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Research Article

Household energy poverty: The concept, issues and implications for Turkiye

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ABSTRACT

The first recognition of energy poverty concept dates to the 1970s. However, the concept did increasingly attract attention only recently. The main reason for increasing attention for energy poverty as an issue to tackle is the growing awareness that energy is not a luxury service for households but an indispensable resource for livelihood. Along with the growing interest in household energy poverty issues, especially of academia, there exists an ongoing debate and variety of approaches as to how energy poverty can or should be defined and measured, particularly in the EU countries. And Turkiye, made subject to a few studies of household energy poverty, is no exception to this situation: Turkiye is among the countries that have not officially defined energy poverty yet. But even so, according to the 2019 Turkish Statistical Institute (TURKSTAT) data, inability of heating the dwelling due to insufficient insulation was found to be the most important problem of households in Turkiye. Therefore, this paper attempts to review the extent of the issue in Turkiye by making use of previous studies and evaluating current information and data on the issue in the country.

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INTRODUCTION

Energy Poverty: The Concept, Measurement Methods and Indicators

Energy poverty has been conceptualized as a problem in the literature first in the 1970s in response to the oil crisis which led to inflation in energy prices [1]. This conceptualization suggests that in the United Kingdom (the UK), if households spend more than twice the median of their income on fuel, light and power, they are considered to be energy-poor. In this definition, spending more than twice the median corresponds to 12% of households' income. One of the earliest definitions of fuel poverty can also be attributed to Richardson [2]. According to this definition, households are considered to be fuel-poor if they cannot afford required fuel costs for heating, lighting and cooking due to the lack of resources [3]. Following these frameworks, it was suggested that households would be fuel poor if they spent more than 10% of their annual income

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on fuel in the UK [4]. Based on a comprehensive data and calculation methods which brought into the forefront the required household energy consumption level, a threshold of 10% share of heating and lighting spending in household income was conservatively set in 1991 in view of the corresponding share being actually 5% in the median household income in the UK in 1988 [5]. The UK changed this definition and adopted the Low-Income High Cost (LIHC) method in 2015 that was suggested by Hills [6], yet the original 10% definition gained a considerable popularity, especially in Europe, mostly due to its simplicity.

Two somewhat distinct definitions of energy poverty become prominent in the literature regarding the characteristics of developing countries and developed countries. First, energy poverty is defined as the condition of being unable to access to energy suppliers in developing countries. On the other hand, in developed countries, the concept is related to the lack of household affordability of basic energy needs in dwellings. This situation is also known as "fuel poverty" [7]. Although some studies consider energy poverty and fuel poverty as distinct concepts [8], it is common to use them synonymously in the literature [9]. However, Bouzarovski and Petrova [10] argue that one common condition underlies all forms of energy and fuel poverty both in developed and developing countries. According to the authors, it is the lack of ability to secure socially and materially required level of energy services.

The nature of the concept of energy poverty is dynamic and culturally sensitive [11]. In other words, definitions may vary from country to country because a 'universal' definition of it does not exist. Although an official definition has not been accepted by the most of the countries in Europe yet, it should be noted that some countries/regions, namely England, Ireland, Scotland, Wales, Northern Ireland, France, Slovakia and Cyprus, have their own official definitions of energy poverty [12].

The relevant literature points out to three methods in measuring energy poverty. They are regarded as expenditure approach, consensual approach and finally, direct measurement approach [11]. Expenditure approach can be divided into two measures, namely absolute and relative [11, 13]. Absolute measures suggest that energy-poor households are the ones that spend more than X percent of their income on energy. Boardman's 10% method is an example for this measure. On the other hand, in relative measures, a median cost to income ratio is typically used to calculate energy costs which are under a relative threshold. The UK 's LIHC method is an example for this measure. According to the LIHC method, households are considered to be fuel poor if their required fuel costs are above the national median level and if their residual income falls below the official poverty line after energy costs have been paid [13]. In February 2021, the UK updated their Fuel Poverty Strategy in order for the fuel-poor to be able to achieve affordable, low-carbon warmth in their dwellings. This strategy is noteworthy in the sense that it is to serve for provision of affordable warmth and lighting for everyone, particularly for those who are the most precarious and struggling to pay their energy bills with ease. Thus, according to the new "Low Income Low Energy Efficiency (LILEE)" indicator, households are considered to be fuel poor if their income falls below the poverty line after required fuel costs have been paid and if the energy efficiency rating of their houses falls below Band C [14]. In consensual approach, researchers use self-report questionnaires or surveys to understand the problem of energy poverty in the eyes of households. Finally, in direct measurement approach, the levels of energy services are measured considering whether sufficient levels of heating and lighting are achieved in the home. This is possible through taking internal temperature readings [13]. The Minimum Income Standard, Hidden Energy Poverty as well as various composite measures such as multidimensional energy poverty indices are the other indicators used for measuring energy poverty in the literature [9, 12, 15, 16, 17]. Since energy poverty is mostly context-specific, it is also possible to conceptualize energy poverty and deprivation using capabilities approach. In this context, energy is seen as a material prerequisite so as to achieve valued capabilities. While the basic capabilities are "maintaining good health and/or being educated" etc., the secondary capabilities are "ability to keep home adequately warm" and/or "accessing information", etc., which also necessitate basic energy services [18]. EU Energy Poverty Observatory [19] divides indicators of energy poverty into two categories: Primary and secondary. These indicators can be seen in Table 1. The two of primary indicators are consensual-based indicators, namely *inability to keep home adequately warm* and *arrears on utility bills*. The other two indicators are expenditure-based indicators, namely *low absolute energy expenditure* and *high share of energy expenditure in income*.

It is important to note that the issue of energy poverty persists in the world, especially in developing countries. The literature suggests that the most important determinants of energy poverty are low-income level, energy-inefficiency in homes and high energy prices [20]. In addition, social inequalities as well as socio-demographic and geographic factors also play a role in identifying energy poverty [21]. On the other hand, it is worth mentioning that energy poverty has detrimental effects on individuals' physical and mental health [20]. For example, Ucal and Gunay [22] found, using TURKSTAT 2014-2018 Life Satisfaction Survey data, that household fuel poverty affects household happiness negatively in Turkiye.

Inability of heating the dwelling due to insufficient insulation was the most important housing problem in 2015 in Turkiye [23]. While 43% of households suffered the lack of heating due to insufficient insulation, 39% of them experienced roof leaks, damp walls/floors/foundation, rot in window frames/floors and 20.6% of them suffered overly dark rooms or the lack of natural light in the dwelling. It is reported that in 2019 inability of heating the dwelling due to

insufficient insulation was still the most important housing problem reported by 39.3% of households in the country; meanwhile, 36.9% of them experienced roof leaks, damp walls/floors/foundation, deteriorated window frames/floors, and 26.1% of them faced air pollution and other environmental problems [24]. Figure 1 shows the change in fuel poverty indicators between the years 2015-2019 in Turkiye. As mentioned in the literature review section of this paper, the year 2015 was the year when energy poverty started to be discussed both in academia and among energy experts in Turkiye.

Figure 1 illustrates that since 2015 no significant improvement has been observed in terms of eliminating household fuel poverty in Turkiye[1]. EUROSTAT data [26, 27, 28] shows that these numbers are quite high compared to the EU-28 average, especially "inability to keep home adequately warm" (EU-28 average: 9.4% in 2015, 8.7% in 2016, 7.8% in 2017, 7.3% in 2018 and finally 7.0% in 2019), "leaking roof, damp walls, floors or foundation, or rot in window frames or floor and etc." (EU-28 average: 15.2% in 2015, 15.4% in 2016, 13.3% in 2017, 13.9% in 2018, and finally 13.1% in 2019) and "arrears on utility bills" (EU-28 average: 9.1% in 2015, 8.1% in 2016, 7.0% in 2017, 6.6% in 2018, and finally 6.1% in 2019). Figure 2 illustrates this data.

According to the EUROSTAT data [26], the percentage of people who cannot keep their homes relatively warm was higher only in Bulgaria (39.2% in 2015, 39.2% in 2016, 36.5% in 2017, 33.7% in 2018 and 30.1% in 2019), Lithuania (31.1% in 2015, 29.3% in 2016, 28.9% in 2017, 27.9% in 2018 and 26.7% in 2019) and Greece (29.2% in 2015, 29.1% in 2016, 25.7% in 2017 and 22.7% in 2018) than that of Turkiye. On the other hand, we see that energy poverty rates, inability to keep home adequately warm, in Portugal (20.4% in 2017, 19.4% in 2018 and 18.9% in 2019) were quite similar to those of Turkiye between the years 2017-2019 [26]. In addition to this data, percentage of arrears on utility bills, another indicator of energy poverty, was higher in Greece (42% in 2015, 42.2% in 2016, 38.5% in 2017, 35.6% in 2018 and 32.5% in 2019), Montenegro (38.4% in 2015, 34.8% in 2016, 31.6% in 2017, 27.7% in 2018 and 32.9% in 2019) and North Macedonia (40.1% in 2015, 41% in 2016, 38.6% in 2017, 36.9% in 2018 and 34.4% in 2019) than that of Turkiye. In 2019, the percentage of arrears on utility bills in Turkiye was quite similar to that of Bulgaria and Serbia [28]. Finally, the percentage of "leaking roof,

Table 1. Primary and Secondary Indicators of Energy Poverty

Primary Indicators	Secondary Indicators
1. Inability to keep home adequately warm (Based on EU-SILC data)	**1.** Fuel oil prices
2. Arrears on utility bills (Based on EU-SILC data)	**2.** Biomass prices
3. Low absolute energy expenditure(M/2) (Based on EU Household Budget Surveys)	**3.** Coal prices
4. High share of energy expenditure in income(2M) (Based on EU Household Budget Surveys)	**4.** Household electricity prices
	5. District heating prices
	6. Household gas prices
	7. Dwelling comfortably cool during summer time
	8. Dwelling comfortably warm during winter time
	9. Number of rooms per person, owners
	10. Number of rooms per person, renters
	11. Number of rooms per person, total
	12. Dwellings in densely populated areas
	13. Dwellings in intermediately populated areas
	14. Poverty risk
	15. Dwellings with energy label A
	16. Energy expenses (for income quintiles 1, 2, 3, 4, 5)
	17. Equipped with air conditioning
	18. Equipped with heating
	19. Excess winter mortality / deaths
	20. Presence of leak, damp, rot

Source: EU Energy Poverty Observatory [19].

1 *TURKSTAT released the 2020 Income and Living Conditions Survey in June 2021. According to the data, 20.3% of households in Turkiye could not afford to keep their homes adequately warm. While 34.7% of households in Turkiye suffered roof leaks, damp walls, floors or foundation or deteriorated window frames or floor and etc., 36.7% of them had difficulty to heat their homes due to insufficient insulation [29].*

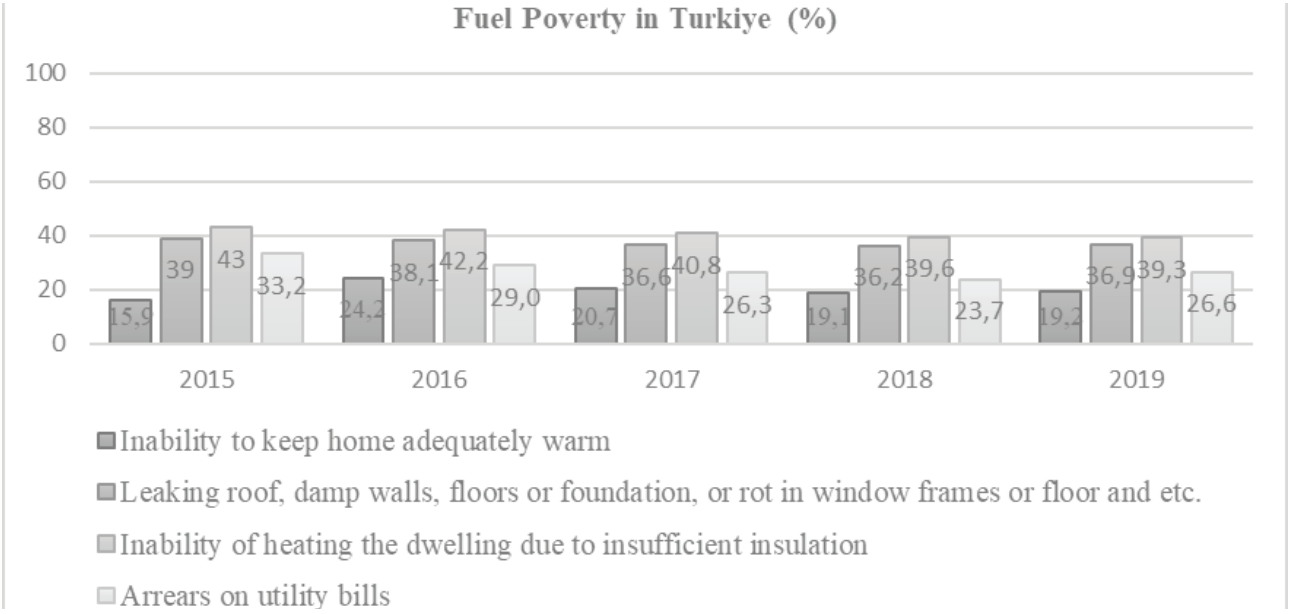

Figure 1. Fuel Poverty in Turkiye with Different Indicators (2015-2019)

Source: TURKSTAT Income and Living Conditions Survey Press Releases [25], EUROSTAT [26, 27, 28].

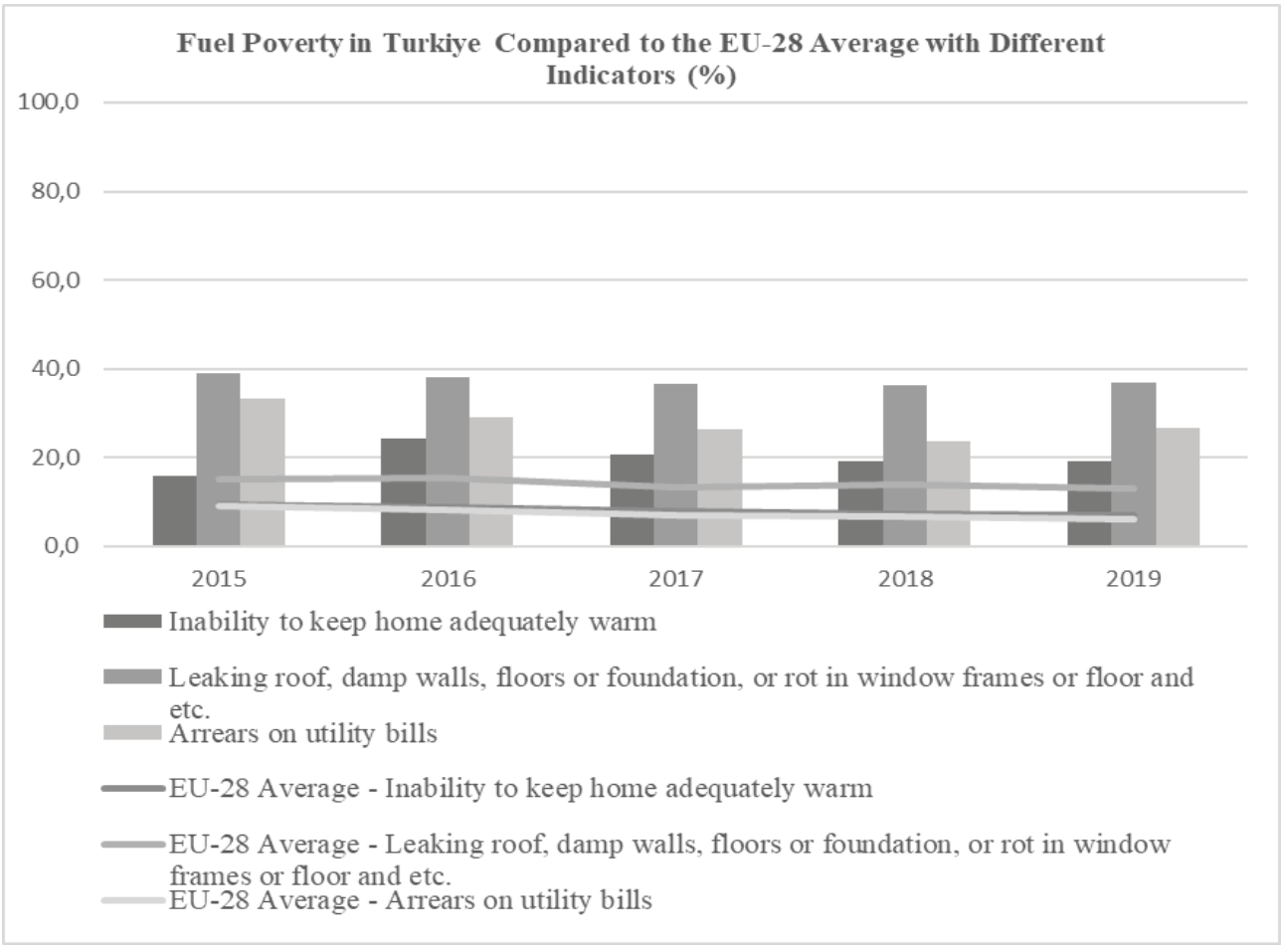

Figure 2. Fuel Poverty in Turkiye Compared to the EU-28 Average with Different Indicators [2015-2019]

Source: EUROSTAT [26, 27, 28].

damp walls, floors or foundation, or rot in window frames or floor and etc." was the highest in Turkiye throughout the years [27].

When thinking about energy poverty, we need to take into account the poverty level since these two variables have a close association [30]. Considering that poverty is still an issue for Turkiye that needs to be tackled, we will look at the percentage of subjective poverty (one of the dimensions of poverty), inability to make ends meet, in Turkiye over the years in Table 2.

Table 2 shows a considerable decline in subjective poverty rates in Turkiye from 2006 to the most recent year available in the EUROSTAT website, 2018. The table, however, also implies that some segments of the population in the country have still varying degrees of difficulty in making ends meet over the years. Though this table shows us that income-poor people and energy-poor people may not necessarily be the same (please see Figure 1, 2), it is quite likely that these people suffer from energy poverty the most because they may have to choose between heating or eating since they may feel a burden on their budgets and cannot afford two expenses, as well as others, together (e.g. energy and food).

In the next chapter, we will look at the situation of energy poverty in Turkiye and try to understand the extent of the problem and its determinants in the country with the help of previous studies related to this issue.

LITERATURE REVIEW

ENERGY POVERTY IN TURKIYE

The literature on the issue of energy poverty in Turkiye is relatively limited. In this paper, the relevant literature in Turkiye has been reviewed by considering if the term 'energy poverty' is found in the article title and/or in the text. According to this approach, research on energy poverty in Turkiye date back to the year 2015. To the best of our knowledge, Emec et al. [32] was the first empirical article that tackled the energy poverty problem in Turkiye using 2012 TURKSTAT Household Budget Survey data[2] [33], constructing an energy choice profile of households to find the main determinants leading to energy poverty in Turkiye. In this study, low-income level of households was found to be one of the most important determinants of household energy poverty in the country. As households' income level increased, they moved away from using conventional energy sources such as wood, coal and dung, and made a transition to modern energy sources. Also, when their educational level increased, their coal and wood consumption declined. Household size had a negative impact on electricity consumption because of high electricity prices. As household size increased, it was observed that households tended to prefer cheaper energy sources rather than using electricity. In addition, as the number of rooms increased, it was seen that households needed more central

Table 2. Subjective Poverty in Turkiye (2006-2018)

	Inability to make ends meet (%)				
Years	**Households making ends meet with great difficulty**	**Households making ends meet with difficulty**	**Households making ends meet with some difficulty**	**Households making ends meet fairly easily**	**Households making ends meet easily**
2006	27.0	32.2	26.0	9.1	5.2
2007	26.5	35.1	23.2	9.5	5.3
2008	24.8	33.4	25.6	9.2	6.2
2009	28.1	32.7	23.2	9.3	6.1
2010	-	-	-	-	-
2011	20.5	36.2	26.1	10.9	5.9
2012	21.0	37.1	26.5	9.8	5.2
2013	18.8	37.7	28.2	10.0	4.9
2014	11.3	32.4	31.1	16.6	7.9
2015	10.6	34.5	31.8	14.9	7.7
2016	6.8	26.3	36.1	20.2	10.1
2017	3.7	12.5	19.7	41.8	18.4
2018	3.5	10.1	16.7	42.0	21.9

Source: EUROSTAT [31].

2 *Data sources of energy poverty for Turkiye can be found in Table 3 in Appendix.*

energy sources such as natural gas instead of wood, coal, dung and the other energy sources. One of the most important findings of this article was that poor households used wood and coal, respectively, as the primary energy sources, regardless of where they lived (e.g. urban or rural areas). In addition, the article supported the 'energy ladder hypothesis', which suggests that when economic status of households improves, they tend to use modern energy sources by abandoning traditional ones. One of the most important features of this article was that it revealed the issue of energy poverty through household energy preferences.

Although Emec et al. [32] was the first one that especially focused on the term 'energy poverty' in Turkiye, the report by Bagdadioglu et al. [34] is also notable in the literature because it touches on the concept of energy poverty while pointing to the term 'energy-poor'. According to this report, the shares of electricity, natural gas and water expenditures of households[3] who belong to the lower income groups in household disposable income and in their total expenditures were above Turkiye's average. Furthermore, the shares of electricity, natural gas and water spending in disposable income of households in the lowest income group was five times as high as that of the households of the richest income group, and the corresponding share in total consumption turned out to be twice as high. In this report, households would be considered to be natural gas poor if they spent more than 10% of their disposable income or of their total expenditures on natural gas. Meanwhile, water poverty threshold was accepted to be 4% for Turkiye considering the level of development in Turkiye in the report [34]. Since water is required for heating, cooking and showering in dwellings [35], it has an important pertinence in energy poverty research.

Sanlı et al. [36] studied the concept of energy poverty and vulnerable consumers in Turkiye. They discussed the lack of access to energy, energy access in the context of human rights, dynamics of energy poverty, and policy recommendations for the issue. This study is very important in the sense that it provided a framework for understanding the concept and the situation of energy poverty in Turkiye.

Another important point in energy poverty research as well as many other research areas is to look at data comparatively. In this regard, Koktas and Selcuk [37] compared energy poverty in Turkiye with that of the EU countries. Their study suggested that in 2017 more than 8% of the households in the EU could not keep their homes adequately warm. Yet the corresponding share turned out to be 22.3% in the same year for Turkiye. Additionally, while the proportion of those who had difficulty paying their utility bills was 8.1% in the EU, it was 24.2% in Turkiye. Both of this information showed that Turkiye was significantly above the EU average with respect to the inability of households to keep their homes adequately warm and to pay their utility bills.

It is also worth paying attention to the work by Eke [38] about energy poverty. It had a conceptual framework mostly focusing on the importance of the concept of energy poverty both in Turkiye and in the rest of the world, relevant measurement methods used in the literature, main determinants of the issue such as low income, energy (in)efficiency, (high) energy prices, etc. as well as implementation of social policies towards solving the problem effectively.

Meanwhile, Selcuk et al. [39] examined the problem of energy poverty in Turkiye. Using 2017 TURKSTAT Household Budget Survey data [40], they found that, although energy poverty had declined over the years, about one-quarter of households in Turkiye still suffered from energy poverty. In addition, nearly half of the lowest-income households in Turkiye faced the risk of falling into energy poverty. The authors also suggested four energy poverty indicators so as to understand the problem. These indicators included: 1) "arrears on utility bills" (e.g. electricity, water and gas), 2) "inability to keep home adequately warm", 3) "households' inability to make ends meet (with total monthly household income)" and 4) "financial burden of the total housing costs", respectively [39]. One should be cautious about using these indicators, especially the third and the fourth ones, because they may cause overestimation of household energy poverty for these data do not comprise energy costs only. Also, "households' inability to make ends meet" can be used as a proxy for subjective poverty [30]. We should note that all indicators have some drawbacks. For instance, inadequate warmth in houses show us only one side of the problem (e.g. heating). Still, it is easy to use and it paves the way for discussing energy/fuel poverty in a wider context, including the issues of social exclusion and material deprivation.

The relevant literature suggests that there is a relationship between housing conditions and individual health outcomes. Based on this information, Kose [41] examined the relationship between energy poverty and individual health, as proxied by heating inadequacy and a health index, which includes both objective and subjective measures of health in Turkiye. At the end of the analysis, he found a negative association between energy poverty and individual health using 2014 TURKSTAT Income and Living Conditions Survey data.

In their article, Emre et al. [42] reviewed the relevant literature comprehensively by making use of the various articles and reports from the world in a chronological order. They defined energy poverty in the context of affordability. They also highlighted that energy poverty is different from income poverty. In other words, they suggested that income-poor households may also suffer from energy poverty, however, non-income-poor households can also

3 *The first three (richest) income groups are opted out of this analysis.*

be energy-poor. This study sets out a framework in order for the interested people in the country to be acquainted with the concept. In other words, it provides some insights on how this issue has been defined and measured in the literature.

Erdogdu [43] examined the issue of energy poverty both in Turkiye and in the rest of the world. According to the author, domestic literature and policy texts do not have adequate discussions on the structural and driving factors as well as indicators of energy/fuel poverty in Turkiye. The author touched on the definitions of energy poverty, possible reasons behind it, some structural transformations leading to energy poverty and energy assistance programs in Turkiye. For example, the study pointed out that since 2019, those who have received welfare benefit have been regarded as "electricity-poor" in Turkiye.

Dogan et al. [44] tried to find out who were more vulnerable to energy poverty in Turkiye. On one hand, their analysis suggested that financial inclusion of households and their socioeconomic characteristics such as age, education level, and being employed reduced energy poverty. On the other hand, they found that marriage and household size increased the odds of being prone to energy poverty. Though the aim of this paper was not directly to focus on the relationship between poverty and energy poverty, its implications showed that the role of poverty on energy poverty research is well worth the attention.

Gavashelishvili [45] examined the relationship between renewable energy use and energy poverty in Turkiye utilizing the nighttime lights data. In this conference paper, the author highlighted the importance of energy in the context of sustainable economic growth and Sustainable Development Goals (SDG 7). The paper suggested that rising energy demand and energy insecurity caused by import dependency on fossil fuels triggered energy poverty in the country. Considering the fact that Turkiye has ranked 70th with a score of 70.4 out of 165 countries in 2021 Sustainable Development Report [46] and the SDG 7 score of the country -though it is moderately improving- is still not sufficient to ensure affordable and clean energy [47], this paper is noteworthy for the way it focuses the role of fossil fuels in exacerbating energy poverty and the importance of renewable energy use in alleviating it in Turkiye. Ucal and Gunay [48] also provided a framework for energy poverty from the energy efficiency perspective. The study is noteworthy because it shows how the concepts of energy poverty and energy efficiency are intertwined and also shows the role of energy efficiency in energy poverty research in Turkiye.

In order to achieve sustainable energy security and environment, modern power generation systems such as smart grid network should also be considered. In this system, *solar PVs*, *solar thermal power plant*, *combined cooling heat and power* (CCHPs), *wind turbines*, *fuel cells*, *electric batteries*, etc. can be used as power sources [49]. In view of the increase in population size and energy demand and of large solar energy potential in Turkiye, the country can benefit some renewable energy technologies such as low-cost solar PV modules and solar water heaters [45, 50, 51, 52, 53], which were offered in the literature as noteworthy solutions to end household energy poverty. However, it is worth mentioning that solar PV modules as well as others may not be enough by themselves to eradicate energy poverty in the world unless underlying inequalities have been eliminated. At this point, the concepts of energy justice and just energy transition come to the fore [54, 55, 56]. Further studies will help better understand these concepts and their role in eradicating energy poverty both in Turkiye and the rest of the world.

It is also worth considering energy storage systems that secure supply and demand fluctuations in energy by enabling excess electricity to be saved for later use and developing the energy supply chain. Since the supply of fossil fuels such as coal, oil and gas are finite and they also release carbon-dioxide emissions and as a result of this, pollute the environment, by using modern energy storage systems, countries may achieve the zero-carbon transition, boost energy efficiency and may increase the use of renewable energy sources thanks to these systems' energy-regulating nature[4]. In this way, energy will be secured and energy prices will be lowered [57, 58, 59]. This will of course have positive repercussions for energy poverty in Turkiye as well as for the other countries in the world. One study showed that in case of using appropriate power generation and storage technologies, Turkiye will achieve a successful transition to renewable energy sources by the end of 2050 [45]. Yet, it is crucial to make sure that this transition will be 'just'.

Finally, Kibar [60] focused on energy poverty and the characteristics of energy-poor households in Turkiye in her thesis study. She calculated energy poverty rates in Turkiye using different EU-based indicators of energy poverty, namely expenditure and consensual. The findings suggest that for households, the odds of falling into energy poverty increases if the household-head is unemployed or inactive; if the household-head is poorly educated, if households live in detached houses and finally, if they are tenants. The thesis study is significant in the sense that it is the first empirical study to understand energy poverty with the help of different energy poverty indicators and to find out who are the energy-poor households in Turkiye.

IMPLICATIONS AND CONCLUSION

Since energy is one of the vital sources for human development, the concept of energy poverty is carefully monitored in the various relevant contexts such as context of

4 *Energy storage systems can help achieve energy transition without hindrance by regulating and stabilizing intermittent renewable energy sources [57].*

Sustainable Development Goals. Given that developing countries have a difficulty in access to adequate energy or that those who live in these countries are unable to keep their homes adequately warm, it is also important to understand the situation of energy poverty in Turkiye, which is itself still a developing country.

Energy poverty remains a major challenge that needs to be tackled both in developing and developed countries. However, while the concept of household energy poverty has been discussed for a few decades in Europe, it gained prominence only in recent years in Turkiye. Therefore, the fact that studies on household energy poverty particularly in Turkiye are scanty should not be surprising. Accordingly, the first implication at this point is that more research is needed to understand the concept in various ways in the country. A particular gap of household energy poverty research in Turkiye is the analysis of determinants as well as consequences of household energy poverty particularly with the help of current official data. TURKSTAT provides detailed and updated data that can be used for household energy poverty. Other data sources may include energy supplying companies and municipalities in Turkiye. In addition to this national secondary data source and perhaps certain other international sources, primary data collection through interviews/surveys at the household level may also be needed depending on the nature and scope of the future research in the country.

Energy poverty in Turkiye is found to be higher than the average of energy poverty levels in European countries. Figure 1 suggests that the lack of insulation and poor-quality housing stock seem to be the most important underlying factors pushing households into energy poverty in Turkiye. However, it is still worth considering that the economic situation of the households is quite likely to hold them back from insulating their homes. Therefore, one of the most critical contributions of the research to come in this regard would be to better understand the nature of energy poverty and energy-poor households in Turkiye. This requires collective effort of academia, government agencies, municipalities, energy suppliers and non-governmental organizations.

While defining and measuring household energy poverty, it is particularly important to target energy-poor households accurately to find out who are the energy-poor people in Turkiye. Measurement methods allow targeting a certain part of a society to the extent permitted by the chosen method however, they may not reflect the target group accurately (e.g. 10% indicator, Hidden Energy Poverty). In other words, the most precarious groups may be overlooked because spending more than 10% of annual income on fuel does not necessarily mean that households are energy-poor or a very low energy spending may also be an indicator of high energy efficiency.

Therefore, several questions arise as for the measurement methods of household energy poverty. Mainly, which households would be identified as "energy poor" in Turkiye? Are they those who cannot afford to keep their homes relatively warm or cannot afford to pay their utility bills due to high energy prices, low-income level and/or inefficient building stock? Alternatively, are they the ones who *pay relatively more of their income for energy compared to higher income households*; but even so, who *feel thermal discomfort* because of poor insulation in their homes, a relatively small budget, high energy prices and/or of their specific needs? Finally, are they the households that *"under-consume" energy*, facing the "*heat or eat*" dilemma due to economic reasons, even though the energy sources are physically available for them? Most importantly, which group is the most energy-precarious in Turkiye? These questions are critical to understanding the term 'energy poverty' in the country.

Further questions might well be propounded as to targeting the energy poor households in Turkiye accurately because "one-size-fits-all" approach does not exist in this regard. Therefore, when examining household energy poverty, identifying characteristics of energy-poor households specific to the country under research, realizing (dis)similarities of these characteristics and prioritizing those who are the most vulnerable to energy poverty are crucial for suggesting strategic policies to alleviate/eliminate household energy poverty. In this sense, qualitative analyses (particularly, focus group methods) alongside of quantitative analyses are crucial to define energy poverty and identify energy-poor/energy-precarious people in the country. Once energy-poor households are identified, we think that some of the possible solutions to this problem could be government income support to the most energy-precarious households, efficient/renewable energy incentives towards relevant households, raising awareness of these households towards efficient energy use and perhaps regulating energy sector.

It is worth noting that conventional energy poverty indicators are still helpful in defining and measuring energy poverty with regard to the particular interest of researchers (e.g. lack of access to modern energy services, inadequate warmth, arrears on utility bills, energy-related expenditure as a share of net income, etc.). In this way, researchers can explore the issue with relative ease. However, understanding a complex concept requires some background information about this concept and characteristics of country and region as well. Furthermore, since energy poverty is a multifaceted concept, it is more likely that choosing one of the methods arbitrarily cannot capture its different facets and consequently, fail to explain it. Therefore, deciding on how to approach the issue of household energy poverty, and accordingly on which methods to be used for measuring household energy poverty in Turkiye is equally notable. As for approaching energy poverty, for instance from the perspective of energy efficiency and renewable energy use in Turkiye, to the best of our knowledge, there is only one conference paper and an Engager Energy Poverty Action contribution, which were mentioned above. Thus, proliferating

APPENDIX

Table 3. Main Data Sources of Energy Poverty

Turkiye	TURKSTAT Household Budget Survey (B Group*: Cross-Sectional)	TURKSTAT Income and Living Conditions Survey (Cross-Sectional)
Period	2002-2018	2006-2018
Frequency	Annual	Annual
Spatial Unit	**A Group:** Regional (NUTS-1, NUTS-2), Country-wide **B Group:** Country-wide	**2006-2014:** NUTS-1, Rural/Urban, Country-wide **2014 -…:** NUTS-1, NUTS-2, Rural/Urban, Country-wide
Type of Data	**A Group:** Combined Micro Data Set **B Group:** Annual Micro Data Set	Cross-Sectional/Longitudinal
Observation Unit	Households and individuals	Households and individuals
Number of Observations	15,552 (in 2018) *Number of Responses: 11,828	For Cross Sectional Survey: 24,068 (in 2018) For 4-year Longitudinal Survey: 16,445 (in 2019)
Data Access	Microdata is freely available, after specific request from government agencies, public enterprises, universities, etc.	Microdata is freely available, after specific request from government agencies, public enterprises, universities, etc.

Source: TURKSTAT [23].

***Note:** B Group Household Budget Survey data was shown as an example in Table 2 due to its relatively easier access and use compared to that of A Group data.

empirical and technical studies that will conceptualize energy poverty in terms of efficient and renewable energy use taking also into account energy affordability issue, power generation and energy storage technologies will be quite helpful.

The above discussion implies the somewhat vague nature of the energy poverty. In Turkiye, like many other countries, there still exists a long way to go in household energy poverty research that should particularly consider country-specific problems and settings. Since the concept is relatively recent in Turkiye in particular, the future research will pave the way for understanding the issue in many respects both at the country and the regional level by adopting different approaches and methodologies for defining, measuring, analyzing, and hence mitigating or even eradicating household energy poverty.

AUTHORSHIP CONTRIBUTIONS

Authors equally contributed to this work.

DATA AVAILABILITY STATEMENT

The authors confirm that the data that supports the findings of this study are available within the article. Raw data that support the finding of this study are available from the corresponding author, upon reasonable request.

CONFLICT OF INTEREST

The author declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

ETHICS

There are no ethical issues with the publication of this manuscript.

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