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Research article

Toward an enhanced policy and action framework to address energy poverty in the Iberian Peninsula: An exploratory analysis

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ABSTRACT

Portugal and Spain share a historical and territorial bond and a severe challenge to alleviate energy poverty, a complex issue affecting millions of people. Reducing this social scourge is a major concern for both governments, which have published national energy poverty strategies in recent years.

This paper critically explores the Iberian policy frameworks to provide insights into prioritising and enhancing energy poverty actions. This comparative analysis focuses on national plans' and critically evaluates the existing and planned policy measures. Additionally, it analyses the potential stakeholder networks that might contribute to mitigating energy poverty.

Findings show good practices to be fostered but shortcomings in policy reach and the impact of some programs. An automatic cash transfer covering all necessitated energy services might be a valid solution for both countries to mitigate energy vulnerability in the short run. In the medium-long term, an *ad hoc*, easy-to-apply-to, energy efficiency subsidy program might boost the structural improvement of vulnerable households' well-being and financial situations. On the planning side, the Iberian national energy poverty strategies have been grounded on similar key action pillars, but their policy proposals lack detailed funding estimates and associated time frames, and do not include ex-ante impact evaluations. These countries can benefit from cross-exchange of good practices and, with the help of the identified stakeholders, reinforce the implementation of their energy poverty policy plans.

The policy recommendations and identified strengths and weaknesses presented in this paper are informative for Iberian decision-makers and other EU Member States, contributing insights on how to enhance and prioritise energy poverty actions.

1. Introduction

Defined as the inability to afford essential energy services [1], energy poverty (EP) affects over 69 million people in Europe - 9.3 % of the population (EU-SILC). The joint European efforts to address this issue started with the EU internal electricity market regulation.

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Abbreviations

2M – "High share of energy expenditure in income" indicator
ADENE – Portuguese national energy agency
AEMET - Spanish State Meteorological Agency
Census - Population and Housing Census
CNMC - Spanish National Markets and Competition Commission
CORs - Spanish reference last resort retailers
DGEG – Portuguese Directorate General for Energy and Geology
EC - European Commission
EP - Energy poverty
EPAH - Energy Poverty Advisory Hub
EPOV - EU Energy Poverty Observatory
ERSE – Portuguese Energy Services Regulatory Authority
ERSE - Portuguese National Energy Services Regulator
EU – European Union
Eurostat - Statistical office of the European Union
HBS - Household Budget Survey
IDAE – Spanish Energy Agency
INE-ES - Spanish National Institute of Statistics
INE-PT – Portuguese National Institute of Statistics
IPMA – Portuguese Institute for Sea and Atmosphere
LNSEPM – Portuguese Long-term National Strategy for Energy Poverty Mitigation
LPG - Liquefied petroleum gas
LTRS - Long-term Renovation Strategies
M/2 – "Low absolute energy expenditure" indicator
MITECO – Ministry for the Ecological Transition and the Demographic Challenge
MS - Member States
MVS – Minimum Vital Supply
NCEP - National Energy and Climate Plans
NEMO - Nominated Electricity Market Operator
OMIE – Spanish electricity market operator
PPS - Purchasing power standard
RDL - Royal Decree-Law
SILC - Survey on Income and Living Conditions
SNSEP Spanish National Strategy against Energy Poverty
VAT - Value added tax
VC – Vulnerable consumer

The EU Directive 2009/72/EC required that Member States (MS) define the 'concept of vulnerable customers and take measures to protect these customers and ensure they have the necessary energy supply in critical times'. More recently, the regulation (EU) 2018/1999 appointed several obligations for the MS' Integrated National Energy and Climate Plans (NECP), such as assessing the number of households in EP and setting reduction goals. Other policies, such as the directive (EU) 2018/844 on the energy performance of buildings (EPBD, and the approved 2024 recast), the Energy Efficiency Directive (EED), the Fit for 55 legislative package, or strategies such as the European Green Deal or the Renovation Wave, restate the urgent need for alleviating EP across the EU. In 2020, the EU Commission published the first document entirely focused on EP, a recommendation document providing the Member States with guidelines for addressing EP [2]. Simultaneously, it proposed the establishment of a Social Climate Fund to mitigate the potential regressive impacts of the climate plans [3]. Finally, in 2023, the EP recommendation was updated [4]. This 'update' included the promotion of just and equal access of all households to renewable energies by implementing energy-sharing schemes (e.g. energy communities), and the engagement and empowerment of vulnerable households and all relevant stakeholders.

At the MS level, different degrees of recognition and policy implementation of EP mitigation can be observed. Some Member States have proposed and agreed definitions, estimated the number of sufferers, defined monitoring indicators, and proposed measures to address it, while others fail even to define it [5–7]. Only a few have developed dedicated national strategies for EP mitigation; hence, progress has been slow and sparse. On the other hand, the EU institutions have made efforts to improve knowledge and partnerships in EP research and action: the Energy Poverty Observatory (EPOV, 2016–2020), ENGAGER Cost action (2017–2021), several Horizon and LIFE calls projects and the Energy Poverty Advisory Hub (EPAH), among others. The last one is the EU's 2021–2024 official EP support entity, which continues the work of EPOV as a knowledge platform, building bridges between stakeholders and Member States, with the primary goal of providing direct support, training, and information to local authorities and civil society organisations for promoting actions to tackle EP. EPAH also aims to establish a sounder connection between research and local policy practice [8],

proposing an improved set of metrics for the EU and overall better measurement at all scales [9,9].

Large and complex challenges such as EP require multi-actor cooperation at regional, national and international scales. In this sense, common causes and manifestations of this issue can be spotted in neighbouring Member States such as Portugal and Spain. Sharing the Iberian Peninsula, these countries have a long-lasting historical bond, defined by geography and marked by shared achievements and hardships. EP is a significant problem, affecting the population of these two nations, both in the winter and summer seasons, sharing similar challenges regarding the drivers and effects of the problem. Both countries are among the few in the EU that have adopted an EP national strategy [10]. Moreover, they share similar socio-economic, climatic and infrastructural characteristics and significantly integrate energy systems. Additionally, the Portuguese and Spanish governments currently have a diverse understanding of this issue and an elaborated regulatory framework to address EP, which justifies the need for a comparative analysis. Several studies have analysed EP in Portugal and Spain from a national, regional, and local perspective, and the governments of both countries have proposed strategies and policies to address this issue.

Previous studies compared efforts in different countries, for instance, Spain with other Mediterranean countries, e.g. Cyprus [11], or focused on the EP policies and measures in different Member States, including both Iberian countries [12]. Others have compared EP in other European countries by unpacking related topics such as EP politics, problems and policy [13,14]. Several other publications have generically analysed and compared efforts to address EP in European countries, e.g. Refs. [14–16]. The last mentioned study summarises the commonalities and differences observed among 9 Member States and the UK, regarding how energy poverty is defined, monitored and tackled. The authors found that there is a lot of disconnect between what is happening at the EU level and what is being done in the countries.

More recently, Sunderland (2024) [17] presented a navigation toolkit to support effective national implementation of the new EU provisions on EP across four key directives: Electricity Market Design Directive, EPBD, EED and the Social Climate Fund regulation. In particular, this report analyses four aspects of the above-mentioned directives: Definition of energy poverty and national policy priority; Protections; Representation of affected groups and consultation for effective policymaking; Funding, support and safeguards. In the same year, the ODYSEE-MURE project conducted a comparison analysis of measures implemented by the EU and national MS policymakers to address EP [18]. This publication concludes that energy consumption subsidies (broadly spread among EU countries) 'should be combined with structural measures of greater impact, emphasising energy efficiency as highlighted in Recommendation (EU) 2023/2407'. At a national level, Mahoney et al. [19] reveal the existence of several unsolved competing agendas within the Portuguese carbon neutrality policies and suggest promoting decarbonisation policies that incorporate EP and rely strongly on citizen participation. Stojilovska et al. [20] went even further by critically reviewing the intersection of climate change and energy poverty approaches from a social policy perspective. That study concludes that addressing energy poverty in an environmentally-conscious manner requires better integration of social perspectives to overcome current technical biases, recognition of the characteristics and needs of people living in energy poverty, and holistic governance approaches, particularly involving the health and housing sectors.

One of the main conclusions of these studies indicates that collaborative and holistic action to address EP in EU Member States is both feasible and beneficial. Combining efforts can enhance the potential for impact and the effectiveness of the response to this social issue. Nevertheless, none of the previous studies have conducted a critical and comprehensive comparative analysis of the context, actors and policies from an EP action perspective Such an analysis could be beneficial for eventually grounding an enhanced policy framework for addressing EP in different Member States.

This paper aims to fill this gap by critically analysing the EP policy framework in the Iberian countries. The goal is to unpack, strengthen and prioritise the different actions against this social issue in Portugal and Spain. Therefore, this work explores two of the three relevant cornerstones in EP mitigation [21,22], as suggested by Ref. [23]: 'Planning and Implementation' and 'Public and Private Participation'. It, therefore, discusses the similarities, differences, and potential learnings regarding the policy and action arenas from both contexts to pave the way for an enhanced Iberian approach.

Following this exploratory analysis, this paper aims to unpack two key research queries for each of the abovementioned EP action cornerstones.

a) **Planning and Implementation:** *What are the strengths and the weaknesses of existing and planned policies in the Iberian Peninsula? What lessons can be learnt to help policymakers improve the policy framework?*
b) **Public and Private Participation***: Who are the key stakeholders in the Iberian Peninsula? What is or could be their role in EP mitigation?*

This study employs a conceptual framework that integrates the analysis of EP strategy development and execution with stakeholder engagement. The framework facilitates a comprehensive examination of the EP landscape by identifying and grouping stakeholders based on their roles and influence and positioning them within a power-interest matrix. On the other hand, this approach allows for a detailed evaluation of existing and planned policies, highlighting strengths and weaknesses, and extracting lessons to inform future policy development. Additionally, it emphasizes the importance of stakeholder collaboration, assessing their contributions and interactions to enhance the overall effectiveness of EP mitigation efforts in Portugal and Spain.

This article is based on research work started during the PhD exchange period of Dr. Roberto Barrella at NOVA University of Lisbon in 2022. Thus, the PhD thesis of Barrella [24] laid the foundation of this study. Moreover, this article is a follow-up paper for a prior study by the same authors [10].

The remainder of the article is organised as follows. Section 2 presents the methodological approach to unpack the abovementioned research queries. Section 3 shows the results obtained from the exploratory analysis of the Iberian frameworks. Section 4 highlights the key conclusions and emerging policy recommendations.

2. Methodology

According to the relevant literature on the topic, e.g. Ref. [25], it is necessary to design and implement EP policies and strategies integrating mitigation and structural measures. The mitigation policies are intended as short-term actions that financially support vulnerable households in paying their energy bills or avoiding supply disconnection in their homes. The structural measures are medium-long-term solutions that promote knowledge/awareness of energy use and improvement of energy efficiency in dwellings.

Therefore, mainly focusing on the national strategies for combating EP in the two countries, this paper analyses and compares the planned and current mitigation and structural policies. Then, the public and private participation aspect examines the composition and impact of the stakeholder ecosystem by analysing their efforts to reduce EP in the two countries.

This section presents the methodological approach applied to carry out the exploratory analysis of these distinct aspects that comprise the approach to tackling EP in Portugal and Spain. Therefore, the investigation focuses on two main elements: policy planning and implementation, and stakeholder engagement (Section 2.1), thus comparing and contrasting countries' approaches and identifying strengths and weaknesses. Taking the insights from this analysis, Section 2.2 describes the method used to address the research queries outlined in Section 1. This section also investigates ways to enhance the policy frameworks for tackling EP in the Iberian Peninsula. This process aims to identify a possible set of shared policy priorities and stakeholders.

2.1. Planning, implementation and involved stakeholders

Dedicated energy poverty strategies are the most direct policy instruments to address EP. These plans also generally mirror the underpinnings of other relevant plans such as the NECPs and the Long-term renovation strategies (LTRS). Thus, the planning analysis of this paper focuses on unpacking the national strategies combating EP in the two countries. It analyses and compares the main policy proposals regarding improving existing structural and mitigation measures and planning new ones.

The comparative analysis of the national EP strategies' policy proposals considers the following characteristics: (a) type; (b) main proposed measures; (c) goals/specific actions, (d) responsible entities; (e) beneficiaries, (f) funding, (g) predicted impact/target; (h) timespan; (i) achievement level. The '(a) type' classification focuses on four policy groups: financial interventions (energy consumption subsidies); consumer protection (disconnection safeguards); energy efficiency (building energy retrofitting); energy and EP literacy (information provision & raising awareness).

Moreover, the measures and programs already implemented in the two countries, either mitigation or structural ones, are analysed according to the following parameters: Criteria for defining beneficiaries; Application process; Benefit and mode of delivery; and Financing. The analysis focuses on energy consumption subsidies (mitigation) and energy efficiency programmes (structural). The latter are also classified according to the type of action: (1) Energy saving support; (2) Aid for the renovation of the thermal enclosure; (3) Aid for the replacement of equipment; (4) Information Provision on energy efficiency. Additionally, the 'EP policy gap' is calculated for the energy consumption subsidies by applying Eq. (1), i.e., by estimating the relative difference between the number of beneficiaries of these measures at the end of the year and the number of energy-poor households in the country estimated for the same year according to the inability to keep home warm indicator.[1] If the number of beneficiary households is equal to or higher than the number of energy-poor households, the EP policy gap is set to 0 %. It should be noted that this indicator is intended to quantify the grade of coverage of the social tariffs among people in EP. In other words, it is plausible for an individual or a household to benefit from these energy consumption subsidies while remaining in energy poverty. In this sense, the effectiveness of these policies in reducing EP was already analysed in previous studies [26].

$$\text{EP policy gap} = (\text{Number of energy poor households} - \text{Number of beneficiary households}) \,/\, \text{Number of energy poor households} \quad (1)$$

The 'bill coverage ratio' is also computed for this kind of subsidies, representing the percentage of the energy bill (before charges and taxes) supported by the allowance.

On the other hand, aiming to objectively compare the potential impact of energy efficiency programs implemented in the analysed countries, two indexes are estimated according to Eqs. (2) and (3) (proposed in Ref. [24])[2]:

$$\text{Non recoverable funds ratio} = \text{Non repayable financing} \,/\, \text{Total investment} \quad (2)$$

$$\text{Additional fund ratio} = (\text{Vulnerable household's benefit} - \text{Non vulnerable household's benefit}) \,/\, \text{Non vulnerable household's benefit} \quad (3)$$

In Eq. (3), the 'benefit' refers to the average amount of the aid. In a particular case, if the energy efficiency program is intended only for vulnerable households (Non-vulnerable household's benefit = 0), the *additional* fund *ratio* is set as 100 %.

Finally, the group of actors (or stakeholder ecosystem) involved in undertaking efforts to reduce EP in Portugal and Spain are described and assessed, to identify good practices and shortcomings regarding their EP action. The stakeholders are identified, and

[1] The number of people reporting being unable to keep an adequate temperature in their homes was converted to a number of households by dividing by the average household size in Spain [70] and Portugal (2021 Census).

[2] In the case of vulnerable households or in the general case, if there is no difference.

their involvement, power, and participation levels are assessed and discussed based on Mendelow's framework [27]. Thus, we applied Mendelow's Power-Interest Matrix [28], which classifies stakeholders according to their ability to affect and influence a determined outcome or system, related to their resources, control and decision-making authority (Power) and their will, interest and concern (Interest) regarding the same outcome or system, determined by their involvement and extent of the outcome's impact in their activity. We apply this rationale to the overarching goal of energy poverty mitigation. In order to differentiate a diverse set of stakeholders, we attribute a numerical classification (0–5) representing the level of power and interest of each stakeholder, where 0 represents no power/interest and 5 represents the highest level of power/interest within the stakeholder's existing ecosystem. This is a relative classification among the stakeholders based on an authors' expert approach with literature support. The assessment of Power pertains to the necessary means, ability, resources and infrastructure to implement broad policy or direct action that shapes energy demand (e.g. buildings' quality, equipment efficiency), energy provision and access (in its different dimensions of production, distribution and retail), including the economic capability of consumers. This power can be defined by law in the case of public entities or simply by the ownership of means of production, knowledge, and lobby influence in the case of private organisations. The Interest reflects the perceived prioritisation of energy poverty mitigation by the stakeholders according to their views expressed in discourse, activities, participation in projects, and dedicated time and resources attributed to energy poverty reduction, as well as potential conflicts with other priorities. This classification and selection of stakeholders was supported by evidence in the literature [19,29,30], EP legislation [31–33] or initiatives and projects [34,35].

2.2. Exploring priority actions for enhancing the Iberian EP policy frameworks

After analysing the differences and commonalities in approaches to EP in Spain and Portugal, the next step aims to assess the two EP action cornerstones and the related queries identified in Section 1 as follows.

a) **Planning and Implementation:** *What are the strengths and weaknesses of existing and planned policies in the Iberian Peninsula? What lessons can be learnt to help policymakers improve the policy framework?*

These queries were addressed by researching Iberian effective and viable solutions for planning and implementing mitigation and structural measures in both countries. Regarding energy consumption subsidies and energy efficiency programs, good practices have been selected for defining the key parameters (such as allocation criteria, the application process, benefits, and financing) to be considered for a potential set of 'Iberian priority measures' while also considering their respective applicability in both national legislative frameworks. Next, the key pillars of the two EP national strategies were compared in terms of policy planning. Moreover, analogous priority areas, similarities and differences between the specific proposed measures were identified and unpacked to establish whether it was possible to develop an enhanced planning approach from the lessons learnt in the two contexts.

b) **Public and Private Participation***: Who are the key stakeholders in the Iberian Peninsula? What is or could be their role in EP mitigation?*

These questions were addressed by critically comparing and identifying the key stakeholders that may be suitable to form a network to lead or support the implementation of actions against EP in the two countries. This analysis focused on which entities might have the power and interest to cooperate with the central governments and other public and private stakeholders to boost the design and implementation of the abovementioned measures.

3. Results and discussion

This section provides a comprehensive exploration of the EP policy and action frameworks in Portugal and Spain, structured into several key subsections.

1. **Setting the Scene of the Iberian Peninsula:** This subsection outlines the socio-economic, climatic, and infrastructural characteristics of Portugal and Spain, highlighting the common challenges and vulnerabilities related to EP in both countries.
2. Planning, actions and stakeholders addressing energy poverty
   - 2.1. **Current Mitigation Measures in the Iberian Peninsula:** Here, we analyse the existing short-term policies aimed at supporting vulnerable households, such as social tariffs and supply disconnection safeguards. The effectiveness, coverage, and limitations of these measures are discussed.
   - 2.2. **Current Structural Measures in the Iberian Peninsula:** This part examines medium-to long-term solutions, including energy efficiency programs and other building retrofitting initiatives. We evaluate the design and implementation of these structural measures.
   - 2.3. **Policy Proposals of the National Strategies:** We compare the national strategies of Portugal and Spain, focusing on their proposed policies, goals, and implementation plans. This subsection identifies strengths, gaps, and areas for improvement in the strategic approaches of both countries.
   - 2.4. **Public and Private Participation:** This subsection assesses the roles and contributions of various stakeholders, including government bodies, NGOs, energy companies, academic institutions, and local communities. We explore the dynamics of stakeholder collaboration and its relevance to EP mitigation.

3. **Prioritising Iberian Actions to Address Energy Poverty:** Based on the findings from the previous subsections, we propose actionable recommendations to enhance EP policies and stakeholder engagement. This includes best practices, innovative solutions, and strategies for effective implementation.

3.1. Setting the scene of the Iberian Peninsula

Similar features can be identified by analysing the key characteristics that define the climate and population in both countries and portray contributing factors to EP vulnerability. Table 1 compares the Portuguese and Spanish data (mostly up to2021[3]) on key parameters for climate, sociodemographic issues, building stock and energy use in the residential sector. The 'worst value' between the two countries is set in bold.

Portugal and Spain are among the warmest countries in the EU, with, respectively, the sixth and fourth highest average number of cooling degree days – CCD – between 1979 and 2021 and the third and fifth lowest average heating degree-days – HDD (see Table 1 – [36]). Spain has higher climate variability and a more significant percentage of arid areas, with cold winters and hot summers. In Portugal, the most severe climate zones (higher energy needs) are the inland regions in the northeast (for winter) and southeast (for summer), which are also some of the less densely populated areas. The regional and national HDD and CDD shown in Table 1 quantitatively represent these climate characteristics.

Both populations have a considerable share of elderly people, over 20 %, which is superior to the percentage of the younger population (under 15 %), this is an indicator of an ageing society and population decline in the medium term. This might lead to increased EP vulnerability, considering that this demographic group often has more significant requirements for thermal comfort and experience poorer health conditions and financial difficulties due to low pensions and higher monthly costs (potentially due to the costs of medication). Purchasing power is slightly lower in Portugal, but income inequality and the risk-of-poverty rate are more significant in Spain, suggesting potentially higher financial vulnerability in Spanish households.

In terms of the dwelling stock, in Spain, the rate of homeownership is higher, about 9 % more than in Portugal. Building energy performance regulations were implemented almost 10 years later in Portugal, and a higher percentage of buildings were built before the regulation was implemented, 15 % more. This indicates a less energy-efficient building stock in Portugal and greater difficulty for households to implement measures to reduce thermal discomfort.

Regarding energy access and affordability, both countries had high PPS electricity and natural gas prices in 2021. However, the situation is more difficult for electricity consumers in Spain and gas consumers in Portugal. Furthermore, there is a higher number of households with contracts in the regulated market in Spain (around 40 %) than in Portugal (around 14 %), and in Spain, the regulated electricity price changes hourly unlike in Portugal where it remains unchanged for months, which, in the Spanish case, can exacerbate vulnerability to energy price hikes. Electricity use in the domestic sector is similar in both countries, around 41 % and 43 % of the final energy consumption respectively for Portugal and Spain. Natural gas, heating gasoil and LPG represent 23 % of consumption in Portugal [37], mainly for DHW and cooking, while in Spain, about 37 % comes from these fossil fuel products (LPG, 6 %, heating gasoil, 10 %, and natural gas, 21 %), mainly for DHW or space heating [38,39]. Final consumption in both countries still considerably depends on fossil fuels, with Spain recording the highest percentage.

Portuguese consumers generally have a higher tax burden associated with energy consumption. However, electricity consumption is taxed at a lower rate than gas. It is also lower than the tax rate on electricity consumption in Spain. Gas still represents a no negligible part of consumption in Portugal, and the higher tax burdens can mean that these consumers are at higher vulnerability risk.

The EU-SILC indicators showcase the potential vulnerability of the population to EP. Both countries have higher 2004–2020 average rates of 'inability to keep home adequately warm' and 'dwelling with deteriorating elements' than the EU-27 average. The same is observed for the year 2021 (reference year – see footnote 3). Among the Iberian countries, Portugal has been in significantly more serious condition, with a 2004–2020 average value of over 26.9 % for the former indicator (8.7 % in Spain) and 23.9 % for the latter, compared to 16.9 % in Spain. In 2021, the Portuguese 'Inadequate temperature' indicator decreased to 16.4 %, which is nonetheless still concerning. These results may be explained by the poor energy performance of the Portuguese building stock compared to the Spanish one (Table 1), and its potential impact on the thermal comfort of occupants. Regarding the arrears on utility bills indicator, both countries have reported relatively low average values compared to the more concerning trend of inadequate temperatures, although Spain registered an increase in 2020 to 9.6 % and remained at 9.5 % in 2021, higher than the average EU value, and a slightly higher average value between 2004 and 2020, 6.8 %, versus the 5.8 % reported in Portugal. The low Portuguese rates can be linked to the automatic attribution of social tariffs to vulnerable consumers (VC), resulting in many households benefitting from this support to reduce bills (see Section 3.2.1).

Fig. 1 shows the most recent values of the 2M, M/2 indicators[4], the inability to keep home warm ('Inadequate temperature'), 'Arrears on utility bills' and the population living in a dwelling with a leaking roof, damp walls, floors or foundation, or rot in window frames or floor ('presence of leak, damp, rot') in Portugal and Spain. These are based on [9,40], a calculation carried out by the authors using 2022 Portuguese HBS data, and the EU-SILC 2023.

Fig. 1 reveals that poor housing quality is problematic in both Portugal and Spain where, respectively, almost one-third and a quarter of the population live in dwellings with the presence of leaks, dampness or rot in windows. Moreover, both countries

[3] 2022 and 2023 data were available for some of these indicators, but 2021 was considered a better reference, given the more marked conjunctural effects of the energy crisis in 2022 and 2023 [26,71].

Table 1
Portuguese and Spanish key parameters on climate, sociodemographic issues, building stock and energy use in the residential sector (2021).

General Indicators	Portugal	Spain
HDD (1979–2021)	Regional values: 313.7–2220.4 (National avg.: 1239)	Regional values: 17.6–2689.3 (National avg.: **1883**)
CDD (1979–2021)	Regional values: 3.8–386.5 (National avg.: 182)	Regional values: 5–501.8 (National avg.: **200**)
Elderly population (%)	**23.4**	20.0
Children under 16 (%)	12.9	**14.0**
Adjusted gross disposable income per capita (PPS)	**19,315**	20,504
GINI Index (%)	**33**	32.1
Risk-of-poverty rate (%)	18.4	**20.0**
Dwelling ownership (%)	**70.0**	78.9 (2011)
Buildings from before the 1st regulation on energy performance (%)	**65.5**	54.6 (2011)
Electricity prices for households (PPS)	0.2451	**0.2512**
Gas prices for households (PPS)	**0.0894**	0.0736
Share of electricity in final energy consumption (%)	39.0	43.0
Share of electricity in domestic final energy consumption (%)	23.0	27.0
Consumers in the regulated market (%)	14.6	40.0

experienced the highest rates in the EU of people living in uncomfortably cold homes during winter (20.8 %). On the other hand, 15.2 % (Portugal) and 16.8 % (Spain) of households have disproportionate energy expenditures according to the 2M. Finally, under-spending (M/2) is a more severe issue in Portugal than in Spain, while arrears on utility bills are worse in the latter country.

In Spain, the publication of the first national report on EP in 2012 [41] sparked interest in the issue. Since then, NGOs, associations and the general population have raised awareness of this social issue. In the same period, regulatory activity has been intense - the Spanish Government have proposed aids to support both electricity and thermal energy services, i.e., a social electricity tariff (*Bono social eléctrico*), which has been subjected to frequent reforms between 2017 and 2021, and a Thermal Social Allowance (*Bono social térmico*), which was introduced in 2018. In addition, since 2019, Spain has had an EP roadmap for the coming years through the National Strategy against Energy Poverty 2019–2024 (SNSEP) [31]. This strategic plan sets the policy framework for this social issue in Spain, as pointed out in Section 3.2.3.

Concerning other key EP-related policy plans, the LTRS, which is the national roadmap for decarbonising and improving the efficiency of buildings, identifies energy efficiency measures that address EP. This strategy aims to contribute to the Spanish National Energy and Climate Plan 2021–2030 (SNECP), which, among many other strategic objectives, is committed to the energy retrofitting of the existing building stock. Both roadmaps include a special mention of EP households, which translates into a specific action plan in the case of the LTRS.

In Portugal, although a generally unknown concept for the general population, awareness of EP has steadily grown in the last decade in the policy arena and the news media. The decree-laws transposing the directives of the Third Energy Package on the internal EU energy market introduced the definition of vulnerable energy consumers in Portuguese legislation. They were followed by the implementation of the electricity and natural gas social energy tariffs in 2010 and 2011. The goal of reducing EP is articulated in key energy policy strategies such as the National Energy and Climate Plan (NECP) 2030, the Roadmap for Carbon Neutrality for 2050, and the Portuguese LTRS. The NECP sets EP reduction as a line of action to achieve a clean, democratic, and fair energy transition, proposing specific measures for improved vulnerable consumer (VC) protection, policy design, monitoring, and information

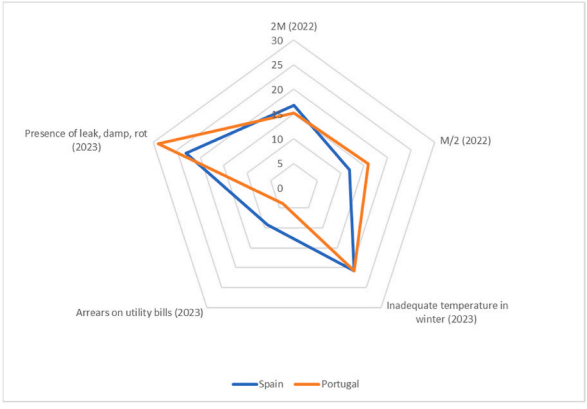

Fig. 1. *Last available official EU data on five selected EP-related indicators (Source:* [9,40]*, own calculation based on 2022 Portuguese HBS data, and Eurostat EU-SILC 2023).*

dissemination. The LTRS defines EP mitigation as an action axis, proposing specific policies to achieve this goal and aligning them with the NECP.

The Long-term National Strategy for Energy Poverty Mitigation (LNSEPM) 2023–2050 was approved by the Portuguese Government in November 2023. The policy proposals of this strategy are analysed in depth in Section 3.2.3.

3.1.1. Iberian electricity and gas markets

In 2007, the Spanish and Portuguese governments created the Iberian Electricity Market to improve coordination and interconnection among all organised and unorganised markets, within the framework of constructing a European internal market in electricity. The active role of this internal market has recently been demonstrated, as the two countries jointly designed and negotiated a mechanism with the EC to decouple gas prices from the Iberian Electricity Market, denoted as 'the Iberian Exception'. There is also an organised Iberian natural gas market to guarantee liquidity and competitiveness in this region. It is based on daily and intra-daily negotiating sessions in auctions or a continuous market.

Regarding the retail market, in Portugal, the National Energy Services Regulator (ERSE) defines the prices annually for all the tariffs and maximum profit related to the energy supplier activities. These activities pertain to the transport, distribution, and logistics of both the regulated and liberalised markets. The energy and commercialisation tariffs are also defined for the regulated market agents, while liberalised market agents define their own. Consumers in Portugal pay 6 % VAT for the fixed terms related to the natural gas volume and contracted electricity power, respectively, under 10,000 m^3 and equal to or under 3.45 kVA. From 2025, the VAT for electricity consumption will be 6 % (down from 13 %) of consumption up to 200 kWh for consumers with a contracted power equal to or lower than 6.9 kVA, while additional consumptions will be taxed at the 23 % rate. Natural gas and LPG consumption is taxed at 23 % regardless of consumption levels. In the second semester of 2021, taxes and levies represented 46.4 % and 26.7 % of the electricity and natural gas prices for the lower consumption band [42,43]. In Portugal 85.7 % of domestic consumers (5.4 million people) are liberalised market clients for electricity and 76.9 % for natural gas [44,45].

In Spain, the National Markets and Competition Commission (CNMC) supervises the electricity, natural gas and renewable energy markets. Concerning the electricity market, they monitor the functioning and degree of competition in both the wholesale and retail markets, as well as the operation of the system. Moreover, the CNMC determines the access tolls, while the Government defines the electric charges. On the other hand, the energy tariffs in the regulated and free market are determined by, respectively, the NEMO, i.e., the Nominated Electricity Market Operator (OMIE in Spain), and by the free-market energy utilities. According to the CNMC, in October 2021, around 60 % of electricity consumers had a fixed-price supply contract in the free market, which allowed them to maintain the agreed prices until the review date of their contracts. In contrast, 40 % of consumers had contracts indexed to the spot market price or on the regulated market tariff. Regarding the taxes, consumers in Spain paid 21 % VAT for electricity consumption during the 1st semester of 2021. VAT for natural gas was also 21 %. In the second semester of 2021, taxes and levies were 41.6 % and 21.2 % of the electricity and natural gas prices for the lower consumption band [42,43].

3.2. Planning, actions and stakeholders addressing energy poverty

The following sections describe and compare the current mitigation and structural measures implemented in Spain and Portugal (Sections 3.2.1 and 3.2.2) and the policy proposals and plans of the respective National Strategies against EP (Section 3.2.3), most of them framed in the EU legislation introduced in Section 1. Finally, Section 3.2.4 assesses the power and interest of the key stakeholders in addressing EP in the two countries.

3.2.1. Current mitigation measures in the Iberian Peninsula

Currently, Spain has two different energy consumption subsidies for vulnerable consumers. The first is the social tariff for electricity (*Bono social eléctrico*, Royal Decree-Law – RDLs – 897/2017 and 15/2018), which is a discount on the electricity bill that depends on socio-economical features of the beneficiary cohabitation unit, who must apply to one of the reference last resort retailers (CORs) to receive it. On the other hand, the 'Thermal social allowance' (TSA, *Bono social térmico* – RDL 15/2018*)* is an energy cheque for thermal uses (heating, DHW and cooking). The beneficiaries are the same as the social electricity tariff (around 1.6 million consumers at the end of 2023), and the payment depends on the severity of the winter in the relevant climate zone and the state budget available. Currently, the social electricity tariff is financed by all the companies involved in the electricity supply, and the application is submitted and managed by the CORs. On the other hand, the TSA is funded by the State and managed by the regional administration.

Regarding the disconnection safeguards, the Spanish Government protects VCs benefitting from the social tariffs and consumers identified as essential by Law 24/2013. For the former, the cut-off prohibition is increased by 2 months (4 months in total) with respect to general consumers (RDL 897/2017). Moreover, the RDL 17/2021 introduced the so-called Minimum Vital Supply (MVS) for these consumers, setting the maximum power at 3.5 kW for six months in addition to the four months stipulated in RDL 897/2017. On the other hand, there is additional protection for consumers identified as essential/priority? for whom a permanent electricity supply disconnection ban is set by Law 24/2013.

In Portugal, the social tariffs consist of a discount on the households' tariff for access to low-voltage electricity networks and/or low-pressure natural gas grids. Around 760k households benefit from the electricity social tariff and around 50k received the natural gas tariff support measure in 2024 (DGEG, 2024). The beneficiaries of both tariffs are identified and attributed funding automatically based on social welfare system data (ADENE, 2019).

Normally, there is no disconnection-safeguard for domestic consumers in Portugal. Energy providers can disconnect consumers upon lack of payment, provided they send a written warning at least 20 days before the predicted date for the disconnection.

Table 2 compares the characteristics of the energy consumption subsidies in the two countries[4] (according to the items proposed in Section 2.1).

Regarding the criteria to qualify as a beneficiary of the social tariffs, both countries have adopted a socio-economic approach, thus assigning the subsidies to the consumers who are recognised as economically disadvantaged. However, the application process is very different. In Spain, the VC needs to apply through the CORs with a considerable amount of paperwork. At the same time, Portugal applies an automatic attribution method. Regarding benefits and financial supports, the Spanish *Bono social eléctrico* is characterised by the same features as the Portuguese *Tarifa Social de Energia, i.e.* they are both transfers in kind financed by the energy companies. On the other hand, the Spanish *Bono social térmico* is a cash transfer paid by the State.

The 'Bill coverage ratio' of the mitigation policies analysed is very similar between the two countries, except for the *Bono social térmico*, which has a value of approximately half of the other policies. Besides, the results indicate that the Portuguese *Tarifa Social de Energia - Eletricidade* do not have an 'EP policy gap', while *Tarifa Social de Energia - Gás Natural* has the highest gap. This is because the gas one is only for natural gas consumers (who are much less than the electricity ones – Section 3.2) who benefit from some social support. On the other hand, according to our calculation, in 2023, Spanish mitigation measures support only 40 % of households with inadequate temperatures during winter. Moreover, this figure didn't change significantly between 2021 and 2023 (EP policy gap from 54.7 % to 60.1 %) because the share of households in EP has been increasing almost equally to the share of social tariffs' beneficiaries. On the other hand, the Portuguese gap has been null since the introduction of the social tariff automatisation.

Analysing the current mitigation policies in Spain, some shortcomings can be pointed out. Firstly, neither of the social allowances reaches everyone in a situation of energy vulnerability. The *Tarifa Social de Energia – Eletricidade* has an apparently null EP policy gap, but we cannot conclude that it reaches all energy-poor households[5] because all the Iberian energy consumption subsidies are not ideally targeting energy-vulnerability [48]. However, we can say that it better reaches economically vulnerable households than the other ones. Secondly, the consumption limits for the *Bono social eléctrico* introduced are inadequate in some cases. Moreover, regarding the *Bono social térmico*, the budget earmarked by the State has been determined as insufficient [26]. Additionally, some regional governments face serious administrative problems in managing the latter scheme allocation [49]. The deficiencies in the amount and effectiveness of the Spanish social tariffs have been analysed in several studies, e.g., Refs. [26,50], which are also supported by the NGOs' experience [51].

Regarding the Portuguese case study, Martins et al. [52] estimate a 0.5 %–3 % percentage point reduction in the share of income on energy costs due to social tariffs for a set of household scenarios. In most cases, although reducing energy costs, the social tariffs do not considerably relieve households of their energy burden. One of the main shortcomings of the social tariffs is the complete reliance on economic criteria to determine the eligibility of beneficiaries, disregarding other types of vulnerability that might cause EP. Despite recognition in official definitions that households that are not in economic vulnerability may still be in EP, such cases are excluded from the Portuguese social tariff.

Another shortcoming of only applying economic criteria is that such a low-income cap may leave out population groups in less severe economic hardship. Moreover, it can be argued that this approach excludes consumers relying on LPG. Attribution is also easier for electricity consumers. For natural gas, the income standard is not enough for eligibility, and the consumer must necessarily be a beneficiary of some social support [53]. On the other hand, the possibility of attribution according solely to income data from the financial authorities can also result in the wrong attribution of the social electricity tariff to people who declare low income but own other financial assets, land, propriety, or undeclared earnings, hence not being in economic vulnerability.

3.2.2. Current structural measures in the Iberian Peninsula

The regulatory framework that guides the implementation and promotion of energy efficiency in Spain is set out in the RDL 390/2021. This RDL transposed the Directive 2018/844 into Spanish law, regarding registration of energy performance certificates (EPCs).

Along the same lines, in October 2021, the RDL 19/2021 was approved. This RDL implements some of the measures proposed in the 2020 update of the Spanish LTRS in the context of the Recovery, Transformation and Resilience Plan, and develops the European instrument Next Generation EU. In the same month (October 2021), the RDL 853/2021 regulated the aid programmes for residential refurbishment and social housing under the same plan.

In Portugal, the Decree-Law n.° 101-D/2020 transposed Directive 2018/844 and partially the Directive (UE) 2019/944, establishing the applicable requirements for the energy performance improvement of buildings and regulating the energy performance certification system, setting the ground rules for any energy efficiency program or action. Furthermore, aiming to incentivise decentralised renewable energy sources, the Portuguese government approved Decree-law 162/2019, setting a new regulation for energy communities to develop a legal framework and facilitate the implementation of these organisations, with potential benefits for EP reduction.

Table A 1 and Table A 2 show the key features of the Spanish and Portuguese programs implemented, focusing on those where critical data were available.

[4] The table shows the *Bill coverage ratio* of the social tariffs before the introduction of the energy crisis' emergency measures in 2021 to focus on the permanent nature of these subsidies. For instance, Portugal didn't change its discounts and the Spanish electricity social tariff discounts in no-emergency times will be reintroduced in 2025.

[5] Also, converting the number of people reporting to be unable to keep an adequate temperature in their homes to the number of households can result in some EP policy gap misestimation, as it is assumed that people benefitting from the social tariff and people reporting to be in thermal discomfort have the same household size.

Table 2
Characteristics of the energy consumption subsidies in Portugal and Spain.

	Criteria for beneficiaries	Application process	Benefit and delivery mode	Financing	EP policy gap (2023)	Bill coverage ratio
Bono social eléctrico (ES)	-Regulated market-Socio-economic (income, household composition)	Through the CORs	Transfer in kind: Discount on electricity bill according to category	All parties operating in the power sector	60.1 %	32.3 %[a]
Bono social térmico (ES)	Same as the *Bono social eléctrico*	'Direct' allocation to the beneficiaries of the *Bono social eléctrico* at the end of the previous year	Transfer in cash: Bank transfer, depending on climate zone and category	General State Budget	60.1 %	18.5 %[b]
Tarifa Social de Energia - Eletricidade (PT)	Beneficiaries of social support schemes or have an annual income lower than 5.808 euros	Automatic attribution	Transfer in kind: Discount on electricity bills	Power producers	0 %	33.8 % [46]
Tarifa Social de Energia - Gás Natural (PT)	Beneficiaries of social support schemes	Automatic attribution	Transfer in kind: Discount on natural gas bills	The domestic non-beneficiaries	89.2 %	31.2 % [47]

[a] Before the RDL 23/2021 and considering the different discounts according to the category. These are the discounts in no-emergency times that will be reintroduced in 2025.
[b] Calculated according to the methodology presented in Ref. [26].

These tables show that Portugal and Spain have implemented several programmes to boost energy efficiency in the residential sector, which have supported key types of energy-efficiency-related measures, ranging from aids for thermal enclosure renovation to improving information for citizens. However, looking at the techno-economic characteristics of these policies, some specific differences and similarities can be pointed out. Regarding the requirements, both countries have been proposing technical and ownership requirements for most of their programmes. However, regarding social aspects, Spain did not propose a specific scheme for vulnerable households. At the same time, Portugal introduced the *Vale Eficiência*, which is specifically designed for people with social energy tariffs. The Spanish programmes are led by its Autonomous Communities (regions – NUTS2), while the Portuguese programmes are implemented through the central administration, although in the second phase of *Vale Eficiência l*ocal governments and energy agencies have a facilitator role, in identifying the eligible citizens and helping with the application. As for the funding and benefits, in Spain, the financing of these programmes comes from different administration levels (EU, national, regional and local), while in Portugal, it stems from European and national levels. In Spain, all the energy efficiency intervention schemes are mainly "non-refundable" subsidies, while the Portuguese programmes use a mix of subsidies and loans.

Moreover, in the former case, the amount of funding almost always depends on the technical results of the retrofitting. It introduces extra coverage according to social criteria (for VCs, low-income and disabled people). This somewhat fills the gap of not having a specific programme for vulnerable households. Looking at the performance factors, in the Spanish case, the *non-recoverable* fund*'s ratio* ranges from 40 % to 73 %, as the average value in each programme. On the other hand, in Portugal, most programmes are designed to cover the whole investment costs with a subsidy, except for one of the subsidies and the loan-based schemes, which require a payback. Regarding the prioritisation of vulnerable households, while the Portuguese Government adopted specific measures such as the *Vale Eficiencia* for this group (*additional* fund *ratio = 100 %),* others do not include any advantage for them (*additional* fund *ratio = 0 %)*. The Spanish central administration (only) included social criteria that raise the subsidy amount for VCs in policies targeted at the general population, thus implementing programs with an *additional* fund *ratio* that ranges from 18 % to 80 %.

3.2.3. *Policy proposals of the national strategies*

The Portuguese and Spanish governments have developed their EP strategies in recent years.[6] Table 3 shows a picture of the main policy contributions made by the two national strategies, referring to the proposals outlined in these plans rather than their actual implementation. This table is based on the approved documents of the LNSEPM and SNSEP. The diagnosis approach of these plans was analysed in previous studies, such as [10], and it is out of the scope of this paper.

As shown in Table 3, both countries have proposed new or enhanced EP policies. Only the Spanish government, however, has previously analysed the advantages and shortcomings of the current policies. Moreover, neither country conducted an ex-ante evaluation of the proposed measures, and only Portugal outlined a preliminary financial and operational plan, although very generic, to implement them. Finally, both the Portuguese and Spanish governments consulted national stakeholders while drafting their strategies, and they proposed and designed a monitoring plan.

Fig. 2 shows an overview of the public actions and policies analysed and proposed in the SNSEP, which addresses mitigation and structural measures and proposes a package of four actions to enhance the EP policy response.

Regarding mitigation measures, Action II proposes replacing the social electricity tariff and the TSA with a unique energy allowance that would be automatic, 'universal' (valid for all energy carriers and uses), and cooperative (among the different

[6] The SNSEP was published in 2019, while the Portuguese one was published in 2023.

Table 3
Contributions made by the EP national strategies of the Portuguese (LNSEPM) and Spanish (SNSEP) governments – checkmark: proposed; X symbol: Not proposed.

Contribution	Portugal	Spain
Establishing a link with other policies	✓	✓
Critical review of current existing policies: advantages and shortcomings	✗	✓
Proposal of mitigation policies	✓	✓
Proposal of structural policies	✓	✓
Ex-ante impact evaluation of proposed policies	✗	✗
Financial and operational plans to implement measures and achieve targets	✓	✗
Outlines monitoring plan	✓	✓
Stakeholder consultation	✓	✓

administration levels). Regarding the safeguard against the disconnection of vulnerable households, the SNSEP proposed establishing a Minimum Vital Supply that would be maintained temporarily, avoiding the total disconnection of the electricity supply. Moreover, Action IV suggests improving energy regulations by incorporating the perspective of energy-poor households in public policy Concerning structural measures, Action III proposes energy efficiency interventions for three timeframes: (1) Short-term measures, low-cost 'express' energy retrofitting of housing; (2) Medium-term measures, including a broader replacement of household equipment and the promotion of public social housing stock; (3) Long-term measures, for a 'Deep Building Retrofitting'. All the suggested energy efficiency measures would require the design of ad-hoc financing schemes for vulnerable households. On the other hand, Action IV recommends improving consumer information levels and 'energy education' by implementing several mechanisms. The implementation of the measures proposed by the SNSEP between 2019 (starting date) and 2021 was critically analysed in a report published by the ECODES foundation [51], whose authors pointed out that only 58 % of these measures have been designed and applied to vulnerable households.

The Portuguese strategy addresses the following priority axes: 1) Housing Energy and Environmental Sustainability; 2) Universal Access to essential energy services; 3) Promote Integrated territorial action; and 4) Knowledge and informed action. The action framework proposed in the LNSEPM set out to: improve energy performance and decarbonise consumption in domestic buildings, increase energy affordability, protect vulnerable consumers, improve identification and monitorisation, boost efforts at the local scale, and promote innovation and training. Under the first axis, the strategy promotes new (loans) and existing financing schemes (like *Vale Eficiência*) for building envelope renovation, the integration of renewable energy systems, water heating, space heating and replacement of cooling and cooking equipment. It also plans to implement VAT reductions for materials and works for the same actions and energy consumed during cooking, namely the use of electric stoves and ovens, and biomass fuels such as pellets. It proposes tax reductions for surplus electricity sales and reducing bureaucracy for implementing energy communities.

For the second axis, the LNSEPM commits to sustaining the social tariff support, financial support for the purchase of LPG bottles, and reducing VAT and grid access tax for vulnerable consumers in energy poverty, as well as to providing non-refundable subsidies for individual and collective renewable energy production and consumption, including new support for the implementation of new energy communities. It also aims to implement mechanisms to stop energy cuts at critical times and assure minimal energy service levels to vulnerable consumers in energy poverty. Regarding the territorial action axis, the strategy outlines the creation of energy support spaces for citizens and training to technical enablers and promotes climate action municipal plans and housing charters. Training for municipal technicians and public contracting programs will also be conducted to increase municipalities' involvement in energy communities. Municipal and state housing renovation and construction via non-refundable subsidies will also be fostered. Finally, the strategy proposes strengthening knowledge, information and visibility. It aims to develop knowledge on the connection between energy poverty, income, comfort, health, social inclusion and hidden energy poverty, while involving the social and health sectors. It will promote literacy in several groups by integrating this topic into school curriculums, producing training sessions, materials, and campaigns to target groups, and improving the content and interconnectedness of existing information platforms. It also plans to propose mechanisms to incentivise social and technological innovation, data intelligence, new products and services, and new financing mechanisms based on the energy, social and health sectors. Finally, it will create training courses to improve professional capacity in this field.

Fig. 2, Table A 3 and Table A 4 present the main features of the four macro policy groups proposed by the EP strategies of Portugal and Spain. Regarding financial interventions, both countries propose social tariff schemes. However, the Spanish strategy proposes a

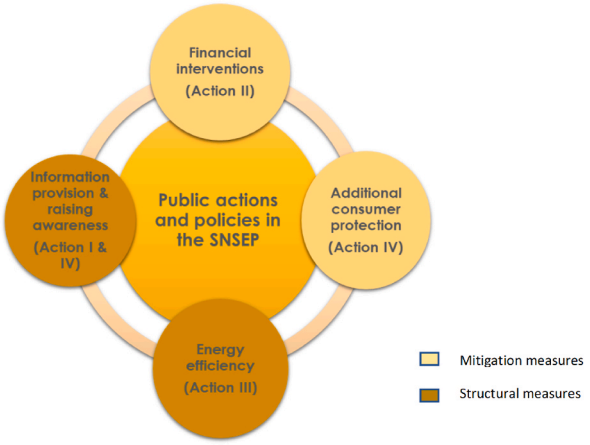

Fig. 2. Overview of the public actions and policies analysed in the SNSEP (Own elaboration from SNSEP).

significant revision - replacing the current subsidies with a new unique energy cheque. Both strategies propose a disconnection safeguard to protect consumers from extreme events and to provide energy at critical times. Regarding permanent protections for consumers, both governments proposed measures to establish a protection network (including health agents) and guarantee minimum energy service levels for VCs. However, the Spanish strategy is more definitive on the latter point and proposes the introduction of an MVS.

Regarding energy efficiency and RES actions, only the Portuguese Government focuses on including the energy poor in energy communities through non-refundable financing and tax waivers. On the other hand, a wide range of measures to improve the energy quality of vulnerable homes' is proposed by both strategies, establishing a solid connection with the LTRS. Both strategies promote building envelope retrofit and equipment replacement. The Portuguese strategy proposes renovation of the building stock and electrification of heating through HVAC equipment replacement, via non-refundable funding and new lending instruments, which have shown poor levels of impact and are arguably inadequate for energy-poor households. In fact, the Portuguese strategy proposes several energy efficiency measures that are not designed or directly targeted to this group and which may hinder effectiveness. The LNSEPM also promotes the electrification of kitchen appliances and incentivises biomass use via tax reductions, extending the current policy scope regarding the decarbonisation of energy uses. On the other hand, the SNSEP analyses three categories of energy efficiency actions according to the timespan and type and proposes different kinds of subsidies, as shown in Fig. 3.

The Portuguese strategy focuses on improving data collection and integration between different sources. It aims to strengthen existing surveys and develop new statistics and indicators to deepen the knowledge of EP and improve accuracy in identifying and targeting the energy poor, for a broader and more integrated perspective of the problem, concerning other critical basic needs and vulnerabilities. There is a growing effort to involve health agents in EP detection in both strategies. Both strategies place emphasis and responsibility on local governments as agents of EP mitigation and local projects in innovative environments to tackle hard-to-reach regional vulnerabilities.

The energy and EP literacy measures proposed by the two governments also have more similarities than differences. The LNSEPM promotes energy literacy in schools and empowers students to become agents of change while creating training sessions and campaigns targeted at consumers in severe energy poverty or at risk of exclusion, as well as the general population. The SNSEP proposed actions that target the general population or people in EP. The LNSEPM also places considerable focus on promoting an innovation ecosystem towards the development of more projects, services and financing schemes, while fostering training among the professionals of the energy sector.

The most significant differences between the two strategies (shown in the fourth and the last two columns of Table A 3 and Table A 4) are the approaches to the designation of responsible entities, timespans and achievement levels. The Portuguese strategy does not define any entity as responsible for the proposed actions, while the Spanish strategy spreads responsibility among several public bodies. The timespan was not defined in Portugal, while Spain only set the implementation and not the completion year for most targets. Furthermore, the Portuguese government outlines measures which have already been implemented while the new measures have not yet been legislated, as the strategy has only recently been approved. On the other hand, the Spanish strategy has made significant progress in implementing half of the identified measures.

3.2.4. Public and private participation: who are the relevant EP stakeholders?

The stakeholder ecosystems in Portugal and Spain are composed of entities that have various levels of impact and participation in addressing EP, forming connections and dynamics that result in synergies or antagonisms that should be cross-analysed and compared. As mentioned in section 2.1, following [27], Figs. 4 and 5 rank the main EP stakeholders, respectively, in Portugal [19,32], and Spain [29,31,54] according to the level of power they have to mitigate this social issue and their interest in doing so.

These figures show the stakeholders identified and classified as follows: Government bodies (Central Government and Parliament -

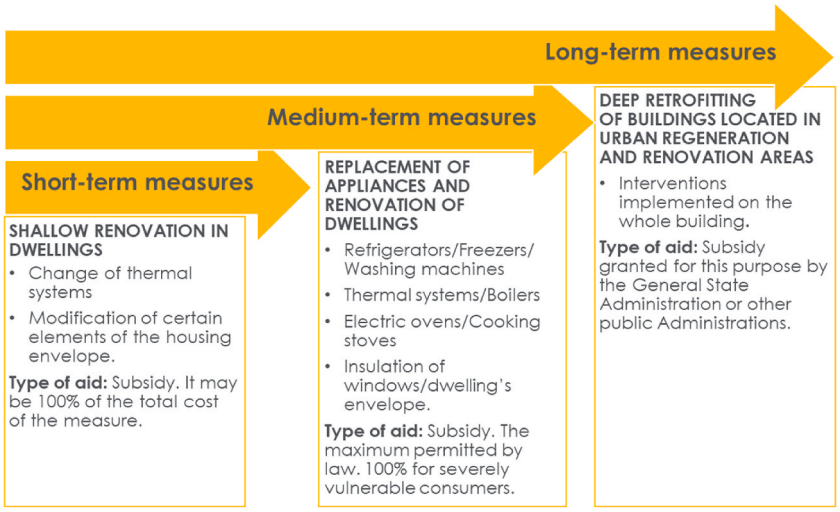

Fig. 3. Categories of energy efficiency actions proposed by the SNSEP.

policy-makers), NGOs (implementers and advocates), Energy companies (service providers and implementers), Academia (researchers and advisors), National and regional energy agencies (technical support and data providers), Local governments (local implementers), Energy market regulators and operators (market oversight, regulation and coordination), Justice/Judicial sector (Judicial authorities and Ombudsmen - safeguards), and Media (awareness-raisers).

In both Iberian countries, the central administration is the most relevant stakeholder due to their power to implement strategies, policies and programs that impact the whole population, allocating public funds and distributing responsibilities to other public and private entities. However, this key role in Spain is partially shared with regional/local administrations and the National Energy Agency, the latter being the leader of many actions proposed in the SNSEP. Moreover, in both Iberian countries, the national energy agency has access to relevant data to study EP, promotes national projects [55] and participates in European initiatives on the topic, focusing on knowledge production and awareness raising. It has a supporting role to the government(s), helping manage national programs and data sources, and even the National Energy Poverty Observatory, in the case of Portugal. Finally, some regional energy agencies have developed analyses and surveys to study the problem and have participated in European and national projects, often in collaboration with academia.

Portuguese and Spanish local governments can contribute more significantly, but action has been limited to occasional initiatives and regulatory action in a few regions**.** The Portuguese strategy is evident in its intention to push for a higher level of influence from local governments and entities in the country.

Furthermore, both the Iberian parliaments have the important role of raising political awareness of the issue, proposing solutions

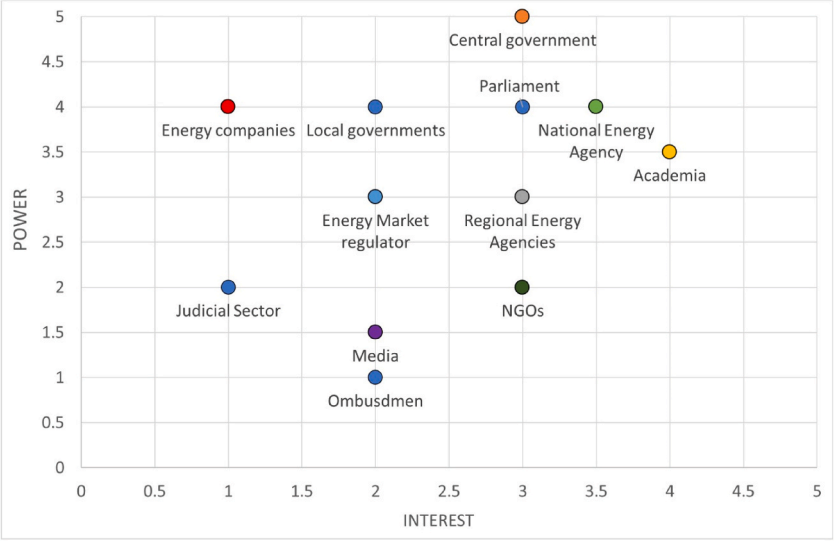

Fig. 4. Main EP stakeholders in Portugal according to their power in mitigating this problem and their interest in efforts for it.

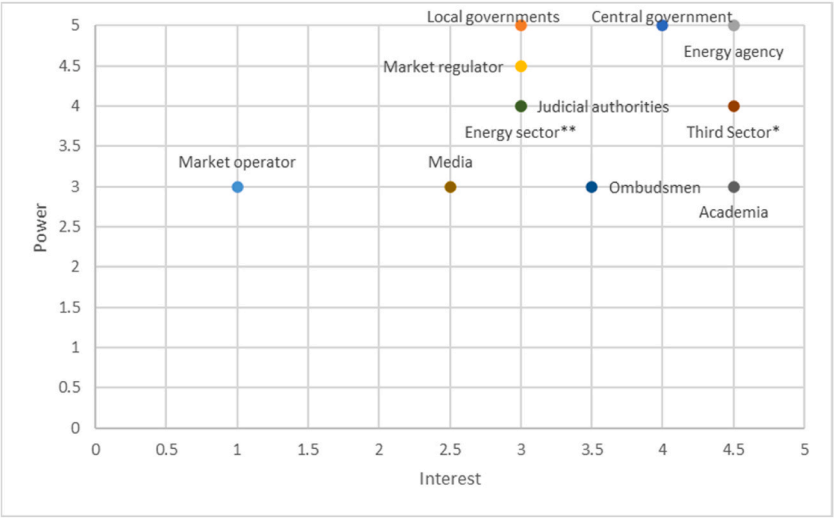

Fig. 5. Main EP stakeholders in Spain according to their power in mitigating this problem and their interest in efforts for it.

and pushing for concrete actions. Energy market regulators also have a role in mitigating EP, regulating the energy providers, providing helpful information on energy prices to consumers and, in the Portuguese case, promoting projects across all sectors to boost energy efficiency.

The judicial sector potentially has a key role in safeguarding energy justice and the right to energy [56]. However, in Spain, the

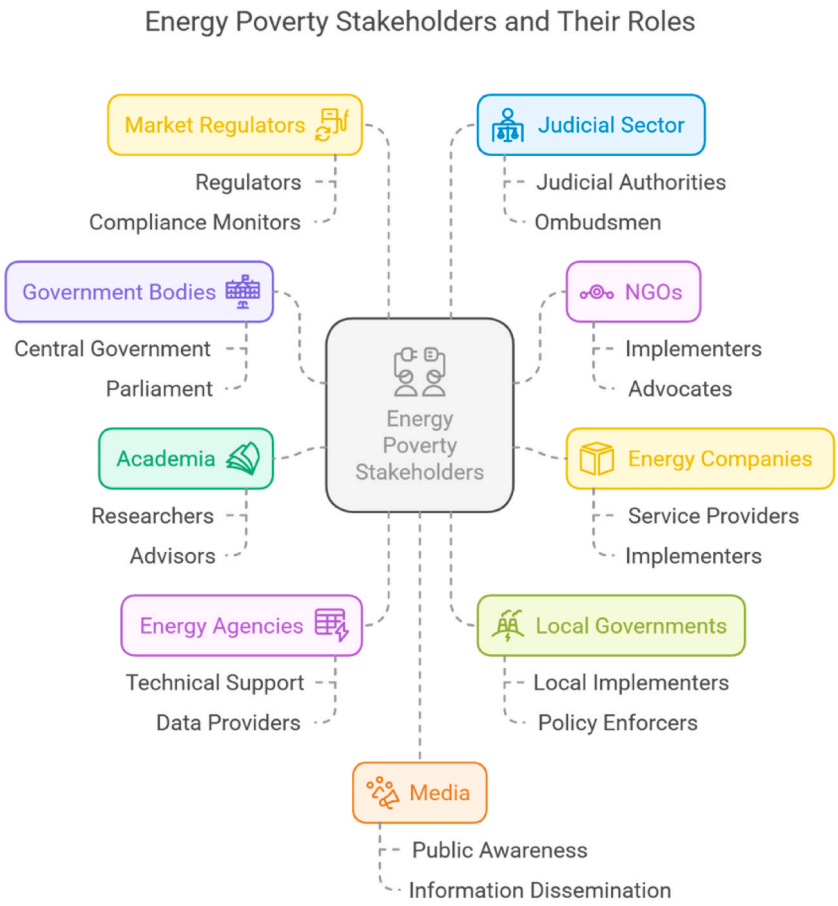

Fig. 6. Energy poverty stakeholder ecosystem in Portugal and Spain (created with Napkin AI).

judges have taken on an active role only in some regions (Catalonia above all) or on specific national topics, such as the controversies surrounding the social tariff, which were solved with several Supreme Court judgments. Moreover, national and (some) regional ombudsmen have carried out different actions to protect vulnerable people affected by EP in Spain, as in other EU countries [57]. The Portuguese Ombudsman also has some ability to voice people's situations of vulnerability. Despite this, there are no reports of the Ombudsman in Portugal being involved in actions against EP. In both countries, the Ombudsmen cannot impose their decisions over judicial, legislative or executive powers.

Academia has played a chief role in defining and characterising EP in both countries, producing important knowledge on understudied topics and testing practical solutions in the field. They also disseminate their work through the media (via interviews and articles), which has had a growing interest in the topic, bringing it to the forefront of discussion.

In the private sector, the Third sector (NGOs, associations, foundations, etc.) has an important role in communication and dissemination, bringing attention to the population's hardships and raising awareness of the issue. Moreover, they often carry out programs that complement the public support of vulnerable households. On the other hand, energy companies set energy prices (at least in the free market) and are often involved in social projects, thus having a considerable potential impact on mitigating this problem and supporting vulnerable consumers through the path of the energy transition [58]. However, their impact on EP mitigation results from occasional or permanent (in the Spanish case) social responsibility projects, which can contribute to studying the problem and deploying actions such as home renovations (e.g. Ref. [59]) but have arguably had limited impact throughout the years, as EP continues to loom large in Portugal and Spain. They are also currently responsible for financing the social tariffs, although this scenario may change for both countries, as future funding will likely include public financing (according to the national EP strategies).

Fig. 6 visualises the stakeholder ecosystem classification and their roles in addressing EP in Portugal and Spain.

3.3. Prioritising Iberian actions to address energy poverty

Several similarities and differences between Portugal and Spain can be pointed out when analysing the results of the previous sections. Regarding the climate, the two countries are among the warmest territories in the EU, which means that Iberian countries could be more vulnerable to climate change effects (at least in absolute terms). However, Spain has a more varied climate, potentially implying a more complex process of identification and monitoring of climate-related issues, which could have different impacts across the country. Indeed, both issues were previously pointed out by e.g. Ref. [60], which stresses the importance of considering both issues in the design of EP policies in the Iberian Peninsula.

Concerning sociodemographic features, both countries are characterised by an ageing and declining population in the medium term. Hence, EP policies should focus on the issues of elderly people, e.g., greater requirements for thermal comfort, technological difficulties, and poorer health conditions. Besides the low-income level, the risk of poverty and inequality are also pressing problems in both countries, indicating the need for a more robust welfare system and the common cause of designing energy transition policies that leave no one behind.

Observing the housing sector, most households own their dwellings, but energy efficiency is generally poor. Thus, most of the population has the power to decide whether to renovate their homes, and in most cases, "deep" retrofitting would be necessary to enhance energy efficiency significantly. However, given the previously mentioned low purchasing power and low levels of awareness of EP prevalent in a significant share of the population, Iberian policies should guarantee priority access to energy efficiency programs for the energy-poor, for example, by considering EP criteria when designing them. Moreover, in both countries, the share of electricity in the final energy consumption of the residential sector is significantly lower than the joint share of other fossil energy carriers, thus highlighting a common challenge of electrifying domestic services (especially heating) or using alternative renewable fuels. Spain and Portugal share a common electricity market (*MIBEL*). However, they have very different ways of transmitting the market prices to the final end-users in the regulated and free markets, and the share of consumers in each market is not comparable.

Concerning the current mitigation policies that have been implemented, both analysed countries have an electricity consumption subsidy that is bill discount designed for low-income households (named VCs) and with very similar bill coverage ratios. However, this social tariff is automatically attributed to VCs in Portugal, while Spanish consumers must apply through the energy suppliers. The automatisation of this subsidy in Portugal has produced a significant rise in consumers benefitting from it (as pointed out by the LNSEPM), thus reaching more low-income households that were previously unaware or unable to succeed in the application process. A similar change could be implemented in Spain given the potential positive effect that could occur (reducing the high EP policy gap shown in Table 2) and the existence of national household income and composition central databases that enable the swift identification of these consumers. The attribution criteria could still be improved towards a more robust metric cross-referencing different datasets and broadening it beyond economic hardship to capture the different dimensions of EP, as the policy gap of these instruments remains significative. The financing scheme of social tariffs has been controversial in both countries (the energy companies being the 'funders'), and the Spanish Government have applied two different actions to address this issue. Thus, given the problems outlined in Section 3.2.1, the solution might be an automatic transfer in cash covering an estimated energy level that guarantees all necessary energy services for an adequate standard of living, considering variations imposed by different household composition and other socioeconomic factors that may be linked to increased vulnerability. This energy consumption subsidy might be funded by the State as it currently happens for the Spanish TSA.

Regarding energy efficiency programs, both countries have been proposing technical and dwelling ownership requirements to benefit from them. The method of prioritising vulnerable people, however, differs between the two countries: the Spanish government has introduced social criteria in general-population policies to enhance access to funding. At the same time, the Portuguese government has implemented *ad-hoc* programs for households benefitting from social energy tariffs. Concerning the application and

management of funding, the efficiency of setting regional administrations responsible for them (Spain) or national ones (the Environmental Fund in Portugal) depends on the different political-administrative organisations. In both countries, the funding of these programmes comes either from EU funds or the General State budget. However, Spain currently prioritises "non-refundable" subsidies over loans,[7] the former being more suited to households in EP considering their reduced purchasing power. Eventually, an *ad hoc*, easy-to-apply-to, non-refundable subsidy-based program for this segment of the population could prove more effective in ensuring access to energy retrofitting in Spain and Portugal while considering the abovementioned political-administrative differences and the landlord-tenant dilemma in rented houses. These still require improvements in the eligibility criteria, as suggested for the social tariffs, towards a more accurate support provision for energy-poor households. The amount of funding allocated to these programs should also be significantly increased if renovation targets are to be achieved [61,63].

On the planning side, the Iberian EP national strategies do not have the same structure but have similarities regarding the main pillars for public actions and policies. Indeed, they both focus on financial interventions, additional consumer protection, energy efficiency, and information and awareness enhancement. Moreover, most of the specific policies in the two strategies have common characteristics and several good practices, especially regarding consumer protection and energy efficiency measures, which could be the base for an enhanced approach. Both strategies are aligned with the proposed measures for retrofitting the building stock envelope and replacing heating and cooling equipment. As stated by Ref. [62], and demonstrated in the Portuguese context in the past, private funding through loans for renovation is not appropriate to support low-income households as they are not usually entitled to them, and the interventions will not generate energy savings in households which already underconsume [63,65]. Private funding should only be considered a future option if initial investment and further indebtedness are not part of the equation for these households. Both strategies would benefit from *ex-ante* analysis to assess measures' impact, proving ground for measure prioritisation and post-implementation monitoring. Concurrently, estimating necessary funding and time frame for actions, as proposed in Ref. [64] for Portugal and [65] for Spain would increase the transparency of strategies.

Extending renovation support to renters is projected in the two countries, though no mechanism for rent control or safeguard for preventing eviction after renovations in homes rented by energy-poor households is proposed, which can further housing inequalities. Due to their interconnection, the intersection and alignment of energy poverty and housing policies are key to addressing both vulnerabilities effectively and for long-term impact. The maintenance and availability of affordable and energy-efficient public housing should also be part of the solution in the Iberian countries, despite being side-lined in the Portuguese strategy.

With reference to particular segments of the population, given the high percentage of elderly people in the two countries, with a significant proportion suffering from EP (2023 Portuguese and Spanish SILC) and its consequences [66], specific renovation programs and informational campaigns/trainings to support this group, which are presently not included in either strategy, could be a beneficial add-on to both plans. This is particularly so given the difficulties faced by this group regarding accessing and applying for funding and potential resistance to change among this group [67].

Measures such as the electrification of space heating proposed in the Portuguese EP Strategy should also be taken up in the EP strategy update of the neighbouring country, as they decrease vulnerable households' dependence on fossil fuel price changes if renewable energy integration is pursued. The strategies should guarantee the connection and integration between energy demand and consumption measures, namely envelope renovation and equipment installation, to ensure effective energy planning and avoid unnecessary expenditures.

This leads to the next point, highlighted in the LNSEPM and which should be considered in the improved framework – the importance of including vulnerable households in renewable energy communities. On the other hand, the SNSEP was published before the corresponding EU directives, so this topic is only included in the suggestion to boost shared self-consumption. Additional supply-side measures focusing on energy price regulation are absent, namely addressing the responsibility of private energy companies as active players in EP reduction, which can play an essential part in a just energy transition. Integrating VCs in renewable energy schemes has been recognised as a complex challenge [64]. Nevertheless, there is potential for this solution to significantly help mitigate the vulnerability of this group of consumers [65], and it should be part of the political framework, contributing to a paradigm change towards energy as a commons, for a higher degree of household energy democratisation. Finally, a more targeted and coordinated framework is bound to be more effective if it advances a broader range of measures, as demonstrated by Ref. [12].

Regarding financial interventions, in addition to the importance of automatising social supports, the Spanish strategy also proposes a unification of supports (a unique energy consumption subsidy) to decrease bureaucracy and promote easier access, which could also be promoted as an enhanced approach in the two countries. As part of the unified support, the SNSEP's TSA and its attribution according to regional climate are essential measures to tackle regional vulnerabilities, and they should be included as part of the Iberian measures to address geographical inequalities. This example of territorial allocation could be extended to other interventions, such as energy retrofit, guaranteeing that resources are mobilised according to territorial vulnerabilities to where they are most needed.

In terms of consumer protection, both strategies agree on a minimum vital supply of energy for the energy-poor, which could be, therefore, a shared measure, taking the Spanish example as it is at a more advanced implementation stage. The two countries' strategies also agree on suspending energy disconnections during extreme events. We argue that an enhanced approach should even go further and prevent disconnections for households in a vulnerable situation in ordinary times, guaranteeing compliance with the Directive (UE) 2024/1711, paragraph (26), which states that 'MS should therefore ensure that vulnerable customers and customers affected by energy poverty are fully protected from electricity disconnections'.

[7] It must be highlighted that the Portuguese EP strategy proposes the prioritisation of "no refundable" subsidies over loans. Therefore, this approach is expected to be included in future aids. Moreover, the strategy also proposes soft loan schemes.

Iberian strategies for both energy literacy and consumer knowledge are varied and comprehensive, proposing various valuable measures focusing on awareness, information dissemination, and capacitation using different channels that could improve citizens' knowledge and engagement, especially valuable for empowering vulnerable consumers on the path to achieving the energy transition. Regarding the involvement of stakeholders in tackling EP, as highlighted in both strategies, the links with other private and public sector actors should also play a part in the two countries, for example, with health agents in identifying the energy poor. This measure has been defended [68] and successfully tested in the UK [69]. Collaboration with energy operators can also be valuable for obtaining valid data for improving measurements and identification. An important aspect that should also be transported to an enhanced approach is the strong emphasis of the LNSEPM on the local level, supporting and empowering local governments and initiatives to drive efforts for reducing this problem in their territories, as highlighted in the EC's recommendation [2] and by the EPAH.

Overall, the national government is the cornerstone for planning and implementing policies for the whole population in both countries; thus, cooperation between the Portuguese and Spanish central administrations and with their respective national stakeholders is the first crucial step to enhance the EP networks (and eventually strengthen Iberian EP cooperation). Regional and local governments and energy agencies could practice the identified priority policies at the local level with the help of the private sector, particularly engaged NGOs and energy companies, further developing the current approach for *Vale de Eficiência* in Portugal. These entities often have the proximity and the resources needed to complement national public actions and are bound to assume more influence in the future ecosystem of actors. Energy regulators and scholars also have an essential role in addressing EP, having the advantage, respectively, of regulating the energy market and being neutral observers who have deeply investigated the topic. There is potential for further Iberian exchange regarding the theory developed by academia and practices implemented for dissemination and mitigation action by associations and local governments in both countries through dedicated platforms. Indeed, this could be the seed for developing future collaborative initiatives in the Iberian Peninsula.

4. Conclusions

This paper uncovers the potential of critically exploring the Iberian policy frameworks in improving EP actions in Portugal and Spain. This study is informative for practitioners in both countries, promoting the sharing of good practices and methods for addressing current weaknesses in existing policies and plans. Indeed, this analysis is based on Iberian climatic, social and cultural similarities and the (relatively) recent political willingness to address EP. In this sense, this work unpacks the key climatic, economic, and socio-demographic characteristics of both countries. Building on this knowledge, it investigates how the countries have addressed energy poverty, focusing mainly on the planning and implementation of policies and public and private participation. The final aim is to explore the policy responses and society's involvement in the fight against this social issue. The paper's findings are not univocal, highlighting several similarities and differences between the two countries' approaches and plenty of room for improvement by learning from best practices and evidence.

We argue that Iberian EP actions can be prioritised and enhanced by drawing on certain aspects explored in this paper. From the policy side, Portugal and Spain have implemented several measures and planning strategies to tackle EP. Regarding the former, the results presented in this paper suggest that an automatic transfer in cash covering the necessary level of energy services for an adequate standard of living might be a valid solution for both countries to mitigate EP in the short run. On the other hand, an *ad hoc,* easy-to-apply-to, energy efficiency subsidy program for vulnerable households might boost the structural improvement of EP in the medium- and long-term, if based on improved eligibility criteria considering the multidimensionality of EP. However, both policies should consider the political-administrative differences between the two countries and some complex issues, such as the landlord-tenant dilemma.

Regarding the planning approach, the Iberian EP national strategies are grounded on similar pillars for public actions and policies. Moreover, most of the policies proposed within them, including financial interventions, additional consumer protection, energy efficiency, and energy literacy, are analogous. In particular, the strategies are aligned on almost all the proposals for the abovementioned energy consumption and efficiency subsidies. On the other hand, they identify different approaches for boosting VCs' participation in the transition to renewable energy sources, namely shared self-consumption (Spain) and energy communities (Portugal). In the long term, these countries can learn from each other and reinforce the implementation of their EP policy plans by enhancing cooperation within the Iberian Peninsula. Both strategies would benefit from including: ex-ante impact assessment and funding estimates, a greater focus on public housing availability and private housing affordability, further supply-side price regulation measures, resource allocation according to territorial vulnerabilities, and coordination of energy demand and consumption reduction measures.

On the stakeholder front, public and private actors in the Iberian Peninsula usually complement their actions, which is a promising principle for building national EP networks in the two countries (potentially cooperating between them). The Central Governments should lead the design and implementation of the abovementioned policies (ratified by the parliament), accompanied by the regional and local administrations, and potentially supported by the national and regional energy agencies. The success of this fight against EP might also depend on the positive interaction with the private sector, particularly with NGOs and energy companies, as well as with agents from the health and housing sectors. Finally, energy regulators and scholars could be important pawns, given their impartiality, regulatory power, and research expertise. Further work might improve the stakeholder rating methodology implemented in this paper by applying some performance evaluation methods, such as collecting feedback via expert surveys.

This work shows that enhancing the Iberian policy frameworks and networks to address EP is a feasible but complex task, which must consider the social, climate and administrative differences between the two countries and count on all relevant stakeholders. The historical collaboration between Portugal and Spain and the frequent similarities detected by this work in the fight against this social issue might also inspire a more cooperative Iberian EP policy approach.

Moreover, these findings could motivate other EU Member States to advance their approaches and boost infra- and international cooperation. These changes can be essential catalysers for a swifter, more comprehensive, just energy transition.

CRediT authorship contribution statement

Roberto Barrella: Conceptualization, Data curation, Formal analysis, Funding acquisition, Investigation, Methodology, Project administration, Resources, Validation, Visualization, Writing – original draft. **Pedro Palma:** Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Validation, Visualization, Writing – original draft. **João Pedro Gouveia:** Conceptualization, Methodology, Supervision, Writing – review & editing. **José Carlos Romero:** Conceptualization, Methodology, Supervision, Writing – review & editing. **Eva Arenas:** Supervision, Writing – review & editing. **José Ignacio Linares:** Supervision, Writing – review & editing.

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Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix. Additional tables

Table A 1Summary of energy efficiency programs implemented in Spain

Measures	Type	Requirements	Application	Funding	Benefit	Number of beneficiaries (households/ consumers)	Non-recoverable funds ratio	Additional fund ratio
Programa PREE (Tipología 1, Subtipologías 2.3 y 2.4, y tipología 3)	Aid for enclosure renovation/Aid for equipment replacement	- Ownership requirements: (A) and (B) - Technical requirements - Specific call requirements (Autonomous Communities, CCAA)	Through the CCAA	National Energy Efficiency Fund: 300 M€.	According to typology: **1.** A: 35 %–85 %; B: 25 %–75 %. (Includes an additional 15 % for social criteria) **2.3.** A: 35 %–55 %; B: 25 %–45 % (includes an additional 10 % for social criteria). **2.4.** A: 35 %–45 %; B: 25 %–35 %. **3.** A-B: 15 %–25 %.	N/A	1. 55 % 2.3. 40 %	1. 23 % 2.3. 40 %
Programa (nº5) de fomento de la mejora de la eficiencia energética y	Aid for enclosure renovation/Aid for equipment replacement	Ownership requirements Ownership requirements (various	Through the CCAA	GGE + CCAA (14): 2018–2021: 131.9 M€.	Max. amount: 12.000€ and 40 % of the eligible investment Exceptions:	N/A	40 % (max.)	88 %

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Measures	Type	Requirements	Application	Funding	Benefit	Number of beneficiaries (households/ consumers)	Non-recoverable funds ratio	Additional fund ratio
sostenibilidad en viviendas		categories) Technical requirements			- Income <3 IPREM (75 %) - Disabled person (18.000€) - Severely disabled person (24.000€)			
Apoyo del FEDER a la eficiencia energética en viviendas	Aid for enclosure renovation/Aid for equipment replacement	N/A	N/A	European Regional Development Fund (FEDER): 74M€.	N/A	N/A	N/A	N/A
Programa PREE 5000	Aid for enclosure renovation/Aid for equipment replacement	- Ownership requirements: (A) and (B) - Technical requirements - Geographical requirements	Through the CCAA	European Recovery and Resilience Mechanism: €50 million	According to typology: **1.** A: 50 %–105 %; B: 40 %–95 % **2.** A: 40 %–95 %; B: 30 %–85 % **3.** A-B: 20 %–75 % (including an additional 15 % for social criteria)	N/A	1. 73 % 2. 63 % 3. 48 %	1. 18 % 2. 20 % 3. 25 %
Guía práctica para la gestión de ayudas a la rehabilitación energética de edificios	Information Provision	N/A	N/A	Higher Council of the Spanish Architects' Associations (CSCAE)	Guide to facilitate the technical-administrative management of EPRSPs	18.6M	N/A	N/A
Guía de la energía	Information Provision	N/A	N/A	IDAE	Guide to household energy consumption and energy savings	18.6M	N/A	N/A
Guía para la elaboración del Libro del Edificio Existente	Information Provision	Technicians drafting the Existing Building Books for refurbishment	N/A	General Secretariat for the Urban Agenda and Housing of the MITMA	Instructions, recommendations, tips and examples for the preparation of the Existing Building Book for retrofitting.	N/A	N/A	N/A

Table A 2Summary of energy efficiency programs implemented in Portugal

Measures	Type	Requirements	Application	Funding	Benefit	Number of beneficiaries (households/ consumers)	Non-recoverable funds ratio	Additional fund ratio
1° Direito - Programa de Apoio ao Acesso à Habitação	Aid for enclosure renovation/ constructing new buildings/ renting for subletting	Families living in housing in substandard conditions, families in financial hardship, Portuguese citizens, and that are not owners of housing in liveable conditions	Through a promoter (municipalities, public companies, cooperatives or associations of residents, institutions of social solidarity)	Public funding from national and European funds and private funding from banks	- Non-refundable payments for 100 % of the project costs. - The Recovery and Resilience Plan will pay for 26 thousand families. For others, the payment is shared between the state and the municipalities.	52,436 families as of August 2022	100 %	100 %
Reabilitar Para Arrendar – Habitação Acessível	Aid for enclosure renovation	Individual or collective person that is a homeowner, with tax and social security status in order	Through the platform Portal da Habitação	European Bank of Investment/ Public Funding	Soft loans to finance up to 90 % of the renovation cost	77 buildings (€12.2 million)	0 %	0 %
Instrumento Financeiro para a Reabilitação e Revitalização Urbanas (IFRRU 2020)	Aid for enclosure renovation	Individual or collective person that is a homeowner, with tax and social security status in order and balanced economic-financial situation	Request for financing from selected banks	Public (National-EU) and private funding from European Banks (50-50)	20-year loans with below-market interest rates	As of December 2022: 2473 renovated homes, €1428M of investment	0 %	0 %

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Measures	Type	Requirements	Application	Funding	Benefit	Number of beneficiaries (households/ consumers)	Non-recoverable funds ratio	Additional fund ratio
Vale Eficiência (2021)	Aid for enclosure renovation/ Aid for equipment replacement	Eligible candidates need to be social energy tariff recipients and homeowners	Through the Platform "Fundo Ambiental"	Environmental fund through Recovery and Resilience Plan: 138–160 M€	1300€+VAT Vouchers to carry out interventions	Programme target: 100,000 vouchers by 2025	100 %	100 %
Programa de Apoio "Edifícios mais Sustentáveis II" (PAE + SII)	Aid for enclosure renovation/Aid for equipment replacement	Eligible candidates have to prove home ownership and have the tax and social security situation in order	Through the Platform "Fundo Ambiental".	Environmental fund through Recovery and Resilience Plan: 135 M€	Non-refundable subsidies of 85 % of costs without VAT for a maximum of 7500€ of support	70,454 accepted and paid applications amounting to €122.6M	85 %	0 %
Plano de Promoção da Eficiência no Consumo de Energia Elétrica (PPEC)	Aid for replacement of equipment/ Information Provision in the context of approved projects	No requirements	Through a promoter (company, municipality, etc)	National funds	Non-refundable financing of the whole project	€11.5M attributed to projects	100 %	0 %

Table A 3Main features of the four macro policy groups proposed by the Portuguese Strategy against EP

Type	Main proposed measures	Goals/Specific actions	Responsible Entities	Beneficiaries	Funding	Predicted Impact/ Target	Timespan	Achievement level
Housing Energy and Enviromental Sustainability	- Energy renovation non-refundable subsidy schemes - Loans for building envelope renovation - Reduced VAT for renovation measures in specific rehabilitation areas - Reduced VAT for equipment replacement, such as heat pumps, solar thermal, biomass equipment, electric water heater, electric stoves - Reduced VAT for biomass fuels - Simplifying electricity surplus sale - Tax exemption of electricity sales profit - Reduce bureaucracy for energy communities licencing	Increase housing energy performance Decarbonise domestic energy consumption	–	All citizens, energy-poor	PRR, Enviromental Fund, Banking Sector, National Budget	- Increase renovated area - Higher percentage of renovated buildings - Decreased number of discomfort hours - Reduced primary energy consumption - Increased locally produced renewable electricity -Increase installed power of decentralised renewable systems - Increase local produced consumption of heating and cooling - Increased share of electricity consumption	–	Zero
Universal Access to essential energy services	Social Tariffs for electricity and natural gas Financial support for the purchase of LPG Reduced VAT for energy purchases Access to regulated market Reduced access fee to the grid Non-refundable subsidies for energy communities and renewable energy systems acquisition	Reduce households with difficulty in paying for energy services Guarantee the protection of vulnerable consumers in energy poverty	–	Enrgy-poor consumers and Vulnerable consumers in energy poverty	Market agents, National Budget, PRR, Environmental Fund	- Reduced energy bills - Increased number of families with PV panels - Increased number of families in energy communities - Lower number of energy interruptions attributable to the consumer	–	Zero

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Type	Main proposed measures	Goals/Specific actions	Responsible Entities	Beneficiaries	Funding	Predicted Impact/ Target	Timespan	Achievement level
Promote Integrated territorial action	- Development of Energy Citizen Spaces - Capacitate Technical Facilitators - Produce Municipal Housing Strategies - Reduce barriers to municipalities to promote energy communities - Provide municipalities with training - Rehabilitate and building public housing	- Reinforce local action structures for consumer support - Increase public housing	–	All citizens, energy poor citizens, vulnerable consumers	PRR, Environmental Fund	- Number of Energy Citizen spaces - More public policy instruments - More energy communities - Increase renovated area - Higher percentage of renovated buildings– Decreased number of discomfort hours - Increased area of new public buildings	–	Zero
Knowledge and informed action	- Information and data integration from different sources - Data Digitalization and intelligence - Implement Training center for the Energy Transition - Training courses on energy renovation, renewable energy production and space heating and cooling equipment installation	- Improve EP diagnosis - Increase Energy Literacy - Stimulate Research and Innovation - Promote Professional Training	–	All citizens, energy poor citizens, vulnerable consumer	PRR, Environmental Fund	- Increase number of EP indicators and methods - Increase number of EP combat initiatives - Number of support structures - Increase energy literacy of children, young people, vulnerable consumers and other consumers	–	Zero

Table A 4

Main features of the four macro policy groups proposed by the Spanish Strategy against EP (Own elaboration from SNSEP, [51] *and other sources mentioned in this paper)*

Type	Main proposed measures	Goals/Specific actions	Responsible entities	Beneficiaries	Funding	Predicted impact/ target	Timespan	Achievement level
Financial interventions	Social energy cheque	Social tariffs' improvement (all energy carriers, automatisation, coordination)	MITECO Regional/local administrations	VCs	General State Budget (needed)	All energy services supported, all vulnerable population benefitting from it, all relevant administrations engaged	2019-?	Zero
Consumer protection	° Minimum Vital Supply (MVS)	° Applying the precautionary principle and expanding the disconnection safeguard	° MITECO	VCs and people in EP, and General population	° Undefined (needed)	° Application of MVS for an additional four months	° 2019-? (with biannual review)	° Total (RDL 17/2021)
	° Regulatory improvements for consumer protection	° Including EP in energy consumer regulation	° Regional/local administrations		° Regular budget of the body involved	° Inclusion of EP in normative and specific legal treatment for VCs and people in EP	° Undefined	° Total (RDL 1/2021)
	° Energy disconnection suspension in extreme weather events	° Suspend energy supply disconnection in case of extreme weather events	° State Meteorological Agency		° Undefined (needed)	° Avoid extreme consequences on population during heat and cold waves	° 2019/20-?	° Zero
	° A protocol to detect situations of EP by healthcare professionals	° Include health agents in the identification of EP	° Ministry of Health and Social Welfare		° Regular budget of the body involved	° Prevention of extreme health consequences of EP	° 2019/20-?	° Zero

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Table A 4 (*continued*)

Type	Main proposed measures	Goals/Specific actions	Responsible entities	Beneficiaries	Funding	Predicted impact/ target	Timespan	Achievement level
Energy efficiency actions	Short-, Medium- and Long-term measures	◦ Low-cost 'express' energy retrofitting of dwellings	◦ MITECO	Low-income households and VCs	Public administration funds and National/ European structural investment funds	◦ Subsidy for VCs up to 100 % of the total cost of the energy efficiency intervention	◦ 2019/20-?	◦ Partial
		◦ Replacement of household equipment	◦ MITMA			◦ Rental, community maintenance and utility costs assistance	◦ 2019/20-?	◦ Partial
		◦ Promotion of affordable social housing	◦ IDAE			◦ Deep renovation plans that include social and environmental criteria	◦ 2020-?	◦ Total (Orden TMA/336/ 2020 and RDL 853/ 2021)
		◦ Deep building retrofitting	◦ Regional/local administrations				◦2020-?	◦ Total (RDLs 106/2018, 737/2020 and RDL 853/2021)
Energy and EP literacy	◦ Improving consumer information and education	◦ Promoting general awareness of EP	MITECO and public and private stakeholders	General population, people in EP	Regular budget of the various bodies involved	◦ Campaigns and events with all stakeholders	◦ 2019-?	◦ Partial
	EP website	◦ Centralised information on EP				◦ EP website with specific sections for citizens, the administrations and professionals	◦ 2019/20-?	◦ Partial
	◦ Communication actions on the use of smart meters	◦ Information provision to VCs and use of smart metering to tackle EP				◦ Specific section in EP website and information to stakeholders	◦Undefined	◦ Zero
	◦ Information on energy saving and efficiency	◦ Permanent communication and information to citizens to promote the improvement of consumption habits				◦ Specific section in EP website and stakeholders proving information to citizens	◦ 2019-?	◦ Partial
	◦ Information on mitigation and structural policies included in SNESP	◦ Permanent communication channel for stakeholders and citizens				◦ Newsletter with information and news - warning system for extreme weather conditions, a mailbox for complaints, suggestions and contributions on EP	◦ 2019-?	◦ Zero

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