European and US Approaches to Energy Poverty: Classifying and Evaluating Design Strategies

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EUROPEAN AND US APPROACHES TO ADDRESS ENERGY POVERTY: CLASSIFYING AND EVALUATING DESIGN STRATEGIES

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Abstract: As climate change accelerates and recent health, energy, and inflation crises exacerbate broader inequality trends, ensuring adequate and affordable access to energy services is becoming increasingly important. In this paper, we conduct an in-depth review of energy poverty policy and program design in the U.S. and Europe. We classify and evaluate different approaches according to four categories of policy choices: assistance, targeting, funding, and governance. We discuss the advantages and disadvantages of the approaches adopted in both contexts, extract key lessons, and provide recommendations to improve the effectiveness of energy assistance policies.

Keywords: Energy poverty; Energy assistance programs; Energy Insecurity; Affordability.

1 INTRODUCTION AND LITERATURE REVIEW

As climate change continues to worsen and cause more extreme temperature fluctuations and weather events, access to sufficient energy services will be increasingly vital. Despite their essential role in the energy transition, low-income households are likely to experience the most significant impacts of these changes [1] [2] [3] [4].[1] Additionally, the most globally efficient policy solutions to address the climate change challenge increases the gap between wealthy and poor dwellings: the deployment of distributed generation leads to an evidenced risk of unbalanced death spiral, as well as carbon taxes have regressive effects, since poorer households' expenditure increases, contrary to their energy consumption [6] [7] [8]. Without the necessary financial support, they will unavoidably struggle to have access sufficient (affordable) energy to maintain adequate living conditions. The goal of this paper is to review how governments currently design strategies to reduce the overall number of households living in energy poverty in order to extract lessons on how to best deliver assistance.

Energy poverty, in the context of this paper, describes the inability of a household to adequately utilize sufficient amounts of electricity, heat, and other energy services due to financial constraints [9] [10]. It is driven by three main factors: sustained low incomes, high energy services costs, and poor dwelling energy efficiency [11] [12] [13]. In the European Union (EU), approximately 9.2% of households report being unable to keep their dwellings adequately warm [14] [15]. Nearly 10% of households in the United States (US) also keep their homes at unhealthy or unsafe temperatures, according to the 2020 Residential Energy Consumption Survey (RECS). In the same year, approximately 20% of households reported having reduced or not purchased basic necessities in order to pay their energy bills [16].

Energy poverty may be responsible for an estimated 40,000 deaths annually during the winter season across 11 European nations [17] [18]. Increased summertime temperatures across the southern US lead to short-term exposure to high indoor temperatures which are associated with adverse health effects and increased deaths [19]. All of the social impacts outlined are negative

[1] For example, in the summer of 2023, Phoenix, Arizona experienced 23 consecutive days of peak temperatures exceeding 110 ºF (43 ºC) and, despite indoor temperatures surpassing 80 ºF (26.5 ºC), residents reported limiting their air conditioning usage in order to reduce their utility bills [5].

externalities associated with energy poverty, which carry economic costs. Governments incur additional expenses in providing social and healthcare services [20] due to the side effects of energy poverty. In addition to moral considerations, there is a sound economic rationale for safeguarding households from energy poverty.

Approaches to address energy poverty differ widely worldwide. Studies on energy poverty policies in Europe highlight the multifaceted approaches taken to address this pressing issue. The EU has implemented a range of policies (described in Section 2) aimed at improving energy efficiency and reducing energy costs for vulnerable households [21]. Research by Palma and Gouveia emphasizes the importance of subnational scale analyses to tailor interventions effectively to local contexts [22]. Additionally, Barrella et al. [23] propose an enhanced policy and action framework specifically for the Iberian Peninsula, highlighting the unique challenges and opportunities in this region. Other significant contributions include the work by Bouzarovski et al. [24], which discusses the broader implications of energy poverty amidst a global crisis and the need for inclusive energy transitions. The study by Dobbins et al. employs a multi-dimensional approach, including policy reviews, statistical analysis, and stakeholder consultations, to analyze energy poverty in the EU, finding that comprehensive policy frameworks are needed to address root causes [25]. Kyprianou et al. compare energy poverty in Cyprus and Spain, revealing significant differences in regulatory frameworks and recommending enhanced support for vulnerable consumers [26]. Another study by Kyprianou et al. examines energy poverty policies in five EU countries, highlighting diverse approaches and the need for synergies among policy fields [27]. Kerr et al. use multiple streams theory to analyze energy poverty in England, Ireland, and France, showing how different definitions and measurements affect policy solutions [28]. Bosseboeuf et al. present a comparative analysis of how ten European countries address energy poverty, focusing on definitions, indicators, governance structures, and national and local policy measures [29]. The study highlights the diversity of approaches and identifies around 40 good practices, emphasizing the importance of local initiatives, national observatories, and integrated strategies that combine social and energy efficiency dimensions.

In the United States, energy poverty is similarly addressed through a combination of direct assistance programs and broader policy measures (see Section 3). Studies by Bednar and Reames highlight the recognition and response to energy poverty in the US, noting that sustained low

incomes, high energy costs, and poor dwelling energy efficiency are primary drivers [30]. Graff's study reviews energy assistance programs and recommends policy enhancements to better support vulnerable households and improve energy security [31]. Batlle et al. reveal that current federal allocations for energy assistance, based on formulas designed nearly four decades ago, do not match well with the geographical distribution of assistance needed across the country [32]. Best and Sinha advocate for large-scale investments in home insulation and solar panels as more effective solutions to energy poverty [33]. Carley, Engle, and Konisky find that energy justice programs vary widely in effectiveness and recommend standardising criteria and increasing funding [34]. Baker, Carley, and Konisky highlight the urgent need for stronger utility disconnection protections to prevent adverse health outcomes and improve energy security [35]. Memmott et al. quantify the prevalence of energy insecurity in the U.S. and identify key demographic and housing-related predictors [36]. The authors emphasise the need for targeted interventions and improved program design to reach the most vulnerable populations.

Regarding the connection with other policy areas, the work by Stojilovska et al. emphasises the importance of integrating energy poverty into broader social policies, especially in light of the climate emergency [37]. In the same line, Mahoney et al. explore how climate change, energy transition, and energy poverty agendas intersect in Portugal, revealing that despite policy-level synergies, practical implementation often results in competing priorities and limited accessibility for vulnerable populations [38]. Giraudet et al. evaluate the cost-effectiveness and distributional impacts of France’s residential heating policies using the Res-IRF energy-economy model, comparing subsidies, carbon taxes, and regulatory instruments [39]. They find that while the carbon tax is the most effective but regressive, targeting subsidies toward low-income households improves both equity and efficiency, and addressing barriers in rental housing is essential to meet long-term energy-saving goals. In the US, Hernandez conceptualizes energy insecurity in the U.S. as a multidimensional issue encompassing economic, physical, and behavioral dimensions, and argues for a more holistic policy framework that integrates housing, health, and energy sectors to address the root causes of energy poverty [40]. Carrión and Hernández focus on the impact of heatwaves on the energy poor and assess how assistance programs should be enhanced to protect vulnerable customers in this type of events [41]. Jessel et al. provide a comprehensive review of energy insecurity in the U.S., highlighting its disproportionate impact on low-income and minority households [42]. The authors call for improved data collection and cross-sectoral policy

coordination to address structural inequities in energy access and affordability. Thompson assesses how energy assistance programs should evolve during the process of grid modernization and decentralization of the power sector [43].

2 METHODOLOGY

In this paper, we focus and confront specifically on the European (EU plus the United Kingdom) and US contexts. We develop an in-depth review and design a classification of the policies designed to address energy poverty across Europe and the US. The main focus of this review is on energy assistance programs and electricity consumption subsidies, but we also look at energy efficiency measures[2]. We assess both the specific and broad-reaching policies, and illustrate how energy poverty policies vary significantly between the US and Europe and within the US and EU Member States. We start by making a broad introduction on the energy poverty policy approaches in both contexts (Section 3), and then build a framework to review and compare approaches to address energy poverty policy in both contexts. This framework includes four key categories of strategical decisions that can be framed around four key questions:

1. Assistance: What forms of support are employed in energy assistance policies?
2. Targeting: How are eligible beneficiaries identified and selected for assistance?
3. Funding: What are the mechanisms through which these programs are financed?
4. Governance: How are responsibilities for policy implementation and oversight distributed among different actors and institutions?

The main dimensions of energy poverty policies, stemming from these key questions are summarized in Table i and analyzed in detail in Sections from 4 through 7. Table i is provided here to guide the reader through the manuscript and it depicts the theoretical framework of the article, one of its main contributions. This framework is based on the design elements of energy assistance programs and represents the decisions that regulators and policymakers must make when designing these policies. Some of these decisions are independent, meaning they are not strongly related to the other design elements. However, many of these decisions are interlinked, as highlighted in the

[2] An assessment of other non-economic measures against energy poverty, such as disconnection bans, is beyond the scope of this article.

following sections. This theoretical framework enables us to compare European and U.S. practices and to highlight dimensions that are usually overlooked when assessing these programs.

Table i. Summary of Dimensions for Energy Poverty Policy Design

Assistance Strategy		**Direct Assistance**		**Indirect Assistance**
		Provided directly to the consumer; Proper calculation of the cost-reflective price, followed by a later application of discounts on such price		Provide support to act on causes of energy poverty, typically activities that lower energy consumption or act on costs to supply energy services
		Payment & Voucher	*Discount*	
		Direct transfer of money from the governing body for energy services costs	Act on the final price paid, with consumers paying a price lower than the cost-reflective amount; Can be distortive or non-distortive	
Targeting Strategy		**Targeted Assistance**		**Untargeted Assistance**
		Apply an explicit targeting strategy in order to properly identify the beneficiaries of the assistance; Governing body determines eligibility rules		Provide assistance to all consumers, or to a very broad part of them (e.g., all residential consumers), without trying to differentiate among their needs
		Application-Based	*Automatic*	
		Potential recipients must apply for benefits	Eligible recipients automatically receive benefits	
Funding Strategy	*Funding Source*	**State budget funding**	**Cross-subsidies**	**Unfunded Subsidies**
		Incorporation of subsidy scheme costs into state budget	Subsidies are covered through surcharges to other system users	Structural lack of financing, from either wrong estimations or explicit regulatory choices, eroding private capital
	Budget Calculation	**Top-down**	**Bottom-up**	
		Budget is pre-determined and amount of benefit is determined by number of participants	Amount of benefit is pre-determined and budget is determined by number of participants	
Governance Strategy	*Policy Creation*	**Centralized Governance**	**Localized Governance**	
		Assistance policy is created by central government and applies internationally/nationally	Assistance policy is created by local community and only serves those residents	
	Implementation & Oversight	**Central Administration**	**Regional / State Administration**	**Local Administration**
		Central governing body performs all duties	States or regional government responsible for implementation	Local governing body, NGO(s), or utility responsible for implementation

From this comparative analysis, we distill best practices. We evidence that, while in principle the socio-economic context does not significantly differ between the two regions (as they would from, for instance, developing countries), the way to approach the energy poverty matter is radically different. As a result, we consider that our review opens the floor to reflect about the mutual lessons to be learnt. Concretely, we discuss the interactions between and outcomes from the different design dimensions in energy poverty assistance programs and policy, including recommendations to improve their effectiveness (Section 8).

The in-depth review focuses on a set of representative energy assistance programs from both sides of the Atlantic, including the two main US federal energy poverty policies (the Low Income Home

Energy Assistance Program, or LIHEAP, and the Weatherization Assistance Program, or WAP) and the direct and indirect assistance policies from five European countries (four from the EU and one outside the EU): France, Ireland, Italy, Spain and the United Kingdom. The main sources of information for this review are summarized in Table ii, although further references are mentioned, when relevant, throughout the article.

Table ii. Energy Assistance Programs assessed in the article and main sources of information

Country	Policy	Link
France	Le chèque énergie	https://chequeenergie.gouv.fr/beneficiaire/eligibilite
Ireland	Warmer Homes Scheme	https://www.seai.ie/grants/home-energy-grants/fully-funded-upgrades-for-eligible-homes/
Italy	Bonus sociale elettrico	https://www.arera.it/it/consumatori/bonus_val.htm#dettagli
Italy	Bonus sociale gas	https://www.arera.it/it/consumatori/bonus_val.htm#dettagli
Italy	Fondazione Cariplo's ALTERNATIVE Call	https://www.fondazionecariplo.it/it/news/ambiente/bando-alternative-al-via-17-nuove-cer.html
Spain	El nuevo Bono social eléctrico	https://www.bonosocial.gob.es/#quees
Spain	Bono social térmico	https://sede.miteco.gob.es/portal/site/seMITECO/ficha-procedimiento?procedure_id=489&procedure_suborg_responsable=196&procedure_etiqueta_pdu=null
UK	Winter Fuel Payment	https://www.gov.uk/winter-fuel-payment
UK	Cold Weather Payment	https://www.gov.uk/cold-weather-payment
UK	Warm Home Discount Scheme	https://www.gov.uk/the-warm-home-discount-scheme
UK	Energy price cap and guarantee	https://www.gov.uk/government/publications/energy-bills-support
US	LIHEAP	https://www.acf.hhs.gov/ocs/low-income-home-energy-assistance-program-liheap
US	WAP	https://www.energy.gov/scep/wap/weatherization-assistance-program

3 GENERAL POLICY CONTEXTS AT BOTH SIDES OF THE ATLANTIC

The recognition of the need to combat energy poverty in the US emerged during the early 1970s, triggered by the oil crisis of that period. One of the earliest efforts was Maine's F.U.E.L. project

(Fuel for the Underheated Elderly and Low Income), initiated in 1973 with the goal of making homes more energy-efficient and providing emergency support. Following this project, the US Government responded with several measures that contributed to address energy poverty, including: the Headstart, Economic Opportunity and Community Partnership Act of 1974, the Energy Policy and Conservation Act of 1975, the Energy Conservation and Production Act of 1976, the inclusion of the Special Crisis Intervention Program in the Supplemental Appropriations Act of 1977, and the Home Energy Assistance Act of 1980.

The US maintains two primary federal programs that have been in operation for several decades to combat energy poverty across the US.[3] The WAP, created in 1976, distributes federal funds to states to help low-income households improve their homes' energy efficiency. This program supports families in reducing their energy expenses by offering grants for the installation of efficient appliances and better insulation. On the other hand, the LIHEAP, started in 1981, allocates federal funds among states to help households manage their utility bills [44].

In Europe, Brenda Boardman released the first official definition of energy poverty in 1991, named 'fuel poverty' in her research [45].[4] However, it took 18 years for the EU to formally introduce energy poverty into law by the Directive on common rules for the internal electricity market (2009/72/EC). In 2016, the European Commission published the 'Clean Energy for All Europeans package' [46] [47] [48] in order to facilitate the energy transition. The document set the Energy Union as a priority and pursues three main goals: (1) 'Putting energy efficiency first'; (2) 'Achieving global leadership in renewable energies'; (3) 'Providing a fair deal for consumers.' In 2018, the European Commission came to a political agreement [49] that sets the targets for energy efficiency (32.5%), renewable energy (32%) and electricity market for 2030. In 2019, the Council of ministers of the EU defined the remaining sections of the 'Clean energy for all Europeans

[3] The US still does not have a formal definition for energy poverty, despite an effort to include it in statute through House Resolution 4266 in the 1st Session of the 117th Congress in 2021.

[4] Her work defined it as the condition where a household is unable to afford the necessary fuel to keep their home at a satisfactory heating level. This definition highlighted the critical intersection of low income, high fuel costs, and energy-inefficient housing, stressing the importance of addressing these factors to combat the issue effectively. This research can be seen as leading to policies designed for addressing permanent energy poverty that does not only exist in times of crisis.

package' [50]. Two of the main intentions of the package were to reduce energy bills and tackle energy poverty.

In this policy framework, the regulation (EU) 2018/1999 [51] established several obligations for the Member-States' integrated national energy and climate plans. Specifically for energy poverty, the EU countries should: (1) asses the number of energy poor; (2) in case of a significant number of energy poor, carry out specific policies and set targets for the reduction of energy poverty in the country; (3) report information on progress towards the national energy-poverty-reduction targets. All this information has to be shared with the EU Energy Poverty Observatory (EPOV), which was the reference EU centre for energy poverty from 2016 to 2020. In this sense, the most recent report of the EPOV on the energy poverty framework in Member States was published in 2020 [52]. Furthermore, in the same year, the EU Commission published a Recommendation Document on energy poverty [53], which summarises the EU legislative framework and points out some guidelines for the analysis [54] and fight against energy poverty. Then, the 'updated' EU recommendation and guidance on energy poverty (2023) have all been part of the EU efforts to make energy poverty a key concept in the energy transition.

From the energy efficiency perspective, the Directive (EU) 2018/844 [55] sets the targets for energy performance of building, taking into account that 50% of EU's final energy consumption is used for air conditioning (heating/cooling), of which 80% is used in buildings. According to this European directive, the renovation in the residential sector would be needed at an average rate of 3% per year to achieve, cost-effectively, the EU's energy efficiency targets. Regarding the EU climate change plans, in 2021, the European Commission presented the amendments and actions of the European Green Deal climate initiatives. In particular, they announced the climate target plan to reduce net greenhouse gas emissions by at least 55% by 2030 (compared to 1990 levels) under the new Fit-for-55 package [56]. Parallelly, they proposed the establishment of a Social Climate Fund[5] to mitigate the potential regressive impacts of the climate plans [57]. This is expected to provide €72.2 billion for the period 2025-2032 in the EU budget from the new

[5] The changes introduced require EU countries to prioritise energy efficiency improvements for vulnerable customers, individuals affected by energy poverty and those living in social housing. To address any potential negative impacts, the revenue generated from the extension of the EU Emissions Trading System (ETS) to buildings and transport will be used through the Social Climate Fund.

Emissions Trading System in order to support European vulnerable households during the transition. Moreover, among the monitoring requirements for Member States, they are required to include: '(a) detailed quantitative information on the number of households in energy poverty; (b) when applicable, detailed information on progress towards the national indicative objective to reduce the number of households in energy poverty.'

Regarding emergency policies, in 2021, 25 of the 27 EU member states had implemented some sort of protection against energy price spikes through a reduction in taxes or surcharges on customer bills or direct assistance to consumers [58].[6] While more temporary policies were enacted to alleviate the increased burden during the European energy crisis (2021-2023), in this paper, we focus on more permanent approaches to address energy poverty for citizens that, in the absence of any policy, would continuously face energy affordability challenges.

To complement national programs, local governments alongside nonprofit organizations have played a pivotal role in developing a wide array of programs aimed at addressing energy poverty across both the US and the EU. Collaborations between government bodies and nonprofit organizations further enrich these programs, bringing together expertise, resources, and community engagement to create comprehensive solutions. This variety of approaches reflects an understanding that energy poverty is a complex issue requiring nuanced, multifaceted responses that can adapt to the unique circumstances and challenges faced by individuals and communities across different regions.

The distinction between policies to address general poverty and those specifically aimed at alleviating energy poverty can be subtle. Many nations lack a formal definition of energy poverty (for instance, Canada, see [59], and Germany [60]), and those that have adopted one take very different forms, even within the EU (see [61]). But the general consensus is that energy poverty is the result of several interdependent factors described above as low affordability (low incomes, high energy costs), and poor dwelling efficiencies, as well as unfavourable socio-demographic and climate contexts [62]. Some households may not be considered as living in poverty by their

[6] Though not exclusively, this analysis is not only but mainly built upon policies enacted in the UK and southern and Western Europe as a consequence of the concentration of strategies specific to energy poverty there. In some of the northern European countries—and those typically with increased wealth and social policies—there is not such a clear differentiation between policies to address general poverty and energy poverty.

respective poverty guidelines, but their energy services costs in their region may push them into poverty. Consequently, not all households experiencing energy poverty are living in poverty and not all households living in poverty are experiencing energy poverty. Even when these groups overlap, energy poverty policies explicitly enable households to afford energy services. Additionally, social policies to address general poverty can require more political will and be more controversial in the public opinion while policies specifically aimed at energy poverty alleviation can be easily defended as necessary for healthy living conditions [63] [64].

In the following sections, we detail a series of dichotomies that allow us to classify different strategies employed in energy poverty policy design.

4 ASSISTANCE STRATEGY

The first distinction we make when classifying policies to address energy poverty is the type of assistance that is provided to consumers: direct versus indirect support. Within direct support mechanisms, the second distinction is between payments versus discounts.

4.1 Direct support mechanisms

Direct support provides financial resources directly to individual consumers to cover part of their electricity expenses. We organize direct support mechanisms in two broad categories: payments and discounts.

The amount of money and frequency of payments are set by the governing body and, in some cases, is calculated to cover some or all of what is considered to be a necessary or basic amount of energy services. The exact calculation of the transferred amount is entirely case dependent. Payments can be in the form of cash or vouchers. Cash transfers afford recipients the flexibility to allocate the funds according to their specific needs and priorities. This empowers individuals to utilize the additional household income to procure goods or services that best suit their circumstances, whether it be payment towards an energy bill or other necessities forgone due to the burden of energy services costs. In the context of direct payments for energy poverty programs, the funds are intended to pay bills for energy services; otherwise, these payments would blur the line with general poverty measures. As a result, there are very few policies that give households cash payments. Instead, vouchers are used. Vouchers are also a form a payment, but they can only

be used for specific purposes, such as credit towards electricity bills, fuel purchases, or natural gas utility bills. This intentionally restricts the freedom of beneficiaries to use it elsewhere while still providing direct financial support after services have already been provided. Vouchers, therefore, are particularly useful when misuse of cash payments is a concern, and policies are specifically targeted at energy poverty.

Discounts act on the final price paid by the end user for energy services, with beneficiaries paying a price lower than the standard or cost-reflective amount. Discounts can be either distortive or non-distortive. Most often, discounts are applied on a per unit basis and are only applicable to a limited amount of consumption. These discounts are distortive and can affect consumption incentives. Discounts that are a lump-sum and apply directly to an energy bill are not distortive. In this sense, they are similar to vouchers, except they apply automatically to the customer's bill.[7]

Between the US and Europe, we notice that both utilize several direct assistance policies with payments to address energy poverty but the methods in which the benefit is transferred varies. In the US, LIHEAP is an example of a direct support policy using payments. The program has no intervention in the market-determined price for energy services. Instead, LIHEAP provides financial support to households to aid them in paying their incurred costs. LIHEAP recipients receive the benefit in one of two ways. In rare instances, a cash payment is provided to the household with the intention that it will be used for utility bill payments. Alternatively, and more common, the agency responsible for administering the funds can also pay the utility directly on behalf of the household, with funds being transferred to the utility and applied to a household's balance. We notice similar direct assistance programs in France and the United Kingdom [65]. In 2018, France instituted the "energy check" to support low-income households with payment of energy bills [66]. In this program, though, the check is not a cash payment but instead is delivered as a voucher that is accepted by a variety of utility suppliers.[8] In the UK, direct assistance is provided as cash infusions to households in the form of the Winter Fuel Payment (WFP), a tax-free annual payment to assist the elderly with affording heating fuels during the winter months

[7] Note that the automatic application of the discount to the customer's bill is different that automatic qualification for the program as discussed in the following sections.

[8] The voucher can be sent to electricity, gas, heat, heating oil, or other heating fuels suppliers, network operators, residential care providers for senior citizens, or APL-approved residential accommodation administrators.

[67]. It ranges in value from £200 to £600. There is also the Cold Weather Payment (CWP) given as a £25 automatic deposit for each week in which the temperature is below 0ºC for seven or more consecutive days between November 1st and March 31st [68].

Direct support policies that employ the non-distortive discount method include Italy's electrical social bonus and a gas social bonus that are applied as discounts on the bill [69]. The electric social bonus benefit is discount directly on the customer bill, ranging from approximately €50 to €70, and the gas social bonus ranges from €11 to €42. The value of each benefit varies by year, and these amounts reflect the increased benefits for 2023. The UK also has a discount program for direct assistance called the Warm Home Discount Scheme (WHDS) which provides a one-time balance reduction of £150 applied directly to a household's electricity bill between October and March [70].

A distortive discount policy that is applied on a per unit basis is in place in Spain, called the Electric Social Bonus [71]. Consumers receive either a 25% or 40% discount on their electricity bill, based on their vulnerability classification. This bonus experienced temporary increases to 65% or 80% from October 2022 to September 30, 2024, then decreased period by period and will reach the original values in 2026. This discount on electricity bills is subject to consumption restrictions, ranging from 1,587 kWh for individuals up to 4,761 kWh for a registered large family or cohabitation unit of five or more people (current as of March 2024) [72].

It is possible for governments to implement policies that act on costs of energy services, impeding the actual pass-through of real costs to the consumer, resulting in a general underpricing of energy services (e.g., through provision of fossil fuels at below-market prices, using either a regulated price cap on domestic resources or import tariffs, tax exemptions for power sector investments to reduce costs, and grants for the installation of certain components of the power system); however, while these measures can reduce the immediate financial burden of energy on consumers, they are typically part of a broader energy strategy rather than specifically energy poverty interventions.[9]

[9] A combination of the UK government and the Office of Gas and Electricity Markets (Ofgem) provide an example of this type of support provided though a discount applied during the cost of service calculation by the utility. Support is provided through a maximum annual energy expenditure for all households on the default tariff in the UK. The UK

4.2 Indirect support mechanisms

In contrast to direct assistance, indirect support policies aim at acting on the causes of increased energy bills, typically by increasing the energy efficiency of a consumer's dwelling and providing support to help lower energy consumption [74]. These policies may involve offering tax incentives or rebates for weatherization or efficiency upgrades that can result in future savings to the household by reducing future consumption.

The WAP is a prime example of an indirect support program in the US. By providing money to install energy efficient upgrades within a consumer's home, the program aims to reduce future energy services costs and, consequently, reduce the household's energy burden. Similarly, the Sustainable Energy Authority of Ireland (SEAI) provides fully funded home energy efficiency upgrades to households as part of the Warmer Homes Scheme. This program covers insulation upgrades, draft-proofing, lighting changes, and advice for energy consumption savings. In France, a wide range of energy efficiency policies has been implemented for vulnerable households. A significant number of these financing programs targeting energy-poor households are implemented through national, regional and local governments, such as the social funds for energy renovation and the Living Better (*Habiteur Mieux*) program [75]. However, private financing is also present through the white certificates scheme, which includes a specific obligation for energy suppliers to promote energy efficiency improvement actions in vulnerable households. Another type of action in the fight against energy poverty in France from an efficiency perspective are the energy audit programmes (*Audit energetique*) [76], developed in collaboration between the three sectors (NGOs, private actors and governments), in order to provide vulnerable households with energy saving advice. In the context of programs promoting or supporting energy efficiency in UK households, several key initiatives stand out. The Green Homes Grant Voucher Scheme (GHGVS),

government supports the Price Guarantee, set at £3,000 annually, and Ofgem supports the Price Cap, set at £1,923 for October to December 2023. The price cap represents the typical default tariff consumer who is on a dual fuel rate and uses 2,900 kWh of electricity and 12,000 kWh-equivalent of gas annually. The maximum amount that households are subject to is the lower amount of the cap or the guarantee. For instance, between October and December 2023, Ofgem's price cap will be in effect over the price guarantee. Despite publishing the cap at the annual amount for a typical household, it is actually a cap per unit of gas and electricity with standing charges accounted for so that consumption behaviors, payment method and location still affect a household's energy expenditures. As a result, households can have annual expenditures well above the published price cap, but their per unit rate is capped at the level that the typical household is exposed to [73].

launched in September 2020 and closed on March 31, 2021, provided low-income homeowners in England with up to €11,402 to implement energy efficiency and low-carbon heating measures, potentially saving up to €684 annually on energy bills. The GHGVS resulted in the installation of 82,500 measures across 47,000 homes, achieving an average annual energy bill saving of €300 per household. The evaluation highlighted that while the scheme successfully improved energy efficiency, it faced challenges in administration and delivery, leading to lower-than-expected uptake [77]. The Green Homes Grant - Local Authority Delivery (LAD) aims to improve the energy efficiency of low-income and low energy-rated homes (D, E, F, or G), including those off the gas grid. As of August 2024, LAD Phases 1, 2, and 3 have collectively upgraded 58,500 homes with 77,800 measures installed [78]. The Energy Company Obligation (ECO) mandates large energy suppliers to deliver energy efficiency and heating measures to energy-poor households across Britain, with 2.8 million measures installed in over 2.1 million homes since 2013, resulting in annual savings of up to €342 for eligible households [79]. The Home Upgrade Grant, approved in 2020 and set to roll out in 2022, replaces the Green Homes Grant, with a total funding of around €1.5 billion, including €171 million aimed at improving the worst-performing off-gas grid homes in England. Lastly, the Minimum Energy Efficiency Standards [80], established in 2015 and updated in 2018, require private landlords renting F or G-rated properties to upgrade to at least an E rating, with a financial contribution of up to €3991 if external funding is insufficient, as a step towards achieving a minimum C rating by 2030.

5 TARGETING STRATEGY

Aside from determining what type of assistance is supplied, a critical challenge is determining who are the recipients of the program and how to reach them. Programs can either be targeted, applying an explicit strategy to properly identify subsidiaries, or untargeted, benefiting all consumers or a very broad range of them without trying to differentiate among needs.

Untargeted policies or schemes are designed to provide benefits or assistance universally, without distinguishing between different levels of need among potential recipients. These policies are implemented with the intent of simplifying administrative processes and ensuring that no eligible individual or household is inadvertently excluded from receiving support [81]. Unlike targeted programs, which require specific criteria to be met for eligibility, untargeted initiatives extend their

benefits to a broad audience, often the entire population or large categories of it, such as all residents within a certain geographical area or any consumer on a given residential tariff design.

An example of an untargeted policy is a progressive rate structure (often referred to as inclining block rates), under which households are charged in a stepwise fashion increasing rates as their electricity consumption increases. For example, in the US state of Idaho, there are three tiers of consumption that have different prices: 0 to 800 kWh priced at approximately $0.10, 801 to 2,000 kWh priced at approximately $0.12, and 2,000 kWh or more priced at approximately $0.14. Inclined block rates can combat energy poverty as they can allow the first tier of electricity be charged below the market reflective value of that electricity and the top tier to be charged above costs. These missing funds can be recovered charging higher rates to the upper tiers (a cross subsidy supported users that utilize the most energy). For this policy to be successful in combating energy poverty, it must hold true that income correlates positively with electricity consumption from the network, so that lower income users benefit from the lower-than efficient prices and higher income users are providing enough money to the utility from higher than efficient prices. This might have been the case until the advent of rooftop solar power, that allows wealthy residential customers to actually withdraw less energy from the grid[10]. Additionally, the amount of consumption that is in the lower-than efficient tiers must be enough to ensure that energy poor households can cover their basic energy needs. Determining what is a sufficient amount of energy usage for a household to maintain healthy indoor temperatures and run necessary appliances is not an easy task and requires site-specific information.

To try better focusing resource allocation on households that require the most assistance, targeted programs can be implemented. In designing a targeting strategy, the governing body is responsible for determining one or more eligibility requirements that must be met by households in order to receive assistance. Eligibility requirements for assistance can span several categories to ensure that support is direct towards households or individuals that face the greatest risk of experiencing energy poverty. These categories include, but are not limited to, income, energy burden, housing

[10] For instance, see [82] for an in-depth discussion on how the deployment of distributed generation technologies potentially threaten the current regulatory balance that includes ameliorating energy poverty. Other authors, as for instance [83], argue that even before the advent of these technologies, electricity use was only loosely correlated with income.

characteristics, demographic groupings, existing program eligibility, and utility data analysis. Determining how households will be targeted and what measurements will be used to track progress acts a proxy for defining energy poverty [29]. Income-based targeting offers assistance to households beneath a certain income threshold, presuming these are more likely to face energy cost challenges. Energy burden targeting, alternatively, aids those spending a high percentage of income on energy, identifying households disproportionately affected by energy expenses. Physical characteristics of housing, such as insulation quality and heating system efficiency, guide interventions towards energy efficiency improvements, directly addressing the infrastructural causes of high energy costs. Demographic targeting prioritizes aid based on age, health, or geographic factors, recognizing some groups' increased vulnerability to energy poverty. Cross-program eligibility and utility data analysis streamline recipient identification by utilizing existing welfare participation and payment patterns, minimizing administrative efforts while ensuring targeted support reaches those in genuine need. If a very specific set of recipients is desired, multiple requirements can be set to qualify, such as households of a certain size that also make less than a specified income and participate in other social welfare programs. More complex targeting schemes may imply a significant administrative burden and may render themselves difficult to implement [84]. This becomes particularly important when automatic enrollment in programs is employed, as discussed later in this section.

The majority of energy poverty policies employ a targeted strategy. In France, the energy check’s amount is based on the household income, with a maximum income threshold, and is adjusted for the number of individuals living within the household. For LIHEAP and WAP in the US, income is the only established threshold. WAP requires that households receiving assistance have an income less than or equal to 200% of the federal poverty line or 60% of the state median income. LIHEAP requires that household income is less than or equal to 150% of the federal poverty line or 60% of state median income. In both programs, US states may enforce stricter rules and allow for receipt of supplemental security income or alternate government benefit programs to qualify households; however, they cannot increase the income thresholds above the set levels. For the UK’s WFP, eligibility is based solely on the recipient’s age. Currently, the benefit is available for individuals born before September 1957.

We also see a variety of policies that include multiple requirements that can add complexity to qualifying for assistance. To qualify for Spain's electricity social bonus households must have contracted the voluntary price for the small consumer (PVPC) tariff, a maximum power capacity less than or equal to 10 kW, and meet the personal, family, and income requirements. Vulnerable consumers, eligible for the 25% discount, must meet only one of four requirements: income less than established levels, possession of title of large family (3 or more dependents), consumer or all members with income are pensioners of the Social Security System, or any member if a beneficiary of the Minimum Living Income. For severe vulnerable consumer status, similar requirements apply but with stricter limits (e.g., receiving an annual income less than or equal to the income thresholds set for vulnerable consumers). Similarly, eligibility for Italy's electrical bonus and gas bonus require a family unit with four dependent children, maximum income thresholds, or receiving the citizenship income or pension. Households can also qualify for the electrical bonus if they experience physical hardship or have a member with a serious illness that is forced to use electronic medical equipment. For the gas bonus, a household's climate zone and gas usage for heating, cooking, or domestic hot water are also considered.

Beyond setting eligibility requirements, to implement targeted assistance the administrative body must be able to identify households that meet the requirements and enroll them in the program. We analyze the two main strategies to identify and also qualify the desired group: application-based or automatic enrollment. In application-based targeting, the regulator defines a set of rules for eligibility for a program and recipients must apply for approval to be a recipient. When an application-based strategy is used, consumers must be aware of the program's existence and notify the governing body that they are eligible for receiving the benefits [85]. For automatic targeting, the governing body still sets the requirements for eligibility but everyone that meets the set criteria automatically receives the benefit. To employ this strategy, the regulator or governing body must have sufficient data on households to automatically enroll them to receive the benefits. The recipient does not need to take any action and should expect to receive the benefit given that they meet the set requirements. For example, if the government decided to automatically enroll all low-income households in a direct payment program, they would need access to each household's income data to automate their system to send payment to the households that meet the requirements. The administrative burden to employ automatic targeting can be quite intensive depending on the volume of data required, the software system(s) necessary, adhering to privacy

protection regulations, and the staff available to administer the program. Once the system is up and running, though, the process can be streamlined and removes the need for application review and approval.

Both of the US federal policy approaches fall into the application-based category along with Ireland's Warmer Homes Scheme, and Spain's social electricity bonus and both Italy's electricity and gas bonuses. The purpose of designing policies with a means tested strategy is to provide the administers of the program data that they may not have easy access to. There is an important distinction, though, in the US and Ireland application processes versus those in Spain and Italy. In Spain and Italy, households request the benefits after proving eligibility and the government or service provider is expected to provide the bonus. In Spain, there are eight reference marketers that are obligated to offer and ensure the receipt of the social electricity bonus after households request it by phone, email, mail, or fax. For Italian households that qualify for assistance, there is a Single Self Declaration form that must be filled out and submitted annually to the corresponding government office (e.g., the National Institute of Social Security or local municipality office) to obtain access to the benefit. There is also an option for households to obtain a pre-filled document that includes pre-fille data by the Italian Revenue Agency and requires only some self-declared user data. In both of these Italian bonus application scenarios, if the household submits the required information for the program, they will receive the benefit. In Spain, on the other hand, the Ministry for Ecological Transition can reject a bonus application if it finds that the household does not meet the eligibility criteria.

In the US, however, households must submit an application that proves they meet eligibility requirements but are not guaranteed to receive the benefit by doing so. The same is true for Ireland's energy efficiency upgrades program. There is still a form and application that must be filled out to self-declare eligibility. Once a household has submitted this information, the governing body responsible for distributing the benefit then reviews the applications submitted and determines which households will be recipients of assistance. The applications in the US appear to be more involved and require more information to prove eligibility than the programs analyzed in Europe For example, the application for WAP requires information and documents on previous utility bills, income, social security numbers, and proof of residence ownership, which is similar to the Spanish case. Additionally, when the budget is constrained and acts as the limiting factor,

applications can lead to the distribution of resources on a first-come first-served basis. Alternatively, the government can wait for all applications to be received and then distribute funds based on greatest need. In both scenarios, there are likely households that are eligible but will not receive any assistance.

Apart from application-based targeting, we see the use of automatic enrollment across a variety of programs in Europe and in special cases of LIHEAP in the US. This the case for the Portuguese social bonuses [86], the UK's CWP, WFP, and WHDS, the French energy check, and Spain's thermal social bonus[11]. In these programs, the governing body is able to use readily available data to determine which households are eligible for the program without the household needing to submit additional information for the program. We notice that the eligibility requirements are based on information that government already has, such as income data from previous years tax returns or climate zone of a household based on geography. For example, the French energy check is automatically sent to households based on their income declaration from the previous year's tax returns. Within the LIHEAP program, households that have already applied and been approved for other federal benefit programs may qualify for automatic eligibility. For the UK's WFP, if you have received the benefit before than you are automatically enrolled to continue receiving the benefit; however, if you have not received the benefit before you must apply if you are not a part of the long list of pre-qualified programs. Automatic enrollment for programs is advantageous in that (nearly) all households that are targeted for the program receive the benefit. Whether the program targeting uses application-based or automatic enrollment, determining the amount of benefit per household, and balancing that against program budget can be a complex process. The following section discusses questions concerning selecting a funding strategy to do so.

6 FUNDING STRATEGY

Determining the source of funding is a crucial step that influences the structure and political feasibility of the assistance program. There are three primary funding strategies commonly used and considered in this analysis: state budget funding, cross-subsidies, and unfunded schemes.

[11] The caveat for the thermal bonus is that households are automatically enrolled based on their eligibility for the electricity social bonus. As a result, Spain's thermal social bonus is technically automatic but it does require the prerequisite of applying to the electricity bonus first.

Additionally, the concepts of closed and open budgets are important for understanding how these strategies are implemented and their impact on policy effectiveness.

The most common funding strategies employed when designing assistance programs are incorporation into the state budget or use of cross-subsidization. In the first approach, the government allocates specific funds to the agency or department responsible for administering the program, transfers to utilities on behalf of beneficiaries, grant programs for efficiency improvements, etc. This method relies on taxpayer money or reduced revenue from tax exemptions or rebates. Cross-subsidization is typically performed at the utility level and passed through to customers as a new line item on the bill or increased rates for energy services.

In the case of unfunded schemes, which are much less common across the US and Europe, there is an explicit absence of dedicated funding for the program. This lack of funding might result from inaccurate budgetary estimations during the planning phase or a deliberate decision to not allocate public or private funds to the program and erode private capital instead. In such cases, the responsibility for increasing affordability may fall directly on energy suppliers or service providers, who are expected to absorb the costs of these mandates without direct financial support from the government or through user surcharges. Unfunded schemes can lead to challenges in sustainability and effectiveness, as they rely on the willingness and ability of energy suppliers to support these initiatives without compensation.

Across all of the policies analyzed, state budget funding is frequently the preferred method for financing energy poverty assistance programs. This method provides a direct, reliable source of funding that ensures the stability and predictability necessary for the long-term planning and implementation of assistance programs. At the same time, this strategy competes with other public spending priorities and requires political capital to be approved. Still, we see that both federal programs in the US, the UK’s WFP and CWP, France’s energy check, Italy’s electrical social bonus and a gas social bonus, and Spain’s thermal bonus are paid for by state budgets.

While less common than state budget funding for assistance programs, we see cross-subsidization employed to fund benefit programs for households through their energy services provider.[12] The UK's WHDS and Spain's electricity social bonus are examples of programs funded through cross-subsidies by other electric consumers. The WHDS requires that energy suppliers are responsible for payment of the discount on qualifying households' bills. Suppliers then recover these costs through a line item on the bill of all consumers. Until recently, Spain's electricity social bonus was implemented as an unfunded scheme, with the burden of financing falling solely on the electricity services companies; however, the Royal Decree-Law 6/2022 and following Order TED/733/2022 shifts the financial burden of the program to all participants in the sector. Now, funding for the benefit is subsidized by generators, distributors, retailers, and residential consumers. We also see benefit programs that utilize cross-subsidization by utility ratepayers across various states and utilities in the US. For example, Ohio's percentage of income payment plan (PIPP) caps the cost of natural gas and electricity bills to 5% of household income for qualifying households, and utilities recuperate lost revenue via a rider on all customers of regulated utilities in the state. In this example, a rider is a charge on the customer's bill that is not included in standard rates but is a separate line item to recover the cost of the program.

An example of an unfunded scheme exists in the UK's energy price guarantee and cap. This benefit is applied as a cap on the amount per unit of energy that providers can charge to consumers, and the lost revenue is not backfilled through any explicit funding mechanism.

6.1 Top-down or bottom-up calculation of program funds

Another critical consideration in designing the budget strategy for an energy assistance program is the choice between a top-down or bottom-up calculation of the total cost to implement the program. In a top-down approach, the total budget is predetermined, and the benefit amount received by each consumer is calculated by the number of participants in the program. Alternatively, the budget can be predetermined, the amount of benefit specified, and the number of possible participants in the program is then set by simple division. The top-down approach is

[12] Traditionally, cross-subsidization could have been seen as a better way to shift the burden of funding assistance programs to the wealthy as a result of the positive correlation of metered consumption with increasing wealth; however, as more distributed generation has been installed and rates remain mostly volumetric, the correlation between wealth and electricity consumption may not work anymore.

preferrable when funds are limited or predictability is required; however, it can force exclusion of some eligible households. Once the budget is set, the program relies on the number of eligible households identified to determine the benefit that each household should receive. If the number of eligible households is large and the program budget is not equipped to provide support for that many households, then a minimum benefit should be set so that households are receiving a meaningful benefit. When this happens, though, it is inevitable that there are eligible households who are unable to receive benefit as the program budget has been exhausted.

The alternate option is the bottom-up approach. In this design, the benefit per eligible household is predetermined and the total cost of the program is calculated by multiplying the benefit by the total number of eligible households. In theory, the predetermined benefit amount would be calculated to be a necessary amount for households to alleviate the burden placed on them by their energy services costs. By starting and the individual level and working up to calculate the budget, all households requiring support are able to receive the benefit. In practice, though, this approach can create very large budget requirements that require massive amounts of spending and can be politically difficult to implement. When the program budget grows beyond a reasonable amount, the governing body may be required to lower the benefit per household to decrease the required funding to a level that is practical and politically feasible. In this way, this approach runs the risk of either incurring cost overruns based on the number of eligible households calculated or only providing enough benefit to partially assist households.

The choice between the top-down or bottom-up budget design is where US and European policies diverge the most. The top-down approach is commonly employed in the US. Both LIHEAP and WAP are funded by appropriations in the federal budget each year. Congress determines the budget for each program every year as part of the larger federal budget decisions. Once the budget for each program is set, the total funding is allocated to states based on historical funding and formulas included in statute [44]. The states are then responsible for distributing the funding allocation they receive to beneficiaries, determining how much each eligible household should get based on the total funds the state received. In previous years, WAP has annually received anywhere between roughly 150 to 275 million USD from Congress whereas LIHEAP has received between approximately 3 up to 4.5 billion USD. In practice, these appropriations are arbitrary and are expected to cover total costs to implement the program (e.g., administration, planning, and

technical operations). Figure 1 illustrates the evolution of LIHEAP budget, the percent of eligible households receiving assistance and the average benefit in recent years, with data published by the US Department of Health and Human Services [87]. Despite the increasing LIHEAP budget, the percent of income-eligible households receiving assistance is decreasing while the average amount of heating benefit remains constant.

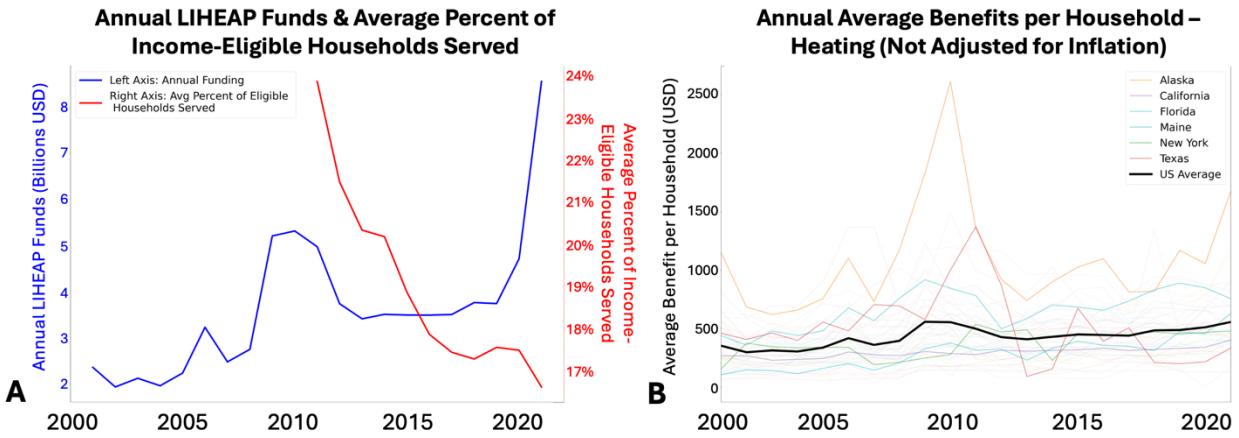

Figure 1. US LIHEAP Budget, Income-eligible Households Served, and Average Annual Heating Benefit

The nominal value of heating benefit remains nearly constant; however, the percent of eligible households being helped decreases over the period despite budget increases. This is a feature of the top-down approach that sets the budget first and then divides up the resources. This suggests that the number of federally eligible households is increasing at a faster rate than the budget for the program is increasing, and the top-down budget design is continuing to limit the number of eligible households that are receiving any assistance. Combining state budget funding with a top-down approach has also been shown to make funding more susceptible to political intervention, as evidenced by the recent cuts to the LIHEAP program [88] [89].

On the other side of the Atlantic, we see that the bottom-up approach is favored. For example, in the UK's WFP, the benefit is set at £200 per household where the oldest member is under 80 years of age and £300 per household with a member 80 or over. The estimated budget for the program then is calculated by multiplying the predicted number of eligible households with the benefit they would receive. Similarly, the French energy check sets amounts for each year and then calculates the number of households that qualify which determines the program budget. It is important to note that once the benefit is set and the total program budget is calculated, governing bodies have

a few ways in which they can reduce the cost if it is not politically feasible or practical. They can decide to decrease the benefit amount, restrict the eligibility requirements, or implement a cap on the maximum number of beneficiaries that receive the benefit. The last option is difficult to argue in determining how eligible households will be selected for receipt of the assistance and can be politically challenging to navigate; however, it can be preferred as an alternative to eroding the amount of assistance provided to allow all eligible households to receive any benefit under a budget constraint. The Spanish social bonus for electricity uses a bottom-up approach by applying different discounts for different categories of vulnerable consumers, identified by socio-economic features, and thus does not have budget constraints. On the other hand, the thermal social bonus varies each year according to the state budget availability, thus applying a top-down approach. Besides, to assign the aid amount, it considers the same vulnerable consumers classification as the electricity ones, plus the climate zones. Finally, the amounts of Italy's electricity and gas social bonuses are calculated using a bottom-up approach, where the benefit per eligible household is predetermined based on household size, geographic location, energy use, and climate zone, and the total program cost is then derived by multiplying this by the number of eligible households. The program is not limited by a fixed number of participants or a capped budget; instead, all who meet the criteria receive the defined benefit, which is automatically applied through the national welfare system.

7 GOVERNANCE STRATEGY

Finally, the last key strategy decision in designing and classifying energy poverty policies is how the assistance program is governed. The governance strategy can be broken into two branches: who enacts the policy and who is responsible for implementation and oversight. In enacting policy, we differentiate between centralized and localized approaches.

Centralized policy enactment occurs when a higher or central authority, such as a national government or a federal agency, makes decisions and formulates policies that are uniformly applied across a broad geographical area or jurisdiction. Centralized policies tend to prioritize consistency and uniformity, aiming to create a cohesive and unified approach to governance. In contrast, localized policy enactment involves granting a significant degree of decision-making authority to lower levels of government or local authorities, such as state governments,

municipalities, or even community organizations. In this model, policies and regulations can be tailored to the unique needs and circumstances of specific regions or communities. Localized policies are often seen as more flexible and responsive to local conditions, allowing for greater customization to address local challenges and opportunities [90].

The scope of policy application differs significantly between these two approaches. Centralized policies typically have a broader scope, applying uniformly across a larger geographic area or population. They are better suited for addressing national or regional challenges that require a standardized approach. On the other hand, localized policies have a narrower scope, as they are designed to address specific issues within a particular community or region. This narrower focus allows for a more nuanced response to local conditions and preferences. Choosing between a centralized or localized enactment strategy depends on the homogeneity within a region, the desired balance between uniformity and customization, and the assistance strategy employed. Additionally, many local governments and organizations may not have the budget and regulatory power necessary to enact energy poverty programs.

The policies we describe are all centralized as they are enacted by a central governing body. There are many localized initiatives across both the US and Europe, including programs enacted by local governments, utilities, and non-governmental organizations (NGOs); however, complete analysis of them is beyond the scope of this analysis. Within centralized enactment of policy, though, the implementation and oversight can be performed at different scales. This analysis considers central, regional, or state and local administration of policy. In a central administration structure, the central governing body that enacts the policy is also responsible for all actions to carry out the program and ensure its success. In some cases, though, the central governing body will enact the policy but delegate responsibility of implementation and administration to regional, state, or local governments. Within local administration, there is the possibility of partnerships with local non-governmental organizations or with utilities to perform duties. When policies are enacted by the central government and implemented by local administration, more flexibility and personalization is introduced within each smaller geographical region to suit the needs of each community. However, the coordination among different administrative levels might create delays in subsidy reception, as is happening with the thermal social bonus in Spain.

In the US, we notice that while both LIHEAP and WAP are enacted by the federal (central) government, their implementation and oversight is performed by each individual state and territory, with some states also engaging local governments to deliver assistance to households. This is aligned with the typical delegation of responsibilities in the US, where federal programs are administered at a more regional or local level given the size and vast, varying geographies across each state. In Europe, there appears to be more coordination and implementation performed by the national (central) government. There are initiatives and requirements that are set by the EU Commission, but the actual policies are designed and implemented by individual member states. For example, the French energy check is designed, enacted, and also administered at the national level. The same holds true for the UK's WFP, CWP, and WHDS. Italy's electrical and gas bonus programs are also handled entirely at the national level. In Spain, the governance is different depending on the subsidy. Both electricity and thermal bonuses are designed by the Central Government, but they are administered, respectively, by energy utilities and regional administrations.

8 DISCUSSION AND POLICY RECOMMENDATIONS

Within the framework we present for designing energy poverty assistance policies, there are several advantages and disadvantages to decisions made in each of the four dimensions. Here we discuss these and provide a discussion on the interactions between decisions made in each step.

A majority of the energy poverty policies implemented in the US and Europe utilize direct assistance. These types of programs are important to provide immediate relief to households to ensure the lights stay on and that indoor temperatures remain healthy. Additionally, these policies, if appropriately targeted and funded [12], could be effective in the near term and can alleviate pressure on the governments to take action to help households. These policies work particularly well when there is an energy crisis and spikes in energy services costs are realized, but they can be seen as treating energy poverty as a temporary experience for households, referred to as palliative as opposed to preventive or curative policies [9]. In reality, there are many households that experience energy poverty consistently from year to year. This distinction between temporary and permanent energy poverty is important when considering the type of assistance strategy to employ. Indirect policies that address energy efficiency or provide access to distributed energy

resources can serve to help address part of the underlying issues that pushes households into energy poverty (recall the three main drivers of energy poverty: sustained low incomes, high energy services costs, and poor dwelling energy efficiency). As it can be largely proposed in the literature [9] [59] [91] [92] by working to fix the causes of energy poverty through indirect support policies, governments can begin to lift households out of energy poverty and reduce their reliance on direct support programs. Another key issue is how to deal with households in rental agreements [93]. The revised EU Energy Efficiency (EU/2023/1791) includes improved regulations to identify and remove barriers related to split incentives for energy efficiency renovations between tenants and owners or among multiple owners.

The preference for direct support assistance programs is noticeable when we compare the budgets of the two programs in the US. LIHEAP, the direct assistance program, is consistently receiving 10 to 15 times more funds from Congress each year than WAP, the indirect assistance program. The difference in funding reflects both the need to provide assistance to help households get through crises each year and also the political resistance to provide funding for indirect assistance projects that realize benefits many years in the future. Additionally, to prove indirect support programs are effective, the projects typically must show that there is a positive return on the investment leading to exclusion of households where repairs are extensive enough that the cost-benefit ratio is less than one. Even more difficult is providing indirect support to households where the occupants are not the property owners. Both WAP in the US and the Warmer Homes Scheme in Ireland require a lengthy application process that includes submission of necessary information, home inspections, connections with third-party contractors to perform upgrades, and assessment of the upgrades after completion. As a result, it is much less burdensome to send direct assistance to households.

Regardless of the assistance strategy selected, the targeting strategy step requires determination of which households will be eligible for the program. For energy poverty policies specifically, the criteria for targeting act as a quasi-definition for energy poverty; however, many targeted policies use only income data or social welfare status, which blurs the line between energy poverty and general poverty experiences. While households that experience energy poverty typically overlap with households that are living in poverty, as defined by the government, they are not always the same. There are households in which their income puts them above the poverty threshold, but their

energy services costs either put them below the poverty line or they are forced to forgo the purchase of necessary goods to pay their energy bills. As a result, when thresholds are derived for a program's targeting strategy, there are two common errors that occur: wrongful exclusion and wrongful inclusion [94]. Specifically, it is important to be cognizant of these errors when numerical cutoffs force differentiation among individuals that should or should not be considered the same [95]. Among the policies instituted in the EU to shield households from the energy crisis beginning in 2021, approximately 78% of all allocated and earmarked funding across member states was used for untargeted programs that acted on prices or supplemented incomes [96]. This is purposeful wrongful inclusion as all households and businesses were affected greatly by the energy price shocks that occurred during the crisis.

In the long term, though, it is important to target these programs to households that need it most. If the only criteria to qualify for the program is energy burden [97], it is likely that some households experiencing energy poverty will be wrongfully excluded as they have an income above the threshold but high energy services costs or have purposefully reduced their consumption to unhealthy levels to lower their energy burden[13]. On the other hand, some households could be wrongfully included if they have a moderate to high income but utilize large amounts of energy (e.g., for electric vehicle charging, private swimming pool heating, etc.) that push their energy burden to be above the threshold. In practice, though, obtaining data beyond income, energy burden, and demographic data can be challenging at the regional or national scale. As a result, many government programs must rely on a select few characteristics to qualify households that lead to these inclusion and exclusion problems. In countries where there are several programs in place, a variety of targeting strategies can be used across the programs to increase coverage of energy poor households inclusion in at least one benefit scheme [99].

Beyond the targeting strategy selected, we note a strong connection between the funding mechanism selected and the usage of an application versus automatic qualification. Policies that employ a top-down approach typically require applications from households to certify household eligibility. On the other hand, there is a clear parallel with the automatic qualification based on

[13] Karpinska & Śmiech (2020) argue that more than 20% of the Central and Eastern European population is exposed to hidden energy poverty. Papada & Kaliampakos (2020) propose a "Degree of Coverage of Energy Needs" index, the ratio of "Actual/Required energy cost" of a household [96].

eligibility and the usage of the bottom-up approach. By estimating the budget based on the number of eligible households, the program is designed to provide benefit to all that qualify so automatic qualification works well. There are some cases of policies designed with the bottom-up approach that use an application system to certify eligibility; however, it is expected that all households that are able to prove eligibility will receive the benefit. In the top-down approach with applications, it is not guaranteed that all households will receive the benefit, as applications need to be reviewed and households selected for qualification to not erode the benefit to a non-useful amount[14].

As a result of how the application process is designed in the US, for instance, there are only a limited number of eligible households that actually benefit from these programs. Therefore, there is a decision to be made within the application design. If the application is solely to confirm household data that the governing body may not have readily available, it can still reach all of the eligible households. When decisions are made based on the application and automatic qualification is not made as a result of successfully submitting the application, families that deserve the assistance may not receive it. Additionally, an issue with any application-based program design is ensuring that all households have knowledge of the program and the resources to apply. Many families, often those who may need assistance the most, are unaware of a program's existence and lack the necessary information on how to enroll in them successfully [100]. Additionally, the private costs associated with applying can limit the benefit and deter eligible participants from applying [101]. Lengthy applications and any required trips to government offices—only open during regular business hours—make these applications especially tough for low-income and rural families. When these programs rely on a household's knowledge of and access to program applications, they risk excluding households that require these benefits to maintain healthy, sustainable living conditions.

Finally, to help reduce the impact of some of the challenges faced in targeting and engaging energy poor households, important decisions in the governance strategy can be made. Households experience energy poverty in many ways and not all households are the same across different regions and sociodemographic groups. As a result, using the power and budgetary capabilities of the centralized government to enact policies and leveraging community knowledge from local

[14] The top-down budget design is also more prone to political intervention, as evidenced by the recent announcement of cuts to LIHEAP funding.

governments and NGOs for implementation can prove useful in promoting successful programs. This approach might ensure that policies are not only ambitious in scope but grounded in practical, locally relevant solutions. By working together, central government and local agencies can enhance the precision of targeting by matching the needs of their community and using useful insight into the lived experiences. Consequently, the local agencies can be useful to the central government body by provided more detailed data to monitor the number of households experiencing energy poverty and at what levels based on different metrics. This comprehensive strategy underscores the importance of flexibility, allowing policies to adapt over time as new insights and challenges emerge, ultimately contributing to the reduction of energy poverty in a more sustainable and inclusive manner. However, it requires dynamic cooperation between different levels of public administration, which can be difficult in some contexts (as we mentioned in the case of the Spanish thermal social bonus).

9 CONCLUSIONS

This analysis highlights the complex and multifaceted approaches taken by the US and European governments to combat energy poverty. Through this review and classification of various policies and programs by assistance, targeting, funding, and governance strategies, we extract key challenges that governments face when designing them. While direct assistance programs provide crucial immediate relief, increasing emphasis on energy efficiency and affordability of distributed energy resources is needed to address the underlying causes of energy poverty. Balancing immediate support with long-term sustainable solutions is difficult both financially and politically; however, we have seen a shift towards this balance in recent years. The effectiveness of any of these strategies requires ongoing evaluation and adaption to ensure that they meet the evolving needs of the energy poor. In terms of funding strategy, top-down budget design may limit the number of eligible households that are receiving any assistance, or reduce the assistance itself. Comprehensive data collection and access to utility data is necessary to improve the targeting of households and the ability of administering agencies to engage with them. Additionally, increased coordination among federal governments, local governments, and NGOs will combine the large-scale budgets and power of centralized governments with the local knowledge of lived experiences to better serve affected communities.

As climate change intensifies and wealth inequality increases, low-income households will face the greatest burdens of the energy transition despite being essential to the transition's success. Future policies should prioritize comprehensive strategies that integrate direct assistance with investments in sustainable energy infrastructure, fostering collaboration across sectors to innovate and implement solutions that not only alleviate energy poverty but also contribute to global environmental goals.

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