EE 406 : Contemporary Economic Issues

Topic : Analysis of the household electrical energy consumption in Thailand in the context of COVID-19 with a set of keywords from Google Trend

Presented to

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Introduction

Nowadays, technological advancement has become one of the key factors that drive the global economy. Many new electrical innovations, including household electrical appliances, have been developed and sold out in the market every year. These innovations are expanded to most of the countries in the world. For this reason, the overall global demand for electrical energy consumption, especially household electricity consumption, has increased. Our everyday lives have become more reliant on electricity. Without electricity, most of the activities would be interrupted. The daily life of people would become more difficult. Electricity can be compared to the main gear that drives the world economy and people's lives. According to Enerdata, a global energy statistical yearbook, global power consumption has been an increasing trend throughout the period since 1990, shown in figure 1. The electricity consumption has increased from around 10,000 TWh in 1990 to around 22,500 TWh in 2020. In 2020, the top 3 countries that had the highest electricity usage were China (6,752 TWh), the United States (3,842 TWh), and India (1,191 TWh), respectively, shown in figure 2. However, in the same year, the global electricity consumption declined by around 1.1% since 2009, shown in figure 1. The power consumption in the US had a strong decline by around 3.9%.

In Thailand, household electricity consumption has increased every year (Bank of Thailand, 2021). In 2020, the electricity consumption in Thailand was around 188 TWh, shown in figure 2. Thai households tend to have a higher electricity usage throughout the period, especially in March - April. The consumption of electricity has reached its peak in March - April every year because the weather has become the hottest during the season, shown in figure 3. Thai household electricity consumption varies with temperature and income level (Pier, 2018). When the average temperature increases, the median of household electricity consumption would be the same trend, shown in figure 4. In addition, in densely populated urban areas, overall electricity consumption is noticeably higher than outside the city, especially the area that is a tourist attraction. That area has the highest electricity consumption per meter, shown in figure 5.

During the Covid-19 pandemic, the rate of Thai household electricity consumption has increased higher than before the pandemic, shown in figure 3. Many Thai households use electrical appliances at their residences more than before. The government's business restriction on the pandemic becomes one of the main reasons behind the increase in the power usage rate. The government policies, such as lockdown measures, tend to encourage citizens to stay at their homes to prevent the pandemic with many restrictions. As a consequence, most educational institutions and companies have to implement the "work from home" policy to allow their students or employees to stay and work at their homes. People have to use electrical appliances and electronic devices, such as mobile and computers, to do their activities at their homes, so the household electricity consumption has increased from those activities. In addition, the other main reasons for the increase in electricity consumption is from the impact of hot temperatures and other government policies, such as alleviating the burden of basic utilities, electricity bill discounts (EPPO, 2021).

Understanding and analyzing the trend of power use can help us better understand the economy and people's livelihoods. The data from the electricity consumption could be used to analyze the economic situation, such as the pandemic, the government policies or even the impact of the temperature on people's behavior. The electricity consumption can also indicate the area that has high economic activity, such as the tourism destination area.

The most accurate and reliable official data about the private final consumption expenditure, including household electricity consumption, is from the Office of the National and Social Development Council (NESDC). However, NESDC always publishes the official gross domestic product article after two months from the end of each quarter. With the delay in the information release, this report will use the private consumption index from the Bank of Thailand (BoT), which provides a monthly index and has less delay in the data release, as the conventional indicator.

One of the main issues that became an idea to create this report is the delay in the release of the private consumption index (PCI) from the Bank of Thailand. Private Consumption Index or PCI is the measurement on the monthly private consumption expenditure. A higher value

indicates an increase in consumer spending. This report will mainly use this index as the main source of data. However, the disclosures are delayed by around 2 months from the present, so the lateness of the data release could become an obstacle for the data analyst to analyze and forecast the data.

Hence, this report will introduce Google Trend as the alternative indicator for predicting Thai household electricity consumption with the conventional indicator. Google Trend is the official tool from Google that provides how frequent the actual searches on each keyword are. The main benefit of this tool is the real-time update of data. This report would like to find out which keyword would become the best alternative indicator to forecast the trend of Thai household electricity consumption.

Literature review

This research will focus on the trend of Private Consumption Index (PCI) about the household electrical energy consumption in Thailand from the Bank of Thailand (BoT). Most of the literature would be about the household electricity consumption in Thailand. There are many sources of the literature review, which can be divided into 4 sub categories :

1) Research Methodologies

   i) According to Pier (2018), the report used the data to provide a high-resolution and up-to-date indicator for the wealth distribution and inequality. The report also used the regression method to analyze the data.
   ii) According to Yoshida, A. (2020), in 2016 and 2017, in-depth visits to 32 houses in Chiang Rai were conducted by using a questionnaire survey.
   iii) According to Thai science journals (2013), the data were analyzed by using multiple regression analysis.
   iv) According to the International Institute for Environment and Development (2016), the change in the home energy use in cities with population density was the hypothesis in this research. This research used MapInfo Professional 4.5 for GIS analysis of DPT data and statistical analysis.
   v) According to Supasa, T. (2017), the methodologies that this research used is the input-output analysis (IO analysis) and the SDA two-polar decomposition method.

2) Datasets

   i) According to Pier (2018), the report obtained the data from the administrative billing records of 16 million residential meters. The report discovered that a household's wealth and temperature can be determining factors to forecast household electricity consumption. However, the

highest-income household has the least price sensitivity, but they are the most responsive to the change in the weather.

ii) According to Yoshida, A. (2020), household characteristics, ownership of electric appliances, usage of air conditioners (ACs), intents to preserve electricity, desire to acquire electric equipment in the future, and predictions for a future lifestyle were all addressed by the data collection. The report discovered that the period of using air conditioners was longer in urban households compared to rural households. Rural households tend to use the air conditioner during the summer or only a few hours before sleeping. The report further suggested that promoting ecologically friendly habits among younger individuals to curb usage of air conditioners would be critical in decreasing future energy consumption.

iii) According to Thai science journals (2013), the report collected the information from 1,150 households in 15 districts in Bangkok. The research found out that physical, structural, social and cultural, and economics had a positive effect on the effect of household electricity consumption.

iv) According to the International Institute for Environment and Development (2016), the report was conducted by using a survey of household questionnaires and other secondary sources from less dense city Chaiyaphum and denser city Roy Et. The research discovered that transport energy usage will be higher in a less dense city.

v) According to Supasa, T. (2017), the research obtained the data from Thailand original's 2000 and 2010 IO tables from NESDB and household expenditure survey. The research revealed that in the Greater Bangkok and Central areas, the number of households was the most important factor driving up residential energy demand.

3) Sub-topics

i) Many researches indicated that the increase in the temperature has a positive correlation with the household electricity consumption.

ii) According to Earth.org (2020), the temperature of Thailand could rise above 29°C, which is equal to the Sahara by 2070, shown in figure 6.

iii) According to the IMF (2021), the report indicated many issues about Thailand's economy and Covid-19. The pandemic resulted in a complete cessation of tourism and a severe reduction in economic activity. This electricity consumption has a positive correlation with the tourist destination area.

iv) According to the Energies (2021), the research discovered that the impact of the Covid-19 had a negative impact on the power consumption and the GDP in the first half of 2020 in Romania by running the regression.

4) Research Gaps

i) The research gaps after reviewing the articles and reports related to the topic can be divided into two sub-topics :

ii) First, most of the reports about household electricity in Thailand do not mention the Covid analysis in the report. Most of them discussed the factors that affect the power consumption, such as the temperature and the income. The Covid pandemic has arrived in Thailand in 2020, so most of the reports about the electricity consumption were published before the pandemic. This could be a big gap for people who are interested in finding the literature review about the household electricity consumption during Covid-19.

iii) Second, it would be a better way to use the conventional data from NESDC or BoT to analyze the data with the alternative data from the data collected from each report.

Data & Research methods

Data

This report used the data from the private consumption index as the conventional indicator and the data from the Google Trend as the alternative indicator. The time range of the data is from 1 January 2010 to 30 September 2021. This report tries to find the alternative indicator, which is keywords from Google Trend, to analyse and forecast the effect of the Covid-19 on household electricity consumption. Note that the information in this article is monthly.

Table 1 : Source of Data

Data	Source of Data	Unit
Private Consumption Index : Household electricity consumption	Bank of Thailand (BoT)	Standardized Index
Keyword Search	Google Trend	Number of Search

Research methods

The research methods of this report begins with obtaining the private consumption index as the conventional data from the official Bank of Thailand website. Then the data will be imported into Microsoft Excel to normalize the data. The alternative data, which are keywords, will be imported from the Google Trend to normalize the data in Microsoft Excel. After that, the data will be visualized as a graph to see the pattern between conventional and alternative data. This process can separate the similar and dissimilar keywords from the conventional data. After that, the Stata will be introduced as a further analysis tool. The Stata program will be used to run the regression to see how closely the data is. The method that this report used on the Stata is the Ordinary Least Squares Regression OLS Regression or simply known as simple linear regression. This type of regression is a simple regression model and has been used to see the

relationship between dependent (the conventional indicator) and independent variables (alternative indicator). This method aims to reduce the sum of square differences between observed and anticipated values as much as possible. The OLS regression function with more explanatory variables will be :

$$\mathbf{Y_i = \alpha + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + ...+ \beta_n X_n + U_i}$$

Where Yi = Dependent variable

α = Intercept in the regression model

β = Coefficient of each independent variables

Xi = Independent variables

Ui = Error term of the regression model

The keywords or the alternative indicators to run the OLS regression would be mainly about the temperature and household electricity appliances. After putting the alternative indicators along with the conventional indicator into the Stata program, the OLS regression in this report will be :

$$\mathbf{Y_i = \alpha + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \beta_6 X_6 + \beta_7 X_7 + U_i}$$

Where Yi = Conventional data “Household electricity consumption”

α = Intercept in the regression model

β = Coefficient of each independent variables

X_1 = The Google Trend keyword searched on “ ร้อน ”

X_2 = The Google Trend keyword searched on “ อุณหภูมิ ”

X_3 = The Google Trend keyword searched on “ พัดลม ”

X_4 = The Google Trend keyword searched on “ ไฟฟ้า ”

X_5 = The Google Trend keyword searched on “ การไฟฟ้า ”

X_6 = The Google Trend keyword searched on “ ไมโครเวฟ ”

X_7 = The Google Trend keyword searched on “ ฤดูร้อน ”

Ui = Error term of the regression model

Result analysis and discussion

(Summary of the OLS regression from figure 7)

After running the OLS regression from the monthly data from 1 January 2010 to 30 September 2021 in the Stata, the correlation between dependent variable, household electricity consumption index, and independent variables, the keywords from Google Trend, tend to be consistent. The independent variables of this report are the Google keywords searched on "ร้อน (hot), อุณหภูมิ (temperature), พัดลม (fan), ไฟฟ้า (electricity), การไฟฟ้า, ไมโครเวฟ (microwave), ฤดูร้อน (summer)". The criteria to choose these keywords is based on the results from the literature reviews. Most of the literature reviews found out that the key determining factor on household electricity consumption in Thailand is the temperature and electrical appliances. The number of sample observations or the sample sizes of this report, including both conventional and alternative indicators, are 141 observations. The R-squared, which can describe the consistency of both conventional and alternative indicators, is around 0.8266 or 82.66 percent, while the adjusted R-squared is 0.8175 or 81.75 percent. The R-squared is quite impressive because it approaches 1, which can confirm that the correlation between the household consumption index with the selected keywords searched are consistent.

In addition, after observing the p and t statistical test, it can confirm that all variables passed the significant test. The independent variables in this report are strongly significant at 5% confidence level. The coefficient of keywords searched from Google Trend on "พัดลม (fan), ไฟฟ้า (electricity), ไมโครเวฟ (microwave), ฤดูร้อน (summer) is positive, which are 0.1663539, 0.27902, 0.1623185, and 0.0302157 respectively. While the coefficient of keywords searched on "ร้อน (hot), อุณหภูมิ (temperature), การไฟฟ้า (electricity)" are negative, which are -0.4025613, -0.0197174, and -0.2962157 respectively.

After observing that the dependent and independent variables are strongly significant, we can conclude that the selected Google Trend keywords can be used to predict the trend of household electricity consumption. This report provides the scatter plot between a dependent variable and the Google Trend keywords searched on "อุณหภูมิ, ร้อน, พัดลม, and ฤดูร้อน" to

illustrate to the relationship between the temperature on household electricity consumption. According to figures 8 - 11, the relationship between both variables shows the seasonal trend that would be increased every April. The temperature in Thailand will become the hottest every April, so we can see that people would search for keywords about the hot temperature in that month. The household electricity consumption also becomes higher every April same as the selective keyword searches. During the Covid-19 pandemic, the conventional and alternative indicators show an increasing trend at a higher rate compared to before the pandemic.

Moving to the discussion part, in my point of view, the Thai household consumption would be mainly dependent on the temperature. In the summer, especially around March - May, people tend to have a high power consumption. Most people tend to use more fans or air conditioners during the hot temperature. As we can see from the figure 3, the power consumption becomes higher every April of every year. The Google Trend keyword searched about the temperature also has the same trend with the PCI data on household electricity consumption. In this case, we can conclude that the selected keyword searched in this report has a high potential to become the predictors of household electricity consumption in Thailand.

The limitation of this research would be the time constraint of the data from the Bank of Thailand. Bank of Thailand only provides the data of the Private Consumption Index (PCI) from 2010 to the present. It is good that the data is updated to the present, but it would be better to have a further analysis of the data for a longer period. The Google Trend provides the keyword searched from 2004 to the present, but we can only use the PCI data from 2010 to the present to analyze along with the keyword searched. In addition, in some topics, using the keyword searched alone may not be enough to use for predicting the data. It would be better to use Google Trend along with other indicators to predict the trend of the data. The Google Trend just provides several searches on each keyword. We can only observe the trend of each keyword to predict and analyze the topic, but it does not mean that the keyword would have a direct impact on the topic. For example, people who search for hot temperatures may not have a high electricity consumption during the summer. It would be better to have a household electricity consumption survey as another alternative indicator to analyze the results along with the keyword searched.

Conclusion and policy recommendation

Conclusion

This report tries to find out that the alternative indicators, keyword searched from Google Trend, would have the potential to predict the conventional indicators, which is the household electricity consumption with the analysis of Covid-19 impact.

The research gap from this study is the constraint to analyze the information of the Thai household electricity consumption index before 2010. The data used in this study begins from 1 January 2010 to 30 September 2021. The information of keyword search on Google Trend has been available since 2004, but the data on private consumption index is available since 2010.

This report obtained the household consumption index from the Bank of Thailand, while it obtained the keywords searched from Google Trend. The data used in this report is from 1 January 2010 to 30 September 2021 with the frequency of monthly data. The data is used to analyze the potential of alternative indicators to predict the trend of conventional indicators with the analysis of Covid-19 impact.

The research methodology in this report is about using the Ordinary Least Squares regression (OLS regression) on the Stata to analyze the relationship between both indicators. After running the regression analysis on the Stata program, the results show that the relationship between two indicators are strongly significant. It can imply that the selected Google Trend keyword search can be used to predict the trend of the conventional indicator. In addition, this report also uses Microsoft Excel to plot the scatter plot to see the relationship between each alternative indicator with the conventional index.

The key findings are divided into 3 main ideas. First, we can use the Google Trend keywords searched on “ร้อน (hot), อุณหภูมิ (temperature), พัดลม (fan), ไฟฟ้า (electricity), การไฟฟ้า, ไมโครเวฟ (microwave), ฤดูร้อน (summer)” to predict the trend of the Thai household electricity consumption from private consumption index. Second, the trend of electricity consumption has

increased every year. During the summer, the trend of household electricity consumption will reach a peak every April of each year. In the same way, the keywords searched about the temperature in Thailand will reach a peak every April as well. Third, with the impact of Covid-19, the rate of electricity consumption has increased. People tend to have higher electricity consumption compared to before the pandemic.

Policy Recommendation

The government policies on the household electricity consumption in Thailand can be divided into 6 topics

First, the government should encourage citizens, especially data analysts, to use the Google Trend keywords as one of the alternative indicators to predict the trend of the data. The Google Trend has a potential to forecast the trend of the data in some area, such as household electricity consumption.

Second, the government should provide subsidies to reduce the initial investment cost for energy efficiency changes in a household. For example, the government should offer a tax deduction for more efficient appliances that can save more energy consumption. For example, the government should reduce the price of the electricity with saving energy symbol (ประหยัดไฟเบอร์ 5)

Third, the government should use the penetration on inefficient technologies, such as the technology that consumes a lot of electricity. This policy aims to help the citizens make the right decision to buy electrical appliances at reasonable prices.

Fourth, the government should distribute efficient electrical appliances to the poor. The government should also provide a price reduction of electricity consumption for the poor. This policy will help the poor to have a better standard of living.

Fifth, the government should invest in research and development in domestic electrical appliance companies, so Thai citizens can access electrical appliances at a cheaper price. This policy also stimulates the economy by supporting domestic companies.

Lastly, during the summer, the government should offer a price reduction of the electricity because the Thai household electricity consumption always reaches a peak every April.

Suggest the further improvement

There are 3 suggestions to improve the report about the analysis of the household electrical energy consumption in Thailand in the context of Covid-19 with a set of keywords from Google Trend :

First, this report only used 7 keywords about the temperature and the electrical appliances to conduct the alternative indicators. However, we can include more than 7 keywords to improve the accuracy of the alternative indicators. For example, we can include more keywords about electrical appliances.

Second, this report used Ordinary Least Squares regression (OLS regression) as the main regression form to run the analysis. However, we can use other methods to analyze the data. The regression analysis is only one way to conduct the analysis.

Third, this report only used the Google Trend keywords as the main alternative indicators. However, as recommended in the research limitation, we should add other indicators to analyze the conventional data, such as household electricity consumption surveys. With more indicators, it will improve the performance of the analysis.

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Appendix

Appendix 1 : Figures and Graphs

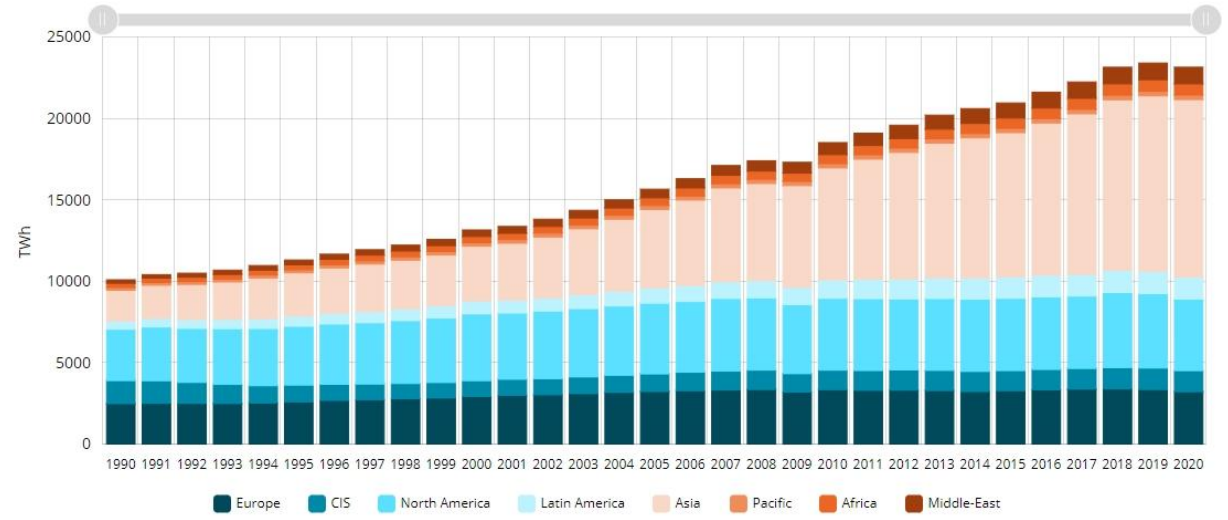

Figure 1 : Global power consumption

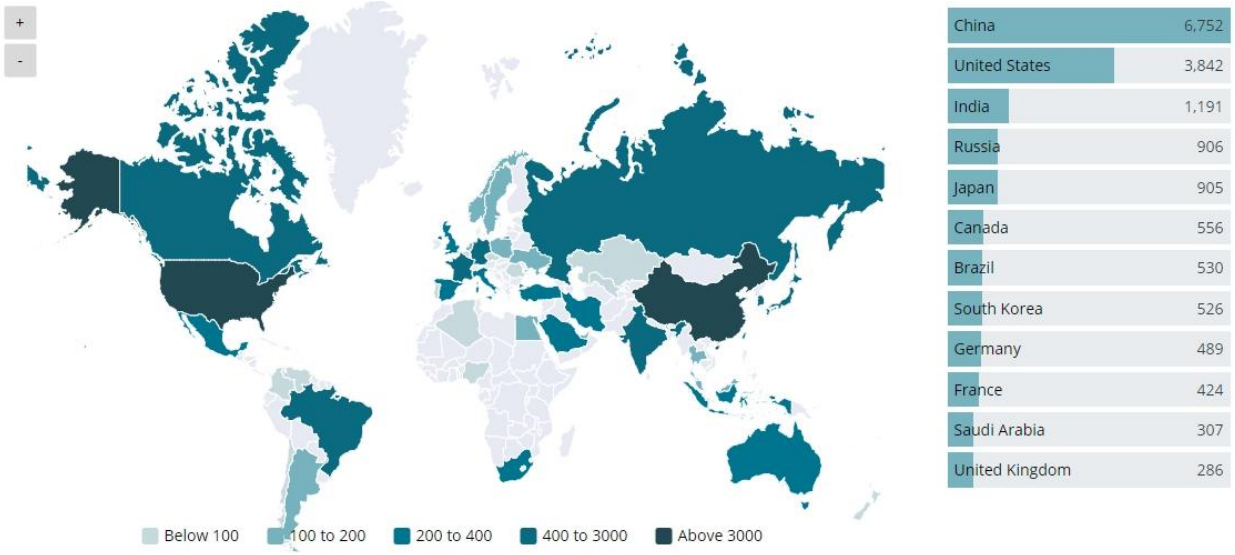

Figure 2 : Global power consumption breakdown by country

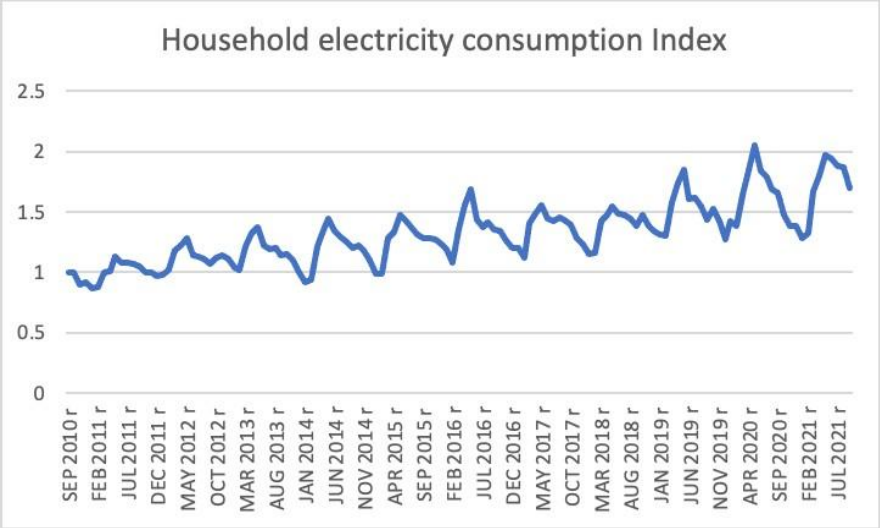

Figure 3 : Household electricity consumption index in Thailand from BoT (normalize)

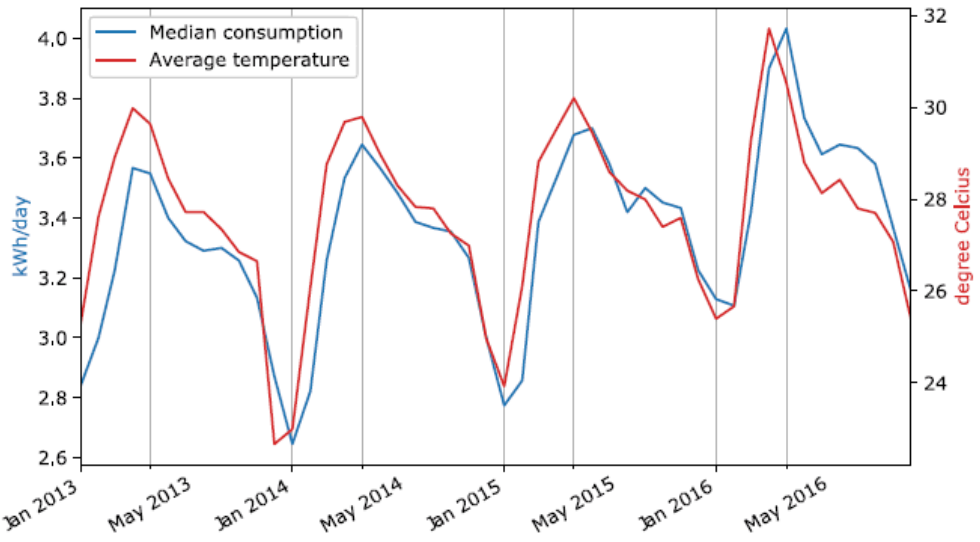

Figure 4 : Median electricity consumption and the average monthly temperature, 2013-2016

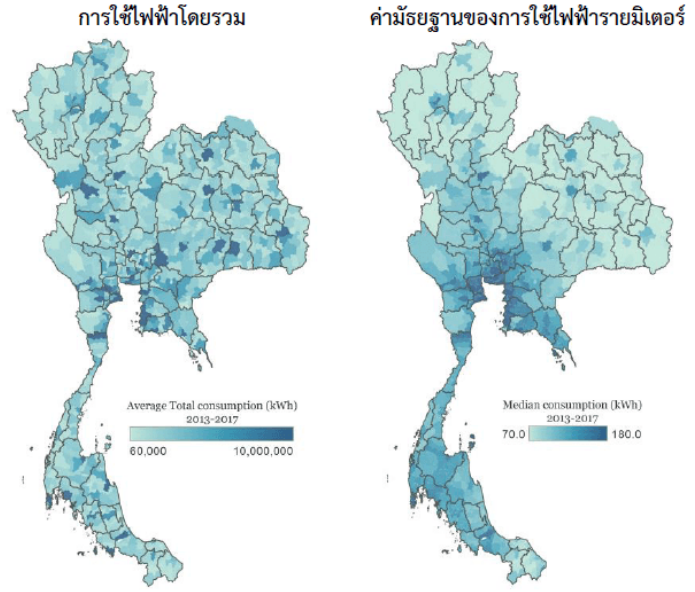

Figure 5 : Electricity used by zip code area

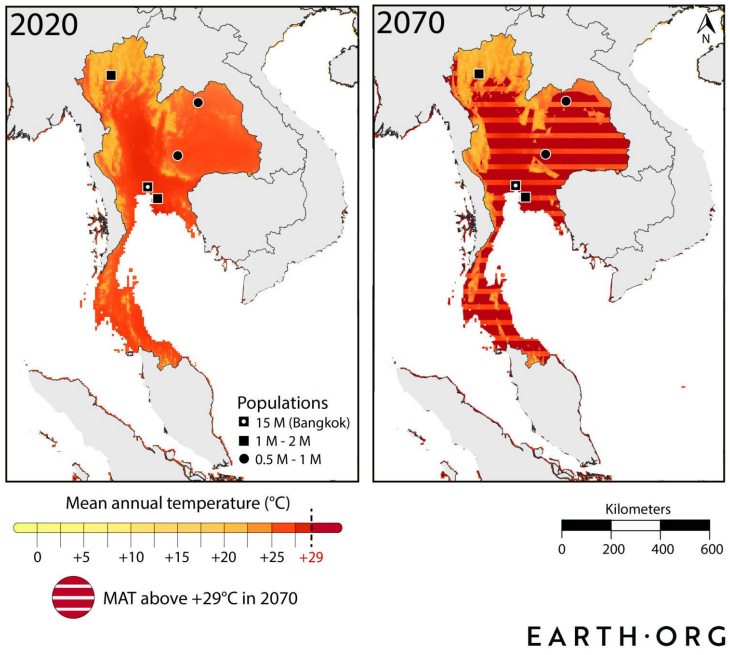

Figure 6 : Forecasted annual temperature in Thailand

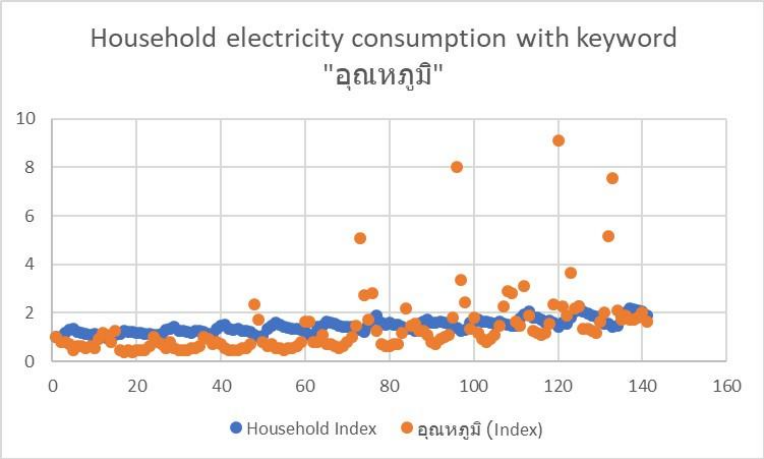

Figure 8 : The scatter plot of household electricity consumption and keyword searched on “อุณหภูมิ” (normalize)

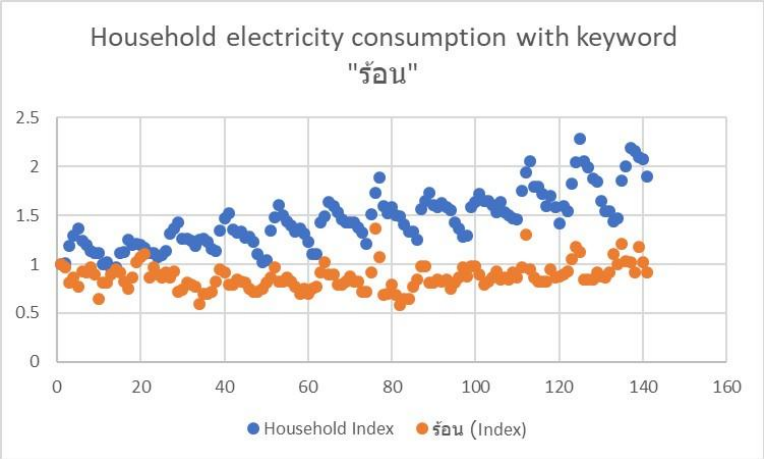

Figure 9 : The scatter plot of household electricity consumption and keyword searched on “ร้อน” (normalize)

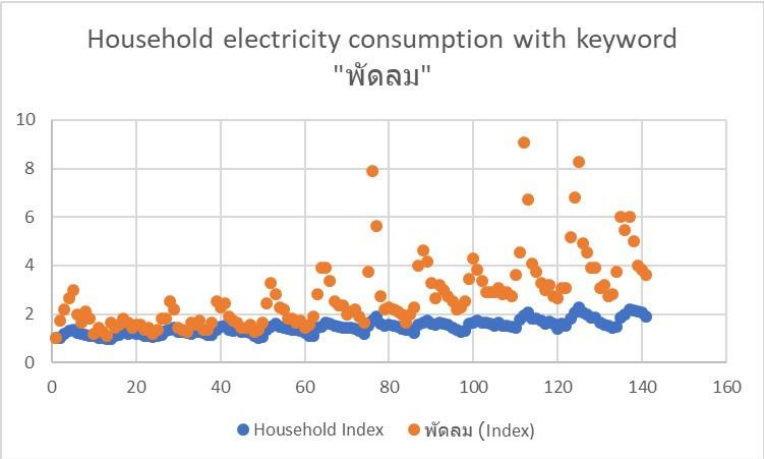

Figure 10 : The scatter plot of household electricity consumption and keyword searched on “พัดลม” (normalize)

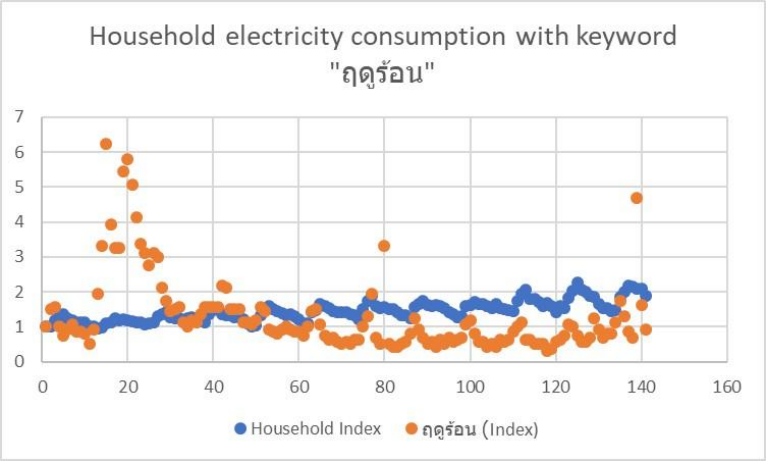

Figure 11 : The scatter plot of household electricity consumption and keyword searched on “ฤดูร้อน” (normalize)

Appendix 2 : Table

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. reg HouseholdIndex รถIndex ชุมชนIndex ทหลมIndex ไฟฟ้าIndex การไฟฟ้าIndex ไมโครเวฟIndex ตู้ตรอนIndex
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Source	SS	df	MS	Number of obs	=	141
				F(7, 133)	=	90.57
Model	9.44758671	7	1.34965524	Prob > F	=	0.0000
Residual	1.98201583	133	.014902375	R-squared	=	0.8266
				Adj R-squared	=	0.8175
Total	11.4296025	140	.081640018	Root MSE	=	.12208

HouseholdIn~x	Coefficient	Std. err.	t	P>|t|	[95% conf.	interval]
รถIndex	-.5877192	.1378851	-4.26	0.000	-.8604506	-.3149878
ชุมชนIndex	-.014415	.00917	-1.57	0.118	-.0325528	.0037229
ทหลมIndex	.1786268	.0120771	14.79	0.000	.1547388	.2025148
ไฟฟ้าIndex	.2824874	.0891408	3.17	0.002	.1061703	.4588044
การไฟฟ้าIndex	-.3070917	.0800798	-3.83	0.000	-.4654864	-.1486969
ไมโครเวฟIndex	.1913446	.0494566	3.87	0.000	.0935214	.2891678
ตู้ตรอนIndex	.0302157	.01293	2.34	0.021	.0046406	.0557907
_cons	1.229059	.0934016	13.16	0.000	1.044315	1.413804

Figure 7 : The results from the regression analysis