SUSTAINABLE ENERGY CONSUMPTION IN DEVELOPING COUNTRIES: AN ANALYSIS ON THAILAND'S HOUSEHOLD SOCIO-ECONOMIC SURVEY

Saranyupa Chaiprasithikul
Graduate School of Business and Commerce, Keio University" Japan.
Corresponding author: chsaranyupa@yahoo.com

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Abstract: Developing countries have been dramatically changing their ways of consuming energy for the past decades. Between 1987 and 2006, developing countries experienced high rate of growth in energy consumption as much as 63 percent per year while energy consumption in OECD countries grew only around 1.5 percent per year. Without effective policies, such dramatic change in energy consumption would undoubtedly lead to unsustainable future of global energy. This paper analyzes distribution of energy consumption across income classes in Thailand by using household socio-economic data of Thailand from the period 2003-2009. It can be found that there were high inequalities in energy consumption among household income classes especially in electricity and transport fuel consumptions. The study also estimates carbon emission of each income class and finds that the highest income group emits carbon emission 7 times higher than the lowest income. The study finally conducts policy scenarios based on the fact findings. The first scenario assumes a change in carbon emission factor, which refers to the technology level of country. The result implies that adaptation of cleaner energy and technology on power generation can substantially decrease carbon emission of Thailand. The second scenario assumes changes in tax on carbon-intensive energies which lead to a substantial decline in carbon emission.

Keywords: "energy policy", "household socio-economic survey", "income quintiles", "sustainable energy consumption",

1. Introduction

Energy policy in developing countries has been a controversial debate among environmentalists for several years. Panel studies of Lee (2005) and Sari et al. (2007) show that energy consumption statistically determines economic growth in developing countries but not vice versa, which implies that energy conservation policy might hamper economic growth in the long-run. However, such macro-level study on energy policy is still unable to answer the question of how energy policy of developing countries should be designed in order to maintain desirable growth. Analysis in micro level which captures individual behaviors in society should also be considered. Pachauri (2002) utilizes input-output table and household data, and finds that as income of the country rises, Indian households tend to consume more gas and petroleum products and less traditional energy like kerosene.

High inequality among income class is also one of the main characteristics of developing countries、which should be taken into account when conducting energy policy in developing countries. For example, Thailand's household socio-economic survey significantly shows some variation of energy consumption among five income classes. While the lowest income quintile consumes less than five percent of total energy consumption, energy consumption of the highest income quintile accounts for over 50 percent. Such information should be useful for designing their sustainable energy policy in developing countries.

Consequently, this motivated the current study to conduct analysis on Thailand's household energy consumption as a case study to seek for sustainable energy policy in developing countries.

2. Objective

The aim of our paper is to: 1) statistically analyze energy consumption pattern by income class, using Thailand's household economic survey in 2006, 2007, 2008, and 2009. To discuss in detail, this paper divides household income distribution into ten income quintiles, and investigates energy consumption pattern of each income quintile by different types of energy; 2) clarify how consumption pattern of each energy and each income class affects carbon emission over time; 3) conduct various policy scenarios to estimate household's energy consumption as well as carbon emission; and finally 4) discuss some implications on energy policy implementations in developing countries based on fact findings.

3. Method

The study first divides household population into 10 quintiles. The first quintile shows cumulative income occupied by 10 percent of the lowest income households while the tenth quintile shows cumulative income occupied by 10 percent of the highest income households.

The study then clarifies energy consumption pattern of each income quintile by energy source from 2006-2009. Thus, energy consumption in monetary unit (Baht) is converted to physical unit by using Thailand's energy price index. Net calorific values provided by Ministry of Energy of Thailand are also referred in converting physical unit into calorific value.

For instance, to obtain electricity consumption in kilowatt per hour, electricity consumption in monetary unit (Baht) is divided by electricity price per kilowatt per hour. Next, the physical value of kWh is converted into MJ by referring to net calorific energy value, which is provided by Ministry of Energy of Thailand.

Carbon dioxide emissions are then estimated by using carbon emission factors provided by IPCC and Ministry of Energy of Thailand except for the case of electricity since proportion of electric generation fuels are expected to be different from OECD countries.

Finally, two scenarios of energy policies are simulated. The first scenario assumes a change in carbon emission factor of electricity with 10 percent increase in natural gas power plants and 10 percent decrease in coal and lignite power plants, implying a change in technology of power genration in the long run. While natural gas accounts for over 60 percent of domestic energy production in Thailand, coal and lignite accounts for only 11 percent. In addition, over 70 percent of electricity are generated by natural gas, and 29 percent by coal and lignite. Therefore, there is potential that Thailand utilizes more natural gas and less lignite and coal for power generation. The emission factor in this scenario accounts for 0.2698. Scenario 2 assumes the government of Thailand imposes 5% of price tax on electricity and diesel consumptions, which is directly incorporated to the nominal price of energy. In order to find response of households to the change in price according to tax, the study uses energy price elasticity of -0.1845 obtained by Dr. Kraipornsak (2006).

4. Data

The data mainly used in this analysis is Thailand's Household Socio-Economic Survey constructed by the National Statistics Office of Thailand, spanning from the period 2006-2009. Expenditures, incomes and other social features of around 140,000 households are observed by the National Statistics Office annually.

In order to clarify energy consumption pattern of Thai households, various sources of energy, which are electricity, cooking gas, gas for other purposes than cooking, charcoal and wood, kerosene, gasoline 91, gasoline 95, high-speed (HS) diesel as well as water supply and underground water are analyzed,

Energy price index in unit Baht and energy calorific values are also referred to convert expenditure in monetary unit into physical and calorific unit,

Finally, the study estimates carbon emissions of various energy sources using carbon emission factors provided by IPCC Task Force on National Greenhouse Gas Inventories except for the case of electricity consumption. Since power generation fuels in Thailand are expected to be different from those of OECD countries, the study uses carbon emission factor for electricity provided by Hinchiranan, Department of Energy Policy and Planning (2006) to estimate carbon emission by electricity consumption in Thailand. The carbon emission factor is equal to 0.5057, which is different from 0.42-0.5 of OECD countries.

5. Study Result

5.1 Energy Consumption Pattern among Income Classes Figure (1) and (2) demonstrate energy consumption patterns among income classes in 2006 and 2009 respectively. Since significant changes are not observed during 2006-2009, we skip the results of year 2007 and 2008. During the period, there are high inequalities among income classes for electricity, cooking gas consumption, water, and transport fuel

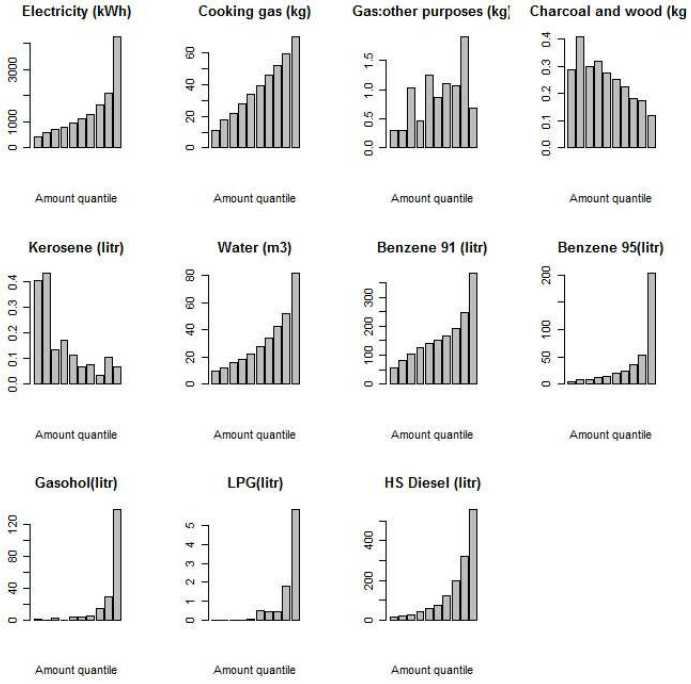

Figure 1: Energy Consumption by Income Class and by Energy Source in 2006

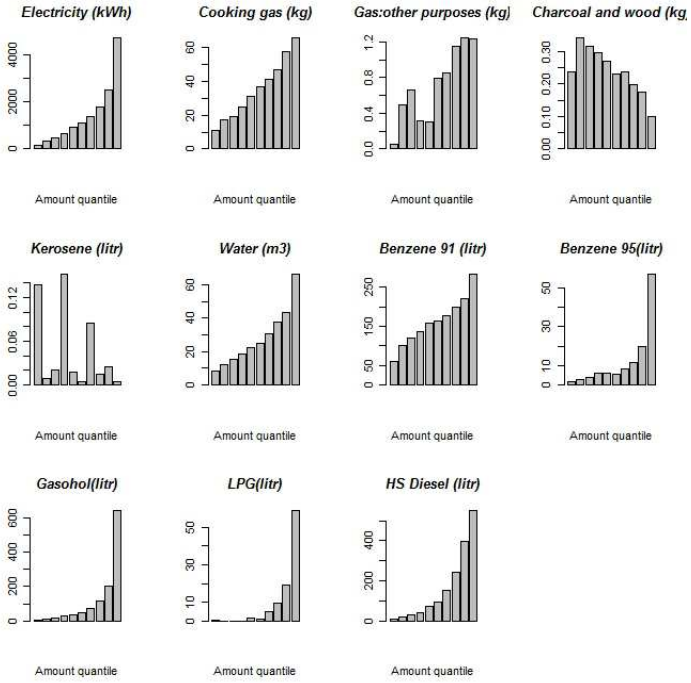

Figure 2: Energy Consumption by Income Class and by Energy Source in 2009

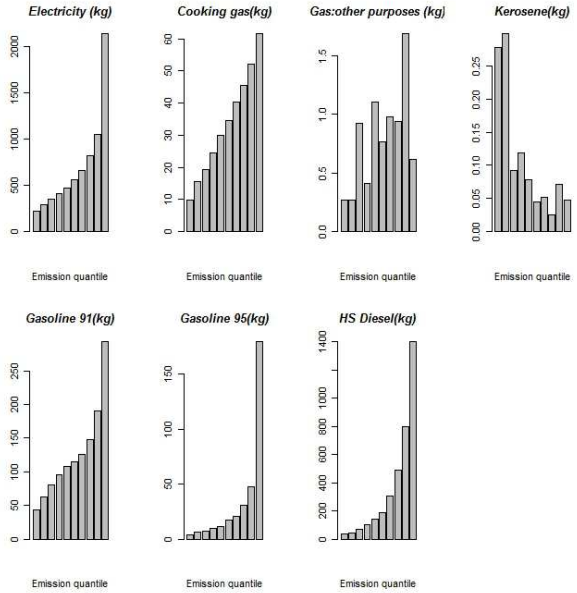

Figure 3: Carbon Emission by Income Class and by Energy Source in 2006

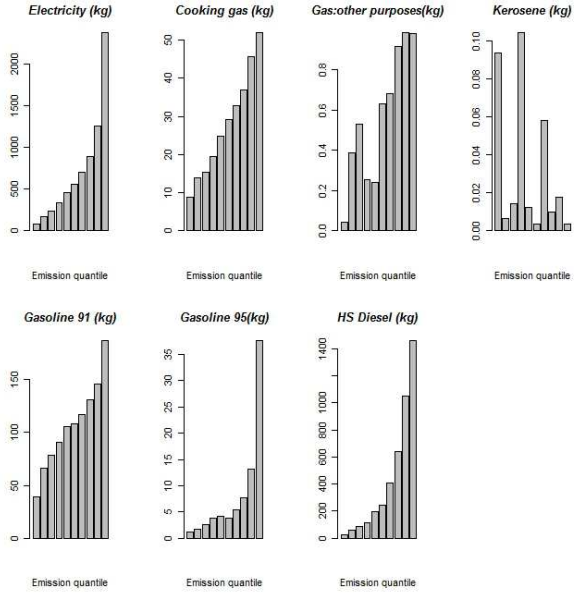

Figure 4: Carbon Emission by Income Class and by Energy Source in 2009

consumptions. Energy inequality slightly improved only in electricity and kerosene consumption. However, for other energy sources, such improving trends are not found.

In 2006, the highest income households consume as much as 57% of total electricity consumption, which is 10 times higher than the lowest income household. For all transportation fuel, the highest income consumed 7 times higher amount of transport fuel than the lowest income.

This can be implied that there is high degree of progressive energy inequality among income groups especially for electricity and transportation fuels. In contrast, inverse inequality for charcoal and kerosene consumption are observed, suggesting that charcoal and kerosene are inferior energy for Thai households.

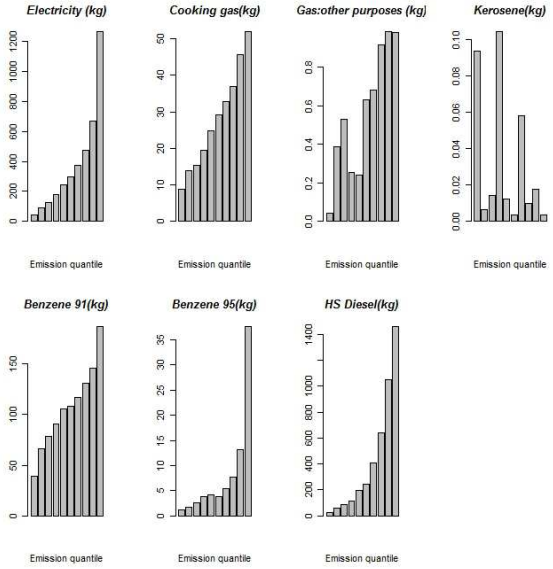

Figure 5: Change in Carbon Emission by Scenario 1 in 2009

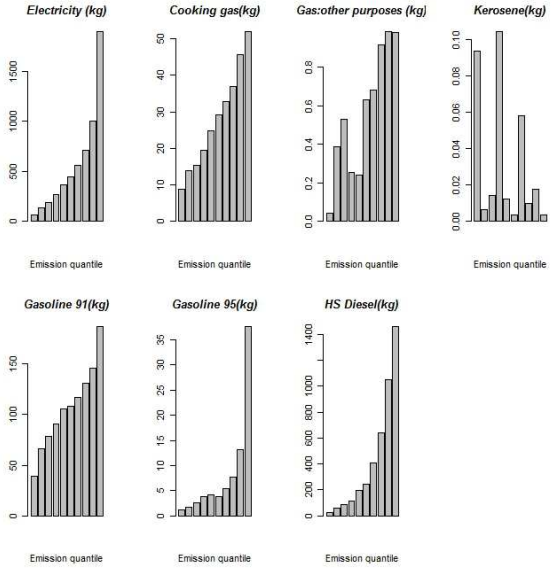

Figure 6: Change in Carbon Emission by Scenario 2 in 2009

5.2 Carbon Emission Figure (3) and Figure (4) show carbon emission by income class in 2006 and 2009 respectively. Due to zero value of charcoal carbon emission factor and insufficient data, only 7 energy sources can be estimated for carbon emission. During 2006-2009, total household carbon emission increased by 19 %, from 13,069 kg-COE to 15,545 kg-COE per household per year.

While carbon emission from electricity and HS diesel consumptions increased by 30% and 13% respectively, carbon emission from other energy consumptions decreased by average 3%. In addition, household electricity and high-speed diesel consumptions account for 60 % and 27% of total household carbon emission.

This implies that the two energies are the main factors for carbon emission in Thailand, and should be regulated in the long term in order to sustain economic and environment of the country.

5.2 Simulation According to the result, the study simulates policy scenarios related to reduction in consumptions of electricity and high-speed diesel. The results of scenario 1 and scenario 2 are illustrated by Figure 5 and Figure 6 respectively. 10 percent increase in natural gas power plants and 10% reduction in coal power plant (scenario 1) results in 29% or 4,537 kg-CO2 decrease in carbon emission per household. This is directly obtained from 46% reduction in CO2 emission from electricity consumption. Additionally, 5% percent of electricity and high-speed diesel taxes (scenario 2) result in 22% and 58% reduction in CO2 emission respectively, which accounts for 28% or 4,598 in kg-CO2 decrease in total carbon emission per household.

6. Policy Implications

The simulation result implies that energy policies imposed on household electricity and diesel consumptions would result in carbon reduction in some level. Scenario 1 implies that adopting technology towards domestic and cleaner energy such as natural gas would substantially reduce carbon emission in household sector. In scenario 2, it can be seen that electricity tax can also substantially reduce carbon emission in household sector.

However, since change in energy consumption of each income class is not assumed in the scenario analysis, energy policy imposed individually on each income quintile cannot be discussed in the current paper. Moreover, the effect of energy policy on economic growth should also be observed. Therefore, it is necessary to conduct more researches in order to find a more suitable and more sustainable energy policy.

7. Conclusion

The paper clarified energy consumption pattern by income class of Thai households by statistically analysing household socio-economic data of Thailand from the period 2006-2009. The paper found that there were high inequalities in energy consumption among household income classes especially for electricity consumption and transportation fuels. The highest income class was responsible for as much as 60 percent of total household energy consumption. The study also estimated carbon emission of each income class and found that the highest income group emitted carbon emission 7 times higher than the lowest income. Moreover, it can be seen that electricity consumption and diesel consumption of households were the main source of carbon emission. Therefore, the current study conducted policy scenarios based on the fact findings. The first scenarios assumed a change in carbon emission factor, which refers to the technology level of country. The result implied that adopting cleaner energy and technology on power generation could substantially decrease carbon emission of Thailand. For scenario 2, taxes on carbon-intensive energies such as electricity and high-speed diesel might also be an option to reduce carbon emission. However, the effects of such policies on economic growth should also be studies further in the future.

8. Acknowledgement

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9. References

[1] *Annual Report of Energy Policy and Planning Office*, Ministry of Energy of Thailand (2006-2009).
Retrieved from http://www.eppo.go.th/info/index-statistics.html

[2] Druckman, A., Jackson, T. (2008). "Measuring Resource Inequalities: The Concepts and Methodology for An Area-based Gini Coefficient", *Ecological Economics*, 242-252.

[3] Jacobson, A., Milman, Anita D., Kammen, Daniel M. (2005). "Letting the Gini Out of the Bottle: Lorenze Curves of Cumulative Electricity Consumption and Gini Cofficients as Metrics of Energy Distribution and Equity", *Energy Policy*, Volume 33, 1825-1832.

[4] Kraipronsak, P. (2006). Long Run Energy Consumption of Thailand: Static and Dynamic System of Demand Equations, *Ecomod2006 International Conference on Policy Modeling 2006*, Hong Kong Convention and Exhibition Center, Retrieved from http://ecomod.net/sites/default/files/document-conference/ecomod2006/1461.pdf

[5] Lee, C. (2005). "Energy Consumption and GDP in Developing Countries: A Co-integrated Panel Analysis", *Energy Economics*, Volume 27, 415-427

[6] Sari, R., Soytas, U. (2007). "*The Growth of Income and Energy Consumption in Six Developing Countries*", *Energy Policy*, Volume 35, 889-898.

[7] Pachauri, S., Sprung, D. (2002). "Direct and Indirect Energy Requirement of Households in India", *Energy Policy*, Volume 39, 511-523.

[8] Pachauri, S., Sprung, D. (2003). "Energy Use and

Energy Access in Relation to Poverty", *Centre for Energy Policy and Economics, Swiss Federal Institutes of Technology, CEPE*, Working Paper Nr. 25.

[9] Pachauri, S. (2004). "An Analysis of Cross-sectional Variations in Total Household Energy Requirements in India Using Micro Survey Data", *Energy Policy* , Volume 32, 1723-1735.

[10] Pachauri, S., Sprung, D. (2011). "Measuring and Monitoring Energy Poverty", *Energy Policy*, Volume 39, 7497-7504.

About the Author

Name:Saranyupa Chaiprasithikul
Mailing address: 250-0005 Kanagawa-ken, Odawara-shi, Nakacho, 1-11-6, 202, Japan
Tel: +(81)8040524455
E-mail: chsaranyupa@yahoo.com