Nguyen, Dung Tien; Thanh Quang Ngo

Article

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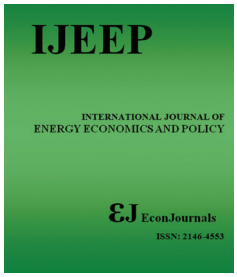

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Dynamics of Household-level Energy Access in Vietnam during 2002-2014

Dung Tien Nguyen[1], Thanh Quang Ngo[2]*

[1]University of Economics and Law, Vietnam National University Ho Chi Minh City, Ho Chi Minh City, Vietnam, [2]Nguyen Tat Thanh University, Ho Chi Minh City, Vietnam. *Email: nqthanh@ntt.edu.vn

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ABSTRACT

The energy sector in Vietnam, a country in energy transition, plays a vital role in the country's economic growth and development. In the current paper, we perform a critical analysis of the dynamics of energy access status in Vietnam, using nationally representative household surveys in seven waves from 2002 till 2014. We find that the most important drivers of the household energy transition are income, urbanization, demographic factors, and the geographic variations. In the future, policies on the pace of urbanization and growth of household income will have a significant impact on the rate of the household energy transition. In addition, social policies aimed at providing greater access to higher education may also influence the pace of the transition. A balanced growth model among different geographic regions can also contribute to a more balanced distribution of energy consumption in Vietnam.

Keywords: Household, Energy Access, Vietnam
JEL Classifications: D11, R22

1. INTRODUCTION

Energy access plays a crucial role in sustainable development in developing world (World Bank [2001], DfID [2002], UNDP [2005]). A growing body of literature points out the significance of greater access to clean and more efficient energy supplies in terms of better welfare and well-being resulting from its linkage benefits to every aspects of development such as improved human health, higher literacy and education (Khandker et al., [2009]; Cabraal et al., [2005]; UN [2002]; Roddis [2000]), enhanced productive effectiveness (UN-Energy, 2005), poverty alleviation (Balachandra [2011]; Cherni et al. [2007]; Haanyika [2006]; Sagar [2005]; UN [2002]) and environment with a recent emphasis on climate change (Ezzati and Kammen, 2002).

There are several studies, which have primarily focused on providing greater insights into current status of access to modern energy carriers and services in the developing countries such as India and China (Pachauri and Jiang, 2008), Australia, Brazil, Denmark, India and Japan (Lenzen et al., 2006), Bolivia, Tanzania and Vietnam (Kooijman-van Dijk and Clancy, 2010), eighteen countries (Nakagami et al., 2008), Brazil, Ghana, Guatemala, India, Nepal, Nicaragua, South Africa, and Vietnam (Heltberg, 2004). These insights have been found to be useful in arriving at alternate strategies including developing future scenarios, estimating investments required and adopting low carbon pathways in achieving universal energy access. The above studies indicate a number of factors affecting household energy transitions, including: Household income, energy prices, costs and quality of supply, and urbanization in determining household energy choices.

Vietnam energy sector plays a vital role in the country's economic growth and development (Luong [2015]; Do and Sharma [2011]; Toan et al. [2011]; Nguyen [2007]; Nguyen [2007]). However, this role is facing some challenges, including ensuring security of energy supply and protecting the environment while maintaining the social and political priorities such as equity, justice, and

transparency (Do and Sharma, 2011). The energy access situation in Vietnam, both in terms of access to cooking and lighting are discussed extensively in the literature (Luong [2015]; Do and Sharma [2011]; Toan et al. [2011]; Tuan and Lefevre [1996]; Tuan and Lefevre [1996]). The focus is predominantly on assessing the current status of access to modern energy carries, analyzing the extent of household dependencies on both traditional and modern fuels, and discussing earlier efforts in expanding rural energy access through policy initiatives and programs. However, a rigorous study capturing the variations in energy access levels across regions in Vietnam, influence of income level on energy access, urban-rural gaps in energy access and the past trends in energy access growth is lacking in the literature. In order to design and implement strategies enabling expansion of energy access in Vietnam, it is essential to have a greater understanding of the dynamics of energy access. As a contribution to bridge this knowledge gap, in this paper, we have presented a detailed analysis of the temporal, income and regional dynamics of energy access situation in Vietnam. Specifically, it is proposed to respond to the following questions by synthesizing the status of access to modern energy carriers in Vietnam:

First, how the access levels to modern energy carriers have changed overtime in Vietnam?

Second, how these access levels vary with income?

Third, how the energy access levels are differentiated across regions in Vietnam?

Findings from our study may provide useful information for policy makers as well as development agencies on energy access in Vietnam. Specially, findings from the temporal, income and regional dynamics of energy access at the household level can be useful inputs for policies to speed up rural development. Our findings may also provide important implications for other emerging and transition economies similar to Vietnam.

The remaining part of the paper is organized as follows: Section 2 describes the dataset. Section 3 verifies factors affecting household energy transition in Vietnam. Section 4 concludes.

2. VIETNAM HOUSEHOLD LIVING STANDARD SURVEY (VHLSS) DATASET AND HOUSEHOLD ENERGY CONSUMPTION

This study is largely based on a large household survey, namely VHLSS of seven waves between 2002 and 2014. For VHLSS in 2002 till 2008, it is carried out by General Statistic Office of Vietnam and under the assistance by a Swedish survey statistician and World Bank staff. The sampling frame in this period was based on a population census in 1999, whereas the sampling frame for VHLSS from 2010 till 2016 is derived from a population census in 2009. The 1999 Census is a status of the Vietnamese population as of April 1st 1999. The 2009 Census was carried out in April 2009, exactly 10 years after the 1999 Census. The VHLSS data are considered to be of high quality and a source of legitimate nationally representative household data for Vietnam. Many researches employ the VHLSSs in their analyses (Mont and Cuong, [2011], Imai et al., [2011], Oostendorp et al., [2009]).

In the survey the respondents were asked to state, among others, their energy consumption for different energy forms in energy and expenditure terms in the past 30 days. In addition to expenditure, the survey also includes home-grown fuel sources for traditional fuels. The VHLSS surveys are representative at national, regional, urban and rural levels.

A summary of households' cooking consumption in 2002-2014 is presented in Table 1.

It is calculated that about nearly 80% and 83% of the total household cooking energy consumption is derived from coal and natural gas in 2002, respectively. These shares for coal and natural gas decline to 52% and 70% in 2014, respectively. Instead, share of gasoline increases to about 83% in 2014. A large decrease in share of kerosene happens between 2002 and 2014, from 52% down to 6%.

Table 1: Sample of households' cooking consumption, 2002-2014

Year	Number of observations (%)						
	2002	2004	2006	2008	2010	2012	2014
Coal							
No	6044 (20.47)	2271 (24.72)	2345 (25.52)	2736 (29.77)	3604 (38.34)	3861 (41.48)	4482 (48.22)
Yes	23,488 (79.53)	6917 (75.28)	6844 (74.48)	6453 (70.23)	5795 (61.66)	5447 (58.52)	4812 (51.78)
Kerosene							
No	14,084 (47.69)	5067 (55.15)	5792 (63.03)	5559 (60.50)	8015 (85.28)	8479 (91.09)	8715 (93.77)
Yes	15,448 (52.31)	4121 (44.85)	3397 (36.97)	3630 (39.50)	1384 (14.72)	829 (8.91)	579 (6.23)
Natural gas							
No	24,574 (83.21)	6577 (71.58)	5923 (64.46)	5013 (54.55)	4273 (45.46)	3530 (37.92)	2834 (30.49)
Yes	4958 (16.79)	2611 (28.42)	3266 (35.54)	4176 (45.45)	5126 (54.54)	5778 (62.08)	6460 (69.51)
Gasoline							
No	18,199 (61.62)	4558 (49.61)	3812 (41.48)	2879 (31.33)	2637 (28.06)	2108 (22.65)	1621 (17.44)
Yes	11,333 (38.38)	4630 (50.39)	5377 (58.52)	6310 (68.67)	6762 (71.94)	7200 (77.35)	7673 (82.56)

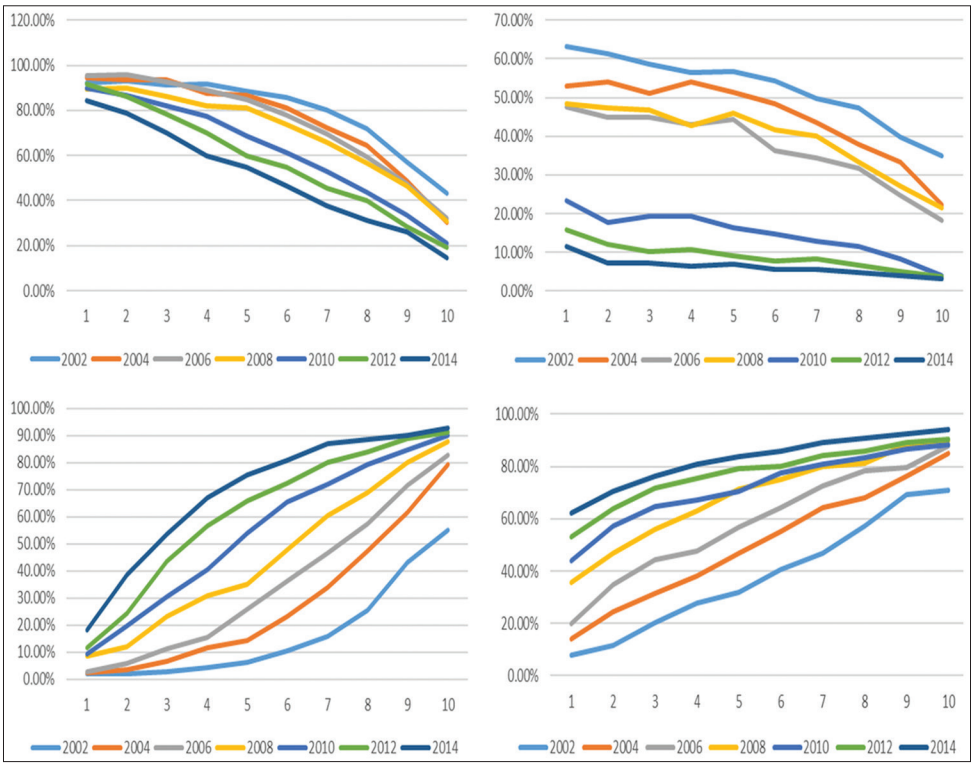
Questions: Which of the following items has your household consumed over the past 30 days? Choosing from one or more of these: (1) Coal, (2) Coal briquette, (3) Petroleum, (4) Kerosene, (5) Mazut oil, (6) Diesel oil, (7) Lubricant, (8) LPG, (9) Natural gas, (10) Firewood, (11) By-products, and (12) other. These answers are grouped into four groups: (1) Coal (including: coal, coal briquette, firewood, and by-products), (2) Kerosene, (3) Natural gas, and (4) Gasoline (including: Petroleum, mazut oil, diesel oil, and lubricant).
Source: Authors' calculation from VHLSS 2002-2014. VHLSS: Vietnam household living standard survey

Table 2: Sample of households' lighting consumption, 2002-2014

Year	Number of observations (%)						
	2002	2004	2006	2008	2010	2012	2014
National-grid electricity	24,890 (86.09)	8474 (93.56)	8727 (95.92)	8891 (98.04)	9075 (96.83)	9095 (97.04)	9178 (97.75)
Battery or generator or small-scale hydro-electricity	589 (2.04)	91 (1.00)	65 (0.71)	28 (0.31)	120 (1.28)	130 (1.39)	115 (1.22)
Gas, oil lamps of various kinds	3431 (11.87)	492 (5.43)	306 (3.36)	150 (1.65)	177 (1.89)	147 (1.57)	96 (1.02)
Total	28,911 (100.00)	9057 (100.00)	9098 (100.00)	9069 (100.00)	9372 (100.00)	9372 (100.00)	9389 (100.00)

Question: Which is the main lighting in your household? Choosing one from these: (1) National-grid electricity, (2) Battery or generator or small-scale hydroelectricity, (3) Gas, oil lamps of various kinds. Source: Authors' calculation from VHLSS 2002 to 2014. VHLSS: Vietnam household living standard survey

Figure 1: Households' cooking consumption by income deciles, 2002-2014



Question on fuel consumption: Which of the following items has your household consumed over the past 30 days? Choosing from one or more of these: (1) Coal, (2) Coal briquette, (3) Petroleum, (4) Kerosene, (5) Mazut oil, (6) Diesel oil, (7) Lubricant, (8) LPG, (9) Natural gas, (10) Firewood, (11) By-products, and (12) other. These answers are grouped into four groups: (1) Coal (including: Coal, coal briquette, firewood, and by-products), (2) Kerosene, (3) Natural gas (including: LPG and natural gas), and (4) Gasoline (including: Petroleum, mazut oil, diesel oil, and lubricant). Source: Authors' calculation from Vietnam household living standard survey 2002 to 2014

A summary of households' lighting consumption in 2002-2014 is presented in Table 2. Over the period of 2002-2014, national-grid electricity is expanded in the country. As dominant lighting source, national-grid electricity accounts for a share of nearly 98%.

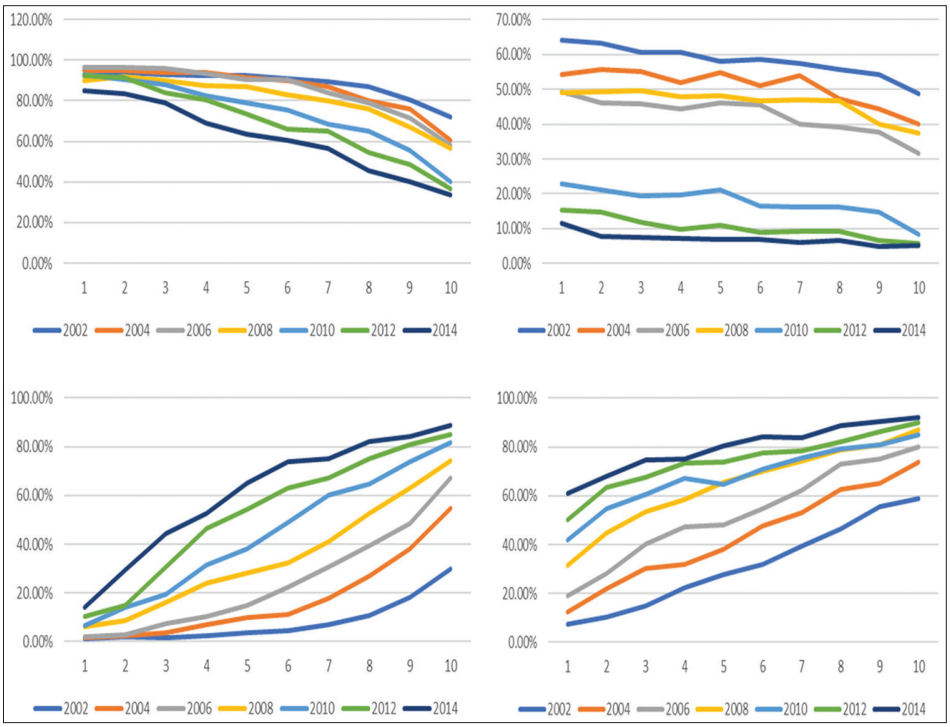
3. FACTORS AFFECTING HOUSEHOLD ENERGY TRANSITIONS IN VIETNAM

The aggregate trends presented in the previous sections provide an overview of some of the changes in the pattern of energy consumption in households of Vietnam over 12 years since 2002. In addition to that, so as to identify the key drivers of changing household choices and residential energy consumption pattern in Vietnam, we discuss such factors as household income, urbanization, along with others demographic differences an, geographic variations in influencing the amounts and patterns of household energy consumption in Vietnam.

3.1. Income

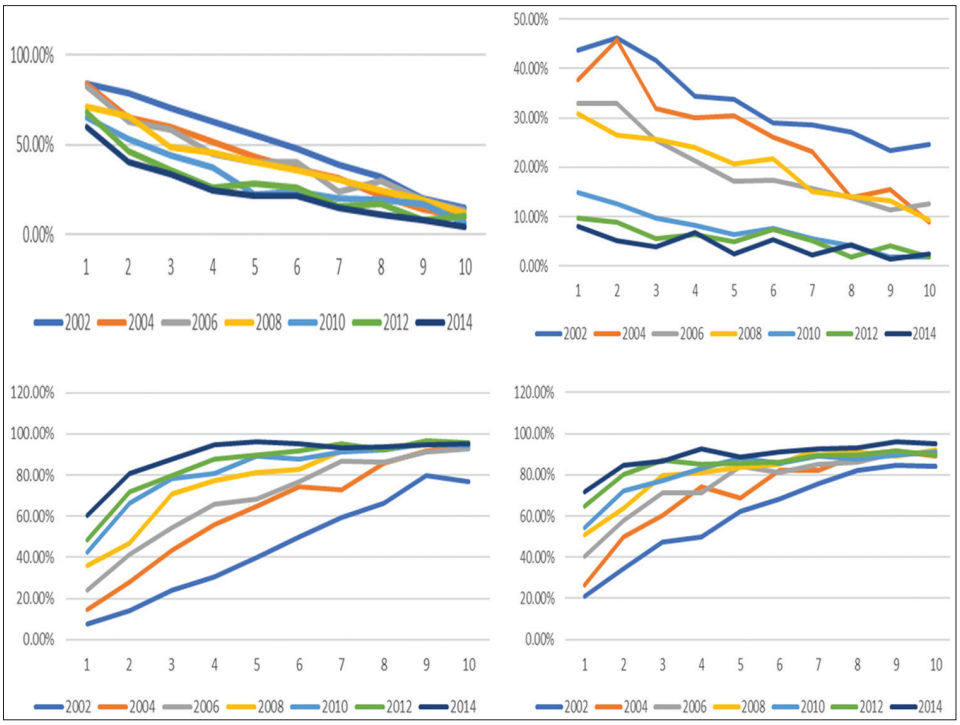
The relationship between income and energy consumption has rooted in the "energy ladder model," which conceptualizes fuel switching in three distinct phases. The first phase is the "universal" one and that is characterized by universal reliance on biomass. In the second phase is the "transition" one that e hypothesizes that households move to "transition" fuels such as kerosene, coal, and charcoal in response to higher incomes, increasing urbanization, and biomass scarcity. The third and final phase of fuel switching is "sustainable" is characterized by households switching to LPG, natural gas, or electricity for cooking. Some recent empirical studies (Li and Just, [2018], Damette et al. [2018]) have been conducted related to this relationship.

Figure 2: Households' cooking consumption by income deciles, rural area 2002-2014



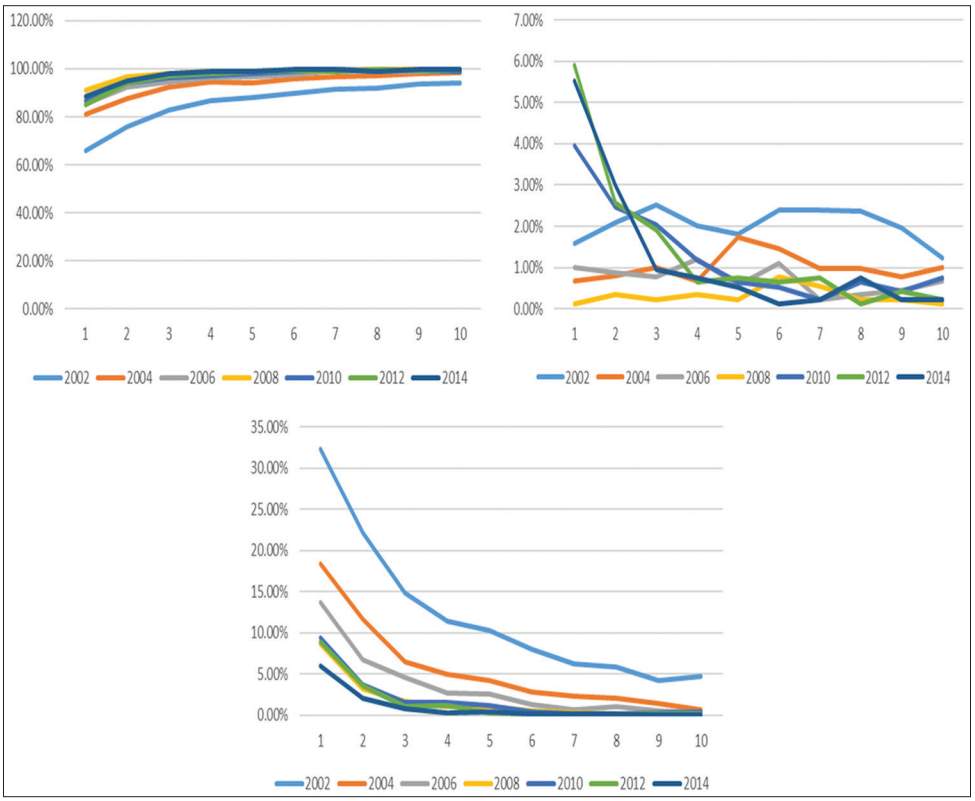
Question on fuel consumption: Which of the following items has your household consumed over the past 30 days? Choosing from one or more of these: (1) Coal, (2) Coal briquette, (3) Petroleum, (4) Kerosene, (5) Mazut oil, (6) Diesel oil, (7) Lubricant, (8) LPG, (9) Natural gas, (10) Firewood, (11) By-products, and (12) other. These answers are grouped into four groups: (1) Coal (including: Coal, coal briquette, firewood, and by-products), (2) Kerosene, (3) Natural gas (including: LPG and natural gas), and (4) Gasoline (including: Petroleum, mazut oil, diesel oil, and lubricant). Source: Authors' calculation from Vietnam household living standard survey 2002 to 2014

Figure 3: Households' cooking consumption by income deciles, urban area 2002-2014



Question on fuel consumption: Which of the following items has your household consumed over the past 30 days? Choosing from one or more of these: (1) Coal, (2) Coal briquette, (3) Petroleum, (4) Kerosene, (5) Mazut oil, (6) Diesel oil, (7) Lubricant, (8) LPG, (9) Natural gas, (10) Firewood, (11) By-products, and (12) other. These answers are grouped into four groups: (1) Coal (including: Coal, coal briquette, firewood, and by-products), (2) Kerosene, (3) Natural gas (including: LPG and natural gas), and (4) Gasoline (including: Petroleum, mazut oil, diesel oil, and lubricant). Source: Authors' calculation from Vietnam household living standard survey 2002 to 2014

Figure 4: Households' lighting consumption by income deciles, 2002-2014



Question on the lighting sources: Which is the main lighting in your household? Choosing one from these: (1) National-grid electricity, (2) Battery or generator or small-scale hydroelectricity, (3) Gas, oil lamps of various kinds. Source: Authors' calculation from Vietnam household living standard survey 2002 to 2014

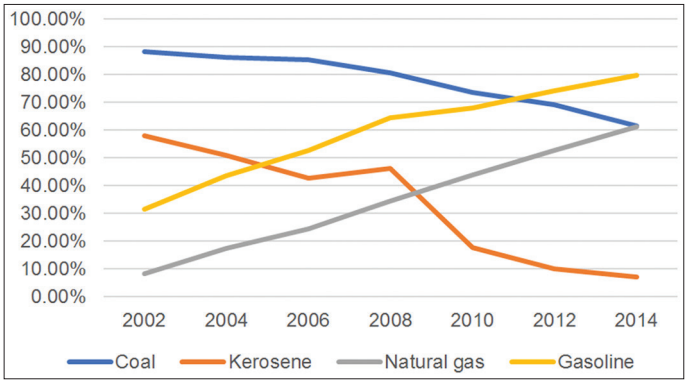
Figure 5: Households' lighting consumption by income deciles, rural 2002-2014

Question on the lighting sources: Which is the main lighting in your household? Choosing one from these: (1) National-grid electricity, (2) Battery or generator or small-scale hydroelectricity, (3) Gas, oil lamps of various kinds. Source: Authors' calculation from Vietnam household living standard survey 2002 to 2014

Figure 6: Households' lighting consumption by income deciles, urban 2002-2014

Question on the lighting sources: Which is the main lighting in your household? Choosing one from these: (1) National-grid electricity, (2) Battery or generator or small-scale hydroelectricity, (3) Gas, oil lamps of various kinds. Source: Authors' calculation from Vietnam household living standard survey 2002 to 2014

Figure 7: Household cooking consumption in rural



Question on fuel consumption: Which of the following items has your household consumed over the past 30 days? Choosing from one or more of these: (1) Coal, (2) Coal briquette, (3) Petroleum, (4) Kerosene, (5) Mazut oil, (6) Diesel oil, (7) Lubricant, (8) LPG, (9) Natural gas, (10) Firewood, (11) By-products, and (12) other. These answers are grouped into four groups: (1) Coal (including: Coal, coal briquette, firewood, and by-products), (2) Kerosene, (3) Natural gas (including: LPG and natural gas), and (4) Gasoline (including: Petroleum, mazut oil, diesel oil, and lubricant). Source: Authors' calculation from Vietnam household living standard survey 2002 to 2014

3.1.1. Income and cooking consumption

Regarding the relationship between economic affluence and residential energy use, it is informative to analyze variations by household income. We find that energy choices vary significantly by affluence level over time, across rural and urban households. Figure 1 shows that as income levels rise, the quantities of traditional energies consumed decrease and of modern energies increase. This is, in general, in line with the "energy ladder model."

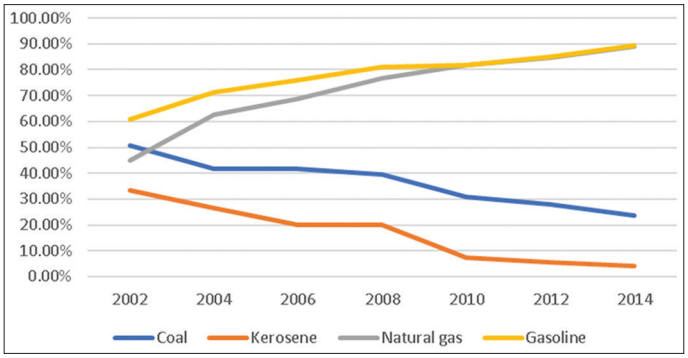
Among rural households, as income levels rise, the quantities of traditional energies consumed decrease and of modern energies increase. However, the speed of decrease in coal consumption and kerosene is less than the speed of increase in natural gas and gasoline consumption (Figure 2). In addition, for the bottom rural decile, does the percentage of coal consumption decline slightly, and the percentage of natural gas consumption increase a little, compared with the huge decline and increase by the top, respectively. In other words, the transition to cleaner commercial energy such as natural gas is rather limited in rural Vietnamese households and it is only among the top decile groups.

Among urban households, by contrast, the transition to modern energy types is more striking with increases in household income levels. The quantities of coal and kerosene energy consumed decreases with rising affluence (Figure 3). Its share decreases from about 84% among the poorest in 2002 to <61% in 2014, for the case of coal.

Among urban households, the quantities of natural gas and gasoline energy consumed increase with rising affluence. Its share increases from <8% among the poorest in 2002 to about 60% in 2014, for the case of natural gas. Also, for the richest decile, its share increases from about 77% in 2002 to about 95% in 2014. In terms of gasoline, its share increases from <22% among the poorest in 2002 to about 72% in 2014. For the richest decile, gasoline's share increases from about 84% in 2002 to about 95% in 2014.

The total shares of modern energy such as natural gas and gasoline used between middle income households and the top decide do not vary much. In short, a clear transition is evident with those in the top deciles clearly shifting away from traditional energy towards more modern ones (Figure 3).

Figure 8: Household cooking consumption in urban



Question on fuel consumption: Which of the following items has your household consumed over the past 30 days? Choosing from one or more of these: (1) Coal, (2) Coal briquette, (3) Petroleum, (4) Kerosene, (5) Mazut oil, (6) Diesel oil, (7) Lubricant, (8) LPG, (9) Natural gas, (10) Firewood, (11) By-products, and (12) other. These answers are grouped into four groups: (1) Coal (including: Coal, coal briquette, firewood, and by-products), (2) Kerosene, (3) Natural gas (including: LPG and natural gas), and (4) Gasoline (including: Petroleum, mazut oil, diesel oil, and lubricant). Source: Authors' calculation from Vietnam household living standard survey 2002 to 2014

3.1.2. Income and lighting consumption

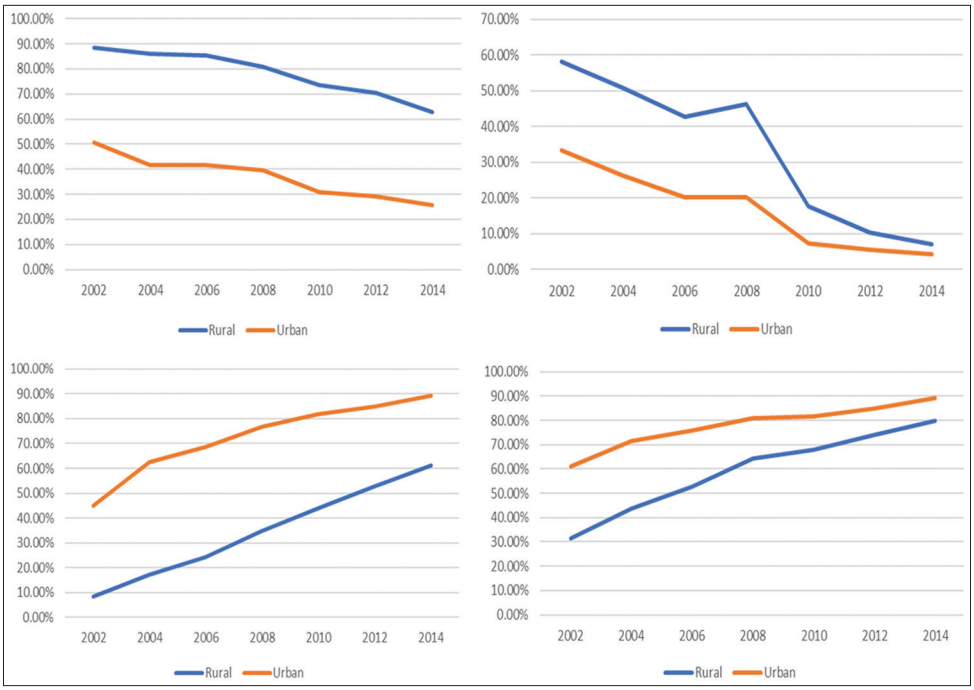
General patterns of lighting consumption by decide in the period 2002-2014 is presented in Figure 4. We also find that lighting choices vary significantly by affluence level over time, across rural and urban households. Figure 4 shows that as income levels rise, the quantities of traditional lighting energies consumed decrease and of modern energies increase. This is also in line with the "energy ladder model."

Among rural households, as income levels rise, the quantities of traditional lighting energies consumed decrease and of modern lighting energies increase. However, the speed of decrease in gasoline lighting is larger than the speed of increase in national-grid lighting (Figure 5). That is, these households obtain more useful energy for lighting from their mix of lighting energy types, for example, from generator. In addition, for the bottom rural decile, a huge decline of gasoline's share from about 36% in 2002 to around 7.5% in 2014 exists. In terms of national-grid, does the percentage increase rather highly, from about 85% in 2002 to around 99% in 2014.

Among urban households, by contrast, the transition to modern lighting energy types is more striking with increases in household income levels. The quantities of gasoline lighting energy consumed decreases rapidly with rising affluence (Figure 6). Its share decreases from about <3% among the poorest in 2002 to <0.1% in 2014, for the case of gasoline.

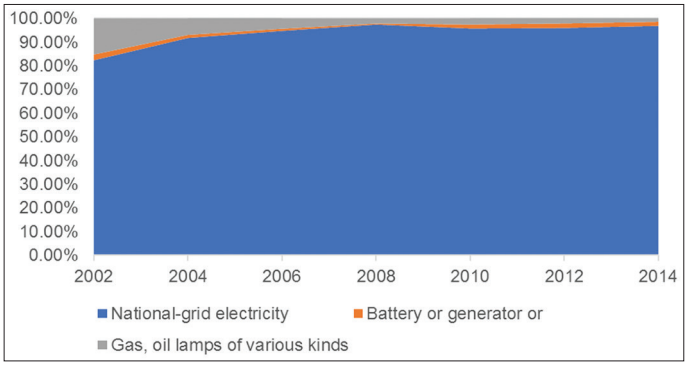
Among urban households, the quantities of national-grid lighting energy consumed increase with rising affluence. Its share increases

Figure 9: Trends in household access to cooking fuels



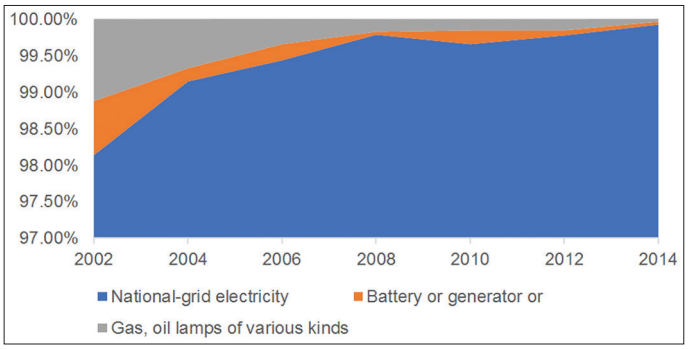
Question on fuel consumption: Which of the following items has your household consumed over the past 30 days? Choosing from one or more of these: (1) Coal, (2) Coal briquette, (3) Petroleum, (4) Kerosene, (5) Mazut oil, (6) Diesel oil, (7) Lubricant, (8) LPG, (9) Natural gas, (10) Firewood, (11) By-products, and (12) other. These answers are grouped into four groups: (1) Coal (including: Coal, coal briquette, firewood, and by-products), (2) Kerosene, (3) Natural gas (including: LPG and natural gas), and (4) Gasoline (including: Petroleum, mazut oil, diesel oil, and lubricant). Source: Authors' calculation from Vietnam household living standard survey 2002 to 2014

Figure 10: Household lighting consumption in rural



Question on the lighting sources: Which is the main lighting in your household? Choosing one from these: (1) National-grid electricity, (2) Battery or generator or small-scale hydroelectricity, (3) Gas, oil lamps of various kinds. Source: Authors' calculation from Vietnam household living standard survey 2002 to 2014

Figure 11: Household lighting consumption in urban



Question on the lighting sources: Which is the main lighting in your household? Choosing one from these: (1) National-grid electricity, (2) Battery or generator or small-scale hydroelectricity, (3) Gas, oil lamps of various kinds. Source: Authors' calculation from Vietnam household living standard survey 2002 to 2014

from about 96.5% among the poorest in 2002 to nearly 100% in 2014, for the case of national-grid. The total shares of modern lighting energy such as national-grid used between middle income households and the top decide do not vary much. In short, a clear transition is evident with those in the top deciles clearly shifting away from traditional lighting energy towards more modern lighting ones (Figure 6).

3.2. Urbanization

Recent some typically related reviews (or empirical studies including an integrated literature review) also investigated these complex relationships between urbanization, economic growth, energy consumption, and CO2 emissions (Pata, 2018), (Ahmad and Zhao, 2018), (Guo et al., 2018), 10.1007/s11356-017-0436-x,) (Al-Mulali et al., 2013) investigated the long run relationship between urbanization, energy consumption, and CO2 emissions (Franco et al., 2017) examined the linkages between urbanization, energy consumption and CO2 emissions (Wang et al., 2018) link between urbanization, economic growth, energy consumption, and CO_2 emissions. (Bakirtas and Akpolat, 2018) investigates the causal relationship between energy consumption, urbanization and economic growth using Dumitrescu-Hurlin panel Granger causality test for the period 1971–2014 in New Emerging-Market Countries (Colombia, India, Indonesia, Kenya, Malaysia, and Mexico). They find that economic growth and urbanization are crucial factors determining energy consumption.

3.2.1. Cooking energy access: Trends and disparities across urban and rural areas

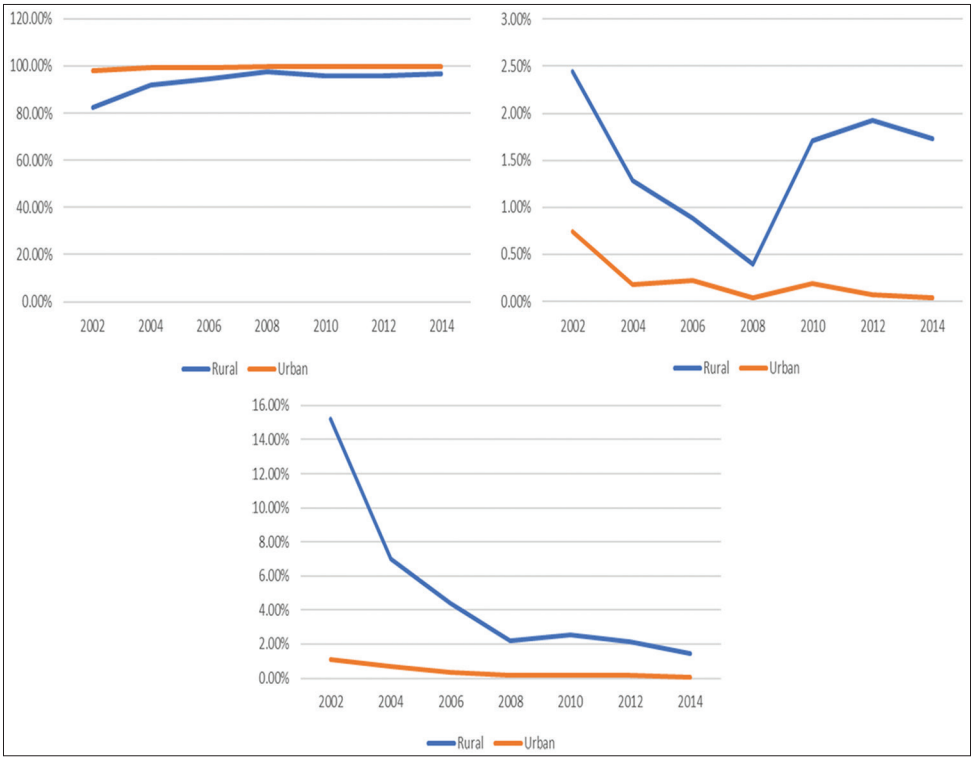
About 70% of the population in Vietnam lives in rural areas. In 2002, the rural cooking energy scenario is largely dependent on traditional biomass fuels such as coal (nearly 90%) and kerosene (nearly 60%) at the same time (Figure 7). About 30% of household uses gasoline for cooking. Only 10% of the rural households use modern carriers like natural gas for cooking. A huge change happens between 2014 and 2002: In 2014, the rural cooking energy scenario is largely dependent on both traditional biomass and modern fuels such as gasoline (nearly 80%), coal (about 60%) and natural gas (nearly 60%) at the same time (Figure 7). <10% of the rural households use kerosene for cooking.

In 2002, the urban cooking energy scenario is largely dependent on traditional biomass fuels such as coal (nearly 50%) and modern fuels such as gasoline (nearly 50%) and natural gas (nearly 45%) at the same time (Figure 8). In 2014, the urban cooking energy scenario is largely dependent on both modern fuels such as gasoline and natural gas (both: Nearly 80%) at the same time (Figure 8). <32% of the urban households use coal for cooking and <5% in case of kerosene.

Figure 9 shows the historical trends in the expansion of household access to modern cooking fuels during 2002-2014 for both the urban and rural areas. The analysis of these trends suggests that the growth trends of household access to modern fuels are steep. In the case of urban regions, the average annual rate of shrinkage in access to coal and kerosene was 3.83% and 4.15% during 2002-2014, respectively. The average annual rate of expansion in access to natural gas and gasoline was 6.34% and 4.04% during 2002-2014, respectively. The trend is not much different for the rural region either and the analysis of the trend shows that the household access to coal and kerosene was decreased annually 3.85% and 7.29% during 2002-2014, respectively. The average annual rate of expansion in access to natural gas and gasoline was 7.56% and 6.91% during 2002-2014, respectively.

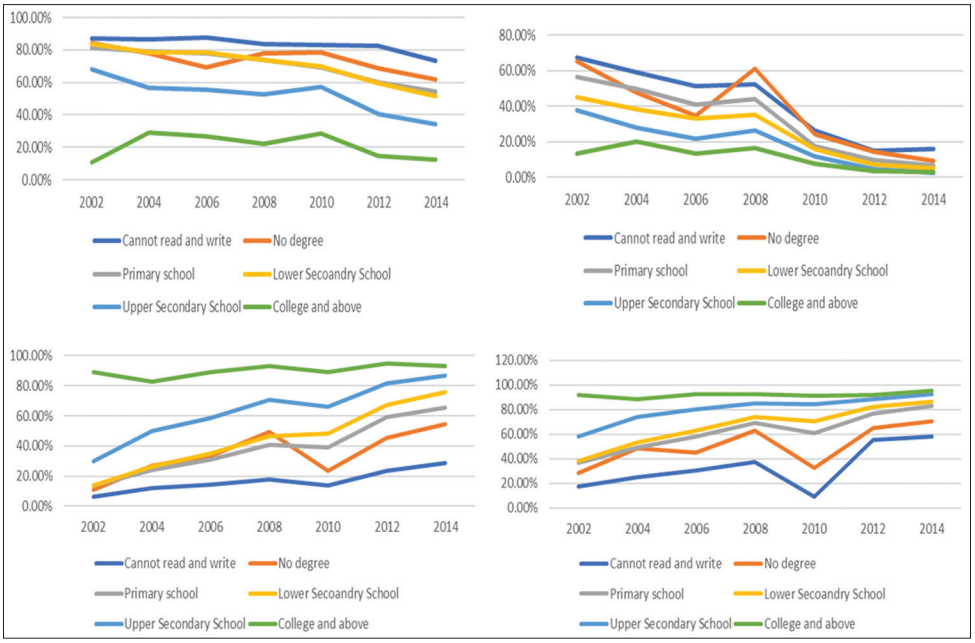
The historical trends show that the gap between the levels of urban and rural household access to traditional cooking fuels such as kerosene is narrowing. The difference in access levels between rural and urban areas was 24.86% in 2002, which decreased to 2.84% in 2014. However, the gap between the levels of urban and rural household access to coal is rather standing still: 37.77% in 2002 and 37.67% in 2014. Unless some initiatives are taken, the gap is not likely to decline sharply in the future. The current need is to promote reduction in both urban and rural household access levels, and definitely at a higher rate in the case of rural households. The historical trends also show that the gap between the levels of urban and rural household access to modern cooking fuels such as gasoline is narrowing. The difference in access levels

Figure 12: Households' lighting consumption by rural and urban areas, 2002-2014



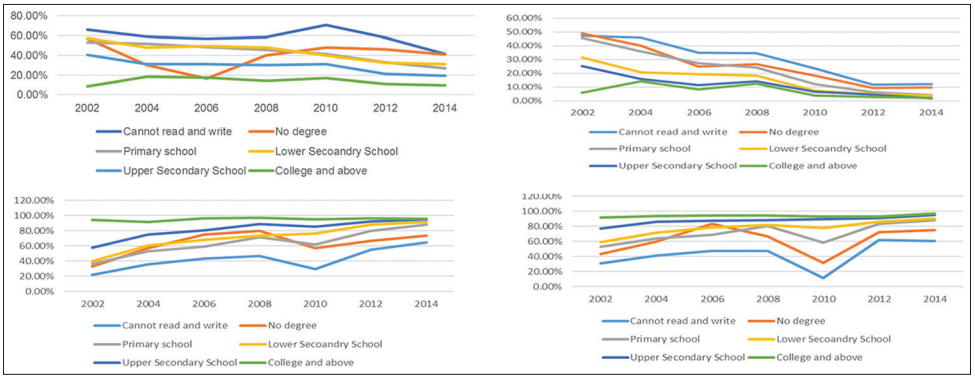
Question on the lighting sources: Which is the main lighting in your household? Choosing one from these: (1) National-grid electricity, (2) Battery or generator or small-scale hydroelectricity, (3) Gas, oil lamps of various kinds. Source: Authors' calculation from Vietnam household living standard survey 2002 to 2014

Figure 13: Households' cooking consumption by household head' s educational levels, 2002-2014



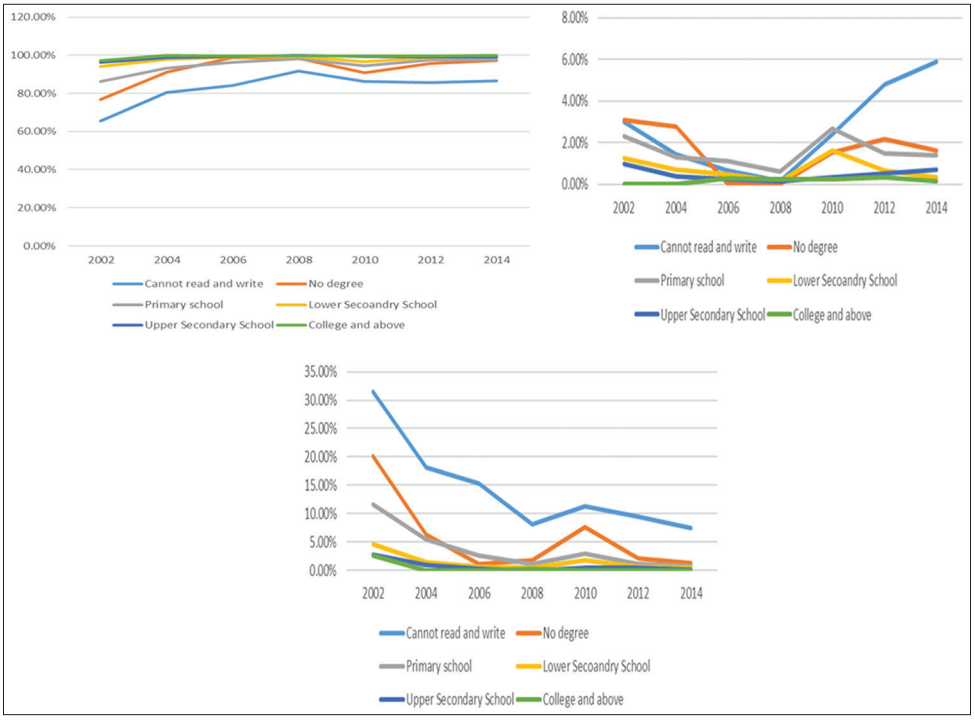
Question on fuel consumption: Which of the following items has your household consumed over the past 30 days? Choosing from one or more of these: (1) Coal, (2) Coal briquette, (3) Petroleum, (4) Kerosene, (5) Mazut oil, (6) Diesel oil, (7) Lubricant, (8) LPG, (9) Natural gas, (10) Firewood, (11) By-products, and (12) other. These answers are grouped into four groups: (1) Coal (including: Coal, coal briquette, firewood, and by-products), (2) Kerosene, (3) Natural gas (including: LPG and natural gas), and (4) Gasoline (including: Petroleum, mazut oil, diesel oil, and lubricant). Question about educational levels: The highest qualification has obtained? Answers are classified as: (1) Cannot read and write, (2) No degree, (3) Primary school, (4) Lower Secondary School, (5) Upper Secondary School, (6) College and above. Source: Authors' calculation from Vietnam household living standard survey 2002 to 2014

Figure 14: Households' cooking consumption by household head' s educational levels, urban 2002-2014



Question on fuel consumption: Which of the following items has your household consumed over the past 30 days? Choosing from one or more of these: (1) Coal, (2) Coal briquette, (3) Petroleum, (4) Kerosene, (5) Mazut oil, (6) Diesel oil, (7) Lubricant, (8) LPG, (9) Natural gas, (10) Firewood, (11) By-products, and (12) other. These answers are grouped into four groups: (1) Coal (including: Coal, coal briquette, firewood, and by-products), (2) Kerosene, (3) Natural gas (including: LPG and natural gas), and (4) Gasoline (including: Petroleum, mazut oil, diesel oil, and lubricant). Question about educational levels: The highest qualification has obtained? Answers are classified as: (1) Cannot read and write, (2) No degree, (3) Primary school, (4) Lower Secondary School, (5) Upper Secondary School, (6) College and above. Source: Authors' calculation from Vietnam household living standard survey 2002 to 2014

Figure 15: Households' lighting consumption by household head' s educational levels, 2002-2014



Question on the lighting sources: Which is the main lighting in your household? Choosing one from these: (1) Nation-grid electricity, (2) Battery or generator or small-scale hydroelectricity, (3) Gas, oil lamps of various kinds. Question about educational levels: The highest qualification has obtained? Answers are classified as: (1) Cannot read and write, (2) No degree, (3) Primary school, (4) Lower Secondary School, (5) Upper Secondary School, (6) College and above. Source: Authors' calculation from Vietnam household living standard survey 2002 to 2014

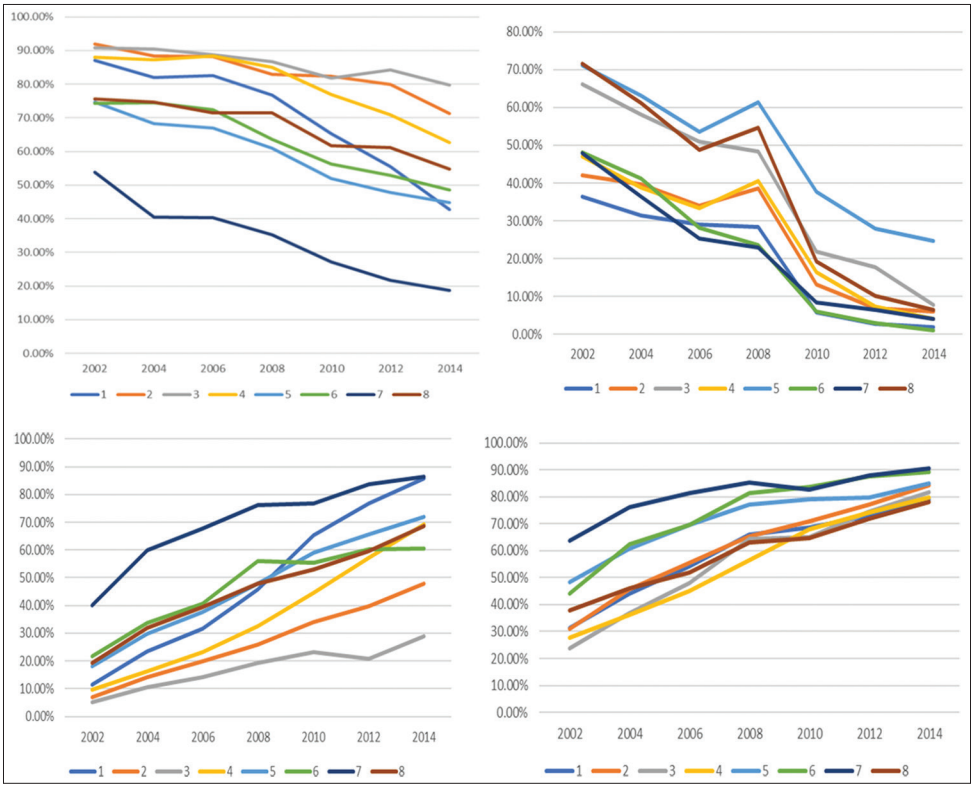
between urban and rural areas was 29.58% in 2002 and decreased to 9.38% in 2014.

3.2.2. Lighting energy access: Trends and disparities across urban and rural areas

Lighting is an important household energy end-use service as it is directly related to quality of life. Vietnam has good achievement in terms of electrification. As showed in Figure 10. In 2002, nearly 82% of rural population have access to electricity. In 2014, about 97 % of rural population are electrified. <1.5% of rural households use gas, oil lamps of various kinds.

In the urban area, in 2002, nearly 98% of urban population have access to electricity. In 2014, about 99.93% of rural population are electrified. <0.05% of urban households use either gas, oil lamps of various kinds or generator (Figure 11).

Figure 16: Households' cooking consumption by regions, 2002-2014



Region 1: Red River Delta; region 2: East Northern Mountains; region 3: West Northern Mountains; region 4: North Central area; region 5: South Central coastal area; region 6: Central Highlands; region 7: South East; region 8: Mekong River Delta. Question on fuel consumption: Which of the following items has your household consumed over the past 30 days? Choosing from one or more of these: (1) Coal, (2) Coal briquette, (3) Petroleum, (4) Kerosene, (5) Mazut oil, (6) Diesel oil, (7) Lubricant, (8) LPG, (9) Natural gas, (10) Firewood, (11) By-products, and (12) other. These answers are grouped into four groups: (1) Coal (including: Coal, coal briquette, firewood, and by-products), (2) Kerosene, (3) Natural gas (including: LPG and natural gas), and (4) Gasoline (including: Petroleum, mazut oil, diesel oil, and lubricant). Source: Authors' calculation from Vietnam household living standard survey 2002 to 2014

The historical trends for the last 12 years spanning between 2002 and 2014, in expanding household access to electricity, shows a small gap between urban and rural access levels (Figure 12). And, the gap is reducing at fast rates. From the figure it appears that the household electrification rates are declining at a rate 1.1% point annually: The gap is 15% points in 2002 and the gap becomes 1.5% point in 2014.

3.3. Demographic Factors

Several previous literatures examine the influence of demographic characteristics on household energy consumption (Li and Just, [2018], Pachauri and Jiang [2008], Jiang and O'Neill [2004]). Jiang and O'Neill (2004) report that household size and age structure have little influence on the probability of using biomass as an energy source. However, the level of education of the head of the household is clearly related to household fuel choice (Jiang and O'Neill [2004], Farsi et al., [2007]). Other demographic factors such as sex of the head of the household may also affect fuel choice as Farsi et al. (2007) report in their study.

In general, a higher level of education is associated with households choosing to use more modern and efficient sources of energy. This is, of course, in part, because higher education translates into higher incomes and expenditure levels for these households. However, both Farsi et al. (2007) and Jiang and O'Neill (2004) report results from discrete choice regression estimations that control for income or expenditure and find an independent influence of education on fuel choice.

3.3.1. Household head's educational levels and cooking consumption

Figure 13 shows the patterns of energy use in Vietnamese households with different levels of education of the head of the household. Data show that households shift to the use of more efficient fuels as their education level improves.

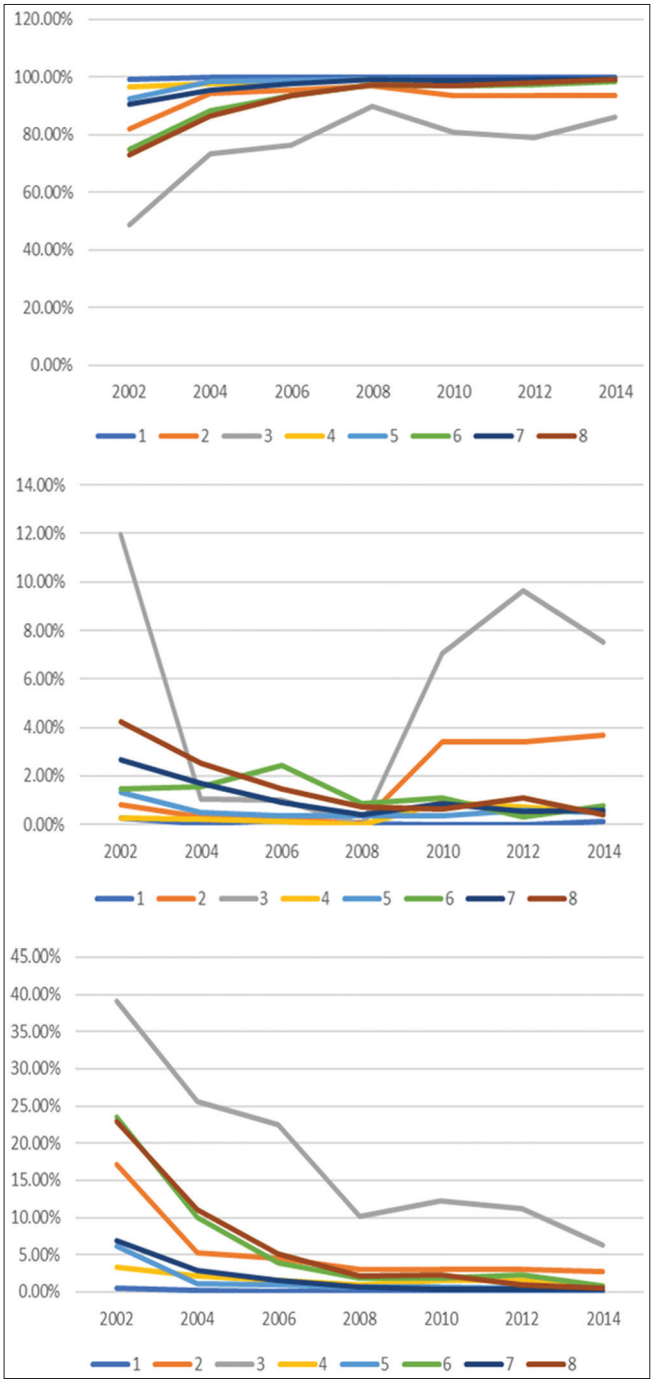
Figures 14 and 15 shows that the shift to the use of cleaner cooking fuels is more pronounced among households in urban areas as compared to those living in rural areas.

3.3.2. Household head's educational levels and lighting consumption

Figure 15 shows the patterns of energy use for lighting in Vietnamese households with different levels of education of the head of the household. Data also show that households shift to the use of more national-grid electricity as their education level improves.

Figure 16 shows the shift to the use of more efficient fuels for lighting among households in rural areas.

Figure 17: Households' lighting consumption by regions, 2002-2014



Region 1: Red River Delta; region 2: East Northern Mountains; region 3: West Northern Mountains; region 4: North Central area; region 5: South Central coastal area; region 6: Central Highlands; region 8: Mekong River Delta. Question on the lighting sources: Which is the main lighting in your household? Choosing one from these: (1) National-grid electricity, (2) Battery or generator or small-scale hydroelectricity, (3) Gas, oil lamps of various kinds. Source: Authors' calculation from Vietnam household living standard survey 2002 to 2014

3.4. Geography and Region

Like many spatially diverse nations, great social and economic differences exist across Vietnam's geography. The variations may lead to regional discrepancies in both household income and wealth and, hence, in energy consumption. Some studies, for example, in China, have examined regional disparities in the patterns of Chinese household energy-use. Feng et al. (2011) found that household indirect energy consumption and CO2 emissions differ by region. Based on households' carbon footprints, Zhang and Lahr (2018) ranked 74 Chinese major cities and found that cities with colder Januarys tend to yield higher household carbon emissions due, naturally enough, to fuel and electricity usage, likely in the form of room heating. Liang et al. (2007) found that improvement in energy end-use efficiency by region appears to generate significant intra-regional energy savings in China.

3.4.1. Cooking energy access: Trends and disparities across economic regions

Figure 16 shows the regional dynamics of household access to four types of cooking fuels. The trends are presented for the last 12 years during 2002-2014 for eight economic regions, namely: (1) Red River Delta, (2) East Northern Mountains, (3) West Northern Mountains, (4) North Central area, (5) South Central coastal area, (6) Central Highlands, (7) South East, and (8) Mekong River Delta. Firstly, in 2002, more than 70% of household used coal in their cooking in most of regions, except for South East where people consumed about 55%. Twelve years later, around 19% of people in South East keep consuming coal, compared to over 43% of households in other regions, in which West Northern Mountains shows to be the least improvement.

Unlike coal consumption, kerosene consumption has been much improved between 2002 and 2014. From over 40% in 2002, it has decreased to <8% in 2014, except for South Central coastal area, which was still at about 25%. Two regions, namely: West Northern Mountains and Mekong River Delta attained much achievement in the study period.

With respect to modern fuels such as natural gas, most regions have improved, and South East is the region with highest percentage of households consuming natural gas throughout the period. However, Red River Delta is the region with huge change. The is region started at 12% of households consuming natural gas in 2002 and has moved to the percentage of 86% in 2014, more or less comparable with that of South East. Comparably, West Northern Mountains is not so successful in terms of natural gas.

With regarding to gasoline, South East is also the region with highest percentage of households consuming gasoline throughout the period, although the rate of change is less than other regions. Central Highlands has attained much performance to be second to the best as South East.

3.4.2. Lighting energy access: Trends and disparities across regions

The regional dynamics of electricity access are being captured in Figure 17. Most of regions are successful in achieving electrification rates in the range of 95% and above. Two of eight regions have electrified coverage <95%: East Northern Mountains, and West Northern Mountains. Those two regions are also the less successful in attaining access to modern cooking fuels as shown in Section 4.3.3.

4. CONCLUSION

In this paper the energy status in Vietnam was discussed from the perspectives of access to modern fuels for cooking and electricity for lighting for households belonging to different income classes, urbanization, demographic factors (such as the education level of the head of the household) and regions of Vietnam in 13 years, 2002-2014. We find that the most important drivers of the household energy transition are income, urbanization, demographic factors, and the geographic variations. For cooking energy, the results indicate that the transition to cleaner commercial energy such as natural gas is rather limited in rural Vietnamese households and it is only among the top decile groups. This indicates lack of initiatives for expanding rural cooking energy access. Among urban households, a clear transition is evident with those in the top deciles clearly shifting away from traditional energy towards more modern ones. Differences in patterns of cooking energy consumption show a rural–urban dichotomy. The historical trends show that the gap between the levels of urban and rural household access to traditional cooking fuels such as kerosene is narrowing. However, the gap between the levels of urban and rural household access to coal is rather standing still, and unless some initiatives are taken, the gap is not likely to decline sharply in the future. The current need is to promote reduction in both urban and rural household access levels, and definitely at a higher rate in the case of rural households. Data show that households shift to the use of more efficient fuels as their education level improves and that the shift to the use of cleaner cooking fuels is more pronounced among households in urban areas as compared to those living in rural areas. The cooking energy consumption pattern varies tremendously among the regions within Vietnam due to diversities and complex distribution of physical geography and social economy. From the perspective of dynamic change, however, social economic development is much an active factor largely determining the spatial distribution and evolution of rural cooking energy consumption.

For lighting energy, among rural households, as income levels rise, the quantities of traditional lighting energies consumed decrease and of modern lighting energies increase. However, the speed of decrease in gasoline lighting is larger than the speed of increase in national-grid lighting. That is, these households obtain more useful energy for lighting from their mix of lighting energy types, for example, from generator. In the urban area, a clear transition is evident with those in the top deciles clearly shifting away from traditional lighting energy towards more modern lighting ones. The historical trends for the last 12 years spanning between 2002 and 2014, in expanding household access to electricity, shows a small gap between urban and rural access levels, the gap is reducing at fast rates. Data also show that households shift to the use of more national-grid electricity as their education level improves. With respect to regions, most of regions are successful in achieving electrification rates in the range of 95% and above.

In the future, policies on the pace of urbanization and growth of household income will have a significant impact on the rate of the household energy transition. In addition, social policies aimed at providing greater access to higher education may also influence the pace of the transition. A balanced growth model among different geographic regions can also contribute to a more balanced distribution of energy consumption in Vietnam.

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