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The Traditions and Technologies of Ecological Construction in Portugal †

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Abstract: This paper identifies the main factors that shape energy poverty. Based on the analysis of statistical, regulatory documentation, as well as the state of the housing stock in Portugal, a number of new factors have been identified that are inherent in developed countries. The factors that shape energy poverty include the low energy efficiency of buildings, lack of access to energy-efficient sources, imperfect regulatory framework in the construction sector, and low level of public awareness of loans to cover energy-related needs. In view of this, it can be argued that energy poverty is not a problem of Third World countries only but is a global problem that will become even more acute as we move to clean and energy-efficient resources. To overcome the problems of energy poverty, the experience of Portugal was analysed. It was found that the practice of granting loans to reimburse the cost of energy purchases is not effective. Based on the analysis of government programmes and plans in Portugal, it was found that one of the most effective ways to overcome energy poverty is to ensure the energy certification of buildings. The incentive for the transition to certification is a set of state programmes on construction loans, allocation of funds for modernisation, etc. The identified factors and tools for stimulating energy efficiency improvement allow us to formulate a strategy for overcoming energy poverty, which includes energy certification of buildings, transition to more efficient and energy-saving heating means, lending to the population, and allocation of funds for modernisation.

Keywords: energy poverty; certification; energy carrier; modernisation

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1. Introduction

In Europe, energy poverty is a serious problem that leads to serious negative consequences for health, well-being, and social inclusion. The COVID-19 pandemic has further highlighted the importance of energy services in everyday life, as many people have spent much more time at home than before. Energy poverty should be understood as the lack of access to modern energy services [1]. However, the problem of energy poverty should not be considered in relation to the country's raw material potential, the level of energy resources, etc. Energy poverty is primarily explained by the level of modern energy services. In other words, a developed, modern society should strive to use safe and efficient energy supply systems.

Energy services are becoming increasingly important. It covers various aspects of life, such as work, education, entertainment, and a comfortable stay at home. We believe that the level of consumption and demand for energy services will continue to grow, which can be explained as follows:

- Many people have been forced to work from home, which has led to an increase in the consumption of electricity and other energy resources;
- Remote learning and online entertainment have become the norm, which has also increased the need for reliable and affordable energy services.

It is worth noting that energy poverty can affect people in different social categories, especially low-income groups, who may face difficulties in paying energy bills and maintaining comfortable conditions at home. This can lead to a deterioration in living conditions and negative impacts on health [2,3].

Before proceeding to the main material, the justification of the research objectives, it is worth analysing the view of the definition of "energy poverty". The term energy poverty first appeared in the early 1990s of the 20th century [3]. And at the initial stage, it was seen exclusively as the lack of sufficient capacity for heating and cooling homes. However, over time, views on this problem have changed. Today, energy poverty is a system of complex systemic inequalities. This inequality is explained by obstacles to the provision of modern energy at an affordable price. At the same time, this problem is difficult to measure because it is dynamic and changes depending on time and space. Today, it is a problem not only of a social dimension but also of a cultural dimension, as it determines the quality of life and must meet basic needs.

Even now, energy poverty is fundamental to improving quality of life and is the basis for economic development. Ensuring access to affordable, reliable, sustainable, and modern energy for all is one of the Sustainable Development Goals [4]. This issue is addressed not only by the governmental but also by supranational institutions and organisations [5–7].

Therefore, to combat energy poverty, it is important to develop policies aimed at ensuring access to efficient and affordable energy services for all segments of the population. Social support programmes and energy efficiency can help to reduce the burden on household budgets and provide more stable living conditions for people. It is a mistake to assume that environmental poverty is unique to the Third World. Given the problems of urbanisation, industrialisation, and the inadequacy of public policy to meet the needs of society, this problem exists in the European Union as well.

Given the global dimension of the problem, as well as the developed regulations [8,9] and practices [10,11], we understand how important it is to study the traditions and technologies of green building in the European Union [12–14]. This requires us to identify the key factors that contribute to the formation of energy poverty. The study of traditions and construction technologies (in the example of Portugal) will allow us to analyse existing approaches to overcoming energy poverty. This study will allow us to recommend the most reliable practices for the construction of houses, which will facilitate access to quality energy resources, which in turn will improve the quality of life. In addition, recommendations for construction will be developed. All of this together allows us to develop a strategy to overcome energy poverty.

2. Methodology

The research methods used were the analysis of reporting documentation on the use of energy types for heating buildings in the European Union [15–19]. We analysed Eurostat data on transport [20–23] and electricity supply to buildings in Portugal [24,25]. The analysis of this documentation allowed us to identify key indicators of energy poverty. Considerable attention was paid to the study of the living conditions of Portuguese residents, which allowed us to identify the types of energy sources used for domestic needs. In addition, we analysed the regulatory framework for construction certification. The results obtained allow us to assess the level of energy poverty, study the balance of energy resources, and formulate recommendations for improving living conditions in Portugal, as well as formulate recommendations on construction technologies that can be used not only in Portugal but also in the European Union.

We analysed the "Casa Eficiente 2020" [26], "The IFRRU 2020 Programme" [27], The National Energy and Climate Plan for the Period of 2021–2030 (PNEC 2030) [28], and The Plan for Recovery and Resilience (PRR 2021–2026) [29].

The final recommendations for overcoming energy poverty through the use of the latest building technologies are formed using the method of iteration and comparison. It is important to note that we aimed to propose strategies that can be implemented in the European Union.

3. Results

3.1. Identification of Key Indicators of Energy Poverty Based on the Analysis of the Use of Residential Energy Sources

In Portugal, the processes of industrialisation and urbanisation started with a certain delay, and public housing policy has not always been properly targeted. The shortage of housing in the second half of the 20th century led to an increase in illegal construction and self-builds, and the number of abandoned buildings increased, especially in Lisbon and Porto. Around the 1970s, around 40% of residential buildings in the country were unlicensed [30,31].

In order to make housing more affordable, a rent freeze was introduced during the Estado Novo dictatorship, but its extension had negative impacts, including a lack of investment by landlords, which led to a deterioration in housing quality. Compared to other European countries, where welfare policies have actively promoted the availability, affordability, and quality of housing, in Portugal, the requirements for thermal insulation of residential buildings began to be regulated by law only in the 1990s, and before that, the level of thermal insulation of the housing stock was much lower [32,33].

Due to the poor quality of construction of residential buildings, many households are in a difficult financial situation, which prevents them from carrying out repairs. Problems exist not only with keeping homes warm. According to Eurostat data for 2020, a quarter of Portugal's population (25.2%) lived in homes with leaks, dampness, or rot on windows or floors. The map below (Figure 1) shows that Portugal is one of the leading European countries in this area.

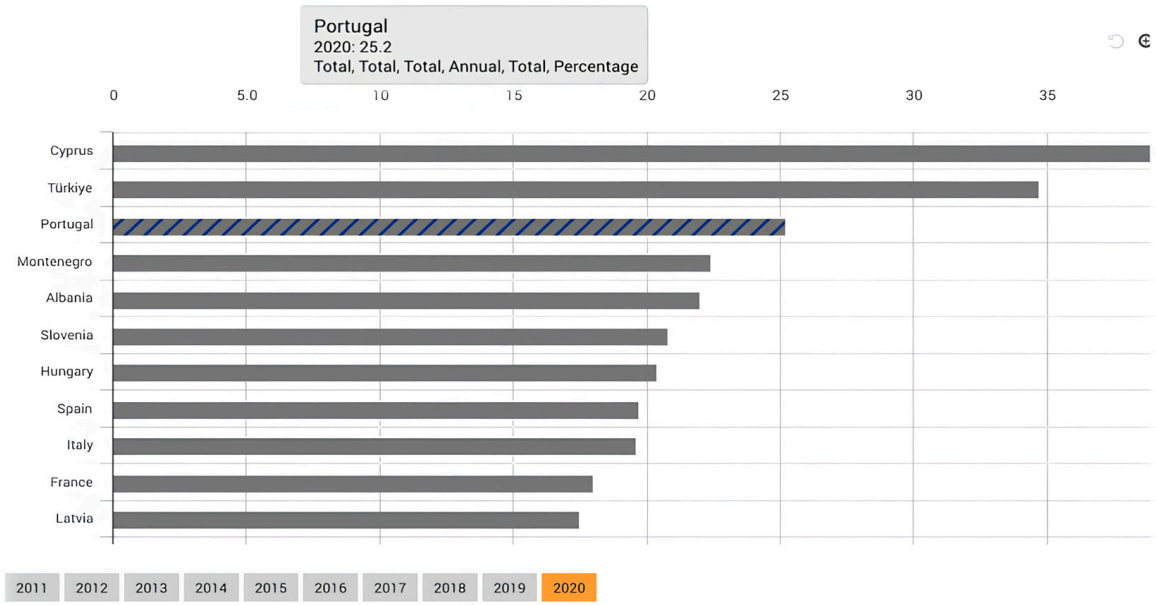

Figure 1. Information on unsatisfactory living conditions among the countries of the European Union.

In Portugal, it is common for houses to be built without heating systems or with only a fireplace, which is extremely inefficient as more than 80% of the heat produced is lost, and such a system requires considerable physical effort to maintain. This is an approach

to construction that is rarely seen in other European Union countries (with the exception of Malta and Spain), where almost all houses have central heating systems or other fixed systems.

In the EU, natural gas is the most commonly used fuel for home heating, but in Portugal, the majority of the population does not have this option. The gas distribution network covers only 34% of households in the country, and it is mostly located in large urban areas (Figure 2). The economically less developed segments of the population, in particular, still use bottled gas, which is more expensive than piped gas and is not sold at preferential tariffs.

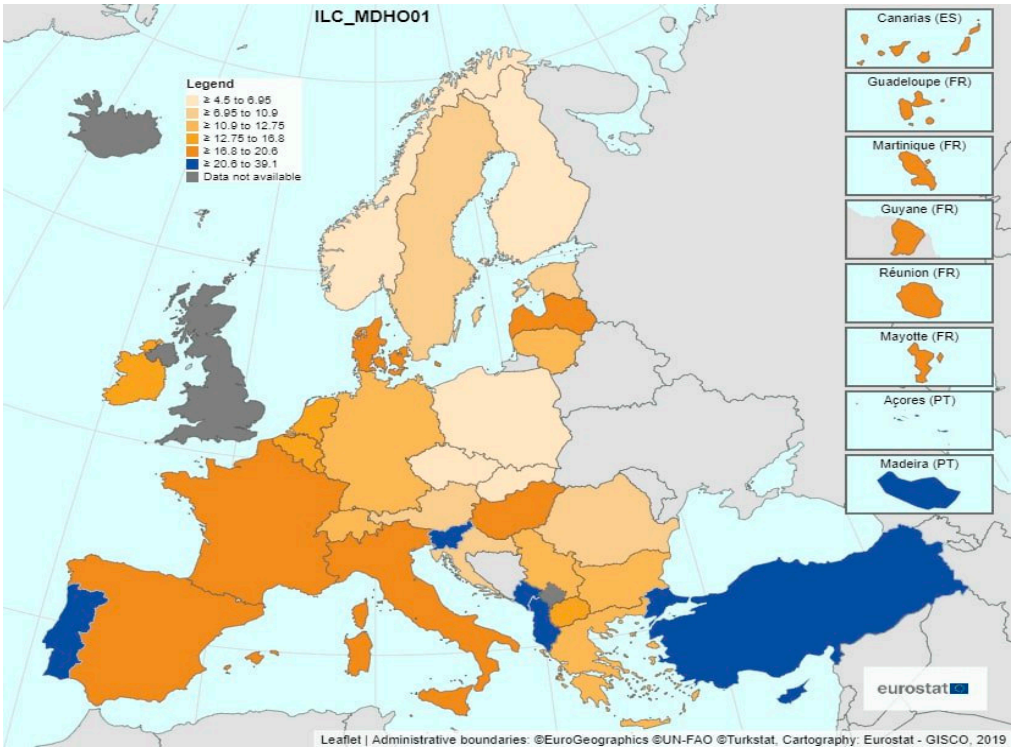

Figure 2. Access of the population to centralised gas distribution networks.

In the absence of stationary heating systems, a significant proportion of the population uses inexpensive portable electric heaters. Obviously, the low cost of such devices means that they are of limited efficiency and have high operating costs. Some people are concerned about high electricity bills and refuse to use heaters at all. In turn, low-income Portuguese, especially, use their electrical appliances until they stop working, even if their efficiency is already reduced, which is often the case with refrigerators, freezers, and televisions. When purchasing appliances, the poorest always prefer the cheapest models without considering future energy costs.

The use of electrical devices to combat the heat is handled with great caution. Despite the fact that since the mid-2000s, Portugal has been actively installing air conditioners in homes (pre-installation of this equipment in new buildings is required), they are still not a common solution among citizens, especially among the most economically vulnerable.

According to Eurostat data for 2021 [34], compared to other EU countries, Portugal was ranked second from the bottom in terms of the share of energy used by households to heat their homes (30.8%). For comparison, the highest rate was observed at that time in Luxembourg (80.3%).

In recent years, electricity prices for households in Portugal have been among the highest in the European Union. According to Eurostat, in the second half of 2018, Portugal ranked first in terms of electricity prices for households and was also among the leaders in

gas prices (when comparing prices at purchasing power parity). At that time, taxes and fees included in electricity bills in Portugal accounted for 55% of the total cost.

The liberalisation of the energy market and the ongoing reforms in the sector have led to a more complex situation in the supply of energy, as the number of energy suppliers has increased and the contractual terms and conditions and differences between distribution networks and suppliers have become more diverse. As a result, this situation has created uncertainty and vulnerability, especially among the most vulnerable segments of the population.

These factors contribute to the identification of key indicators of energy poverty.

1. A significant proportion of the Portuguese population (18.9% or 1.9 million people) has limited ability to ensure an adequate level of heat in their homes;
2. Approximately 752,956 households (1.9 million people) benefited from preferential electricity tariffs;
3. Approximately 34,709 households (87,000 people) benefited from preferential gas tariffs;
4. About 1,202,567 households (3 million people) face energy costs that account for 10% or more of their income;
5. The energy efficiency of residential buildings is relatively low, with 69.6% of all dwellings in Portugal classified as C or below;
6. Approximately 4.3 per cent of the population (440,000 people) is in arrears for utilities.

3.2. Analysis of the Practice of Applying State Policy to Cover Energy Costs

Based on the definition of energy poverty, analysis of selected key indicators, and comparison with social assistance and income information, it is estimated that between 1.9 and 3 million people in Portugal are in energy poverty, based on their housing conditions and the ratio of income to energy consumption.

In 2010, as part of the National Energy Strategy, a special preferential tariff for electricity was introduced (under Decree Law 128-A/2010), and the following year, in 2011, a preferential tariff for natural gas was also introduced (under Decree Law 101/2011). These preferential tariffs are aimed at helping the most economically vulnerable segments of the population. The preferential electricity tariff is available to citizens who receive various social benefits and whose total annual income does not exceed EUR 5808. However, access to the preferential tariff for natural gas is more limited, and there are still no preferential tariffs for bottled gas. Amid the pandemic crisis, in 2020, social tariffs for electricity and natural gas became available to all unemployed people.

According to data for 2020, the percentage of households that benefited from the preferential electricity tariff was approximately 14% of the total number of households, while for the social tariff for natural gas, this figure was 2% of the total number of households that consumed natural gas. The dynamics of the number of people receiving preferential tariffs are shown in the above graph (Figure 3).

While measures taken to support a large number of citizens in covering their energy costs are important, they do not address the root causes of energy poverty.

3.3. Study the Effectiveness of Introducing Energy Certification of Buildings to Overcome Energy Poverty

In 2020, Portugal adopted the National Energy and Climate Plan for the period 2021–2030 (PNEC 2030) [28]. The plan aims to develop a long-term strategy to combat energy poverty, including programmes to promote energy efficiency and the integration of renewable energy sources.

In March 2021, a set of measures aimed at combating energy poverty was included in the Recovery and Resilience Plan (PRR 2021–2026). In particular, it was decided to allocate 100,000 cheques as direct assistance to the most vulnerable families to improve their energy supply in residential buildings. These and other measures and policies were later developed and expanded as part of the National Long-Term Strategy for Combating

Energy Poverty for the period 2021–2050. This strategy foresees, among other things, the allocation of at least EUR 300 million for measures to improve the energy efficiency of residential buildings.

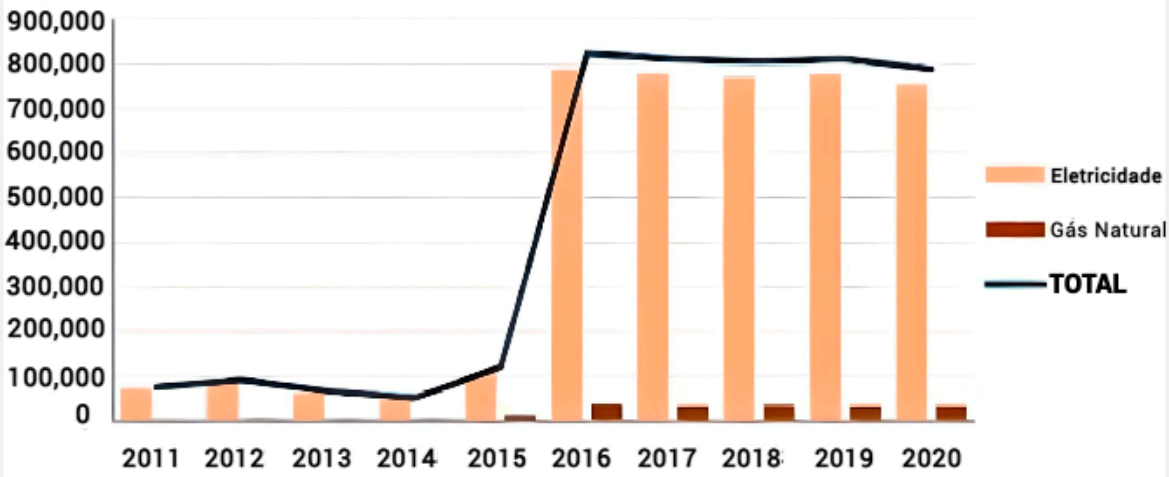

Figure 3. Dynamics of population distribution by types of resources that benefited from preferential tariffs.

In 1990, Portugal first established requirements for assessing the thermal insulation of residential buildings and preventing overheating. In 2006, the Energy Certification System for Buildings (SCE) was approved, which allows for the assessment of the energy efficiency of buildings based on an eight-step scale (from A+, very efficient, to F, very inefficient) and provides owners with up-to-date information on the impact of this classification on comfort, health, and energy consumption. Each building's energy class and energy efficiency, including the contribution of renewable energy sources, corresponds to a specific colour in the figure. They are presented in comparison to a reference value and are calculated under standard conditions. The energy performance rating is an indicator of the overall efficiency of a building. The higher the rating, the higher the energy efficiency and the lower the operating costs. The same scale is used to determine the environmental impact of a building.

Between 2014 and 2020, approximately 1.3 million energy certificates were issued, but only 12.3% of residential buildings were classified as very efficient (A and A+). Approximately 70% of certified residential buildings have an efficiency class of C or lower, as shown in the chart (Figure 4).

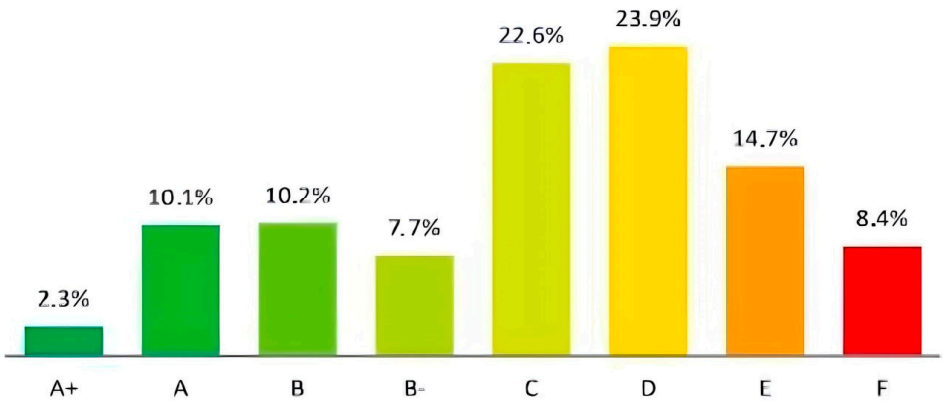

Figure 4. Distribution of residential dwellings in Portugal by energy efficiency level (based on SCE assessment) where A+ corresponds to the difference between the calculated specific heat losses and the maximum permissible value of A+ 0–25%; A 26–50%; B 51–75%; B- 76–100%; C 101–150%; D 151–200%; E 201–250%; F more than 251%.

Based on the analysis of energy certificates, it can be concluded that the national housing stock does not provide all its residents with adequate living conditions, such as proper heat, sound insulation, and indoor air quality.

Much of the housing stock is outdated and in need of repair. The issue of improving the energy efficiency of buildings during such repairs remains open and requires careful consideration.

It is mandatory to obtain an energy certificate in these cases:

1. New buildings under construction;
2. Secondary real estate subject to major repairs, i.e., repairs where the total cost of works is more than 25% of the total cost of the building based on the average construction cost published annually;
3. Real estate for sale or lease;
4. Buildings that are subject to financing programmes if energy certification is required for the implementation of the programmes;
5. Owners of buildings who are eligible for tax benefits if energy certification is required to obtain these benefits.

To obtain an energy certificate, it is enough to contact one of the many organisations that provide such services, such as SCE. You need to prepare a package of documents and ensure that experts have access to the premises. Once the experts have assessed the building, you should wait for their decision and obtain an energy certificate. It is worth noting that energy efficiency certificates have validity periods that depend on the purpose of the building.

4. Discussion

Based on an analysis of the Portuguese housing stock and government policies in the building and energy sectors, it was found that a significant proportion of Portuguese households (18.9%) have limited capacity to meet their energy needs. This is due not so much to low income but mainly to the low level of energy efficiency of buildings (70%). This problem has arisen due to a number of circumstances that are factors in the formation of energy poverty:

1. The state is lagging behind in the development of the regulatory framework in the form of construction requirements. This provoked unsatisfactory quality of housing sanitary and hygienic conditions in part of the Portuguese population (25.2%). By this indicator, Portugal is one of the leaders in the European Union. Based on this, it can be assumed that the delay of the country's leadership and lack of attention to construction requirements is one of the factors behind the formation of energy poverty;
2. The low energy efficiency of buildings and imperfect heating systems. The example of Portugal shows that more than 80% of dwellings use fireplaces as a source of heating. These are rather imperfect heating systems. In addition, portable electric heaters, which have low energy efficiency, are used as an alternative to centralised heating. This can be explained not only by the lack of resources on the part of the population but also by the lack of access to more economically advantageous resources, such as natural gas;
3. Ineffective state policy in the area of combating energy poverty. This is reflected in the fact that a part of the population does not use the right to loans to cover energy costs.

Thus, we have identified the factors that contribute to energy poverty, which is expressed not only in terms of access to resources but also in terms of access to more efficient heating, electricity, etc. One of the most important triggers is government policy. It is the state that sets the requirements for construction, which subsequently affects the condition of buildings and energy efficiency. This allowed us to further analyse the existing regulatory framework in Portugal and establish that the key to overcoming energy poverty is the introduction of energy certification in the form of energy certificates.

An energy certificate (Figure 5) provides a number of benefits to the property owner. First, a building with a higher energy class becomes a competitive advantage in the real estate market. In addition, a certificate can help to attract financing at more favourable rates or to benefit from IMI or IMT property tax exemptions.

Figure 5. Sample energy certificate.

A variety of tools are available to property owners to support the implementation of the measures specified in the energy certificate. Using these tools, financing or incentives can be obtained to improve and renovate the property.

The Casa Eficiente 2020 programme provides concessional loans for activities aimed at improving the environmental performance of private residential buildings, in particular, in the areas of energy efficiency, water conservation, and municipal waste management. Renovations can cover both interior and exterior works of the building. The programme is open to owners of residential buildings, their sections, and related condominiums, and buildings can be located in any region of the country.

The IFRRU 2020 programme is designed to invest in urban renewal and energy efficiency across the country. This instrument promotes the comprehensive rehabilitation of buildings, including multi-apartment and private houses over 30 years old or younger, but with a low level of conservation (2 or less according to the criteria set out in Decree-Law no. 266-B/2012 of 31 December).

Real estate tax incentives (IMI) allow municipalities to set a reduction of up to 25% of the municipal real estate tax rate for energy-efficient urban buildings for certain years. These incentives apply if the buildings have an energy class A or show improvements two levels higher than before.

Real estate transfer tax (IMT) exemptions provide tax relief for the purchase of property intended for renovation if the relevant renovation work is started within three years of the purchase date and other conditions are met.

The use of these tools allows for sustainable improvements in energy efficiency and is an important step in the fight against energy poverty and the promotion of environmental sustainability in real estate.

5. Conclusions

This paper is a comprehensive study that addresses one of the most important issues—overcoming energy poverty. Based on the data of leading organisations (Eurostat, reports on energy certification in Portugal, etc.), we have identified a number of factors that shape energy poverty. These factors include an imperfect regulatory framework for construction, which causes buildings to not meet sanitary, hygienic, and ergonomic requirements; public awareness of the possibilities of reimbursement of energy costs; and the cost of energy and the efficiency of their use for domestic needs. The low level of the energy efficiency of buildings, as well as the population's access to quality energy, are also worth noting. All of this shows that energy poverty is not a problem for the Third World alone but is a global issue that will become even more acute as we move towards clean and energy-efficient resources.

To overcome the problems of energy poverty, the experience of Portugal was analysed. It was found that the practice of granting loans to reimburse energy costs is not effective. This is due to the lack of awareness of the population about the possibilities, as well as the unsatisfactory condition of the housing stock.

An analysis of Portugal's regulatory documents and government programmes has shown that energy certification of buildings is a prerequisite for overcoming energy poverty. The transition to energy efficiency is stimulated by a set of government programmes on construction loans, allocation of funds for modernisation, etc.

A study of the factors that shape energy poverty, as well as an analysis of state policy in the field of green building technologies, can offer a deeper understanding of the problem.

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