O Ponto de Transição conta com o apoio de um perito qualificado para prestar aconselhamento sobre faturas de eletricidade e gás, bem como informação sobre a obtenção de financiamento para a renovação energética das habitações e apoio ao preenchimento de candidaturas.

No local, ou ainda pelo endereço contacto@ponto-de-transicao.pt ou telefone 925 260 049, é possível agendar, igualmente sem custos, uma avaliação energética técnica à habitação.

O projeto procura melhorar o conforto térmico das habitações, reduzir despesas com energia e otimizar a eficiência energética das casas, o que constitui uma resposta inovadora e de proximidade no combate à pobreza energética, promovendo o envolvimento dos cidadãos no caminho para a descarbonização.

O Ponto de Transição está aberto ao público das 10h00 às 14h00 às segundas e quintas, das 13h00 às 17h00 às terças e sextas e das 10h00 às 17h00 às quartas. O espaço funciona também no primeiro sábado de agosto, dia 6, das 10h00 às 13h00.

Figure 42: Transition Point in the local newspaper

Flyers were made available to increase user interaction and facilitate the initial contact by containing basic service information, contact information and schedule. To attract inhabitants that received the flyer to enter the projects mobile unit, was offered a LED lamp for everyone who had a flyer. This was to motivate users to enter and ask for available services. In Figure 43 is represented the flyer used for the second location, in Luisa Todi's Avenue in Setúbal.

Figure 43: Transition Point's Flyer

To attract users of all ages and with ease in using online services, were also conducted digital advertisements on social media platforms like Facebook and Instagram, allowing to have a wider reach. These online advertisements were limited for users older than 18 and connected to the internet in Setúbal. Figure 44 represents a section of the advertisement promoted by

the Calouste Gulbenkian Foundation, when clicked, users are redirected to the project's webpage.

Figure 44: Facebook advertisement (J. P. Gouveia et al., 2022)

- **Social Responsibility Associations**

Associations that already know and have direct contact with vulnerable inhabitants are important to act as an intermediary to facilitate reaching vulnerable individuals that are hard to reach due to their socioeconomic or demographic characteristics. This association can help disseminate the project's services and objectives with vulnerable inhabitants. A list of local entities with over 60 social institutions were identified and contacted to disseminate the project services and objectives to help vulnerable citizens. Homeowners' associations play an important role in to communicate with a wider spectrum of the population.

6 RESULTS AND ANALYSIS

The data analysed in this chapter was collected using the survey developed by CENSE and ENA in cooperation with other project partners. The data were collected and stored in ENA's database and subsequently analysed using the Power BI tool.

As described in the previous chapter, the pilot has faced some barriers in the first location. Initially, the Transition Point's pilot was meant to help the most needed in an area with a higher density of citizens vulnerable to energy poverty. Since the inauguration of the pilot in February of 2022 near a hotspot of vulnerable population, the daily affluence of users registered was inconsistent through the three months, as shown in Figure 45. In this location, the number of interactions was lower than expected. This could be linked to the low energy literacy and concerns about entering an unfamiliar place that could charge or mislead users to do something they do not want or cannot afford. Another possibility for the lower affluence during the first deployment is the fact that certain inhabitants associate energy with a particular Portuguese energy supplier that, for them, is associated with an added cost or bad service, creating an invisible wall at the entrance of the point.

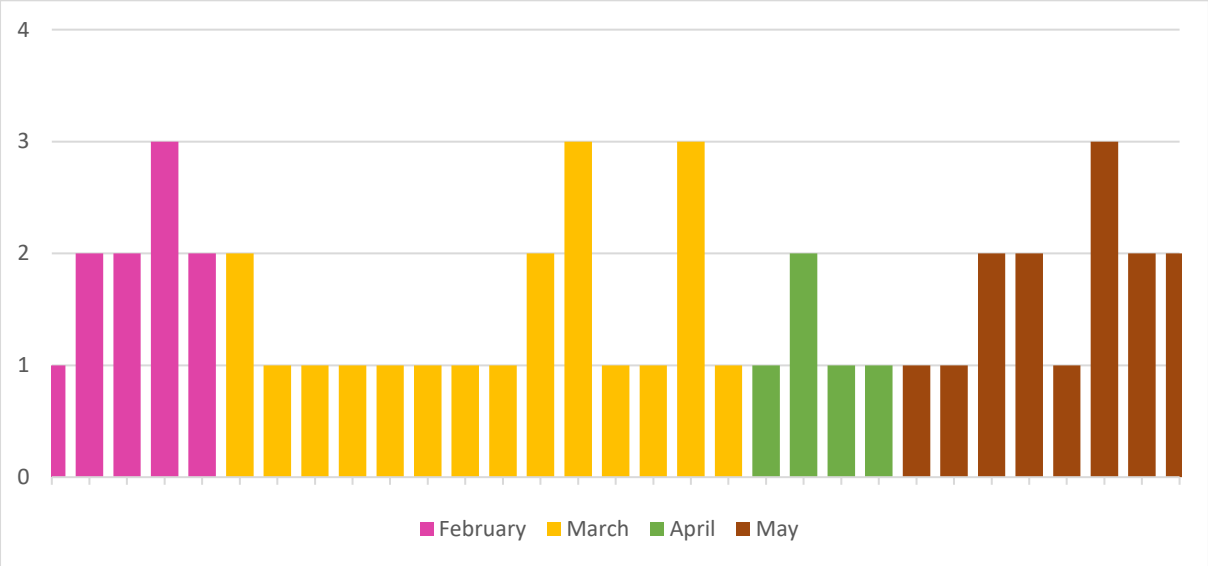


Figure 45: Transition Point's daily affluence in the first location.

To reach the largest number of users possible, the management team has used several methods to increase the number of daily users. During the period shown in the above figure,

various kinds of marketing were used, such as newspaper advertisements and articles, online marketing tools, and outdoors. The attendance of persons registered an increase that could be directly linked to the release of advertisements and news articles. The first peak, by February 23rd, was recorded after the inauguration and after the media released several news articles about the Transition Point, users from that period reported on the survey that they got to know the project from advertisements, news articles or from messages displayed on the exterior of the point. During the deployed period, most of the surveyed individuals admitted that the eye-catching theme and location of the mobile unit was the main reason they came in, as represented in Figure 46. In this Figure, it is also evident that the advertisements' effectiveness is the second most significant reason for contact, with almost a fourth of the surveyed inhabitants admitting to having known about the project via advertisements.

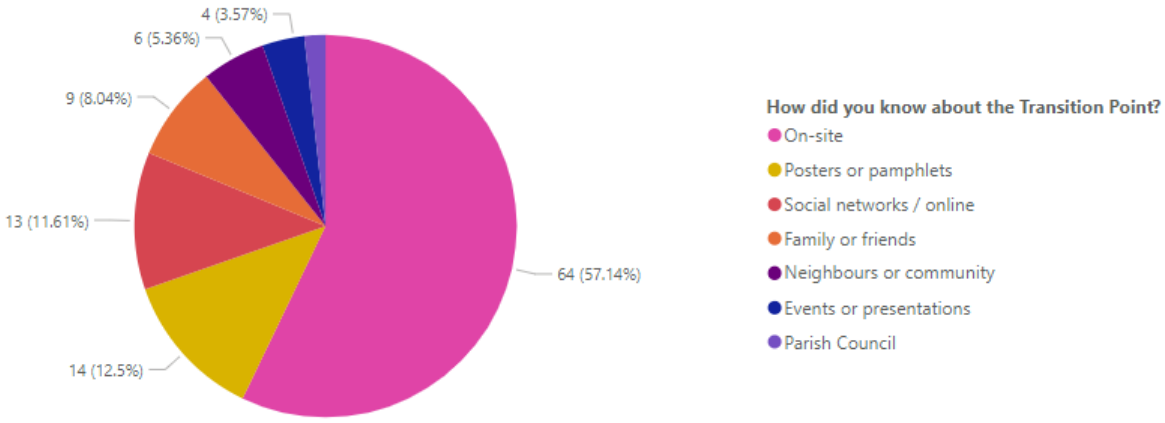


Figure 46: How did citizens found out about Transition Point

While the Point was placed near the 2nd of April Market, the initial location, 32 users have reached out to the Point to receive energy advisory distributed from five different parishes of the Setúbal region, as shown in Figure 47. Of these 32 registered users, two were from Azeitão parish, both male and older than 65 with a high level of education. These two users have admitted that they avoid turning on appliances to maintain a comfortable temperature at home due to increased energy consumption. From the União de Freguesias de Setúbal parish were registered eight users from all age groups (above 35), but the majority were females, older than 50, and with high levels of education. The results from this parish were more diverse, but the majority agree that it is challenging to maintain a comfortable temperature at home at

a reasonable cost. The most significant number of users who attended at the Transition Point are from the São Sebastião parish, this parish is the closest to the physical location of the Point,

but very few were from the neighbouring buildings surrounding the Point. Most of these users were female, over 55, and with an average education level.

Figure 47: First location user distribution

When the Transition Point's mobile unit was relocated to one of the busiest avenues of the city of Setúbal, contacts with the population increased significantly and became more regular, as shown in Figure 48. In this Figure, it is possible to identify the relocation based on an activity increase at the beginning of June 2022. Compared with the previous location, the second location gave the project more visibility and interaction opportunities than the first location in a residential area.

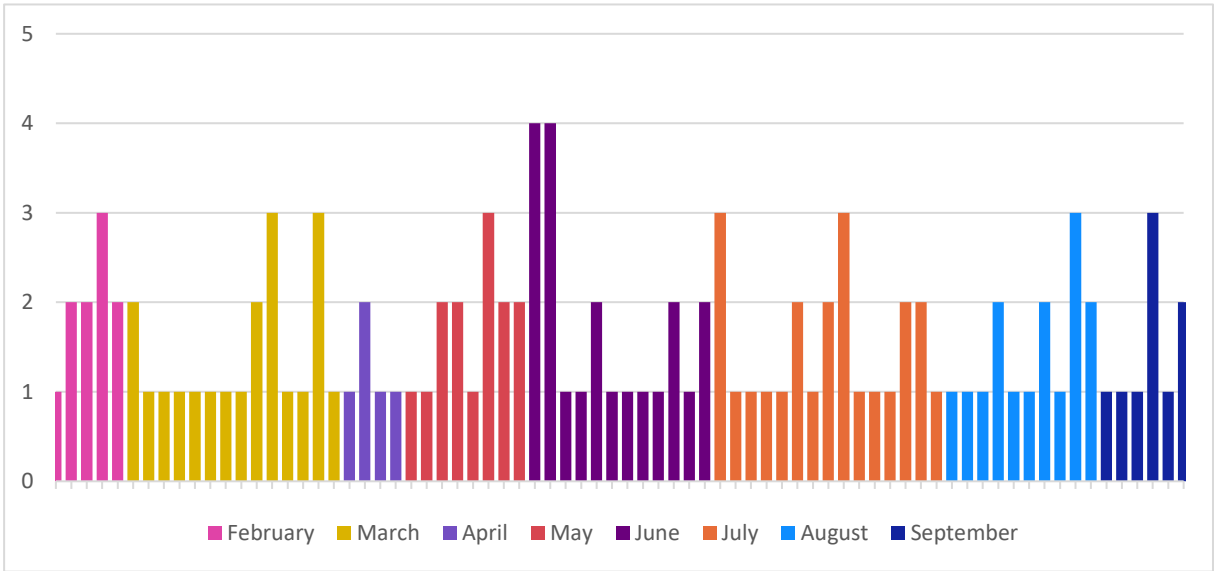


Figure 48: Affluence per month in both locations

From a global perspective, most interactions were from residents of the two most populous and central parishes of Setúbal. (São Sebastião and União de Freguesias de Setúbal). These two parishes represented approximately 83% (42.37% and 40.66%, respectively) of the total surveyed population, as demonstrated by Figure 49 . At the first location, there was very low affluence of inhabitants from local neighbourhoods. These citizens were not receptive to the project, even showing discomfort in asking for help, possibly due to unfamiliarity with the intentions and functioning of the service. The attendance of citizens who do not live in the neighbourhood or nearby was also relatively small, possibly since this area is known for some social problems, causing discomfort and mistrust to inhabitants of other neighbourhoods.

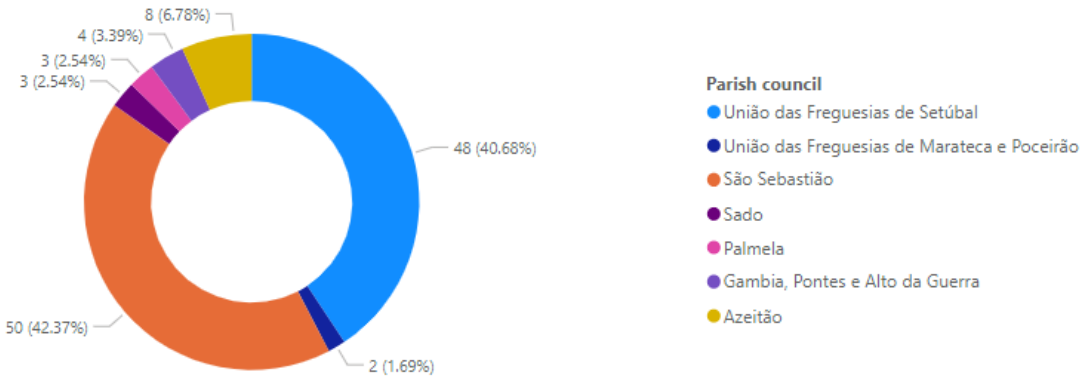


Figure 49: Accumulated user distribution per parish council

Analysing the age of the surveyed individuals of both locations is possible to identify that in the first location, near the market on 2 de Abril (2nd of April), it was registered that most of the contacts were made from elderly (over 65) inhabitants, even more, significant in quantitative terms, than the second location in the Luisa Todi Avenue. When the mobile unit was relocated to Luisa Todi Avenue, the age distribution of the surveyed inhabitants registered was more consistent between the ages of 45-54, 55-64, and over 65 (Figure 50). This is caused by the fact that in the second location, the project had an increase in visibility thanks to the characteristics of this busy location. With the second location being right in the city centre and being close to banks, supermarkets, and markets, was registered an increase in surveyed individuals of working age (18-65). This contrasts with the first location, which was mainly residential, with only a traditional market close to the container's location.

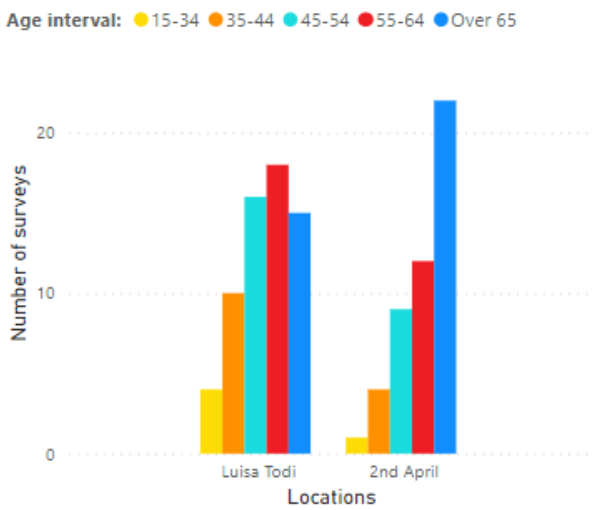


Figure 50: Age of the surveyed persons by location

After analysing all valid surveys, it was possible to conclude that women (52.63%) have been more receptive and interested than men (47.37%). The difference is not very significant, only representing a difference of about 5% between the two genders, as demonstrated in Figure 51 and Figure 52. In terms of education, the great majority of the surveyed have high levels of education, with 55 having superior education. For most of these individuals, mandatory education was until the 9th grade; Figure indicates that over 76% of the valid inquiries have largely surpassed the minimum legal level of education.

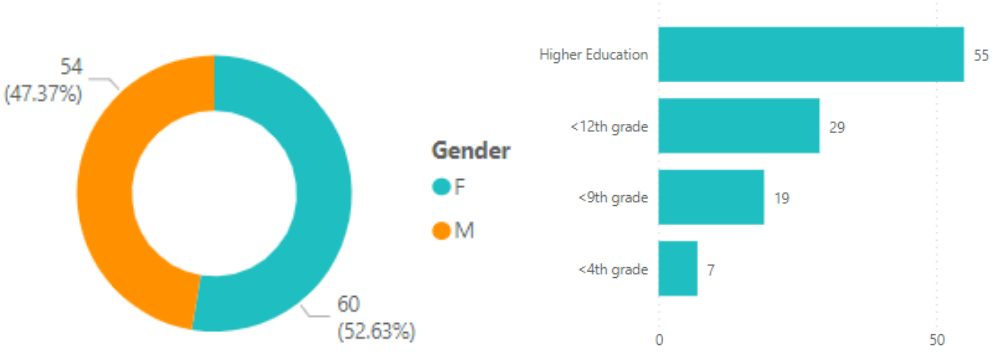


Figure 51: Gender of the surveyed citizens and Figure 52: Level of education of the surveyed citizens

Considering the employment status of the surveyed, most of the respondents were employed or retired; very few were unemployed or with another status, as indicated by Figure 53. With a significant amount of the surveyed individuals being over 45, it is to be expected this distribution.

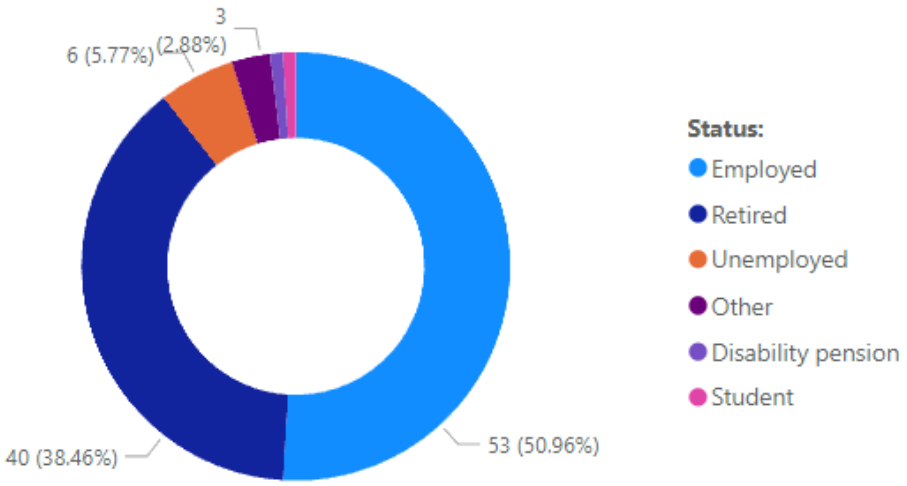


Figure 53: Employment status

Regarding the average household income, the surveyed public was evenly distributed in the available income brackets, with a little deviation between them. It is impossible not to notice that 24 of the total respondents do not feel comfortable sharing their household income; this could be double-sided. This can indicate that users have a higher income that is not relevant for the type of support they are requesting, or the respondent's income is low, and they do not want to share it with others, especially with a known person (Figure 54 and Figure 55). Survey respondents also reported ease of using online services; only 7 of the 27 valid responses responded being uncomfortable with using digital services, as shown in Figure 54 and Figure 55.

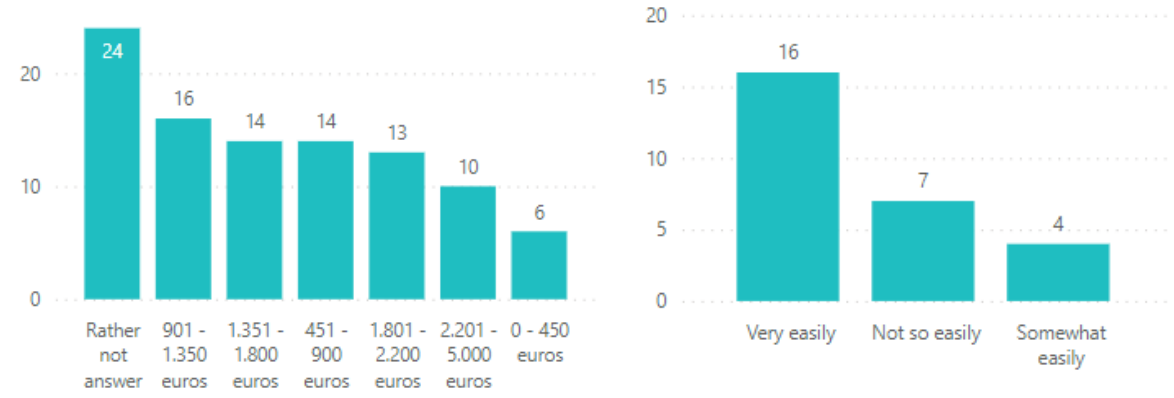


Figure 54: Household income and Figure 55: Ease in using online services

Figure 56 allows us to better analyse the level of vulnerability to energy poverty. From left to right, conditions are in order of approval. This means that respondents think that "paying energy bills limits my ability to purchase other goods/services" do not affect them as much as "I take measures to combat cold/heat instead of turning on equipment" does. The surveyed population agrees that having a cold at home in the winter and being hot in the summer is very frequent. Avoiding switching equipment to maintain a comfortable temperature at home is also common among the inquired population. This goes in line with the expected results for this project.

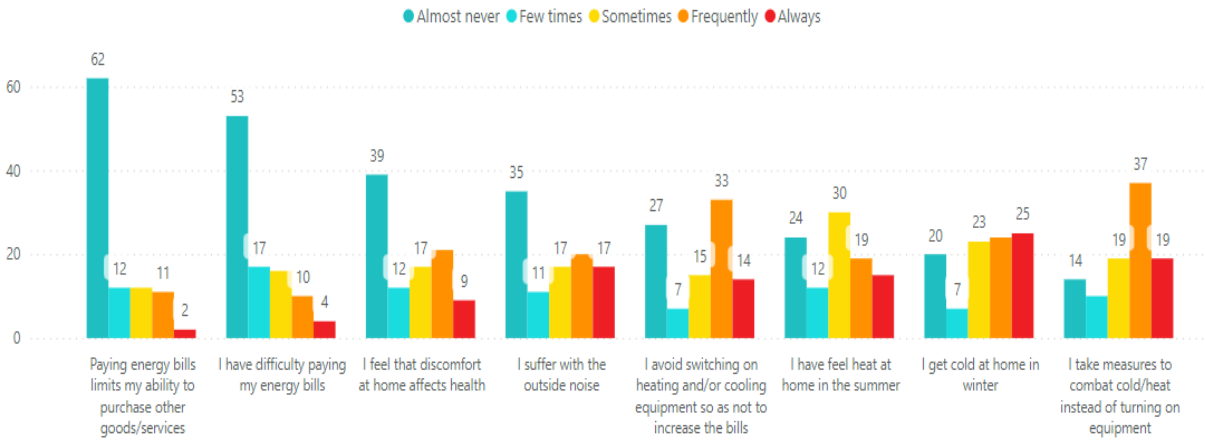


Figure 56: Vulnerability to energy poverty

The average surveyed inhabitant owns the house they live in or live in a house owned by a close relative; very few people (2) live in social housing. With one of the main objectives of this project being to reach vulnerable inhabitants, especially those who benefit from social

benefits such as social housing, and with the Setúbal region known for its high density of inhabitants in these conditions, it is evident that this project could not reach this group of vulnerable inhabitants as represented by Figure 57 and Figure 58. The average household has three bedrooms (T3), as indicated in Figure 57 and Figure 58.

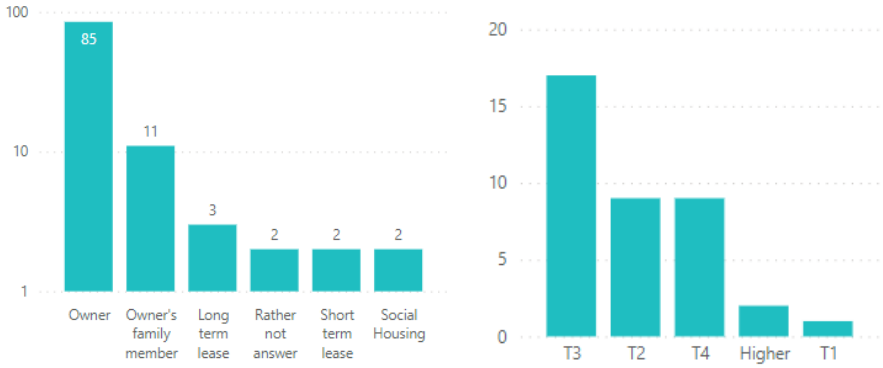


Figure 57: Forms of ownership and Figure 58: House typologies

Approximately half (55.27%) of the inquired individuals live in houses built in the 80s and 90s, and some have been built even earlier, indicating that most buildings do not comply with current performance regulations for energy efficiency. This is in line with the Portuguese average in terms of constriction periods. Figure 59 corresponds to the decade in which surveyed citizens inhabit.

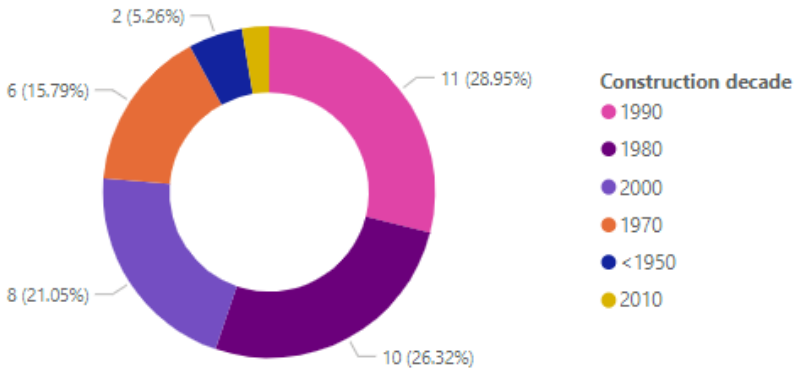


Figure 59: Decade of construction

Challenges and data discussion

After analysing the collected data with Power BI, it was possible to identify some patterns. The daily affluence of users was inconsistent in the first location; at the beginning, the project

produced some curiosity among the population and registered an increase in affluence in the first week. After investing in publicity and other communication strategies, it was identified that the lack of affluence was most likely caused by location. At the end of May, when the mobile unit was relocated to a busier location in the central part of town, the number of user contact increased and became more constant, between two and three surveys per day. During the near six-month period since the implementation of this pilot project, most of the surveyed inhabitants live in the most central parishes of Setúbal; these are coincidentally the most populous parishes of the region. Users from the first location tended to be in the age group of over 65 and retired. In contrast, the second location has a more homogeneous distribution for being in the city centre. Interestingly, most of the surveyed individuals had a college degree, even though most of the population was over 65.

Most interviewed dwellers responded that their energy bills do not affect them much, but most agree that their home does not have proper thermal comfort in hot and cold months. This can be aggravated by the fact that most of the surveyed population lives in houses built before the first regulation (i.e., 1990) regarding energy efficiency and thermal comfort. Most users live in houses built before the year 2000, indicating that they likely do not have insulation or windows with double glazing for maintaining a comfortable interior temperature.

Since the beginning of this pilot implementation (*i.e.,* February 2022), there have been challenges when helping the community. One of the biggest challenges was helping the initially targeted audience; this OSS was placed in an area with a high density of residents vulnerable to energy poverty. These residents usually inhabit houses owned by the council or live in rental properties. This makes helping the neediest, in terms of energy poverty, a lot harder. To improve energy efficiency at home using the available government help, these residents must have the financial ability to pay for the renovations and be homeowners. Since most residents who live near the point do not own the property where they live or have the financial availability to pay upfront for renovations, it makes it almost impossible to help those who need the most without additional funding.

To help the largest number of citizens with the available resources, the project management team decided to make some changes regarding the targeted audience; instead of focussing on those who needed the most, it was decided to help other portion of the

population with an inferior exposure to energy poverty but with a higher possibility of being helped. This was decided after analysing the affluence and the conditions of the residents that asked for help from the experts. It was registered a significant number of citizens that did not know how to improve their thermal comfort at home but have all the requirements to be eligible for the available programs to retrofit their homes.

7 Conclusions and Next Steps

With Portugal being one of the most affected countries by energy poverty and with the aggravation of climate conditions, it is crucial to follow and develop projects and ideas like the case study to mitigate the harsh consequences of climate change. With buildings consuming a significant part of the available energy and a new energy crisis on the horizon, energy poverty will probably affect more people in European countries, especially in Portugal. So, it is essential to make behavioural improvements, reduce energy consumption, and improve efficiency. The exploration of an Energy Efficiency One-stop shop has been a challenge to all the persons involved going from the expert in the field to those who have been part of the development team of this pilot project. One of the most notorious challenges was identifying and implementing effective measures to attract and interact with the target audience known for low energy literacy and income. As indicated in the previous chapter, the first location, in proximity to neighbourhoods with a higher index of vulnerability to energy poverty, detected that the surrounding areas were apprehensive about entering and receiving free energy counselling. Social and psychological phenomena could be linked to the fear that pushes back inhabitants from entering the TP, the fear of entering an unfamiliar place, being charged, or being surprised with hidden costs are some of the various reasons to push back potential visitors. It was also concluded that most of the visits made by inhabitants of surrounding neighbourhoods did not have eligibility criteria or economic stability to apply for government grants to improve their living conditions and efficiency.

As discovered in the previous chapter, after analysing the collected data, most of the contacts in the TP were about the available government grants, especially after the Program for More Sustainable Buildings ended in early May. The expert's testimony concludes that some users tend just to ask if the program is still open to new applications. This was so significant that ENA developed a counter application to determine these inhabitants that only asked for basic information. Since the last update, approximately 150 inhabitants had asked for the availability of government grants to improve their homes, allowing for validate public adoption of these measures. This represents that almost half of the total interactions were just to ask if

there were any public grants available to improve dwelling efficiency. In total, were registered over 300 interactions with citizens since the implementation of the project in Setúbal.

With similar staying periods in both locations, was evident the importance of the location for the success of the project. At the first location, the TP mobile unit was closer to the population with a higher vulnerability index, but that did not translate to a higher number of contacts. On the contrary, it registered lower affluence than expected. With a low budget, the project could not proceed to renovate homes of those with poorer living conditions. The adaptation of the project to the available services has revealed successful based on the data analysed. It was identified that there was a pattern of the characteristics of the surveyed inhabitants; most had economic possibilities to undergo with the initial investment to improve their living conditions, owned the home they lived in, and were interested in applying for the available grants. With this premise, the relocation of the mobile unit to a different location within the city was justifiable and later led to increased activity with the public. With better results in a busier part of town shared by everyone, interested inhabitants with more capabilities did not feel out of place visiting TP.

Next steps

With the lessons learned from this innovative Portuguese OSS pilot project and with the interest of energy agencies, municipalities, and inhabitants in participating actively in reducing energy poverty vulnerability and improving residential buildings efficiency, it is expected that this methodology to be the national or even international standard to implement an Energy Efficiency One-stop Shop. The project's replicability capabilities have raised the possibility of implementation in other regions of the Setúbal district. In this pilot phase, it is expected to catalyse changes and allow to promote other entities to invest in similar project in behalf of this common problem. With the creation of synergies with other entities such has energy agencies and governmental funds, other regions can benefit from the lessons of this pilot project allowing for a greater number of beneficiaries. With national mediatic coverage of the approach to this common problem, other municipalities have shown their interest in adopting this model in conjunction with local energy agencies to address energy poverty. This way, it opens the opportunity for future research and monitoring of future stages of this project. It is

also important to collaborate with welfare institutions capable of reaching hart to reach citizens.

It is important to perform a cost-effectiveness analysis to determine if this project is a viable solution to address energy poverty of vulnerable populations. The total cost of this initiative was not shared with project partners, making it impossible to determine it cost-effectiveness. In future projects, costs of implementation and operation should be taken into consideration as an important section of the project. Because when using partner's funds, it is important to use it wisely to reach as much people as possible.

Project follow-up is interesting since it is important to analyse the project's impact on the population. It would also be interesting to develop the project further and create a net of advisory points throughout the country and beyond borders.

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ANNEX A - TRANSITION POINT SURVEY

This survey was developed to collect relevant data about the impact and performance of the pilot on the population and the characteristics of the dwellings and their respective inhabitants.

Questions	Initials	Secondary	Domestic visit	Impact assessment	Answer options										
Introduction, authorization to use data, confidentiality, identification of the person completing the survey															
Participant identification															
Applicant's name	1				open answer										
Have you visited the transition point before?	1				Yes	No									
Age	1				15-34	35-44	45-54	55-64	65 or more	prefer not to answer					
Genre	1				M	F	nonbinary	prefer not to answer							
Nationality	1				Portuguese	Other (which one?)	prefer not to answer								
Literary abilities	1				<4th year	<9th grade	<12th grade	higher education	prefer not to answer						

Work situation	1				em-ployed	Un-em-ploy ed	student	re-tired	disa-bility pen-sion	other (which one?)					
County	1				list										
Parish	1				list										
How easily do you use online services?	1				very easy	some ease	little ease	pre-fer not to an-swer							
How did you know about the existence of this fulcrum on en-ergy?	1				family or friends	neig hbou rs or com-mu-nity	Social net-works / online	post-ers or fly-ers	con-taine r	Parish Coun-cil	Event s or prese nta-tions	prefer not to an-swer			
Thermal comfort / (energy poverty)															
Cold step at home in winter (1 to 5)	1				5 - Of-ten	4 - Of-ten	3 - Some-times	2 - Few times	1 - Al-most neve r	prefer not to answer					
I have heat at home in the sum-mer (1 to 5)	1				5 - Of-ten	4 - Of-ten	3 - Some-times	2 - Few times	1 - Al-most neve r	prefer not to answer					
I suffer from outside noise (1 to 5)	1				5 - Of-ten	4 - Of-ten	3 - Some-times	2 - Few times	1 - Al-most neve r	prefer not to answer					
I avoid connecting heating and/or cooling equipment so as not to increase bills (1 to 5)	1				5 - Of-ten	4 - Of-ten	3 - Some-times	2 - Few times	1 - Al-most neve r	prefer not to answer					
I have difficulty paying energy bills (1 to 5)	1				5 - Of-ten	4 - Of-ten	3 - Some-times	2 - Few times	1 - Al-most neve r	prefer not to answer					

Paying energy bills limits my ability to purchase other goods/services (eg medicines, internet) (1 to 5)	1				5 - Often	4 - Often	3 - Sometimes	2 - Few times	1 - Almost never	prefer not to answer					
I take measures to combat the cold/heat instead of turning on equipment (eg blankets, sweaters, leaving the house) (1 to 5)	1				5 - Often	4 - Often	3 - Sometimes	2 - Few times	1 - Almost never	prefer not to answer					
I feel that discomfort at home affects health (eg frequent colds in winter, breathing problems) (1 to 5)	1				5 - Often	4 - Often	3 - Sometimes	2 - Few times	1 - Almost never	prefer not to answer					
Does my house have drafts, cracks, dampness or mold?	1				Yes	No	Do not know / Prefer not to answer								
Additional energy expenditure per winter month compared to the rest of the year (€)	1				Numeric field	Do not know / Prefer not to answer									
Additional energy expenditure per summer month compared to the rest of the year (€)	1				Numeric field	Do not know / Prefer not to answer									
Housing and household identification															
form of ownership		1			Owner	owner's family	long term lease	short term lease	Social habitation	prefer not to answer					
building type		1			detached house	semi-detached house	Apartment in multi-family building	prefer not to answer							
Number of floors in the building		1	1		Numeric field										
typology		1	1		T1	T2	T3	T4	greater than T4	prefer not to answer					
Area (m2)		1	1		Numeric field										

Number of people in the household, per person:		1			Numeric field									
Age		1			15-34	35-44	45-54	55-64	65 or more	prefer not to answer				
Genre		1			M	F	nonbinary	prefer not to answer						
Nationality		1			Portuguese	Other (which one?)	prefer not to answer							
Literary abilities		1			<4th year	<9th grade	<12th grade	higher education	prefer not to answer					
Work situation		1			employed	Unemployed	student	retired	disability pension	other (which one?)	prefer not to answer			
Average monthly household income		1			0 - 450 euros	451 - 900 euros	901 - 1350 euros	1351 - 1800 euros	1801 - 2200 euros	2201-5000	Above 5001 euros	prefer not to answer		
Energy consumption														
tariff type		1			simple	bi-hour	tri-hour	Do not know / Prefer not to answer						
Contracted power (kVA)		1			3.45 kVA	4.6 kVA	5.75 kVA	6.9 kVA	10.35 kVA	> 10.35 kVA	Do not know / Prefer not to answer			
Do you have a social tariff?		1			Yes	No	Do not know / Prefer not to answer							
Electricity bill verification - Electricity consumption last period		1	1		Numeric field									

Electricity bill verification - Number of days in the period		1	1		Numeric field										
Do you have piped natural gas?		1			Yes	No	Do not know / Prefer not to answer								
Verification of the natural gas bill - consumption in the last period		1	1		Numeric field										
Natural gas bill verification - number of days in the last period		1	1		Numeric field										
Got bottled gas?		1			Yes	No	Do not know / Prefer not to answer								
if yes how many bottles per month?		1			Numeric field	Do not know / Prefer not to answer									
Do you have other energy sources?		1			biomass	other (which one?)	Do not know / Prefer not to answer								
if yes average annual cost		1			Numeric field	Do not know / Prefer not to answer									
Main transport type?		1			individual car	Public transportation	motorcycle	bicycle/scooter	Shared car ("ride")	On foot	company transport	Other	prefer not to answer		
Average cost of fuel per month for transport (€)	1			up to 50 euros	51-100 euros	101-200 euros	200-500 euros	More than 501 euros	Do not know / Prefer not to answer						
construction characteristics															
Decade of construction		1	1		before 1919	1919 - 1945	1946-1960	1961 - 1980	1981 - 1990	1991-2004	2005 - 2015	after 2015	Do not know / Prefer not to answer		
The building has been renovated since its construction.		1	1		windows	Painting	Air conditioning	Roof	facades	Other (which one?)	No	Do not know / Prefer not to answer			
Do you have an energy certificate?		1	1		A+	A	B	B-	C	D	E	F	Yes, but Do	There	Do not know /

													not know the class	is not	Prefer not to answer
Identification of the type of frame		1	1		metallic	Wood	PVC								
Identification of the type of glass		1	1		Simple	Double	Other (which one?)	Do not know / Prefer not to answer							
Checking the existence and type of roller shutter box			1		There is not	interior	abroad								
Checking the existence of protections in the external glazed openings		1			With inner protection (what kind?)	With outer protection (what kind?)	No protection								
Measurement of the glazed area			1		Numeric field										
DHW production															
Kind of equipment		1	1		gas boiler	electric water heater	gas water heater	heat pump	solar thermal	biomass boiler	Other (which one?)	Do not know / Prefer not to answer			
Number of weekly baths			1		Numeric field										
equipment age		1	1		<1 year	1 year <age <10years	10 years< age<20 years	>20 years	Do not know / Prefer not to answer						
Is there a timer on the water heater?			1		Yes	No									
Adequate electrical connection of the water heater?			1		Yes	No									
Is there gas extraction in the boiler/heater?			1		Yes	No									
Is the water heater placed in the toilet?			1		Yes	No									

Do you have flow reducers installed in the showers?			1		Yes	No									
How many showers are there?			1		Numeric field										
Air conditioning															
Kind of equipment		1	1		Fireplace	fireplace with heat recovery	Heat pump / air conditioning	electric radiator	bar heater	gas radiator	thermo fan	Other (which one?)	Do not know / Prefer not to answer		
equipment age		1	1		<1 year	1 year <age <10years	10 years< age<20 years	>20 years	Do not know / Prefer not to answer						
If you have air conditioning, what temperature do you use in summer and winter?		1		Numeric field											
Lighting															
Division: Kitchen															
lamp type			1		glowing bulb	halogen	dichroic	FLC	FT8	FT5	LED				
number of lamps			1		Numeric field										
Daily operating hours			1		Numeric field										
Division: living room															
lamp type			1		glowing bulb	halogen	dichroic	FLC	FT8	FT5	LED				
number of lamps			1		Numeric field										
Daily operating hours			1		Numeric field										
Division: Rooms															
lamp type			1		glowing bulb	halogen	dichroic	FLC	FT8	FT5	LED				

number of lamps			1		Numeric field										
Daily operating hours			1		Numeric field										
Home appliances															
Do you have a washing machine?			1		Yes	No									
washing machine age			1		<1 year	1 year <age <10years	10 years< age<20 years	>20 years	Do not know / Prefer not to answer						
Do you have a tumble dryer?			1		Yes	No									
tumble dryer age			1		<1 year	1 year <age <10years	10 years< age<20 years	>20 years	Do not know / Prefer not to answer						
Do you have a dishwasher?			1		Yes	No									
age dishwasher			1		<1 year	1 year <age <10years	10 years< age<20 years	>20 years	Do not know / Prefer not to answer						
number of refrigerators			1		Numeric field										
refrigerator age			1		<1 year	1 year <age <10years	10 years< age<20 years	>20 years	Do not know / Prefer not to answer						
Number of freezers			1		Numeric field										
age of the freezer			1		<1 year	1 year <age <10years	10 years< age<20 years	>20 years	Do not know / Prefer not to answer						
Is the refrigerator away from heat sources?			1		Yes	No									

Space between the back of the fridge and the wall			1		Numeric field										
Do the fridge rubbers seal well?			1		Yes	No									
Do you have an oven?			1		Yes	No									
Does the oven have a light?			1		Yes	No									
pathologies															
Are there broken windows or window frames?			1		Yes	No									
Are the coatings degraded?			1		Yes	No									
Is there mold on the walls or ceiling?			1		Yes	No									
Are there cracks in the walls?			1		Yes	No									
Stand-by and ghost consumption															
Number of electronic equipment (routers, boxes, coffee machine, etc.)			1		Numeric field										
Check for consumption in stand by / phantom (or the existence of sockets with switch)	1		Yes	No											
Ventilation															
Check for gaps in glazed doors and openings			1		Yes	No									
Renewable energy															
Do you have any renewable energy production equipment?		1	1		photovoltaic	solar thermal	biomass	Other (which one?)	Do not know / Prefer not to answer						
Scheduling the visit															
Do you want to schedule a visit?		1			Yes	No									
Contact person name		1			open answer										
date to visit		1			date field										

time to visit		1			date field										
Household		1			open answer										
Location identification help		1			open answer										
Contacts - email		1			open answer										
Contacts - phone		1			open answer										
Impact assessment / monitoring															
Did you apply for any support since counseling?				1	Yes, which one?)	No	Do not know / Prefer not to answer								
Have you implemented any measures since counseling?				1	Yes, which one?)	No	Do not know / Prefer not to answer								
Were you surprised by the information about your energy consumption?			1	Yes	A little		No	Do not know / Prefer not to answer							
Were you surprised by the information about energy saving solutions?			1	Yes	A little		No	Do not know / Prefer not to answer							
After the home visit, what barriers remain?				1	Lack of time / other priorities	I cannot apply for support	Lack of information	Too much bureaucracy	financial limitations	too complex	No barriers persist	Do not know / Prefer not to answer			
Has your thermal comfort increased?				1	Yes	A little	No	Do not know / Prefer not to answer							
Have your energy costs decreased?				1	Yes	A little	No	Do not know / Prefer not to answer							