KSUC-OI-017

Determinants of energy poverty in the central coastal area, Vietnam

Yen Hai Nguyen* and Xuan Hung Pham
University of Economics, Hue University, 99 Ho Dac Di street, Hue City 49000, Vietnam
*Corresponding author: nguyenhaiyen@hueuni.edu.vn

Abstract

This study utilises the updated microdata from Vietnam to investigate the determinants of energy poverty in the Central Coastal region. Energy poverty is calculated using the income and expenditure-based approach, and the findings indicate that over 54% of households in the Central Coastal region spend more than 10% of their income on energy costs. The study reveals a significant difference in energy poverty concerning socio-demographic and geographical factors, such as gender, age, ethnicity, education and income in the Central Coastal region. These findings raise concerns for policymakers, emphasising the need to address adverse impacts on health and education for those experiencing energy poverty in the Central Coastal area.

Keywords: Energy Poverty, socio-demographic, policymakers

Introduction

The significant implications of energy poverty, as highlighted by its substantial impact on various aspects of human life, including health, education and well-being (Churchill & Smyth, 2021; Zhang, Li, & Han, 2019), extend to the economic status of both developed and developing countries (Araújo, 2014; Halkos, 2017). Furthermore, the crucial role of clean energy has once again been underscored in the United Nations' Sustainable Development Goals, where clean energy now constitutes the seventh goal for sustainable development, aimed at alleviating energy poverty (UN, 2018).

In particular, an estimated 1.2 billion people suffer from a lack of access to electricity, and nearly 40 per cent of the world's population depends on traditional fuels like firewood and agricultural residues for cooking to meet their daily energy needs (UNDP, 2017). Therefore, addressing energy poverty and meeting the sustainable energy needs of residents with lower incomes, who spend more on insufficient energy, pose challenges for developing countries.

The Central Coastal region, in particular, and Vietnam, in general, are not exceptions to the challenges faced by developing countries. This region in Vietnam presents a typical case for an examination of determinants of energy poverty. Although this area is one of the regions with the largest percentage of

access to electricity in Vietnam, with over 97% of residents having access to electricity compared to other regions (Asian Development Bank, 2015), the monthly income per capita in the Central Coastal region is still among the lowest income groups compared to the Red River Delta, South East and Mekong River Delta, with about 3,400 thousand Vietnam dong in 2020 according to General Statistics Office (2021). In addition, there are many types of minority ethnicities in the Central Coastal region, with over 18 minority groups accounting for 10.9% in surveys, and most people live in rural areas. As a result, despite the higher percentage of people accessing electricity in this region, lower income still remains a constraint for the Central Coastal area residents to access clean energy.

To the best of our knowledge, this study represents the first research in the literature that investigates the determinants of energy poverty, focusing on households' characteristics and utilising microeconomic data from the Central Coastal area of Vietnam. The objectives of the current study are as follows: i) examining the level of energy poverty in the Central Coastal area of Vietnam; ii) identifying determinants of energy poverty through socioeconomic and demographic factors. By thoroughly analysing the extent of energy poverty in the Central Coastal region, our paper contributes valuable insights to this specific region and, more broadly, to Vietnam. Additionally, the insights found in this paper raise public awareness about energy poverty and enhance valuable public policies, not only in Vietnam but also in other developing countries.

Literature review

Energy poverty has recently emerged as a significant concern in the formulation of sustainable energy policies across many nations, particularly evident with the ongoing trend in developed countries towards shifting to renewable energy sources. Besides, developing countries are making a concerted effort to enhance residents's access to modern energy, such as electricity. The impacts and determinants of energy poverty, along with its consequences on the well-being and socio-economics of human beings, have been extensively investigated in both developed and developing nations. The following literature provides a brief overview of empirical studies on energy poverty, with a specific focus on Asia, and, more particularly, Vietnam.

Using data from the Indian Human Development household survey, an assessment of energy poverty was conducted in India (Khandker, Barnes, & Samad, 2012; Sadath & Acharya, 2017). Khandker et al. (2012) identified a correlation between energy poverty and income poverty in India, as the country still relies on traditional sources such as firewood to meet about 90% of its energy requirements. In Pakistan, Qurat-ul-Ann and Mirza (2021) examined the intensity level of multidimensional energy poverty among residents, utilising data from the Pakistan Social and Living Standards Measurement survey. In Sri Lanka, using the latest data in the country to examine the determinants of energy poverty, the findings indicated

that the energy-poor population has been affected by health and education factors (Jayasinghe, Selvanathan, & Selvanathan, 2021).

Vietnam has witnessed rapid economic growth accompanied by an increased demand for electricity following the significant economic reform in 1986. Along with the support of international aid, the Vietnamese government has made substantial investments in the national electricity grid to meet the population's energy demand. There has been significant progress in the percentage of households with a grid electricity connection. In 1976, the rate was only 2.5% nationwide; however, by 1990, it increased to 14%, and in 2005 with the promulgation of the Electricity Law, the percentage of households accessing national electricity reached 98% by 2010 (Lee & Gerner, 2020).

Despite the expansion of the electricity grid in Vietnam, financial constraints are a barrier that creates a gap between the energy-poor and non-poor in utilising electricity or energy clean in Vietnamese regions. As a result, some empirical studies reveal energy poverty in Vietnam, which remains an unexplored definition and results in the country. Specifically, Feeny, Trinh, and Zhu (2021) examined the impact of temperature shock and energy poverty in Vietnam using VHLSS data from 2010 to 2016. The measurement approaches of energy poverty were utilised based on energy consumption, energy income and multidimensional poverty index. The findings indicated that households located in rural areas of the North and Central Coast regions suffer from the impact of temperature shocks. Additionally, utilising micro household data, Son and Yoon (2020) explored the relationship between household electricity and income in Vietnam. The study found that household income emerged as a crucial determinant of electricity consumption, revealing an inequality in electricity usage among households. In addition, the correlation between energy transition, energy poverty and inequality in Vietnam was examined using household data in the period 2004 and 2016 (Nguyen, Nguyen, Hoang, Wilson, & Managi, 2019). The authors found that despite the energy transition from traditional to modern energy sources among both rural and urban residents, the households characterised by poverty and belonging to minority ethnic groups continued to rely on traditional energy sources. The study found that the alleviation of energy inequality was more pronounced compared to income and consumption inequalities.

In summary, the above literature review can be further understood through several key points. Firstly, energy poverty has been extensively investigated in many countries, employing various measurement approaches, particularly in developing countries. Secondly, despite some studies analysing energy poverty in Vietnam, previous research has primarily focused on the transition of energy poverty, the relationship between temperature shocks and energy poverty, and the investigation of how income affects access to electricity. Thirdly, rapid economic growth also provides an opportunity to improve electricity access, especially for rural residents in developing nations. Although the high rate of ability to access electricity reflects a country's efforts to limit inequality in energy transition, income inequality remains a barrier for the energy poor. Hence, our study contributes to the literature on these points. We utilise updated microdata in Vietnam to investigate energy poverty in the Central Coastal region and apply an

econometric framework to explore the determinants of energy poverty in this region that have not been studied before.

Data and Methodologies

Data

In this research, we utilize the Vietnam Household Living Standard Survey (VHLSS), conducted by the Vietnam Statistical Organization with technical support from the World Bank.

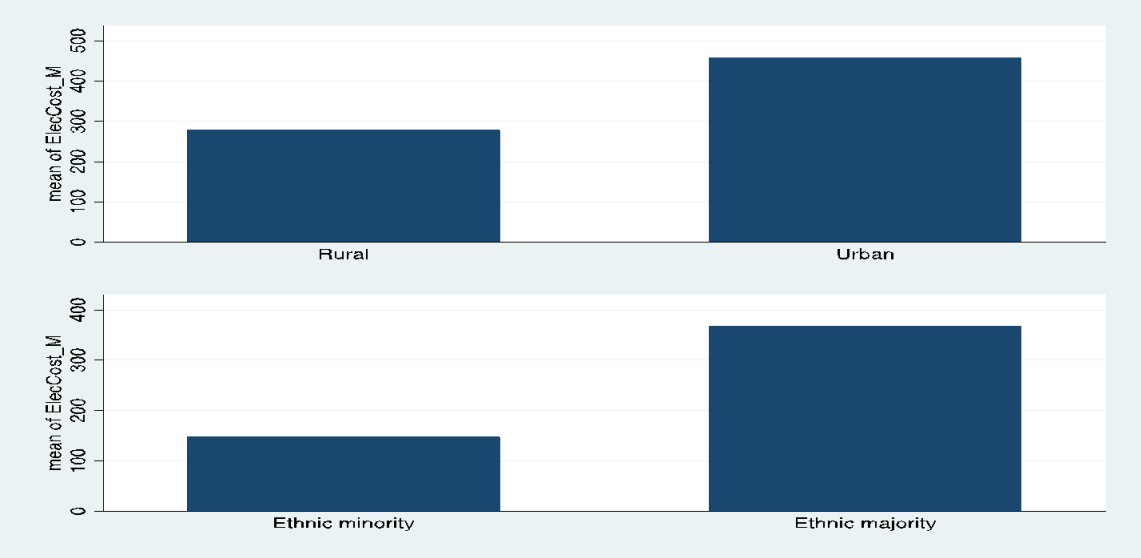

Figure 1: Average monthly expenditure on electricity costs across sectors and ethnic groups

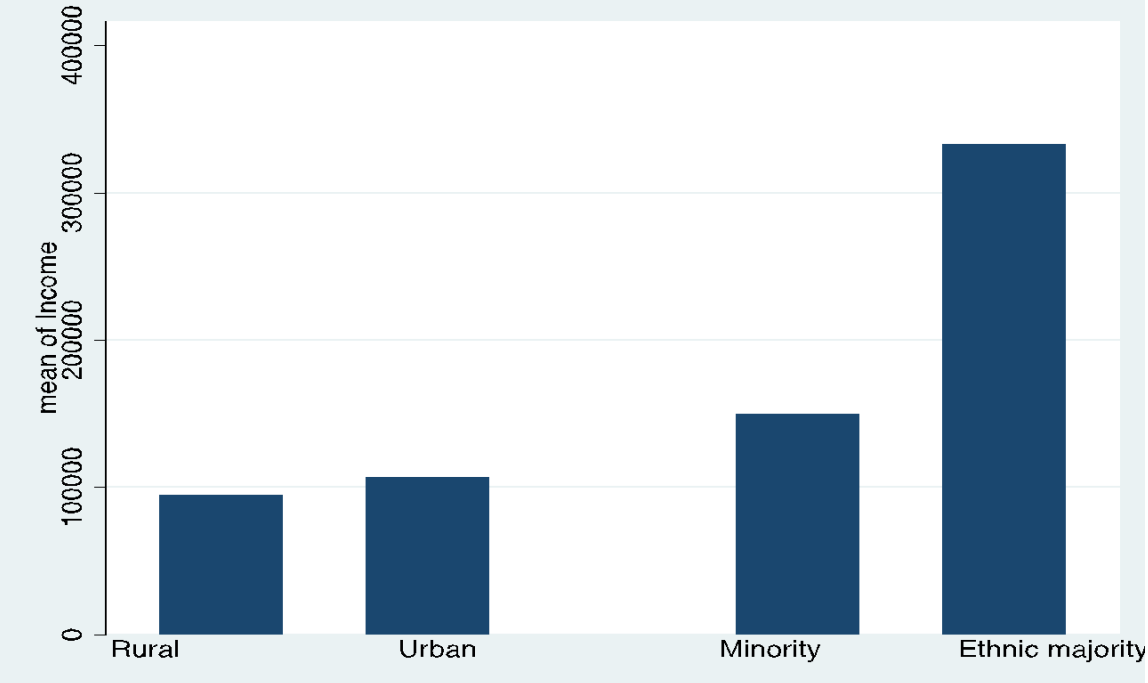

Figure 2: Average yearly income across sectors and ethnic groups

VHLSS provides socioeconomic and demographic information in the microdata, enabling a detailed analysis by residential sector (both rural and urban), income level, ethnicity and gender. The study uses

updated data from 2020, and the sample size of the VHLSS 2020 comprises 9399 households from 3133 communes across 64 provinces in Vietnam. However, the study only focuses on ten provinces in the Central Coastal region, with a sample size of 1230 households in 2020. Figure 1 and Figure 2 present significant income inequality and monthly expenditure on electricity costs across sectors and ethnic groups in this region. Detailed information on the demographic characteristics of the head of the household will be presented in Table 1.

Table 1: Summary Statistics

Demographic characteristics	Percentage	Demographic characteristics	Percentage
Ethnicity		Age category of household head	
Kinh	92.1	18-41	24.6
Other	7.9	42-59	49.6
Sector		Over 60	25.8
Urban	40.6	Education level of household head	
Rural	59.4	No schooling	17.4
Average number of employed memebers in a houshold	2.18	Primary level	30.7
Gender of household head		Secondary level	27
Male	71.87	Highschool level	15.5
Female	28.13	Advanced level and above	9.4
Average expenditure on firewood of a household	493.7	Average of energy costs as percent of income	0.195

Methodology

We examine the determinant of energy poverty in the Central Coastal region in Vietnam, encompassing ten provinces, using the estimated energy poverty. The model specification is based on the literature review, as exemplified by previous studies (Abbas, Li, Xu, Baz, & Rakhmetova, 2020; Gupta, Gupta, & Sarangi, 2020; Jayasinghe et al., 2021).

$$EP = b_0 + \sum_{i=1}^{2} b_{1i} ETHNICITY_i + + \sum_{i=1}^{2} b_{2i} URBAN_i + b_3 SIZE + b_4 NUMWORK + b_5 FHH_i + \sum_{i=1}^{3} b_{6i} AGE_i + \sum_{i=1}^{5} b_{7i} EDU_i + b_8 lnFIREWOOD + \varepsilon \quad (1)$$

is the number of employed household members in each household, and lnFIREWOOD is the logarithm of expenditure on firewood in each household. FHH represents the gender of the household head and is a

dummy variable (female=1 and 0 otherwise). Age is also a dummy variable presenting the age group of the household head with the base age group 18-41yrs; $age_{i;}$ i=1 (42, 59); i=2 (60 and over). URBAN is a dummy variable denoting the residential location of the household in urban or rural areas, with urban=1 and rural equals 0.

Equation (1) employs a quantile regression model in this study, chosen for its three advantages as outlined by Cameron and Trivedi (2010). Firstly, it permits the examination of how the distribution of energy poverty is affected by independent variables, so quantile regression allows us to understand richer data. Secondly, in cases where the data contains outliers, the quantile model proves to be more robust compared to the OLS model. Finally, since heteroskedasticity is a common characteristic of cross-sectional data used in this paper, the quantile model is well-suited for addressing this issue.

In order to analyse the determinants of energy poverty, rather than focusing on the measurement of factors' impact on energy poverty, the endogeneity problem will not be addressed in this paper. Additionally, there are specific concerns about utilising instrumental variables to tackle the endogeneity problem in non-linear models (Jayasinghe et al., 2021; Mahadevan & Hoang, 2016; Subramanian & Deaton, 1996). Hence, this paper exclusively concentrates on examining the determinants of energy poverty.

The empirical literature has witnessed substantial approaches to measuring energy poverty, given the ongoing lack of a universally defined definition for this concept. Energy poverty can be measured through both objective and subjective methods. The subjective measure is directly obtained through surveys, indicating whether a household can meet its energy needs. Objective measures comprise three common approaches. Firstly, the income and expenditure-based approach introduced by Boardman (1991) indicated that a household is energy-poor if it spends over 10% of its income on energy bills. Secondly, the low-income and high-cost measure states that a household will be considered poor if the costs of fuels are more than the median level (Hills, 2012). Lastly, the multidimensional energy poverty index involves the utilisation of several dimensions in the measurement of energy poverty (Nussbaumer, Bazilian, & Modi, 2012).

Due to the limitations in the microdata without the subjective questions related to energy poverty, this paper only employs the objective dimensions of energy poverty. Among some approaches to objective measurement of energy poverty, including measurement-based income, consumption and multidimensional index, each method still contains some limitations. In this paper, we employ the income-based energy poverty measurement introduced by Boardman (1991). This method has demonstrated yielded results compared to alternative measurements (Awaworyi Churchill, Smyth, & Trinh, 2022; Churchill & Smyth, 2021; Feeny et al., 2021).

Results

The results of OLS and quantile regression models are presented in **Table 2,** which is associated with Eq. (1)**.** In both models, the majority of the estimated coefficients are statistically significant at the 5%

and 1% levels of significance. Additionally, the consistency of the direct relationship between energy poverty and other explanatory variables is observed in both OLS and quantile regression models. Compared to the rural sector as a base dummy, urban sector households exhibit a higher degree of energy poverty.

Table 2: Determinants of energy poverty in the Central Coastal region, Vietnam

Variables	Quantile regression model	OLS model
(1)	(2)	(3)
Ethnicity	0.0532**	0.0406**
	(0.013)	(0.036)
Urban	0.0513***	0.0507***
	(0.000)	(0.000)
Household Size	0.0288***	0.0349***
	(0.000)	(0.000)
Number of employed memebers in the houshold	-0.0250***	-0.0382***
	(0.000)	(0.000)
Female-headed households (HH)	0.0282**	0.038***
	(0.026)	(0.009)
Age category of HH (base: 18-41)		
42-59	-0.0493***	-0.0449***
	(0.001)	(0.008)
Over 60	-0.0340**	-0.0286
	(0.042)	(0.120)
Education level of HH (base: no schooling)		
Primary level	-0.0268	-0.00180
	(0.109)	(0.912)
Secondary level	-0.0397**	-0.0259
	(0.023)	(0.124)
Highschool level	-0.0462**	-0.0461**
	(0.021)	(0.018)
Advanced level and above	-0.0336	-0.0321
	(0.158)	(0.217)
lnfirewood	0.0464***	0.0797***

Variables	Quantile regression model	OLS model
(1)	(2)	(3)
	(0.000)	(0.000)
Constant	-0.155***	-0.294***
	(0.000)	(0.000)
Observations	1,229	1,229
Pseudo R-squared / R-squared	0.2	0.239

Note: p-values are in parentheses, ***, **, * indicate at 1%, 5% and 10%, respectively.

Moreover, female-headed households present higher levels of energy poverty compared to male-headed counterparts. The degree of energy deprivation is lower for household heads aged 42-59 and those over 60, compared to the age category of 18 to 41 for household heads. In addition, the results suggest that higher education among household heads is associated with lower levels of energy poverty. Furthermore, households that increasingly rely on firewood show a higher prevalence of energy poverty, and larger household sizes are correlated with increased levels of energy deprivation.

Conclusion

The study fills a gap in the current literature on energy poverty by investigating its determinants in the Central Coastal region of Vietnam. Utilising an income and expenditure-based approach, we measure energy poverty as households spending more than 10% of their income on energy bills, indicating that the household is experiencing energy poverty. Over 57% of households in the Central Coastal region spend more than 10% of their income on energy bills, signifying a significant prevalence of energy poverty in the region. Furthermore, the study indicates that there is a notable inequality in energy poverty in the Central Coastal region, with a variety of socio-demographic and geographic factors serving as determinants of energy poverty in this region of Vietnam. Consequently, policy implications play a crucial role and are drawn in this study. The Vietnam energy policy should ensure that the energy poor have access to electricity, and households are willing to shilf to clean energy for cooking. In addition, it is essential to improve household income to overcome the income barrier, thereby alleviating reliance on traditional energy sources and supporting the energy poor. Furthermore, affordable pricing mechanisms and subsidising clean energy should be considered as national policies to alleviate energy poverty in Vietnam.

References

Abbas, K., Li, S., Xu, D., Baz, K., & Rakhmetova, A. (2020). Do socioeconomic factors determine household multidimensional energy poverty? Empirical evidence from South Asia. *Energy policy, 146*, 111754.

Araújo, K. (2014). The emerging field of energy transitions: Progress, challenges, and opportunities. *Energy research & social science, 1*, 112-121. doi:10.1016/j.erss.2014.03.002

Asian Development Bank. (2015). Assessment of Power Sector Reforms in Vietnam.

Awaworyi Churchill, S., Smyth, R., & Trinh, T.-A. (2022). Energy poverty, temperature and climate change. *Energy Economics, 114*, 106306. doi:10.1016/j.eneco.2022.106306

Boardman, B. (1991). Fuel poverty: from cold homes to affordable warmth. *Pinter Pub Limited.*

Cameron, A. C., & Trivedi, P. K. (2010). *Microeconometrics using stata* (Vol. 2): Stata press College Station, TX.

Churchill, S. A., & Smyth, R. (2021). Energy poverty and health: Panel data evidence from Australia. *Energy Economics, 97*, 105219.

Feeny, S., Trinh, T.-A., & Zhu, A. (2021). Temperature shocks and energy poverty: Findings from Vietnam. *Energy Economics, 99*, 105310.

General Statistics Office. (2021). Result of the Vietnam Household Living Standards Survey 2020. *Statistical Publishing House*.

Gupta, S., Gupta, E., & Sarangi, G. K. (2020). Household Energy Poverty Index for India: An analysis of inter-state differences. *Energy policy, 144*, 111592.

Halkos, G. (2017). Global energy and sustainable development: Introduction.

Hills, J. (2012). Getting the measure of fuel poverty: Final Report of the Fuel Poverty Review.

Jayasinghe, M., Selvanathan, E. A., & Selvanathan, S. (2021). Energy poverty in Sri Lanka. *Energy Economics, 101*, 105450.

Khandker, S. R., Barnes, D. F., & Samad, H. A. (2012). Are the energy poor also income poor? Evidence from India. *Energy policy, 47*, 1-12.

Lee, A. D., & Gerner, F. (2020). Learning from Power Sector Reform Experiences : The Case of Vietnam. In (Vol. 9169): World Bank, Washington, DC.

Mahadevan, R., & Hoang, V.-N. (2016). Is There a Link Between Poverty and Food Security? *Social indicators research, 128*(1), 179-199. doi:10.1007/s11205-015-1025-3

Nguyen, T. T., Nguyen, T.-T., Hoang, V.-N., Wilson, C., & Managi, S. (2019). Energy transition, poverty and inequality in Vietnam. *Energy policy, 132*, 536-548. doi:10.1016/j.enpol.2019.06.001

Nussbaumer, P., Bazilian, M., & Modi, V. (2012). Measuring energy poverty: Focusing on what matters. *Renewable & sustainable energy reviews, 16*(1), 231-243. doi:10.1016/j.rser.2011.07.150

Qurat-ul-Ann, A.-R., & Mirza, F. M. (2021). Multidimensional Energy Poverty in Pakistan: Empirical Evidence from Household Level Micro Data. *Social indicators research, 155*(1), 211-258. doi:10.1007/s11205-020-02601-7

Sadath, A. C., & Acharya, R. H. (2017). Assessing the extent and intensity of energy poverty using Multidimensional Energy Poverty Index: Empirical evidence from households in India. *Energy policy, 102*, 540-550.

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

Subramanian, S., & Deaton, A. (1996). The Demand for Food and Calories. *The Journal of political economy, 104*(1), 133-162. doi:10.1086/262020

UN. (2018). Policy Brief #8: Interlinkages Among Energy, Poverty and Inequalities. *New York.*

UNDP. (2017). Delivering Sustainable Energy in a Changing Climate—Strategy Note on Sustainable Energy 2017-2021. *New York,*.

Zhang, D., Li, J., & Han, P. (2019). A multidimensional measure of energy poverty in China and its impacts on health: An empirical study based on the China family panel studies. *Energy policy, 131*, 72-81. doi:https://doi.org/10.1016/j.enpol.2019.04.037