Journal of International Economics and Management
Journal homepage: http://jiem.ftu.edu.vn

Income and electricity consumption issue: evidence from European households

Dat Ngoc Nguyen[1]
Foreign Trade University, Hanoi, Vietnam
Duy Van Nguyen
Phenikaa University, Hanoi, Vietnam
Kien Trung Dao
Phenikaa University, Hanoi, Vietnam
Thuy Trong Than
Ho Chi Minh City University of Industry and Trade, Ho Chi Minh City, Vietnam
Dat Dinh Nguyen
Foreign Trade University, Hanoi, Vietnam

Received: 05 May 2023; **Revised:** 23 October 2023; **Accepted:** 07 December 2023
https://doi.org/10.38203/jiem.024.1.0080

Abstract

Research on electricity consumption plays an important role in the development of sustainable national strategies and mitigation of global climate change. With global economic development in general, and Europe in particular, the demand for electricity in households is increasing. Therefore, based on demand theory, this study evaluates the impact of income on electricity consumption in European households. Data were collected from 35 European countries and analyzed. The instrumental variable regression results indicate that income positively impacts electricity consumption in European households. The electricity consumption of European households provides evidence that supports the prediction of demand theory, as an increase in household income as well as a decrease in price leads to a rise in overall consumption. However, the effect of price is not statistically significant. The findings also show that population growth and inflation positively influence household electricity consumption. The outcomes of this study have theoretical and practical implications for improving energy efficiency and effective electricity use in European households. Therefore, it is necessary to continue implementing energy-saving strategies at the household level in the context of increasing electricity consumption in Europe.

Keywords: Income, Electricity consumption, Sustainability, Households, European households

[1] Corresponding author: nguyenngocdat@ftu.edu.vn

1. Introduction

Electricity consumption is crucial in sustainable development (Vasseur *et al.*, 2019). Sustainable development aims to meet the needs of the present generation without compromising the ability of future generations to meet their own needs. Electricity consumption affects the environment, economy, and society, and therefore, it is essential to manage it sustainably (Hamilton *et al.*, 2013; Nejat *et al.*, 2015). The sustainable use of electric power involves reducing the consumption of non-renewable resources, minimizing greenhouse gas emissions, and improving energy efficiency (Hamilton *et al.*, 2013). The use of renewable energy sources such as solar, wind, and hydroelectric power can significantly reduce the reliance on non-renewable resources and minimize the carbon footprint (Nejat *et al.*, 2015). Moreover, sustainable electricity consumption can contribute to the economic development of a country by reducing energy costs, creating job opportunities in the renewable energy sector, and promoting energy independence (Kotsila and Polychronidou, 2021). Sustainable electricity consumption can also improve people's quality of life by providing access to reliable and affordable energy, reducing the health risks associated with pollution from non-renewable sources, and enhancing the resilience of communities to natural disasters. In conclusion, sustainable electricity consumption is critical to sustainable development (Lu *et al.*, 2020). It requires a concerted effort from individuals, companies, and governments to reduce energy consumption, promote renewable energy sources, and improve energy efficiency (Lu *et al.*, 2020; Nejat *et al.*, 2015). We can create a more sustainable and equitable world for future generations by adopting sustainable electricity consumption practices.

Economic development and household electricity consumption are closely related (Alberini *et al.*, 2011; Kotsila and Polychronidou, 2021; Kwakwa, 2021; Narayan and Smyth, 2005). As a country's economy grows, there is usually an increase in the number of households and, consequently, a rise in the electricity demand (Kotsila and Polychronidou, 2021; Lianwei and Wen, 2021; Lu, 2006). This is because economic development increases the standard of living and the number of appliances and gadgets used in households (Lianwei and Wen, 2021; Weber and Perrels, 2000). In developing countries, the level of economic development is typically low, and as such, the demand for electricity is also low (Stern, 2019; Wolfram *et al.*, 2012). However, as the economy improves, there is an increase in the demand for electricity as households acquire more appliances and gadgets (Lianwei and Wen, 2021; Lu, 2006). On the other hand, in developed countries, the level of economic development is typically high, and the electricity demand is also increased due to the high standard of living and the widespread use of appliances and gadgets (Lianwei and Wen, 2021; Lu, 2006).

Energy consumption in general and electricity consumption in particular in households have received much attention in debates on urban sustainability and housing policies due to the potential consequences of climate change (Vasseur *et al.*, 2019). In Europe, the civil industry accounts for about one-third of energy consumption and is responsible for 16% of total CO2 emissions (Vasseur *et al.*, 2019). Households have been promoted as the main actors that can play an important role in reducing energy usage.

There are several studies on the factors influencing household electricity consumption behavior (Ding and Peng, 2020; Ekholm *et al.*, 2010; Lianwei and Wen, 2021). Many researchers have pointed out that income distribution and personal preferences play a role in increasing household energy consumption (Ding and Peng, 2020; Ekholm *et al.*, 2010; Fan *et al.*, 2017). Some studies have shown that public utilities help reduce household energy consumption (Ding and Peng, 2020). Some studies show differences in electricity consumption across different geographical regions (Ding and Peng, 2020; Lianwei and Wen, 2021). Therefore, examining the influence of income on electricity consumption in different contexts or regions may yield different and intriguing results.

Climate change and energy consumption are considered important issues in the European region. However, specific research on income, economic development, and household electricity consumption has not been conducted. There is still much debate about the relationship between income and electricity consumption. High income may increase the electricity demand (Louw *et al.*, 2008), but it can also lead to investment in energy-saving devices. This study aims to investigate the relationship between income and electricity consumption levels in European households. The question is whether increasing income only leads to an increase in electricity demand or if there are other positive effects. The study will examine the existence of the demand theory in explaining the relationship between income and household electricity consumption. Based on these findings, government policies can be formulated to help households achieve efficiency and save electricity usage in the context of rising incomes.

The remainder of this study is organized as follows. Section 2 presents the theoretical framework and reviews relevant research. At the same time, the theoretical relationship between income and electricity consumption in households is presented based on demand theory. Section 3 presents research methods. Results are presented and discussed in section 4, and conclusions are drawn in section 5.

2. Literature review

2.1 Electricity consumption behavior in households

Electricity consumption refers to the various actions and behaviors that result from using electrical energy (Guo *et al.*, 2018; Matsumoto *et al.*, 2022). These activities can include turning on lights, using electronic devices such as televisions and computers, charging mobile phones and other electronic devices, using heating and cooling systems, cooking with electrical appliances, and operating machinery and equipment that requires electricity (Guo *et al.*, 2018; Matsumoto *et al.*, 2022; Widen and Wackelgard, 2010). The frequency, duration, and intensity of these activities can vary depending on individual preferences, lifestyle, and work requirements (Kamaludin, 2013). Electricity consumption activities are essential for modern living, but they also have a significant impact on the environment and can cause climate change if they are not managed efficiently (Thivel *et al.*, 2013).

2.2 Electricity consumption activities in households in Europe

Electricity consumption in European households has been a topic of interest for researchers and policymakers due to its impact on energy efficiency, climate change, and the economy (Matsumoto *et al.*, 2022). Several studies have been conducted to understand the patterns and determinants of electricity consumption in European households. One of the key findings of these studies is that household electricity consumption varies significantly across European countries (Jones and Lomas, 2015; Matsumoto *et al.*, 2022). For example, households in Northern European countries such as Sweden and Denmark consume less electricity compared to Southern European countries like Italy and Greece. This can be attributed to differences in climate, housing types, and cultural factors.

Another important factor that influences electricity consumption in households is income. Studies have found that households with higher incomes consume more electricity than those with lower incomes (Louw *et al.*, 2008). This is because higher-income households can afford to purchase energy-intensive appliances and have larger homes that require more energy for heating and cooling (Louw *et al.*, 2008; Sovacool, 2011). The type of housing also plays a significant role in electricity consumption. For example, households living in apartments consume less electricity than those living in detached houses (Louw *et al.*, 2008; Sovacool, 2011). This can be attributed to the fact that apartments are usually smaller and more compact, requiring less energy for heating and cooling. The age of the household members is also an important factor in electricity consumption. Studies have found that households with children consume more electricity than households without children (Yunusov and Torriti, 2021). These households consume more energy for cooking, cleaning, and entertainment.

2.3 The theoretical framework

Demand theory is a fundamental concept in economics that explains the relationship between the price of a goods or service, income, and the quantity that consumers are willing to purchase at that price (Cleland and Wilson, 1987; Moscati, 2007). The theory suggests that as the price of a good or service increases, the demand will decrease, and as the price decreases, the demand will increase (Cleland and Wilson, 1987; Moscati, 2007). This inverse relationship between price and demand is known as the law of demand (Tan *et al.*, 2015). The theory also considers other factors influencing demand, such as consumer income, preferences, and expectations (Louw *et al.*, 2008; Sovacool, 2011). Accordingly, if a consumer's income increases, they may be willing to purchase more of a good or service even if the price remains the same. Similarly, if a consumer’s preferences shift towards a particular product or service, demand for that item may increase (Louw *et al.*, 2008; Sovacool, 2011).

2.4 Hypothesis development

In household electricity consumption, when households have a higher income, they will desire to buy more of their own consumption devices, such as buying more devices to satisfy their hobbies (cooking, entertainment, increasing the convenience of life) (Kwakwa, 2021; Louw *et al.*, 2008; Sovacool, 2011). While higher-income individuals may allocate more

money towards entertainment and conveniences, lower-income individuals often focus on basic needs such as food, shelter, and education (Kwakwa, 2021). According to demand theory, as income increases, there is a tendency to increase the level of household electricity consumption. Therefore, the research hypothesis is as follows:

H1: Income has a positive impact on households' electricity consumption.

3. Research method

3.1 Research model

Based on the Demand theory and previous studies (Kotsila and Polychronidou, 2021; Matsumoto *et al.*, 2022), a research model is constructed as follows:

$$Electricity\ consumption_{it} = \alpha_i + \beta_1 Income_{it} + \beta_2 Price_{it} + \sum_{j=1}^{n} \beta_j Control\ variables_{it} + v_i + \varepsilon_{it}\ .$$

The variables are described in Table 1.

Table 1. The variables

Variables	Content	Reference	Expected
Dependent variable			
EC	Electricity consumption in households (Thousand tonnes of oil equivalent)	Matsumoto *et al.* (2022)	
Independent variable			
Income	GDP per capita	Matsumoto *et al.* (2022), Kotsila and Polychronidou (2021)	+
PR	Electricity price	Lianwei and Wen (2021)	-
Control variables			
POP	Population total		+
INF	Inflation (annual %)		-

Source: Authors' compilation

In addition to evaluating the impact of income on electricity consumption, we also used control variables such as population and inflation. An increase in the population leads to a higher demand for electricity in countries (Fan *et al.*, 2017). High inflation indicates a general rise in the prices of goods, causing households to change their electricity consumption habits to save costs (Gunay, 2016). A high electricity price results in households paying higher electricity bills, causing them to consume less to meet their expected spending levels (Ding and Peng, 2020; Lianwei and Wen, 2021).

3.2 Data collection

The data were collected for 35 European countries from 2010 to 2021 from two open data sources. Firstly, data on independent and control variables were collected from the World Bank's official website. Secondly, the dependent variable on household electricity consumption was collected on Eurostat. The data were collected individually and then aggregated into one

comprehensive data file before being analyzed on STATA software. The data were cleaned, and countries with insufficient data from 2010 to 2021 were removed before being entered into the STATA software.

3.3 Data analysis

With data collected from European countries from 2010 to 2021, data analysis of the appropriate table is conducted for this study. Initially, basic models such as fixed effects model (FEM) and random effects model (REM) are implemented, and the Hausman test is used to select the appropriate model. If the model encounters autocorrelation or heteroskedasticity phenomena, adjusted models such as generalized least squares (GLS) or robustness will be used. Additionally, to ensure that the model is not affected by endogeneity, the study analyzes the instrumental variables (IVs) model for handling endogeneity through two-stage least squares regression (2SLS). 2SLS regression analysis is a statistical technique used to analyze structural equations. This technique is an extension of the ordinary least squares regression method. It is used when there are errors in the dependent variable that are correlated with the independent variables. The final analysis through the IVs model will be used in this study.

4. Results and discussion

4.1 Descriptive analysis

After being inputted into the STATA software, the data will be described to provide preliminary information about the data. The statistical results indicate that the mean of EC is 8986, with the maximum being 63839 and the minimum being 68. The mean of income is 31,972 USD/year, with the largest being 134,000 USD/year and the minimum being 2,124 USD/year. The mean of population is 163 million people, with the maximum being 83 million people and the minimum being 0.3 million people. The mean of inflation rate is 2%, with the maximum being 48.7% and the minimum being -2.09%. Details can be found in Table 2.

Table 2. Summary statistics

Variables	Obs.	Mean	Median	SD	Min	Max
EC	420	8986.36	4146.28	13320.66	68.76	63839.12
INCOME	420	31972.402	24407.341	25478.898	2124.662	1.34e+05
PR	420	0.176	0.099	0.023	0.501	0.192
POP	420	1.63e+07	6.98e+06	2.21e+07	3.18e+05	8.32e+07
INF	420	2.095	1.717	3.122	-2.097	48.700

Source: Authors' calculation

In addition to overall statistics, the study presents variable changes each year. It can be seen that the trend of electricity consumption in households tends to decrease from about 10000 thousand tonnes of oil equivalent in 2010 to about 8000 thousand tonnes of oil equivalent in 2021. However, the trend of Income is not clear. There are different changes between years and changes in population and inflation. Detailed data over the years are presented in Table 3.

Table 3. The variables by year

year	mean(EC)	mean(INCOME)	mean(POP)	mean(INF)	Mean (PR)
2010	10188.07	29825.97	16164193	2.57	0.170
2011	9183.23	32468.41	16151054	3.77	0.178
2012	9597.77	30681.82	16179617	2.89	0.188
2013	9688.63	32057.81	16220232	1.69	0.189
2014	8534.95	32713.89	16259673	0.85	0.189
2015	8770.61	28589.12	16298297	1.87	0.184
2016	8986.15	29205.23	16334379	0.84	0.185
2017	8952.01	31274.54	16360934	2.30	0.189
2018	8928.89	33908.89	16387327	2.23	0.201
2019	8800.60	33174.22	16400183	1.93	0.204
2020	7942.54	32446.33	16407383	1.01	0.203
2021	8187.39	37322.60	16388523	3.18	0.218

Source: Authors' calculation

4.2 Regression

The variables EC (Electricity Consumption), INCOME, and PR (Electricity Price) are taken in logarithm form when conducting regression analysis. The Hausman test results indicate that the FEM model is more appropriate than the REM model. However, tests for autocorrelation and heteroskedasticity indicate that both models exhibit these phenomena. We adjust the model through GLS to address these issues. Additionally, instrumental variable regression (IV) is used to address the endogeneity issue in the model. Difference generalized method of moments (DGMM) model is not performed in this model because the number of countries analyzed is 35 and the number of instruments used is large, so DGMM is not suitable for this case (although DGMM can also address endogeneity issues). At the same time, panel data with short time series should be tested for stationarity, which is rarely used in studies using panel data. The results of the IV and GLS models are almost indistinguishable. In Table 4, models (1) and (2) display the regression results using FEM and REM. Model (3) presents the results of the generalized least squares (GLS) model. Model (4) excludes the variable Price as an independent variable due to its strong correlation with the independent variable INF. Additionally, model (5) is conducted without INF. Simultaneously, from an economic theory perspective, inflation can affect electricity prices, and conversely, electricity prices can also impact inflation. Therefore, in this case, the endogenous variables used in models (4) and (5) are Electricity Price and Inflation. This is also the reason why INF and LnPr do not appear together in a single equation.

We use the Hansen test, the underidentification test (UIT), and the weak identification test (WIT) to check the concordance of the Instrumental variable. The results of the IV-2SLS analysis indicate that the Instrumental variable used is appropriate (Table 4). The best

model to use is a combination of both models (4) and (5). This is especially valid when all the tests are satisfied, and there is no significant difference in the effect of Income in both models (4) and (5). Combining these models can provide a more comprehensive and robust analysis.

The results all indicate that INCOME has a positive and statistically significant impact on EC. Therefore, it is possible to conclude that the research hypothesis is accepted. POP has a positive and statistically significant impact on EC. INF has a positive and statistically significant impact on EC. The electricity price has no impact on EC (the beta is insignificant). The regression results are described in detail in Table 4.

Table 4. The result of regression

	(1)	(2)	(3)	(4)	(5)
LnEC	**FEM**	**REM**	**GLS**	**IV**	**IV**
LnINCOME	0.105***	0.143***	0.337***	0.140***	0.152***
	(0.028)	(0.026)	(0.019)	(0.042)	(0.0508)
LnPR					-0.064
					(0.042)
LnPOP	0.753***	0.993***	1.005***	0.864**	0.958**
	(0.131)	(0.037)	(0.011)	(0.406)	(0.361)
INF	0.001	0.002	0.029***	0.008***	
	(0.001)	(0.001)	(0.005)	(0.002)	
Constant	-4.753**	-8.889***	-11.08***		
	(2.076)	(0.652)	(0.263)		
Country	Yes	Yes	Yes	Yes	Yes
Observations	420	420	420	420	420
Number of countries	35	35	35	35	35
Hausman test		0.005			
Autocorrelation test		0.000			
Heteroskedasticity test		0.000			
Endogeneity test				0.228	0.283
UIT				0.001	0.000
WIT- Kleibergen-Paap				14.512	146.991
Hansen J test				0.114	0.093

Notes: Standard errors are in parentheses. *, **, and *** indicate statistical significance at 10%, 5%, and 1%, respectively.

Source: Authors' calculation

4.3 Discussion

The results indicate that INCOME has a positive impact on EC, and show that when countries increase their average income levels, household electricity consumption will increase. This result is consistent with the demand theory. People with a higher income will desire a better quality of life. Households are willing to buy more electricity-consuming devices even if their prices do not decrease (Kwakwa, 2021). Therefore, household energy consumption still increases significantly when people's incomes increase. This result is consistent with previous studies that have all indicated the positive impact of income on EC (Kwakwa, 2021; Louw *et al.*, 2008; Sovacool, 2011).

The POP control variable positively impacts electricity consumption in European countries, indicating that population growth is a pressure on electricity demand. Although the population growth rate in European countries is considered low, with -0.1% in 2021 (Word Bank, 2023), this shows that population issue is also a problem that needs to be forecasted so that countries can plan for household electricity supply. The recent decrease in population has led to a reduction in electricity consumption per capita. If the current trend of population decline continues, the proportion of electricity consumption in European households will continue to decrease further. This result is consistent with previous studies by Yunusov and Torriti (2021), which indicated that POP has a positive impact on household electricity consumption.

The impact of inflation on the economy has an upward effect on household electricity consumption. The macroeconomic market fluctuations affect the electricity consumption level in households. When inflation occurs, the cost of goods and services increases, including energy cost. This can lead to increased production and consumption of goods and services, leading to increased demand for electricity (D'Acunto *et al.*, 2016; Gustafson, 2013). Furthermore, inflation can also encourage investment in infrastructure and energy technology. As energy cost rises, businesses and governments may be willing to invest in renewable energy sources and energy-saving technologies, helping to reduce long-term energy costs and promote sustainability.

Finally, electricity prices have no impact on household electricity consumption. This indicates that increases in electricity prices do not change the level of household electricity consumption in Europe. Europe has made significant progress in adopting renewable energy sources. The increased availability of renewable energy has stabilized electricity prices to some extent, as the cost of generation is less dependent on fluctuating fossil fuel prices (European Commission, 2019). This price stability might reduce the perceived impact of price changes on household consumption. Some European countries have implemented social welfare policies or subsidies to mitigate the impact of electricity price increases on vulnerable households. These measures ensure that electricity remains affordable, reducing the sensitivity of consumers. This result is consistent with the previous study, showing no relationship between energy price and electricity consumption (Olutomi and Lester, 2007).

5. Conclusion

This study aims to understand the theoretical relationship between income and household electricity consumption. Based on theoretical literature and previous research, we synthesized a demand theory that could explain this relationship. The study also built a model to evaluate the impact of income on household electricity consumption in Europe. Based on data collected from 35 European countries from 2010 to 2021, the results show that income positively impacts household electricity consumption. The study also revealed the positive impact of population growth on household electricity consumption. From the results of this study, we pointed out some implications both in theory and practice.

From the research results, the study has made significant contributions in terms of theory by pointing out the existence of demand theory in the relationship between income and electricity consumption in European households. The demand theory has explained that when household income increases, it increases the demand for consumption in general and electricity consumption in particular (buying more electrical devices, using electrical devices for extended periods, and more frequently).

The research also suggests some practical implications for the stakeholders based on the research results. Firstly, for those whose income increases and therefore increases household electricity consumption, policies that encourage the use of energy-saving and efficient electricity are still needed and should continue to be implemented in households. Secondly, in addition to promoting energy-saving and efficient electricity usage behavior, using energy-saving devices is also a factor that helps reduce electricity consumption in the context of increasing use of electrical appliances in households. Although studies have shown the positive impact of income on household electricity consumption, there are still some limitations to the research. Firstly, we only assessed the GDP per capita of each country and did not evaluate each household's income and electricity consumption. Secondly, changes in income levels from developing to developed countries or vice versa can affect household electricity consumption in each country. This study has not yet examined household electricity consumption changes (income jumps).

We suggest some ideas for further research on the same topic from these limitations. Firstly, future studies should use surveys on income and electricity consumption in each household to examine the details of each household as well as conduct surveys for each country and compare the differences between different countries. Secondly, future research should evaluate the income jump in household electricity consumption in countries. Reducing or increasing income may stimulate or restrain the demand for electricity consumption in countries.

Acknowledgment: This study is funded by Foreign Trade University under research program number FTURP02-2020-11.

References

Alberini, A., Gans, W. and Velez-Lopez, D. (2011), "Residential consumption of gas and electricity in the US: the role of prices and income", *Energy Economics,* Vol. 33 No. 5, pp. 870 - 881.

Cleland, J. and Wilson, C. (1987), "Demand theories of the fertility transition: an iconoclastic view", *Population Studies,* Vol. 41 No. 1, pp. 5 - 30.

D'Acunto, F., Hoang, D. and Weber, M. (2016), "Unconventional fiscal policy, inflation expectations, and consumption expenditure", CESifo Working Paper Series 5793, CESif, Munich.

Ding, Y.X. and Peng, S. (2020), "Study on the spatial distribution and influencing factors of household energy consumption in China", *Resource Development Market,* Vol. 36 No. 4, pp. 366 - 370.

Ekholm, T., Krey, V., Pachauri, S. and Riahi, K. (2010), "Determinants of household energy consumption in India", *Energy Policy,* Vol. 38 No. 10, pp. 5696 - 5707.

European Commission. (2019), "Fourth report on the state of the energy union", Available at https://commission.europa.eu/publications/fourth-report-state-energy-union_en (Accessed 23 May, 2021).

Fan, J.L., Zhang, Y.J. and Wang, B. (2017), "The impact of urbanization on residential energy consumption in China: an aggregated and disaggregated analysis", *Renewable and Sustainable Energy Reviews,* Vol. 75, pp. 220 - 233.

Gunay, M.E. (2016), "Forecasting annual gross electricity demand by artificial neural networks using predicted values of socio-economic indicators and climatic conditions: case of Turkey", *Energy Policy,* Vol. 90, pp. 92 - 101.

Guo, Z., Zhou, K., Zhang, C., Lu, X., Chen, W. and Yang, S. (2018), "Residential electricity consumption behavior: influencing factors, related theories and intervention strategies", *Renewable and Sustainable Energy Reviews,* Vol. 81 Part 1, pp. 399 - 412.

Gustafson, D.J. (2013), "Rising food costs & global food security: key issues & relevance for India", *Indian Journal of Medical Research,* Vol. 138 No. 3, pp. 398 - 410.

Hamilton, I.G., Steadman, P.J., Bruhns, H., Summerfield, A.J. and Lowe, R. (2013), "Energy efficiency in the British housing stock: energy demand and the homes energy efficiency database", *Energy Policy,* Vol. 60, pp. 462 - 480.

Jones, R.V. and Lomas, K.J. (2015), "Determinants of high electrical energy demand in UK homes: socio-economic and dwelling characteristics", *Energy and Buildings,* Vol. 101, pp. 24 - 34.

Kamaludin, M. (2013), "Electricity consumption in developing countries", *Asian Journal of Research in Social Sciences and Humanities,* Vol. 2 No. 2, pp. 84 - 90.

Kotsila, D. and Polychronidou, P. (2021), "Determinants of household electricity consumption in Greece: a statistical analysis", *Journal of Innovation and Entrepreneurship,* Vol. 10 No. 1, pp. 1 - 20.

Kwakwa, P.A. (2021), "The carbon dioxide emissions effect of income growth, electricity consumption and electricity power crisis", *Management of Environmental Quality: An International Journal,* Vol. 32 No. 3, pp. 470 - 487.

Lianwei, Z. and Wen, X. (2021), "Urban household energy consumption forecasting based on energy price impact mechanism", *Frontiers in Energy Research,* Vol. 9, 802697.

Louw, K., Conradie, B., Howells, M. and Dekenah, M. (2008), "Determinants of electricity demand for newly electrified low-income African households", *Energy Policy,* Vol. 36 No. 8, pp. 2812 - 2818.

Lu, H. (2006), "An empirical analysis of the impact of farmers' income level on the household energy consumption structure in the countryside", *Finance and Trade Research,* Vol. 3, pp. 28 - 34.

Lu, Y., Khan, Z.A., Alvarez-Alvarado, M.S., Zhang, Y., Huang, Z. and Imran, M. (2020), "A critical review of sustainable energy policies for the promotion of renewable energy sources", *Sustainability,* Vol. 12 No. 12, 5078.

Matsumoto, S., Mizobuchi, K. and Managi, S. (2022), "Household energy consumption", *Environmental Economics and Policy Studies,* Vol. 24, pp. 1 - 5.

Moscati, I. (2007), "Early experiments in consumer demand theory: 1930-1970", *History of Political Economy,* Vol. 39 No. 3, pp. 359 - 401.

Narayan, P.K. and Smyth, R. (2005), "Electricity consumption, employment and real income in Australia evidence from multivariate Granger causality tests", *Energy Policy,* Vol. 33 No. 9, pp. 1109 - 1116.

Nejat, P., Jomehzadeh, F., Taheri, M.M., Gohari, M. and Majid, M.Z.A. (2015), "A global review of energy consumption, CO2 emissions and policy in the residential sector (with an overview of the top ten CO2 emitting countries)", *Renewable and Sustainable Energy Reviews,* Vol. 43, pp. 843 - 862.

Olutomi, A.I. and Lester, H.C. (2007), "Modelling OECD industrial energy demand: asymmetric price responses and energy-saving technical change", *Energy Economics,* Vol. 29 No. 4, pp. 693 - 709.

Sovacool, B.K. (2011), "Conceptualizing urban household energy use: climbing the energy services ladder", *Energy Policy,* Vol. 39 No. 3, pp. 1659 - 1668.

Stern, D.I. (2019), "Energy and economic growth", in Soytas, U. and Sari, R. (Eds.), *Routledge Handbook of Energy Economics,* Routledge, London, pp. 28 - 46.

Tan, Z., Ju, L., Reed, B., Rao, R., Peng, D., Li, H. and Pan, G. (2015), "The optimization model for multi-type customers assisting wind power consumptive considering uncertainty and demand response based on robust stochastic theory", *Energy Conversion and Management,* Vol. 105, pp. 1070 - 1081.

Thivel, D., Tremblay, M.S. and Chaput, J.P. (2013), "Modern sedentary behaviors favor energy consumption in children and adolescents", *Current Obesity Reports,* Vol. 2, pp. 50 - 57.

Tinbergen, J. (1975), *Income differences: recent research,* North-Holland Publisher, Amsterdam.

Vasseur, V., Marique, A.F. and Udalov, V. (2019), "A conceptual framework to understand households' energy consumption", *Energies,* Vol. 12 No. 22, 4250.

Weber, C. and Perrels, A. (2000), "Modelling lifestyle effects on energy demand and related emissions", *Energy Policy,* Vol. 28 No. 8, pp. 549 - 566.

Widen, J. and Wackelgard, E. (2010), "A high-resolution stochastic model of domestic activity patterns and electricity demand", *Applied Energy,* Vol. 87 Vol. 6, pp. 1880 - 1892.

Wolfram, C., Shelef, O. and Gertler, P. (2012), "How will energy demand develop in the developing world?", *Journal of Economic Perspectives,* Vol. 26 No. 1, pp. 119 - 138.

World Bank. (2023), "Data World Bank", Available at https://data.worldbank.org/indicator/SP.POP.TOTL (Accessed 10 April, 2023).

Yunusov, T. and Torriti, J. (2021), "Distributional effects of time of use tariffs based on electricity demand and time use", *Energy Policy,* Vol. 156, 112412.