Cuadernos de Economía (2024) Volume 47, Issue 134, 10-18

Asociación Cuadernos de economía

Cuadernos de economía

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Identifying the Effect of Energy Poverty on Income Poverty, Health, Education, Environment and Future Food Security

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Energy poverty (ENP) constitutes a significant global challenge, adversely impacting income, education, healthcare, and the environment. This critical issue warrants the attention of current students. The present study investigates the impact of energy poverty on income, healthcare, education, environmental degradation, and food insecurity. Primary data were collected from university students in Iraq using a structured questionnaire. The data were then analysed using Smart-PLS to perform statistical investigation and modelling analysis. The results reveal a positive association between ENP and issues related to income, healthcare, education, environmental degradation, and food insecurity in Iraq. Based on these findings, the study provides practical recommendations for policymakers, aimed at reducing income, healthcare, education, and environmental poverty, as well as food insecurity, through significant improvements in energy resources.

https://doi.org/10.32826/cude.v47i134.1402

Introduction

ENP pertains to situations where households are unable to afford or access adequate energy resources. This issue has been extensively explored by researchers such as Sy & Mokaddem (2022). Bednar & Reames (2020) underscore the critical role of energy in human well-being, illustrating its importance in addressing fundamental needs and enhancing social conditions. The efficiency of buildings significantly impacts factors such as water quality, temperature regulation, waste management, and ventilation. Halkos & Gkampoura (2021) identify four dimensions of ENP: access to energy, availability of resources, energy production, and the quality of energy supply. In developing countries, electricity poverty often arises from limited access to electricity compared to traditional fuel sources. ENP represents a serious challenge affecting both rural and urban economies, characterized by low income, restricted access to modern energy, and high costs. The complexity of this issue has prompted the development of various strategies to address it (Mien et al., 2023; Zhao et al., 2022). For instance, in rural Bangladesh, 58% of households experience energy scarcity, and 45% face energy poverty. In India, ENP impacts 57% of rural areas and 28% of urban areas. In Latin America, ENP is linked to social exclusion, while in the European Union, it is more prevalent in the eastern, central, and southern regions. The issue of ENP in Latin America is primarily associated with social exclusion and energy access (Cong et al., 2022). Proposed solutions include improving rural lighting, repairing biomass stoves, and utilizing renewable fuels. The Kuznets curve theory suggests that economic growth and increased consumption may exacerbate ENP. Analysing behaviours and situations to assess inequities and power imbalances can help uncover hidden aspects of poverty (Che et al., 2021).

ENP significantly impacts health, society, the economy, and the environment. Within the European Union, the energy crisis has emerged as a pressing issue necessitating political intervention. In Sri Lanka, factors such as gender, age, ethnicity, and income influence the severity of poverty. Addressing ENP is intricately linked to the transition to low-carbon energy sources (Bouzarovski et al., 2021). Maintaining indoor temperature is vital for a healthy living environment, yet low-income families are at risk due to inadequate heating. Iraq faces considerable challenges in addressing renewable energy issues. Effective energy policy, including the adoption of renewable energy and nuclear power, is critical (Zhao et al., 2021). Despite these challenges, there is optimism regarding the potential of solar energy projects for Iraq's energy future. Inefficient operations and excessive overtime are major issues within Iraq's energy sector, exacerbating ENP and adversely affecting health and education (Nyborg, Singh, & Hoogensen Gjørv, 2022; Muthuswamy & Ragavendran, 2024; Stojilovska et al., 2022).

Iraq, as a developing country with significant oil reserves and extensive oil exports, faces the challenge of diminishing energy resources and environmental degradation due to the emission of harmful gases from extensive oil drilling and burning. The production of renewable energy resources, such as wind, solar, bioenergy, and hydroelectric power, remains limited. Consequently, many people experience energy poverty due to insufficient access to clean energy resources, which impedes their ability to meet domestic and economic needs while protecting their environment. This energy poverty also contributes to related social issues, including income poverty (INP), educational poverty (EDP), health poverty (HEP), ENP, and food insecurity (FOI). The government should prioritize the development of renewable energy sources, such as solar and wind power, to enhance electricity access in remote areas. Raising awareness about the impact of energy poverty is crucial to addressing these associated social issues. The present study aims to investigate the relationship between ENP and income, health, education, environmental poverty, and food insecurity. An additional objective is to evaluate the role of government support in mediating the effects of ENP on these factors. Furthermore, this study highlights the importance of reporting ENP among college students, providing valuable insights for environmentalists, educators, policymakers, and other stakeholders. The findings of this research are significant for addressing ENP and its associated social issues in Iraq.

Although the major subject of this study, ENP, is derived from existing literature, the study itself makes a substantial contribution to the field. 1). This study not only sheds light on the contemporary issue of ENP by analysing its causes, intensity, and spread but also provides a comprehensive understanding of its adverse consequences within a community. By examining the influence of ENP on INP, EDP, HEP, ENP, and FOI, this research enriches the existing literature significantly. 2). While previous studies have addressed the issue of ENP, they have primarily focused on its economic effects, often neglecting the associated social issues such as income, health, education, environmental poverty, and food insecurity. This study makes a significant contribution by thoroughly examining the social impacts of ENP, thus filling a critical gap in the literature. 3). The interconnections between ENP and issues such as income, health, education, environmental poverty, and food insecurity have been explored in various studies. However, there is a scarcity of written material specifically addressing these interrelated issues in the context of Iraq. This study is exceptional in that it examines the relationship between ENP and these social issues within Iraq, providing valuable insights and contributing uniquely to the literature.

The current paper is divided into five parts. Following the introduction, there is a review of previous literature, which is used to construct hypotheses regarding the relationship between ENP, INP, EDP, HEP, ENP, and FOI. The third part briefly explains the methods chosen for data collection and analysis. In the fourth part, the collected data are analysed, and the results related to the hypotheses are presented. The final section discusses the study's results in reference to previous studies and provides implications, conclusions, and limitations.

Literature Review

The literature on the concept of ENP in Iraq was reviewed comprehensively. Based on this review, hypotheses were formulated to assess whether the research can elucidate the impact of ENP on private income, general health, educational levels, environmental conditions, and food security.

ENP adversely affects economic conditions and represents a significant global energy crisis. INP is characterized by inadequate income to fulfil the needs of the population (Kudaier, Kareem, & Mohammed, 2024; Nguyen & Nasir, 2021). Energy shortages have led many individuals to lose job opportunities or struggle with maintaining online work, as inefficient energy provision imposes financial constraints (Bucko, Exenberger, & Héjjová, 2022; Igawa &

Managi, 2022; Zhao & Zhang, 2024). Rising energy prices prevent many from affording electricity bills, leading to reduced residential energy usage. This situation intensifies financial pressures and highlights the psychological and physical impacts of ENP, particularly under pandemic conditions (Dong et al., 2022). The study conducted by Bardazzi et al. (2021) examines the impact of ENP on income. It highlights that in countries where renewable energy sources such as bioenergy, solar power, and wind power are produced in limited quantities, and energy supply is insufficient, households are forced to purchase energy at higher prices to meet their needs. This situation disrupts household budgets, leading to inadequate income to cover financial requirements. Similarly, Hassan et al. (2022) discuss that widespread ENP can slow down economic activities, which in turn reduces revenue generation. Consequently, workers' incomes also decrease. Based on these observations, the following hypothesis is proposed:

H1: There is a significant relationship between both variables "ENP & INP".

The literature review begins by defining "education poverty," which is characterized by the denial of children's right to education and the opportunity to develop essential skills for success in a rapidly evolving society. The implementation of distance learning programs during extended lockdowns has supported students, particularly those facing financial hardships (Apergis et al., 2022). However, students in remote areas experience difficulties accessing education due to energy shortages, which hinder face-to-face interactions necessary for effective information exchange (Amin et al., 2020). The COVID-19 pandemic has exacerbated these issues, with energy shortages preventing students from attending online classes and completing assignments on time. Reliable energy access, which enables consistent internet connectivity, is therefore crucial (Rafi et al., 2021). Doğanalp et al. (2021) conducted a study investigating the impact of ENP on EDP. They found that energy is critical for infrastructure such as lighting, heating, cooling, and operating electrical appliances, which in turn affects the health and performance of both teachers and students. High levels of energy poverty often correlate with poor-quality school infrastructure, leading to diminished educational outcomes. Based on this perspective, the following hypothesis is proposed,

H2: There is a significant relationship between ENP and EDP.

The literature review begins by defining "educational poverty," which is characterized by the denial of children's right to education and the opportunity to develop skills essential for progress in a rapidly evolving society (Oliveras et al., 2020). While the implementation of distance learning programs during extended lockdowns provided relief, particularly for students with financial resources, those in remote areas struggled to access education due to energy shortages, which impeded face-to-face interactions necessary for effective information exchange (Ballesteros-Arjona et al., 2022; Juarranz, 2023). During the COVID-19 pandemic, ENP disproportionately affected students, preventing them from participating in online classes and completing assignments on time. Consequently, reliable energy access, which ensures consistent internet connectivity, is deemed crucial today (Bentley et al., 2023). Bukari et al. (2021) explore the relationship between ENP and health, arguing that reliance on fossil fuels due to insufficient access to renewable energy disrupts weather balance and elevates global temperatures. This disruption adversely affects natural resources and the environment, leading to health issues for individuals exposed to polluted air and degraded resources. Thus, ENP contributes to HEP. Based on these observations, the following hypothesis is proposed,

H3: There is a significant relationship between ENP and HEP.

Environmental poverty is characterized by inadequate shelter and essential health resources, a condition worsened by ENP. ENP exacerbates environmental degradation and contributes to global warming due to reliance on traditional energy sources (Ehsanullah et al., 2021; Zhou et al., 2022). BRICS countries, in particular, have experienced significant environmental challenges due to ENP (Batool et al., 2023). Research conducted by Adom et al. (2021) highlights concerns regarding ENP and its impact on environmental degradation. The study notes that in countries where the production of renewable energy resources—such as wind, geothermal, hydropower, bioenergy, and solar power—is minimal, there is a limited supply of clean energy. Consequently, reliance on fossil fuels, which emit harmful substances and greenhouse gases, increases, leading to environmental pollution. Additionally, Li et al. (2021) investigate the relationship between EMP and EVP. Their study finds that in the presence of ENP, the frequent combustion of fossil fuels, as opposed to the use of renewable energy resources, results in the emission of gases that damage the ozone layer and increase global temperatures. This pollution deteriorates environmental quality and depletes natural resources. Based on these findings, the following hypothesis is proposed,

H4: There is a significant relationship between ENP and EVP.

ENP significantly affects food security, with evidence linking the cost of electricity and bioenergy to food supply and security. Studies indicate that ENP can have an impact on food security by influencing both the cost and availability of essential resources (Okyere & Lin, 2023). In the European Union, ENP and associated security concerns affect agricultural production and food prices (Hussain et al., 2023). Nie et al. (2021) define energy poverty as a lack of affordable, sufficient energy, which poses an increasing threat to atmospheric quality (air quality, temperature, and climate) and natural resources. The insufficient access to energy and poor-quality natural resources impede the growth of food, resulting in inadequate nutrition and supply. Consequently, ENP contributes to food insecurity within a country. Based on this research, the following hypothesis is proposed,

H5: There is a significant relationship between ENP and FOI.

Materials and Methods

The article investigates the impact of ENP on various forms of poverty—income, health, education, environmental, and food insecurity. Primary data was collected from university students in Iraq using a questionnaire administered through multiple accessible websites, targeting active students. A five-point Likert scale was employed to measure six operational variables. Out of 512 surveys distributed, 381 were returned, with 91 deemed incomplete, resulting in 290 valid responses. The collected data were analysed using SPSS software. The survey included items designed to assess different forms of poverty. Specifically, energy poverty was measured using four items adapted from Xiao et al. (2021). Income poverty was assessed with five items sourced from Refaeli & Achdut (2022). Health poverty was evaluated through five items based on Demirtas et al. (2022). Education poverty was measured

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using five questions derived from Northrup et al. (2020). Environmental poverty was assessed with five items adapted from Ding et al. (2022), and food insecurity was measured using five questions based on Pérez et al. (2018). These measurement items are detailed in Table 1.

Table 1: Items and Variables.

Construct	Items	Descriptions	Sources
ENP	ENP_1	Having the physical energy to meet the energy needs of the household such as heating, lighting and cooking	(Xiao et al., 2021)
	ENP_2	Skin problems due to traditional energy consumption	
	ENP_3	Mental and physical disability due to lack of productive energy	
	ENP_4	Difficulty in taking a bath/shower due to work pressure.	
Income Poverty	INP_1	Loss of opportunities to find new energy due to ENP find a job online	(Refaeli et al., 2022)
	INP_2	Power outage due to unpaid bills	
	INP_3	Parents earn good salaries	
	INP_4	ENP is the main cause of income poverty	
	INP_5	Difficult to pay monthly bills due to income poverty	
Health Poverty	HEP_1	Lack of hot water for shower Lack of energy	(Demirtas et al., 2022)
	HEP_2	Air conditioning/cold water always makes me sick	
	HEP_3	Life bad, and negatively affects education Poor health affects income poverty	
	HEP_4	Poor health affects poverty.	
	HEP_5	I shiver every day because of the cold house	
Educational Poverty	EDP_1	It difficult to study online participation completed due to insufficient energy teaching and assignments	(Northrup et al., 2020)
	EDP_2	Engaging education thanks to online courses carrying out activities	
	EDP_3	Using traditional energy sources resulting from air pollution	
	EDP_4	Conventional energy consumption causes air pollution.	
	EDP_5	Access to clean, filtered or boiled water.	
Environmental Poverty	EVP_1	An unhealthy environment affects educational performance.	(Ding et al., 2022)
	EVP_2	We must strive more to develop a healthy environment	
	EVP_3	You suffer from chest tightness, cough, wheezing and asthma due to polluted air	
	EVP_4	Provide an electric or solar heater to warm the room	
	EVP_5	Maintain a good sanitation program in your area	
Food Insecurity	FOI_1	Impact of ENP on Food Accessibility	(Pérez et al., 2018)
	FOI_2	Does the availability of energy sources affect your ability to store and cook food	
	FOI_3	Does spending on energy bills affects your household's budget for purchasing food	
	FOI_4	Do you believe that high energy costs contribute to food insecurity in your community	
	FOI_5	Have you resorted to alternative, potentially safer cooking methods (e.g. open flame) due to lack of access to clean energy?	

The study utilized Smart-PLS to evaluate both the measurement model and the structural model. Smart-PLS is a robust tool for analysing primary data, particularly when handling large datasets, and is known for delivering optimal outcomes (Hair et al., 2017). Additionally, Structural Equation Modelling (SEM) was employed as a practical method for analysing the relationships among variables. SEM offers several advantages over traditional methods, including the ability to analyse both independent and dependent variables comprehensively, and provides accurate and reliable results due to its stability and robustness (Hair Jr et al., 2020). In this study, SEM was selected as the primary analytical method to investigate the relationships between variables. The research model, illustrated in Figure 1, was developed based on an extensive literature review to refine the research methodology. The model indicates that ENP significantly impacts income poverty, education poverty, health poverty, environmental poverty, and food insecurity. The study's structure comprises one ENP and five dependent variables, as detailed above.

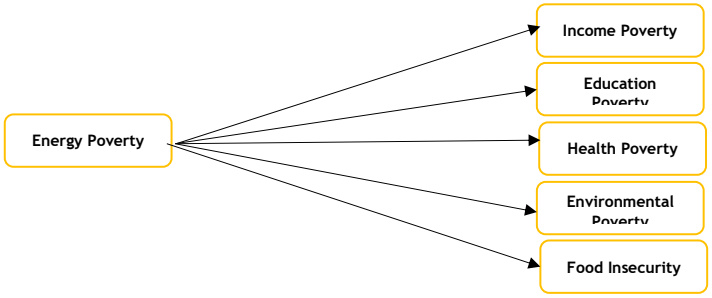

Figure 1: Research Model.

Results and Discussion

The analysis of responses from 290 students provides a summary of their demographic characteristics. Among the

respondents, females constituted the majority at 68.7%, while males made up 31.3%. The predominant age group was 20 to 25 years old, representing 41.2% of the sample. City residents were the largest group, accounting for 42.7% of the respondents. The majority of students, 56%, rely on parental support, with only 5.4% owning their own homes. Additionally, a notable proportion of students, 17.7%, were engaged in part-time work to support their financial needs, particularly related to their studies. These demographic details are summarized in Table 2.

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Table 2: Respondents Demographic Profile.

Factor	Frequency	Percent
Gender		
Male	91	31.3%
Female	199	68.7%
Age		
20-25	119	41.2%
26-30	75	25.9%
31-35	47	16.1%
36-40	39	13.6%
41-0ver	10	3.2%
Residential Location		
Urban	124	42.7%
Suburban	105	36.1%
Rural	61	21.1%
Financial Aspect		
Part-Time Job	51	17.7%
Own Business	11	3.6%
Parents	202	69.7%
Siblings or Other Relatives	26	8.9%

The study evaluates the items' correlation to assess convergent validity. The results demonstrate that the factor loadings and average variance extracted (AVE) values exceed 0.50. Additionally, the alpha and composite reliability (CR) values are greater than 0.70. These findings indicate a strong correlation between the items. The detailed values are presented in Table 3. The study evaluated discriminant validity by examining the correlation among variables. The results revealed that the Heterotrait-Monotrait (HTMT) ratios were below 0.85, indicating a low correlation between variables. These findings are presented in Table 4. Finally, path analysis was conducted to investigate the relationships among the variables. The results demonstrate that energy poverty positively correlates with income poverty, healthcare poverty, education poverty, environmental poverty, and food insecurity in Iraq, thereby supporting hypotheses H1, H2, H3, H4, and H5. These results are detailed in Table 5.

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Table 3: Convergent Validity.

Constructs	Items	Loadings	Alpha	CR	AVE
Educational Poverty	EDP1	0.934	0.944	0.958	0.820
	EDP2	0.861			
	EDP3	0.932			
	EDP4	0.936			
	EDP5	0.860			
Energy Poverty	ENP1	0.846	0.855	0.902	0.697
	ENP2	0.837			
	ENP3	0.845			
	ENP4	0.809			
Environmental Poverty	EVP1	0.842	0.911	0.933	0.737
	EVP2	0.875			
	EVP3	0.869			
	EVP4	0.826			
	EVP5	0.881			
Food Insecurity	FOI1	0.529	0.856	0.891	0.634
	FOI2	0.946			
	FOI3	0.906			
	FOI4	0.946			
	FOI5	0.531			
Health Poverty	HEP1	0.795	0.852	0.892	0.622
	HEP2	0.787			
	HEP3	0.748			
	HEP4	0.803			
	HEP5	0.809			
Income Poverty	INP1	0.865	0.884	0.915	0.684
	INP2	0.830			
	INP3	0.803			
	INP4	0.781			

	INP5	0.854

Table 4: Discriminant Validity.

	EDP	ENP	EVP	FOI	HEP	INP
EDP						
ENP	0.549					
EVP	0.423	0.448				
FOI	0.501	0.459	0.709			
HEP	0.040	0.193	0.112	0.150		
INP	0.625	0.582	0.484	0.523	0.083	

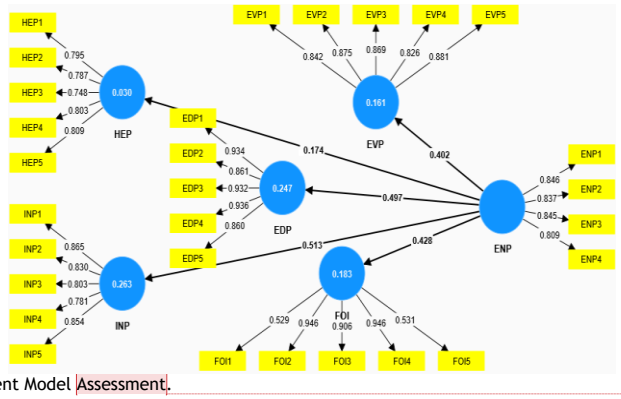

Figure 2: Measurement Model Assessment.

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Table 5: Path Analysis.

Relationships	Beta	Standard Deviation	T Statistics	P Values
ENP -> EDP	0.497	0.048	10.280	0.000
ENP -> EVP	0.402	0.039	10.186	0.000
ENP -> FOI	0.428	0.056	7.600	0.000
ENP -> HEP	0.174	0.046	3.802	0.000
ENP -> INP	0.513	0.049	10.517	0.000

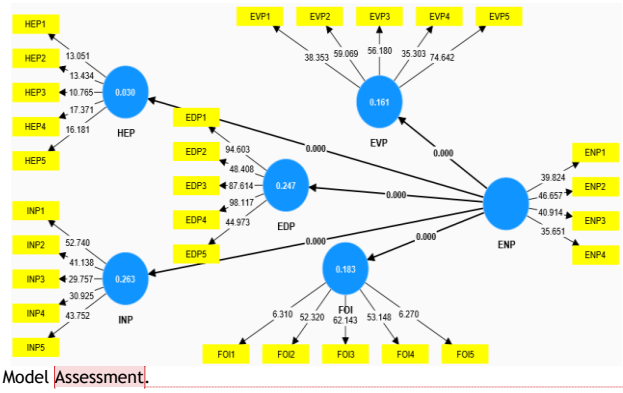

Figure 3: Structural Model Assessment.

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Discussion

The results indicate a positive relationship between ENP and INP. This finding is consistent with Wang & Lin (2022), which explores the impact of ENP on individual income. Their study suggests that heightened ENP, coupled with interruptions in economic activities, leads to increased INP. Similarly, Awan & Bilgili (2022) argue that both domestic and economic activities rely directly or indirectly on energy. When access to energy resources is restricted or their prices are high, the overall costs of economic activities rise, resulting in reduced profits and lower incomes. Moreover, the results reveal a positive relationship between ENP and EDP. This is supported by Katoch et al. (2024), who examine how ENP affects educational outcomes. They contend that energy is crucial for the infrastructure of educational institutions, impacting both the physical environment and communication. High-intensity ENP adversely affects educational performance, leading to increased EDP. This is further corroborated by Sule et al. (2022), who note that ENP can restrict transportation options within budget constraints, affecting the ability to access quality

education for children.

The results indicate a positive relationship between ENP and HEP. This finding is supported by Pan et al. (2021), who suggest that inadequate access to energy resources impairs the ability to regulate household heating and lighting, potentially affecting body temperature and vision, thus jeopardizing overall health. Additionally, İpek & İpek (2024) report that high ENP leads to limited production of renewable energy sources such as wind, hydropower, bioenergy, and solar power, resulting in a shortage of clean energy and negatively impacting public health. Furthermore, the study finds a positive association between ENP and EVP. This is corroborated by Middlemiss (2022), who observes that countries experiencing energy poverty often rely on traditional energy sources like coal, oil, and wood. The combustion of these fuels releases smoke and harmful gases that degrade the atmospheric layer, leading to environmental degradation. Halkos et al. (2021) also support these results, indicating that increased ENP exacerbates the use of fossil fuels, contributing to environmental deterioration. The results indicate a positive relationship between ENP and FOI. This finding is supported by Pondie et al. (2023), who argue that a lack of clean energy resources in food production companies hampers their ability to operate efficiently and without pollution. Consequently, food production suffers, leading to shortages and increased food insecurity. Additionally, Porto Valente et al. (2022) find that rising ENP adversely impacts the natural environment and degrades crops, further contributing to food insecurity.

Conclusion

ENP presents a significant challenge in Iraq, exacerbating various dimensions of poverty including income, education, healthcare, environmental degradation, and food security. The findings of this study underscore the severe implications of ENP on students, who experience both physical and mental health issues that adversely affect their learning outcomes. Many individuals in Iraq struggle with high electricity costs, leading to economic stagnation and exacerbating poverty. Additionally, limited access to energy resources hampers online commerce and further deepens economic hardship. The interplay of pandemic conditions and ENP has compounded the psychological and physical burdens on the population. The lack of energy negatively impacts educational development, economic conditions, transportation, and overall student well-being. Effective management of energy access is crucial for improving health and educational outcomes in Iraq. Furthermore, the country's reliance on inadequate energy sources contributes to environmental degradation and impedes global progress. To address these challenges and mitigate the adverse effects of ENP, it is essential for the government to implement strategic policies aimed at resolving the energy crisis. Reducing ENP is critical not only for alleviating poverty but also for enhancing the overall health and prosperity of the nation.

Policy Recommendations

Research demonstrates that Energy and ENP significantly affects income, health, education, environment, and food security. Based on these findings, several recommendations have been proposed to mitigate ENP, particularly in Iraq. Financial incentives for low-income individuals to promote the adoption of renewable energy could potentially exacerbate poverty. It is also essential to identify and assist low-income communities disproportionately impacted by ENP. Distance learning programs, including online courses and projects, frequently face disruptions due to power outages and technical issues. Effective energy usage can positively influence students' learning experiences. Additionally, strategies to alleviate stress and enhance energy access are crucial for maintaining physical and mental health. Regulating rising energy prices in Iraq is essential for safeguarding vulnerable communities. Utilizing modern energy sources such as solar energy and biogas can alleviate ENP. Given Iraq's abundant solar resources, photovoltaic systems represent an efficient electricity generation method. Social management strategies, such as the two-child policy, could also mitigate resource poverty and ENP. Law enforcement should play a role in developing and implementing effective measures for solar energy deployment, particularly those aimed at temperature reduction. Addressing energy deficits will not only improve health and well-being but also support academic success. Therefore, policies that address income, education, health, and environmental issues related to ENP should be implemented. This study provides guidance for policymakers to formulate regulations that aim to reduce poverty and food insecurity through significant advancements in energy resources.

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Limitations and Future Recommendations

The study faced several limitations that warrant attention. Initial attempts to conduct face-to-face interviews were impeded by various issues. Consequently, an online survey was administered from November 2023 to February 2024, spanning approximately three months. During this period, it became evident that students encountered significant energy shortages, which adversely affected their ability to participate effectively in online activities. As a result, electrical and technical problems led to delays in obtaining the results.

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