

Review

# Future Design Approaches for Energy Poverty: Users Profiling and Services for No-Vulnerable Condition

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**Abstract:** Analyzing data from the Energy Poverty Observatory in Europe, it emerges that more than 50 million households in the EU live in energy poverty (people that cannot heat their homes during winter; cannot make their homes comfortable during the summer; pay their energy bills late). Research studies realized in the last 20 years highlight that making energy demand efficient and effective is the more significant and socially important the more it is able to involve users who are unable to sustain energy demand. The evolution of the research sees a narrowing of the field of investigation by focusing on the user dimension of energy poverty, stressing the role of citizens not only as consumer but also as producers of solutions to tackle energy poverty, real energy communities of agents. The paper aims to provide a systematic literature review highlighting the major findings of the topic, investigating the relationship between spatial and social issues, and looking at the state of energy poverty by addressing the profiling of users and consequently of services useful to overcome their current vulnerable condition. The paper is structured in two core sections. The first one gives the results of a systematic literature review on the energy/fuel poverty topic, the second one deepens the role of communities and individuals need, crucial in defining new design approaches for supportive solutions to tackle energy poverty.

**Keywords:** energy poverty; vulnerable users; energy communities; energy poverty metrics

## 1. Introduction

Energy poverty is gaining attention from European [1,2] global [3,4] policies and research paths [5,6] for more than a decade. The concept identifies a situation where a family or individual does not achieve an adequate level of essential energy services often due to a cascade of conditions, including low income and high energy expenditure caused by poor energy efficiency of housing [7].

It is a complex and often fragmented problem crossing several disciplines [8,9] affecting from 50 to 150 million people who are unable to pay for the primary energy services—such as heating, cooling, lighting, travel, and electricity—that are needed to ensure a decent standard of living [10].

Based on pioneering studies [11,12], a household could be affected by energy poverty due to low income, high energy costs, and energy inefficient dwellings. In concrete terms, this means that vulnerable citizens [13] do not have access to energy services or that the use of these energy services compromises their ability to access other basic services. The Covenant of Mayors 2018 highlights that energy poverty can have serious consequences for health, well-being, social inclusion, and quality of life [14]. According to the report conducted by the International Energy Agency [15], energy poverty includes not only lack of access to modern energy services, but also the reliability of these services and concerns in the affordability of access. Households affected by energy poverty, experience inadequate levels of some essential energy services such as lighting, heating/cooling, use of household appliances, transport, and much more.

Data from the Energy Poverty Observatory show that, in Europe, more than 50 million households alone live in energy poverty conditions, and in particular:

- 57 million people are unable to heat their homes during winter;
- 104 million people are unable to access a minimum level of comfort during summer;
- 52 million people pay their energy bills late.

In Italy, the various existing indicators estimate that Italian households in energy poverty are between 2.2 and 4.3 million. About 9.4 million individuals [16–18] can be considered energy poor and vulnerable, as they are unable to sustain energy costs to maintain an adequate level of comfort. For this reason, energy poverty has been seriously taken into account by several policy areas and agendas concerning social, economic, political, environmental, health [19], and climate. In particular, the European Commission's "Clean Energy for All European Citizens" [20] legislative package is providing measures to strengthen the position of the consumers, by providing rules that will give them more flexibility while also protecting them. The package focuses also on self-determination of the consumer, who is allowed to take its own decisions on "how to produce, store, sell or share energy" [20].

The European Commission (EC) has long been committed in tackling the problem, reinforcing its engagement with the establishment of the EU Energy Poverty Observatory in January 2018—to measure, monitor, and share knowledge and good practices to manage energy poverty—and the growing number of initiatives funded and promoted on the subject. The Covenant of Mayors for 2030, in addition to "taking action to mitigate climate change and adapt to its inevitable effects, requires signatories to commit to providing access to secure, sustainable and affordable energy for all. Covenant signatories can improve the quality of life of their citizens and create a fairer and more inclusive society through the reduction of energy poverty" [14].

The challenge of energy poverty has also been included in the United Nations' Agenda 2030 as one of the actions foreseen in Sustainable Development Objective 7 "Ensuring access to affordable, reliable, sustainable, and modern energy systems for all". These are just the last global orientation tackling a phenomenon that is emerging as a consequence of long-lasting macro-level [21] trends, such as the economic crisis, the obsolescence of the building stocks, the lack of qualitative data and knowledge about fuel poverty penetration, the heterogeneity of the phenomenon.

In 2009, EU GDP fell by 4.2% compared to 2008 and there was a sharp increase in unemployment. The economic and financial crisis that started in 2007 occurred against a background of falling wages for European workers. In addition, there was an increase in domestic energy prices, due to the EU's dependence on imported sources. From the end-user perspective, evidence suggest that the price of domestic energy in the EU has steadily increased since the mid-1990s, gradually reducing the purchasing power of households [22]. In the case of Italy for example, the increase in prices, while consumption was substantially stable, has led to an increase in energy expenditure, whose incidence on the total rose from 4.7% in 2007 to 5.1% in 2017. This created a worrying prospect for the most vulnerable households.

Furthermore, most Southern Europe buildings were built in the last century without (or with few) wall insulation, leading to inadequate winter performances. Not to mention the general low thermal transmittance values of surfaces, influencing thermal lag and, consequently, building summer performances. In fact, as assessed by researchers [23,24], fuel poverty is strongly linked with the thermal characteristics of buildings and fuel poor people are not only income poor. Thus, the topic is complex as it involves not only the necessity to create and boost national or local policies, but also the need to find methods for target identification, data sharing, and profiled services.

Energy transition and the resulting emergence of energy poverty take place against the background of marked differences between EU Member States. The geographical-spatial component is becoming increasingly important [25,26], together with the political-programmatic characterization of each state, and within them. For example, Italy is reducing its national energy-clean measures due to recent

austerity policies but also to its political instability; this leaves room for the individual regions or even municipality to take over and produce operative but fragmented policies; Germany, on the other hand, is proposing a transformation of the energy sector with large-scale measures of energy efficiency and renewable energy solutions.

A growing amount of studies [13,27–29] highlight that making energy demand more efficient is all the more significant and socially important the more it is able to involve users who are unable to sustain energy demand. Therefore, contemporary research paths and European policy documents are narrowing the field of investigation by focusing on the user dimension of energy poverty, stressing the role of citizens not only as consumer, but also as producers of solutions to tackle energy poverty and real energy communities of agents.

Following these premises, the paper aims to read the concept in a European dimension not only by providing a five-years systematic literature review highlighting the most recent findings of the topic but also providing a qualitative analysis related to methods of measurement, mitigation measures, and users and vulnerabilities. In particular, the decision to focus mainly on the last five years was led by the intention to detect the most innovative and recent approaches to fuel poverty and to discover if the scientific debate is proceeding toward the inclusion of profiling studies.

In fact, the point of view of the relationship between the state of buildings and the state of poverty is investigated by addressing one of the determinants in the resolution of energy poverty: the profiling of users and consequently of services useful to overcome their current condition of poverty.

In order to answer to those research questions, the paper is structured in two core sections. The first one gives the results of a systematic literature review on the energy/fuel poverty topic having the objective to understand the main and more recent lines of development in the last five years; the second one performs a research aiming to deepens the role of communities, of vulnerabilities, and the potentialities of profiling services to address the problem. Finally, the conclusion recalls the main findings of the paper, assess some field limitations of the papers, and draft future research paths.

## 2. Research Methodology

The research underlying this paper is twofold, and it follows the structure of the paper. The first part of the paper follows in fact the methodology of the systematic literature review, implying the selection of a database, a timeframe, and specific queries, with the objective to analyze the most recent lines of development on the fuel and energy poverty topic.

The second part follows the methodology of a literature review of papers appeared in the most important international journal, without covering a specific timeframe and including both open access and not-open access papers. This review included the concepts of energy poverty measures, users and vulnerabilities and measures of mitigation. This second part of the research has the objective to give a more qualitative analysis of some of the main interesting aspects of the topic.

The systematic literature review has been performed in December 2019–January 2020 by using the Web of Science (WOS) database and by selecting open access and papers accessible from university libraries and online databases [30]. As a limitation to the field of investigation, the literature review has been done only considering papers written in English, as it is commonly recognized as the scientific international language and belonging to the European context. The results of this systematic review are showed in paragraph 3.

In the repositories, we searched works of the last five years (2015–2020) and we entered the following queries:

- “energy citizenship” on WOS, with a research in the entire paper text, 11 results
- “energy poverty”, on WOS, entire paper text, 129 results
- “fuel poverty”, on WOS, entire paper text, 150 results
- “energy vulnerability”, on WOS, entire paper text, 32 results
- “energy poverty” AND “participation”, on WOS, 12 results

- “fuel poverty” AND “participation”, on WOS, 13 results
- “energy vulnerability” AND “participation”, on WOS, entire paper text, 1 result.

The totality of the previous papers has been browsed and filtered following some rules as follows:

- unique entries (duplicate papers have been deleted);
- thematic relevance (for example papers focusing on media analysis such as TV channels and newspaper, or papers on transportation poverty, or on technical solutions not specifically linked with energy or fuel poverty were not considered);
- geographical relevance (only European fuel and energy poverty has been taken into account).

From these filters, 118 paper remained and were analyzed in depth. The analysis covered the following aspects:

- diffusion of the research and the related main themes in the last five years;
- thematic subdivision of papers;
- geographical distribution of case studies;
- identification of research red lines.

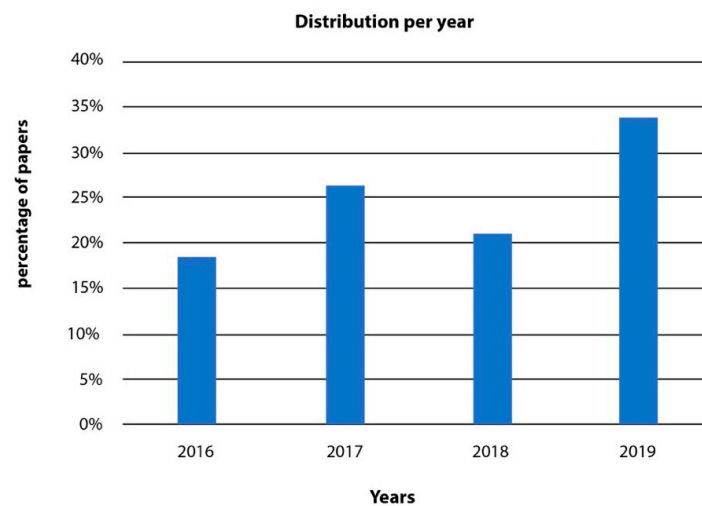
### 3. Analysis of Articles on European Energy Poverty: A Systematic Literature Review of the Most Recent Approaches

As introduced, energy and fuel poverty is a growing theme for European researchers. In the past years, in particular, the topic sees an increase in interest from several research fields. Not only the social science is interested in the topic but also architecture, medicine, and policies studies. On the one hand, in fact, the problem is more and more highlighted by policy-makers and professionals, and, on the other, more knowledge is produced, allowing more people searching innovative solutions.

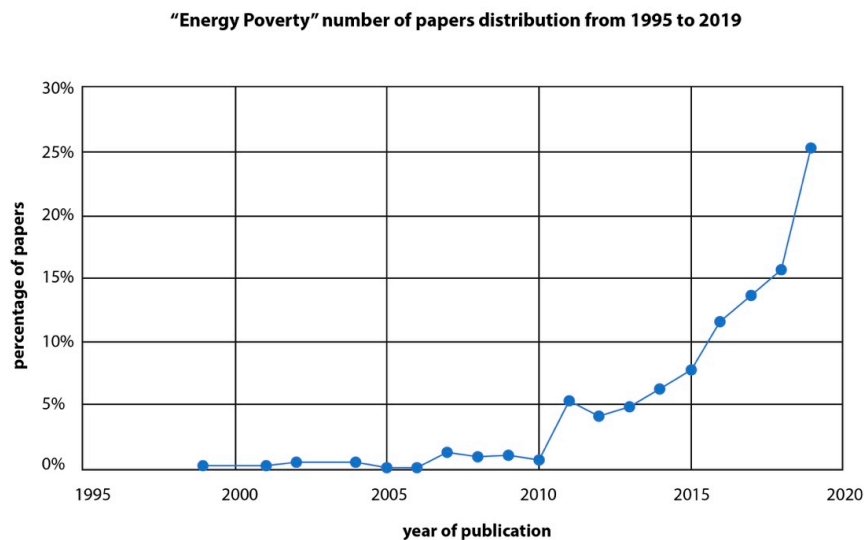
On the semantic point of view, it is possible to observe how the two locutions of “fuel poverty” and “energy poverty” are generally considered as synonyms. Both, in fact, tend to include water, electricity, gas, and other fuels. A third locution appears frequently in the search: “energy justice” which can be considered a more general topic, not only working on technical solutions, but also including socio-political aspects.

On the chronological point of view, the systematic literature review (Figure 1) shows that almost the 35% of the total number of analyzed papers was written in 2019. Even with this predominance, the topic has been quite well investigated homogeneously in the last five years, with a small increase in 2017. An additional query on the WOS database about the keyword “energy poverty”—starting from 1995—showed how the topic has increased year by year since 1999, with a boost starting from 2010 (Figure 2), when the awareness on climate change and the role of building retrofitting in improving households conditions increased.

It is during these years that one of the first policies has been developed in the UK. In particular, the first UK policy is relevant as it sets a threshold below which a household can be considered fuel poor according to Boardman studies [31] (to spend more than 10% of the household income on energy in the home). Additionally, as described by Dubois and Meier [21], in 2009, a European project (EPEE) analyzed that, in the EU, fuel poverty involved between 50 and 125 millions of people and they put the attention to the connection between people vulnerability (especially in relation with elderly, disabled people and single-parent families) and the quality of buildings, highlighting how fuel poverty is more likely to happen in cold damp properties with insufficient heating system and insulation.



**Figure 1.** The image shows the distribution of the papers in the last few years.



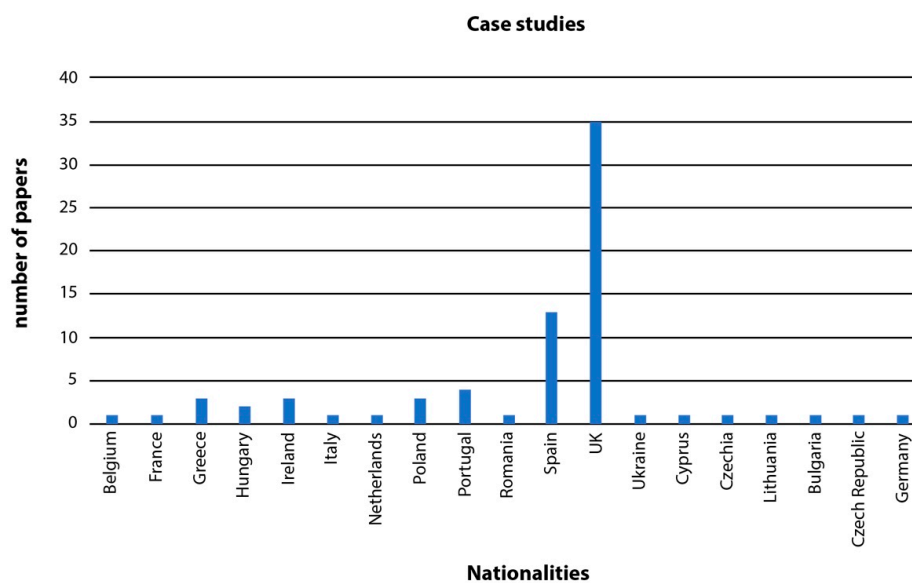
**Figure 2.** The image shows the growth of the number of papers from 2000 to 2019.

Considering the last five years, the selected papers can be clustered according to major recurring themes. In fact, 10 major categories have been found, as follows:

- welfare;
- theory (including also papers about semantic and definition);
- technical solutions (papers focusing on solving fuel/energy poverty on the technical point of view);
- stakeholders (papers focusing on the role of urban actors in mitigating fuel/energy poverty);
- profiling (papers focusing on specific targets);
- policies;
- participation (papers focusing on the role of participation and citizen engagement as a way to mitigate fuel/energy poverty);
- methods (papers proposing new methodologies to analyze the topic, also including indexes and indicators);
- health (papers specifically targeted to analyze the effect of fuel/energy poverty on health);
- behavioral studies (papers focusing on the role of people behaviors).

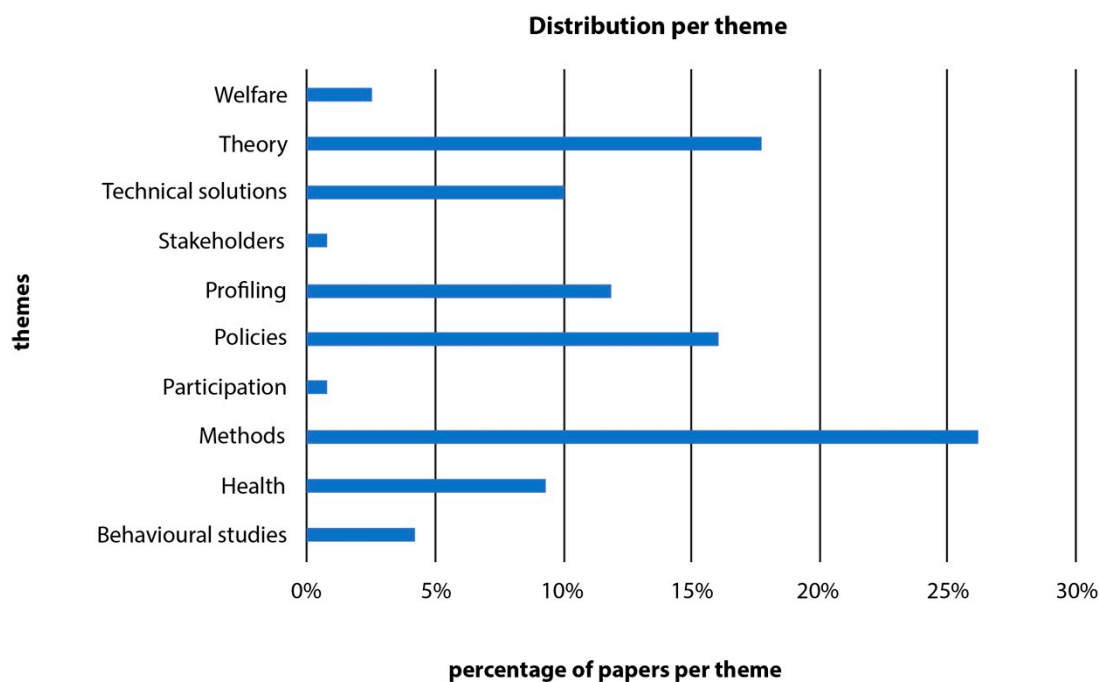
Before going deep into the identification of the main trends per each theme, it is important to notice that the majority of the selected paper apply their research and analysis on specific case studies. In fact, only a few papers, mainly related to the theory and method category, are untied from a specific case study. Furthermore, 3.58% of papers are related to a specific application. This finding is interesting as it shows how the topic is strictly linked with local contexts. As, in fact, argued by Dubois, “fuel poverty is strongly linked to the characteristics of housing [ . . . ] indeed fuel poverty often results from a combination of low incomes and high energy needs” ([23], p. 107).

Among 58% of research applied to case studies, the high majority (51%) is referred to UK case studies, as visible in Figure 3. In fact, in Europe, the United Kingdom has been one of the first countries implementing specific national policies to solve it [2]. Thus, despite most part of the research seeming to come from the UK, several countries are strengthening their effort in addressing the topic, according to their individual policy framework. Secondly, in Spain (19%), there is a growing attention for the topic, while the rest of applications are mostly equally spread across Europe, with few highlights in Greece, Hungary, Ireland, Poland, and Portugal. Excluding the UK, most applications are concentrated on Southern Europe (39% of papers). This might be related to the effects of the economic crisis hitting harder in Southern Europe countries, provoking cascade negative effects on the construction industry—in charge of the management and improvement of the building’s performances—and on the economic possibilities of the most fragile sector of the population. Furthermore, most Southern European buildings were built in the last century without (or with few) wall insulation, leading to inadequate winter performances. Not to mention the general low thermal transmittance values of surfaces, influencing thermal lag and, consequently, building summer performances. In fact, data provided by the European Energy Poverty Observatory, in 2018, about the share of population not able to keep their home adequately warm, confirm how the worst situations are mainly concentrated in Southern and Eastern Europe with Bulgaria recording 33.7% of population in this situation, followed by Lithuania with the 27.9%, Greece (22.7%), Cyprus (21.9%), Italy 14.0%. In addition, data about arrears on utility bills seem to confirm this evidence: Spain 35.8%, Bulgaria 30.1%, Croatia 17.5%, Romania 14.4%, and Slovenia 12.5%. Even if these indicators are not sufficient to completely show the fuel poverty situation in Europe [32], they still seem interesting as they confirm the presence of emergencies in those regions and thus the necessity of increasing a knowledge and service creation effort for mitigating it.



**Figure 3.** The graphic in the image represents the geographic distribution of the papers analyzed.

Assuming that a significant part of papers relies on local analysis, the thematic point of view is also interesting for the objectives of this research. In fact, given the 10 categories identified, it is interesting to note that most of them are spread in three major topics: methods and indicators (26%), theory (18%), and policies (16%) (Figure 4). This fact shows that the European debate about the topic seems to still be concentrated on answering research questions such as: “how can we measure the phenomenon?”, “what is the extent of it?”, “how can the fuel/energy poverty be defined?”, “what does energy/fuel poverty mean?”, “how can we increase our knowledge about it?”. In particular, the identification of methods and indicators seems to be the most explored theme.



**Figure 4.** The graphic in the image represents the thematic distribution of the papers analyzed.

As described in several research works [33–35], the most used methodology for understanding the extension of the topic and for analyzing its characteristics in a specific context is to combine quantitative data from statistics (local, national, and European) with qualitative data. If the first category is more easy to find, the second one entails a deeper and closer relation with the local context. In fact, qualitative data are almost always collected through interviews and focus groups or with forms of participation usually adopted in social science disciplines. An increasing amount of studies is then focusing on the spatial aspects of the phenomenon, linking the role of the urban space with the poverty [36–39]. In fact, there are several aspects linked with the spatial approach: on the one hand, there are social connections at the neighborhood dimension that can mitigate energy poverty by creating chains of solidarity and support; on the other hand, the homogeneous district often has similar characteristics in terms of building performance and energy necessities. Thus, implementing a spatial approach into the analysis of energy poverty can give new insights both on the design/technical and social perspectives.

Finally, another interesting method for improving knowledge on energy poverty and, together, studying new strategies is strictly connected with BIM innovations. As described in Zhang et al. [40], in fact, the Building Information Technology can be successfully used also for energy poverty by adding socio-economic information to the model. This allows for investigating retrofitting solutions, among a panel of interventions, also considering poverty-related information.

Among the papers centered on methodologies, an important number of them proposes new metrics of measurement in terms of indicators or indexes. A deeper analysis of these is provided in the following paragraphs.

The second category where papers are concentrated is the theoretical one. As a matter of fact, the topic is still under analysis especially for what concerns the link between energy poverty and energy justice. Attention is in fact related to the ethical aspects of energy and to the necessity to guarantee its access to everybody [40]. However, the majority of theory-related papers are concentrated between 2015 and 2017, with less development in the last two years, where, instead, the new topic of energy citizenship arises. With energy citizenship intended, there is participation of customers in energy production not only as passive actors of the market but as prosumers and active participants [41]. However, the link between energy poverty and energy citizenship is still under-explored, and it constitutes an interesting line of research for the future of the topic.

The systematic literature review showed some red lines and some current trends of the international debate about fuel and energy poverty. The two core themes that seem to be highly relevant for the extent of this research are mainly two: metrics for increasing knowledge on the phenomenon, which is the base for then addressing the problem with efficient solutions, and profiling as a way to study solutions (products and services) specifically targeted to different categories of people.

#### **4. A Qualitative Analysis on Three Core Aspects of Energy Poverty: Methods of Measurement, Users and Vulnerabilities, Mitigation Measures**

##### *4.1. Measuring Energy Poverty: Critiques to Standard Methods*

The current multiplicity of measurement methods and the growing research interest in providing alternative metrics is a critical point. Data incompatibility, different database and data sources, different measurement units, and different scales of reference are only some of the limitations to a national/international metric for the phenomena.

A review of the most recent proposals of metrics for energy poverty highlights clearly the fragilities of the current metrics while providing possible solutions. The UK is a pioneer in research into assessing the extent of fuel poverty, but France and Germany have also developed a considerable amount of research [42,43] into the issue of assessing and identifying who is most vulnerable.

Moving forward from the initial indication of less than 10% of income as an indicator of energy poverty [31], EPOV has been providing and gathering a series of data concerning energy poverty and, more importantly, it has been collecting different metrics. This data stream has been providing more evidence-based approaches to energy poverty [12], but also a higher awareness of the multi-dimension of the problem and of its metrics. Many authors [44,45] recall the critical issues arising from geographical diversity (different countries require different mixes of policies and measures to address energy poverty) and of scale (macro level and policies and micro level to implement tailored-based measures). To this is added the lack of a common definition, one of the main causes of the insufficient policy measures adopted so far [46]. In the light of this complexity, several attempts have been made to develop a number of effective measurement strategies, covering not only diversified domestic energy uses, but also the habits of different segments of the population.

The amount of variables and indicators to be aggregated to measure energy poverty—and eventually to provide a profile of the consumer—is linked to the different interpretations and definitions of such topic [44,47]. The indicators provided have a varied nature (e.g., self-reported experiences, income, energy expenditure, building features) and rely on secondary dimension linked to energy poverty determinants (e.g., energy market, climate, cost of living). This opens up a criticality in terms of research on the topic, of political framing (related to welfare or housing or energy), and of possible actions to tackle it. A further challenge for research entails finding a key for its reading that is multi-disciplinary, related to specific context, user-centered but at the same time that provides practical, economic, and feasible solutions to be applied short-term.

As reviewed by many articles [45,47,48], the European Commission has been suggesting since 2010 a series of consensual indicators deriving from existing data surveys. With a consensual approach to energy poverty measurement, Pye et al. [28] suggest “a pragmatic approach” tailored according to each member state according to their best available data. Nevertheless, this attempt seems insufficient



to deal with the lack of correlation among the definition of energy poverty, the clear identification of the users and the indicators to monitor it. To address this multiplicity, Rademaekers et al. [49] recommend using an array of indicators in combination, such as: “high share of energy expenditure in income: part of population with share of energy expenditure in income more than twice the national median (EPOV, 2010 HBS); hidden energy poverty: part of population whose absolute energy expenditure is below half the national median (EPOV, 2010); inability to keep home adequately warm: based on self-reported thermal discomfort (Eurostat, 2016 SILC); arrears on utility bills: based on households’ self-reported inability to pay utility bills on time in the last 12 months (Eurostat, 2016 SILC)” [8]. This multi-dimension of indicators is enabled by the “Statistics on Income and Living Conditions” (Eurostat-SILC) that provides a set of proxy indicators used to compare energy poverty within the EU. A multi-indicators approach is also suggested by Herrero [48] who calls for methods that might capture as many variables as possible, not only in terms of domestic energy services measurement but also intersecting social, behavioral, demographic, etc. The author warns that a single-indicator might reduce the vastity and multi-disciplinarily of the issue and therefore of the possibility to tackle it. He urges the use of several indicators able “to capture the diversity of experiences and intensities” [48] of the issue.

These methodologies might be useful to frame energy poverty in a specific moment and place. Nevertheless, the phenomenon is subject to fluctuations and variations related to primary and secondary factors. Furthermore, data are referred either to the production sectors or to the type of energy carrier or source, such as, for example, the production or distribution of electricity, the need for electricity or heat. Moreover, the data may come from different sources: data collected and managed by institutional entities, authorities or other public or private research bodies, or open data. The different databases collect and return the information following their own criteria, in different format and aggregation. This kind of database on energy needs or consumption for the various sectors are not directly comparable with other databases, e.g., for the construction and real estate sector or the demographic sector. In other words, there is no direct correlation between energy needs and consumption and their identification and location at urban level.

For this reason, Rademaekers et al. [49] provide an additional set of indicators (demographic factors, energy prices, income, kind of household, heating system, supply choice, building efficiency and building stock, policy intervention) to be applied to cross-identify it.

This short review of the measurements methodologies shows a large effort in the quantification of the phenomena, in spite of a discursive and narrative approach, based more on quality. Despite showing a common denominator in the observation of the individual user, the approaches lack a narrative, explorative, and descriptive dimension and risk to exclude some categories and variables from the analysis. The user role remains underexplored; nevertheless, its key importance is widely mentioned, using different labels and evoking concepts. This reading key is addressed in the following chapter.

#### *4.2. The User Dimension of Energy Poverty*

To tackle energy poverty implies a change of paradigm in the everyday lifestyles and a different configuration of the urban socio-technical systems, linked to energy as a social necessity [50]. These systems (infrastructural, electric, logistic, waste, etc.), in fact, require a complete review in the way they are organised, distributed, and managed. Both their technical features and their social roles and responsibilities [50] need to change in order to provide the basis for the support of the transition towards a more efficient and sustainable urban system. In the research on energy poverty, the key role of users has been largely recalled by literature. Energy saving linked to user behavior is deemed as significant as that deriving from technology [51]. Two main orientations towards the users are highlighted: target users as “vulnerable customers” and pro-active users indicated as “energy communities” and “energy citizenship”.

The concept of vulnerable customers can include income levels, the available share of energy expenditure, energy efficiency of households, dependence on electrical equipment for health reasons,

age, among other criteria. Pye et al. [28] categorized the different interpretation of the concept according to each Member State, highlighting the recurrence of a user as a receipt of social welfare, while in France, Sweden, and Italy, it reflects the relationship between low income and high expenditure. Recent studies include vulnerable users, low-income families with children, elderly people in nursing homes, rented persons, and those with an unstable employment situation [52,53]. Directive 2019/944 of 5 June 2019 concerning common rules for the internal market in electricity and amending Directive 2012/27/EU, in Article 28 identifies users as “vulnerable customers”, stating that “member States shall take appropriate measures to protect customers and shall in particular ensure that vulnerable customers are adequately protected”. Around this concept, a working group of the European Commission was created, following the 2015 Citizen Energy Forum: the Vulnerable Consumer Working Group (VCWG), in charge of exploring the potential for common approaches across the EU to vulnerability and energy poverty users’ definitions and policies. This concept, however, seems to narrow the field of application to mere economic customers’ communities, identifying them with economic/financial indicators and moving away from the concept of energy as a necessity and a human right [54], but rather towards energy as a commodity. An attempt to overcome this risk is to face the issue extending the idea of energy to the concept of citizenship meant as collective ownership and exercise of rights.

Designing a different role for the users, it is possible to imagine a proactive community, including vulnerable groups, that progressively adopts effective solutions, strategies, and management policies to face collectively the energy poverty issues.

The concept of energy citizenship [34,55–57] entails an “approach [that] argues for the social necessity of public engagement and participation in processes of policy-making and planning, driven by principles of local empowerment” [55]. This definition urges the citizens to be involved not only in a personal change of their behavior—by reducing their energy consumption expenditures (EU Directive 2018/2012)—but also in being agents and providers of solutions to address (part of) the wider energy poverty problem. In this view, users are called to “shape new routines and enact system change” [58]; therefore, they seem to be autonomously drawn to behave in order to improve their condition while at the same time set an example for a deep change toward a more efficient energy consumption and use. Ultimately, they should be politically influential [56], hence acting as social and political actors [34,35].

Many authors argued that this interpretation of “user as energy citizen” tends to “ignore crucial questions of unequal agency and access to resources” [50] identifying the citizens only as those who can purchase and spend in a market regime, causing exclusion issues and failing to include the same categories affected by energy poverty issues, and the vulnerable customers themselves. Bues and Gailing [59] stress the significative role of economic power dynamics in citizens’ engagement, which limit the access to technology and economic/financial resources, as well as to knowledge, information and data. Lennon et al. [50] propose to “re-conceptualize energy citizenship, moving away from individualist and economic perspectives and locating it within collective contexts of engagement”. This approach seems to recall what has been commonly defined as energy communities, another evocative label used to frame not only the attention to the user, but its pro-active role in the management and improvement of sustainable behaviors around energy.

The energy communities are introduced in the Regulation (EU) 2018/1999 (11/12/2018), in particular in the art. 20 “Integrated Communications on renewable energy” as “the subjects to be promoted and facilitated for the self-consumption of renewable energy” (letter b paragraph 7). This definition followed the growing decentralization and distribution energy systems [33,60] as a precondition likely to produce a new category of actors engaged in the energy system with new active roles.

In the preamble of Regulation 2018/1999, it is pointed out that “[...] member States should assess the number of households in energy poverty, taking into account the domestic energy services needed to ensure a basic standard of living in their national context, existing social policy and other relevant policies, as well as the Commission’s indicative guidelines on related indicators, including geographical dispersion, which are based on a common approach to energy poverty”.

It is clear that the attention to the user (as vulnerable customer) and its pro-active involvement as agent–energy community, energy citizenship—is key for tackling energy poverty issues in Europe. Nevertheless, some authors [34] highlight the lack of practical indication of measures or stress the limitation in these general labels. In fact, these approaches tend to overlook the qualitative identification criteria of such agents, their behavioral patterns, their possibility to access resources (in terms of knowledge, information, as well as financial ones) together with the connection with the characteristics of the buildings in which they live and the correlation with their demographic and financial situation. This opens up a reflection on accessibility, to information and knowledge. European cities and metropolis particularly benefit from the presence of knowledge structures, the density and easiness of connection and access to information and economic sources. The territorial reality in which the cities fit, however, presents phenomena of increasing social and political polarization, depopulation of internal territories and the removal of disadvantaged social classes in favor of a few categories that hold most of the knowledge capital. In this scenario, it appears that the majority of the poorer energy communities may be left out from the decision-making epicenters, as well as from the possibility of political participation and representation.

It is widely known that energy poverty emerges as determined by three factors: income, energy cost, and building characteristics. Following the above-mentioned strategies that focus on the role of the user as consumer and producers of solutions, the challenge is to adopt a new design approach, able to combine spatial issues with new services, new enabling technologies, and new supportive management tools.

#### *4.3. Mitigation Strategies from Literature*

Participation is one of the ways in which energy poverty can be mitigated. Some studies indeed focus on the role of community participation in improving the knowledge on energy and on energy services. As an example, Martiskainen et al. [61,62] describe the organization of Energy Cafés, a format for letting communities engaging with energy locally. In particular, the community organize pop-up temporary events where information and advice on energy are provided to other persons. As assessed in the conclusion of the paper, “Energy Cafés open up for various forms of advocacy, highlighting a broken link between the expectations of the energy markets and energy practices in the home” [62].

Participation is also intended as the involvement of other actors besides end-users (which usually are residents). Several studies [57,63] focus in fact on the benefits of involving in a coordinated analysis and problem-solving other categories of persons, such as owners and tenants, social workers, and healthcare practitioners.

Policy-related papers (16% of the total) are mainly focused on the analysis of current policies in different European countries. Especially addressed to analyze the UK situation, some others compare different countries among them.

Profiling-related papers (12%) are of particular interest as they recognize how energy poverty can be different in relation with different people living in a household. In fact, there are several categories of people potentially more exposed to energy poverty, but also energy poverty can affect them differently (also with different health effects). In relation with the literature review, actually, the categories of persons more studied in relation with energy poverty are students, elders and young. However, up to now, it seems that research is concentrated in identifying the effects of fuel poverty on them instead of defining solutions specifically designed for these categories. This last point doesn't seem to be present in most of the papers, but it constitutes an interesting topic to be further developed.

From a technical point of view, 10% of analyzed papers focus on technical and technological solutions to fuel and energy poverty. Among them, most are based on finding solutions to produce more energy from renewable sources [64–68]. In particular, Donaldson et al. [68] propose the use of urban brownfields for producing energy targeted to poor households. Some research is then focused on the implementation of storage systems and lithium batteries together with energy production [64,65]. Very few papers focus on retrofitting solutions as a way to reduce and mitigate energy poverty.

Often, researchers argue that deep retrofitting solutions are costly and they usually need a temporary relocation of tenants. However, as in Aranda et al. [69], some solutions are proposed, such as working on the building envelopes, on lighting systems and on energy generation. Nevertheless, less disruptive and low-cost retrofitting solutions (also not linked to solving energy poverty) have been studied by architectural and engineering researchers for years, but they do not seem to constitute the unique response to fuel poverty because, as many authors argue, fuel and energy poverty also involves social, political, and economic concerns [70–74].

## 5. Discussion and Conclusions

The systematic literature review showed how currently it is possible to recognize some red lines in which the European research on fuel and energy poverty is mostly aligned.

At first, most research is still investigating the knowledge about the topic, in terms of definitions, semantic analysis, and theories, but also in terms of collecting and analyzing data. For the matter of data collection, it seems that the current research is mostly aligned to merge quantitative data coming from official sources (local, national, or EU) with qualitative data coming from different forms of participatory approaches (from interviews, focus groups, and observation).

A high amount of effort is put into defining the most suitable indexes and metrics to describe the phenomenon. In terms of technical solutions, most of the literature is aligned in working mainly on RES, storage, and less in retrofitting solutions. However, the role of technical solutions doesn't seem to be enough to mitigate the problem, as poverty has deep social, political, and economic roots that need to be understood.

For that reason, several studies are now proposing the role of urban actors and solidarity chains at the neighborhood level as a way to complement, with soft solutions, the harder component of retrofitting.

Most studies, then, are concentrated in the United Kingdom, as one of the first countries highly engaged in addressing the issue, even if some other countries are showing an increasing amount of attention, especially Spain and, in general, the Southern European countries.

Despite the presence of a high interest in the topic, some barriers and limitations can still be found, as well as potentially interesting new lines of research.

The limitations and barriers have been distinguished in three categories: economic, social, and technic/technological.

Concerning the economic issues, the high cost of the energy mitigation measures of the single or block of buildings is still one of the major challenges. As, for example, indicated in the Report on the state of energy poverty in Italy (2018), climate change affects household energy demand, exerting upward pressure on energy prices, whose incidence on the total rose from 4.7 per cent in 2007 to 5.1 per cent in 2017. The percentage incidence of energy expenditure is higher for less well-off households (those with a lower than average expenditure). The condition of these households has worsened over the last decade: in 2007, 20% of the least affluent households spent about 6% of total spending on lighting, heating, cooking, and cooling domestic environments, and, ten years later, this share increased by about half a percentage point (while it was stable or even decreasing for other households). In fact, electricity prices have long been burdened by systemic charges linked to the support of renewable energy and the mechanism for pricing emissions within the EU; in the future, the same will happen for other energy sources that will be subject either to some form of carbon tax or to other forms of restrictions on their use (such as the use of coal in electricity generation).

According to many predictions [22,45], European cost of electricity will rise further in the coming decades, due to the energy transition, the prosecution of the economic crisis and a serious de-carbonization struggle that will lead to a further increase in energy prices.

A second economic issue regards the difficulties in systemically eradicating the issue with subsidies and economic support measure. As pointed out by Bouzarovski [54], in fact, subsidies and measures

that avoid disruption as a result of repeated arrear payments temporarily alleviate the energy poverty of households, but do not solve the problem at all.

The social aspects concern understanding and awareness, understood as self-awareness or understanding of the phenomenon of the population regarding energy and energy efficiency. Certain conditions such as energy poverty are not understood as emergency conditions by the population. While people who are in the condition of Absolute Poverty are identified and aware and have access to social services in the territory (Municipality, Caritas, etc.), the condition of Energy Poverty is not recognized.

Many financial schemes and social benefits have been developed to support the installation of measures that reduce energy consumption [36], but they are not well exploited, as low-income households cannot save the necessary funds to cover their initial expenses and generally have difficulty in obtaining a loan.

The condition of Energy Poverty involves a series of actions by subjects that can be “measured” in social/sociological terms, such as:

- difficulty in paying bills;
- management of how to use heating systems (turning the system off and staying in the cold to spend less);
- tolerating conditions of discomfort, hot/cold, for long periods, particularly in summer (heat waves, etc.).
- health conditions, pathologies, etc.

Indicators of social aspects should be oriented to the identification of the above-mentioned conditions. Nevertheless, vulnerable groups of citizens are not easily categorized because their individual needs, knowledge, culture, or living conditions cannot always be simply labelled. Therefore, knowledge transfer on energy use and energy efficiency advice should be targeted to people’s specific social situations. The variety of stress factors and living conditions makes knowledge transfer difficult.

The technical/technological limitations do not specifically concern knowledge or development limitations, but rather expensive applications of them. Household efficiency measures are particularly relevant for reducing energy poverty, but much can also be done in the direction of energy savings in other areas. Low cost solutions [8] might be a temporary answer to tackle emergencies (e.g., monitoring systems, room control temperature, devices for the production of DHW—Domestic Hot Water, selection of energy-efficient installations and equipment, electrical storage batteries). Additionally, as the major signs of energy poverty within people are difficultly detectable (e.g., low indoor temperature), it seems that the current progressive transition to smart cities, and the use of digital connected devices in households—such as smart thermostats—can be of great help for gaining a deeper insight also on the energy poverty topic.

Among the solutions proposed to support the increase of energy efficiency in housing are related to:

- norms and regulations: mandatory construction standards for new constructions (e.g., insulation materials, windows); mechanisms that provide for the installation of efficient heating systems/electrical installations by service providers and whose costs are repaid by consumers over time through the supply contract;
- subsidiary measures: energy efficiency improvements in the home, sometimes with higher amounts for lower incomes; reduce the costs of the investment (i.e., tax deduction for part of the expenses for efficiency);
- educational: establishment of “energy tutors” who advise, on a case-by-case basis, what choices to make to improve the energy efficiency of the home;
- specific actions for homeowners: targeted actions to qualify the investment made (issue of energy efficiency certificates following the intervention, profits for the rental of the property).
- welfare and policy: including better social tariff, new services, energy audit, investment assistance.

Another interesting aspect, emerging from the literature, is the necessity to link data with the spatial dimension by using the technologies of BIM and GIS. The use of such software can in fact be helpful in understanding the urban dynamics on energy poverty and, thus, in finding specific solutions to each context. However, it is necessary to understand the availability of qualitative data from the public and energy providers and to boost their transition to open source aggregated datasets.

In conclusion, it seems that the problem needs an integrated and holistic approach, able to combine the technical issues about building performances, enabling technologies, with a deeper understanding of social connections, economic conditions (also in terms of investigating why people are in economic difficulties). A complete understanding of people behavior and awareness can help in the characterization of profiles to face the several challenges connected to energy poverty.

Behaviors and local cultural factors can drive basic energy use practices [75]: the factors and their relationships that influence consumer behavior and practices are dynamic, highly dependent on human elements, change over time, and influence consumer behavior. For these regions, the process of consumption practices becomes unpredictable and detached from any recognizable pattern [76]. Investigating the size and value of end-user profiles and behaviors before the design phase [77] helps to identify the best combination of technical and social measures, through the adoption of user-friendly energy efficiency systems that could reduce the energy poverty, facilitate the use by tenants and increase their environmental and energy awareness.

The design challenge is to contribute to the necessary framework made of technical and social solutions, policies for energy justice, and participatory processes to understand the energy equity dimension in terms of accessibility and affordability [39].

#### *Limitations and Further Research*

The paper has some limitations due to its choices and methodology. At first, the decision to exclude non-English written papers resulted, obviously, in a limitation in the number of analyzed findings. Especially for what concern locally specific case studies, some interesting approaches were probably not included into the analysis for that reason. However, we believe that the general analysis and the major findings of the paper have not been penalized by this choice.

The paper identified some interesting trends that could be deepened in future research and, in particular, the following:

- the connection between energy poverty and the spatial approach that use BIM and GIS software allowing a coordinated approach among technicians and the geo-localization of vulnerabilities seems to be very interesting in order to deeply understand the phenomenon and its spatial specificities;
- the necessity to study the presence of potentially different profiles of vulnerable people and thus to study services more aligned to their specificities.

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