University of Miskolc

Faculty of Economics

Hantos Elemér Doctoral School of Business, Management and Regional Sciences

Mohammad Jaber

Thesis statements of the dissertation

Towards Better Understanding of Energy Poverty in Jordan: A Multidimensional Phenomenon

Head of the Doctoral School
Prof. Géza Tóth
Professor

Academic Supervisor
Tekla Szép, PhD
Associate Professor

Miskolc, 2024

Table of Contents

1. The rationale of the research and justification of energy poverty

This chapter is an introductory section of my research topic, questions, and objectives. Firstly, I present an overview of the Jordanian energy sector and how my research will contribute to bridging the current gap in the literature. Additionally, I discuss the main theories and concepts related to my research. Within this chapter, I also describe the preparation process of this dissertation, including the formulation of the hypotheses. Finally, I justify the relevance and significance of my doctoral research. Figure 1 visualizes the research scope and connections based on this dissertation.

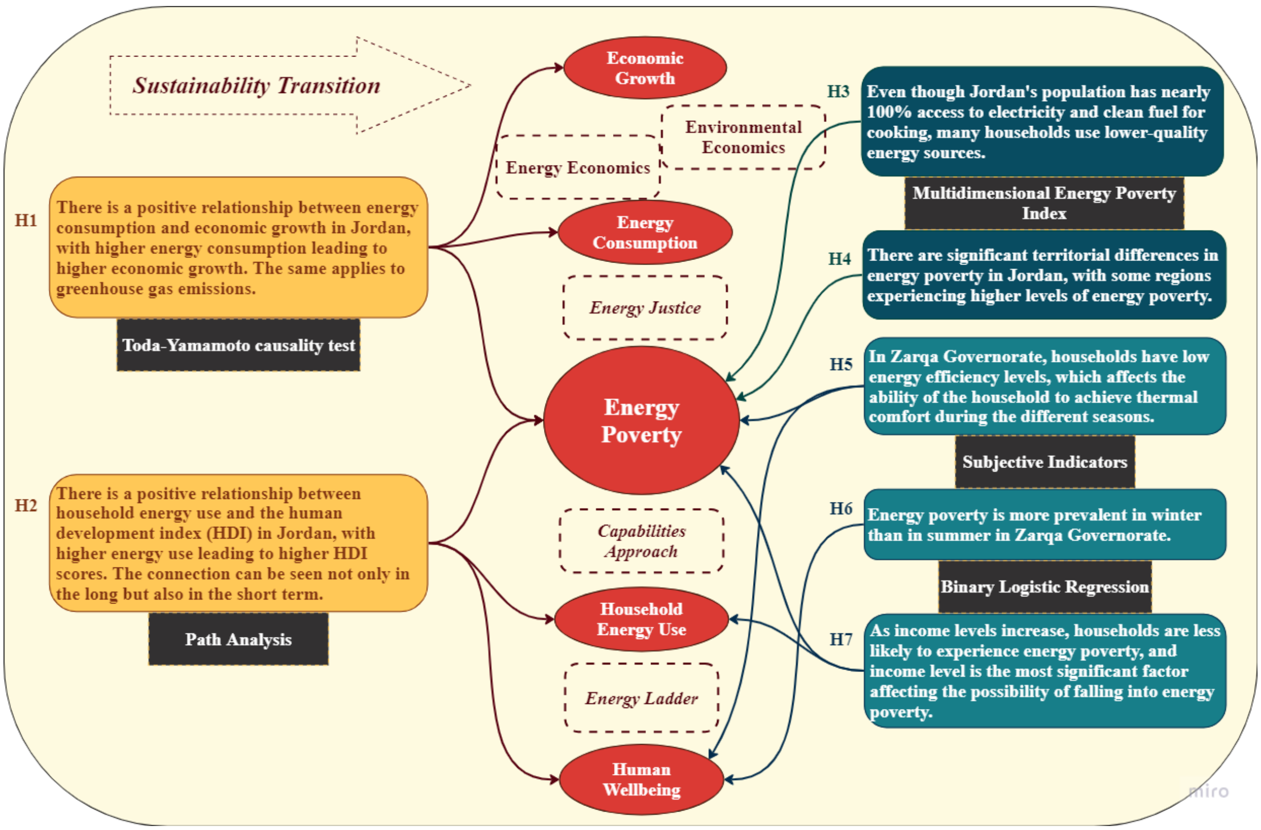

Figure 1. Visualizing the Research Scope and Connections.
Source: own compilation.

1.1. Jordan's Energy Landscape: Challenges and Transition to Renewable Sources

1.1.1. Jordan Energy and Climate Change

Jordan is a middle-upper-income country (World Bank Country and Lending Groups – World Bank Data Help Desk, 2020) and the most politically liberal country in the Arab world. Jordan, a young country that became an independent kingdom in 1946, has a strategic location in the Middle East region with its capital, Amman, the country's largest and most populated city; its total area is 89,342 km^2. The country mostly has no port on the sea except 26km of coast in Aqaba city. It is a non-oil-producing country that mainly imports energy from surrounding countries. It has abundant renewable energy resources, primarily solar and wind (Jaber et al., 2004; Jaber and Probert, 2001,

2001). Jordan consumes more energy per unit of economic output than other countries with similar social and economic structures (Saeedan and Friedrich-Ebert-Stiftung Amman office, 2011).
Before 2003, Jordan purchased oil from Iraq below market rates, and the government subsequently transferred some of these cost advantages to consumers. After 2003, Jordan lost this affordable oil source, and the rise in global prices followed. While global food prices doubled between 2002 and 2008, global energy prices increased more than threefold (Atamanov et al., 2017). Although the government was compelled to raise prices in 2005 and again in 2006, it kept them below levels elsewhere. As a result, government spending on petroleum subsidies alone accounted for 5.8% of GDP in 2005 (Coady et al., 2006). After Palestine, Jordan has the second-highest fuel and electricity prices in the Arab world, attributed to price liberalization initiatives in recent years and a fixed tax on oil derivatives (Jordan News, 2022). A new electricity tariff was introduced in the first third of 2022 and targeted Jordanian families, holders of permanent Jordanian passports, and Gazans will also benefit, as well as subscription service meters for households (The Jordan Times, 2021). The subsidized tariffs are divided into three categories: consumers who use between 1 and 300 kWh of electricity pay 50 fils per kWh (1 Jordanian Dinar equals 1000 fils), those who use between 301 and 600 kWh pay 100 fils per kWh, and those who use more than 600 kWh pay 200 fils per kWh (The Jordan Times, 2021).

1.1.2. Energy poverty

Energy and fuel are related but distinct concepts. Energy is the ability to do work or to produce heat(Bhattacharyya, 2011), while fuel is a substance that possesses internal energy and creates heat when burned or obtains energy from sources such as solar radiation or geothermal reservoirs beneath the Earth’s surface (Bhattacharyya, 2011). In other words, fuel is a source of energy. For example, gasoline is a standard fuel used to power cars, while the energy released by burning gasoline makes the car move. The difference between energy and fuel can be thought of as the difference between the potential to do work and the means of releasing that potential. However, they are frequently used interchangeably; fuel and energy poverty are not always the same. Energy poverty refers to a household’s inability to access and purchase sufficient amounts of energy for their requirements. In contrast, fuel poverty particularly refers to the circumstance in which a household cannot pay to heat their home effectively. However, because it focuses on the particular need for heating and the difficulties that households may encounter in meeting this need, fuel poverty is seen as a distinct instance of energy poverty. In this regard, fuel poverty is a more specific type of energy poverty that is frequently used to describe the difficulties that households encounter in meeting their heating demands.
The study of energy poverty and fuel poverty reveals that there are some similarities and differences. Framing both concepts under energy insecurity and vulnerability, Figure 2 summarizes those similarities and differences from the literature. In the third and fourth chapters, energy and fuel poverty are examined in detail, among other terminologies upon which the figure was built.

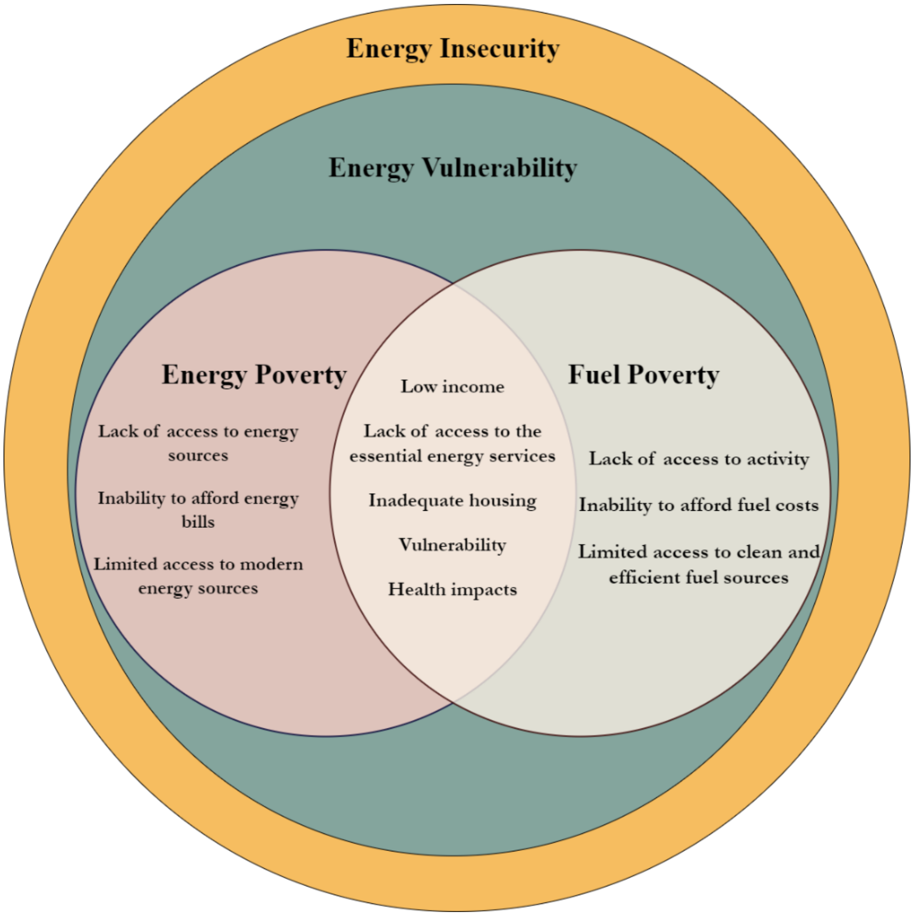

Figure 2. Conceptualizing the framework of energy and fuel poverty.
Source: Author's compilation based on literature.

1.2.Theoretical Background

Energy poverty is a complex issue widely studied in the literature, often in conjunction with related concepts such as fuel poverty, energy vulnerability, energy insecurity, and energy justice. In this chapter, I will examine the main theories and concepts that help us understand and explain energy poverty within the context of energy insecurity and vulnerability. Additionally, I will explore the role of justice in analyzing energy poverty and consider how various theories can inform our understanding of this issue. Energy poverty is multidimensional and can be studied from different angles and scientific and social disciplines. The main theories and ideas discussed in this section align with this dissertation's research goals, and the main results in each chapter are reflected in the mentioned theories.
While writing the dissertation, I followed the process in Figure 3. The process started with reviewing theories mostly about energy poverty from various perspectives. After examining the theories, hypotheses were formulated regarding energy economics and energy poverty in Jordan. The selection of the methods used in my dissertation was controlled by the fact that data availability and credibility forced me to test the methods and explore the ones that fit with the available data. Calculations followed data collection from different sources to test my hypotheses. Lastly, based on the results, I could formulate theses in line with the hypotheses.

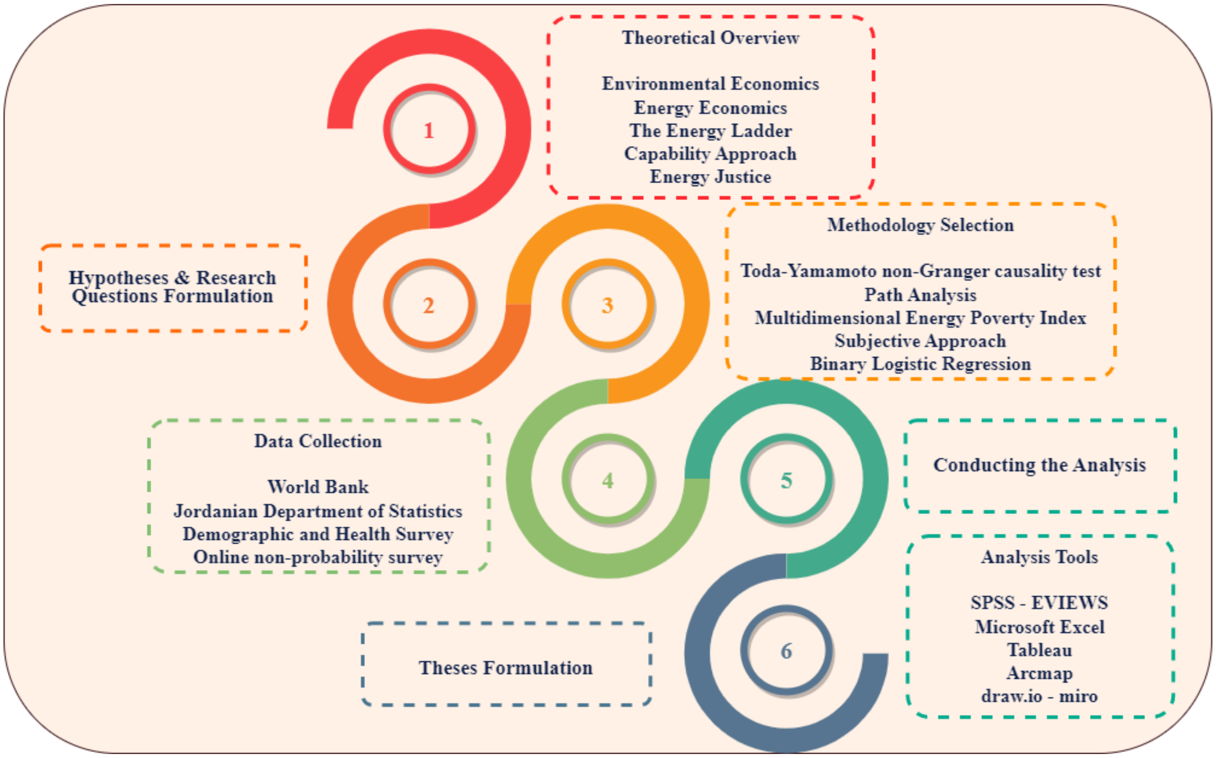

Figure 3. Dissertation Development Process.

Source: own compilation.

The main goal of my dissertation is to examine the characteristics of energy poverty in Jordan. While energy poverty is recognized as a multifaceted and complex issue, I studied the relationship between energy and economic growth and climate change on the one hand and the relationship to human well-being on the other hand. I use multiple methods based on various data sources and types to achieve this goal. In this dissertation, I am testing the following hypotheses:

H1	There is a positive relationship between energy consumption and economic growth in Jordan, with higher energy consumption leading to higher economic growth. The same applies to greenhouse gas emissions.
H2	There is a positive relationship between household energy use and the human development index (HDI) in Jordan, with higher energy use leading to higher HDI scores. The connection can be seen not only in the long but also in the short term.
H3	Even though Jordan's population has nearly 100% access to modern energy sources, many households suffer from energy poverty.
H4	There are significant territorial differences in energy poverty in Jordan, with some regions experiencing higher levels of energy poverty.
H5	In Zarqa Governorate, households have low energy efficiency levels, which affects the ability of the household to achieve thermal comfort during the different seasons.
H6	Energy poverty is more prevalent in winter than in summer in Zarqa Governorate.
H7	As income levels increase, households are less likely to experience energy poverty, and income level is the most significant factor affecting the possibility of falling into fuel poverty.

In the second chapter, I test the first hypothesis using the Toda-Yamamoto non-Granger causality test using three indicators: final energy consumption, economic growth, and greenhouse gas emissions covering 1990-2018. The third and fourth hypotheses are examined using the path analysis test on cross-sectional data from the Jordanian governorates for 2009 and 2017. In the third chapter, I use the multidimensional energy poverty index on two health and demography surveys from 2009 and 2018 to estimate energy poverty in Jordan at different geographical and socio-economic levels. The fourth chapter examines the characteristics of fuel poverty in the Zarqa governorate through the consensual approach. The method used in this chapter is data collection through an online survey targeting people living in the Zarqa governorate in central Jordan and analysis using contingency tables, binary logistic regression, and composite indicators.

2. Exploring the nexus between economic growth, energy, climate change, and human well-being

2.1. Energy Consumption and Economic Growth in Jordan: Theoretical Perspectives

Several factors and relationships can be observed when studying energy poverty in Jordan: First, energy is needed to meet basic human needs. Energy consumption is, therefore, critical to economic and social development and prosperity (Halkos and Gkampoura, 2021). Second, Jordan's energy system and security have been a topic of concern and exploration in recent years. Jordan imports almost 94% of its energy supply (Sandri et al., 2020). Third, the sustainability of the energy sector is represented by the share of renewable energy in the energy mix and the contribution of renewable energy consumption to economic growth (Ministry of Energy and Mineral Resources, 2020). Finally, Jordan is an emergent economy with universal access to electricity; residents rely primarily on modern energy sources, so they do not spend time gathering wood or utilizing unclean energy sources.

Energy is one of the leading drivers of economic growth, employment, and sustainable development (Gatto and Busato, 2020). Improving access to sustainable and affordable energy sources would alleviate poverty, contribute to protecting the environment, and build solid institutions (Rosa, 2017). In Jordan, fossil fuel is the primary source of energy. The country's energy consumption in 2021 is dominated by the transport sector (around 40%), followed by the residential sector (around 25%). By source, oil products followed by electricity are the dominant ones. Net energy imports in Jordan reached 378.9 TJ by 2019 (IEA, 2022), which accounts for nearly 94% of Jordan's total energy in Jordan. In addition, the energy sector suffers from several challenges, such as increasing demand, limited domestic energy resources, the unstable political situation in the surrounding countries, and the resulting security/price issues, poor planning, and losses in the sector (Albezuirat et al., 2018).

2.2. Results and discussion

I tested the relationship between EC, GDP, and GHG in this chapter using the Toda-Yamamoto technique. A simple VAR equation was estimated. Using the optimal lag length criteria, the VAR model was re-estimated to include the order of integration of the variables and the number of lags. Then, the non-Granger Causality, or the Toda-Yamamoto causality test, was performed. On the other hand, path analysis was used to test the relationship between EE and HDI, among other secondary explanatory variables, as discussed in the previous section. Path analysis uses a series of ordinary least squares which are built upon each other. The first step examines the primary variable effects on the secondary variables' groups. The second step examines the impacts of the primary and secondary dependent variables on the dependent variable. The last step includes all the variables in the regression together against the dependent variable.

2.2.1. Results of the Toda-Yamamoto causality test

Understanding the relationship between energy consumption and economic growth is essential. The outcomes regarding the direction of the causality relationships have significant policy associations. As mentioned earlier in the chapter, energy is one of the main factors that incentive economic growth. Thus, determining which one of the four hypotheses the relationship follows would result in better policy suggestions.

- ***Unit root test***

The unit root of energy consumption and economic growth was tested using the Augmented Dicky-Fuller (ADF) and Phillips–Perron (PP) tests. The unit root test for both level and first difference forms was performed, including constant only and constant and linear trends. The results of the unit root tests in Table 1 and

Table 2 shows that the time series are integrated at first difference. The order of integration value will be used later when testing the modified VAR model and the causality test.

Table 1. ADF unit root test results

	Maximum Lag (AIC)	**ADF unit root test Intercept**		**ADF unit root test Intercept and trend**	
		I(0)	**I(1)**	**I(0)**	**I(1)**
ln**EC**	**6**	-1.813 (0.366)	**-6.631** **(0.000)****	**-3.697** **(0.041)***	**-4.596** **(0.006)****
ln**GDP**	**6**	-2.200 (0.211)	**-3.798** **(0.008)****	-0.925 (0.938)	**-4.483** **(0.007)****
lnGHG	**6**	1.077 (0.996)	**-3.717** **(0.011)***	-1.378 (0.845)	**-4.395** **(0.010)****

Values in () are P-values, whereas * and ** are the 5% and 1% significance levels, respectively.

Table 2. PP unit root test results

	PP **unit root test Intercept**		PP **unit root test Intercept and trend**	
	I(0)	**I(1)**	**I(0)**	**I(1)**
ln**EC**	-2.190 (0.214)	**-6.502** **(0.000)****	-2.190 (0.476)	**-6.674** **(0.000)****
ln**GDP**	-1.499 (0.519)	**-3.950** **(0.006)****	-1.040 (0.922)	**-4.612** **(0.005)****
lnGHG	-0.539 (0.869)	**-4.136** **(0.004)****	-1.785 (0.685)	**-4.042** **(0.019)***

Values in () are P-values, whereas * and ** are the 5% and 1% significance levels, respectively.

After determining the variables' integration level, the next step is to define the model's optimal lag length to ensure it is free from serial correlation and other problems. The model indicates that the optimal lag order is three, as predicted by four criteria. This number is used in the modified VAR model alongside the order of integration, as noted earlier in the methodology. Table 3 shows that the optimal number of lags is two according to three criteria.

Table 3. VAR Lag Order Selection Criteria

Lag	LogL	LR	FPE	AIC	SC	HQ
0	54.69618	NA	3.76E-06	-3.97663	-3.83147	-3.93483
1	168.4664	192.5343	1.20E-09	-12.0359	**-11.45522***	-11.8687
2	178.501	14.66586	1.14E-09	-12.1155	-11.0993	-11.8228
3	196.4648	**22.10931***	**6.25e-10***	**-12.80498***	-11.3533	**-12.38696***

* Indicates lag order selected by the criterion. LR: sequential modified LR test statistic (each test at 5% level). FPE: Final prediction error. AIC: Akaike information criterion. SC: Schwarz information criterion. HQ: Hannan-Quinn information criterion

The causal relationships between energy consumption, economic growth, and greenhouse gases are listed in Table 4. The Toda Yamamoto causality test results show that energy consumption significantly causes economic growth and greenhouse emissions. On the other hand, the null hypothesis of no causality is accepted in the other direction. Energy consumption in Jordan is increasing yearly, as the data deceptive in the previous section shows, and such an increase resulting from the high demand will boost economic growth and increase GHG emissions. The results support the growth hypothesis and can be applied to GDP and GHGs. As energy demand keeps rising, policies should focus on accelerating the energy transition, improving efficiency, enhancing storage capacity, and incentivizing the adoption of clean technologies.

Table 4. Toda-Yamamoto causality test results.

Null Hypothesis	Chi-Square (χ^2)	P-value
Energy consumption does not cause economic growth	28.900	**0.000**
Energy consumption does not cause greenhouse gas emissions	8.788	**0.032**
Economic growth does not cause energy consumption	3.212	0.360
Economic growth does not cause greenhouse gas emissions	1.633	0.652
Greenhouse gas emissions do not cause energy consumption	4.618	0.202
Greenhouse gas emissions do not cause economic growth	3.354	0.340

2.2.2. Energy Expenditure and Income Regional Inequality

Before proceeding to the path analysis results, this section highlights the regional inequalities between the Jordanian Governorates in this section. Regional data regarding annual average energy expenditure and income were collected from DOS while preparing the data for the path analysis for 2008 and 2017. Then, using a scatter plot, I built two charts to show the position of each governorate in terms of energy expenditure and income against the arithmetic mean (which represents the horizontal and vertical lines, respectively). The resulting charts can be seen in Figure 4 and Figure 5.

The two arithmetic mean lines divide the chart into four corners: the upper right corner represents the governorates that have higher average income and energy expenditure, the lower right corner for those who have higher income and lower energy expenditure, the lower left corner represents those who have low income and energy expenditure, and the upper left corner represents the group

of governorates that have lower income than average and higher energy expenditure. Income and energy expenditure levels have generally grown between the two years.
Comparing the two years of measurement, we notice that Amman has the highest income and energy expenditure levels in the observed years. Amman hosts the capital city of Amman, and it is the most populous governorate in Jordan, where jobs are primarily available and higher income levels and services are available. When examining the two charts together, we can see that a shift had happened, and the governorates' situation regarding income and energy expenditure changed. In 2008, Balqa, Zarqa, and Irbid had the highest energy expenditure levels compared to the other governorates. This situation changed, especially for Irbid and Balqa, where income levels had increased above the average and moved from the "unfortunate corner" to better conditions. Zarqa, on the other hand, shows that energy expenditure compared to 2008, energy expenditure and income levels became less than the average, meaning that most households in Zarqa managed to adapt to lower energy consumption or improvements in energy efficiency helped them to shift energy expenditure to a lower level than the national average.

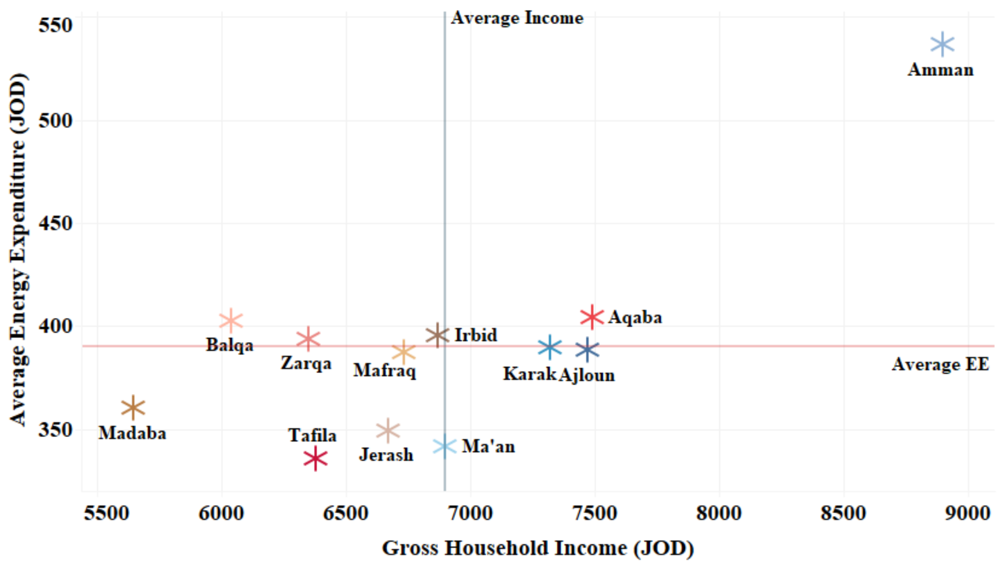

Figure 4. The relationship between the Jordanian Governorates regarding energy expenditure and income levels in 2008.
Source: Own compilation.

When examining the lower left corner in 2008, we can find four governorates: Madaba, Mafraq, Tafila, and Jerash, and out of these four, Mafraq shifted from the low-expenditure, low-income corner to the low-income high-expenditure corner, indicating that this governorate did not benefit economically or improved energy efficiency during the study period. Moreover, Madaba's situation changed positively; the energy expenditure levels remained below average, while income levels were boosted to be higher than the average. This observation indicates that households in Madaba may have adapted to lower energy consumption levels or, while income increased, energy efficiency levels increased. Tafila and Jerash remained in the same corner, and the income level in Jerash is the lowest among the 12 governorates in 2017.

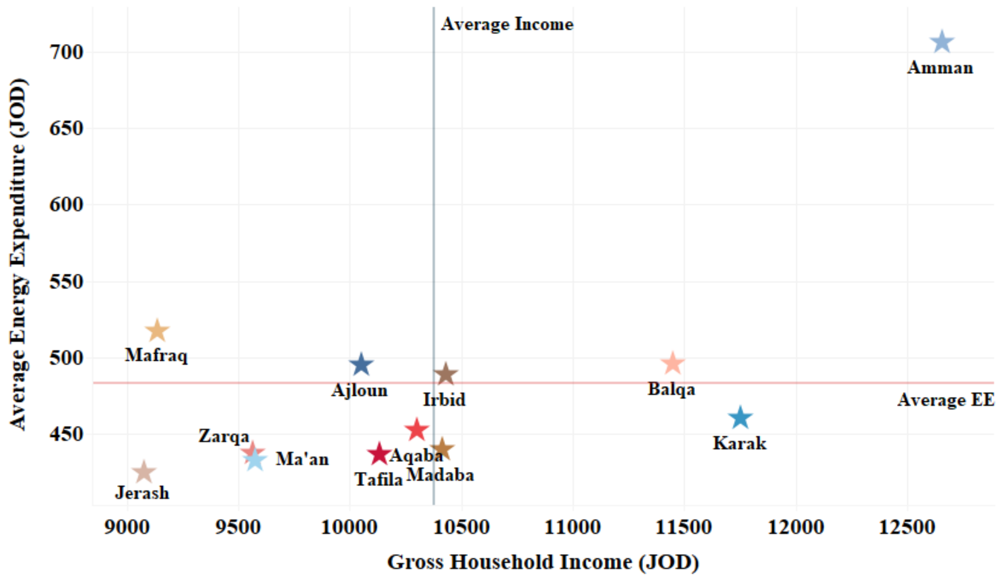

Figure 5. The relationship between the Jordanian Governorates regarding energy expenditure and income levels in 2017.
Source: Own compilation.

Finally, we can notice that Ajloun witnessed a dramatic change in income levels, from above the average to less than the average, and most importantly, from low energy expenditure to higher-than-average expenditure. This situation in Ajloun requires more investigation to assess the factors that led to this change. The charts show a vast gap between households in Amman and the other governorates regarding income and expenditure levels.

2.2.3. Results of the path analysis

Path analysis is used in this section to study the main primary and secondary causes of HDI in the Jordanian governorates. Factors examine the relationship between household annual energy expenditure and HDI in 2008 and 2017. The analysis directly assesses the primary explanatory factor's effect on the independent variable or through other intermediate (secondary explanatory) factors (Jaber, 2022; LaBelle et al., 2022). Path analysis uses a set of ordinary least squares (OLS) built on one another.
The selected factors included in the path analysis are a proxy for energy consumption represented by average annual energy expenditure in each governorate and HDI on the governorate level, among other factors, as mentioned in the previous section. The initial number of variables was filtered and excluded from part of the list to eliminate the multicollinearity issues. The path analysis compares the geographical differences between the Jordanian governorates regarding energy expenditure relationship to HDI directly and indirectly. The cross-sectional data used are based on the Expenditure and Income Survey conducted by the Department of Statistics in 2008 and 2017.
The application of simple multivariate linear regression, including all the variables' results, is listed in Table 5. HDI is used as the dependent variable in this step. The variables included in the analysis explain that the regional ratio of HDI with R^2 in the two years analysis is slightly the same. Changes in the weights of the variables show a significant change through the years. In 2008, urbanization had the most significant effect on HDI, while in 2017, energy expenditure and income were the

significant factors. Regardless of significance, it is noted that the coefficient values changed between the two years.

Table 5. Regression results for the primary and the secondary indicators against HDI.

Coefficients	Variable	HDI, 2008	Std. Error	HDI, 2017	Std. Error
β_1	EE	-0.016	0.000	-0.789*	0.000
β_2	IN	-0.285	0.000	1.072*	0.000
β_3	WD	-0.243	0.000	0.428	0.000
β_4	UB	0.731**	0.029	0.303	0.038
β_5	HE	-0.316	0.000	-0.126	0.000
β_6	ED	0.664	0.000	0.562	0.000
R^2		0.814		0.813	

Note: * 10% significance level, ** 5% significance level, and *** 1% significance level.

The regression analysis results between energy expenditure and HDI are listed in Table 6. The findings indicate that energy expenditure explains itself in 30% and 10% of the variances of the HDI. Energy expenditure plays a vital role in the distribution of the dependent variable. It is also noticed that the relationship between the variables in 2017 is insignificant, and the coefficient value has decreased compared with 2008, showing a slightly significant effect. The positive values indicate that energy expenditure motivates HDI, enhancing human well-being. On the contrary, declining energy expenditure hinders human well-being.

Table 6. Binary regression results between EE and HDI.

Coefficients	HDI, 2008	Std. Error	HDI, 2017	Std. Error
β	0.527*	0.000	0.316	0.000
R^2	0.278		0.100	

Note: * 10% significance level, ** 5% significance level, and *** 1% significance level.

Indirect paths should be constructed to understand how energy expenditure influences secondary explanatory factors (step 4). In 2008, energy expenditure significantly affected income, urbanization, health, and education expenditures. On the other hand, in 2017, energy expenditure significantly affected income, health, and education expenditures. The results show that using wood for heating has no significant relationship with energy expenditure in the two years and that when a household chooses to spend more on energy services, the tendency to use wood for heating decreases. In general, in the model, energy expenditure alone did not influence HDI in Jordan in 2008 but only in 2017. It is also noted that increasing the spending on energy affects HDI negatively.

Regarding the secondary explanatory variable effect on the dependent variable, in 2008, urbanization was the most significant effect on HDI, while in 2017, average annual income significantly affected HDI. The shift from urbanization to income indicates that in Jordan, while the urbanization level stabilized in recent years, income became more vital in determining the value of HDI. Energy expenditure only had a significant effect on HDI in 2017.

Direct and indirect impacts on HDI

In the previous section, the strength of the paths was identified. In this step, the territorial impacts of energy expenditure are identified. Here, the reason behind identifying the paths' strengths is to understand whether energy expenditure directly or indirectly (through the secondary explanatory variables) impacts human well-being. β coefficient values of the binary regression are broken into two parts (direct and indirect). Table 7 lists the results.

Table 7. The roles of the direct and indirect paths in explaining the HDI.

	HDI, 2008	HDI, 2017
Indirect	0.543	1.105
Direct	-0.016	-0.789
Total	0.527	0.316

The direct effect of energy expenditure on HDI over the two years is negative. While appropriate path parts are multiplied, indirect paths may pass across the primary and secondary variables, combined from the beginning to the dependent variable (irrespective of significance). In 2008, the indirect effect was calculated as follows: (0.751*-0.214) + (-0.332*-0.243) + (0.563*0.731) + (0.846*-0.316) + (0.803*0.664) = 0.543. On the other hand, in 2017, it is calculated as follows: (0.666*1.072) + (-0.107*0.428) + (0.427*0.303) + (0.528*-0.126) + (0.666*0.562) = 1.105.
The results of the path analysis show that the indirect effect of energy expenditure through other economic and social factors is more significant than the direct effect. The results indicate that human well-being will improve if energy expenditure is accompanied by increased income, enhanced health and education, and urbanization development. Since the indirect impacts are more significant, the change in the explanatory variable will take longer for the impacts to affect the HDI.

2.3. Conclusions

This chapter asked several questions related to energy consumption, economic growth, climate change, and Human well-being. The first part of the chapter employed the Toda-Yamamoto causality test on annual data from 1990-2018. This part was concerned with offering a better understanding of the situation at the national level and how each factor can impact the other. On the other hand, the second part studied the relationships between energy expenditure and HDI considering several socio-economic factors (secondary explanatory factors). The analysis was based on cross-sectional data from two Jordanian surveys from 2008 and 2017.
The Toda-Yamamoto non-Granger causality test showed that energy consumption in Jordan causes economic growth and greenhouse gas emissions. The results back the growth hypothesis, which means that if Jordan continues in the growth process, energy will play an essential role. Moreover, while the energy mix in Jordan is still dominant in fossil fuel, more emissions will be released from consumption. Policies in Jordan should focus on offering incentives for adopting renewable energy, upgrading the energy network, decentralizing the energy sector through energy community initiatives, and improving energy efficiency. Such improvements would decrease GHG emissions and ensure healthy economic development.
Path analysis results showed that energy expenditure in Jordan does not directly play a role in HDI. On the other hand, the relationship is more significant through the indirect explanatory variables. In 2008, urbanization was the primary significant explanatory variable where energy expenditure in urban areas enhances the HDI, while in 2017, this relationship shifted from urbanization to total annual income. Moreover, while the total indirect effect on HDI increased in 2017, the direct impact became higher, and the results of the total effect showed a decrease between the two years. Based on the findings, if people in Jordan spend more on household energy due to increased consumption, it will reduce their well-being because it has a negative relationship with the Human Development Index (HDI). However, combining energy expenditure with other factors like income, health, and education expenditure will have a positive effect in the long term. Still, it will

take longer to see the results. Improving the quality of education and universal health services alongside growth in income levels would enhance the level of human well-being in Jordan.

3. Measuring Energy Poverty in Jordan using the Multidimensional Approach

Energy poverty is a complex and multifaceted issue affecting individuals, households, and communities worldwide. It refers to the inability of people to afford or access sufficient energy to meet their basic needs and can have severe consequences for health, education, and economic development. In this chapter, I aim to measure energy poverty in Jordan using a multidimensional energy poverty index (MEPI) developed by Nussbaumer, Bazilian, and Modi (2012). Specifically, I seek to answer the following questions: What characteristics of energy poverty in Jordan are based on the multidimensional energy poverty index? Did energy poverty decrease between 2009 and 2018 as a timeframe of the study? Do Jordanian households benefit more from solar energy as a source of energy? And What are the territorial differences regarding energy poverty in Jordan?

I will use data from the Demographic and Health Survey (DHS) conducted by the Jordanian Department of Statistics in 2009 and 2017-2018 to address these questions. The DHS provides detailed information on households' health, fertility, and socio-economic profiles, including indicators of multidimensional energy poverty. I will use the capabilities approach and the MEPI to measure energy poverty in the Jordanian governorates and examine the urban and rural areas to understand any differences in energy poverty between these two regions.

The analysis builds on the previous chapter, which examined the relationship between energy expenditure and human well-being in Jordan and showed that other intermediatory factors facilitated the relationship between these variables. By measuring energy poverty in Jordan using a multidimensional approach, I aim to provide a nuanced understanding of the issue and its impacts on the country's individuals, households, and communities. However, it is worth noting that the availability of data and the need for sufficient literature on energy poverty in Jordan force limitations on this study.

The previous chapter examined the relationship between energy expenditure and human well-being to connect expenditure patterns in the Jordanian governorates to human development while considering other socio-economic factors using path analysis. The results showed that human well-being in Jordan is not related directly to energy expenditure (consumption); other intermediatory factors facilitated the relationship. Energy poverty must be measured after setting the broader context of Jordan's energy situation. This chapter is concerned with measuring energy poverty in Jordan, recognizing the multidimensional nature of the issue. In contrast, using the subjective approach, the next chapter measures fuel poverty in one governorate.

Results and Discussion

3.1. Estimation of energy poverty in Jordan

A MEPI was estimated for Jordan in 2009 and 2018. Moreover, the index was calculated for the governorates, wealth index, and urban/rural levels. Figure 6 and Figure 7 show the spatial distribution of the MEPI at the governorate level for 2009 and 2018, respectively. The results indicate that the MEPI in Jordan was 0.20 in 2009 and 0.21 in 2018. The results reveal that the MEPI has increased by 0.01 during the nine years between the two surveys. However, if MEPI<0.6, households suffer moderate energy poverty (Nussbaumer et al., 2012).

Nonetheless, with an average of 0.20 over nine years, energy poverty means the issue is persistent and not truly realized. Ignoring energy poverty can lead to unfavorable consequences in the future.

Energy poverty is connected to social welfare, other factors such as the socio-economic situation of households, and environmental impacts such as climate change. Considering the headcount ratio results, it shows that 53% of the population in 2009 experienced energy poverty, which increased in 2018 to 60%. In addition, energy poverty intensity results indicate that the severity of energy poverty decreased between the two years from 0.38 to 0.36, suggesting that poverty among poor households or individuals is relatively severe. Table 8 lists more details regarding the values of the headcount ratio, intensity of energy poverty, and the MEPI.

Table 8. Detailed MEPI results in Jordan, governorates, and the urban/rural levels.

Comparison Level/Year	Headcount Ratio (*H*)		Intensity of Energy Poverty (*A*)		MEPI	
	2009	2018	2009	2018	2009	2018
Jordan	0.53	0.60	0.38	0.36	0.20	0.21
Mafraq	0.65	0.78	0.38	0.36	0.25	0.28
Zarqa	0.52	0.63	0.39	0.39	0.20	0.24
Jerash	0.56	0.71	0.38	0.32	0.22	0.23
Madaba	0.51	0.62	0.38	0.38	0.19	0.23
Ma’an	0.54	0.61	0.39	0.36	0.21	0.22
Balqa	0.51	0.55	0.40	0.38	0.20	0.21
Tafila	0.52	0.56	0.38	0.37	0.19	0.21
Ajloun	0.49	0.62	0.38	0.32	0.19	0.20
Karak	0.60	0.56	0.39	0.37	0.23	0.20
Aqaba	0.51	0.56	0.39	0.35	0.20	0.20
Irbid	0.47	0.56	0.38	0.34	0.18	0.19
Amman	0.44	0.46	0.38	0.37	0.17	0.17
Urban	0.48	0.59	0.38	0.36	0.18	0.21
Rural	0.62	0.64	0.38	0.36	0.24	0.23

Amman and Irbid are the least multidimensionally energy-poor regions in both years, with a MEPI value of 0.17 and 0.18, respectively. Mafraq, a governorate in the country’s northern region, has the highest MEPI values of 0.25 and 0.28 in 2009 and 2018, respectively. The city of Mafraq accommodated the biggest refugee camp in the country, which was established after the civil war in Syria. The sudden increase in the number of inhabitants placed pressure on resources and opportunities in Jordan. Zarqa witnessed a rise in the MEPI of 0.04; in Karak, the MEPI decreased by 0.03. It is worth noting that Amman is the densest governorate in the country.

Regarding urban/rural residences, the results show that the energy poverty of urban residences increased by 0.03. However, rural homes show a decrease in energy poverty of 0.01. It is worth noting here that 0.98 of the population lives in urban areas, which means that an increase in energy poverty is not a good sign regarding development, among the other social circumstances of the urban areas. The results also show that the differences between urban and rural areas regarding modern and sustainable energy availability are insignificant.

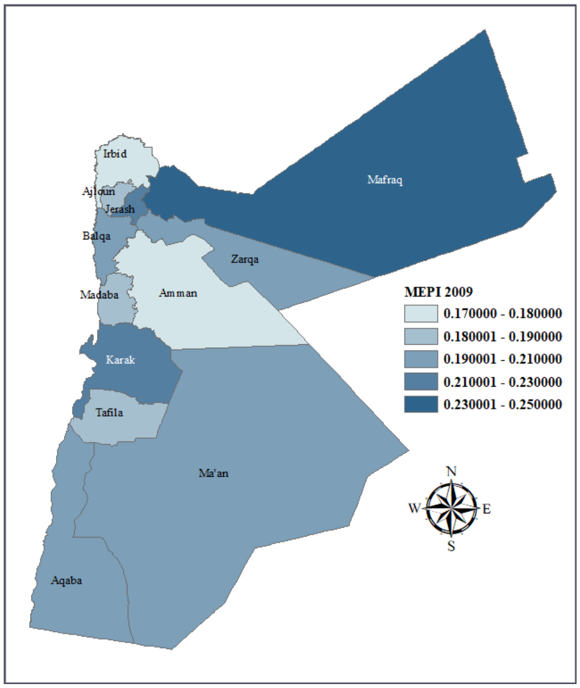

Figure 6. MEPI Results in Jordan for the year 2009.

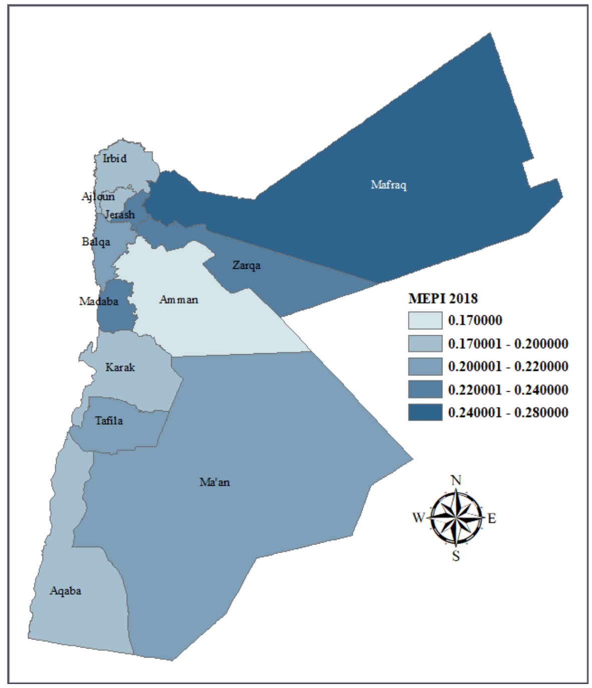

Figure 7. MEPI Results in Jordan for the year 2018.

.

Several governorates displayed noticeable changes in MEPI from 2009 to 2018. Nine of the twelve governorates demonstrated an increase in MEPI during this period. Interestingly, Amman and Aqaba did not experience any significant change in MEPI between 2009 and 2018, while Karak showed a slight improvement. The MEPI displayed varying trends over the study period across different wealth categories. Notably, the poorest category showed a decrease in MEPI, declining from nearly 0.36 to approximately 0.25.

On the other hand, the poorer category experienced a smaller decrease. However, the remaining categories exhibited an increase in MEPI. While an increase in the MEPI might not be an ideal indicator of household economic conditions, it was evident that the differences between the various wealth categories reduced over time.

3.2. Conclusions

Multidimensional energy poverty was examined in this chapter for the years 2009 and 2017/2018. In addition, the main factors affecting energy poverty were tested using the binary logistic regression for 2017/2018 survey data. Despite the well-established literature on energy poverty, there is still a research gap on the situation and extent of energy poverty in the Middle East and Jordan. The results revealed that the MEPI in Jordan slightly increased between 2009 and 2018, expressly by 0.01. Considering these results, it can be concluded that Jordanian households suffer from moderate energy poverty. Furthermore, the results indicated that energy poverty might increase if not addressed early. The problem of energy poverty is linked to many other issues, such as climate change, health, and social justice.

In addition, the spatial distribution of energy poverty was estimated. The results showed that disparities between Jordan's governorates are not high. However, nine governorates witnessed an increase in energy poverty, especially in Mafraq, a region that hosts the largest refugee camp in the country. Amman and Aqaba saw no change, while Karak's energy poverty decreased. Urban areas showed increased energy poverty, while rural areas showed the opposite. Finally, energy poverty based on the wealth index was estimated. The results revealed variations between the two years of concern. Poor houses showed an improvement in energy poverty, living conditions, and ownership of modern energy means. On the other hand, the rich showed signs of increased energy poverty, which requires more research and indicates a continuous decrease in inequalities between different social levels.

Based on the results discussed earlier, the following recommendations are suggested to identify energy poverty in Jordan:

1. Include the concept of energy poverty in the national energy plan by identifying the scope of energy poverty within the context of Jordan. The current Jordan Energy Strategy and Energy Efficiency Plan do not mention energy poverty. On the contrary, it only focuses on energy efficiency, which is not the only determining factor of energy poverty.
2. Assess the differences in residential energy consumption during the different seasons to better understand the impacts of climate variations on household energy consumption.
3. It is recommended to start collecting fuel/energy poverty data by adding more questions to the national surveys about utility bill arrears and coping with indoor ambient temperatures during the summer and winter. The MEPI lacks information on this because it tries to capture energy poverty through the lens of available energy services and does not consider other factors or dimensions.
4. It is recommended to broaden the programs launched by the government to support poor people in improving house efficiency by creating house renovation fund programs.
5. The results suggest a revision of current energy subsidy programs to benefit energy-poor households and increase the support to families that utilize solar energy for electricity generation.

The results prove that energy access does not necessarily mean that energy poverty is alleviated; however, achieving energy access can solve this issue. The problem of energy poverty is still not fully realized at the household and policymaker levels. The empirical results of this study shed light on the need to understand better the causes and effects of energy poverty on Jordanian households. Further studies are needed to understand the socio-economic factors, health impacts, financial burdens, or, more precisely, the multidimensional impacts of energy poverty on Jordanian households.

4. Quantifying Household Energy Poverty Indicators in the Zarqa Governorate Using the Subjective Approach

In chapter three, I estimated the multidimensional energy poverty index, which reflects modern energy services availability at home and the household's capability to achieve these services. The index included data on the type of fuel cooking, indoor pollution, availability of household appliances, telecommunication services, entertainment devices, and sustainable energy sources utilized in the household.

This chapter aims to fill the gap in fuel poverty in Jordan and understand the significant factors that affect fuel poverty in Jordanian houses. The importance of this chapter is represented by not focusing on income and energy expenditure as the main factors of energy poverty but also the significant characteristics of homes' energy efficiency, thermal comfort, and financial difficulties related to not being able to pay utilities on time. Additionally, this chapter addresses the characteristics of energy poverty in the summer and winter seasons. Finally, the outcomes of this study will motivate the movement beyond traditional energy poverty assessment that focuses on energy access represented by electricity access or the type of cooking fuel.

In this chapter, I seek to answer the following questions: What are energy efficiency characteristics in the sample households? What is the difference between summer and winter regarding reported energy poverty in the sample households? How are arrears on utility bills connected to other energy poverty subjective indicators and income levels? What are the socio-economic determinants of subjective energy poverty in the sample households?

4.1. Findings

4.1.1. Utility arrears in the past 12 months

The question about this indicator is, "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?". The results show that 64.7% of the respondents reported having utility arrears during the last twelve months, while the rest had no problems paying the bills.

4.1.2. Characteristics of Households' Energy Efficiency

The study uses three questions to identify issues related to the energy efficiency status of households, focusing on the presence of humidity, poor ventilation, leaks, dampness, and rotting window frames. The descriptive results of the responses are summarized in Table 9.

Table 9. Subjective characteristics of Households' energy efficiency

The dimension	Yes	No
Does the household suffer from humidity	288 (**61.1%**)	184 (38.9%)
Does the household suffer from Poor ventilation of the dwelling	157 (33.2%)	316 (**66.8%**)
Does the household suffer from a leaking roof, damp walls/floors/foundation, rot in window frames or floor	336 (**71.1%**)	137 (28.9%)

As shown in the table, despite 61.1% of the respondents reporting humidity, 66.8% report good ventilation in their households. In addition, the results also indicate that 71.1% of households suffer from leaking roofs, damp walls/floors/foundations, or rotting window frames.

4.1.3. Characteristics of Summer Energy Poverty

Regardless of the literature on winter fuel poverty, this study tries to capture both summer and winter characteristics. This section discusses summer energy difficulties and then moves to winter-related ones. The questions related to summer are if the household suffers from high temperatures during summer, whether the household can keep the household cool during summer, and whether the household members have difficulty sleeping due to feeling too hot.

Table 10 summarizes the descriptives of the mentioned questions. The table shows that 85.8% of the respondents' households suffer from high temperatures during summer, 64.5% cannot afford to keep their homes adequately cool, and 65.2% have difficulties sleeping due to feeling too hot.

Table 10. Subjective characteristics of summer energy poverty

The dimension	Yes	No
High temperatures during summer	405 (**85.8%**)	67 (14.2%)
Can your household afford to keep its home adequately cool?	176 (35.5%)	305 (**64.5%**)
In the past twelve months, have the household members had any difficulties sleeping due to feeling too hot?	308 (**65.2%**)	164 (34.8%)

4.1.4. Characteristics of Winter Energy Poverty

Understanding the difference between summer and winter energy difficulties is essential. It can lead to better formulation of policies that fit the Jordanian context and help predict the possible adaptation measures to respond to future climate change. The same questions were used, but this time focusing on Winter times. Table 11 summarizes the descriptive statistics. The results show that despite 65.3% of the households being cold during winter, only 36.8% had difficulties sleeping due to feeling cold.

Table 11. Subjective characteristics of winter energy poverty

The dimension	Yes	No
Cold and difficult to heat during winter	308 (**65.3%**)	164 (34.7%)
Can your household afford to keep its home adequately warm?	222 (46.9%)	251 (**53.1%**)
In the past twelve months, have the household members had difficulties sleeping due to feeling too cold?	174 (36.8%)	298 (**63.2%**)

4.1.5. The association between variables, utility arrears under the lens

Since the variables of interest are categorical, the relationship is tested using the crosstabulation function with Pearson's chi-square test. Contingency tables compare observed frequencies with expected ones (Field, 2017). In this section, there is an interest in comparing how respondents describe the characteristics of energy poverty. Thus, this section will compare the data collected about utility arrears with those collected on some energy poverty characteristics.

- *Utility arrears vs. the presence of roof leaks/wall damps/rot window frames*

Table 12 shows the contingency table between the two variables. The outcomes indicate that 79.3 percent of the respondents with utility arrears suffer from a leaking roof, damp walls, or a rot window frame. However, around 55 percent of respondents who suffer from the issue have no problems with utility arrears. The chi-square test value is 29.313, with a significance level of <0.001; this result indicates that utility bill arrears are significantly associated with poor household efficiency. Testing the strength of association revealed that the Phi value is 0.249 and $P<0.0001$, indicating a statistically significant association between the two variables. In addition, the relationship is positive, meaning that the relationship between the variables is direct and moderate.

Table 12. Utility arrears vs. the presence of leaks, damp, or rot.

			presence of leaks, damp, or rot		Total
			Yes	No	
Utility arrears	Yes	Count	242	63	305
		% within Utility arrears	79.3%	20.7%	100.0%
	No	Count	93	74	167
		% within Utility arrears	55.7%	44.3%	100.0%
Total		Count	335	137	472
		% within Utility arrears	71.0%	29.0%	100.0%

- *Utility arrears vs. the ability to keep the household adequately cool.*

Comparing the utility bills arrears with the ability to cool the household shows that only 20.9 percent of the households suffering from arrears can afford to cool, while 79.1 percent cannot. At the same time, 62.3 percent of the respondents who can cool their households do not have arrears on utility bills. The chi-square value is 80.697 with a significance level of <0.001; this result indicates that utility bill arrears are significantly associated with the ability to cool the household. Table 13 shows more details on the associated relationship. The Phi value of the test (-0.413) and significant (P-value<0.0001) indicates that the relationship between the two variables is inversely moderate.

Table 13. Utility arrears vs. the ability to keep the household adequately cool.

			Ability to keep home adequately cool		Total
			Yes	No	
Utility arrears	Yes	Count	64	242	306
		% within Utility arrears	20.9%	79.1%	100.0%
	No	Count	104	63	174
		% within Utility arrears	62.3%	37.7%	100.0%
Total		Count	168	305	473
		% within Utility arrears	35.5%	64.5%	100.0%

- *Utility arrears vs. the ability to keep the household adequately warm*

When examining the responses related to keeping the household warm, Table 14

Table *14* shows that 74.3 percent of the respondents reported that they could heat their household with no utility arrears. On the other hand, 68.2 percent of those with bills in arrears cannot heat their homes adequately. The chi-square value is 78.093 with a significance level of <0.001; this result indicates that utility bill arrears are significantly associated with the ability to warm the household. Like the ability to keep the household cool, the Phi value (-0.407) shows an inverse significant moderate association between the variables with a p-value<0.0001.

Table 14. Utility arrears vs. the ability to keep home adequately warm.

			Ability to keep home adequately warm		**Total**
			Yes	No	
Utility arrears	Yes	Count	97	208	305
		% within Utility arrears	31.8%	68.2%	100.0%
	No	Count	124	43	173
		% within Utility arrears	74.3%	25.7%	100.0%
Total		Count	221	251	472
		% within Utility arrears	46.8%	53.2%	100.0%

- *Characteristics of income levels and fuel poverty.*

The questionnaire respondents were asked to report their income within seven categories. In Jordan, the minimum monthly wage is 260 Jordanian Dinars (JOD) according to 2022 regulations. Among the respondents, those with a monthly income of 261 – 400 JOD have a higher ratio of utility arrears, followed by those whose income is less than 260 JOD. The chi-square value is 58.187, with a p-value of <0.0001. In the income level, Cramer's V was estimated, and the results revealed a direct significant moderate relationship with a value of 0.351 and P-value<0.0001. Table 15 details the association between income level and utility arrears.

Table 15. Utility arrears vs. income levels

			Total disposable income							
			< 260 JOD	261 – 400 JOD	401 – 550 JOD	551 – 700 JOD	701 – 850 JOD	851 – 1000 JOD	>1000 JOD	Total
Utility arrears	Yes	Count	62	98	49	40	24	22	10	305
		% within utility arrears	20.3%	32.1%	16.1%	13.1%	7.9%	7.2%	3.3%	100 %
	No	Count	7	37	30	20	27	15	30	166
		% within utility arrears	4.2%	22.3%	18.1%	12.0%	16.3%	9.0%	18.1%	100 %
Total		Count	69	135	79	60	51	37	40	471
		% within utility arrears	14.6%	28.7%	16.8%	12.7%	10.8%	7.9%	8.5%	100 %

4.1.6. Composite measurement of energy poverty in Zarqa governorate

Calculating the composite index of energy poverty in Zarqa governorate yielded a significant result. This framework operates under the assumption that relying solely on consensual measures, such as self-reported inability to maintain adequate warmth, is inadequate for comprehensively grasping the intricate economic and material foundations of energy poverty. Hence, it advocates the incorporation of supplementary indicators elucidating the housing and financial circumstances of the populace to achieve a more comprehensive and holistic understanding (Bouzarovski, 2014; Dubois, 2012).

The results of estimating the Energy Poverty Index are listed in Table 16. In general, when using an equal weight for all the indicators, energy poverty is high (64.27). On the other hand, when the Inability to cool during summer takes a weight of 0.5 and is used with arrears (0.25) and house faults (0.25), energy poverty increases slightly to 66.97. In contrast, when focusing on the inability to warm the household, energy poverty decreases to levels lower than the general index (61.58). In general, the results are relatively stable in all three cases, while it is important to note that summer energy poverty is higher than in the winter season.

Table 16. Energy Poverty composite levels in Zarqa governorate.

	$Inability_W$	$Inability_S$	Arrears	House faults	EPI
Equal Weights (0.25)	0.14	0.16	0.17	0.18	64.27
Summer EPI		0.32	0.17	0.18	**66.97**
Winter EPI	0.27		0.17	0.18	61.58

4.1.7. Determinants of fuel poverty indicators in Zarqa governorate

Four logistic regression models were built to determine the factors that affect the occurrence of arrears on utility bills, the household's inability to pay to keep the home adequately warm or cool, and the presence of leaks, dampness, or rot. Following the literature, the backward likelihood ratio is advised as it enters all the variables in the first step of the analysis and removes the variables that can affect the model fit to observed data (Field, 2009; Thomson and Snell, 2013). The explanatory variables were selected based on the literature and the interest in exploring the relationship of new variables to fuel poverty. In each model and by using the backward likelihood ratio, we aimed to include different socio-economic variables in the initial model and allow SPSS to eliminate the variables with no relationship to the dependent variable. As mentioned earlier, this study aims to explore the factors that can influence the fuel poverty different characteristics in Zarqa Governorate. Thus, instead of including only those cited in the literature, we included new factors in each model. For clarity, all the factors entered in the model's first step are mentioned under the results tables.

- *Modeling the determinants of arrears on utility bills.*

A logistic regression uses sociodemographic variables to predict if a household will struggle with utility arrears. According to **Table *17***, the model chi-square result suggests that the overall model is statistically significant and that the predictors are related to the outcome value. The -2 log-likelihood result indicates that the model fits the mode well, whereas Nagelkerke's R-square revealed that the model explains 40.6% of the variance in the dependent variable. Lastly, the Hosmer and Lemeshow Test results indicate that the logistic regression model fits the observed data well.

Table 17. Logistic regression model statistics to predict utility arrears.

		df	significance
Model chi-square	165.379	22	0.000
-2 log-likelihood	448.008		
Nagelkerke R Square	0.406		
Hosmer and Lemeshow Test	9.142	8	0.330

The results indicated that living in Table 18 a rural area increases the odds of utility arrears by 39.9% more than living in urban areas. The results also suggest that homes not using solar energy to produce electricity have a higher odd of 31.52% of experiencing utility arrears, which indicates

that households who manage to install solar panels to produce electricity can save money compared to those who don't have such technology Additionally, retired household heads decrease the odds of having utility arrears by 2.56% compared with employed household heads. On the other hand, economically inactive or unemployed households cannot predict utility arrears.
Compared to income levels less than 260 JOD, the odds of experiencing utility arrears decrease with increasing income levels; the relationship is significant except for households with 551 – 700 JOD and 851 – 1000 JOD. Income levels and occupation of the head results suggest that increasing the minimum wages and improving life quality can help households escape fuel poverty by decreasing the chances of having utility arrears. In addition, leaks, dampness, rot, and the inability to cool or warm the households increase the odds of having utility arrears more than in households without such problems. The results indicate that if a household has one of the difficulties related to fuel poverty, it will have a higher chance of suffering from all other energy-related hardships.

Table 18. Logistic regression model to predict utility arrears.

	B	Sig.	95% C.I.for EXP(B)		
			Lower	Exp(B)	Upper
Rural (1 = yes)	1.383	0.000	1.85	3.989	8.598
Using solar energy to generate electricity (1 = no)	1.148	0.024	1.166	3.152	8.524
Occupation of the head of the head		0.063			
Unemployed	0.247	0.694	0.375	1.28	4.365
Economically Inactive	-0.601	0.293	0.179	0.548	1.679
Retired	-1.363	0.014	0.086	0.256	0.761
Source of Income		0.117			
Household business	1.024	0.019	1.186	2.785	6.542
Pensions	1.13	0.051	0.995	3.097	9.633
Remittances from country or abroad	0.63	0.473	0.336	1.877	10.5
Other	0.205	0.707	0.422	1.227	3.574
Total disposable income		0.003			
261 – 400 JOD	-0.869	0.093	0.152	0.419	1.157
401 – 550 JOD	-1.154	0.037	0.107	0.315	0.933
551 – 700 JOD	-0.79	0.174	0.145	0.454	1.417
701 – 850 JOD	-1.756	0.003	0.054	0.173	0.549
851 – 1000 JOD	-0.731	0.237	0.143	0.481	1.617
More than 1000 JOD	-2.306	0.000	0.028	0.1	0.354
Ability to keep home adequately warm (1 = no)	0.875	0.002	1.377	2.398	4.175
Ability to keep home adequately cool (1 = no)	1.185	0.000	1.904	3.271	5.62
presence of leaks, damp, or rot (1 = yes)	0.522	0.045	1.011	1.685	2.808
Constant	-1.118	0.141		0.327	

Variable(s) entered on step 1: District, Urban/rural, Type of dwelling, Tenure type, Dominant means of cooling, Main source of heating, Does the dwelling use solar energy to generate electricity? Occupation of the head, Source of Income, Total disposable income, can your household afford to keep its home adequately warm? Can your household afford to keep its home adequately cool? Presence of leaks, damp, or rot.

- *Determinants of the ability to cool*

In Table 19, the binary logistic regression model results suggest that the model is statistically significant (Chi-square = 215.645, $p < 0.001$), indicating that the independent variables included in the model are collectively associated with the ability to pay to cool home. The -2 log-likelihood of 398.459 shows an acceptable model fit to the data. The Nagelkerke R Square of 0.504 suggests that approximately 50.4% of the variance in the dependent variable can be explained by the independent variables included in the model. Moreover, the Hosmer and Lemeshow Test results indicate that the logistic regression model fits the observed data well.

Table 19. Model statistics of the ability to pay to keep the household adequately cool.

		df	significance
Model chi-square	215.645	13	0.000
-2 log-likelihood	398.459		
Nagelkerke R Square	0.504		
Hosmer and Lemeshow Test	11.024	8	0.200

The results in Table 20 revealed that the coefficients of the variables Arrears on utility bills in the last twelve months, High temperatures during summer, and Difficulty sleeping due to feeling hot increase the odds of difficulty keeping the home cool and are statistically significant at the 0.05 level. Being retired, compared to being employed, shows a statistically significant association with a higher likelihood (2.104 times higher odds) of being unable to keep the household cool. In addition, households with a larger area in the range of 100-199 m^2 and 200-299 m^2 exhibit a statistically significantly higher likelihood of keeping the household cool compared to households with an area less than 50 m^2. Moreover, households with incomes in the 261-400 JOD and 851-1000 JOD range showed a statistically significantly higher likelihood of maintaining a cool household compared to households with incomes less than 261 JOD. However, income ranges of 401-550 JOD, 551-700 JOD, 701-850 JOD, and more than 1000 JOD did not demonstrate a significant relationship with the ability to keep the household cool.

Table 20. Logistic regression results of the factors affecting the ability to keep the household cool.

	B	Sig.	95% C.I.for EXP(B)		
			Lower	Exp(B)	Upper
Occupation of the head of the head		0.045			
Unemployed	-0.692	0.200	0.173	0.5	1.444
Economically Inactive	-0.253	0.665	0.247	0.777	2.44
Retired	0.744	0.022	1.111	2.104	3.981
Total disposable income		0.049			
261 – 400 JOD	-1.084	0.045	0.117	0.338	0.976
401 – 550 JOD	-0.964	0.099	0.121	0.381	1.201
551 – 700 JOD	-0.113	0.854	0.268	0.893	2.98
701 – 850 JOD	-0.643	0.297	0.157	0.526	1.76
851 – 1000 JOD	-1.702	0.009	0.051	0.182	0.657
More than 1000 JOD	-0.883	0.184	0.113	0.414	1.519
Arrears on utility bills in the last twelve months (1 = yes)	1.471	0.000	2.566	4.354	7.388
Difficulty sleeping due to feeling hot (1 = yes)	1.875	0.000	3.719	6.518	11.424

High temperatures during summer (1 = yes)	1.351	0.000	1.806	3.859	8.246
Dwelling Area		0.000			
100 199 m^2	-1.129	0.005	0.148	0.323	0.705
200 – 299 m^2	-2.267	0.000	0.037	0.104	0.287
More than 300 m^2	-1.083	0.150	0.078	0.339	1.478
Constant	-0.743	0.281		0.475	

Variable(s) entered on step 1: District, Urban/rural, Does the dwelling use solar energy to generate electricity? Occupation of the head, Source of Income, Total disposable income, a leaking roof, damp walls/floors/foundation, rot in window frames or floor, Utility arrears in the past 12 months, hot/difficulties sleeping, High temperatures during summer, area of the dwelling.

- *Determinants of the ability to heat*

The binary logistic regression model results in **Table *21*** revealed a significant chi-square value of 206.838 and a p-value of 0.000, indicating that the model is statistically significant. The -2 log-likelihood of 445.995 shows an acceptable model fit to the data. The Nagelkerke R Square suggests that approximately 47.4% of the variance in the dependent variable can be explained by the independent variables included in the model. Furthermore, the Hosmer and Lemeshow Test results indicate that the logistic regression model fits the observed data well.

Table 21. Model statistics of the ability to pay to keep the household adequately warm.

		df	**significance**
Model chi-square	206.838	13	0.000
-2 log-likelihood	445.995		
Nagelkerke R Square	0.474		
Hosmer and Lemeshow Test	6.339	8	0.609

The results in Table 22 revealed that households not using solar energy have less chance of having heating difficulties during winter. Still, the significance of the relationship is slightly low (>0.05). As the results previously showed, difficulties in warming the household are significantly related to leaks, dampness, rotting window frames, and arrears on utility bills. In terms of dwelling area, the results show that compared to households with 50-100 m2, larger households will have less likelihood of having difficulties warming the household, but with odds ratios that are very low. Moreover, households with difficulty heating during winter and their members having difficulty sleeping due to feeling cold have a higher likelihood of experiencing difficulties in warming their households properly by increasing the odds by 41.58% and 33.09%, respectively.

Table 22. Logistic regression results of the factors affecting the ability to keep the household warm.

	B	**Sig.**	**95% C.I.for EXP(B)**		
			Lower	Exp(B)	Upper
Using solar energy to generate electricity (1 = no)	-1.04	0.065	0.117	0.353	1.068
presence of leaks, damp, or rot (1 = yes)	0.532	0.048	1.005	1.702	2.883
Arrears on utility bills in the last twelve months (1 = yes)	1.361	0.000	2.364	3.900	6.433
Area of dwelling		0.000			
100 199 m^2	-1.503	0.000	0.115	0.222	0.431
200 – 299 m^2	-1.818	0.000	0.067	0.162	0.391
More than 300 m^2	-1.774	0.007	0.047	0.17	0.613

Cold and difficulty of heating during winter (1 = yes)	1.425	0.000	2.515	4.158	6.876
Difficulty sleeping due to feeling cold (1 = yes)	1.197	0.000	1.979	3.309	5.532
Constant	-0.212	0.751		0.809	

Variable(s) entered on step 1: District, Urban/rural, Does the dwelling use solar energy to generate electricity? Occupation of the head, Source of Income, Total disposable income, a leaking roof, damp walls/floors/foundation, rot in window frames or floor, Utility arrears in the past 12 months, area of the dwelling, Main source of heating, Cold, and difficulty of heating during winter, Cold/difficulties to sleep, type of dwelling.

- *Determinants of the presence of leaks, damp, or rot*

Table 23 shows that the model statistics and fit are statistically significant. Moreover, the Nagelkerke R Square suggests that the independent variables included in the model can explain approximately 46.9% of the variance in the presence of leaks. Finally, the Hosmer and Lemeshow Test results indicate that the logistic regression model fits the observed data well.

Table 23. Model statistics of the presence of leaks, damp or rot

		df	significance
Model chi-square	192.820	15	0.000
-2 log-likelihood	375.391		
Nagelkerke R Square	0.479		
Hosmer and Lemeshow Test	6.202	8	0.625

Modeling the determinants of leaks, dampness, or rot in Table 24 revealed that compared to the employed head of the household, other categories decrease the odds of having the problem, and the retired head category shows a significant relationship. The results indicate that homes with utility arrears, humidity problems, and poor ventilation have increased odds of having leaks, damp, or rot issues. For instance, humidity has increased the odds by 140%, increasing the probability of leaks, dampness, or rot in the household. Finally, compared to household salaries and wages, households with income sources "business or pensions" have higher odds of having issues related to leaks.

Table 24. Logistic regression results of the factors affecting the presence of leaks, damp, or rot.

	B	Sig.	95% C.I.for EXP(B)		
			Lower	Exp(B)	Upper
Occupation of the head of the head		0.099			
Unemployed	-0.637	0.280	0.167	0.529	1.679
Inactive economically	-1.192	0.066	0.085	0.304	1.081
Retired	-1.233	0.030	0.096	0.291	0.888
Source of Income		0.041			
Household business	0.983	0.033	1.082	2.671	6.596
Pensions	1.557	0.008	1.511	4.747	14.915
Remittances from country or abroad	0.388	0.714	0.185	1.474	11.763
Other	1.109	0.091	0.839	3.032	10.961
Arrears on utility bills in the last twelve months (1 = yes)	0.899	0.001	1.45	2.458	4.169
Humidity (1 = yes)	2.641	0.000	8.053	14.023	24.417
Poor ventilation of the dwelling (1 = yes)	0.88	0.013	1.201	2.41	4.836
Constant	-1.23	0.000		0.292	

Variable(s) entered on step 1: District, Urban/rural, Does the dwelling use solar energy to generate electricity? Occupation of the head, Source of Income, Total disposable income, Utility arrears in the past 12 months, area of the dwelling, Main source of heating, type of dwelling, Can your household afford to keep its home adequately warm? Can your household afford to keep its home adequately cool? Cold and difficulty of heating during winter, High temperatures during summer, Humidity, and Poor ventilation of the dwelling.

4.2. Discussion and Conclusions

The present chapter aimed to examine households' energy poverty indicators by surveying the self-reported summer and winter fuel poverty indicators, observe the association between different subjective indicators and income and arrears on utility bills, and evaluate the factors determining the possibility of fuel poverty with the respondents' group in the Zarqa governorate. The results shed light on several key issues related to fuel poverty and energy efficiency in the Zarqa governorate.

One significant finding of this chapter is that respondents' households suffer from problems related to building efficiency. Even when the respondents report good ventilation in their homes, they still face humidity-related issues and a leaking roof, damp walls/floors/foundation, or rot window frames. This indicates that households in the Zarqa governorate face significant challenges related to building conditions, which can contribute to higher energy usage and fuel poverty.

The results also highlight the significant impact of summer-related energy problems on households in the Zarqa governorate. Many households reported suffering from high temperatures in the summer season but cannot afford to cool down. This not only affects their comfort but also poses sleep difficulties. It also shows that many households cannot afford to cool down even if they recognize that they suffer from high temperatures in the summer season. Even though most respondents reported that they suffer from cold indoor temperatures and difficulties adequately warming, most do not have problems sleeping due to feeling cold. This difference might be referred to as the fact that people can use different mechanisms to deal with cold rooms by wearing extra layers of clothes (and/or) using extra blankets to warm themselves. It is worth noting that the heating system in Jordan, as shown previously, is centered around using gas and kerosene heaters, which are portable devices usually used in one or two rooms in the house, leaving the rest of the rooms unheated.

Moreover, unlike in summer, in winter, people cannot keep heaters on while sleeping, so they turn them off to avoid the risk of suffocating or burning the house. In addition, the Energy Poverty Index was calculated using four indicators that reflect seasonal differences represented by the ability to heat or cool the household, arrears on utility bills, and house faults. The results revealed that using the index energy poverty levels are high, especially in summer, highlighting the possible impacts of Jordan's climate on people's ability to cope with summer energy needs.

Modeling the determinants of fuel poverty revealed interesting results. For example, utility arrears are more likely to happen in rural areas. In addition, the results also show that income is critical in increasing fuel poverty, as higher-income households are less likely to experience utility arrears. The results showed that when income increases, utility arrears decrease, indicating that a better economic situation means a lower chance of falling into fuel poverty situations. The results indicate that improving household income levels can help eliminate fuel poverty.

Modeling the inability to cool the households revealed similar results to utility arrears regarding the relationship to income. In Jordan, the number and frequency of heat stress days can threaten families in terms of their ability to adequately cool their households in summer (Jaber, 2023). The results also indicate that the inability to cool and warm the household adequately has a negative link to the dwelling size. The results suggest that within the sample, those with smaller dwellings may suffer from issues related to achieving thermal comfort, which is also linked to the household's energy efficiency characteristics. Finally, modeling the presence of leaks, dampness, or rot revealed that this issue is more likely to appear in households with negative energy efficiency characteristics, have arrears on their utility bills, and happen in households relying on pensions and private business as a source of income. The results indicate that the survey respondents generally live in households with poor insulation and cannot afford to maintain a comfortable indoor temperature during the different seasons, which probably leads to higher energy consumption and accumulation of bills. The findings highlight the challenges faced by households in terms of building efficiency and energy affordability, particularly during the summer and winter months. These challenges are more severe for low-income households and those living in rural areas.

Regarding policy interventions, improving building efficiency through insulation and weatherization measures and promoting the use of renewable energy sources could alleviate the burden of energy costs on households. Additionally, targeted subsidies and financial assistance programs could relieve households experiencing fuel poverty. Policies must consider the specific needs and circumstances of vulnerable families in the Zarqa governorate.

In conclusion, while the limitations should be acknowledged, the findings highlight the urgent need to address fuel poverty in the Zarqa governorate and Jordan. Targeted policy interventions are necessary to improve building efficiency and energy affordability, particularly for vulnerable households. Further research is needed to understand the factors contributing to energy poverty and develop practical policy solutions.

5. Conclusions and Policy Recommendations

5.1. Summary

Theories perceive energy in different ways. While environmental economics is the field where the moral approach of allocating resources is counted, natural resources economics has a better recognition for energy economics. Natural resources economics recognizes two dimensions of energy economics: first, energy is a critical input as a power source, and second, energy is a source of pollution.

Through reviewing relevant theories, energy economics shows a better point of view when it comes to energy poverty. I examined how energy demand can determine societies' probability of achieving the desired service. In the review, I showed that energy demand could be understood from two different points of view: microeconomics and macroeconomics. For example, the first is determined by energy use intensity and efficiency, while the latter focuses more on per capita income, GDP, and relative energy prices. Finally, Zweifel, Praktiknjo and Erdmann (2017) argue that energy demand would increase if the population grows, alongside income and economic growth.

In the later parts, I reviewed the energy ladder and energy stacking theories. I showed that the main difference between the two concepts is that the energy ladder shows that when the economic status improves, a household can move from low-quality fuel to a better and cleaner one. On the hand, energy stacking shows that households can switch between different types of fuels as the economic situation may change with time.

In the second chapter of my study, I aimed to examine the interplay between energy poverty, economic growth, and climate change while also considering the theories of environmental and energy economics, as well as energy justice and the energy ladder concept.

To explore these relationships, I employed two distinct approaches. Firstly, I utilized the Toda-Yamamoto non-Granger causality test to analyze the connection between economic growth, energy consumption, and greenhouse gas (GHG) emissions in Jordan. The outcomes of this analysis demonstrated that as energy consumption increases in Jordan, it contributes to economic growth. However, it also leads to a simultaneous rise in GHG emissions, highlighting the environmental challenges associated with energy use. These findings align with environmental and energy economics principles, emphasizing the importance of sustainable energy practices to balance economic development and environmental concerns.

Secondly, while considering energy justice and the energy ladder concept, I delved into the relationship between energy expenditure (as a proxy for energy consumption) and the Human Development Index (HDI). Employing path analysis within the 12 governorates of Jordan, I investigated the direct and indirect associations between energy expenditure and HDI using various socio-economic indicators. The results revealed a negative direct relationship between energy expenditure and HDI, indicating potential energy justice issues where higher energy expenditure does not necessarily translate into improved human well-being. However, the indirect relationship, encompassing intermediate indicators, displayed a positive association. This finding aligns with the energy ladder concept, highlighting the importance of transitioning to cleaner and more sustainable energy sources to enhance human development outcomes. In the third chapter of my study, I employed a modified version of the Multidimensional Energy Poverty Index (MEPI) to assess changes in energy poverty in Jordan between 2009 and 2017. By examining these changes through the capabilities approach and the energy ladder theory lenses, I gained more profound insights into the dynamics of energy poverty in the context of human capabilities and sustainable energy transitions.

The MEPI, incorporating dimensions such as cooking fuel, kitchen location, appliance ownership, access to modern communication means, and the presence of a solar water heater, allowed for a comprehensive assessment of energy poverty. Drawing from the capabilities approach, which emphasizes individuals' freedom to live fulfilling lives, my study recognized the crucial role of access to modern energy services in enhancing human capabilities and well-being.

Analyzing the results of the MEPI, I found that the overall index did not undergo significant changes between the two study years, indicating that energy poverty in Jordan remained relatively stable. However, variations were observed at the governorate, rural/urban, and wealth index levels. Notably, the highest MEPI score was recorded in Mafraq Governorate, suggesting lower energy poverty, while the Capital Region Amman had the lowest score, indicating relatively higher energy poverty levels.

These findings, when viewed through the lens of the energy ladder theory, shed light on the progress made in transitioning to cleaner and more sustainable energy sources. The presence of a solar water heater as a clean energy source in households correlated with higher MEPI scores, reflecting advancements along the energy ladder. Moreover, the slight decrease in MEPI scores in rural areas and the increase in urban areas indicated a potential upward movement within the energy ladder for urban households. The fourth chapter aimed to deepen the understanding of energy poverty in Jordan by examining household energy-related challenges. Due to data limitations, a survey was constructed based on existing literature, and responses were collected from residents of the Zarqa Governorate. Through the analysis of the collected data, several key findings emerged, which can be understood within the frameworks of the energy ladder, energy stacking, energy justice, and the capabilities approach.

The findings revealed poor building energy efficiency as a prominent characteristic of energy poverty, indicating the need for transitioning along the energy ladder towards cleaner and more

efficient energy sources. Additionally, households faced challenges in adequately cooling or warming their homes, suggesting reliance on multiple energy sources, aligning with energy stacking.
Moreover, the results indicated issues related to utility bill arrears and disparities between rural and urban areas, highlighting the relevance of energy justice considerations. Ensuring equitable access to affordable and reliable energy services is crucial to addressing these disparities and promoting household energy justice.
Drawing from the capabilities approach, the findings emphasized the impact of energy-related challenges on individuals' capabilities. Enhancing energy infrastructure and implementing policies that improve energy access can empower individuals to overcome fuel poverty and fully realize their capabilities. Based on the results of my dissertation, I formed the following theses:

H1. Accepted	T1: Energy consumption Granger causes both economic growth and greenhouse gas emissions in Jordan. The analysis confirms the growth hypothesis. Since the relationship is significant, as energy consumption increases, economic growth will increase but at the expense of emitting more GHG emissions.
H2. Partially Accepted	T2a: The path analysis indicates that human development in Jordan is not directly affected by energy consumption, where the relationship is negative and increased between 2008 and 2017. The impact of energy expenditure on human development is slow and takes more time to appear. T2b: Indirect impact of energy expenditure through income, urbanization, health, and education expenditure has a positive impact on HDI, and investing in improving those services would boost HDI in the future. The path analysis also indicates that Jordanian society reacts slowly to new policy adjustments.
H3. Accepted	T3: Based on the MEPI, Jordanian households suffer from moderate energy poverty. Energy poverty may increase if not appropriately addressed and targeted interventions implemented to enhance the capability of Jordanian households to utilize energy effectively.
H4. Partially Accepted	T4: The levels of energy poverty in Jordan vary by governorate, with the highest levels observed in Mafraq, where the largest refugee camp is located. These results highlight the need to consider the unique socio-economic and structural factors contributing to each region's energy poverty when designing and implementing policies and programs to address this issue in Jordan.
H5. Accepted	T5: Households in Zarqa Governorate suffer from poor energy efficiency, represented by humidity and the presence of leaks, wall dampness, and rotting window frames.
H6. Rejected	T6: Energy poverty in summer is more prevalent than in winter in Zarqa Governorate; this was reported as high temperatures, inability to cool efficiently, and difficulty sleeping due to high temperatures.
H7. Accepted	T7: The empirical evidence establishes a clear correlation between income and energy poverty on utility arrears and the inability to cool residential dwellings adequately. Conversely, this correlation lacks significance concerning the inability to heat premises sufficiently and the occurrence of leaks, wall dampness, and deteriorated window frames.

5.2. What is energy poverty, and how the results of this dissertation can be translated in reality?

In this dissertation, I applied multiple methods to assess energy poverty in Jordan. This issue is multifaceted, and thus, to understand it better, especially in the case of Jordan, where the concept is relatively related to the traditional energy access percentage in any developing country.
In the second chapter, as energy consumption determines economic growth, any strategic plans for the energy system should be cautious that reducing energy consumption will negatively impact the Jordanian economy. Thus, a transition in the system should be gradual, and the consumption patterns in the different sectors should be considered. Moreover, future plans should consider a gap between the Jordanian governorates on the one hand and the Amman governorate on the other. I proved in my analysis that residential energy expenditure (consumption) has a direct negative

relationship with human well-being, indicating a gap between households' energy needs and practices and what can be optimum for Jordanian households. Future energy plans that target improving efficiency in the residential sector should include the users' perspective and consider the population growth and the energy consumption differences in the different regions.

The results in chapters three and four have a direct recommendation in terms of alleviating energy poverty. While energy poverty is multidimensional, ownership of modern appliances comes with the cost of being able to afford and maintain it in the long term. The results from the third chapter recommend that development projects target governorates with the highest energy poverty score. Moreover, energy poverty as an issue affecting households should be included in future policies and laws to result in programs supporting families that fall under energy poverty. Policies should include improving energy efficiency, implementing retrofitting programs in older buildings, and further investigating the pricing of fuels and affordability to households.

In conclusion, I suggest a modified definition of energy poverty based on my results for Jordan: *"A situation arises when a household has poor energy efficiency; is incapable of achieving appropriate energy services which are modern, and sustainable due to economic or social barriers."*

The suggested definition realizes the multidimensional nature of energy poverty, emphasizing the importance of improving energy efficiency and enhancing the economic and social position of the energy poor in Jordan. As the country is moving forward with an energy transition to increase the reliance on renewable energy and achieve energy security, it is essential to include those with energy hardships in the strategies and the plans from the beginning so they will not suffer from further implications of energy poverty.

The importance of my research results shed light on an issue that was neglected for a long time. Current results show that households in Jordan face different forms of energy poverty. These forms hinder people's ability to access new technologies or benefit from energy efficiency improvements.

5.3. Future Research Plan

While writing my dissertation, I encountered several research-oriented areas and topics I plan to study. These are the following:

1. Investigating the impact of energy prices on households' energy consumption patterns in Jordan.
2. Investigating the coping strategies that the energy-poor households in Jordan follow to deal with energy hardships.
3. Investigating energy and transport poverty in Jordan.
4. Assessing energy transition in Jordan and the possible impacts on energy poverty.
5. Investigating energy inequality and the consequences on energy transition in Jordan.
6. Investigating the impacts of severe weather events in both winter and summer on Jordanian households' energy consumption, especially those who suffer from energy poverty.
7. Examining the relationship between energy and water poverty in Jordan.
8. Analysis of possible impacts of energy transition in Jordan on the prevalence of energy poverty.
9. Expand the study of energy poverty and energy poverty alleviation possibility in the Middle East and North Africa region.

References

Albezuirat, M., Iqbal Hussain, M., Al-saraireh, F., Ahmad, R., 2018. Jordan Energy Sector Choices and Challenges 1, 22. https://doi.org/10.5281/zenodo.1452373

Atamanov, A., Jellema, J., Serajuddin, U., 2017. Energy Subsidies Reform in Jordan: Welfare Implications of Different Scenarios. pp. 179–206. https://doi.org/10.1007/978-3-319-52926-4_7

Bhattacharyya, S.C., 2011. Energy Economics. Springer London, London. https://doi.org/10.1007/978-0-85729-268-1

Bouzarovski, S., 2014. Energy poverty in the European Union: landscapes of vulnerability. WENE 3, 276–289. https://doi.org/10.1002/wene.89

Coady, D., El-Said, M., Gillingham, R., Kpodar, K., Medas, P., Newhouse, D., 2006. The Magnitude and Distribution of Fuel Subsidies: Evidence from Bolivia, Ghana, Jordan, Mali, and Sri Lanka (IMF Working Paper No. WP/06/247).

Department of Statistics (DOS), 2020. Population – Department of Statistics [WWW Document]. URL http://dosweb.dos.gov.jo/population/population-2/ (accessed 9.1.21).

Dubois, U., 2012. From targeting to implementation: The role of identification of fuel poor households. Energy Policy, Special Section: Fuel Poverty Comes of Age: Commemorating 21 Years of Research and Policy 49, 107–115. https://doi.org/10.1016/j.enpol.2011.11.087

Field, A., 2017. Discovering statistics using IBM SPSS statistics, 5th edition. ed. SAGE Publications, Thousand Oaks, CA.

Field, A.P., 2009. Discovering statistics using SPSS: and sex, drugs and rock “n” roll, 3rd ed. ed. SAGE Publications, Los Angeles.

Gatto, A., Busato, F., 2020. Energy vulnerability around the world: The global energy vulnerability index (GEVI). Journal of Cleaner Production 253, 118691. https://doi.org/10.1016/j.jclepro.2019.118691

Halkos, G.E., Gkampoura, E.-C., 2021. Coping with Energy Poverty: Measurements, Drivers, Impacts, and Solutions. Energies 14, 2807. https://doi.org/10.3390/en14102807

IEA, 2022. Jordan - Countries & Regions [WWW Document]. IEA. URL https://www.iea.org/countries/jordan (accessed 9.26.22).

Jaber, J.O., Badran, O.O., Abu-Shikhah, N., 2004. Sustainable energy and environmental impact: role of renewables as clean and secure source of energy for the 21st century in Jordan. Clean Techn Environ Policy 6. https://doi.org/10.1007/s10098-003-0232-9

Jaber, J.O., Probert, S.D., 2001. Energy demand, poverty and the urban environment in Jordan. Applied Energy 16.

Jaber, M., 2023. Summer Energy Poverty and Climate Change in Jordan. Presented at the Conference of Hantos Elemér Business and Regional Sciences Doctoral School, University of Miskolc, Faculty of Economics.

Jaber, M.M., 2022. Analysis of selected economic factor impacts on CO2 emissions intensity: A case study from Jordan, 1990–2015. Regional Statistics 12, 16.

Jordan News, 2022. Gas is optimal fuel for winter heating in Jordan --— expert - Jordan News | Latest News from Jordan, MENA. Jordan News | Latest News from Jordan, MENA.

LaBelle, M.C., Tóth, G., Szép, T., 2022. Not Fit for 55: Prioritizing Human Well-Being in Residential Energy Consumption in the European Union. Energies 15, 6687. https://doi.org/10.3390/en15186687

Ministry of Energy and Mineral Resources, 2020. Annual Report. The Ministry of Energy & Mineral Resources, Amman, Jordan.

Nussbaumer, P., Bazilian, M., Modi, V., 2012. Measuring energy poverty: Focusing on what matters. Renewable and Sustainable Energy Reviews 16, 231–243. https://doi.org/10.1016/j.rser.2011.07.150

Rosa, W. (Ed.), 2017. Transforming Our World: The 2030 Agenda for Sustainable Development, in: A New Era in Global Health. Springer Publishing Company, New York, NY. https://doi.org/10.1891/9780826190123.ap02

Saeedan, M.N., Friedrich-Ebert-Stiftung Amman office, 2011. Sustainable energy mix and policy framework for Jordan. Amman.

Sandri, S., Hussein, H., Alshyab, N., 2020. Sustainability of the Energy Sector in Jordan: Challenges and Opportunities. Sustainability 12. https://doi.org/10.3390/su122410465

The Jordan Times, 2021. Reduced electricity tariff will take effect in first-third of 2022 — EMRC.

Thomson, H., Snell, C., 2013. Quantifying the prevalence of fuel poverty across the European Union. Energy Policy 52, 563–572. https://doi.org/10.1016/j.enpol.2012.10.009

World Bank Country and Lending Groups – World Bank Data Help Desk [WWW Document], n.d. URL https://datahelpdesk.worldbank.org/knowledgebase/articles/906519-world-bank-country-and-lending-groups (accessed 12.29.20).

Zweifel, P., Praktiknjo, A., Erdmann, G., 2017. Energy Economics, Springer Texts in Business and Economics. Springer Berlin Heidelberg, Berlin, Heidelberg. https://doi.org/10.1007/978-3-662-53022-1

6. **Dissertation-Driven Academic Output: Published Works by the Author**

1. Jaber, M., Szép, T., 2023. Understanding the causality relationship between renewable energy consumption and unemployment rates: The Toda-Yamamoto technique. Presented at the International Conference on Economics and Business Management, Hungarian Economists' Society from Romania, Department of Economics and Business Administration in Hungarian Language at Babeş–Bolyai University, and the Partium Christian University, pp. 104–115.
2. Jaber, M.M., 2023. Multidimensional energy poverty in Jordan between 2009 and 2018: Progress and possible policy interventions. Regional Statistics 13. http://dx.doi.org/10.15196/RS130303 - (Q2 Journal)
3. Jaber, M., 2023. Summer Energy Poverty and Climate Change in Jordan. Presented at the Conference of Hantos Elemér Business and Regional Sciences Doctoral School, University of Miskolc, Faculty of Economics.
4. Jaber, M., 2023. Facilitating Energy Transition in Borsod County: Current Situation and Possible Transition Pathways, in: 2023 19th International Conference on the European Energy Market (EEM). Presented at the 2023 19th International Conference on the European Energy Market (EEM), pp. 1–5. https://doi.org/10.1109/EEM58374.2023.10161851
5. Szép, T., Jaber, M., Kashour, M., 2022. Changing European Energy Policy – The Challenge of the Energy Price Storm. Theory, Methodology, Practice - Review of Business and Management 18, 69–82. https://doi.org/10.18096/TMP.2022.02.04
6. Jaber, M.M., 2022. Analysis of selected economic factor impacts on CO2 emissions intensity: A case study from Jordan, 1990-2015. Reg. Stat. 12, 193–208. https://doi.org/10.15196/RS120101 - (Q2 Journal)
7. Jaber, M., 2020. Multivariate Granger Causality Between Energy Consumption And Economic Growth In Jordan, in: Szűcs, P. (Ed.), . Presented at the PhD Students' Forum, University of Miskolc, Faculty of Economics, p. 6.