ENERGY POVERTY IN TÜRKİYE: AN EVALUATION THROUGH CONSENSUAL-BASED INDICATORS

A THESIS SUBMITTED TO
THE GRADUATE SCHOOL OF NATURAL AND APPLIED SCIENCES
OF
MIDDLE EAST TECHNICAL UNIVERSITY

BY

FATMA YAĞMUR ÖZGÜR

IN PARTIAL FULFILLMENT OF THE REQUIREMENTS
FOR
THE DEGREE OF MASTER OF SCIENCE
IN
CITY PLANNING IN CITY AND REGIONAL PLANNING

DECEMBER 2023

Approval of the thesis:

ENERGY POVERTY IN TÜRKİYE: AN EVALUATION THROUGH CONSENSUAL-BASED INDICATORS

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ABSTRACT

ENERGY POVERTY IN TÜRKİYE: AN EVALUATION THROUGH CONSENSUAL-BASED INDICATORS

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December 2023, 86 pages

Energy poverty is a global problem observed in housing and living environments in relation to housing problems (i.e., deprivation) and income poverty for a long time. Although it affects different segments of the housing stock and societies, energy poverty still needs a unified international definition and measurement method. The issue is rapidly finding its place in international policy agendas. However, Türkiye still lacks a decent legal definition of the concept and does not contain any related information or policies in the national policy documents, neither under housing nor energy-related topics. This thesis emphasizes that defining and measuring the level of energy poverty in Türkiye will reveal the long-ignored layers of Turkish housing characteristics and living conditions of households. Regional scale analysis regarding the energy poverty in Türkiye and the vulnerable households and housing stock in terms of this problem is an essential starting point for defining energy poverty and designing national policies about this problem. Hereby, this study aims to explore the incidence of energy poverty in Türkiye, employing consensual-based indicators of energy poverty together with household and housing characteristics. In

this regard, 'arrears on utility bills' and 'thermal comfort' and their relationship with household type, income, mode of tenure, and existing housing conditions are examined to reveal which residential and community segments are more exposed to energy poverty. TURKSTAT's Income and Living Conditions Survey (ILCS) raw data dated 2020 is employed for this purpose. The study's findings exhibit that the highest energy poverty incidence is observed in the Eastern and Southeastern Anatolia regions. Furthermore, household income is found to be the most prominent factor in relation to energy poverty as it affects other variables directly. Also, vulnerable household groups regarding energy poverty are detected as families with children, the elderly, and multi-person households. Several conclusions follow from the analysis. Energy poverty is a significant problem in Türkiye that requires designing policy measures to tackle this problem. Nevertheless, the incidence of energy poverty displays a spatial polarization at the regional level. This means designing spatially informed policy measures is a necessity. Also, the current definitions (or lack thereof) and measurement methods of energy poverty are insufficient to capture the extent of the problem. Therefore, there is a need for a national definition of the issue and its measurement method in order to monitor the process.

Keywords: Energy Poverty, Consensual-based Indicators, Household Characteristics, Housing Characteristics, Türkiye

ÖZ

TÜRKİYE’DE ENERJİ YOKSULLUĞU: UZLAŞMAYA DAYALI GÖSTERGELER ÜZERİNDEN BİR DEĞERLENDİRME

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Yüksek Lisans, Şehir Planlama, Şehir ve Bölge Planlama
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Aralık 2023, 86 sayfa

Enerji yoksulluğu, konut sorunları (yoksunluk) ve gelir yoksulluğuyla bağlantılı olarak uzun süredir konut ve yaşam ortamlarında gözlemlenen küresel bir sorundur. Her ne kadar konut stokunun ve toplumların farklı kesimlerini etkilese de enerji yoksulluğu hala üzerinde uzlaşılmış bir uluslararası tanım ve ölçüm yöntemine ihtiyaç duymaktadır. Konu hızla uluslararası politika gündemlerinde de yerini bulmaktadır. Ancak Türkiye hâlâ kavramın düzgün bir yasal tanımından yoksundur ve ulusal politika belgelerinde ne konut ne de enerji ile ilgili başlıklar altında ilgili herhangi bir bilgi veya politikaya yer vermemektedir. Bu tez, Türkiye'deki enerji yoksulluğu düzeyinin tanımlanması ve ölçülmesinin, Türkiye'deki konut özellikleri ve hanelerin yaşam koşullarının uzun süredir göz ardı edilen katmanlarını ortaya çıkaracağını vurgulamaktadır. Türkiye'deki enerji yoksulluğu ve bu sorun açısından kırılgan hane halkı ve konut stokunun bölgesel ölçekte analiz edilmesi, enerji yoksulluğunun tanımlanması ve bu soruna ilişkin ulusal politikaların tasarlanması için önemli bir başlangıç noktasıdır. Böylelikle bu çalışma, hane ve konut özellikleriyle birlikte enerji yoksulluğunun uzlaşmaya dayalı göstergelerini kullanarak Türkiye'deki enerji yoksulluğu görülme sıklığını araştırmayı amaçlamaktadır. Bu bağlamda, 'fatura ödemelerindeki gecikmeler' ve 'termal konfor' ile bunların hane tipi, gelir, konuta mülkiyet şekli ve mevcut konut koşulları ile olan ilişkileri incelenerek hangi konut ve topluluk kesimlerinin enerji yoksulluğuna daha fazla maruz kaldığı ortaya çıkarılmaktadır. Bu amaçla TÜİK'in 2020 tarihli Gelir ve Yaşam Koşulları Araştırması Ham Verisi'nden (GYKA) yararlanılmıştır. Araştırmanın bulguları, en yüksek enerji yoksulluğu oranının Doğu ve Güneydoğu Anadolu bölgelerinde görüldüğünü ortaya koymaktadır. Hane halkı gelirinin diğer değişkenleri doğrudan etkilemesi nedeniyle enerji yoksulluğu açısından en öne çıkan faktör olduğu tespit edilmiştir. Ayrıca enerji yoksulluğu konusunda hassas hane grupları olarak çocuklu aileler, yaşlılar ve çok kişilik haneler saptanmıştır. Analizden çeşitli sonuçlar çıkmaktadır. Enerji yoksulluğu, Türkiye'de bu sorunla mücadeleye yönelik politika tedbirlerinin tasarlanmasını gerektiren mühim bir sorundur. Bununla birlikte enerji yoksulluğu bölgesel düzeyde mekânsal bir kutuplaşma sergilemektedir. Bu, mekansal farklılıkları göz önünde bulunduran politika tedbirlerinin tasarlanmasının bir zorunluluk olduğu anlamına gelir. Ayrıca, enerji yoksulluğuna ilişkin mevcut tanımlar (ya da bunların eksikliği) ve ölçüm yöntemleri, sorunun boyutunu kavramak açısından yetersizdir. Bu nedenle sürecin izlenebilmesi için konunun ulusal bir tanımına ve ölçüm yöntemine ihtiyaç vardır.

Anahtar Kelimeler: Enerji Yoksulluğu, Uzlaşmaya Dayalı Göstergeler, Hanehalkı Özellikleri, Konut Özellikleri, Türkiye

To my beloved family

ACKNOWLEDGMENTS

First and foremost, I would like to express my utmost gratitude to my thesis advisor, Assoc. Prof. Dr. Özgül Burcu Özdemir Sarı, for her unwavering patience, support, and encouragement throughout this process. It would have been impossible to complete this thesis without the academic explanations and advice, emotional support, and help she provided me whenever and wherever possible, regardless of time and place. I am in awe of her dedication and selflessness as a colleague, and I couldn't be more grateful that she is my thesis advisor as she always supported me in my academic development by being a role model, guiding and helping me in every aspect.

I extend my sincere thanks to my jury members Assoc. Prof. Müzeyyen Anıl Şenyel Kürkçüoğlu and Assist. Prof. Dr. Esma Aksoy Khurami for giving up their time, offering their expertise, and providing constructive feedback on my thesis. Their invaluable contributions and insights, as well as their patience with me, have been vital in improving the quality of this study.

I truly appreciate my close friends and colleagues, Ayşe Ceren Gürbüz, İlayda Zelal Akın, and Pınar Çobanyılmaz, for always being there for me whenever I needed even at my lowest and my highest. Their continuous encouragement and support, both mentally and physically, have gotten me through this rough patch, even sometimes when we were far away. Study dates, coffees, and virtual therapy sessions with them immensely helped me. Without them, it would have been impossible to complete this thesis.

My deepest and heartfelt gratitude goes out to my family: my mother, Melahat Özgür; my father, Mustafa Özgür; my sister Betül Aysu Özgür; and to my extended family, which includes my uncles Avni Kurt, Aladdin Kurt, Bedrettin Kurt, Metin Kurt, Hayati Kurt and my aunts Mülayim Kurt, Hatice Ayar. Losing one of you has taught all of us how important we are to each other. All your countless sacrifices and

efforts have made me who I am and where I stand today. Your belief in me always pushed me to do more for myself and you, even in times I didn't believe in myself. Despite the physical distances, you were always there with me from the beginning till the end. My most prominent strength was your continual love and support and I could not have done this without you.

Lastly, thank you from the bottom of my heart for everyone involved in this process.

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ABBREVIATIONS

BEIS: Department for Business, Energy & Industrial Strategy, United Kingdom

DOE: US Department of Energy

DV: Dependent Variable

EHS: English Housing Survey

EP: Energy Poverty

EPOV: EU Energy Poverty Observatory Hub

EU: European Union

EU-HBS: European Union Household Budget Survey

EU-SILC: European Union Statistics On Income And Living Conditions

FP: Fuel Poverty

HBS: Household Budget Survey

ILCS: Income and Living Conditions Survey

LEAD: Low-Income Energy Affordability Data Tool

LIHC: Low-Income High Costs

LILEE: Low-Income Low Energy Efficiency

NUTS: Nomenclature of Territorial Units for Statistics

OECD: The Organization for Economic Cooperation and Development

TURKSTAT: Turkish Statistical Institute

UK: United Kingdom

UN: United Nations

US: United States

CHAPTER 1

INTRODUCTION

1.1 Background

Imagine being part of a society where fundamental necessities like heating in the winter and cool air in the summer are considered perks. This is the harsh truth for millions of people throughout the world who are living in housing and energy poverty. These interconnected challenges make it impossible for people and their households to afford sufficient housing and basic energy services for an adequate standard of living. Energy is a crucial link in today's world, fueling everything from homes and companies to economies and infrastructure. This vital resource, however, stays out of access for billions of people globally, who are trapped in an endless loop of energy poverty.

Energy poverty, which affects 3 billion people worldwide, is a major impediment to sustainable development and fair growth (Karlsson, 2013). According to the World Bank, 2.2 billion people lack secure housing, and 1.3 billion do not have access to electricity (Brosemer et al., 2020), caused by the Ukraine war-induced energy crisis aggravating these problems and worsening poverty for vulnerable communities. Energy poverty is characterized by a lack of access to dependable, cheap, and environmentally friendly energy services, which limits the chances for progress of individuals and communities (Li et al., 2021). This can manifest in the inability to access necessities like lighting, cooking appliances, and communication technologies and reliance on inefficient and polluting fuels. Energy poverty has far-reaching repercussions, including residential air pollution, asthma and other respiratory health issues, and disparities in health outcomes. Furthermore, dependence on conventional fuels such as biomass adds to air pollution, deforestation, and climate change, increasing worldwide environmental problems.

Economic turmoil can also be caused by a lack of energy availability, which impedes production and growth.

Energy poverty literature evolved in the 1980s due to the realization that having access to energy is a complex interaction of problems related to society, the economy, and the environment and has various definitions. One of the first definitions made by Isherwood and Hancock classified "high fuel expenditure households" as individuals who pay more than double the national average (median) for fuel and power (Osbaldeston, 1984, p. 368). Boardman (1991) subsequently defined energy-poor households as "those who are unable to afford a sufficient amount of energy services, particularly warmth, for 10% of their income". European Union defines energy poverty as the situation in which households are unable to access essential energy services and products (Tirado Herrero & Jiménez Meneses, 2016). Energy poverty refers to the condition where households lack affordable and reliable access to the essential energy services necessary for daily life, such as heating, cooling, and lighting (González-Eguino, 2015). All these broadened definitions underlined the problem's complex nature, noting that energy poverty entails more than just staying warm in the winter or cooling in summer, but also about reduced quality of life and limited chances for growth. Despite being described as a lack of access to contemporary energy sources, it has since taken several forms, such as insufficient energy usage, reliance on polluting fossil fuels, or high energy spending (Li et al., 2021). Thereafter, it became abundantly clear that the condition of housing had a significant impact on energy usage and affordability. Higher utility bills are caused by poor thermal insulation, ineffective heating and cooling systems, and damp conditions prevalent in inadequate dwellings (Primc et al., 2019).

Furthermore, energy poverty also occurs where inefficient fuels like firewood and kerosene pose health and environmental risks, and lack of electricity hinders education, healthcare, and economic opportunities (Karlsson, 2013). In developed nations, rising energy costs trap low-income households in a cycle, causing difficult choices between heating homes or food which sometimes called as 'heat or eat dilemma' (Grey et al., 2017). Far-reaching results of energy poverty among households and housing characteristics are being observed throughout the world (Chen & Feng, 2022). Examples can be cold dwellings, which can cause respiratory diseases, especially among children and older individuals, or poor lighting, interferes with learning and production. Families are exposed to indoor air pollution due to a lack of availability of environmentally friendly cooking fuels, which has serious health consequences. Furthermore, the financial hardship caused by energy bills may restrict access to other critical services.

Poverty, infrastructure deficiencies, and geographic inequities all contribute to energy poverty (Abel, 2016). It frequently results in restricted access to energy sources, forcing people and their households to rely on inefficient and potentially harmful fuels. Lack of infrastructure, particularly in isolated or rural locations, prevents the expansion of electricity distribution networks, leaving people in the dark. Geography is also important, as steep terrains, remote islands, and dry locations present substantial problems. Energy poverty can put an additional burden on households, causing them to spend a large amount of their income on energy, prolonging poverty cycles (Son & Yoon, 2020).

Energy poverty is a societal problem that affects billions of people, primarily in developing nations and communities with limited resources (Abel, 2016). Vulnerable populations in energy-poor families experience issues in education, health, and satisfying basic necessities (Chen & Feng, 2022), underscoring the need for more comprehensive poverty-fighting strategies. Middlemiss (2022) highlights that energy poverty significantly affects vulnerable groups, including low-income households, the elderly, people with disabilities, single-parent households, immigrants, and refugees, leading to health issues, social isolation, and economic hardship.

Energy poverty has serious implications, including the continuation of poverty cycles, stagnation of growth, the exacerbation of health disparities, and the fueling of ecological destruction or political instability (Dogan et al., 2021). Understanding energy poverty demands going beyond metrics and facing disproportionate resource allocation as well as systemic disparities and will need a paradigm shift to see energy as an essential human right necessary for well-being, education, and economic growth (Abel, 2016). Having access to this essential resource is a fundamental human right, not a privilege.

Tackling energy poverty is not only a humanitarian necessity; it also serves as a critical step toward accomplishing international sustainable development goals. Despite the fact that Sustainable Development Goal 7 recognizes energy poverty as a worldwide challenge, tackling it successfully requires a comprehensive perspective, as demonstrated in the goal's mission to "ensure access to affordable, reliable, sustainable, and modern energy for all" (United Nations, 2021).

In Türkiye case, energy poverty still remains an undiagnosed problem. However, various studies tried to capture energy poverty levels in Turkish housing stock and among Turkish households. Özdemir Sarı (2023) found that Türkiye’s overall rate of energy poor is 32% as of 2021. Additionally, energy poverty rates of 17% according to the 10% indicator, 18% according to the 2M indicator, and 7% according to the LIHC indicator were observed in a research for Türkiye (Şenyel Kürkçüoğlu, 2023). These findings give insight into the significant energy poverty levels for Türkiye and indicate the need for deeper analysis to reveal its relation with housing, which creates the need to study and basis for this thesis.

All in all, a comprehensive approach is required to combat energy poverty, which includes promoting renewable energy, increasing energy efficiency of housing stock through better insulation and energy-saving appliances, and providing targeted subsidies and aids to empower households with affordable energy solutions is crucial and needed.

1.2 Aim and the Scope of the Thesis

The main aim of this thesis is to discuss the level of energy poverty in Turkey according to different indicators, which dimension of energy poverty these indicators measure, which segments of society and which parts of the housing stock reveal energy poverty more according to these indicators, and the policy options regarding these issues are considered. Accordingly, it should be underlined that, this thesis only aims to determine the relationship between household and housing characteristics and energy poverty, that is, which segments of society and housing stock experience energy poverty more. However, issues such as energy efficiency and housing reinvestment with energy efficiency purposes, which are mentioned in the international literature in relation to energy poverty, are not included in the scope of this thesis. Moreover, as fuel poverty and energy poverty concepts can be used interchangeably in international literature, the term "energy poverty" is adopted in this study to reflect on both issues.

The study seeks to identify these relationships as there has yet to be a detailed empirical study previously done on the existing energy poverty exposure of Turkish households and housing stock. Existing literature on energy poverty in Turkey has not yet indicated what types of housing and households are experiencing the reality of energy poverty. Consequently, the necessity to investigate this subject and fill the gap in relevant literature has been a priority.

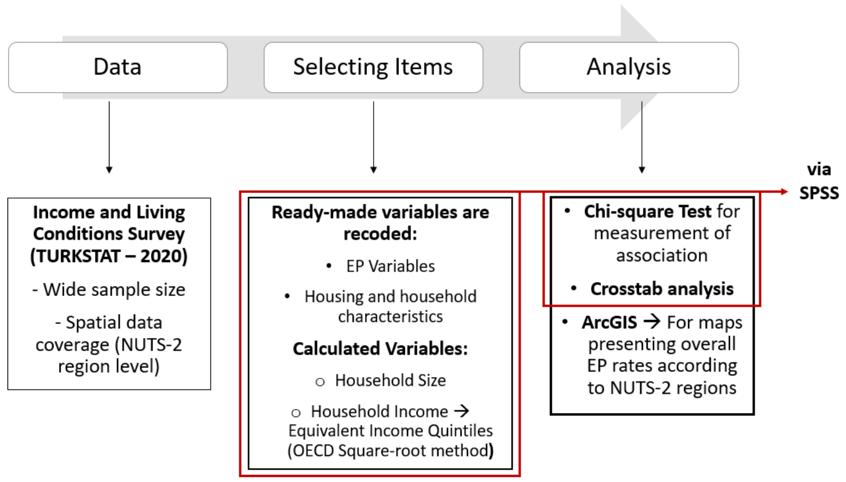
1.3 Data and Method

In this study, TURKSTAT's 2020 Income and Living Conditions Survey (ILCS) data was utilized for examining the relationship between energy poverty and household and housing characteristics as it offers spatial data as well as the variables necessary to the housing and energy poverty-related studies for Türkiye. The data set provides detailed information and several variables at household level to assess energy poverty levels, such as having arrears on utility bills and lack of thermal comfort. Other variables in relation are chosen after the literature review, namely household size, income and household type, problems related to leaky roofs, damp walls, heating problems due to the insulation of dwellings, dwelling size, number of rooms in a dwelling, and so on. Energy poverty indicators vary in the literature. The indicators chosen for this study are adapted from the European Union Energy Poverty Observatory's (EPOV) methodology. These indicators and associated variables are measured with a consensual-based method, and they represent self-reported assessments of households regarding 'arrears on utility bills' and 'ability to keep home adequately warm' (see for instance, Thema and Vondung, 2020). Although all these variables were available in the raw data, many were recoded, and variables such as household income and size were recalculated for the purposes of this study. Thereafter, the obtained variables were analyzed through the SPSS program using cross-tabulation analyses to reveal energy poverty in relation to housing and household characteristics. Contingency table analysis is preferred particularly because the dependent variables that represent energy poverty in this study were in the nominal measurement scale. Also, most of the independent variables are categorical data. Data tables provided by the cross-tabulation procedure are useful in this kind of cases where the incidence of the event (energy poverty) is investigated, since these tables allow to examine two or three-way relationships between the variables of concern. Also, cross-tabulation procedure in SPSS allows the researcher to observe correlation coefficients between the variables, allowing an examination of the direction and strength of the relationship between the variables of the study. In addition to the analysis conducted in SPSS, the ArcGIS program was used in this study for the regional-level analysis and visual representation of the energy poverty problem in Türkiye.

1.4 Structure of the Thesis

This thesis follows the structure represented in Table 1.1. Accordingly, the study aims to examine the incidence of energy poverty in Türkiye with regard to the selected indicators, reveal the different dimensions of the problem measured by different indicators, display the household and dwelling characteristics of the energy poor and their spatial distribution, and highlight policy options with regard to the findings of this study.

Table 1.1 The Structure of the Thesis

Aim:	Discuss the level of energy poverty in Türkiye according to different indicators
	Which dimension of energy poverty these indicators measure, which segments of society are energy poor
	Which parts of the housing stock reveal energy poverty more according to these indicators
	Identify policy options regarding these issues
Literature	Definitions & Measurement Methods
	Housing and Household Characteristics
	Energy Poverty Discussions in Türkiye
Data & Method	
Analysis & Conclusion	Policy implications for addressing EP in Türkiye

With these aims, first, a literature review is presented in Chapter 2, which is conducted to examine definitions and measurement methods of energy poverty, to evaluate the research gap existing in the national literature, and to compile the necessary information to guide the empirical analysis in this study. The literature review is followed by the method chapter (Chapter 3), where data, variables and analysis methods of the study are presented in detail. Chapter 4 presents a descriptive analysis of energy poverty in Türkiye. The study is finalized with Chapter 5, where policy options are evaluated in line with the findings and conclusions of the study.

CHAPTER 2

LITERATURE REVIEW

Today, energy poverty is affecting 1.3 billion people worldwide while directly influencing their health, development, and basic needs (González-Eguino, 2015). Energy poverty is caused not only by individual factors but also by systemic problems such as energy infrastructure, irregular and uneven development, and access to energy carriers (Bouzarovski & Simcock, 2017). Access to energy is another façade of energy poverty as a human right, and energy systems in the world are controlled by capitalism and privatization policies, resulting in problems in the equal distribution of necessary services and emphasizing existing inequalities (Brosemer et al., 2020).

2.1 Energy Poverty Definitions and Measurement Methods

The terms Energy Poverty (EP) and Fuel Poverty (FP) are used in international literature to describe the same cross-cutting problems and affect the same social sections. The differences between the concepts are increasing and more pronounced, especially in various geographies. Both terms are deeply related to residential energy use and are influenced by socio-economic factors such as income status (Li et al., 2014). All of these variables are deepening general poverty, rapidly eroding health and well-being, and undermining development.

EP is an issue that proves to be a problem on global and regional scales and has various definitions. For this reason, in this study, EP definitions and measurement methods were classified and introduced regionally. Moreover, the fact that the study method and findings gave regional results for Türkiye also affected this classification.

The EP can occur in all climatic conditions, in poor and developing countries, and describes itself as the problem of transportation to simple energy sources. It is measured by specific scales and indicators by international institutions such as the EU Energy Poverty Observatory. FP can be defined as a primarily economic issue related to access to energy. Because it is treated as an economic problem, it is a term commonly used in developed, rich and cold climate countries, measured by affordability ratios (like in UK), FP is usually measured through institutions such as governments and state energy agencies. Li et al. (2014) disclosed in their study that different households in developed and developing countries are exposed to different problems. The study revealed that energy-poor households were found in more developed countries, while fuel-poor ones were observed in developed countries and the impact of cold climate conditions was observed on households experiencing the two problems at the same time.

EU definition

The European Union Energy Poverty Observatory Hub (EPOV) defines energy poverty as "the situation in which households are unable to afford the energy services necessary to live a warm and healthy life." (Thema & Vondung, 2020). This definition is based on three key factors as low-income, high energy expenditures and energy inefficiency of existing housing stock. Low-income households are more likely to suffer with energy bills. Households with high energy bills are more likely to spend a substantial amount of their income on energy, leaving less money for other essentials. Households with inadequate energy efficiency are prone to consume more energy than necessary, making it difficult to finance energy expenditures. Moreover, this study also highlights the fact that EP is a severe social issue that can lead to social exclusion and health issues, as households struggle to heat their homes, use hot water, and operate basic electrical appliances, reducing their quality of life.

According to Thomson et al. (2017) there are three main methods of EP measurement as expenditure-based, consensual-based and direct measurement approaches. With the expenditure-based approach, the investigations made about home energy costs versus absolute or relative criteria offer a proxy for determining the amount of residential energy deprivation. This strategy is popular because of its apparent impartiality and measurable character. Consensual-based method depends on self-reported assessments of interior living conditions and the capacity to get certain basic requirements in the society where a household exists. Direct measurement compares the amount of energy services (such as heating) achieved in the residence to a predetermined norm. It is difficult to implement owing to the technological problems involved in evaluating energy services and establishing sufficient standards.

Despite its asserted objectiveness and quantifiability, the spending approach to evaluating energy poverty has received much criticism. From incorrect interpretations in across the nation applications to simplistic estimates of demands and income, the technique runs the danger of underestimating the real scope of the problem, especially among disadvantaged populations with unique energy needs or restricted access to important data (Harrington et al., 2005; Healy & Clinch, 2004). While the consensus-based approach to measuring energy poverty has advantages such as easier data collection, capturing social marginalization beyond expenditure (Bouzarovski, 2013), and empowering respondents, it has limitations such as subjectivity (insufficient reporting and societal differences), low intersect with other measurements, reliance on possibly flawed hypotheses, and unproven consensus across diverse populations (Palmer et al., 2008). Additionally, as an additional shortcoming of this approach, Thomson et al., (2017) state that the EU-SILC approach, which is commonly used in Europe to measure energy poverty, has limitations due to its dependence on secondary data and a lack of standardized data on real energy usage or family requirements. This data gap makes accurate evaluations and policy planning impossible, demanding increased data quality and alternate methodologies.

It is also noteworthy to state that the expenditure-based approach captures the financial aspects of energy poverty and measures households' energy expenditure in relation to their income. Consensual based approach relies on self-reported experiences of limited access to energy services. It focuses on the subjective experience of energy poverty and provides valuable insights into the lived realities of households struggling to afford energy. Although consensual based indicators are difficult to standardize, they offer qualitative data that can be spatialized which makes it reliable. Even if EP is calculated based on the expenditure-based indicators (M/2 & 2M) it cannot be traced the results in terms of spatial organization. This makes consensual-based indicators advantageous in terms of spatialization.

US definition

The United States does not have a single official definition of energy poverty. Despite the absence of a formal definition, the United States addresses energy poverty through fragmented initiatives such as Low-Income Home Energy Assistance Program (LIHEAP) and Weatherization Assistance Program (WAP), which are motivated by reactive reactions to crises such as the 1973 oil crisis rather than a long-term plan (Bednar & Reames, 2020). This can be traced back to initiatives regarding fuel projects which focused on weatherization and immediate assistance and have evolved alongside government reorganizations and new programs, all of which act as indirect acknowledgments of the issue in the absence of a broad framework for tackling affordability gaps.

LIHEAP and WAP are federally supported energy efficiency initiatives that assist households with low incomes in lowering their energy expenses (Kaiser & Pulsipher, 2006). LIHEAP helps to subsidize high energy costs, whereas WAP delivers cost-effective improvements through whole-house retrofit options. Both programs advise energy efficiency measures by taking into account the building envelope, electronics, and cooling and heating systems, along with yearly weatherization services offered by private contractors and in-house workers. Additionally, using the American Community Survey and Energy Information Administration data, the LEAD Tool presents projected low-income home consumption of energy statistics for energy alleviation management for low-income families based on income, energy costs, fuel type, and dwelling type (DOE, 2020).

Each program seeks to treat the symptoms of energy poverty, but the legislation does not legally identify the issue. Murray and Mills (2014) state that despite verifiable accomplishments such as lower energy prices, improved child growth and health, and lower greenhouse gas emissions, the efficacy of existing interventions is obscured by weak performance measurements that have been left out in national energy poverty reduction plans. In a recent study, Brosemer et al., (2020) criticized that in the U.S., energy poverty crisis as a concept that lacks accessibility, affordability, democracy, and justice. The study revealed that many sections of society are experiencing difficulties in accessing affordable energy, that the rising energy charges are associated with a disproportionate increase in the risk of living in energy poverty among low-income groups, and that there is no justice and democracy process on energy use because these sections are not involved in any process.

UK definition

The Warm Homes and Energy Conservation Act of 2000 defined a fuel-poor household as "...one that must spend more than 10% of its income on all fuel use and to heat its home to an adequate standard of warmth." (Eastham, 2001). Additionally, The UK Department for Business, Energy and Industrial Strategy (BEIS) (2020) referred to energy poverty as the situation in which households are unable to afford to keep their homes at a comfortable temperature.

According to Hills (2012), haphazardly used measurements have impeded the UK's efforts to define fuel poverty. In this study, the first "10% indicator" proved untrustworthy due to shifts in energy costs, which obscured household-level effects. While England chose the more focused "Low-Income High Cost" metric, its reliance on relative income conceals market impacts and leaves the rest of the United Kingdom sticking to the inaccurate 10% indicator (Bednar & Reames, 2020). According to Lidell and Morris (2010), the LIHC indicator eliminates many low-income people who live in small, inefficient homes since it concentrates on huge under-occupied buildings. Thus, making the existing 10% criterion insufficient and the criterion should be updated in light of more recent statistics and regional differences in energy prices. In the United Kingdom, the Low-Income Low Energy Efficiency (LILEE) metric is aimed at redefining fuel poverty measurement by concentrating on low-income households with high energy usage expenditures who live in inefficient dwellings. According to Middlemiss (2016), this measurement is consistent with government goals, ensuring precise identification of persons in need of assistance and encouraging enhanced support and policy initiatives.

Table 2.3 demonstrates the EP measurement methods used by countries and political-economy unions regarding their approaches, the definition of indicators and datas-sets they use for measurements currently.

Table 2.1 Energy Poverty Measurement Methods By Country And Political-Economy Unions

Country	Approach	Indicators	Definition of Indicators	Data Set
EU	Consensual-based	Arrears on utility bills	Question: Can your household afford to keep its home adequately warm?	EU-SILC (Survey on Income and Living Conditions)
		Ability to keep home adequately warm	Question: In the past twelve months, has the household been in arrears, i.e. has been unable to pay the utility bills (heating, electricity, gas, water, etc.) of the main dwelling on time due to financial difficulties?	EU-SILC
	Expenditure-based	M/2	Absolute (equivalized) energy expenditure below half the national median	EU-HBS (Household Budget Survey)
		2M	Share of (equivalized) energy expenditure (compared to equivalized disposable income) above twice the national median	EU-HBS
UK	Expenditure-based	Low-Income High Costs (LIHC)	Households that are in the bottom 20% of the income distribution and have fuel costs that are more than 10% of their income.	English Housing Survey (EHS)
		Low-Income Low Energy Efficiency (LILEE)	Households which have low income (the gross annual income before housing costs is below the LILEE threshold for its size) and low energy efficiency (the dwelling has an energy efficiency rating of band E or below (E, F, or G).)	EHS
US	Expenditure-based	Low-Income Energy Affordability (LEAD) Data Tool	Average energy burden (cost) of low-income households as a percentage of income spent on energy	American Community Survey and Energy Information Administration's data

Note: Adapted from BEIS (2020; 2023), DOE (2020; 2022), EPOV (2020).

2.2 Household and Household Characteristics Related to EP

Energy poverty is a multifaceted issue that is influenced by a number of factors, including low income, high energy expenditure, poor energy efficiency, and housing conditions. Housing conditions can play a significant role in deepening energy poverty, particularly for low-income households (Hills, 2011). In addition, from another point of view, when analyzing the underlying cause of domestic energy poverty, the main focus should not be on access to and affordability of fuel, but on the problem of access to adequate energy services and, therefore, the definition of fuel poverty remains archaic, and definitions such as energy service and poverty are needed (Bouzarovski & Petrova, 2015). Many socioeconomic factors, such as household size and income levels, can trigger and affect energy poverty. As none of these factors alone can describe energy poverty, various combinations of them can cause and deepen EP. For the EP to be measured correctly, housing characteristics are important issues to be addressed apart from the heating and cooling needs (Gouveia et al., 2019).

Income-based energy poverty measurements may not reflect the true magnitude of this poverty. Even in households heavily affected by income inequality, electricity, etc., consumption is very high (Son & Yoon, 2020). Energy poverty leads to physical and emotional health problems, financial stress, social isolation, and the "heat-or-eat" dilemma. Thus, improving energy efficiency in such homes can significantly improve comfort, and warmth, reduce heating bills, and alleviate social isolation (Grey et al., 2017).

Even if energy access increases, this may not immediately translate into an improvement or increase in energy use. Although many households have difficulties accessing energy, their usage rates vary widely, and poor families may not be able to use affordable energy infrastructure because of their limited financial capabilities (Son & Yoon, 2020). A study in Poland that analyzed energy data during the Covid-19 lockdowns and compared it to the pre-pandemic period revealed that electricity demand increased during the pandemic as the usage of home appliances increased, and that this increase affected very large neighborhoods, which highlighted the impact of residential energy use on future energy systems (Bielecki et al., 2021).

While the need for cooling increases compared to heating for dwellings in hot climates, it is also observed that the heating problem still creates huge health and energy needs problems (Gouveia et al., 2019). The concentration of energy poverty in areas with poor health conditions worsens its adverse effects (Bouzarovski & Simcock, 2017). A dwelling's energy performance influences a household's energy demand and contributes highly to energy poverty (Fabbri, 2015).

Climatic changes have a direct impact on energy poverty levels, especially considering how cold the winters are or how hot the summers are. These impacts also return to households as additional expenditure on heating and cooling operations and can shake their budgets deeply (Gouveia et al., 2019; Thomson et al., 2019). Moreover, the sensed/perceived extreme heating problem during the summer season is common throughout Europe, and cooling, which is the solution to this problem, must be part of energy poverty (Thomson et al., 2019). In addition, overheating as a vulnerability develops as a combination of a dwelling’s ability to stay cold, being able to cope with heat, and the health effects of heat (Thomson et al., 2019).

Energy poverty is influenced by the availability or absence of heating and cooling infrastructures in specific locations, with some nations having limited access to central heating or cooling technologies (Gómez-Navarro et al., 2021). Living comfortably in a heated home is often considered protective for human health, particularly for the elderly and young children in colder climates. (Liddell & Morris, 2010). Conversely, Long-term living in cold and poorly equipped houses may increase mortality rates (Wilkinson et al., 2007). Energy poverty has a major detrimental influence on physical and emotional health, money, and social well-being in low-income areas since residing in a cold home owing to energy poverty might be very stressful, creating despair and loneliness as well (Grey et al., 2017).

Hazardous and unwell dwelling conditions can also contribute to energy poverty. Many studies related to interventions of installing heating or enhancing insulation in homes have demonstrated considerable improvements in resident health and well-being (Shortt & Rugkåsa, 2007). Most notably, condensation, mold, and dampness decreased, leading to better temperature control and increased home utilization and comfort (Belaïd, 2018; Hong et al., 2009) which also reduces energy poverty. Damp or moldy homes, for example, may demand more energy to heat and cool, and they may also cause health issues that make it difficult for residents to work or attend school. However, even after receiving energy-efficient modifications, low-income households still suffered fuel poverty, demonstrating the ongoing issue of balancing income with energy expenditures (Shortt & Rugkåsa, 2007) since lower income households residing in energy-inefficient homes stand at the forefront of risk (Belaïd, 2018). Furthermore, home renovation is extremely important, with restored dwellings clearly less prone to fuel poverty (Belaïd, 2018; Peralta et al., 2017). Housing retrofitting involves improving energy efficiency in homes through insulation, efficient equipment, or renewable energy self-consumption. These measures reduce environmental impact and dependency on public administration. However, they are expensive and can be challenging to implement due to technical and administrative challenges (Gómez-Navarro et al., 2021). Grey et al. (2017) stated that improving energy efficiency through interventions such as house modifications may have a significant impact on people's lives. In this study, participants in focus groups reported feeling warmer, more relaxed, and less worried after receiving treatments. As a result, they were able to save money, feel less socially excluded, and even invite people over. Surprisingly, the mental and social benefits of increased indoor temperatures tended to exceed the direct health benefits.

There is a prominent correlation between the energy efficiency of housing, insulation status, and energy poverty (Sánchez-Guevara Sánchez et al., 2018; Burholt & Windle, 2006). Houses with insulation problems lead to higher energy costs as they are harder to heat and cool. Additionally, the use of old heating and cooling systems in older dwellings can increase energy consumption, as it is inefficient and costly.

Burholt and Windle (2006) argue that the high level of energy poverty in households living in the old parts of the residential stock can be explained by the lower level of the energy efficiency of the stock. Since these older dwellings have thinner walls, less insulation, and older heating and cooling systems, people living in these houses may need more energy to heat their homes. Also, these households that are vulnerable to energy poverty may often need more care in their homes. Cold homes due to energy poverty also led to significant health issues such as increased risk of death by respiratory illnesses which emphasize the impact of retrofitting related to energy efficiency of housing stock (Peralta et al., 2017). In accordance, upgrades to housing such as new windows and doors, ventilation, boiler, etc., eliminating housing problems such as mold and dampness were found to improve the mental health and thermal comfort of its residents (Poortinga et al., 2017). Although Sharpe et al. observed similar results in their 2020 study that energy efficiency measurements such as installment of new heating systems improved home interior temperature and reduced energy poverty for low-income households, they also noticed that not all households profited from these benefits equally and some faced undesirable consequences such as increased bills and non-improving energy poverty levels. Sánchez-Guevara Sánchez et al. (2018) emphasized the need to consider regional differences such as climate, existing heating and cooling systems and energy resources, when examining energy poverty related to insulation. Additionally, even if the income levels of the households are similar, factors such as the floor level of the housing unit, the orientation of the house, and the ill thermal envelope affect each other and create different energy poverty issues (Sánchez-Guevara Sánchez et al., 2018).

Older homes often experience higher heat loss and poorer thermal regulation (Hamilton et al., 2017; Legendre & Ricci, 2015). Thereby, households living in older homes might be at a higher risk of energy poverty compared to newer parts of the stock (Healy & Clinch, 2004; Riva et al., 2021). A recent research by Hamilton et al. (2017) examined the multidimensional relationships between building and household factors and indoor temperature in English households using data from the

English Follow-Up Survey (EFUS). The data demonstrated statistically significant connections between indoor temperature and housing age, size, tenure, composition, household income, employment, and energy performance. Notably, older homes had lower mean temperatures than newer homes; nevertheless, the newest homes did not always have the warmest interiors. In addition, houses with worse energy performance were clearly cooler, emphasizing the critical significance of energy efficiency in preserving thermal comfort. Furthermore, higher socioeconomic status, as measured by wealth and employment, was related to warmer interior temperatures, implying possible thermal comfort inequities.

Walker et al. (2014) conducted a study to assess fuel poverty at the home level, taking into consideration both physical dwelling attributes and household-driven factors such as household size, heating timetables, and electricity usage. According to the findings, fuel poverty is concentrated in certain geographic locations, and houses are often of moderate or low energy efficiency. The research also discovers that not all homes in these locations are affected by fuel poverty to the same extent, hence highlighting the importance of identification of high-risk locations, followed by household-by-household surveys in such areas. In addition, older housing stock often results in higher energy bills for households due to their increased energy consumption as a percentage of their income (Walker et al., 2014) which goes hand-in-hand with the previous assumptions made by different scholars regarding older houses.

Fabbri (2015) argues that energy poverty traps residents of inefficient buildings in a cruel cycle: unable to improve their homes' energy performance due to financial constraints, they grapple with high energy bills. Current methods of identifying these vulnerable households were found to be intricate by Fabbri, and while policies aim to ease immediate burden through cost reduction, a long-term vision for building upgrades remains elusive.

Legendre and Ricci (2015) identified that different EP assessment technologies depict opposing landscapes by capturing diverse groups: one method focuses on energy expenditure, identifying older homes, while another detects active individuals in flats. Aside from measuring errors, they concluded that wealth plays a critical role in worsening fuel vulnerability. Since, fuel expenses disproportionately affect low-income households, specifically those who live alone or are retired. Furthermore, housing features, including low energy performance, dependency on individual boilers, and use of propane/butane for cooking, increase susceptibility. Their study concluded with the notion that access to community heating systems or municipal gas, on the other hand, can provide some protection.

Household composition also plays a prominent role, with large families and single-person dwellings facing greater challenges compared to couples (Belaïd, 2018). Tenure status emerges as another significant factor, with private rented housing amplifying vulnerability compared to homeownership. Unsurprisingly, employment status was found to impact fuel poverty, with both unemployed and working households exhibiting higher risk than those with higher incomes.

Economic support for energy poverty involves managing energy expenditure costs, either by paying higher bills or flattening them by distributing costs with less energy expenditure periods, and reviewing contracts to discard unnecessary costs or find better prices (Gómez-Navarro et al., 2021).

Healy and Clinch’s 2004 research reveals a vicious cycle between energy poverty and dampness where low-income households with inadequate heating are four times more likely to suffer from condensation and dampness, perpetuating health risks and financial burdens. While the fuel allowance offers some relief, it's a mere bandage, as recipients are still three times more likely to be fuel-poor than others.

Mode of tenure, whether a household owns or rents its home, can also play a significant role in energy poverty. Homeowners generally have more control over their energy usage and can make changes to their homes to improve energy efficiency (Burlinson et al., 2018; Dalla Longa et al., 2021). However, homeowners may encounter financial challenges in implementing these improvements (O'Sullivan et al., 2017). If a homeowner believes they will save money on energy costs over time, they are more likely to invest in energy-efficient modifications such as insulation or a new heating system, or to ask for financial aid to help them make energy-efficient changes. A tenant, on the other hand, may be unwilling to make these investments because they will not immediately benefit from the aid and savings. Dalla Longa et al. (2021) reveals that classifying households based on risk requires distinct thresholds for each data level. Income is the main factor, but other factors like population density and house ownership also play a role. Neighborhood-level data may highlight the impact of crowds while individual households grapple with their own weight. Their study also suggests that as energy poverty is a subject that adapts to different social landscapes, it is crucial for policymakers to craft targeted interventions that reach those most at risk, regardless of their societal differences.

Renters are more likely to be energy-poor than owners (Legendre & Ricci, 2015; Scarpellini et al., 2015), and living in rented accommodation raises the likelihood of energy poverty in comparison to owner-occupied buildings (Belaïd, 2018; Gómez-Navarro et al., 2021; O'Sullivan et al., 2017; Riva et al., 2021). Furthermore, because they have restricted rights and inadequate incentives, tenants may be less inclined to make energy-efficient renovations (Mashhoodi et al., 2018). Economic strain and balancing food and utility expenses are widespread, and young people are far more inclined than adults to report cold houses, with almost half reporting that their homes are frequently or always cold (O'Sullivan et al., 2017). The absence of control over heating, as well as cultural considerations such as bedroom location in colder areas of the home, all contribute to difficulties in establishing thermal comfort. While no geographical disparities were discovered, people living in private leases or government-owned social housing appeared at greater risk of energy poverty.

Tenants are mostly low-income households (Romero et al., 2018), which might lead to them opting for low-cost housing to save money. However, the low thermal insulation in the housing may have a negative impact on their energy poverty levels (Grösche, 2009).

One probable cause is that rental housing is inefficient in terms of energy use. Landlords have few incentives to refurbish their properties for energy efficiency, while renters have restricted rights and little incentive to make efficient energy efficiency upgrades and retrofitting procedures in their houses (Mashhoodi et al., 2018). Thus, the rental housing stock is characterized by more severe energy efficiency issues compared to other parts of the stock. On another note, renting indicates a representation of reduced household income that necessitates the use of low-cost housing to limit expenditure and potentially leads to increased energy consumption because of the property's poor thermal efficiency (Romero et al., 2018).

When the economic impact and cost of energy poverty on households are measured, low-income households, smaller households and those with dwelling units are observed to experience EP more (Xie et al., 2022). A study in China found that when households in cold climates convert energy infrastructure to electricity and natural gas to increase clean energy use, heating expenditures rose for participant households, leading to energy poverty (Xie et al., 2022). The study also pointed out that the financial aid provided by the state could not cover these new costs.

Abbas et al. (2020) argued that low-income households are deprived of energy because their existing earnings are not enough to meet their energy expenditures, which will create a vicious circle and push these low-income households to spend less on their domestic energy needs and bills. In terms of household size, larger households are found to be more likely to experience energy poverty.

The multidimensional energy poverty problem is also more common in renter households and rented dwellings than in home-owners. Energy poverty in rural areas might increase due to the dependence on fossil fuels and old energy infrastructure. Along with problems such as poverty and low incomes, the troubles caused by natural geography and terrain make it difficult to implement energy infrastructure, thus making access to energy difficult (Abbas et al., 2020). Another vulnerable group found in income-based energy poverty studies is households made up of individuals living alone, especially elderly and retired people and they are pushed into EP by high costs (Legendre & Ricci, 2015). In their study, Burholt and Windle (2006) observed that a large proportion of the elderly are energy-poor, that state financial assistance is insufficient, and that those with the lowest income spend the most on heating their homes.

Burlinson et al. (2018) also identify three categories of related to energy poverty: income poverty, housing-cost-induced poverty, and fuel-cost-induced poverty. Income poverty, primarily affecting non-white populations, results in low wages and unemployment. Housing-cost-induced poverty, primarily affecting young men, homeowners, and tenants, primarily affects the private rental sector. Fuel-cost-induced poverty, smaller in number, affects both homeowners and private tenants, leaving them vulnerable to high energy bills. This disaggregation can lead to more effective policy interventions, such as energy efficiency upgrades in private rentals and income support for households struggling with fuel and other expenses (Burlinson et al., 2018). Lower-income households are more likely to experience energy poverty (Primc et al., 2019) due to limited disposable income, making it difficult to balance essential energy needs with other household expenses, and living in older, less energy-efficient homes (Son & Yoon, 2020). A UK study indicates that wealthier middle-income households may also experience energy poverty due to living in inefficient homes (Walker et al., 2014).

According to Riva et al. (2021) energy poverty is a social issue that is deeply rooted in household composition. Families with lone parents, older adults, or those with disabilities face higher fuel-cost burdens. Gender disparities also contribute to energy poverty, with women often bearing a heavier burden. They also discussed that income should not be the only main factor, as even households with higher incomes can be on the edge of energy poverty if their social vulnerability increases. Their research found that the type of dwelling also plays a role in increasing energy poverty, with single-family homes being more energy-efficient than apartments. Renters, especially in urban centers, face a disadvantage due to a lack of control over energy-saving modifications. Older dwellings and those in need of repairs struggle to retain warmth, leading to higher energy demands and higher bills (Riva et al., 2021).

Households with multiple members face greater energy needs than smaller ones (Abbas et al., 2020; Robinson, 2019; Romero et al., 2018). Multiple-generation families may face energy poverty as a result of higher lighting, heating, cooling, and electrical use, as well as reduced energy adaptability, making it more difficult to preserve energy (Bednar & Reames, 2020; Kanagawa & Nakata, 2008). Additionally, in their study about multiple households in UK, Cauvain and Bouzarovski (2016) found out that due to legal difficulties, inadequate living conditions, and negative public opinion, the multiple occupancy housing sector (HMOs) suffers a condition that marginalizes people and renders them vulnerable to fuel poverty, which is aggravated by alienation from legislative structures and inadequate energy systems.

Households with disabled or elderly inhabitants may be more exposed to energy poverty since these persons may struggle to keep their houses in great repair or reduce their consumption of energy to save energy (Ivanova & Middlemiss, 2022; Riva et al., 2021; Robinson, 2019; Snell et al., 2015). Similarly to the heat-or-eat dilemma, a household with multiple kids might be forced to choose between heating and cooling their home to maintain the right level of comfort, which can have significant health repercussions for the children (Abbas et al., 2020; Tonn et al., 2021). A single-parent home with little finances may struggle to keep warm and might devote a large percentage of its revenue to cooling and heating expenses (Kearns et al., 2019; Primc et al., 2019; Sunikka-Blank & Galvin, 2021). Energy poverty can be influenced by other household characteristics, such as low education or literacy levels, which may limit understanding of energy conservation measures and access to energy assistance programs (Kose, 2019).

Large households with low-income status often face energy poverty, as they struggle to manage higher energy needs while unable to afford adequate services. For large households, living in poorly insulated dwellings further complicates managing energy costs and maintaining a comfortable living environment (Chen & Feng, 2022). Lower-income households with smaller rooms may struggle to maintain comfortable temperatures, while middle-income households with larger rooms may have higher energy bills due to larger living spaces and more appliances (Eisfeld & Seebauer, 2022; Robinson, 2019). Upper-income households with larger rooms may invest in energy-efficient upgrades like insulation and smart thermostats (Jessel et al., 2019).

The size, as well as the number of rooms in a dwelling, have a considerable impact on energy consumption since larger houses often include additional living space and appliances, and therefore, a greater energy demand (Xie et al., 2022).

The association of dwelling size and energy deprivation might be based on energy expenses, with larger dwellings typically being colder than ones that are smaller (Hamilton et al., 2017; Sánchez-Guevara et al., 2014; Sharma et al., 2019). Furthermore, burdening households with increased energy bills in order to keep rooms warm increases the probability of residential energy vulnerability exposure (Burlinson et al., 2018). Nevertheless, other studies have come to a different conclusion that households that live in compact dwelling units might be more prone to energy poverty in some cases (Belaïd, 2018).

2.3 Energy Poverty Discussions in Türkiye

There is no agreed definition of energy poverty in Turkey. Although the concept, which entered the international literature in the 1990s, was initially seen in rural areas, it now affects many urban settlements and emerges as a problem for which no policy has been developed. Low-income households affected by increasing energy costs, prices and unemployment rates have put Turkish households in an even more difficult situation, especially after the 2008 economic crisis (Erdoğdu, 2020). The issue of EP was generally seen as the situation of families whose electricity and natural gas were cut off due to unpaid bills across the country. This situation was actually at a point where more policy could be produced when considering the subject of expenditure, and with the social aid of the state, the subject entered the academic literature. However, the problem was always going beyond investigating the ratio of existing energy resources such as electricity and coal to the income of households (Erdoğdu, 2020). Many policies have been prepared, especially regarding electricity expenditures, and incentives have been offered to industries. In the study conducted by Emeç et al. (2015) with HBS data, it is observed that income directly affects energy choices in energy poverty in Turkey, and low-income households turn to cheaper traditional fuel types. The authors also linked access to modern energy resources and infrastructure problems with energy poverty, but did not draw a direct conclusion on this. Most studies in Turkey focus on the financial aspect of energy poverty. This approach provides valuable insights into household affordability, but it neglects other crucial dimensions.

According to the study by Selçuk et al. (2019), almost one-quarter of Turkish homes are energy-poor, with half of the lowest-income households experiencing this problem. The proportion of energy-poor families reduced from 36% in 2003 to 23% in 2017. However, their results have shown that the poorest households did not improve significantly. Accordingly, in 2017, 72% of houses lacked natural gas, 63% possessed floor heaters, 11.5% possessed hot water, and 10.3% possessed toilets. The results of this study, which tries to measure the socioeconomic levels of energy poor households, align with the literature findings. These implications significantly point out and support the claim that the EP has a greater impact on housing and household characteristics.

Additionally, the Turkish government's commitment is evident in the National Energy Efficiency Action Plan (NEEAP), which aims to reduce energy consumption by 14% by 2023 (T.C. Ministry of Energy and Natural Resources, 2022). This initiative focuses on improving energy efficiency and reducing reliance on expensive imports. Yet the results regarding this plan have not been published.

All in all, there is a lack of studies focusing on housing and household problems in relation to energy poverty in Türkiye. This is a significant gap, as housing quality and energy efficiency are directly linked to household energy consumption and affordability and result in energy poverty.

2.4 Key Findings

Energy poverty, defined as the inability to buy appropriate energy services for basic requirements, is a complicated issue with far-reaching repercussions. While traditional measures frequently focus exclusively on financial elements, a fuller understanding emerges when the different effects of energy poverty on households and their living situations are included. Each area of energy poverty highlights a distinct aspect of this complex problem. For instance, while expenditure-based indicators appear to be a simple approach to assessing the financial burden, they may not capture the entire picture.

Consensual indicators, such as thermal comfort and indoor air quality, provide light on the everyday realities of energy poverty, highlighting how a lack of energy access leads to chilly, wet, and possibly dangerous living conditions. Furthermore, concentrating simply on spending misses the critical role that housing conditions play in sustaining energy poverty. Inadequately insulated homes, leaky windows, and out-of-date heating and cooling systems may drastically increase energy usage, putting even the most financially secure households in an energy crisis. Furthermore, due to their special demands and limited resources, certain household features, such as big families, renters, handicapped persons, elderly residents, single parents, and low-income households, experience heightened vulnerability.

Existing studies in Turkey often overlook energy poverty dimensions, relying solely on expenditure-based indicators. This narrow approach hinders effective interventions and targeted support. An integrated approach incorporating financial and consensual measures, housing conditions, and vulnerable household characteristics is crucial for comprehensive solutions. All of these vulnerabilities regarding EP and vulnerable groups affected by and affecting its incidences were gathered from this literature review. The variables chosen for this study will be determined in the next chapter after examining these results from the literature review.

CHAPTER 3

DATA AND METHODS

In previous sections, it has been discussed that energy-poor households are the leading vulnerable group among all households from different perspectives, and they constitute a significant share in the renewal, reinvestment, and rehabilitation decisions in housing stock. Moreover, energy-poor households' decisions in renewal and reinvestment decisions are discussed in relation to the general condition of the existing housing stock, infrastructure features of the dwellings, and household characteristics. This part of the study aims to explore the distinctive qualifications of households and dwellings that affect and contribute to energy poverty levels in Türkiye by utilizing cross-sectional data from the 2020 Income and Living Conditions Survey (ILCS) of TURKSAT at the national and NUTS-2 region levels.

The main argument of this thesis is that energy poverty is highly intertwined with household and dwelling characteristics. In order to reveal the energy poverty levels in relation to household and housing characteristics, EPOV's Consensual-based Approach was mainly utilized in this study. ILCS data was preferred over the Household Budget Survey (HBS) data for the analysis as it contains the main variables of EP and other housing and household-related variables as well as the spatial reference at least at the NUT-2 regions level. For the measurement, some ready-made variables such as arrears on utility bills, inability to keep the homes warm, mode of tenure, household type, number of rooms available to the household, size of the dwellings in square meters, presence of leaky roofs, damp walls, rotten walls and presence of heating problems caused by the insulation of the dwelling were provided by the ILCS data and recoded to be used in the analysis as the literature findings suggest. Household size and income variables were recalculated to represent reliable results. Household size variable is recalculated using weight coefficients provided in the raw data. The household income variable is recalculated using the

Square-root Scale Method of Equavalisation of Household Income provided by OECD (2020). Thereafter, these variables were ready to use for the Consensual-based Approach. Figure 3.1 summarizes the method of the thesis.

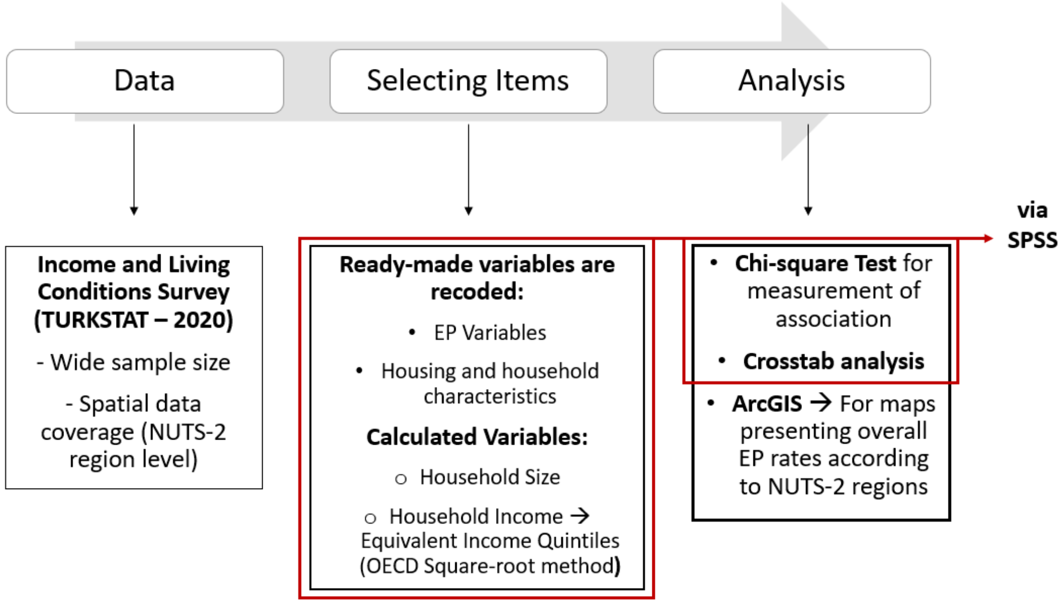


Figure 3.1. Method Flow of the Thesis

3.1 Data: Income and Living Conditions Survey Data (TURKSTAT – 2020)

ILCS data collection in Türkiye started in 2006 in the context of integration and adaptation to the European Union, to demonstrate income distribution among households and individuals, and to gauge living standards, social exclusion, and poverty levels in Türkiye. ILCS is an annual and regularly conducted survey. The annual panel survey method is adopted in order to create comparable data with European countries regarding comparable income distribution, relative income poverty, and living standards. Geographic coverage of the data includes all residential areas and all household members in Türkiye. ILCS data was provided with respect to NUTS-1 region levels until 2013. In 2014, the NUTS classification level of 2 was also made available to the researchers. Subjects covered in the data have a wide range from housing to demographics.

According to TURKSTAT (2021), for 2020 ILCS data, 27437 households were visited for data collection. Surveys were made with 25706 of these households. For various reasons, surveys could not be conducted with the 1731 households left. The most current population projections are used to weigh and publish the results of ILCS. The weight coefficients used for generating estimates about the mass population are based on the population projections of the Address-based Population Registration System.

3.2 Variables

From TURKSTAT ILCS data, two of the energy poverty-related indicators of the EPOV's Consensual-based Approach can be derived. In this data set, the 'Arrears on utility bills' and 'Inability to keep home adequately warm' variables are readily available and employed in this study as the basis for the analysis. These two variables are coded as dependent variables as the study aims to observe the relationship between EP levels and independent variables. Since these two consensual-based approach variables are considered as dependent variables in this study, the independent variables that will be explained further in this part are crucial as the results showing EP levels are depending on these independent variables.

3.2.1 Dependent Variables

The first variable, namely 'arrears on utility bills' is employed to investigate the frequency of energy poverty problems in line with income and inequalities. This variable is represented and explained as the "*condition of households not being able to pay electricity, water and gas bills as planned in the last 12 months"* in ILCS. The following frequencies regarding arrears on utility bills are observed from the ILCS raw data employed in this study.

Table 3.1 Inability to Pay Electricity, Water and Gas Bills As Planned in the Last 12 Months

	Frequency	Valid Percent	Cumulative Percent
1. Yes (Once)	942344	3.8	3.8
2. Yes (2 or more times)	3807357	15.3	19.0
3. No (Didn't happen)	19839627	79.5	98.5
4. No such payment	362517	1.5	100.0
Total	24951846	100.0	

These frequencies show the share of households that are unable to pay their utility bills as planned in the last 12 months. Since the households that answered *"Yes (Once), Yes (2 or more times), No such payment"* are clearly experiencing problems while paying their utility bills, all three of these classes are recoded into "At risk of EP". The households that answered *"No (Didn't happen)"* are recoded into "Not at risk of EP" since they are able to pay their utility bills as planned in the last 12 months. After this step, this dependent variable is renamed as **"Dependent Variable (DV) 1: Arrears on utility bills"**. The following frequencies in Table 3.2 shows the final distribution of Dependent Variable (DV) 1 after the recoding process.

Table 3.2 Dependent Variable (DV) 1: Arrears on Utility Bills

	Frequency	Valid Percent	Cumulative Percent
Not at risk of EP	19839627	79.5	79.5
At risk of EP	5112219	20.5	100.0
Total	24951846	100.0	

The inability to keep the home adequately warm variable represents the energy poverty problems in relation to dwelling standards and economic capacity of households. This variable is expressed with the question of "Is your household financially able to cover the cost of heating your home?" with '2' for 'No' and '1' for 'Yes' answers in ILCS data. Since it is also the second dependent variable chosen for the analysis, this variable of households' economic ability to cover the heating costs of the house is renamed as **“Dependent Variable (DV) 2: Inability to keep home adequately warm”**. Households which answer ‘No’ is recoded as “At risk of EP” and ‘Yes’ is recoded as “Not at risk of EP”. The following frequencies represent the distribution of Dependent Variable (DV) 2 which exhibits economic ability of households to cover the heating costs of their dwellings after the recoding process in the ILCS data.

Table 3.3 Dependent Variable (DV) 2: Inability to Keep Home Adequately Warm

	Frequency	**Valid Percent**	**Cumulative Percent**
Not at risk of EP	20459302	82.0	82.0
At risk of EP	4492545	18.0	100.0
Total	24951846	100.0	

In the end, two dichotomous dependent variables were obtained to be used in the anaysis.

Table 3.4 Dependent Variables Which Are Recoded As Main Dependent Variables

Dependent Variables	**Codes**
Dependent Variable (DV) 1 Arrears on utility bills	“No” recoded as "Not at risk of EP" “Yes” recoded as "At risk of EP"
Dependent Variable (DV) 2 Inability to keep home adequately warm	“Yes” recoded as "Not at risk of EP" “No” recoded as "At risk of EP"

From the Tables 3.2 and 3.3, it can be observed that approximately one fifth of the households are exposed to EP whether the issue is related to having arrears on utility bills or not being able to cover the heating cost of their dwellings. Since both variables are recoded as main variables of this study, the overlap rates between them are examined through a crosstab analysis to understand their relationship to one another.

Table 3.5 Overlap Rates of the Two Dependent Variables (DV) of EP

		DV 1: Arrears on utility bills		
		Not at risk of EP	At risk of EP	Total
DV 2: Inability to keep home adequately warm	Not at risk of EP	69.5%	12.5%	82.0%
	At risk of EP	10.0%	8.0%	18.0%
	Total	79.5%	20.5%	100.0%

The consensual-based dependent variables of this study that are derived from the data set employed were cross examined for observation of how much they overlap. From Table 3.5, it can be deducted that the overlapping rates for households at risk of poverty are lower between these dependent variables. Özgür and Özdemir Sarı (2022) have found in their study that the energy-poor households were 30.5% of all households in the country when these two dependent variables are cross-examined. This result indicates that these two main dependent variables are exhibiting low rates of agreement. When the two dependent variables of expenditure-based approach that are derived from Household Budget Survey (HBS) are examined, the measured EP level of households was 36.3% (Özgür & Özdemir Sarı, 2022). Thus, their study points out the problem of both approaches and dependent variables are representing different dimensions of EP. They also highlighted the similarities in terms of household and housing features when these dependent variables are examined based on different housing and household variables.

3.2.2 Independent Variables:

The ILCS data also provides 8 variables that are related to household characteristics, income and socio-economic conditions, and dwelling standards. In total, 10 variables are investigated in the analysis part of the study. These 8 variables; mode of tenure, household type, income, household size, number of rooms available to the households, size of the dwellings, presence of leaky roofs, damp walls, rotten windows and heating problems related to insulation are independent variables of this study. From these independent variables, only household size and income variables were recalculated using SPSS program. Other independent variables were readily available in the ILCS data. Therefore, they were only renamed, thus considered as recoded using SPSS also. For the household size variable, a weighting method/process is carried out in order to reveal the real values that represent all households in the country from the ILCS data as it was created by sampling (TURKSTAT, 2021). These weighting coefficients were adapted from Eurostat's Implementing Regulation No: 2019/2240 with respect to population projections. This study adopts the OECD's Square Root Scale method of Equivalisation for Household Income. Household income variable exists in the ILCS raw data. However, adjusting the income variable according to household size will enable more equal comparisons between households, as the needs of households increase with each additional person, but this increase cannot be proportional due to various economic conditions (OECD, 2020a). Due to these limitations of the existing data, the raw data of household income values are adjusted and equivalized in five income quintiles using the 'square root scale' method to be easily classified and examined (Aksoy, 2017). With the equivalence scale method, values are assigned to each household type in the population in proportion to their needs and by taking into account household size and age factors (OECD, 2020b). Table 3.6 represents a summary of these independent variables which are recoded and recalculated for this study's purposes.

Table 3.6 Independent Variables

Variables	Codes
Ready-made/Recoded variables	
Mode of Tenure	1. Owner 2.Tenant 3.Lodging 4.Not owner but accommodation is provided free
Household Type	1. One Person Households 2. Extended-family households 3. Multi-person no family households 4. Couple without resident children 5. Couple with at least one resident children 6. Lone Parents with at least one resident children
Presence of leaky roofs/damp walls/rotten windows	1. Yes 2. No
Presence of a heating problem caused by the insulation of the house	1. Yes 2. No
Number of rooms available to the households	1-10 rooms
Size of the dwellings in square meters	1. 0 - 90 2. 90 - 110 3. 110 - 130 4. 130 - 150 5. 150 >
Recalculated variables	
Household Income (Equivalized)	1. Lowest 2. Low 3. Medium 4. High 5. Highest
Household Size	1-13

3.3 Method of Analysis

The analysis of energy poverty among Turkish households is done in 2 steps. The existing situation and hidden levels of energy poverty through two main variables are explored using descriptive statistics and frequency distribution analysis initially. Before this analysis, the EP variables taken from the ILCS according to consensual-based approach were accepted as dependent variables and recoded as the main dependent variables using the SPSS program. The independent variables were obtained from the same data set according to literature findings. Some of the independent variables were only recoded as they existed ready-made in the data set. Other ones were recalculated using different coefficents and equavalisation methods to represent and capture the reality of EP among the country's population. The crosstabulations were made between the dichotomous (dependent) and independent variables. A Chi-square analysis for independence was also represented for each crosstabulation to examine the relationship between main dependent variables with independent variables as well as within the variables chosen. Crosstabulations which reveal a statistically significant ($p < .01$) Chi-square value is presented in this study. In addition, Phi and Cramer's V values are also given with crosstabulations in order to examine the direction and strength of the association between the variables. Cramer's V coefficient is recommended as the correlation coefficient for nominal variables.

To assess the association levels between all variables of the study, another crosstabulation was made using SPSS program. All the variables were cross-examined to check whether there is multicollinearity between them. Multicollinearity can be referred as the situation where there is a very high correlation between at least two variables, meaning these variables being highly similar and may result in inaccuracies when used together in the same analysis (Siegel & Wagner, 2022). Although there is no exact limit on the minimum multicollinearity level, Tabachnick and Fidell (2013) sets the threshold for multicollinearity if correlation coefficient (r) is higher than 0.65. Hair et al., (2010) states that there is multicollinearity between two variables if a correlation coefficient (r) is 0.9 or above. Tables 3.7 and 3.8 represents the association levels among the variables used in this study. In light of these findings, none of the variables used in the analysis are multicollinear and all of them can be utilized together.

For the first part of the analysis section, two dependent variables of energy poverty were crossed with the region variable and results were transferred to the ArcGIS program and spatialized. Thus, it was possible to see how energy poverty levels were distributed in which regions according to the two dependent variables.

In the second part, the relationships between energy poverty and basic household and housing variables for each dependent variable were again cross examined via SPSS. In this context, energy poverty dependent variables and their relationships with independent variables such as ownership, household type and size, number of rooms, square meter dwelling size, income groups, insulation problem, and leakage problem were examined.

Table 3.7 Measures of Association

	DV 1	DV 2	Mode of Tenure	Household Type	Household Income (Income Quintiles)	Household Size	Presence of leaky roofs/damp walls/rotten windows	Presence of a heating problem caused by the insulation of the house	Number of rooms available to the households	Size of the dwellings in square meters
DV 1	1	.279*	.155*	.133*	.241*	.092*	-.193*	-.165*	.140*	.159*
DV 2	.279*	1	.104*	.080*	.340*	.083*	-.236*	-.229*	.176*	.193*
Mode of Tenure	.155*	.104*	1	.107*	.073*	.106*	.085*	.088*	.090*	.157*
Household Type	.133*	.080*	.107*	1	.044*	.519*	.077*	.072*	.130*	.171*
Household Income (Income Quintiles)	.241*	.340*	.073*	.044*	1	.064*	.254*	.253*	.144*	.184*
Household Size	.092*	.083*	.106*	.519*	.064*	1	.093*	.102*	.141*	.145*
Presence of leaky roofs/damp walls/rotten windows	-.193*	-.236*	.085*	.077*	.254*	.093*	1	.502*	.189*	.219*

Table 3.8 (Cont'd) Measures of Association

Presence of a heating problem caused by the insulation of the house	-.165*	-.229*	.088*	.072*	.253*	.102*	.502*	1	.140*	.191*
Number of rooms available to the households	.140*	.176*	.090*	.130*	.144*	.141*	.189*	.140*	1	.537*
Size of the dwellings in square meters	.159*	.193*	.157*	.171*	.184*	.145*	.219*	.191*	.537*	1

*p < 0.1

Source: TURKSAT, 2020 ILCS Data

CHAPTER 4

ENERGY POVERTY IN TÜRKİYE: A DESCRIPTIVE ANALYSIS

4.1 EP in Turkey: Regional Comparisons

In this part of the analysis, it is aimed to explain the level of the EP problem throughout Türkiye. As it was discussed in the previous chapter, the main consensual-based dependent variables of energy poverty actually measure different dimensions of the energy poverty problem. Therefore, in the first part of the analysis, the existing states of EP were displayed by cross-examining to regions to better understand the spatial distribution of the different aspects of the EP problem. Overall EP levels by regions were revealed by maps created with ArcGIS.

4.1.1 Arrears on utility bills

In line with the first consensual-based dependent variable, energy poverty was examined based on having arrears on utility bills. As presented in Figure 4.1, households which experience EP due to economic restraints as they are not able to pay their bills on time are mostly located in the Eastern and Southeastern Anatolia Regions.

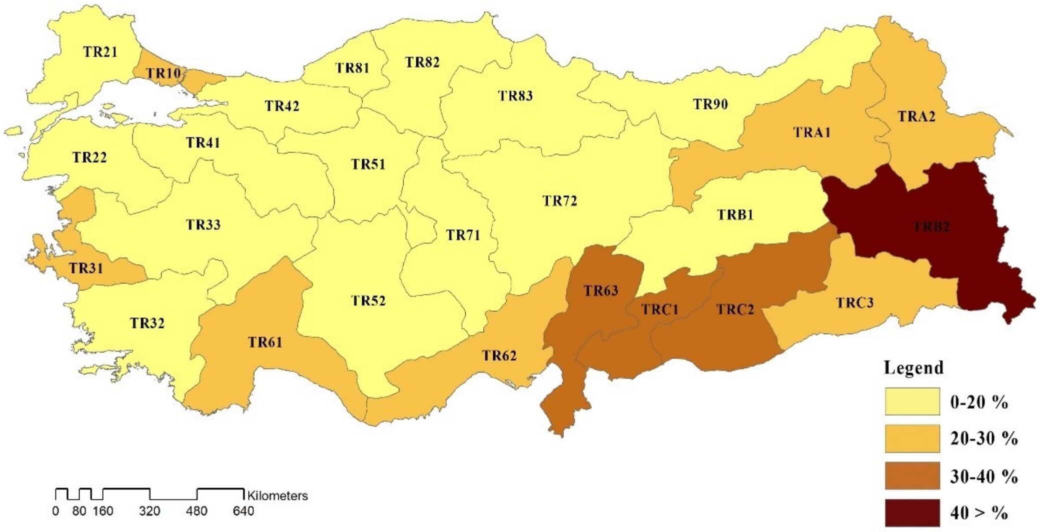


Figure 4.1. Level of Households Experiencing EP Due to Arrears on Utility Bills By NUTS-2 Regions (% of Energy Poverty Within the Regions)

Figure 4.1 displays that EP due to arrears on utility bills is experienced at most by the households living in TRB2 region (Van, Muş, Bitlis, Hakkari) with 46.9%, exceeding all other regions. Yet, the EP levels in other regions are also relatively high. The second rank in high EP levels is taken by TR63 region (Hatay, Kahramanmaraş,Osmaniye) with 38.7%, TRC1 region (Gaziantep, Adıyaman, Kilis) with 33.3% and TRC2 region (Şanlıurfa, Diyarbakır) with 31.3% of households within the region.

For comparison, according to EPAH's 2022 report, in 2021, almost 6.4 % of the population and up to 9.6% of households in the European Union faced arrears on utility bills. According to an analysis done by EPOV (Bouzarovski et al., 2020), measured EP levels through consensual-based dependent variables were particularly higher in the Southern and Eastern Europe. Same study found that the EP levels of Greece and Bulgaria exhibit the highest rates of EP due to arrears on utility bills, with 15% and 16% respectively. These ratios remain relatively low compared to the country average of Türkiye (%20.5). The gap with the EU countries gets widened in the southern and eastern parts of the country.

Additionally, some metropolitan cities which are also employment centers such as İstanbul, İzmir and Adana are exhibiting slightly higher rates of EP, between 20 to 25%. This might mean that some households living in these regional centers for business and industries are still at a high risk of being energy-poor.

4.1.2 Inability to keep home adequately warm

Energy poor households due to inability to keep home adequately warm was investigated with respect to their spatial distribution. Figure 4.2 displays the severity of EP levels due to economic and housing problems. A similar spatial distribution trend with arrears on utility bills can be seen in Figure 4.2 as the share of households that experience EP due to inability to keep home warm is higher in Southeastern and Eastern Regions.

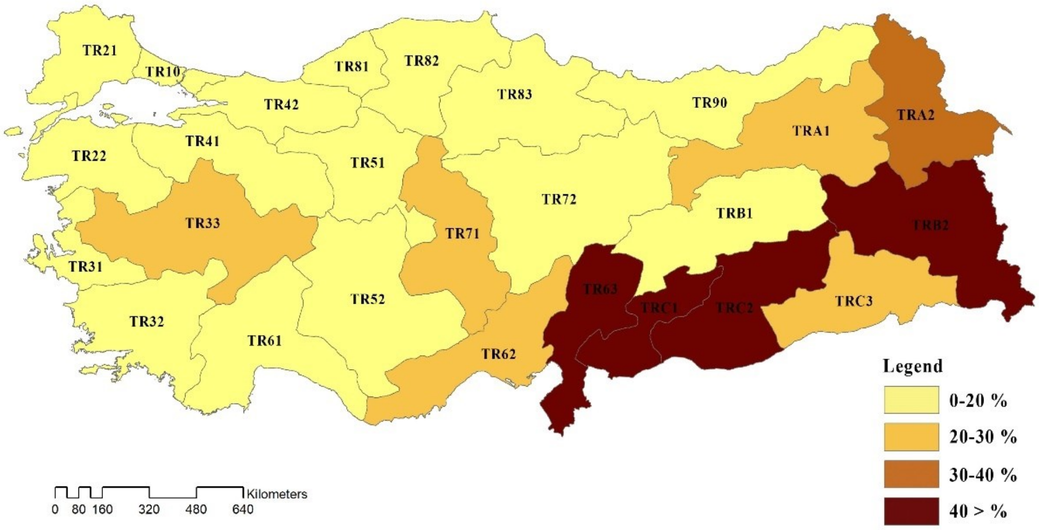


Figure 4.2. Level of Households Experiencing EP Due to Inability to Keep Home Warm by NUTS-2 Regions (% of Energy Poverty Within the Regions)

Households are highly exposed to EP due to inability to keep warm in TR63 region (Hatay, Kahramanmaraş, Osmaniye) with 48.1%, TRB2 region (Van, Muş, Bitlis, Hakkari) with 45.1%, TRC2 region (Şanlıurfa, Diyarbakır) with 41.3% and TRC1 region (Gaziantep, Adıyaman, Kilis) with 41.1% rates.

Overall, both dependent variables had shown different aspects of the EP as 'arrears on utility bills' is more related with income and inequality, while 'ability to keep home warm' is related to dwelling conditions and economic ability of households. In both cases, Eastern and Southeastern parts of Türkiye were found severely energy-poor. These results might indicate that EP is related to different household and housing characteristics. In her study of housing and living environment deprivation, Güven (2023) also found a similar geographic accumulation of problems regarding different dimensions of deprivation, such as heating problems, the presence of damp walls, rotten windows, or leaky roofs, and existence of no indoor shower/baths are mostly concentrated in Eastern and Southeastern Anatolia region.

4.2 Housing and Household Characteristics in relation to EP

4.2.1 Mode of Tenure

Different tenure modes might have different impacts on EP levels in the country as the literature suggests. Tables 4.1 and 4.2 represent the households' distribution according to two main dependent variables.

Table 4.1 Distribution of Households In the Country According to DV 1:

		Mode of Tenure				
		Owner	**Tenant**	**Lodging**	**Not owner but accommodation is provided free**	Total
DV 1	Not at risk of EP	47.3%	19.8%	1.1%	11.3%	79.5%
	At risk of EP	**8.4%**	**7.8%**	**0.2%**	**4.1%**	**20.5%**
	Total	55.7%	27.5%	1.3%	15.4%	100.0%

Table 4.2 Distribution of Households In the Country According to DV 2:

		Mode of Tenure				
		Owner	**Tenant**	**Lodging**	**Not owner but accommodation is provided free**	Total
DV 2	Not at risk of EP	47.4%	21.7%	1.2%	11.7%	82.0%
	At risk of EP	**8.3%**	**5.8%**	**0.1%**	**3.8%**	**18.0%**
	Total	55.7%	27.5%	1.3%	15.4%	100.0%

Table 4.1 displays that 8.4% of the households in the society are energy poor owner-occupiers whereas 7.8% of the energy poor tenants. In terms of 'arrears on utility bills' the ratios are very close with respect to owners and tenants. This means that any measure to support households to ease their utility bill payments may benefit both owner-occupiers and tenants. On the other side, Table 4.2 reveals that almost 8% of the society is energy poor owner-occupiers who are unable to keep their home warm. This ratio declines to 5.8% for energy poor tenants. This finding may have two types of conclusions. First, being an owner-occupier does not preclude all types of problems (such as energy poverty) for households. This means, policies encouraging owner-occupation among low-income families have to consider the life-cycle costs of housing in addition to initial cost of buying a house. Second, in-kind support by the government or municipalities for the energy poor in terms of providing fuel should not be targeted solely to tenants. It is apparent that owner-occupiers are also in need of such in-kind distributions.

In addition, Tables 4.3 and 4.4 represent the existence of EP among different tenure modes.

Table 4.3 Existence of EP According to DV 1 Among Different Tenure Modes:

		DV 1		
		Not at risk of EP	**At risk of EP**	Total
Mode of Tenure	Owner	85.0%	**15.0%**	100.0%
	Tenant	71.8%	**28.2%**	100.0%
	Lodging	82.1%	**17.9%**	100.0%
	Not owner but accommodation is provided free	73.3%	**26.7%**	100.0%
	Total	79.5%	20.5%	100.0%

Table 4.4 Existence of EP According to DV 2 Among Different Tenure Modes:

		DV 2		
		Not at risk of EP	**At risk of EP**	Total
Mode of Tenure	Owner	85.0%	**15.0%**	100.0%
	Tenant	78.9%	**21.1%**	100.0%
	Lodging	94.0%	**6.0%**	100.0%
	Not owner but accommodation is provided free	75.6%	**24.4%**	100.0%
	Total	82.0%	18.0%	100.0%

Tables 4.3 and 4.4 illustrate that since tenants have higher housing expenditures as they pay for rent as well as utility bills, they are likely to be more vulnerable to EP in terms of both DVs among different tenure modes. Because tenants do not have high capacities of making investments related to energy-efficiency of the dwellings they rent (Belaïd, 2018), and they already experience financial constraints (Romero et al., 2018) regarding the rents and bills, they are more exposed to EP in terms of arrears and inability to keep warm. A significant yet interesting result from these tables are about the EP levels among not-owner type of tenure since they also exhibit

high rates of EP for both DVs. It can be inferred that within this group of people who are not able to pay anything and dependent on their families are mostly exposed to EP, too. This may also indicate further policy implications regarding the housing stock conditions for different tenure modes as the EP rates significantly grow.

4.2.2 Household Type

When the distribution of household types were investigated through EP dependent variables, the ostensible conclusion is the households with children, which consists of couples and lone parents with at least one resident children, are exposed to EP more than the other groups. It is crucial to examine the levels of EP among different household types to further investigate and explain the vulnerability of each one.

Table 4.5 Existence of EP Among Different Households According to DV 1:

		DV 1		
		Not at risk of EP	**At risk of EP**	Total
Household Type	One Person Households	83.3%	**16.7%**	100.0%
	Extended-family households	74.1%	**25.9%**	100.0%
	Multi-person no family households	72.4%	**27.6%**	100.0%
	Couple without resident children	89.3%	**10.7%**	100.0%
	Couple with at least one resident children	77.3%	**22.7%**	100.0%
	Lone Parents with at least one resident children	71.1%	**28.9%**	100.0%
	Total	79.5%	20.5%	100.0%

According to Table 4.5, households which experience EP due to arrears on utility bills are more common in extended-family, multi-person no family, couples and lone parents with at least one children groups. Table 4.6, however, shows a slightly different result as it highlights that households that experience EP due to being unable to keep their home warm are mostly extended families and lone parents with children.

Table 4.6 Existence of EP Among Different Households According to DV 2:

		DV 2		
		Not at risk of EP	**At risk of EP**	Total
Household Type	One Person Households	81.2%	**18.8%**	100.0%
	Extended-family households	77.3%	**22.7%**	100.0%
	Multi-person no family households	81.6%	**18.4%**	100.0%
	Couple without resident children	87.3%	**12.7%**	100.0%
	Couple with at least one resident children	82.4%	**17.6%**	100.0%
	Lone Parents with at least one resident children	75.8%	**24.2%**	100.0%
	Total	82.0%	18.0%	100.0%

What is common in both tables is the lone parents with at least one resident children and extended family households are more energy-poor in both cases. Lone parent households might also suffer from income poverty as they lack additional parental income of a couple. Moreover, households with children and large households in general are likely to be at risk of EP. This finding highlights the need for policy responses particularly to reduce energy poverty risk of elderly people and children.

4.2.3 Household Income (Equivalized)

The relationship between household income and EP dependent variables is highly important as it shed the light on the vulnerabilities of the households further. The main argument is that less income translates into less disposable income which is used for rent, bills and in turn it contributes to EP levels greatly. Table 4.7 and 4.8 represents the distribution of EP levels among equal intervals of household income. EP manifests itself mostly in lower income quintiles evidently. Yet, even in the high and highest quintiles EP still exists.

Table 4.7 Distribution of EP Among Equal Intervals of Household Income According to DV 1:

		Household Income (Equivalized)					
		Lowest	**Low**	**Medium**	**High**	**Highest**	Total
DV 1	Not at risk of EP	13.0%	14.7%	16.1%	17.1%	18.6%	79.5%
	At risk of EP	**7.0%**	**5.3%**	**3.9%**	**2.9%**	**1.4%**	20.5%
	Total	20.0%	20.0%	20.0%	20.0%	20.0%	100.0%

Table 4.8 Distribution of EP Among Equal Intervals of Household Income According to DV 2:

		Household Income (Equivalized)					
		Lowest	**Low**	**Medium**	**High**	**Highest**	Total
DV 2	Not at risk of EP	12.0%	15.2%	17.0%	18.3%	19.5%	82.0%
	At risk of EP	**8.0%**	**4.8%**	**3.0%**	**1.7%**	**0.5%**	18.0%
	Total	20.0%	20.0%	20.0%	20.0%	20.0%	100.0%

The conclusion that can be made from these tables is that as income increases, the percentage of households at risk of EP decreases. This is an expected outcome considering the effects of households' budget constraints on paying bills and keeping the house at an intended temperature. However, observing energy poor households among high and highest income quintiles is not an expected result. This finding may be the reflection of the poor construction quality of the dwellings in the country which have strong relations regarding the energy consumption levels of the buildings. Another reason for this may be the larger dwelling sizes of these groups which triggers higher energy consumption levels. These issues requires further investigations; yet, this is not possible with the ILCS data.

Table 4.9 Distribution of Household Income Among DV 1:

		DV 1		
		Not at risk of EP	**At risk of EP**	Total
Household Income (Equivalized)	Lowest	65.0%	**35.0%**	100.0%
	Low	73.4%	**26.6%**	100.0%
	Medium	80.4%	**19.6%**	100.0%
	High	85.6%	**14.4%**	100.0%
	Highest	93.2%	**6.8%**	100.0%
	Total	79.5%	20.5%	100.0%

Table 4.10 Distribution of Household Income Among DV 2:

		DV 2		
		Not at risk of EP	**At risk of EP**	Total
Household Income (Equivalized)	Lowest	60.0%	**40.0%**	100.0%
	Low	76.1%	**23.9%**	100.0%
	Medium	85.0%	**15.0%**	100.0%
	High	91.3%	**8.7%**	100.0%
	Highest	97.5%	**2.5%**	100.0%
	Total	82.0%	18.0%	100.0%

When EP levels among household income are examined, a similar trend of shares of being at risk of EP in relation to income can be seen. Yet, the households at the lowest end of the household income variable are at risk of EP by 35% and 40% rates according to DV 1 and 2, respectively. Which means that from Table 4.9 and 4.10, the EP conditions in each quintile are not measured with equal intervals. This finding may be considered as the effect of uneven income distribution in the country on EP levels. However, as Table 4.9 and Table 4.10 highlight, a significant share of households in the high and highest income quintiles also suffer from EP. As discussed above, this may either be the reflection of poor dwelling quality or the high energy consumption levels.

4.2.4 Dwelling Size and Household Income

Dwelling size is another variable that plays a prominent part in EP. Literature suggests that larger dwellings are difficult to heat and keep warm. When dwelling size and EP dependent variables were cross-examined, the results showed that households that live in 90 squaremeter sized or less dwellings are more likely to be energy poor compared to others.

Table 4.11 Relationship Between Household Income Among Different Dwelling Sizes (Percentage of Household Income Within Dwelling Sizes):

		Household Income (Equivalized)					
		Lowest	Low	Medium	High	Highest	Total
Dwelling Size	0-90	26.3%	23.9%	20.4%	17.5%	11.9%	100.0%
	90-110	18.8%	21.5%	21.5%	21.1%	17.0%	100.0%
	110-130	17.1%	17.2%	19.2%	22.5%	24.0%	100.0%
	130-150	14.7%	15.4%	19.8%	21.4%	28.7%	100.0%
	150 >	10.8%	11.7%	16.0%	19.6%	42.0%	100.0%
	Total	20.0%	20.0%	20.0%	20.0%	20.0%	100.0%

As dwelling size increase, the EP levels for both dependent variables were decreased. Yet, it is worthy to note that the EP is not vanished from the larger sized building stock. These may indicate EP related problems are occuring in various parts of the stock. Thereafter, the relation between dwelling size and household income was cross examined. As it can be observed from Table 4.11, dwelling sizes increase as the income increase in Türkiye. Also households at the lowest income quintiles are more frequent in smaller dwellings. In accordance with the literature, larger dwelling size may contribute to higher energy-poverty levels, but the existing conditions of housing stock must also be considered while assessing the relations between dwelling size and EP levels.

4.2.5 Housing Problems

Housing problems in this analysis are discussed under two variables namely the presence of leaky roofs/damp walls/rotten windows and presence of a heating problem caused by the insulation of the house. From crosstabulations and measurement of association table, both variables has shown significant correlation to each other. Table 4.12 shows the presence of different housing problems. Among all households, 22% is experiencing both problems. 10% of them are having heating problem due to poor insulation and 12% are experiencing problems related to leaky roofs/damp walls/rotten windows. Overall, 44,2% of all households experience one or two of these problems related to their dwelling.

Additionally, when these two independent variables were cross examined with DV 1 and 2, 36% of the households were found to be at risk of EP due to having arrears on utility bills. This rate goes up to 44.2% when households that are at risk of EP due to lack of thermal comfort is investigated. The overlap rates increase which indicates that the households experiencing these problems already, are the ones that experience these problems altogether.

Table 4.12 Presence of Different Housing Problems Among All Households (Total %):

All households		Presence of a heating problem caused by the insulation of the house		
		Yes	No	Total
Presence of leaky roofs/damp walls/rotten windows	Yes	22.1%	10.0%	32.1%
	No	12.0%	55.8%	67.9%
	Total	34.1%	65.9%	100.0%

Table 4.13 and 4.14 indicates that the levels of EP are higher in the dwellings that experience leakage and isolation problems. For both dependent variables, these problems are more likely to occur in households/dwellings that are at risk of EP already.

Table 4.13 Presence of Leaky Roofs/Damp Walls/Rotten Windows According to EP DV 1 and 2 (Percentage of EP Within the Housing Problem):

		Indicator 1	**Indicator 2**
		At risk of EP	**At risk of EP**
Presence of leaky roofs/damp walls/rotten windows	Yes	31.8%	31.2%
	No	15.1%	11.8%

Table 4.14 Presence of Heating Problem Caused By the Insulation According to EP DV 1 and 2 (Percentage of EP Within Housing Problem):

		Indicator 1	**Indicator 2**
		At risk of EP	**At risk of EP**
Presence of a heating problem caused by the insulation of the house	Yes	29.7%	30.2%
	No	15.7%	11.7%

Another dimension regarding the housing problems is their relationship between income variable. Since income is also highly correlated to these variables, crosstabs were made to identify the extent of this relationship. Furthermore, these housing related problems might occur at any part of the housing stock. In the literature review, it was evident that sometimes high-income households may be at risk of EP in relation to experiencing problems as leaky roofs, damp walls or loss of heat due to poor insulation. These high income households may also own larger dwellings which can result in inability to keep the homes adequately warm.

To answer these, income and housing problem variables were cross examined.

Table 4.15 Presence of Leaky Roofs/Damp Walls/Rotten Windows Within Household Income Quintiles:

		Household Income (Equivalized)					
		Lowest	Low	Medium	High	Highest	Total
Presence of leaky roofs/damp walls/rotten windows	Yes	9.7%	8.1%	6.4%	4.9%	2.9%	32.1%
	No	10.3%	11.9%	13.6%	15.1%	17.1%	67.9%
	Total	20.0%	20.0%	20.0%	20.0%	20.0%	100.0%

Table 4.16 Presence of Heating Problem Caused By The Insulation Within Household Income Quintiles:

		Household Income (Equivalized)					
		Lowest	Low	Medium	High	Highest	Total
Presence of a heating problem caused by the insulation of the house	Yes	10.1%	8.4%	7.0%	5.4%	3.2%	34.1%
	No	9.9%	11.6%	13.0%	14.6%	16.8%	65.9%
	Total	20.0%	20.0%	20.0%	20.0%	20.0%	100.0%

It can be observed that as income increase, the number of problems related to dwelling decreases for both variables from Table 4.16 and 4.17 . However, these problems do not disappear completely which indicates to problems regarding the dwelling conditions. In other words, even in the the part of the building stock that accommodates higher income earners, these housing problems exist and have not been solved yet.

4.2.6 Review of the Findings

According to the analysis results of this study, which was conducted to measure energy poverty in Turkey according to household and housing characteristics, EP is most evident in the Southeastern and Eastern Anatolia regions according to both dependent variables. This result, which gives the general distribution of EP in Turkey, may actually be related to variables such as some household income problems and the physical characteristics of the housing stock.

When the level of EP is examined with other parameters, it is seen that some vulnerable household groups come to the fore, while the importance of the income variable affects many independent variables. Since it is discussed in the literature that the income variable directly affects the physical characteristics of both the household and the house, the results also support this claim. The most vulnerable groups in households that are considered energy-poor are those with children and the elderly. However, when the type of housing ownership is examined, it becomes clear that both homeowners and tenants are directly and deeply affected by EP. In addition, when variables such as housing size, leakage, moldiness, and insulation related to the housing stock were examined, their relationship with income was also observed. As income increased in Turkey, housing size increased and housing problems decreased, but did not disappear.

Housing problems related to energy always exist in both the parts of the building stock that accommodate low-income people and the parts that accommodate high-income people. The fact that housing problems do not disappear in any income group can be attributed to the physical deficiencies, wear and tear and deterioration of the housing stock in Turkey. Additionally, it can be observed that larger households living in smaller residences may be more energy-poor.

When the relationship between number of rooms in the dwellings and EP dependent variables were examined, it was seen that smaller dwellings (which has 1, 2 and 3 rooms) have the highest rate of being at risk of energy-poor due to having arrears on their utility bills (DV 1). For thermal comfort (DV 2), again smaller dwellings with 1 and 2 rooms have the highest rate of being at risk of EP. The relationship between household size and EP levels also supports literature since the larger household sizes experience EP more according to both dependent variables, 8 and 9 respectively, from the analyses made.

Accordingly, even tough results that were consistent with some of the inferences put forward in the literature were obtained, but some results, such as dwelling size analysis, did not coincide with the literature. In order to reveal the severe effects of EP in Turkey, these results need to be examined further in more detail and integrated into policies.

CHAPTER 5

CONCLUSION

5.1 Energy Poverty: A Brief Review of the Existing Problems

In this thesis, energy poverty and its measurement through a consensual-based approach have been discussed. The EP remains a complex and multi-layered problem of today, interrelated to different issues as well. Geographical disparities between other parts of the world and infrastructure limitations may result in a lack of access to modern energy sources. Access to current energy sources like electricity and clean cooking fuels is unevenly distributed, predominantly affecting rural and remote areas in developing countries. Besides, the need for proper grid infrastructure and distribution networks hinders access, particularly in remote areas. Affordability is another aspect of EP since it involves price volatility, fluctuations, and different energy systems. Changes in energy prices, like rising gas costs, can render even primary energy needs unaffordable for low-income households, even in developed countries. Older, inefficient buildings and appliances require more energy, increasing bills and exacerbating EP. EP also heavily impacts health and the environment as climate change debates exacerbate, city pollution rises, and socio-economic problems increase. Access to clean energy is crucial for addressing climate change, but EP often forces people to use unsustainable and polluting sources. Reliance on these polluting fuels for cooking, like firewood and coal, leads to indoor air pollution, causing respiratory illnesses and millions of deaths annually. EPnergy poverty may also restrict educational and economic opportunities, trapping people in a cycle of poverty and hindering development.

“Arrears on utility bills” is a significant indicator of EP. When people cannot afford to pay their energy bills, they may be forced to ration their energy use, which can lead to a number of problems. For example, they may not be able to heat their homes adequately in the winter or cool them in the summer. This can lead to health problems, such as respiratory illnesses and heat stroke. In addition, people who are behind on their utility bills may have difficulty accessing other essential services, such as water and sanitation.

On the other hand, the "inability to keep home adequately warm" is an indicator of EP's harsh reality. Winter chills seep beyond discomfort for millions, posing severe health risks and compromising basic living. Living in a cold home can trigger respiratory issues, especially in vulnerable groups like children and the elderly. The dampness and chill often lead to mold growth, further jeopardizing health and well-being. Beyond physical harm, the inability to find warmth translates to constant stress, impacting mental health and hindering daily activities. This indicator paints a picture of unequal access to essential comfort and highlights the urgent need for affordable, reliable heating solutions for energy-poor communities.

The grip of EP tightens around people and families in different ways depending on their living conditions. The mode of tenure is critical in this dynamic. Tenants, for example, frequently lack control over energy improvements and efficiency measures, exposing them to increased energy expenses passed on by landlords. Furthermore, the threat of eviction or landlord reprisal may discourage people from lobbying for greater insulation or alternative energy sources in their houses. Tenants, specifically those in low-income households, frequently live in older, less energy-efficient homes with inadequate insulation and antiquated heating systems. This compels people to choose between paying expensive energy costs or foregoing essential luxuries such as warmth. Landlords may be hesitant to renovate these properties because they are motivated by short-term earnings rather than long-term investment, prolonging the pattern of EP. This gap in tenure emphasizes the need for tougher controls on energy-efficiency requirements in rental buildings, empowering tenants and ensuring they are not unfairly burdened by the significant costs of insufficient heating. In contrast, financially distressed homeowners may struggle to make critical repairs or renovations to increase their home's thermal performance, repeating the cycle of chilly and expensive living. Furthermore, uncertain tenure, whether renting or residing in squatter neighborhoods, can result in intermittent access to power networks, increasing the issues of EP.

EP has a varying impact on different sorts of households. Because of the increasing usage of appliances and lights, large households' energy bills will increase. To manage their energy expenditures, they sometimes have to make difficult decisions, such as reducing their use of warm water or even meals. Single-person families, particularly those with elderly members on limited incomes, may find it difficult to meet even basic energy demands. They may experience difficulties in dealing with alternate heating sources or gaining access to assistance services. Because of specific equipment, lighting requirements, and temperature-controlled facilities, families with handicapped members have greater energy demands. They frequently encounter intricate bureaucracy in order to obtain aid, which adds to their stress. Rural populations frequently lack inexpensive grid-connected power and must rely on higher-priced choices such as diesel generators. Energy expenses rise even more due to a lack of rivalry among energy suppliers and a lack of public transit.

EP and substandard housing may create a never-ending struggle for comfort and warmth. Leaky roofs and walls let vital temperatures escape, causing people to raise thermostats and face escalating energy bills. This economic burden is exacerbated by health problems, since moist walls promote mold and respiratory ailments, especially among fragile youngsters and the elderly. The continual struggle for warmth has a negative impact on mental health, resulting in anxiety and despair. The ramifications go beyond individual residences. Inefficient energy usage in these inadequately insulated buildings puts pressure on national power systems and adds to greenhouse gas emissions. This environmental cost impacts everyone by deteriorating air quality and contributing to climate change.

Household size and EP are intertwined in a challenging circumstance. Attempts to keep warm collide with space constraints in smaller homes. Inadequate insulation enables essential heat to be lost, forcing people to choose between high thermostat settings and financial pressure. Overcrowding exacerbates this problem by causing families to snuggle together for warmth, losing privacy, and possibly exacerbating respiratory concerns. Larger homes confront a separate quandary: their energy consumption, like their population, expands, increasing the expense of appropriate heating. With numerous generations frequently living under one roof, the mental and financial hardship of insufficient heat increases.

Income has an immense impact on EP levels. Low-income families face a harsh reality: keeping warm is more than simply a luxury; it's a financial balancing act. Turning up the thermostat may provide temporary warmth, but the cost is high on already-strained finances. This ongoing trade-off - heating or food, heating or financial stress - may have an impact on one's well-being.

5.2 Policy Options Based on the Findings

Policies to combat energy poverty could consider homeowners and tenants separately: As the findings of this study display, the share of owner-occupiers who suffer from both dimensions of EP studied in this thesis constitutes almost 8% of the total households in the country. This reflects a significant share and calls for action to reduce EP among homeowners. In this case, financial support and regulatory measures can offer a lifeline. Also, it isn't easy to consider all the outcomes of EP in this study separately because each of the findings affects the other. For example, the fact that tenants have high energy costs due to the rent and their expenditures causes them to be directly considered energy-poor, and since they cannot invest in housing, the energy efficiency of the housing stock decreases. The long-term deterioration of housing features increases EP. In such a vicious circle, the causes of EP that trigger each other should be examined together, and a more holistic solution scheme should be created.

The results of this study reveal that both homeowners and tenants are severely affected by EP, albeit in different ways. Energy-poor homeowners in Türkiye refers to people who own a home but cannot afford their energy bills due to increasing energy costs and fixed or low incomes. This can affect people living in both cities and rural areas. For homeowners, as for tenants, solutions such as financial support and assistance are needed to significantly ease the payments of utility bills, which take a significant part of their income. It is important to remember that since the income distribution in Türkiye is generally disproportionate, homeowners may also face income problems and live as low-income households even if they own a house. This income inequality is reflected in homeowners not being able to make the investments they want in their own homes, which leads to physical problems in the housing stock. Thus, not all aid to the energy poor should focus on tenants but also on low-income homeowners. As a policy that can be implemented as soon as possible, homeowners should benefit from energy and fuel subsidies at specific rates, such as coefficient changes on bills or certain percentages of bills being covered by the state. In this way, low-income homeowners, who constitute a significant part of the stock in Türkiye, can use some of their income to invest in their dwellings. In addition, it is vital to prepare and implement different financial aid programs for physical problems related to EP that homeowners experience in their homes, such as moisture, mold, and lack of infrastructure. Policies such as targeted grants and rebates can help homeowners afford energy-efficient upgrades like insulation, heating system replacements, and smart home technologies. Low-interest loans can make these upgrades even more accessible, while property tax breaks incentivize homeowners to invest in sustainability. In addition, policies, including implementing directives regarding energy-efficient upgrades, offering financial incentives and assistance programs, and providing education regarding energy poverty to all households, are necessary.

With the increasing energy costs, the burden of living in energy-inefficient housing is directly reflected in energy bills, deeply affecting both homeowners and tenants. However, the results of this study show that tenants bear more of this bill burden. The reason is that since tenants' income levels are lower than those of homeowners, the physical properties of the houses they rent are in poorer condition. Tenants with low-income levels spend a significant portion of their income on energy bills related to the paid rent and the poor conditions of the housing unit. Thus, they cannot make the necessary investments in energy efficiency in the rental house they live in, even if they want to. For tenants, it may be a solution to balance the inequalities in income share, one of the most determining factors of these conditions, by reducing the payment volume on bills. However, considering the rents paid by tenants separately from homeowners, solutions such as providing more financial support to tenants and appointing different coefficients on bills such as electricity and natural gas should be sought depending on different modes of tenure. Only in this way can EP and consumption levels be reduced by protecting the rights of both homeowners and tenants. Rural households also need to be included in these policy solutions. In order for both homeowners and tenants to live in better housing conditions, an additional policy could be to provide tax deductions and loan opportunities to homeowners and financial support to tenants for energy efficiency investments in housing.

Conditions of the housing stock should provide input in policy design as well as household income levels: Another result of the study is that although EP incidences actually differ between income groups, they are observed at every point of the housing stock in Turkey when looking at the housing characteristics and the structural situation of the stock. Regarding EP, most of the buildings built in Turkey are inadequate in terms of structural features of the housing stock, such as heating, insulation, moisture, mold formation, and especially energy efficiency. This creates a cycle of poverty that burdens entire households by increasing energy consumption and bills due to housing characteristics. Additionally, tenants have little say in the energy efficiency of the rented residence because they can rent a dwelling as much as the rent they pay and their income level allow. In other words, tenant households, compared to their equivalent homeowners in terms of income, are almost always trapped in older and substandard buildings, use more energy, and pay more energy bills. Therefore, when developing policies regarding residential energy efficiency, priority classes should be determined according to households' income levels and needs. When the housing size, housing-related problems, and the effect of income examined in this study are inspected, the fact that EP occurs even in areas where the income level is highest and the housing is thought to be in the best conditions reveals that this problem has a direct impact on the entire housing stock in Türkiye. In other words, some deficiencies can cause energy poverty in every part of the housing stock. One of the highest priority policies must be to conduct in-depth research on the building inventory in Türkiye to find the accurate EP level in the existing housing stock and the conditions that cause it. The solutions related to energy efficiency in housing stay mainly at the architectural level or in the form of individual solutions, that is, households investing in their homes upon their wishes. This emphasizes the need to create policies at more national and provincial levels that are directly related to strategic points.

Existing policies to combat poverty should be reviewed according to the vulnerable groups of EP and their needs: For different households, it is seen that vulnerable groups such as the elderly and children stand out as energy-poor. Aid provided to households in Türkiye is prioritized for families with children and generally remains at the level of food and clothing. However, new regulations should be introduced for vulnerable households in terms of EP, and they should be prioritized according to income groups because poverty levels are ever-increasing in the country.

Regarding existing policies, the Turkish Government determined that electricity, natural gas, and fuel aid will be given to households that meet certain conditions under the Shelter-Food category of Social Assistance Services. Although these aids provide temporary relief to households, their continuity and effects cannot be monitored. Fuel aid is delivered to households in the form of coal deliveries during the winter months, and since it increases fossil fuel consumption, it cannot effectively contribute to solving EP. Natural gas aid is provided in two equal installments, based on the thermal maps of the climatic conditions in Turkey, but the payment period is unclear. Electricity subsidies are provided on a monthly basis and are primarily provided to very low-income households that meet the conditions to receive assistance and to households with people living dependent on medical devices due to chronic illness. There is no social assistance package regarding investments related to energy efficiency in the housing stock. While the impact of all this aid on the energy poverty levels of households cannot be ignored, it should also be noted that the content of these assistance programs can be further improved and developed. It is necessary to increase and diversify the types of aids based on parameters such as property ownership, income level, and physical deterioration levels of the house. Policies regarding these issues will help to improve energy consumption and offer different solutions to different types of households and housing. In addition, the main area where energy efficiency practices and incentives are encouraged in Turkey is industry, and there are no taxes or incentives for buildings. A path can be followed regarding the transformation of buildings by providing tax incentives first and then providing financing for energy efficiency. Factors such as climatic conditions, infrastructure problems, and local characteristics, which are not covered within the scope of this thesis, should also be considered when developing similar policies. Priority research should be carried out, and then, along with these factors, the necessary policies that will respond to each problem of households and the housing stock must be provided.

All in all, based on the findings of this thesis, it has been seen that EP deeply affects all households and housing stock in Turkey, albeit at different levels. The leading causes and consequences of real EP can be better understood, primarily if a detailed study is carried out on households, housing stock conditions, and inventory. Although there is no direct solution to EP in Turkey, there are policies, especially regarding income and payment, under social assistance. However, these solution efforts remain as only financial support and cannot solve most of the problems that the EP brings. Applying the existing policy options in Turkey to all households and housing types in the country with a top-down approach and "one-size-fits-all" logic does not contribute to the solution of EP. On the contrary, it is urgently necessary to offer different solution options for different housing and household types, considering the characteristics of the Turkish housing stock and households.

5.3 For Further Research

The method used in this study was adapted from EPOV, and TURKSTAT ILCS data was used. Household Budget Survey (HBS) data and its related EP indicators were not utilized since HBS data does not provide spatial codes. Also, the consumption and expenditure data present in the HBS data cannot be provided by the ILCS data used in this study. Utilizing these two data sets together would be more efficient for a more detailed EP study. Therefore, as a suggestion to institutions that collect statistics, such as TURKSTAT, it is essential to provide a database where these two data sets can be employed together. As the EU can process these two data together, EP results obtained are more detailed for EU countries. Since two separate data sets were used in different studies in Turkey, it is observed that the data sets could be improved in this respect for future studies. In addition, not including details of vulnerable households, such as disabled individuals, in the data sets may negatively affect the level of detail of the research and results in Turkey. Creating a more comprehensive and integrated database in the future will reveal more accurate inferences about the state of EP in Turkish households and housing stock.

Moreover, there is no standard definition of the concept of EP in Türkiye. It is urgently necessary to develop a definition of this concept. If the definition is to be developed, it should be a comprehensive definition that can describe the minimum consumption levels, income levels, and housing conditions of households. Based on this developed definition, EP measurement methods in Türkiye should also be determined, and it would be beneficial to evaluate these measures annually through the primary databases provided by TURKSTAT.

REFERENCES

Abbas, K., Li, S., Xu, D., Baz, K., & Rakhmetova, A. (2020, November). Do socioeconomic factors determine household multidimensional energy poverty? Empirical evidence from South Asia. Energy Policy, 146, 111754. https://doi.org/10.1016/j.enpol.2020.111754

Abel, C. F. (2016, April 2). Review of The Spirit Level: Why More Equal Societies Almost Always Do Better. Administrative Theory & Praxis, 38(2), 150–155. https://doi.org/10.1080/10841806.2016.1174042

Antepara, I., Papada, L., Gouveia, J. P., Katsoulakos, N., & Kaliampakos, D. (2020, July 16). Improving Energy Poverty Measurement in Southern European Regions through Equivalization of Modeled Energy Costs. Sustainability, 12(14), 5721. https://doi.org/10.3390/su12145721

Atkinson, A. B., & Bourguignon, F. (1982, April). The Comparison of Multi-Dimensioned Distributions of Economic Status. The Review of Economic Studies, 49(2), 183. https://doi.org/10.2307/2297269

Banerjee, R., Mishra, V., & Maruta, A. A. (2021, September). Energy poverty, health and education outcomes: Evidence from the developing world. Energy Economics, 101, 105447. https://doi.org/10.1016/j.eneco.2021.105447

Barslund, M., & Ludolph, L. (2019, September 14). Could the decrease in Belgian government debt-servicing costs offset increased age-related expenditure? Public Sector Economics, 43(3), 225–246. https://doi.org/10.3326/pse.43.3.1

Bednar, D. J., & Reames, T. G. (2020, March 23). Recognition of and response to energy poverty in the United States. Nature Energy, 5(6), 432–439. https://doi.org/10.1038/s41560-020-0582-0

BEIS. (2023, February 28). Fuel poverty statistics methodology handbooks. GOV.UK. Retrieved December 5, 2023, from https://www.gov.uk/government/publications/fuel-poverty-statistics-methodology-handbook

Belaïd, F. (2018, March). Exposure and risk to fuel poverty in France: Examining the extent of the fuel precariousness and its salient determinants. Energy Policy, 114, 189–200. https://doi.org/10.1016/j.enpol.2017.12.005

Best, R., Hammerle, M., Mukhopadhaya, P., & Silber, J. (2021, July). Targeting household energy assistance. Energy Economics, 99, 105311. https://doi.org/10.1016/j.eneco.2021.105311

Bielecki, S., Skoczkowski, T., Sobczak, L., Buchoski, J., Maciąg, U., & Dukat, P. (2021, February 12). Impact of the Lockdown during the COVID-19 Pandemic on Electricity Use by Residential Users. Energies, 14(4), 980. https://doi.org/10.3390/en14040980

Boardman, B. (1991, January 1). Fuel Poverty. Belhaven. http://books.google.ie/books?id=HwYtAAAAMAAJ&q=brenda+boardmann&dq=brenda+boardmann&hl=&cd=2&source=gbs_api

Bouzarovski, S. (2013, August 20). Energy poverty in the European Union: landscapes of vulnerability. WIREs Energy and Environment, 3(3), 276–289. https://doi.org/10.1002/wene.89

Bouzarovski, S., & Petrova, S. (2015, November). A global perspective on domestic energy deprivation: Overcoming the energy poverty–fuel poverty binary. Energy Research & Social Science, 10, 31–40. https://doi.org/10.1016/j.erss.2015.06.007

Bouzarovski, S., & Simcock, N. (2017, August). Spatializing energy justice. Energy Policy, 107, 640–648. https://doi.org/10.1016/j.enpol.2017.03.064

Bouzarovski, S., & Tirado Herrero, S. (2016, July 26). The energy divide: Integrating energy transitions, regional inequalities and poverty trends in the European Union. European Urban and Regional Studies, 24(1), 69–86. https://doi.org/10.1177/0969776415596449

Bouzarovski, Thomson, Cornelis, Varo, Guyet, & Directorate-General for Energy (European Commission). (2020). Towards an inclusive energy transition in the European Union : confronting energy poverty amidst a global crisis. In European Union (MJ-04-20-314-EN-N). EU Publications Office. Retrieved December 25, 2022, from https://op.europa.eu/en/publication-detail/-/publication/4a440cf0-b5f5-11ea-bb7a-01aa75ed71a1/language-en

Brosemer, K., Schelly, C., Gagnon, V., Arola, K. L., Pearce, J. M., Bessette, D., & Schmitt Olabisi, L. (2020, October). The energy crises revealed by COVID: Intersections of Indigeneity, inequity, and health. Energy Research & Social Science, 68, 101661. https://doi.org/10.1016/j.erss.2020.101661

Burholt, V., & Windle, G. (2006, July). Keeping warm? Self-reported housing and home energy efficiency factors impacting on older people heating homes in North Wales. Energy Policy, 34(10), 1198–1208. https://doi.org/10.1016/j.enpol.2004.09.009

Burlinson, A., Giulietti, M., & Battisti, G. (2018, May). The elephant in the energy room: Establishing the nexus between housing poverty and fuel poverty. Energy Economics, 72, 135–144. https://doi.org/10.1016/j.eneco.2018.03.036

Castaño-Rosa, R., Solís-Guzmán, J., Rubio-Bellido, C., & Marrero, M. (2019, June). Towards a multiple-indicator approach to energy poverty in the European Union: A review. Energy and Buildings, 193, 36–48. https://doi.org/10.1016/j.enbuild.2019.03.039

Chen, K., & Feng, C. (2022, July 6). Linking Housing Conditions and Energy Poverty: From a Perspective of Household Energy Self-Restriction. International Journal of Environmental Research and Public Health, 19(14), 8254. https://doi.org/10.3390/ijerph19148254

Dalla Longa, F., Sweerts, B., & van der Zwaan, B. (2021, September). Exploring the complex origins of energy poverty in The Netherlands with machine learning. Energy Policy, 156, 112373. https://doi.org/10.1016/j.enpol.2021.112373

de Vries, R., & Blane, D. (2012, November 23). Fuel poverty and the health of older people: the role of local climate. Journal of Public Health, 35(3), 361–366. https://doi.org/10.1093/pubmed/fds094

Deller, D., Turner, G., & Waddams Price, C. (2021, November). Energy poverty indicators: Inconsistencies, implications and where next? Energy Economics, 103, 105551. https://doi.org/10.1016/j.eneco.2021.105551

DOE. (2020, April). Low-Income Energy Affordability Data (LEAD) Tool . In DOE (US Department of Energy). U.S Department of Energy. Retrieved January 1, 2023, from https://www.energy.gov/scep/slsc/articles/low-income-affordability-data-lead-tool-resource-summary#:~:text=The%20Low%2Dincome%20Energy%20Affordability%20Data%20(LEAD)%20Tool%20is,fuel%20type%2C%20and%20housing%20type.

DOE. (2022). About the Weatherization Assistance Program. Energy.gov. Retrieved December 5, 2023, from https://www.energy.gov/scep/wap/about-weatherization-assistance-program

Dogan, E., Madaleno, M., & Taskin, D. (2021, July). Which households are more energy vulnerable? Energy poverty and financial inclusion in Turkey.

Energy Economics, 99, 105306. https://doi.org/10.1016/j.eneco.2021.105306

Duzgun, B., Koksal, M. A., & Bayindir, R. (2022, October). Assessing drivers of residential energy consumption in Turkey: 2000–2018. Energy for Sustainable Development, 70, 371–386. https://doi.org/10.1016/j.esd.2022.08.016

Eastham, J. (2001, January). UK Department Of Trade And Industry - European Funding Seminar. Materials Technology, 16(3), 203–204. https://doi.org/10.1080/10667857.2001.11754324

Eisfeld, K., & Seebauer, S. (2022, February). The energy austerity pitfall: Linking hidden energy poverty with self-restriction in household use in Austria. Energy Research & Social Science, 84, 102427. https://doi.org/10.1016/j.erss.2021.102427

Emeç, H., Altay, A., Aslanpay, E., Özdemir, M. (2015). Türkiye'de Enerji Yoksulluğu ve Enerji Tercihi Profili. Finans Politik Ve Ekonomik Yorumlar(608), 9-21.

EPAH. (2021). EPAH Report: Tackling energy poverty through local actions – Inspiring cases from across Europe. Energy Poverty Advisory Hub. Retrieved March 18, 2023, from https://energy-poverty.ec.europa.eu/discover/publications/publications/epah-report-tackling-energy-poverty-through-local-actions-inspiring-cases-across-europe_en

EPAH. (2022). Energy Poverty National Indicators: Insights for a more effective measuring. Energy Poverty Advisory Hub. Retrieved May 26, 2023, from https://energy-poverty.ec.europa.eu/discover/publications/publications/energy-poverty-national-indicators-insights-more-effective-measuring_en

Erdoğdu, S. (2020). Dünyada ve Türkiye'de Enerji Yoksulluğu üzerine. Türkiye'nin Enerji Görünümü, 29-45.

Fabbri, K. (2015, September). Building and fuel poverty, an index to measure fuel poverty: An Italian case study. Energy, 89, 244–258. https://doi.org/10.1016/j.energy.2015.07.073

Gómez-Navarro, T., Calero-Pastor, M., Pellicer-Sifres, V., Lillo-Rodrigo, P., Alfonso-Solar, D., & Pérez-Navarro, N. (2021, April). Fuel poverty map of Valencia (Spain): Results of a direct survey to citizens and recommendations for policy making. Energy Policy, 151, 112162. https://doi.org/10.1016/j.enpol.2021.112162

González-Eguino, M. (2015, July). Energy poverty: An overview. Renewable and Sustainable Energy Reviews, 47, 377–385. https://doi.org/10.1016/j.rser.2015.03.013

Gouveia, J. P., Palma, P., & Simoes, S. G. (2019, November). Energy poverty vulnerability index: A multidimensional tool to identify hotspots for local action. Energy Reports, 5, 187–201. https://doi.org/10.1016/j.egyr.2018.12.004

Graff, M., & Carley, S. (2020, May 1). COVID-19 assistance needs to target energy insecurity. Nature Energy, 5(5), 352–354. https://doi.org/10.1038/s41560-020-0620-y

Grey, C. N. B., Schmieder-Gaite, T., Jiang, S., Nascimento, C., & Poortinga, W. (2017, April 12). Cold homes, fuel poverty and energy efficiency improvements: A longitudinal focus group approach. Indoor and Built Environment, 26(7), 902–913. https://doi.org/10.1177/1420326x17703450

Grösche, P. (2009). Housing, Energy Cost and the Poor - Counteracting Effects in Germany's Housing Allowance Program. SSRN Electronic Journal. https://doi.org/10.2139/ssrn.1491477

Hair, J. F., Black, W. C., Babin, B. J., & Anderson, R. E. (2010). Multivariate Data Analysis (7th ed.). Pearson Prentice Hall.

Hamilton, I., O'Sullivan, A., Huebner, G., Oreszczyn, T., Shipworth, D., Summerfield, A., & Davies, M. (2017, April). Old and cold? Findings on the determinants of indoor temperatures in English dwellings during cold conditions. Energy and Buildings, 141, 142–157. https://doi.org/10.1016/j.enbuild.2017.02.014

Harrington, B. E., Heyman, B., Merleau-Ponty, N., Stockton, H., Ritchie, N., & Heyman, A. (2005, May). Keeping warm and staying well: findings from the qualitative arm of the Warm Homes Project. Health and Social Care in the Community, 13(3), 259–267. https://doi.org/10.1111/j.1365-2524.2005.00558.x

Healy, J. D., & Clinch, J. (2004, January). Quantifying the severity of fuel poverty, its relationship with poor housing and reasons for non-investment in energy-saving measures in Ireland. Energy Policy, 32(2), 207–220. https://doi.org/10.1016/s0301-4215(02)00265-3

Hills, J. (2012, March). Getting the measure of fuel poverty. CASE Report 72. London.

Hong, S. H., Gilbertson, J., Oreszczyn, T., Green, G., & Ridley, I. (2009, June). A field study of thermal comfort in low-income dwellings in England before and after energy efficient refurbishment. Building and Environment, 44(6), 1228–1236. https://doi.org/10.1016/j.buildenv.2008.09.003

Ivanova, D., & Middlemiss, L. (2021, December 13). Characterizing the energy use of disabled people in the European Union towards inclusion in the energy transition. Nature Energy, 6(12), 1188–1197. https://doi.org/10.1038/s41560-021-00932-4

Jessel, S., Sawyer, S., & Hernández, D. (2019, December 12). Energy, Poverty, and Health in Climate Change: A Comprehensive Review of an Emerging Literature. Frontiers in Public Health, 7. https://doi.org/10.3389/fpubh.2019.00357

Jiglau, G., Bouzarovski, S., Dubois, U., Feenstra, M., Gouveia, J. P., Grossmann, K., Guyet, R., Tirado-Herrero, S., Hesselman, M., Robic, S., Sareen, S., Sinea, A., & Thomson, H. (2022). Looking Back to Look Forward: Reflections from Networked Research on Energy Poverty. SSRN Electronic Journal. https://doi.org/10.2139/ssrn.4259788

Kaiser, M. J., & Pulsipher, A. G. (2006, March). Science and politics: The 1981 and 1984 LIHEAP distribution formulas. Socio-Economic Planning Sciences, 40(1), 15–51. https://doi.org/10.1016/j.seps.2004.08.001

Kanagawa, M., & Nakata, T. (2008, June). Assessment of access to electricity and the socio-economic impacts in rural areas of developing countries. Energy Policy, 36(6), 2016–2029. https://doi.org/10.1016/j.enpol.2008.01.041

Kearns, A., Whitley, E., & Curl, A. (2019, June). Occupant behaviour as a fourth driver of fuel poverty (aka warmth & energy deprivation). Energy Policy, 129, 1143–1155. https://doi.org/10.1016/j.enpol.2019.03.023

Kose, T. (2019, May 4). Energy poverty and health: the Turkish case. Energy Sources, Part B: Economics, Planning, and Policy, 14(5), 201–213. https://doi.org/10.1080/15567249.2019.1653406

Lee, J., & Byrne, J. (2019, September 26). Expanding the Conceptual and Analytical Basis of Energy Justice: Beyond the Three-Tenet Framework. Frontiers in Energy Research, 7. https://doi.org/10.3389/fenrg.2019.00099

Legendre, B., & Ricci, O. (2015, May). Measuring fuel poverty in France: Which households are the most fuel vulnerable? Energy Economics, 49, 620–628. https://doi.org/10.1016/j.eneco.2015.01.022

Li, K., Lloyd, B., Liang, X. J., & Wei, Y. M. (2014, May). Energy poor or fuel poor: What are the differences? Energy Policy, 68, 476–481. https://doi.org/10.1016/j.enpol.2013.11.012

Li, W., Chien, F., Hsu, C. C., Zhang, Y., Nawaz, M. A., Iqbal, S., & Mohsin, M. (2021, August). Nexus between energy poverty and energy efficiency: Estimating the long-run dynamics. Resources Policy, 72, 102063. https://doi.org/10.1016/j.resourpol.2021.102063

Liddell, C., & Morris, C. (2010, June). Fuel poverty and human health: A review of recent evidence. Energy Policy, 38(6), 2987–2997. https://doi.org/10.1016/j.enpol.2010.01.037

Liddell, C., Morris, C., McKenzie, S., & Rae, G. (2012, October). Measuring and monitoring fuel poverty in the UK: National and regional perspectives. Energy Policy, 49, 27–32. https://doi.org/10.1016/j.enpol.2012.02.029

Mashhoodi, B., Stead, D., & van Timmeren, A. (2018, December 18). Spatial homogeneity and heterogeneity of energy poverty: a neglected dimension. Annals of GIS, 25(1), 19–31. https://doi.org/10.1080/19475683.2018.1557253

Meyer, S., Laurence, H., Bart, D., Middlemiss, L., & Maréchal, K. (2018, June). Capturing the multifaceted nature of energy poverty: Lessons from Belgium. Energy Research & Social Science, 40, 273–283. https://doi.org/10.1016/j.erss.2018.01.017

Middlemiss, L. (2016, October 18). A critical analysis of the new politics of fuel poverty in England. Critical Social Policy, 37(3), 425–443. https://doi.org/10.1177/0261018316674851

Middlemiss, L. (2022, July). Who is vulnerable to energy poverty in the Global North, and what is their experience? WIREs Energy and Environment, 11(6). https://doi.org/10.1002/wene.455

Moore, R. (2012, October). Definitions of fuel poverty: Implications for policy. Energy Policy, 49, 19–26. https://doi.org/10.1016/j.enpol.2012.01.057

Mould, R., & Baker, K. J. (2017, April 26). Uncovering hidden geographies and socio-economic influences on fuel poverty using household fuel spend data: A meso-scale study in Scotland. Indoor and Built Environment, 26(7), 914–936. https://doi.org/10.1177/1420326x17707326

Murray, A. G., & Mills, B. F. (2014, March 12). THE IMPACT OF LOW-INCOME HOME ENERGY ASSISTANCE PROGRAM PARTICIPATION ON HOUSEHOLD ENERGY INSECURITY. Contemporary Economic Policy, 32(4), 811–825. https://doi.org/10.1111/coep.12050

O'Sullivan, K. C., Howden-Chapman, P., Sim, D., Stanley, J., Rowan, R. L., Harris Clark, I. K., & Morrison, L. L. (2017, December). Cool? Young people investigate living in cold housing and fuel poverty. A mixed methods action research study. SSM - Population Health, 3, 66–74. https://doi.org/10.1016/j.ssmph.2016.12.006

Odink, J. (1995, December 12). Introduction: Household Equivalence Scales. Journal of Income Distribution®. https://doi.org/10.25071/1874-6322.697

OECD. (2020a). Adjusting household incomes: equivalence scales. . OECD Project on Income Distribution and Poverty. Retrieved October 24, 2023, from https://www.oecd.org/social/inequality-and-poverty.htm

OECD. (2020b, June). Compare your income – Methodology and conceptual issues. OECD Statistics. https://www.oecd.org/statistics/Compare-your-income-methodology.pdf

Okushima, S. (2017, October). Gauging energy poverty: A multidimensional approach. Energy, 137, 1159–1166. https://doi.org/10.1016/j.energy.2017.05.137

Oliveras, L., Peralta, A., Palència, L., Gotsens, M., López, M. J., Artazcoz, L., Borrell, C., & Marí-Dell'Olmo, M. (2021, January). Energy poverty and health: Trends in the European Union before and during the economic crisis, 2007–2016. Health & Place, 67, 102294. https://doi.org/10.1016/j.healthplace.2020.102294

Osbaldeston, J. (1984, May). Fuel poverty in UK cities. Cities, 1(4), 366–373. https://doi.org/10.1016/0264-2751(84)90009-x

Özdemir Sarı. (2023). Cumhuriyet'in Yüzüncü Yılında Konut Sorununun Farklı Yüzleri. İdealKent. In press.

Özgür, F. Y., & Özdemir Sarı, Ö. B. (2022, May 15). Enerji Yoksulluğunun Ölçülmesinde Öznel ve Nesnel Yaklaşımların Değerlendirilmesi. Retrieved December 23, 2023, from https://open.metu.edu.tr/handle/11511/101704

Palmer, G., MacInnes, T., & Kenway, P. (2008). Cold and Poor: An analysis of the link between fuel poverty and low income. Report New Policy Institute.

Papada, L., & Kaliampakos, D. (2018, May). A Stochastic Model for energy poverty analysis. Energy Policy, 116, 153–164. https://doi.org/10.1016/j.enpol.2018.02.004

Peralta, A., Camprubí, L., Rodríguez-Sanz, M., Basagaña, X., Borrell, C., & Marí-Dell'Olmo, M. (2017, January 4). Impact of energy efficiency interventions in public housing buildings on cold-related mortality: a case-crossover analysis. International Journal of Epidemiology, dyw335. https://doi.org/10.1093/ije/dyw335

Poortinga, W., Jones, N., Lannon, S., & Jenkins, H. (2017, December). Social and health outcomes following upgrades to a national housing standard: a multilevel analysis of a five-wave repeated cross-sectional survey. BMC Public Health, 17(1). https://doi.org/10.1186/s12889-017-4928-x

Primc, K., Slabe-Erker, R., & Majcen, B. (2019, May). Constructing energy poverty profiles for an effective energy policy. Energy Policy, 128, 727–734. https://doi.org/10.1016/j.enpol.2019.01.059

Riva, M., Kingunza Makasi, S., Dufresne, P., O'Sullivan, K., & Toth, M. (2021, November). Energy poverty in Canada: Prevalence, social and spatial distribution, and implications for research and policy. Energy Research & Social Science, 81, 102237. https://doi.org/10.1016/j.erss.2021.102237

Robinson, C. (2019, August). Energy poverty and gender in England: A spatial perspective. Geoforum, 104, 222–233. https://doi.org/10.1016/j.geoforum.2019.05.001

Robinson, C., Bouzarovski, S., & Lindley, S. (2018, February). 'Getting the measure of fuel poverty': The geography of fuel poverty indicators in England. Energy Research & Social Science, 36, 79–93. https://doi.org/10.1016/j.erss.2017.09.035

Robinson, C., Bouzarovski, S., & Lindley, S. (2018, February). 'Getting the measure of fuel poverty': The geography of fuel poverty indicators in England. Energy Research & Social Science, 36, 79–93. https://doi.org/10.1016/j.erss.2017.09.035

Romero, J. C., Linares, P., & López, X. (2018, April). The policy implications of energy poverty indicators. Energy Policy, 115, 98–108. https://doi.org/10.1016/j.enpol.2017.12.054

Sánchez-Guevara Sánchez, C., Neila González, F. J., & Hernández Aja, A. (2018, June). Energy poverty methodology based on minimal thermal habitability conditions for low income housing in Spain. Energy and Buildings, 169, 127–140. https://doi.org/10.1016/j.enbuild.2018.03.038

Sánchez-Guevara Sánchez, C., Sanz Fernández, A., & Núñez Peiró, M. (2020, September). Feminisation of energy poverty in the city of Madrid. Energy and Buildings, 223, 110157. https://doi.org/10.1016/j.enbuild.2020.110157

Sánchez-Guevara, C., Fernández, A. S., & Aja, A. H. (2014, December 17). Income, energy expenditure and housing in Madrid: retrofitting policy implications. Building Research & Information, 43(6), 737–749. https://doi.org/10.1080/09613218.2014.984573

Scarpellini, S., Rivera-Torres, P., Suárez-Perales, I., & Aranda-Usón, A. (2015, November). Analysis of energy poverty intensity from the perspective of the regional administration: Empirical evidence from households in southern Europe. Energy Policy, 86, 729–738. https://doi.org/10.1016/j.enpol.2015.08.009

Selçuk, L. I., Gölçek, A. G., & Köktaş, A. M. (2019, October 31). Energy Poverty in Turkey. Sosyoekonomi, 27(42), 283–299. https://doi.org/10.17233/sosyoekonomi.2019.04.15

Şenyel Kürkçüoğlu. (2023). Ankara'da Yakıt Yoksulluğunun Sosyo-ekonomik Özellikler ve Konut Koşulları Çerçevesinde Değerlendirilmesi . İdealKent. In press.

Sharma, S. V., Han, P., & Sharma, V. K. (2019, September). Socio-economic determinants of energy poverty amongst Indian households: A case study of Mumbai. Energy Policy, 132, 1184–1190. https://doi.org/10.1016/j.enpol.2019.06.068

Sharpe, R. A., Williams, A. J., Simpson, B., Finnegan, G., & Jones, T. (2020, December 1). A pilot study on the impact of a first-time central heating intervention on resident mental wellbeing. Indoor and Built Environment, 31(1), 31–44. https://doi.org/10.1177/1420326x20975468

Shortt, N., & Rugkåsa, J. (2007, March). "The walls were so damp and cold" fuel poverty and ill health in Northern Ireland: Results from a housing intervention. Health & Place, 13(1), 99–110. https://doi.org/10.1016/j.healthplace.2005.10.004

Siegel, A. F., & Wagner, M. R. (2022). Multiple Regression. Practical Business Statistics, 371–431. https://doi.org/10.1016/b978-0-12-820025-4.00012-9

Snell, C., Bevan, M., & Thomson, H. (2015, November). Justice, fuel poverty and disabled people in England. Energy Research & Social Science, 10, 123–132. https://doi.org/10.1016/j.erss.2015.07.012

Son, H., & Yoon, S. (2020, December). Reducing energy poverty: Characteristics of household electricity use in Vietnam. Energy for Sustainable Development, 59, 62–70. https://doi.org/10.1016/j.esd.2020.08.007

Sunikka-Blank, M., & Galvin, R. (2021, March). Single parents in cold homes in Europe: How intersecting personal and national characteristics drive up the numbers of these vulnerable households. Energy Policy, 150, 112134. https://doi.org/10.1016/j.enpol.2021.112134

T.C. Ministry of Energy and Natural Resources. (2022). Türkiye Ulusal Enerji Planı. T.C. Enerji ve Tabii Kaynaklar Bakanlığı. Retrieved January 1, 2023, from https://enerji.gov.tr/Media/Dizin/EIGM/tr/Raporlar/TUEP/T%C3%BCrkiye_Ulusal_Enerji_Plan%C4%B1.pdf

Tabachnick, B. G., & Fidell, L. S. (2013). Using Multivariate Statistics (6th ed.). Allyn and Bacon.

Thema, & Vondung. (2020). EPOV Indicator Dashboard: Methodology Guidebook. Wuppertal Institut für Klima, Umwelt, Energie GmbH.

Thomson, H., Bouzarovski, S., & Snell, C. (2017, March 20). Rethinking the measurement of energy poverty in Europe: A critical analysis of indicators and data. Indoor and Built Environment, 26(7), 879–901. https://doi.org/10.1177/1420326x17699260

Thomson, H., Simcock, N., Bouzarovski, S., & Petrova, S. (2019, August). Energy poverty and indoor cooling: An overlooked issue in Europe. Energy and Buildings, 196, 21–29. https://doi.org/10.1016/j.enbuild.2019.05.014

Thomson, H., Snell, C., & Liddell, C. (2016, April 20). Fuel poverty in the European Union: a concept in need of definition? People Place and Policy Online, 10(1), 5–24. https://doi.org/10.3351/ppp.0010.0001.0002

Tirado Herrero, S., & Jiménez Meneses, L. (2016, April 20). Energy poverty, crisis and austerity in Spain. People Place and Policy Online, 10(1), 42–56. https://doi.org/10.3351/ppp.0010.0001.0004

Tirado Herrero, S., & Jiménez Meneses, L. (2016, April 20). Energy poverty, crisis and austerity in Spain. People Place and Policy Online, 10(1), 42–56. https://doi.org/10.3351/ppp.0010.0001.0004

Tonn, B., Hawkins, B., Rose, E., & Marincic, M. (2021, March). Income, housing and health: Poverty in the United States through the prism of residential energy efficiency programs. Energy Research & Social Science, 73, 101945. https://doi.org/10.1016/j.erss.2021.101945

United Nations. (2021). The Sustainable Development Goals Report. Retrieved August 6, 2023, from https://heinonline.org/HOL/LandingPage?handle=hein.journals/drtom2021&div=25&id=&page=

Walker, R., McKenzie, P., Liddell, C., & Morris, C. (2014, September). Estimating fuel poverty at household level: An integrated approach. Energy and Buildings, 80, 469–479. https://doi.org/10.1016/j.enbuild.2014.06.004

Wilkinson, P., Smith, K. R., Joffe, M., & Haines, A. (2007, September). A global perspective on energy: health effects and injustices. The Lancet, 370(9591), 965–978. https://doi.org/10.1016/s0140-6736(07)61252-5

Xie, L., Hu, X., Zhang, X., & Zhang, X. B. (2022, February). Who suffers from energy poverty in household energy transition? Evidence from clean heating program in rural China. Energy Economics, 106, 105795. https://doi.org/10.1016/j.eneco.2021.105795