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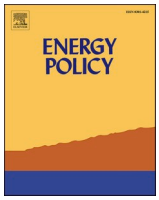

Extreme energy poverty: The aftermath of Lebanon's economic collapse☆

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ABSTRACT

We collect primary data by conducting a survey on 931 Lebanese households who work in seven pre-specified sectors across all Lebanese governorates. The survey was supplemented by five groups of Key Informant Interviews that helped in formulating the survey questionnaire and in validating and interpreting the data from the survey. This paper aims to provide an assessment of the extent of energy poverty in Lebanon against comparators. Energy poverty is gauged using three indicators: (i) percentage of households able to keep their household warm, (ii) percentage of income spent on energy and, (iii) the low-income high-cost approach. Our findings uncover that Lebanese households suffer from the highest prevalence of energy poverty amongst comparators and, in absolute (rather than comparative) terms, a very high incidence of energy poverty. The findings underscore the dire need for measures that aim to mitigate the energy poverty of Lebanese households. We prescribe and discuss policy actions to alleviate the drastic situation which is further exacerbated by the ongoing crises. Our actionable policy recommendations are tailored to Lebanon's specificities and cover the different relevant energy sectors; electricity, transportation, cooking, and heating.

1. Introduction

Energy poverty is a major challenge facing countries in their efforts to meet Sustainable Development Goal number 7 (SDG7: ensure access to affordable, reliable, sustainable and modern energy for all) and to reach the net-zero emissions goal. This is even more so for countries such as Lebanon, which is currently facing a multidimensional crisis, described by the World Bank (2021a) as being among the ten, and possibly three, worst crises globally since 1900. Since the onset of the crisis, real Gross Domestic Product (GDP) as well as real GDP per capita have contracted by over 35% (World Bank, 2022a), wiping out 15 years of economic growth. While the country has suffered from long-standing electricity sector problems, the Lebanese households had been able, prior to the onset of the crisis in 2019, to rely, albeit at a high cost, on private diesel generators to compensate for electricity supply shortage. The protracted economic crisis has greatly limited Lebanese households' purchasing power and ability to afford private alternatives for electricity generation.

In spite of a high electrification rate (100%, World Bank, 2022b), the country has suffered from a shortage of supply and hence experienced extended blackouts since the 1990s. The public utility, Electricité du Liban (EdL), has resorted to rationing electricity, providing residents with 12–21 h of electricity per day between 1990 and 2019, depending on the region, with more severe rationing in areas further away from the capital, Beirut.[1] Lebanese households have, prior to the economic crisis, commonly resorted to private diesel generators to compensate for the electricity shortages. This setup has been documented by various studies investigating the Lebanese electricity sector (El-Khatiri, 2014; Dagher and Ruble, 2011; Fardoun et al., 2012; Hamdan et al., 2012). The situation has been frequently criticized suggesting that the Lebanese consumers pay the highest electricity bills, while suffering from the most unreliable and lowest quality service in the region (Fardoun et al., 2012). World Bank (2009) and Abi Ghanem (2018) provide a good overview of the impacts of power outages on the everyday lives of Lebanese families.

The situation worsened in 2011 with the high influx of Syrian

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[1] More specifically, the IMF (2019) provide additional information on the unequal and inadequate provision of electricity in Lebanon prior to the economic crisis. The IMF (2019) report that whereas Beirut receives 21.2 h of electricity per day, the Bekaa region receives only 12 h of electricity per day. Further, the IMF (2019) note that the average duration of daily shortages in Lebanon, which stands at 5.4 h per day, is higher than the average of 3.7 h in the Middle East and Africa region.

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refugees and the consequent overload of the already weak electricity infrastructure, and turned into a catastrophic situation in 2019 as a result of the concurrent crises hitting the country. The sudden stop of inflows following the popular uprising of October 17, 2019 precipitated systemic crises in banking, debt, and the exchange rate, as well as a devastating economic crisis. Lebanon's economic woes, which led to a sharp contraction in GDP, have been aggravated by the outbreak of COVID-19 and the catastrophic Port of Beirut explosion on August 4, 2020. The severe currency depreciation and triple-digit inflation (World Bank, 2023) have eroded Lebanese families' purchasing power (Abou Zaki et al., 2022). Moreover, a set of misguided economic policies resulted in depleting the country's foreign reserves (Dagher and Nehme, 2021a).

The ramifications of the combined crises were clearly visible in 2021. As a result of fuel shortages due to lack of foreign reserves, EdL could hardly provide more than 2 h of electricity per day. However, Lebanese households, impoverished by the economic crisis, no longer had the means to offset the gap via standby generators. A study by Human Rights Watch (HRW, 2023) found that as of the beginning of 2021, the average Lebanese household estimated that they go about 9 h per day with no electricity at all from any source, up from 90 min per day pre-crisis. As expected, the number of hours that a household went without electricity per day was correlated with household income. This is in line with the World Bank's (2009) finding that the share of households using private generators is correlated with income. The HRW (2023, p. 2) report concludes that "Electricity in Lebanon has effectively become a service only the wealthiest can afford, reinforcing the country's deep-seated inequality and further pushing people into poverty during one of the worst economic crises in modern history."

Prior to the 2019 crisis, the Lebanese had benefitted from the currency peg for several decades which resulted in an overvalued and strong local currency, the Lebanese Pound (LBP), that artificially raised the purchasing power of households. Thus, contrary to the problematic electricity sector, other energy fuels were widely accessible and affordable to the Lebanese. With respect to transportation, the low gasoline tax rate kept the transportation fuel relatively inexpensive. In fact, Lebanon is regarded as one of the countries with the highest rebound effect in transportation (i.e., consuming more gasoline as cars become more energy efficient; see, for example, Moshiri, 2020). The overreliance on private vehicles combined with the lack of a modern public transport system, had resulted in stifling traffic congestions. Diesel used for heating houses had been subsidized for a very long time, making it very reasonable priced for the majority of households. The same applied to butane gas which is used by most households for cooking. This situation has declined dramatically since 2019. Many articles report anecdotal evidence of the worsening energy poverty in Lebanon, but quantitative data are still lacking.

This study's contributions are threefold. This study is the first to collect primary data on a broad range of questions related to energy poverty after the onset of the crisis. Second, it offers several energy poverty measures for Lebanon that can be used in future longitudinal studies. Third, it offers substantial and actionable policy recommendations that account for the impact of the continuing multifaceted crises the country is facing.

The study's focus on Lebanon provides insights into the energy poverty issue that are not available in other studies. This is because Lebanon is a country with a unique history and context, which has shaped the way that energy poverty manifests itself in the country. The study's findings can be used to inform policy decisions and to develop programs that can help to reduce energy poverty in Lebanon and other countries in the Middle East and North Africa (MENA) region.

The remainder of the paper is structured as follows. In section 2, a review of the related literature is provided. This is followed, in section 3, with a description of the data collection methodology. Section 4 presents the main findings while section 5 provides an in-depth discussion and interpretation of the findings. Finally, in section 6, we offer concluding remarks as well detailed and actionable policy recommendations.

2. Literature review

In his pioneering study, Lewis (1952) defined the concept of energy poverty as the inadequate use of energy that affects people's living standards. Affordability is crucial when defining energy poverty, as demonstrated by the World Health Organization's (WHO, 2018) recommendation of a minimum temperature of 18 °C for living spaces. Santamouris et al. (2007) and others provide evidence that low-income households spend a higher ratio of their income on energy than middle-income households, indicating energy poverty. Belaïd (2018) and Makdissi and Wodon (2006) find that low-income households are more likely to be fuel poor, as are those who live in homes that are poorly insulated or energy inefficient. Furthermore, Burlinson et al. (2018) argue that housing poverty is a significant contributing factor to fuel poverty, and thus interventions that address both are needed. Household energy consumption and energy-saving behaviors also play a crucial role in fuel poverty. Lévy and Belaïd (2018) find that the size of the household, age, and socioeconomic status also affect energy consumption.

Energy poverty not only affects a household's access to basic energy services, but it also has significant health and social impacts. The adverse effects of cold temperatures on human health have also been documented (Hassi et al., 2005; Deschenes, 2014; Hondula et al., 2015). Moreover, Hernández (2016) find that 'energy insecurity' can lead to respiratory problems, mental health issues, and decreased quality of life, while Hills (2012) reveals that fuel poverty disproportionately affects vulnerable populations such as the elderly and those with disabilities. Using 42 expert interviews as well as focus groups, Sovacool et al. (2023) reveal a sense of shared vulnerability relating to the risk of energy and transport poverty in the United Kingdom owing to the increase in energy prices following the Russian invasion of Ukraine.

Boardman (1991) introduced the 10% threshold as an income-based indicator of energy poverty, which has been widely used in subsequent research (Heindl, 2015; Roberts et al., 2015) and applied to various regions, such as France (Legendre and Ricci, 2015), Greece (Papada and Kaliampakos, 2016), Spain (Romero et al., 2014), and Southern Europe (Scarpellini et al., 2015). Belaïd (2019) provides evidence that rising energy prices and declining income increase the probability of being fuel poor, while Galvin and Sunikka-Blank (2018) argue that fuel poverty exacerbates income inequality, as those with lower incomes are more likely to experience it. The European Parliament (2017) also defines energy poverty as a situation where a household spends more than 10% of its disposable income on energy services. The study reveals that around 10% of European households suffer from energy poverty, and the problem is more significant in Southern and Eastern European countries.

However, concerns have been raised about the universality of the 10% threshold (Hills, 2012), and researchers have suggested that factors other than income may also be important in evaluating energy poverty (Barnes et al., 2011; Hills, 2012). In developing countries, energy poverty also involves accessibility issues, as many households lack access to modern forms of energy (International Energy Agency, 2022). For example, energy poverty is more severe than income poverty in Bangladesh (Barnes et al., 2011), African countries (Nussbaumer et al., 2012), Pakistan (Awan et al., 2022), and Nigeria (Ogwumike and Ozughalu, 2016).

Recent research has adopted a multidimensional perspective when investigating energy poverty. Sovacool et al. (2012) underscore the complexity of energy poverty, discuss its many dimensions and propound that the existing literature tends to focus on electricity services while placing a lesser emphasis on clean cooking. The author builds on the approach of Bazilian et al. (2010) to broaden the scope of energy poverty to encompass lighting, heating and cooking, mechanical power, and mobility. Our survey considers all of the latter dimensions. Bezzera et al. (2022), Mendoza Jr. et al. (2019) and Nasserbaumer et al. (2013)

propose multidimensional measures of energy poverty in developing economies that focus on accessibility and consider multiple energy sources. However, these measures do not incorporate affordability, omitting important information. Additionally, the variations in energy poverty estimates necessitate a systematic and rigorous analysis of these empirical studies to obtain a true measure of energy poverty (Qur-at-ul-Ann et al. 2020).

Energy poverty has been studied extensively with a focus on its impact on health, the economy, and the environment. Indoor air pollution resulting from the use of solid fuels for cooking and heating is a significant risk factor for respiratory diseases and death in poor countries (WHO, 2018). Cold and damp housing is identified as the main cause of human illness (Hood, 2005), and the increased risk of related diseases cannot be easily avoided, especially for children (Thomson et al., 2003). Energy poverty also leads to worse physical and mental health, increases the number of stressors, and risky health behaviors, such as smoking and overeating (Liddell and Guiney, 2015; Tod and Thomson, 2017). Affordable warmth is crucial for human life, and improvements in heating and insulation are associated with extending life expectancy among both males and females (Green and Gilbertson, 2008). However, existing studies in Lebanon lack data and detailed information at the household level, further motivating this study.

Energy poverty has serious and growing public health concerns related to indoor air pollution, physical injury during fuelwood collection, and lack of refrigeration and medical care in areas that lack electricity (Sovacool, 2012). To address these issues, this study aims to establish the first measures of energy poverty in Lebanon that encompass both *accessibility* and *affordability*. Using household-level survey data, the measure can be connected with detailed household information to address policy-relevant questions. This approach provides added value by measuring the level of energy poverty in the country.

3. Data collection and methodology

3.1. Data collection

A structured questionnaire was administered to gauge the effect of the protracted economic crisis on Lebanese households across the country's geography. The respondents are heads of households who are employed in seven economic sectors, which include: (i) agriculture, (ii) construction, (iii) education, (iv) food and beverage, (v) health, (vi) manufacturing and (vii) retail. The structured survey comprised four main sections. These include: (i) sociodemographic data, (ii) housing, expenses, facilities and assets, (iii) coping strategies, and (iv) migration. More precisely, the survey allowed for collecting both quantitative and qualitative data on 931 individuals drawn from all of Lebanon's governorates.

A subsection, falling under housing, expenses, facilities and assets, was dedicated to questions pertaining to energy poverty. The questions in the latter subsection comprised a mix of numerical, binary and Likert scale questions. The responses to these questions are the basis for conducting the analysis of energy poverty in Lebanon that follows.

We offer more details on the qualitative and quantitative components of the survey next:

Quantitative data: The survey questionnaire consisted of 52 questions, of which 15 directly addressed the household's energy situation. These questions were designed to assess: 1. The ability of the household to keep their home warm, 2. The percentage of income spent on energy, 3. The sources of energy used by the household and 4. The challenges faced by the household in accessing energy.

The main eligibility criteria for the survey are: (i) being 18 years or older at the time of the survey, (ii) holding the Lebanese citizenship, and (iii) being employed in one of the seven sectors of interest. In order to obtain a representative sample in each of the seven sectors, sample size calculations using a 95% confidence interval and an 8.5% margin of error showed that we need a minimum of 133 households per sector for a total of $133 \times 7 = 931$ surveys. Several teams of enumerators worked in parallel in different regions making use of hand-held tablets and the Kobo toolbox. For most sectors, recruitment was done on site in the workplace.

Qualitative data: This information was collected through five group Key Informant Interviews (KIIs) including around 5 experts in each session. The KIIs were conducted with experts from different sectors, including energy, economics, and social policy. The KIIs were designed to help in formulating the survey questionnaire and to validate and supplement the preliminary findings from the survey.

The data collection exercise was conducted in two phases. The first phase included the development of the survey questionnaire and the conduct of the first two KIIs. The second phase consisted of performing the field survey and the remaining three KIIs.

The data collection exercise was a rigorous, structured and systematic process that was designed to ensure the quality and validity of the data. The use of a mixed-methods approach allowed for a more comprehensive understanding of energy poverty in Lebanon.

3.2. Limitations of the study

The study has a number of limitations, which include: (i) the number of responses in the Mouhafazas of Baalbak-Hermel and Nabatieh and the Cazas of Baalbek and Minnieh-Dannieh, which are more granular geographies than governorates (i.e., Mouhafazas), is small (ii) the survey was conducted at a specific point in time (March 2022), and the findings may not be representative of the current situation, (iii) the study was conducted in Lebanon, so the findings may not be generalizable or directly comparable to other countries, (iv) the study focused on households and the findings may not be generalizable to other groups, such as businesses or institutions, and (v) the study was conducted using self-reported data, which can be subject to bias. Acknowledging the latter limitation helps place the study in context and the findings of the study should be interpreted with the aforementioned limitations in mind.

3.3. Conceptual framework and underpinnings

We closely follow the conceptual framework and underpinnings of Belaïd and Flambard (2023), who thoroughly enumerate and conceptualize the factors causing fuel poverty and discuss its socioeconomic impacts. We refer the reader to Sections 2 and 3 of Belaïd and Flambard (2023) for a detailed discussion of the conceptual framework. In reference to Fig. 1 of Belaïd and Flambard (2023), the high incidence of energy poverty for Lebanese households, as discussed next, largely stems from elevated energy costs, particularly following the Russian invasion of Ukraine, as well as from weak financial circumstances that can be ascribed to the massive loss in purchasing power that is due to the depreciation of the LBP.

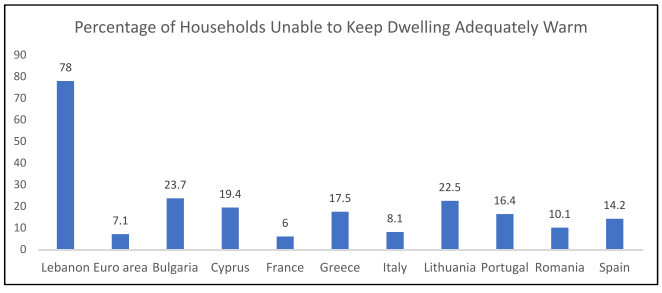

Fig. 1. Percentage of Households which are Unable to Keep Dwelling Adequately Warm.

The paper's theoretical foundations are also based on the concepts of the ability to keep a house warm, the percentage of income spent on energy, and, following Belaïd (2022), the Low-Income High Cost (LIHC) approach. The ability to keep a house warm is a fundamental human right, and households which are unable to maintain a comfortable temperature in their homes are at risk of experiencing a number of negative consequences, including poor health, social isolation, and financial hardship. This concept is supported by the capabilities approach, which argues that people have the right to access the resources they need to live a good life. In the context of energy poverty, the capabilities approach suggests that households have the right to access affordable, reliable, and sustainable energy. The percentage of income spent on energy is another important factor in determining whether or not a household is suffering from energy poverty.

Households which spend a large percentage of their income on energy are at risk of experiencing financial hardship and may be unable to meet their other basic needs. This concept is supported by the relative deprivation theory, which argues that people's well-being is not just determined by their absolute level of income, but also by their relative position in society. In the context of energy poverty, the relative deprivation theory suggests that households which spend a large percentage of their income on energy are likely to feel deprived, even if they are technically above the poverty line.

The LIHC approach is a widely used framework for measuring energy poverty (Belaïd, 2022). The LIHC approach takes into account both the ability to keep a house warm and the percentage of income spent on energy. Households which are unable to maintain a comfortable temperature in their homes and/or spend a large percentage of their income on energy are considered to be experiencing energy poverty.

This paper's theoretical foundations lay the groundwork for understanding the causes of energy poverty, the effects of energy poverty, and the necessity for alleviating energy poverty. The capacities approach, relative deprivation theory, and the LIHC framework all provide useful insights into the nature of energy poverty and the issues that must be tackled to alleviate it.

4. Main findings

4.1. Energy poverty across two dimensions: ability to keep household adequately warm and percent of income spent on energy

Our analysis begins with a comparative assessment of Lebanese households' energy poverty based on two simple indicators: (i) percentage of households able to keep their household warm[2] and, (ii) percentage of income spent on energy. For the former, cross-country data for the two indicators are obtained from 2022 EU-SILC survey conducted by Eurostat (2022) in 2022, whereas data for the latter are obtained from the Organization for Economic Cooperation and Development (OECD, 2021) housing conditions survey that was conducted in 2019. When measuring the share of income spent on energy, the percentage of income refers, more precisely, to the "share of income spent on aggregate energy such as electricity, gas for cooking, home heating, and transportation." We should note, at the outset, two important caveats that limit the scope of direct cross-country comparisons of energy poverty between Lebanon and other countries. First, our exact definition of energy poverty may slightly differ from the OECD and Eurostat's. Second, the measurement of energy poverty is undertaken at two different points in time. Despite that caution is called for when drawing comparisons between Lebanon and the other countries, we view our findings, discussed next, as generally indicative of the very high incidence of energy poverty in Lebanon vis-à-vis comparators.

When conducting the comparative analysis of Lebanese households' energy poverty, we select a group of comparator countries whose data are available in the two databases (i.e., the EU-SILC and OECD housing conditions index). These countries are: Bulgaria, Cyprus, France, Greece, Italy, Lithuania, Portugal, Romania, and Spain. It should be noted that, following Lebanon's protracted economic crisis, GDP growth and, as a consequence, GDP per capita of Lebanon contracted sharply. In fact, Lebanon's GDP per capita, in current or constant dollars, is the lowest among the comparators. The sizeable decrease in GDP per capita prompted the World Bank to reclassify Lebanon in 2022 as a lower-middle income country down from an upper-middle income country. Indeed, Lebanon is the only lower-middle income country in the sample according to the World Bank classification. The other countries in the sample are either upper-middle income (Bulgaria) or high-income countries (all of the rest).[3] Hence, the disparity in income level between Lebanon and its comparators is large.

Fig. 1 provides a comparison of the percentage of households unable to keep their dwelling adequately warm. Strikingly, Lebanon registers, by a wide margin, the highest incidence of households which are unable to keep their dwelling adequately warm. In fact, 78% of Lebanese households report an inability to keep their household warm. Among the comparators, Bulgarian and Lithuanian households report the highest incidence of an inability to keep the household warm at, respectively, 23.7% and 22.5%, but these percentages appear to be significantly lower than those of Lebanese households. While more than 10% of Cypriot, Portuguese, Greek and Romanian households are unable to keep their dwellings adequately warm, these percentages are, again, significantly lower than for Lebanese households. Moreover, in comparison to the Euro area, the percentage of Lebanese households which are unable to keep their dwelling adequately warm is more than ten time the Euro area's average percentage. Our findings thus uncover the severe energy poverty of Lebanese households along the dimension of keeping their households warm.

Fig. 2 provides a comparative assessment of percentage of income spent on energy across the ten countries. Again, the percentage of income spent on energy by Lebanese households is remarkably larger than that of comparator countries. More specifically, Lebanese households on average spend about 69% of their income, or more than two third of their household income, on energy. Among the comparators, Romanian and Portuguese households report the highest shares of income spent on energy at, respectively, 21.1% and 20%. For all the remaining countries in the sample, the percentage of income spent on energy is lower than 20%. Moreover, the share of income spent on energy by Lebanese households is approximately 3.5 times the OECD average. Again, the findings along the dimension of the share of income spent on energy

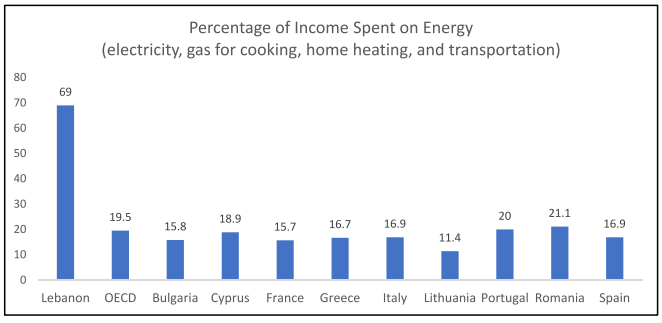

Fig. 2. Percentage of Income Spent on Energy (electricity, gas for cooking, home heating, and transportation).

[2] This variable is an indicator of energy poverty as it measures the ability of households to maintain adequate indoor temperatures during cold weather.

[3] Romania was recently classified as a high-income country by the World Bank, up from its previous status as an upper-middle income country.

underscore the severe energy poverty of Lebanese households.

It should be noted, in this context, that the energy poverty of Lebanese households appears to have increased markedly following the economic crisis. A survey conducted in 2017 by United Nations Development Program ((UNDP 2018)), prior to the onset of the Lebanese crisis, revealed that 16% of households pay more than 10% of their income on electricity provision in Lebanon. Although the measurement of energy poverty may differ across this and the UNDP's study, the findings of the UNDP are useful to show the steep upward trajectory of energy poverty of Lebanese households.

4.2. Energy poverty through another lens: the Low-Income High Cost

Following Belaïd (2022) and Belaïd and Flambard (2023), we measure energy poverty using the LIHC approach. Belaïd (2022) and Belaïd and Flambard (2023) build on Hills (2012) to measure energy poverty across four dimensions. The four dimensions are (i) income poverty-high energy and housing costs; (ii) income poverty -high energy costs; (iii) income poverty-high housing costs; and (iv) income poverty. The LIHC is based on the premise that households with low incomes spend a disproportionate amount of their income on energy-related expenses, such as heating, cooling, and lighting. The LIHC approach aims to identify households which face a significant burden from these expenses and are therefore likely to experience energy poverty.

We rely on our survey data and results in order to construct the LIHC for Lebanon. More specifically, we use a set of thresholds to identify households which are likely to be experiencing energy poverty. These thresholds are based on the percentage of household income that is spent on energy-related expenses.

For example, a common threshold used in the LIHC approach is that households which spend more than 10% of their income on energy-related expenses are considered to be experiencing energy poverty. This threshold is based on the rationale that households which spend more than 10% of their income on energy are likely to face significant financial hardship and may be unable to meet their other basic needs, especially if they earn less than 75% of the median national income in Lebanon.

In order to compute the LIHC measure, households are classified into one of the four following categories:

- **LILC** (Low Income Low Cost) households: These are households which have low incomes and low energy-related expenses, they make up 1% of households in Lebanon.
- **HILC** (High Income Low Cost) households: These households have higher incomes but still face a significant burden from energy-related expenses, they make up 2% of households in Lebanon.
- **HIHC** (High Income High Cost) households: These households have higher incomes and relatively low energy-related expenses, they make up 61% of households in Lebanon.
- **LIHC** (Low Income High Cost) households: These households have low incomes and a disproportionate burden from energy-related expenses, they make up 36% of households in Lebanon.

Fig. 3 provides a graphical representation of the taxonomy used.

We employ the threshold of 10% to classify households in terms of the energy burden. The threshold is based on the American Council for an Energy-Efficient Economy (ACEEE, 2020) qualification that a household which spends more than 10% of its income on energy can be classified as experiencing a severe energy burden. We also employ as an income threshold 75% of the median income of the households in our survey.

Table 1 provides the classification of the households in our survey across the LILC, HILC, HIHC and LIHC categories.

Fig. 4 offers a cross-country comparison of the LIHC for countries for which we have data.

The data for the LIHC for France, Germany, Jordan and Egypt are collected from published studies. In particular, Legendre and Ricci (2015), Heindl (2015), and Belaïd (2022) as well as Belaïd and Flambard (2023) provides estimates for the LIHC of, respectively, France, Germany, Jordan and Egypt. Data for the LIHC for Italy are obtained from the Italian observatory on energy poverty (OIPE, 2017), whereas the data for the LICH for Turkey and Poland are, respectively, from Dogan et al. (2021) and Bouzarovski et al. (2019).

Akin to the findings across the two other dimensions of energy poverty, the cross-country comparative analysis using the LIHC brings to the fore the severe energy poverty of Lebanese households. Indeed, the LIHC for Lebanese households, which stands at 36%, is notably larger than for any of the comparators. When comparing to Jordan and Egypt, two Arab league and MENA countries that exhibit cultural and socio-economic similarities to Lebanon, we find that energy poverty according to the LIHC is more than twice that of Jordanian households and more than four times that of Egyptian households.[4] Further, with the

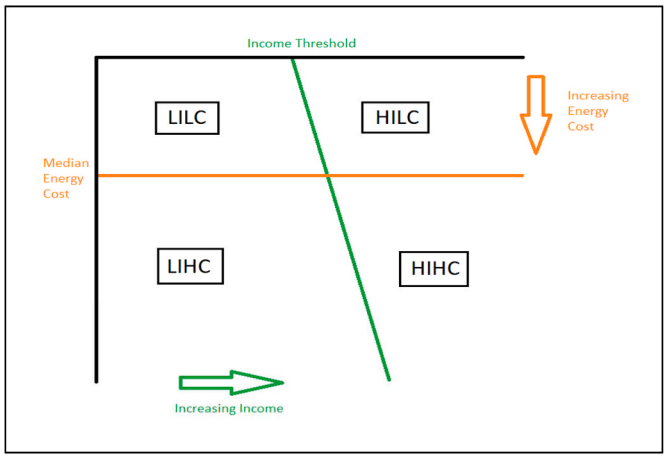

Fig. 3. Low-income high cost for Lebanon.

Table 1
Classification of lebanese households across LILC, HILC, HIHC and LIHC.

Energy Poverty Category	% of Households
LILC	1%
HILC	1.5%
HIHC	61.50%
LIHC	36%

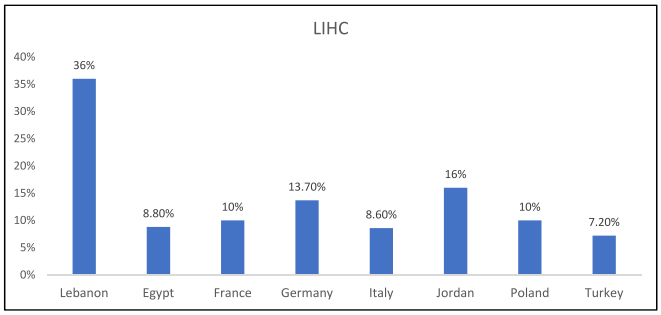

Fig. 4. Cross-country low-income high-cost comparisons.

[4] Egypt is a lower-middle income country whereas Jordan is an upper-middle income country according to the World Bank classification. Hence, these countries are broadly comparable to Lebanon in terms of average household income.

exception of Germany and Jordan, the LIHC for all of the countries is at, or lower than, 10%. This sheds light on the severe energy poverty of Lebanese households.

5. Discussion of the findings

A natural question that arises is the following: Why is the energy burden so high for Lebanese households? This section attempts to answer this question.

The sudden stop of capital inflows on October 17, 2019 precipitated a triple crisis in Lebanon. Indeed, a currency, systemic banking and, ultimately, a sovereign debt crisis have stricken the country in quick succession over the period October 2019 to March 2020. The country's financial crisis has been classified by the World Bank (2021a) as being among the worst ten, and possibly three, crises worldwide since the mis-1800s. According to the World Bank (2022a), the crisis scarred the country. The protracted economic collapse has also impoverished the Lebanese. Indeed, data from the World Bank's World Development Indicators database indicates that real GDP per capita, in current US dollars, fell from $9225.8 in 2018 to $4136.1 in 2021. The country's deep financial crisis was met, according to the World Bank (2020), by deliberate policy inaction. The lack of a comprehensive reform agenda aimed at preserving and defending a bankrupt economic model that caters for the vested interests and rent-seeking opportunities of the political and economic elites.

Dislocations in the longstanding exchange rate peg, which dates back to 1997, had started emerging in August 2019. With the rapid decrease in foreign currency reserves, Lebanon's central bank, the Banque du Liban (BdL), engineered a multiple exchange rate system designed to allow commercial banks, which were essentially in selective default, to provide depositors with access to their foreign currency deposits in the domestic currency at an unfavorable exchange rate (i.e., at a loss or a haircut). The latter policy response by the BdL, coupled with a continued monetization of the debt, led to a precipitous increase in currency in circulation as well as to an inflation-depreciation spiral (World Bank, 2020). Indeed, according to the Central Administration of Statistics, average inflation stood at 154.8 and 171.2 percent in 2021 and 2022, respectively, while the LBP depreciated severely and lost more than 95% of its value by September 2022 (World Bank, 2022a). The triple-digit inflation, coupled with the severe loss of purchasing power of wages that are predominantly paid in LBP, significantly eroded the purchasing power of Lebanese households.

Despite the dwindling foreign currency reserves at BdL, an ineffective, unsuccessful, and costly experiment with subsidizing essential and critical imports, including a list of food items, medicine and, notably, gas, diesel and gasoline was launched in 2019 (Dagher and Nehme, 2021b). The subsidy scheme created incentives for smuggling, led to acute shortages of diesel and gasoline and was distortionary and regressive (World Bank, 2021b). With the rapid depletion of foreign currency reserves, the subsidy scheme also quickly proved to be untenable and was terminated for energy products in a disorderly manner in September 2021. The lifting of subsidies compounded the energy poverty of Lebanese households, largely because gasoline and diesel are priced in USD.

The rapid depreciation of the LBP decreased revenues in the local currency of the central electricity utility, EdL. The drop in revenues, coupled with shortages of fuel and EdL's inability to secure cash and foreign exchange for fuel payments (World Bank, 2022c), led to a significant fall in electricity generation. Due to its precarious financial position, EdL resorted to the increased use of rolling blackouts and electricity supply was limited to about 2 h per day starting in July 2021. Lebanese households were thus forced to rely on the use of diesel generators, which are a very costly and highly polluting alternative, to make up for the shortfall in supply. This, in turn, further eroded the purchasing power of Lebanese households and increased their energy burden significantly.

Following the general discussion of our findings above, we proceed to a more elaborate discussion of our survey results. To start with, our results reveal that the incidence of energy poverty differs across Lebanon's geography. In fact, owing to the provision of electricity in Zahle not by EdL but by the Electicité de Zahle as well as the use of hydropower plants in West Bekaa, these two regions are less dependent on the supply of electricity from private diesel generators and exhibit a lower incidence of energy poverty. Our findings also suggest that the incidence of energy poverty is marginally, albeit insignificantly so, lower in governorates that have more access to hydropower.

We explore next the effect of household characteristics in determining the incidence of energy poverty and thereby exploit additional information from our survey.[5] Our findings reveal that energy poverty is inversely related to the level of education of the head of the household. That is, the higher the educational attainment of the head of the household (which generally correlates with a higher income), the lower the incidence of energy poverty. In addition to the differences in income, this finding could also be attributable to the fact that heads of households with a higher educational attainment are more likely to reside in energy efficient dwellings, be aware of energy saving tips, and have the resources to make energy-efficient upgrades to their homes.

We also find, perhaps expectedly, that larger households tend to spend a larger percentage of their income on energy. Indeed, approximately 27.3% and 35.9% of households with, respectively, one and two members spend 70% or more of their income on energy whereas approximately 46.8% and 54.4% of households of six and six and more members, respectively, spend 70% or more of their income on energy. Finally, our findings suggest that the households which rent their dwelling spend a larger share of their income on energy, therefore experiencing a higher incidence of energy poverty, than households which own their dwelling. The latter finding can be interpreted as follows: Renting a house is generally correlated with a lower level of income, which, in turn, increases the energy poverty. Further, households which own their dwellings generally tend to have the financial means to invest in energy-efficient appliances and make energy-saving investments such as solar energy.

6. Conclusion and policy implications

Using first-hand data that are collected from a household survey that was conducted across Lebanon's geography, this paper provides an assessment of the extent of energy poverty in Lebanon against comparators.

Energy poverty is gauged using three measures: (i) percentage of households able to keep their household warm, (ii) percentage of income spent on energy, and (iii) the low-income high-cost measure. Our findings uncover that Lebanese households suffer from the highest prevalence of energy poverty amongst comparators and, in absolute (rather than comparative) terms, a very high incidence of energy poverty. The findings underscore the dire need for measures that are aimed at mitigating the energy poverty of Lebanese households.

While the findings also indicate that energy poverty appears to be widespread in many countries, the specific drivers and extent of the energy burden can vary significantly depending on factors such as the availability and affordability of energy sources, government policies and programs, and the country's overall economic and social context. Analyzing these variances and recognizing commonalities across nations could help in the development of effective policies and initiatives to alleviate energy poverty that are suited to each country's individual requirements and challenges.

For instance, differences and inconsistencies in the LIHC values among countries can be related to a number of factors such as energy prices, income levels, housing conditions and climate. Energy

[5] We thank an anonymous reviewer for making this important suggestion.

affordability is affected by diverse factors globally. With regards to household heating expenditure, areas with cooler temperatures may be prone to higher energy poverty rates as they incur increased costs trying to stay warm during cold seasons. Further complications occur when high-energy tariffs place additional burdens making it hard for families with limited budgets.

Nevertheless, effective government programs similar to the ones in France offer financial relief aimed at reducing this risk of insecurity. The government of Germany has undertaken a range of policy interventions aimed at boosting energy efficiency in homes and reducing the cost of energy to mitigate the risks posed by energy poverty. Policymakers can identify common trigger factors for energy poverty by analyzing and comparing LIHC values across different countries. Targeted policies promoting renewable energy usage and energy efficiency could help reduce costs, so households can enjoy better living conditions, while battling this type of poverty.

In Lebanon's particular case, implementing an immediate plan to restore EdL's generation capacity and diminish the use of rolling blackouts would be of paramount importance for alleviating the energy poverty of Lebanese households. Increasing EdL's power supply would be an essential pillar for allowing households to lower the costs associated with using private diesel generators and serve to combat the environmental degradation caused by private diesel generators. Further, developing a plan to tackle the longstanding inefficiencies in the country's power sector is very much warranted. As noted by the IMF (2019), the electricity plan must be predicated on (i) increasing production capacity, (ii) reducing losses, (iii) reducing production costs and (iv) increasing tariffs.

Successfully designing and implementing a plan for enhanced power generation by EdL has met with several obstacles owing to Lebanon's confessional-based governance system.[6] In fact, EdL's generation capacity has long been below demand and the electricity utility has suffered from technical and non-technical losses that are estimated to stand at 43% of production (IMF, 2019). Further, the tariffs charged by EdL have not been cost-reflective and made the utility largely dependent on transfers from the government. These transfers contributed to a ballooning public debt of 171% of GDP in 2019 (World Bank, 2022a) and adversely affected Lebanon's fiscal stance. According to the World Bank (2016), transfers to EdL amounted to, cumulatively, 55.4 percent of GDP and 40 percent of the total debt stock over the period 1992 to 2006.

The Ministry of Energy and Water (MoEW) has embarked, in 2023, on changing the tariff structure for it to be more cost-reflective. However, the change in tariffs has only led to a modest improvement in electricity generation and is not expected, due to inadequate tariff collection, to fully address EdL's revenue shortfall or inability to secure foreign exchange over the long-term. A natural way to reduce non-technical losses would be to install smart meters. Moreover, improving the Distribution Service Provider (DSP) framework and the distribution grid would be another avenue to mitigate losses (IMF, 2019). Introducing competition, at least on the generation and distribution sides (with transmission remaining under government control), should also be priorities for the government. For instance, the provision of electricity by Electicité de Zahle has proven to be a successful experiment in de-centralizing the generation of electricity. The government plan should also comprise prioritizing the development of a diversified energy mix. This will ensure energy security, reduce dependence on expensive diesel generators, and provide a more stable source of energy for households.

The electricity crisis facing Lebanese households has prompted a shift towards Distributed Renewable Energy (DRE) in a bid to mitigate the exorbitant costs and harmful environmental and health impacts of private diesel generation. Despite that the switch towards DRE has been disorganized, it is a step in the right direction and the government should devise a strategy to facilitate, oversee and invest in the shift towards DRE. It is also essential for policymakers to enable and organize the surge in investment in renewable energy given that Lebanon has significant potential for renewable energy because of its favorable climate and the abundance of days with sunshine and wind. For instance, policymakers may consider, space permitting, establishing solar farms to accelerate the switch towards renewable energy.[7]

The government should also provide incentives for large-scale private investments in renewable energy projects and introduce feed-in tariffs to encourage renewable energy generation as remedies for the electricity supply shortage. These policy actions will not only reduce the reliance on expensive fossil fuels, but also create jobs and support economic growth. In the short-run, policymakers should consider minimizing the red tape and streamlining the process of approvals required to install residential and commercial solar energy.[8]

In parallel, policymakers should promote the use of renewable energy in the transportation sector by waiving customs fees for electric and hybrid vehicles. Registration fees should also be removed. Moreover, in view of Lebanese households' energy poverty being ascribed, in part, to expenses associated with transportation, the government should seek funding from the international community and undertake an ambitious public transportation plan. Mass transport has been sorely lacking in Lebanon since the end of the civil war in 1990 and providing the public with options for public transportation will contribute to alleviating transport poverty.

Finally, expanding the Emergency Social Safety Net (ESSN) program, funded by the World Bank, should be an immediate policy priority. More specifically, increasing cash transfers to the low income and rural households of Lebanon's mountainous regions (which receive significant snowfall and contend with low temperatures during the winter) is warranted. We recommend that the cash assistance covers cooking fuel whose prices have become exorbitant, to keep back families from switching to non-clean fuels. Evidence from other countries has shown that consumer awareness interventions to educate households/individuals about the problems and dangers associated with traditional fuels for cooking have been very effective (Singh et al., 2023).

The set of policy prescriptions we suggest will help in mitigating the effects of climate change, COVID-19 and the concurrent crises Lebanon is facing on energy poverty rates, and enhance the country's ability in achieving SDG7. If policies are well-designed and efficiently implemented, the lower-income households will be protected from the negative impacts of the crises and shielded from the cost burden of the energy transition. These policies are also expected to have a positive impact on the country's GDP, as the lack of electricity and mass transportation have been major impediments to economic growth.

CRediT authorship contribution statement

Leila Dagher: Conceptualization, Methodology, Software, Validation, Formal analysis, Investigation, Data curation, Writing – original draft, Writing – review & editing. **Ibrahim Jamali:** Conceptualization, Methodology, Software, Validation, Formal analysis, Investigation, Data curation, Writing – original draft, preparation, Writing – review & editing. **Oussama Abi Younes:** Conceptualization, Methodology, Software, Validation, Formal analysis, Investigation, Data curation, Writing – original draft, preparation, Writing – review & editing.

[6] For instance, an electricity plan was proposed by the government on April 9, 2019 and ratified by parliament on April 17, 2019. Progress on the implementation of this plan has been limited.

[7] Solar farms have successfully provided 21 h of electricity in Lebanon's remote northeast. See, for example, https://news.trust.org/item/20211022130438-vu65d/.

[8] Currently, installing solar energy requires several layers of approval starting with the municipality.

Declaration of competing interest

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

Data availability

The data that has been used is confidential.

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