EE406 Final paper : Factors that affect Thai electricity demand

Presented to

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Introduction

Electricity is an important part of the economy and people's modern life. Several economic and household activities are all required to consume electricity, because it helps operate activities that contribute to the higher share of GDP, operate electrical appliances and entertainment, and improve food production. Thai residential energy consumption has grown steady since 1995 up until now. The residential electricity consumption only accounts for 15 percent of the country's energy consumption. However, environmental policies and conservation efforts should be considered in order to conserve the natural resources for the future generation.

Natural gas-fired is the major source of Thai power generation which accounts for 66 percent of the total share. Coal and lignite is another source that generates electricity in the country, contributing to 21 percent of the share. Even though Thailand is a natural gas producer, Thailand still needs to import another resource of electricity generation. The reasons behind this are population growth and rising domestic demand for consuming more fuel. As a consequence, Thailand might be affected by global oil price fluctuation and supply. However, the Thai government expects to increase coal generation in order to reduce dependency on imported natural gas, and they also plan to emphasize more on renewable energy to build the country's long-term power generation.

In the October 2021, the latest update, Thailand imports the highest volume of liquefied natural gas according to data released by the customs department. The two biggest suppliers for oil are Australia and Malaysia.

The characteristics of energy consumption might be different in each region, but due to limitations in accessing raw data, this paper only considers the electricity consumption in Thailand as a whole. This paper conducts study about factors that affect electricity demand in Thailand. The factors includes Thai's population and Google search keyword such as "ไฟฟ้า (electricity)", "น้ำมันแพง (high oil price)", and "ประหยัดไฟ (save energy)". The paper would like to identify the relationship between dependent variables (electricity consumption) and independent variables (factors) and see whether these factors affect electrical demand or not. Furthermore, this paper also includes the nighttime light data in order to further the study and analyze the relationship between Thai's population growth and nighttime light.

Literature review

This research focuses on the characteristics of household electricity consumption in Thailand. This paper reviews several literature reviews and divides into 2 main categories, papers that are related to factors that affect energy consumption in specific regions and in Thailand as a whole, to see the outcome and the reasons behind the result.

1. Literature related to factors that affect Thai's energy consumption in specific region

- Pattana and Chamlong (2013) examine the factors that affect the energy consumption of households in Bangkok metropolitan. The author gathers the data from households in Bangkok district and analyzes the result by using Multiple regression analysis. The results show that there are three main important factors that create positive effects on household energy consumption. These include economic factors, physical and structural and social and cultural. The paper suggests that in order to reduce home energy use, household size, household location, quality of home appliances, and implementation of renewable energy should be considered. Moreover, government intervention is required to set the standard social and environmental policy.
- Tharinya and Shu-san Hsiau (2017) analyze the Thai's residential energy consumption characteristics and factors that affect the growth in energy use by using an energy input-output method. The results show that direct energy consumption accounts for roughly 30 percent of total residential energy use and indirect energy consumption such as commerce and agriculture account for 70%. In Bangkok and the central region, the number of the household is the main factor that increases the energy consumption, however, in the Northern and Southern region, factors that contribute to energy use are the changes in income per capita.
- Kittikun and Watcharapong (2019) conduct the study regarding the trend of household energy consumption to see the direction and the actual circumstances of electricity consumption in Thailand. A survey was conducted to collect the data on characteristics of household electricity consumption. This paper chose the sample size randomly using the method of stratified random sampling. They also apply load factor, seasonal factor, and utilisation factor to enhance the data accuracy. This paper summarizes the result into 4 groups, household characteristic, dwelling characteristic, electricity consumption, and saving potential. The result from the survey shows that the average side of the household across Thailand was the same. For the dwelling characteristic, most Thai dwelling characteristics are town house, duplex and townhome. Thai people consume a high amount of energy from their home appliances such as air conditioner, refrigerator, light bulb indoor, rice cooker, television, fan, electric bottle, and light bulb outdoors. Moreover, they also state that Thailand can use energy more efficiently and reduce the source of greenhouse gas by replacing the old appliances.

- Aya and Panate (2021) showed the differences in household energy consumption between rural and urban households in the Northern part of Thailand using a household interview and a questionnaire survey. The paper summarizes that rural and urban households have different characteristics in using air conditioners. Urban households use the AC more frequently than the rural household. And households with small children tend to use AC for longer periods.

2. Literature related to factors that affect energy consumption in Thailand as a whole

- Jelena and Marija (2018) studied the different factors that influence the households electricity consumption. The paper was conducted by reviewing several international literature reviews related to household electricity consumption along with econometric and statistical methods. The factors were grouped into 4 factors : cognitive and affective factors, socio-demographic factors, behavioral factors and contextual factors such as policy and electricity price changes. It showed that all factors have a significant effect on energy consumption. Therefore, when the government and policy makers design the policy for reducing the energy consumption, they need to take all factors into consideration in order to achieve energy efficiency at the whole national level.
- Supit (2021) Thailand has very limited domestic oil supply, so Thailand is a major energy importer. The majority of Thai electricity resources come from thermal generation which include coal, natural gas and oil. This paper uses modelling assumptions to see the direction of future resources and to see the alternative resources. According to the author's calculation, oil is still expected to be the primary energy resource. However, the share of coal used as an energy source project to decrease. Moreover, the final energy consumption project will grow by 1.6% per year from 2017 to 2050. As a consequence, the average annual growth of CO_2 emission tends to increase by 3% per year. With this situation, government intervention is required to protect and reserve the major energy resource as well as mitigate the consequences of global warming. The paper suggests that Thailand needs to improve energy efficiency, reduce the intensity of energy consumption, especially oil consumption, and seek for more sustainable energy resources like hydro power and solar in the future. As the main energy importer, Thailand needs to concentrate on oil saving in order to become less dependent on this resource and avoid the fluctuation from the world's price.

Data

This study uses regression analysis based on time series from secondary data, monthly, between 2004 and 2019. The data required to conduct this analysis come from several resources. Firstly, economic Indicators data as electricity demand in 2004-2018 is acquired from the Bank of Thailand. Secondly, the provincial Nighttime light index in 2004-2018 is from google earth engine. Lastly, For the Google search keywords data "ไฟฟ้า (electricity)", "น้ำมันแพง (high oil price)", and "ประหยัดไฟ (save energy)" from 2004-2018 retrieved from Google trends.

Methodology

To identify the relationship between electricity demand and the factors, the most common and simple methodology is Ordinary Least Square Regression (OLS). This method will show the relationship between dependent and independent variables.

Ordinary Least Square Regression (OLS)

OLS or also known as linear regression is a statistical method used to analyze and estimate the relationship between a dependent and one or more independent variables. This method approximates the variables relationship by minimizing the sum of the squares error in the difference between the predicted values and observed values then put together into the straight line.

OLS regression function:

$Y_t = \alpha + \beta * X_t + U_t$ Where Y_t = Dependent variable

And α = Intercept of the model

β = Coefficient of independent variables

X_i = Corresponds to i explanatory variable of the model

U_i = A random error with the expectation 0 and variance σ^2

Result Analysis

(Summary of the OLS regression, Appendix 1)

Model 1

$$\ln(\text{electricity demand}_t) = \beta_0 + \beta_1 \ln(\text{population}_t) + U_t$$

Model 1 shows the regression result of Thai electricity demand and Thai population growth, showing in appendix 1, table 1 From the table, R square in this regression is high, because both indicators share the same upward trend. (see appendix1, figure1) The small number of P values in the result indicate that population is statistically significant to electricity demand. Meaning that 1 percent growth in Thai population increases the use of household electricity by 2.9 percent.

Model 2

$$\ln(\text{electricity demand}_t) = \beta_0 + \beta_1 \ln(\text{ค่าไฟฟ้า}_t) + U_t$$

Model 2 shows the regression result of Thai electricity demand and Google trend keyword "ค่าไฟฟ้า (electricity)" which showed in appendix 1, table 2. R square in this regression is 0.68 meaning that Google trend keyword "ค่าไฟฟ้า" explain electricity demand by 68 percent. Moreover, P value is lower than 0.05 which imply that Google trend keyword "ค่าไฟฟ้า" is statistically significant to the electricity demand. The coefficient of Google trend keyword "ค่าไฟฟ้า" is negative, so this keyword is negatively correlated with the electricity demand. In the other word, 1 percent increase in searching "ค่าไฟฟ้า" in google will leads to a decrease in electricity demand by 41 percent. When people search this word in Google, it might be the case when the price has risen up to check electricity price, therefore people decrease their usage and start to save more electricity use in their household.

Model 3

$$\ln(\text{electricity demand}_t) = \beta_0 + \beta_1 \ln(\text{น้ำมันแพง}_t) + U_t$$

This regression model show in appendix 1, table 3 the correlation of electricity demand and Google search keyword "น้ำมันแพง (high oil price)". R square in this regression result is very low. It implies that Google search keyword "น้ำมันแพง" cannot explain electricity demand as much as previous terms. Moreover, P value is not lower than 0.05, meaning that “น้ำมันแพง” is not statistically significant to electricity demand, so R square is very low. As a result, when fuel's price is high, the demand for

electricity is not affected because electricity is necessarily good, so people still need to use it in their daily life even if the cost of fuel is high.

Model 4

$$\ln(\text{electricity demand}_t) = \beta_0 + \beta_1 \ln(\text{ประหยัดไฟ}_t) + U_t$$

This regression model show the correlation of electricity demand and Google search keyword "ประหยัดไฟ (save energy)" which showed in appendix 1, table 4. R square in this regression model is very low, meaning that google search keyword "ประหยัดไฟ" can explain electricity demand only 1.5 percent. Moreover, the P value in this model is 0.84 which is higher that 0.05. It indicates that google search keyword "ประหยัดไฟ" is not statistically significant to Thai electricity demand. The results imply that even if people want to save energy consumption, they still demand to use it eventually. It is difficult to avoid using electricity in people's daily life.

Model 5

$$\ln(NTL_t) = \beta_0 + \beta_1 \ln(\text{population}_t) + U_t$$

The correlation between Nighttime light and population growth showed in appendix 1, table 5. R square in this regression is high, because both indicators share the same upward trend (see appendix 1, figure 5). The P value is very low which indicates that population is statistically significant to the nighttime light. The growth of Thai population increases the use of Nighttime light. It can indicate that the more the population grows, the more nighttime activities. When population growth increases 1 percent, it will increase NTL by 4.71 percent.

Policy recommendation

Government can use the google trend search engine to analyze the behavior of Thai electricity demand. However, the behavior of each region might be different across countries, so they should collect the regional survey to rule out the differences in each region. Furthermore, Google trends can be used to study in other different fields such as transportation and food production.

Since 2004-2018, Nighttime light data has increased over time as well as electricity demand (see Appendix 2, figure 6 and 7). Importing natural oil from other countries might not be sustainable in the long run now that countries might experience price fluctuation from the global oil market. Therefore, the government should consider other alternative renewable energy resources such as hydropower and wind that can generate enough future electricity demand.

Due to the higher demand in electricity consumption in many sectors, governments need to implement practical and long term policy to sustain limited resources. Moreover, they can use sentimental indexes in order to trace and collect feedback from citizens from each region. As a result, they can adapt the future policies and plans that are suitable for all regions.

Thailand is currently experiencing a low birth rate and aging population. As a consequence, low birth rate will likely slow down electricity demand in the short-term. Moreover, an increase in the aging population could lower economic growth as well. To tackle this problem, the Thai government should attract foreign young workers more to offset the loss from domestic workers. It can be in the form of increasing minimum wages or extending the working visa period. They should also create incentives for Thai's citizens to increase the birth rate and increase existing workers' productivity.

Conclusion

From the OLS regression result, factors that affect the Thai electricity demand are only Thai's population and Google trends keyword "ค่าไฟฟ้า". These 2 factors both fall into the 5 percent level of significance, meaning that they both have statistically significant effects on electricity demand. For the population, it shows positive correlation with electricity demand, however, Google trends keyword "ค่าไฟฟ้า" show the negative relationship. Moreover, the regression results from Nighttime light and population display a high value of R square which means that population has a significant and positive effect on the nighttime light.

In addition, Thai electricity demand has been increasing and tends to grow continuously in the future. Government should focus more on the alternative resource to generate domestic demand rather than import resources from another country. However, the environmental externality of using electrical resources should be concerned as the main priority. Government should strictly monitor overall energy consumption and control it to an appropriate level. They should also conduct the research and study of electricity consumption in each region in order to implement a suitable strategy for each province in Thailand.

Suggestion for further research

Apart from the factors mentioned above, there might be other factors that can affect Thai electricity demand such as economics factors, regional factors, household types, income, demographic factors and industry. If this study includes all the factors, It will show more interesting effects and outcomes in the electricity demand.

Limitation of time and data make it difficult to generate accurate results now that some factors are retrieved from Google trend which is the global search engine. As a result, I cannot identify which specific region searched for this term. In the future, if Google trends can specify the search location and region, the analysis will be more thorough and accurate.

Bibliography

Chapagain, K., Kittipiyakul, S., & Kulthanavit, P. (2020). Short-Term Electricity Demand Forecasting: Impact Analysis of Temperature for Thailand. *Energies*, *13*(10), 2498. https://doi.org/10.3390/en13102498

International - U.S. Energy Information Administration (EIA). (2017, February). US Energy Information Administration. https://www.eia.gov/international/analysis/country/THA

Kamalad, S. (2021, March). *Thailand Country report*. Energy Outlook and Energy Saving Potential in East Asia 2020,. https://www.eria.org/uploads/media/Books/2021-Energy-Outlook-and-Saving-Potential-East-Asia-2020/23_Ch.16-Thailand-1603.pdf

Krstić, J., Reljić, M., & Filipović, S. (2018). Factors influencing electricity consumption: a review of research methods. *Management:Journal of Sustainable Business and Management Solutions in Emerging Economies*. Published. https://doi.org/10.7595/management.fon.2018.0021

Poolsawat, K., Tachajapong, W., Prasitwattanaseree, S., & Wongsapai, W. (2020). Electricity consumption characteristics in Thailand residential sector and its saving potential. *Energy Reports*, *6*, 337–343. https://doi.org/10.1016/j.egyr.2019.11.085

Sirichotpundit, P., Poboon, C., Bhanthumnavin, D., & Phoochinda, W. (2013). Factors Affecting Energy Consumption of Households in Bangkok Metropolitan Area. *Environment and Natural Resources J.*, 31–40. https://www.thaiscience.info/journals/Article/ENRJ/10892142.pdf

Supasa, T., Hsiau, S. S., Lin, S. M., Wongsapai, W., & Wu, J. C. (2017). Household Energy Consumption Behaviour for Different Demographic Regions in Thailand from 2000 to 2010. *Sustainability*, *9*(12), 2328. https://doi.org/10.3390/su9122328

Yoshida, A., Manomivibool, P., Tasaki, T., & Unroj, P. (2020). Qualitative Study on Electricity Consumption of Urban and Rural Households in Chiang Rai, Thailand, with a Focus on Ownership and Use of Air Conditioners. *Sustainability*, *12*(14), 5796. https://doi.org/10.3390/su12145796

Appendix

Appendix 1

Table 1 : Regression result of electricity demand and Thai population growth

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.8836226
R Square	0.7807889
Adjusted R S	0.77948407
Standard Err	0.07025993
Observations	170

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	2.95390025	2.95390025	598.384551	2.9793E-57
Residual	168	0.82932496	0.00493646		
Total	169	3.78322521			

	Coefficients	*tandard Erro*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	-43.334429	2.15793613	-20.081423	1.6403E-46	-47.594594	-39.074263	-47.594594	-39.074263
Population	2.95499997	0.1208001	24.4619	0.00	2.7165182	3.19348173	2.7165182	3.19348173

Figure 1 : The trend of electricity demand and Thai population growth

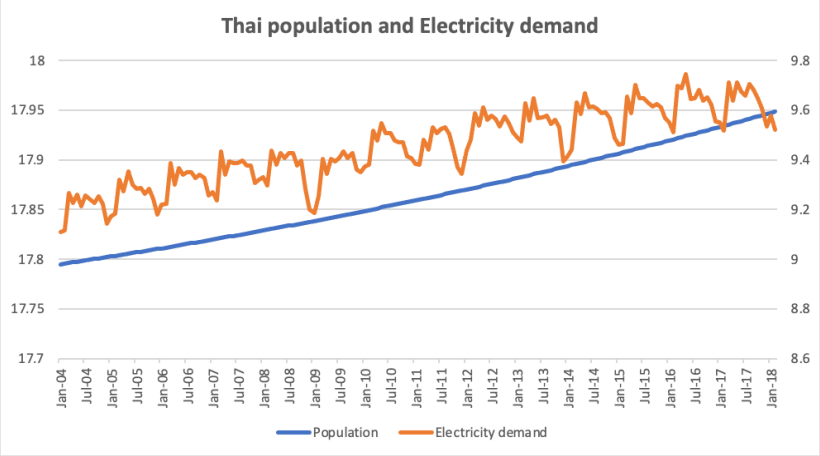


Table 2: Regression result of electricity demand and Google trend keyword "ค่าไฟฟ้า (electricity)"

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.6896866
R Square	0.4756676
Adjusted R S	0.47254658
Standard Err	0.10866253
Observations	170

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	1.79955767	1.79955767	152.407439	2.4784E-25
Residual	168	1.98366753	0.01180754		
Total	169	3.78322521			

	Coefficients	*tandard Erro*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	10.7171345	0.10276661	104.286158	1.249E-154	10.5142542	10.9200148	10.5142542	10.9200148
ไฟฟ้า: (Thail	-0.4168067	0.03376227	-12.345341	0.00	-0.4834597	-0.3501538	-0.4834597	-0.3501538

Figure 2 : The trend of electricity demand and Google trend keyword "ค่าไฟฟ้า (electricity)"

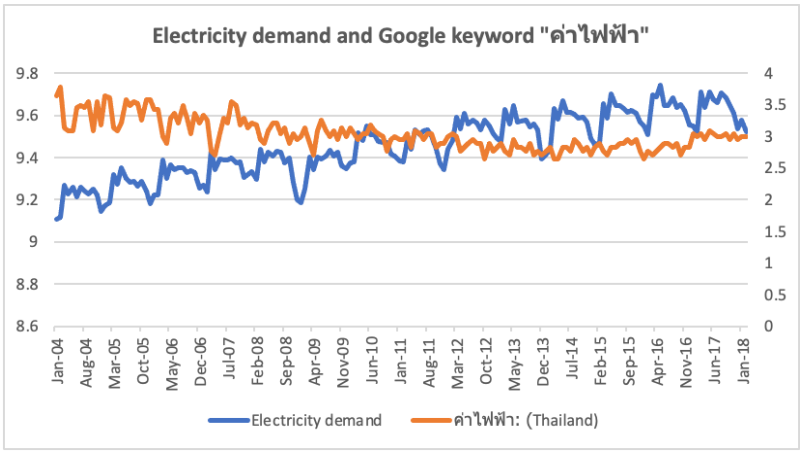


Table 3 : Regression result of electricity demand and Google trend keyword "น้ำมันแพง (high oil price)"

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.02203472
R Square	0.00048553
Adjusted R Sc	-0.005464
Standard Erro	0.15002754
Observations	170

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	0.00183687	0.00183687	0.08160848	0.77548128
Residual	168	3.78138834	0.02250826		
Total	169	3.78322521			

	Coefficients	*tandard Erro*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	9.44866407	0.0180166	524.442191	6.071E-272	9.41309597	9.48423217	9.41309597	9.48423217
น้ำมันแพง: (T	0.00624549	0.02186246	0.28567198	0.78	-0.0369151	0.04940605	-0.0369151	0.04940605

Figure 3 : The trend of electricity demand and Google trend keyword "น้ำมันแพง (high oil price)"

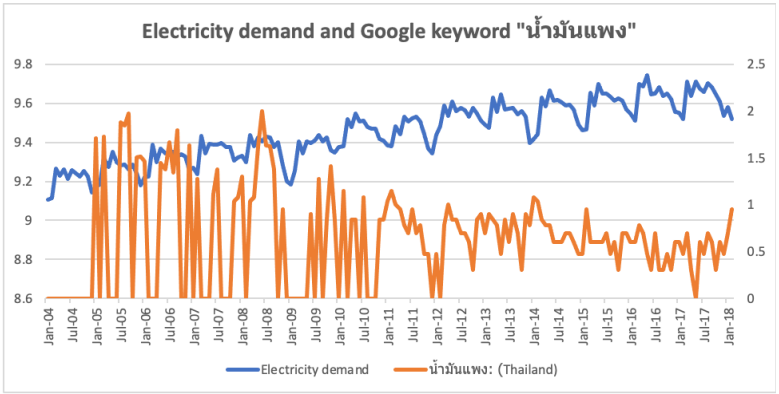


Table 4 : Regression result of electricity demand and Google trend keyword "ประหยัดไฟ (save energy)"

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.01576583
R Square	0.00024856
Adjusted R Sc	-0.0057023
Standard Erro	0.15004533
Observations	170

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	0.00094036	0.00094036	0.04176869	0.8383087
Residual	168	3.78228485	0.0225136		
Total	169	3.78322521			

	Coefficients	*tandard Erroi*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	9.4465333	0.03194867	295.678445	3.526E-230	9.38346071	9.50960589	9.38346071	9.50960589
ประหยัดไฟ: (	0.00718967	0.03517902	0.20437391	0.84	-0.0622602	0.07663958	-0.0622602	0.07663958

Figure 4 :The trend of electricity demand and Google trend keyword "ประหยัดไฟ (save energy)"

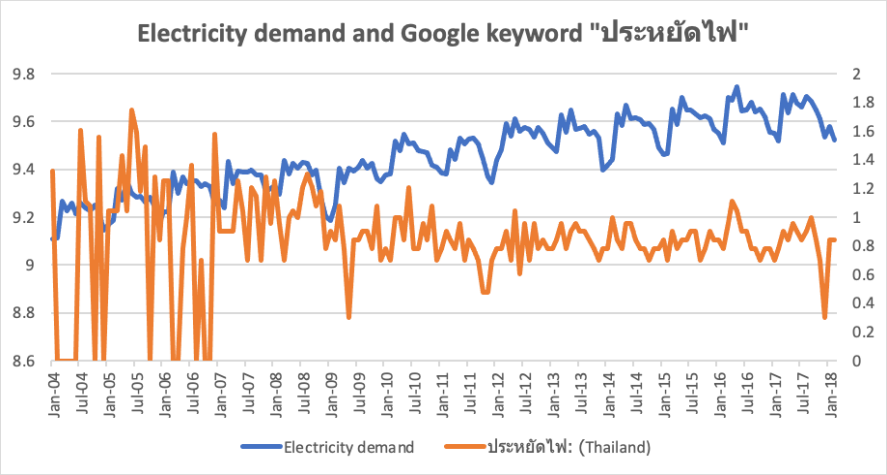


Table 5 : Regression result of Nighttime light and population growth

SUMMARY OUTPUT

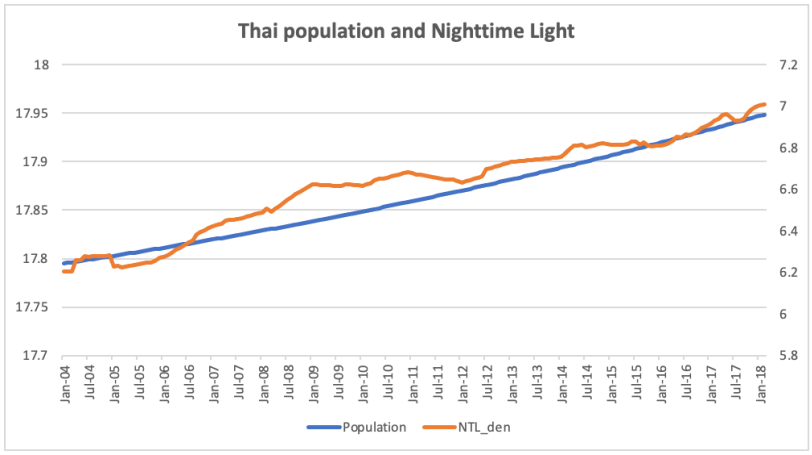
Regression Statistics	
Multiple R	0.9615646
R Square	0.92460648
Adjusted R Sc	0.92415771
Standard Erro	0.06037135
Observations	170

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	7.50920604	7.50920604	2060.30812	3.1733E-96
Residual	168	0.61230968	0.0036447		
Total	169	8.12151572			

	Coefficients	*tandard Erroi*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	-77.544018	1.85422223	-41.82024	9.8928E-91	-81.204596	-73.88344	-81.204596	-73.88344
Population	4.7114716	0.10379836	45.3906171	0.00	4.50655442	4.91638879	4.50655442	4.91638879

Figure 5 : The trend of Nighttime light and population growth



Appendix 2

Figure 6 : Nighttime light trend

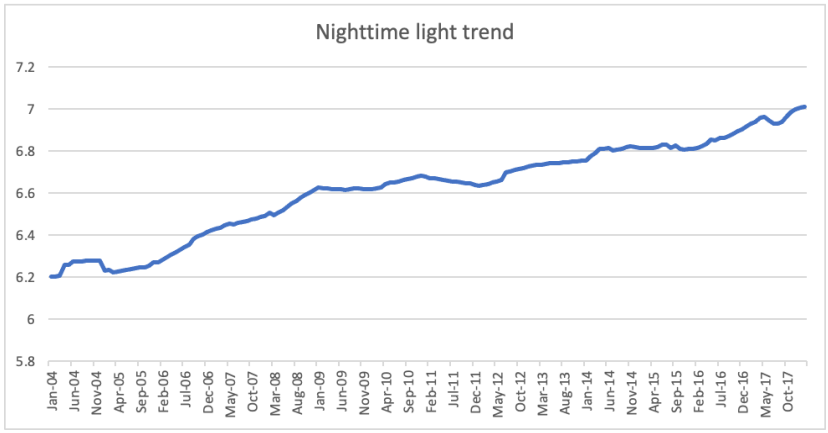


Figure 7 : Electricity demand trend