Does Thailand's new electric vehicle policy affect Battery Electric Vehicle (BEV) adoption?

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An Independent Study Submitted in Partial Fulfillment of the Requirements
for the Degree of Master of Arts in Business and Managerial Economics
Field of Study of Business and Managerial Economics
FACULTY OF ECONOMICS
Chulalongkorn University
Academic Year 2021

นโยบายรถยนต์ไฟฟ้าใหม่ของไทยส่งผลต่อการเลือกใช้ยานยนต์ไฟฟ้าพลังงานแบตเตอรี่ (BEV, Battery Electric Vehicle) หรือไม่

น.ส.อภิญญา ฐิติพัฒนาวาณิช

สารนิพนธ์นี้เป็นส่วนหนึ่งของการศึกษาตามหลักสูตรปริญญาศิลปศาสตรมหาบัณฑิต
สาขาวิชาเศรษฐศาสตร์ธุรกิจและการจัดการ สาขาวิชาเศรษฐศาสตร์ธุรกิจและการจัดการ
คณะเศรษฐศาสตร์ จุฬาลงกรณ์มหาวิทยาลัย
ปีการศึกษา 2564

Independent Study Title	Does Thailand's new electric vehicle policy affect Battery Electric Vehicle (BEV) adoption?
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Field of Study	Business and Managerial Economics
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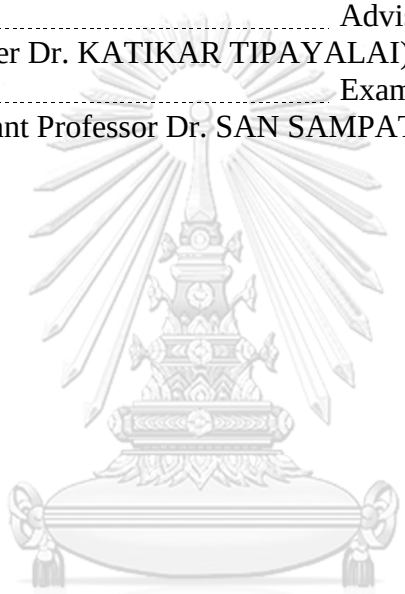

อภิญญา ฐิติพัฒนาวาณิช : นโยบายรถยนต์ไฟฟ้าใหม่ของไทยส่งผลต่อการเลือกใช้ยานยนต์ไฟฟ้าพลังงานแบตเตอรี่ (BEV, Battery Electric Vehicle) หรือไม่. (Does Thailand's new electric vehicle policy affect Battery Electric Vehicle (BEV) adoption?) อ.ที่ปรึกษาหลัก : อ. ดร.กติกา ทิพยาลัย

การขนส่งคิดเป็นประมาณร้อยละ 27 ของการปล่อยก๊าซเรือนกระจกทั้งหมดในสหรัฐอเมริกา การเปลี่ยนจากรถยนต์ที่ใช้เครื่องยนต์สันดาปภายในเป็นรถยนต์ประเภทที่สะอาดกว่า เช่น ยานยนต์ไฟฟ้าแบตเตอรี่ (BEV) อาจสามารถลดมลพิษทางอากาศและก๊าซเรือนกระจกที่ปล่อยสู่ชั้นบรรยากาศและชะลอภาวะโลกร้อนลงได้ อย่างไรก็ตาม คนส่วนใหญ่ยังมีความคลางแคลงใจในความน่าเชื่อถือและราคาของ BEV รัฐบาลหลายแห่งในประเทศที่พัฒนาแล้ว เช่น นอร์เวย์ ได้พิสูจน์แล้วว่านโยบายส่งเสริมการใช้รถ EV ของรัฐบาลสามารถกระตุ้นการใช้ BEV ได้จริง สารนิพนธ์นี้จะวิเคราะห์โดยเฉพาะอย่างยิ่งในกรณีของนโยบายส่งเสริมการใช้รถ EV ของประเทศไทย ซึ่งรวมไปถึงนโยบายจูงใจที่ไม่ใช่ตัวเงินและตัวเงิน เช่น การลดภาษีนำเข้าและภาษีสรรพสามิตหรือเงินอุดหนุน 18,000 บาท ถึง 150,000 บาท หรือการยกเว้นอากรนำเข้าชิ้นส่วนอิเล็กทรอนิกส์ เทคนิค Ordinary Least Square ได้ถูกใช้เพื่อวิเคราะห์ว่านโยบายส่งเสริมการใช้รถ EV และปัจจัยที่เกี่ยวข้องอื่นๆ สามารถส่งผลให้มีการจดทะเบียนรถ BEV ใหม่เพิ่มขึ้นหรือไม่ ซึ่งสรุปได้ว่านโยบายส่งเสริมการใช้รถ EV นั้นมีความเกี่ยวข้องกับการเพิ่มขึ้นของการจดทะเบียนรถ BEV ใหม่ถึง 40-65% โดยปัจจัยที่เกี่ยวข้องอื่นๆ เช่น ราคาน้ำมันนั้นมีนัยสำคัญทางสถิติในประเทศไทย โดยที่หากราคาน้ำมันดีเซลเพิ่มขึ้นร้อยละ 1 ต่อลิตร จะสัมพันธ์กับจำนวนรถยนต์ BEV ที่จดทะเบียนใหม่รายเดือนเพิ่มขึ้นร้อยละ 1.3 และร้อยละ 1.65-2.16 สำหรับราคาน้ำมันเบนซินที่เพิ่มขึ้นร้อยละ 1 ต่อลิตร ในขณะเดียวกันอัตราดอกเบี้ยเงินกู้ รายได้เฉลี่ยของครัวเรือน และจำนวนสถานีชาร์จดูเหมือนจะไม่มีนัยสำคัญทางสถิติที่จะส่งผลกระทบต่อตัวเลขรถยนต์ BEV จดทะเบียนใหม่

สาขาวิชา	เศรษฐศาสตร์ธุรกิจและการจัดการ	ลายมือชื่อนิสิต .....
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6484089529 : MAJOR BUSINESS AND MANAGERIAL ECONOMICS
KEYWOR D: EV, Electric Vehicle, BEV, Battery Electric Vehicle, EV Incentives

Apinya Thitiphatthanawanit : Does Thailand's new electric vehicle policy affect Battery Electric Vehicle (BEV) adoption?. Advisor: Lect. Dr. KATIKAR TIPAYALAI

Transportation accounted for about 27 per cent of the total Greenhouse gas emissions in the United States. The shift from Internal Combustion Engine vehicles (ICEs) to a cleaner vehicle type such as Battery Electric Vehicles (BEV), could potentially reduce the air pollution and Greenhouse gases released into the atmosphere, thus, slowing down the pace of global warming. However, most people still have doubts on the reliability and prices of the BEVs. Many governments in developed countries such as Norway have proved that government incentives policy can be used to incentivize the BEV adoption. This paper analyzes particularly on the case of Thailand's EV incentives policy, including both non-monetary and monetary incentives policy such as a reduction of import duty and excise tax, 18,000 Baht to 150,000 Baht subsidy, and exemption of import duties on electrical components. In addition, the Ordinary Least Square method was used in this paper to analyze whether the EV incentives policy and other relevant factors could lead to a higher number of new BEV registered or not. It was concluded that the EV incentives policy is associated with an increase in new BEV adoption by 40-65 per cent. Other relevant factors such as oil prices appear to have statistically significant predictive power for the adoption of BEV in Thailand; a 1 per cent increase in diesel price per liter is associated with a 1.3 per cent increase in the number of new BEV registered monthly, and 1.65-2.16 per cent for a 1 per cent increase in Benzene price per liter. Meanwhile, lending interest rate, median household income, and the number of charging stations do not seem to be statistically significant to affect the new BEV adoption.

Field of Study:	Business and Managerial Economics	Student's Signature .....
Academic Year:	2021	Advisor's Signature .....

ACKNOWLEDGEMENTS

The completion of this Individual Study paper could not have been completed without the continuous support from my advisor Dr Katikar Tipayalai. I would like to express my sincere gratitude and appreciation to Dr Katikar for her scholarly advice, guidance, suggestions, patience, valuable knowledge, and encouragement.

I would also like to thank all the staff of the Master of Arts in Business and Managerial Economics (MABE) for their constant guidance and for providing necessary information regarding the research process.

I would also like to thank all my friends who helped me proofread this long manuscript and provided useful ideas to make this paper to become whole.

Finally, I would like to thank my parents- Mr Parinya and Mrs Aree who support me in every aspect, financially by money, physically by food, and mentally by love.

Apinya Thitiphatthanawanit

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1. Introduction and objectives

From walking, horse riding, biking, to driving, humans constantly innovate for better and faster transportation. Nowadays, the Electric Vehicle market is gaining popularity as technological innovation in the development of Electric vehicles has become more advanced over the last decade. However, not so many people know that the electric vehicle was invented almost 200 years ago by a Hungarian innovator named Ányos Jedlik (Department of Energy, 2014). It was just a small-scale electric car, but that was a starting point in the realm of electric vehicles. Further major development of electric vehicles occurred in the late 1880s when William Morrison introduced a practical electric wagon to the USA. In addition, the Americans liked the quiet nature of the electric cars so much to the point that they outsold other types of cars in 1900 and accounted for one-third of all cars on the road (Thompson, 2017). The heyday of the electric cars came to an end when Henry Ford introduced the cheaper alternative - the Ford Model T, a gasoline-powered car in 1908; by 1935, all electric vehicles disappeared (Thompson, 2017).

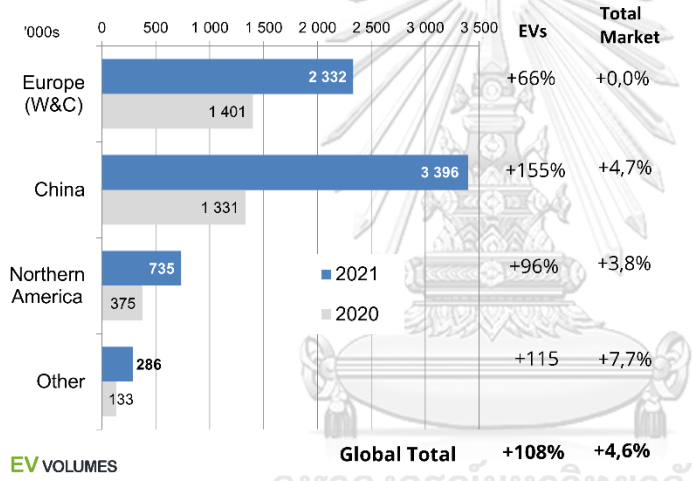
The revival of electric vehicles was due to two major events in 1990. Firstly, President Bush proposed the amendment of the Clean Air Act in order to curb three major threats to the environment which were acid rain, urban air pollution, and toxic air emission (United States Environmental Protection Agency, 2020). Secondly, political conflict between two major oil producing-countries: Kuwait and Iraq, had caused an upward spike in worldwide oil prices (See Figure 1). Together, these two major events had sparked interest for automotive manufacturers to heavily invest in developing multiple types of electric cars; Hybrid Electric Vehicle (HEV), Plug-in Hybrid Electric Vehicle (PHEV), Fuel Cell Electric Vehicle (FCEV), and Battery Electric Vehicle (BEV).

Figure 1. 1970 – 2016 Timeline: A brief history of oil prices

Note. Reprinted from *Office of Energy Efficiency & Renewable Energy*, 2016, https://www.energy.gov/eere/timeline/timeline-brief-history-oil-prices-and-vehicle-technologies

Subsequently, in the late 1990s, various automotive manufacturers introduced their first mass-produced electric vehicles; Toyota Prius was released in Japan by Toyota, and the General Motors introduced the EV1 to the United States (GM heritage center, n.d.). Since then, the passion to develop a better electric car was adopted by many automotive companies. For example, Tesla Motors was founded in 2003 by a group of engineers who believed that "electric vehicles can be better, quicker and more fun to drive than gasoline cars" (Tesla, n.d.).

Figure 2. BEV+PHEV sales and percentage growth



Note. Reprinted from *Global EV Sales for 2021*, by Roland. Irle, 2021, https://www.ev-volumes.com/country/total-world-plug-in-vehicle-volumes/

Fast forward to the present time, the trend for electric vehicles is booming unlike the world has ever seen before. According to EV-volumes (2021), global sales of electric vehicles have grown dramatically by 108% in 2021, which was 6.75 million EV cars sold in one year. Sales growth in China was the strongest, with 155 per cent growth, followed by 66 per cent, 96 per cent, and 115 per cent from Europe, Northern America, and others, respectively (See Figure 2).

Apart from technological advancement that sparks the interest in electric vehicles, another important factor that drives up the EV sales are government policies. Many governments from all around the world have become more concerned about exhaust gases released by conventional vehicles which are accelerating the global warming issues. To be able to understand why all leaders across the world are

rushing to incentivize people to buy electric vehicles over conventional cars, it is best to elaborate on how conventional cars are damaging the environment and the health of the people.

Conventional vehicles or Internal Combustion Engine (ICE) vehicles are powered by gasoline or diesel fuel. Various gases such as carbon dioxide (CO_2) and greenhouse gases are emitted from the combustion process in ICE vehicles. In addition, car pollution alone accounted for one in five of the United States' total global warming pollution (Green, 2018). These gases will trap heat in the atmosphere and accelerate the global warming issue. Many scientists raise environmental concerns that every life on Earth will be at high risk if global warming reached 2 degrees Celsius above pre-industrial levels. According to a study by Alessandro Dosio et al (2018), it is projected that a rise of 2 degrees Celsius would expose 36.9 per cent of the population to extreme heat waves at least once every five years. Sea levels will also rise by 0.36 to 0.87 meters by the year 2100, causing a more severe tidal flooding (Thompson et al, 2021). Earth biodiversity is also at risk; "The number of species projected to lose over half of their climatically determined geographic range at 2°C global warming (18% of insects, 16% of plants, 8% of vertebrates)" (Hoegh-Guldberg et al, 2018).

Furthermore, global warming could be the first dominos to fall and trigger other social problems to collapse as well. According to a study by Diffenbaugh and Burke (2019), global warming has increased economic inequality between countries. A study shows that from 1961 to 2010, the GDP per capita of the world's poorest countries decreased by 17 to 31 per cent due to global warming. The authors have concluded that it was due to "wealthy countries have benefited disproportionately from the activities that have caused global warming, while poor countries suffer disproportionately from the impacts" (Diffenbaugh and Burke, 2019, p.9812). The research conducted by the World Bank (2020) also suggests similar findings; climate change can push additional 132 million people into extreme poverty by 2030. "As the impacts of climate change mount, millions of vulnerable people face disproportionate challenges in terms of extreme events, health effects, food security, livelihood security, water security, and cultural identity." (World Bank, n.d.). The ironic fact is that people who get affected the most by climate change, are the least contributor to the crisis.

As a result, many governments gather together and try to reach environmental agreements. For example, the 26th Conference of the Parties (COP26) was held recently in 2021 in Glasgow, which brought together 120 leaders from all around the world. The main purpose is to recognize the emergency to limit the increase in global mean temperature to 1.5 degrees Celsius. In addition, another main agreement in COP26 was to move away from fossil fuels. Up until 2022, 137 countries including Thailand are joining the net-zero emission pledge. Net-zero emission refers to a state in which the greenhouse gases released into the atmosphere and removed from the atmosphere are balanced (Net Zero Climate, 2021). With this net-zero target, countries set out clear strategies to pursue the target. In line with a net-zero goal, many countries started off with the attempt to promote a shift to electric vehicles.

Developed countries, Norway for example, had been promoting electric vehicles since the 1990s such as exemption from registration tax, free public parking, toll exemptions, Value added tax exemption, and Public EV charging station construction (Figenbaum and Kolbenstvedt, 2013, as cited in Mersky et al, 2016). Many developing countries are also adopting similar policies to promote the sales of electric vehicles. For example, in 2019, the Indian government has approved Phase 2 of the FAME Scheme in which the fund for this scheme is used to build charging infrastructure and subsidize electric vehicles, ranging from Rs 10000 per kWh to Rs 15000 per kWh (Ministry of Heavy Industries, n.d.). While in Vietnam, the registration fee is exempted for 3 years and reduce the excise tax (Vietnamnet, 2022).

Additionally, this report will focus on one of the developing countries which is Thailand. Thailand is following a similar path as the other countries. At COP26, Prime Minister Prayut Chan-o-cha pledged that Thailand is trying to address the climate change crisis by aiming to have 15 million electric vehicles by 2035, reach carbon neutrality by 2050, and achieve net-zero greenhouse gas emission in or before 2065 (Royal Thai Embassy, 2021).

The beginning of the electric vehicle policy started in 2015 when Thailand showed its vision for energy issues and became an Associate member country of the International Energy Agency (IEA) (IEA, 2016). With the support and guidance from IEA, Thailand had launched the Thailand Energy Information Centre to integrate country-wide energy data and use them to facilitate the energy policy-making process. During the same year, the Thai government launched various policies to promote electric vehicles. For instance, the Energy Efficiency Plan (EEP2015) set the target to promote the use of PHEV and BEV totaling 1.2 million electric vehicles by 2036 (Ministry of Energy, 2015). With these initiatives to promote the electric vehicle by the Thai government, an academic and private sector in Thailand were motivated and thereby, had formed a group and established the Electric Vehicle Association of Thailand (EVAT) in September 2015. The main EVAT's goals are "to promote and advertise and safety usage of EV to the public" (EVAT, n.d.). EVAT also supports the government in the research and development of electric vehicle technologies with the aim to increase global competitiveness.

Apart from the EVAT, there are other organizations that are working hard to accommodate a smooth implementation and development of the electric vehicles policy. Firstly, the Board of Investment (BOI) is responsible to create investment incentives for foreign investors. BOI is seeking to increase the coverage area of the electric vehicle charging stations, while also "setting requirements for projects seeking to receive BOI incentives, including a minimum of 40 chargers per project, at least 25% of which must be quick chargers."; in return, up to 5 years of corporate income tax will be exempted for the investors (Thailand Board of Investment, 2019). The BOI, together with the National Science and Technology Development Agency (NSTDA), also have another role to execute the ambitious plan by the Thai government, which is to become an electric vehicle producing regional hub. The BOI had granted custom deductions for electric vehicle parts and equipment, while the

NSTDA was paired up with the private firm to research and develop the EV Aluminum Bus (NSTDA, 2021).

In mid-February 2022, the EV board of Thailand had approved and released a new incentive package for electric vehicles. The package consists of 2 components. 1. The tax incentives - that is to reduce the import duty of BEV priced up to 2 million baht by 40 per cent, 20 per cent reduction for those priced between 2 and 7 million baht, and lastly the excise tax cut for imported EVs from 8 per cent to 2 per cent. 2. The non-tax incentives – 18,000 baht subsidy for electric motorcycles from eligible car producers, 70,000 baht per EV unit of passenger cars that has 10 to 30 kWh battery capacity, 150,000 baht subsidy for more than 30 kWh battery capacity, and lastly, the exemption of import duties on electrical components which aim to support the production (Hanh, 2022).

These exemptions and reduction of taxes are costly to the government as they reduce the overall government revenues, therefore, it is important for the policymakers to determine whether the EV incentives policy is worth the trade off or not. Hence, the main objective of this study is to find the effectiveness and its magnitude of Thailand's EV incentives policy to the number of new adoptions of BEV cars, as well as to investigate other factors that might infer the rate of BEV adoption in Thailand. In addition, the methodology used to investigate and analyze the relationship is Ordinary Least Square.

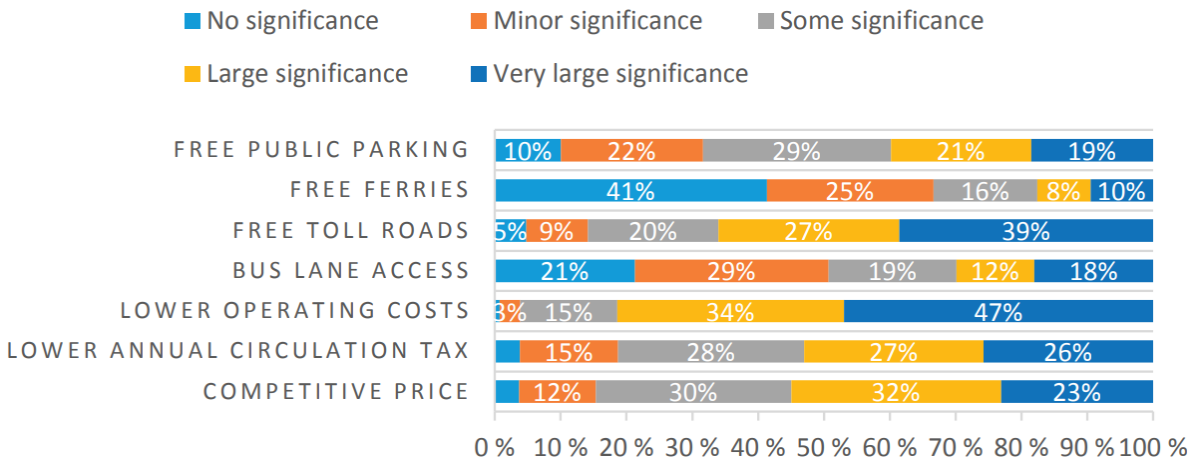
The remainder of this paper is structured as follows: Section 'Literature Review' discusses the effectiveness of the EV incentives policy conducted in OECD countries, Section 'Data' discusses the data gathering process and the content used in this paper, Section 'Methodology' describes the methodology used to analyze the data, Section 'Results and discussion' reports the results and the interpretation of the findings, and Section 'Conclusion' summarizes the paper and identify limitations of the present study and potential in the future research.

2. Literature Review

2.1 The case of developed countries

There are many studies observed the effectiveness of the EV policy on many developed countries. Many studies were explored mainly on the Organization for Economic Co-operation and Development (OECD) countries. For instance, Figenbaum et al (2014) have had much research on the Norwegian electric vehicle policy. The very first BEV entered to Norway in 1990, yet the incentives policy was introduced as early as 1992 in a form of registration tax exemption; following by free public parking incentives in 1993, reduction in annual circulation tax in 1996, the exemption of road toll in 1997, and a VAT exemption in 2001. Figure 3 shows the degree of importance of factors and incentives when buying a BEV as stated by BEV owners. It can be seen that some incentives were effective, namely, the exemption of toll road (66% state large significance or very large), reduced annual circulation tax (53%), and the competitive price ICE (55%).

Figure 3. The degree of importance of factors and incentives when buying BEV as stated by BEV owners

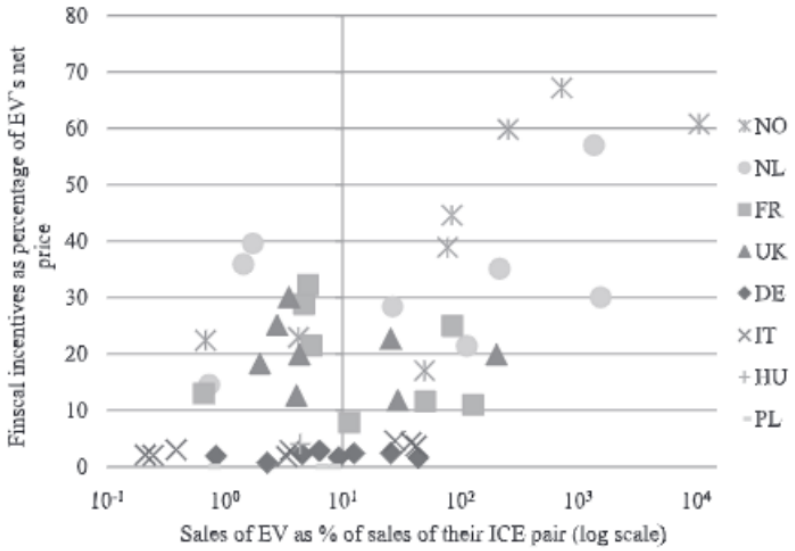


Note. Reprinted from *Electric vehicles – environmental, economic and practical aspects*, Figenbaum, E., Kolbenstvedt, M. & Elvebakk, B., 2014, https://www.toi.no/getfile.php/1337250-1411472277/Publikasjoner/T%C3%98I%20rapporter/2014/1329-2014/1329-2014-el.pdf

According to Lévay et al (2017), all electric vehicles are more expensive than those of similar ICE due to the high cost of electric battery packs. Hence, the most important incentive scheme is the reduction of the purchase price of BEV in relative to ICE vehicles (Lindberg and Fridstorm, 2015). This could be in the form of 1. The direct subsidy to BEV, and 2. A tax on ICE vehicles. In addition, Lévay et al (2017) had observed the relationship between Fiscal incentives and sales (See Figure 4). The authors calculated the total amount of incentive as the sum of subsidy, VAT, registration tax, and circulation tax differences between electric vehicles and their similar ICE pair. The equation is as follows:

$$\text{Incentives} = S + (VAT_{ICE} - VAT_{EV}) + (T_{r,ICE} - T_{r,EV}) + (T_{c,ICE} - T_{c,EV})$$

Figure 4. Fiscal incentives versus electric vehicle sales

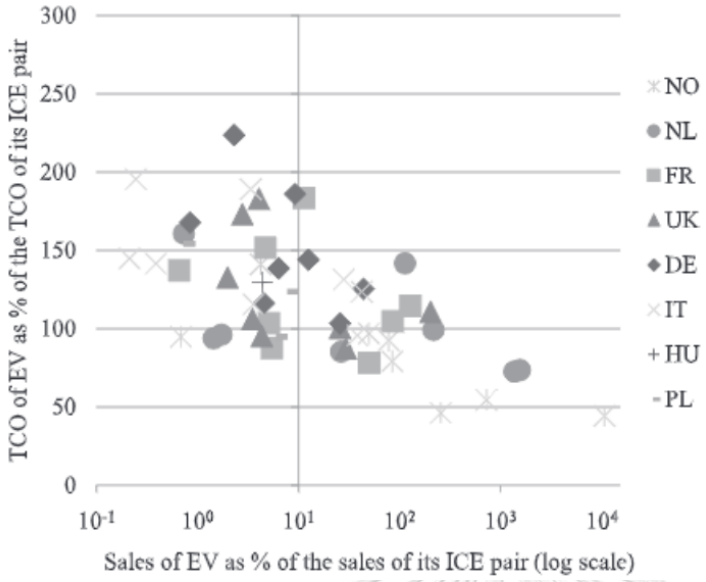


Note 1. Reprinted from "The effect of fiscal incentives on market penetration of electric vehicles: A pairwise comparison of total cost of ownership," by Lévay, P.Z., Drossinos, Y., & Theil, C., 2017, *Energy Policy, 105*, p. 530. Copyright 2017 by Elsevier Ltd.

Note 2. NO = Norway, NL = Netherlands, FR = France, UK = United Kingdom, DE = Denmark, IT = Italty, HU = Hungary, PL = Poland

Figure 4 also shows that the higher the fiscal incentives as a percentage of the electric vehicle's net price (x-axis), the higher sales of electric vehicles as a percentage of sales of their similar ICE pair (in log scale). Norway's fiscal incentives are more generous than the other countries. That was due to the high VAT rate for the ICE vehicles, subject to 25 per cent, while BEVs were exempt. On the other hand, it can be seen that countries with low fiscal incentives such as the Netherlands, France, and the United Kingdom, or a country with no fiscal incentives at all – Poland; their sales of electric vehicles as a percentage of their ICE pair are significantly lower.

Figure 5. Relative TCO versus relative electric vehicle sales by country



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Lévay et al (2017) also consider other costs and benefits of the electric vehicle and ICE vehicle apart from the subsidy given, such as the fuel costs saving and depreciation in order to find True Cost to Own (TCO). The result is shown in Figure 5, there is a negative relationship between True Cost to Own (TCO) and the sales of electric vehicles as a percentage of the sales of its similar ICE pair (in log scale). In other words, lower costs are associated with higher sales. This negative relationship between electric vehicle sales and TCO reflects the law of demand and supply in which with a higher price (the net price of the electric vehicle), buyers will demand (net sales) less of goods.

2.2 The case of Thailand

Since Thailand's incentives policy had just been introduced in February 2022, there was no empirical evidence upon the effectiveness of the EV incentives policy. However, there were research about key barriers to EV adoption conducted by Kongklaew et al (2021). In Kongklaew et al's paper (2021), the concerns for the BEV adoption in Thailand are ranked as shown in Table 1.

Table 1: Barriers to EV adoption rankings

Barrier	Rank	Barrier	Rank
Public infrastructure	1	Battery cost	9
Range on charge	2	EV price	10
Battery life	3	Workplace infrastructure availability	11
Safety	4	EV maintenance cost	12
Highway infrastructure availability	5	Engine power	13
Charging time	6	Size and styles	14
Reliability	7	EV resale value	15
Infrastructure availability at home	8	EV fuel cost	16

Note. Reprinted from "Barriers to Electric Vehicle Adoption in Thailand", by

Kongklaew, C., Phoungthong, K., Prabpayak, C., Chowdhury, M.S., Khan, I.,

Yuangyai, N., Yuangyai, C., & Techato, K, 2021, *Sustainability 2021*, p. 13,12839.

The financial barrier like the EV price was ranked 10th out of the 16 factors. In addition, the EV price was defined by the authors as the EV market price without purchase subsidy. Meanwhile, the results suggest that Thai people are more concern about the infrastructure barriers such as public infrastructure and Highway infrastructure which were ranked 1st and 5th respectively. This might suggest that EV price does not concern Thai people as much as the availability of infrastructure (charging stations) and hence, the monetary incentives policy may not be as effective as the policy that promotes charging facilities.

On the other hand, a paper conducted by Montian et al (2019) had conducted a survey and identified 4 key factors that influencing consumer's intention to purchase electric vehicle in Bangkok, Thailand, namely, 1. Finance factors, 2. Technology factors, 3. Infrastructure factors, and 4. Policy mechanism factors. The variables inside each factor are listed in Table 2.

Table 2. The factors variable table

1. Finance factors	2. Technology factors	3. Infrastructure factors	4. Policy mechanism factors
Purchasing price of EV	Driving Range	Number of charging	Tax policy
Fuel price of EV	Safety of EV	Charging Station Networks	Ecological Policies
Maintenance Cost of EV	Performance of EV	Charging conditions	Financial Incentives
Resale Value	Charging Time		1st EV car policy
	Lifetime of Batteries		

Note. Reprinted from “An Empirical Study of Key Factors Influencing Consumer’s Purchase Intention Towards Electric Vehicle in Bangkok Metropolis, Thailand”, by Montian, K., Suthikarnnarunai, N., & Rattanwong, W. 2019. Available at SSRN: http://dx.doi.org/10.2139/ssrn.3497384

According to all this research, we can say that the effects of incentives are positive to boost the sales of electric vehicles in the developed and OECD countries, while it is also shown to be significant in the survey conducted in Thailand. This paper, rather than conducting a survey, will analyze the actual data to identify the effectiveness of the EV incentives policy. It is interesting to observe whether Thailand will behave similarly or differently to the previous findings with the ongoing pandemic situation that affects people’s health condition and financial conditions. In addition, this research paper will explore the effects of the EV policy on the number of newly BEV cars registered via the Thai Department of Land Transport.

3. Data

The Thai government has made the most of data accessible online. The observation time period is between May 2020 and April 2022. The data descriptions are provided below:

3.1 BEV sales in Thailand

The BEV sales were obtained from the Department of Land Transport (DLT) which is one of the government departments under the jurisdiction of the Ministry of Transport. These data include data such as all newly registered electric vehicles in Thailand, the newly registered figures of every province (77) in Thailand, types of the vehicles, and whether it is the private use or business use. In addition, the data are provided on a monthly interval. Because the electric vehicles incentives policies were being implemented in every province of Thailand and made effective at the same time, this paper will include all newly BEV registration figures across the country in the analysis.

3.2 Interest rate (Flat rate)

The interest rate (flat rate) was obtained from Kiatnakin Phatra Bank. Kiantnakin Phatra Bank is a middle-size commercial banking business in Thailand. It is chosen for this analysis because the data are available online and it is a bank with a long history of over 40 years. Moreover, Kiatnakin’s lending interest rate are similar to other commercial banks. Hence, its lending interest rate is stable to use in this analysis.

Within 24 months of the time period analyzed in this paper, there was one amendment to the interest rate. Between April 2020 and August 2021, the flat interest rate was in between 2.65 per cent to 9.00 per cent. The flat interest rate decreased to 2.35 per cent and was effective in September 2021 and is used until the end of our observation period (April 2022). In addition, the lending interest rate can fall into any of the ranges mentioned above depending on 1. Types of car, 2. The car brand, 3. The car model, 4. The amount of down payment, 5. Installment period, 6. The buyer qualifications, and 7. Promotion at that time (Kiatnakin Phatra Bank, 2021). Hence, for ease of complexity, the minimum amount of 2.65 per cent and 2.35 per cent will be used in the analysis.

3.3 Incentive data

The Thai government has offered various incentives for the adoption of electric vehicles starting from February 2022 (Bangkok Post, 2022). Recall:

1. The tax incentives
    - reduce the import duty of BEV priced up to 2 million baht by 40 per cent
    - 20 per cent reduction for those priced between 2 and 7 million baht
    - the excise tax cut for imported EVs from 8 per cent to 2 per cent.
2. The non-tax incentives
    - 18,000 baht subsidy for electric motorcycles from eligible car producers
    - 70,000 baht per EV unit of passenger cars that have 10 to 30 kWh battery capacity
    - 150,000 baht subsidy for more than 30 kWh battery capacity
    - The incentives/ electric vehicle policy was modeled as a binary, 0=before the policy approval and 1=after the policy approval.

3.4 Oil price

The oil prices were obtained from PTT Oil and Retail Business Public Company Limited (PPTOR). Two types of oil price will be used as an independent variable. The types of oil chosen for this analysis are 1. Diesel oil price per liter and 2. Benzene oil price per liter. Diesel oils are chosen because according to Green Network (2019), it is used the most for Thailand's land transportation, that is around 70 million liters per day. For benzene oil type, Gasoline 95 is chosen over other type of benzene i.e., Gasohol 91, E20, etc, because according to Green Network (2019), Gasoline 95 is the most used benzene oil in Thailand, accounted for 42.8 percent of all benzene, or around 14 million liters per day. The prices used for the analysis are monthly weighted average of the oil retail price in the capital city of Thailand, Bangkok. The detailed calculation can be found on Appendix 1.

Noted that the diesel oil price during the observation period were regulated by the government. The government has placed a cap on the diesel oil price below 30 baht. The 30 baht per liter diesel price cap were lifted on May 1 which is out of our observation range (Bangkok Post Public Company Limited, 2022).

3.5 Median Household Income

Median Household Income (per month) data was retrieved from National Statistical Office (NSO) of Thailand. Median household income is chosen over average household income to summarizing the income at the country-level as it filtered out the outlier of extremely high or low income of the sample. The NSO of Thailand conducts the household survey on median income every 2 years. Hence, there were no median income provided for 2020 and 2022. As a result, this analysis will assume that the median income did not change.

3.6 Number of charging stations

Number of charging stations includes the charging stations in Thailand provided by the main providers. Noted that the data will not represent all charging stations in Thailand since there are many small providers. Hence, this report will only include the main service providers. This includes 3 Thai state-owned enterprises, 1. Provincial Electricity Authority (PEA), 2. Electricity Generating Authority of Thailand (EGAT), and 3. The Metropolitan Electricity Authority (MEA). The data for these three state-owned providers were available to retrieve from their official websites (See Appendix 2). In addition, charging stations provided by the private sector are also included. This includes charging stations from 1. PTT Oil and Retail Business Public Company Limited- retrieved from its official Facebook page and its official websites, and 2. EA Anywhere- the largest charging stations provider in Thailand.

Table 3. Descriptive statistics of the data

	New BEV registered	*Flat interest rate %*	*Diesel price/ liter*	*Benzene price/ liter*	*Median income*	*No. of charging stations*
Mean	494.17	2.55	24.06	27.46	27642.00	509.33
Standard Error	62.95	0.03	0.90	1.15	239.45	15.51
Median	424.50	2.65	24.17	27.18	28454.00	503.00
Standard Deviation	308.41	0.14	4.40	5.64	1173.04	75.97
Sample Variance	95116.14	0.02	19.37	31.86	1376022.26	5771.71
Kurtosis	2.86	-1.57	-1.33	-0.47	-1.57	-0.20
Skewness	1.73	-0.76	-0.15	0.53	-0.76	0.75
Range	1222.00	0.30	13.85	19.95	2436.00	244.00
Minimum	169.00	2.35	16.09	19.15	26018.00	413.00
Maximum	1391.00	2.65	29.94	39.10	28454.00	657.00
Sum	11860.00	61.20	577.37	658.98	663408.00	-
Count	24.00	24.00	24.00	24.00	24.00	24.00

Table 3 shows the descriptive statistics of the data. The main key points are:

- The 2-year average number of new BEV registered are 495 vehicles. The minimum BEV registered were 169 cars in May 2020, and the maximum of 1391 cars in March 2022. The total BEV registered within the 24 months are 11,860 cars.

- The flat interest rate was stable within 2.35 and 2.65 percentage range.
- Diesel price per liter was at its lowest at 24.06 baht per liter in May 2020 and reached its highest of 29.94 baht per liter in April 2022. Similarly, Benzene oil price was lowest at 19.95 baht per liter in May 2020 and almost double, at its peak at 39.1 baht per liter in March 2022. The overall trend is upward sloping.
- The median household income in 2021-2022 was 28,454 baht per month, an increase of 9.36 percent from the 2019-2021 median of 26,018 baht per month.
- Within 24 month-period, total number of charging stations provided by the main providers has increased by 244 stations, from 413 stations in May 2020 to 657 stations in April 2022.

Table 4. Correlation table

	New BEV registered	*EV policy*	*interest rate %*	*median income*	*Diesel price/liter*	*Benzene price/ liter (95)*	*No. of charging stations*
New BEV registered	1						
EV policy	0.8373	1					
interest rate %	-0.7104	-0.5345	1				
median income	0.5792	0.2672	-0.5	1			
Diesel price/liter	0.7734	0.4964	-0.8043	0.8498	1		
Benzene price/ liter (95)	0.9037	0.7093	-0.8049	0.7693	0.9555	1	
No. of charging stations	0.8728	0.7471	-0.8204	0.6913	0.9072	0.9618	1

4. Methodology

The OLS is a regression method that find a straight line which is as close as possible to the data points, minimizing the squares of the errors. The coefficients found can be used to predict the value of dependent variable from independent variable that is not in the sample. The Ordinary Least Square (OLS) method was chosen because we aim to explore the correlation between the dependent variable – the adoption of EVs (new BEV registered monthly) and interested independent variables, namely,

- EV incentives policy (as a binary, 0=before the policy approval and 1=after the policy approval)
- Bank lending rate (as a percentage)
- Average household income (per household per month)
- Diesel price (per liter)
- Benzene price (per liter)
- Number of charging stations (number of available stations in the country).

In this paper, the observation time period is between May 2020 and April 2022. The total observations are 24 months. These variables can be shown in a linear regression form as,

General model specification

New BEV registered monthly = Constant + X_1 EV policy incentives + X_2 Bank lending rate + X_3 Average household income + X_4 Diesel price + X_5 Benzene price + X_6 Number of charging station *(1)*

The Forward Selection procedure is implemented, and the independent variables have been added gradually from model to model; see Table 5.

- Model 1 includes the EV policy incentives, Bank lending rate, Average household income, and Diesel price per liter as an independent variable.
- Model 2 will remove the Diesel price per liter and add Benzene price per liter instead.
- Model 3 will add the number of charging stations as a control.

Noted that there is multicollinearity between Diesel and Benzene price per liter, hence, Diesel price is omitted in model (2) and (3). The reason behind this is that since the Thai government had been subsidizing to cap the diesel below 30 baht per liter; it is assumed that this could affect the validity of the regression result.

The regression was then run again with a lagged dependent variable and is also shown in Table 5. It was added to the regression model as we are concerned about the endogeneity with the equation (1). According to Wilkins (2017), the exclusion of a lagged dependent variable can lead to severe bias in others coefficient estimates. Since we try to investigate whether the EV incentives policy effect the BEV adoption rate or not, the endogeneity can be a problem as having higher adoption of BEV could then motivate the government to create the EV incentives policies. In other words, more BEV registrations lead to EV incentives policy, not the other way around. Therefore, we try to address the endogeneity by adding the lagged dependent variable shown below:

General model with Lagged-dependent variable

New BEV registered monthly = Constant + X_1 EV policy incentives + X_2 Bank lending rate + X_3 Average household income + X_4 Diesel price + X_5 Benzene price + X_6 Number of charging station + X_7 Lagged Dependent Variable *(2)*

The log-log model specification is also run, and the results are shown in Table 6. We chose to run a log-log regression because, as we can see in the descriptive summary in Table 3, the dataset is moderately skewed. Hence, a logarithmic transformation is used to transform a highly skewed variables into a more normalized dataset. The log-log regression equation is expressed as:

Log-Log model specification

log (New BEV registered monthly) = Constant + X_1 (EV policy incentives) + X_2 log (Bank lending rate) + X_3 log (Average household income) + X_4 log (Diesel price) + X_5 log (Benzene price) + X_6 log (Number of charging station) *(3)*

5. Results and discussion

Table 5. General Model results

	Model 1	*Model 1 with LDV*	*Model 2*	*Model 2 with LDV*	*Model 3*	*Model 3 with LDV*
Intercept	-500.2780	−371.7730	-431.2390	−379.0520	155.2139	414.2540
EV incentives policy	557.4017***	534.2280***	340.5722**	404.2680**	395.6055**	509.9200***
Lending interest rate	-153.1310	−286.066	-46.8054	−48.0357	-79.5726	−263.3570
Median income	0.0279	0.0489	-0.0095	0.0075	-0.0056	0.0217
Diesel price per liter	22.5836	0.0916	-	-	-	-
Benzene price per liter	-	-	37.4080**	23.5323	50.9667**	33.8687
No. of charging stations	-	-	-	-	-1.4779	−1.9294
LDV	-	0.4320*	-	0.2302	-	0.3525
Adjusted R square	0.8462	0.8462	0.8723	0.8723	0.8752	0.8752
N	24	24	24	24	24	24

Note: *, **, and *** denote the significance levels of 10%, 5%, and 1%, respectively.

Table 5 shows the results of our models subjected to a variety of controls. By following the stepwise regression, it allows us to observe the consistency in the results for the EV incentives policy in which it may weakly correlated with the other controls. From Table 5, we can summarize that the EV incentives policy implemented by the Thai government is consistently positive and statistically significant across all models. To elaborate in more detail, since our EV incentives policy is a binary variable, the presence of the EV incentives policy will increase the number of new BEVs registered to the Department of Land Transport by approximately 557 vehicles in model (1), 340 vehicles in model (2), and 395 vehicles in model (3). These results match with the outcome observed in many OECD countries we have mentioned in the literature review section; it suggests the effectiveness and robustness of the policy. The lending interest rate (flat rate) is also found to have a negative relationship across all models but is insignificant in all models. Similarly, median income does not appear to have a significant effect on the new registration of BEV in all models.

Focus specifically on model (1) and (2) which has the costs variables like the diesel and benzene oil price, the diesel price per liter does not appear to have any significant effect to the adoption of BEV; this might be due to the fact that the government was subsidizing to cap the diesel price. On the other hand, model (2) result shows that the benzene price per liter is significant at 5% significant level; one baht rise in benzene oil price per liter (Gasohol 95) would increase the new BEV adoption by 37 cars. The significance of the benzene price appears to be consistent on model (4) as well but with a larger magnitude of approximately 51 cars per one baht rise in benzene price.

Meanwhile on table 5, the regression results with a lagged dependent variable (abbreviated as LDV) show that the EV incentives policy still maintains its significance across the three models, with a lower magnitude in model (1), and higher magnitude in model (2) and (3). According to Jenn et al (2018), “The potential endogeneity issue is directly addressed because the use of the LDV represents the

incentive, which cannot plausibly be affected by future sales of electric vehicles". However, the benzene oil price has lost its significance under the lagged dependent variable model. Nevertheless, the fact that the EV incentives policy is consistently significant and has the similar magnitude in with-and-without LDV suggests that the results from our model are robust.

Table 6. Log-Log Regression results

	(Log) Model 1	*(Log) Model 2*	*(Log) Model 3*
Intercept	-25.31	-20.19	−15.96
EV incentives policy	0.65***	0.40*	0.46**
Lending interest rate	-0.49	-0.24	−0.61
Median income	2.70	2.05	2.11
Diesel price per liter	1.30*	-	-
Benzene price per liter	-	1.65**	2.16**
No. of charging stations	-	-	−0.99
Adjusted R square	0.867005	0.875820	0.874514
N	24	24	24

Note: *, **, and *** denote the significance levels of 10%, 5%, and 1%, respectively.

Table 6 shows log-log model specification regression results. The coefficient of a dummy variable (EV incentives policy), with a log-transform dependent variable (New BEV registered monthly) is interpret as the percentage change in New BEV registered monthly is associated with having the dummy variable characteristic, ceteris paribus. This means that, the number of new BEV registered monthly is approximately 65 per cent higher with the presence of the EV incentives policy in model (1), 40 per cent in model (2), and 46 per cent in model (3), all other things held constant.

In model (1), apart from the EV incentives policy, only diesel price per liter is statistically significant; a 1 per cent increase in diesel price per liter is associated with a 1.3 per cent increase in the number of new BEV registered monthly. Similarly, only benzene price per liter is significant in model (2) and model (3); a 1 per cent increase in benzene price per liter is associated with a 1.65 per cent increase in the number of new BEV registered monthly in model (2), and 2.16 per cent increase in model (3).

6. Conclusion

In present time, the biggest challenge to humanity that can ultimately put many million humans and other species on risks, is the global warming issue. One of the main human contributions to this global warming issue is from car transportation. In the United States, car pollution alone is accounted for 20 per cent of all Greenhouse gas emission. Even though nowadays there are various brands of electric vehicle offered in the market. However, despite its polluting abilities, it is also true that majority of people finds the conventional vehicle' characteristics to be more attractive such as reliability, more variety, and most importantly, that the people are familiar with the conventional cars. The market would need some time to switch to the electric vehicle realm. However, the normal rate of adjustment might be too slow to save the Earth from global warming issues. Therefore, many governments around the world had launched the EV incentives policy along with other relevant policies to speed up the rate of adjustment and put an end to ICE cars. In addition, this paper aims to find the effectiveness of Thailand's new electric vehicle policy on the Battery Electric Vehicle (BEV) adoption. Ordinary Least Square were run on 24 months data points from May 2020 to April 2022 to see which variables are significant to affect the rate of BEV adoption in Thailand. The results illustrate that the EV incentives policy is associated with the new BEV adoption by 40-65 per cent. Meanwhile, Log-Log regression results show that these variables: lending interest rate, median household income, number of charging stations, are insignificant to affect the new BEV adoption.

In normal circumstances, oil prices volatility remains relatively stable, however, as the pandemic situation become less severe due to both the constant development of vaccine and other prevention method such as Favipiravir drug which already become an intermediate solution more countries lift Covid-19 pandemic restrictions, the demand for oil increases accordingly. On the other hand, a recent political conflict which already become a full-scale invasion according to Reuter's article between Russian and Ukraine (NATO) is also an important contributor that cause the world oil prices to hike as the European Union announced that it would cut oil imports from Russia by 90 per cent, causing the supply shortage. The shortage of oil causes end-user oil price to rise as well. This volatility in the world oil price also reflect in our analysis. Apart from the EV incentives policy, there are two variables that are statistically significant, the diesel and benzene oil price per liter. The rise in oil prices which are the direct cost of ICE cars might be an important factor that influence BEV purchasing decision.

Limitations

In terms of data and regression model used in this study, there are some limitations of the present study. Firstly, the number of explanatory variables in the models are limited as the data are not available to obtain. For example, if the price of the new BEV registered are known, it would be more beneficial as we will be able to identify the effectiveness of the EV incentives policy for a different BEV price range. Secondly, the characteristics of the new BEV registered were not investigated in this

study, it might be an important factor that influence BEV purchasing decision. Thirdly, since the EV incentives policy was recently rolled out, the length of the study period is only 24 months. Lastly, since BEV technology is still quite new to the Asian market, there are limited relevant theoretical literature to explain the relationship between incentive policies and BEV adoption; a presence of relevant literature in neighbor countries that share similar traits, would be useful to enhance our understandings. All these limitations can be addressed and further examine in the future research once there is more data available for us.

Appendices

Appendix 1

	May-63		Jun-63		Jul-63		Aug-63		Sep-63		Oct-63	
	Diesel	**Gasohol**	**Diesel**	**Gasohol**	**Diesel**	**Gasohol**	**Diesel**	**Gasohol**	**Diesel**	**Gasohol**	**Diesel**	**Gasohol**
1	14.44	17.45	17.09	19.95	18.69	20.95	19.29	21.25	18.79	21.75	18.59	22.25
2	14.44	17.45	17.09	19.95	18.69	20.95	19.29	21.25	18.79	21.75	18.59	21.85
3	14.44	17.45	17.69	20.55	19.19	21.55	19.29	21.25	18.79	21.75	18.59	21.85
4	14.44	17.45	17.69	20.55	19.19	21.55	19.29	21.25	18.79	21.75	18.59	21.85
5	14.44	17.45	18.29	21.15	19.19	21.55	19.29	21.25	18.79	21.75	18.59	21.85
6	14.94	17.75	18.29	21.15	19.19	21.55	19.29	21.25	18.79	21.75	18.59	21.85
7	14.94	17.75	18.29	21.15	19.19	21.55	19.29	21.65	18.79	21.75	18.59	21.85
8	15.79	18.35	18.29	21.15	19.19	21.55	19.29	21.65	18.79	21.75	18.59	21.85
9	15.79	18.85	18.29	21.15	19.19	21.55	19.29	21.65	18.19	21.75	18.59	21.85
10	15.79	18.85	18.89	21.75	19.19	21.55	19.29	21.65	18.19	21.75	18.89	22.05
11	15.79	18.85	18.89	21.75	19.49	21.85	19.29	21.65	18.19	21.25	18.89	22.05
12	15.79	18.85	18.89	21.45	19.49	21.85	19.29	21.65	17.89	21.25	18.89	22.05
13	15.79	18.85	18.89	21.45	19.49	21.85	19.29	21.65	17.89	21.25	18.89	22.05
14	15.79	19.25	18.89	21.45	19.49	21.85	19.29	21.95	17.89	21.25	18.89	22.05
15	15.79	19.25	18.89	21.45	19.49	21.85	19.29	21.95	17.89	21.25	18.89	22.05
16	15.79	19.25	18.89	21.45	19.19	21.55	19.29	21.95	17.89	21.25	18.59	21.55
17	15.79	19.25	18.39	20.95	19.19	21.55	19.29	21.95	17.89	21.25	18.59	21.55
18	15.79	19.25	18.39	20.95	19.19	21.55	18.99	21.95	18.19	21.75	18.59	21.55
19	16.29	19.75	18.99	21.55	19.19	21.55	18.99	21.95	18.19	21.75	18.59	21.55
20	16.79	20.25	18.99	21.55	19.19	21.55	18.99	21.95	18.19	21.75	18.89	21.55
21	16.79	20.25	18.99	21.55	19.19	21.55	18.99	21.95	18.19	21.75	18.89	21.55
22	17.09	20.25	18.99	21.55	19.19	21.55	18.99	21.95	18.69	22.25	18.89	21.55
23	17.39	20.25	19.39	22.15	19.59	21.95	18.99	21.95	18.69	22.25	18.89	21.55
24	17.39	20.25	19.39	22.15	19.59	21.95	18.99	21.95	18.29	21.75	18.89	21.55
25	17.39	20.25	19.39	22.15	19.59	21.95	18.99	21.95	18.29	21.75	18.89	21.55
26	17.39	20.25	19.39	22.15	19.59	21.95	18.99	21.95	18.29	21.75	18.89	21.55
27	17.39	20.25	18.99	21.55	19.59	21.95	19.29	22.25	18.29	21.75	18.89	21.55
28	17.39	20.25	18.99	21.55	19.59	21.95	19.29	22.25	18.29	21.75	18.89	21.55
29	17.39	20.25	18.99	21.55	19.59	21.95	19.29	22.25	18.29	21.75	18.89	21.55
30	17.09	19.95	18.99	21.55	19.59	21.55	19.29	22.25	18.59	22.25	18.49	21.15
31	17.09	19.95			19.59	21.55	19.29	22.25			18.49	21.15
Weighted AVG	**16.08516129**	**19.15322581**	**18.65**	**21.34666667**	**19.32225806**	**21.65**	**19.2029**	**21.7952**	**18.3567**	**21.6833**	**18.7384**	**21.721**

	Nov-63		Dec-63		Jan-64		Feb-64		Mar-64		Apr-64	
	Diesel	**Gasohol**	**Diesel**	**Gasohol**	**Diesel**	**Gasohol**	**Diesel**	**Gasohol**	**Diesel**	**Gasohol**	**Diesel**	**Gasohol**
1	18.49	21.15	20.79	22.35	21.19	22.75	22.09	24.25	23.99	26.05	23.49	26.65
2	18.49	21.15	20.79	22.35	21.19	22.75	22.09	24.25	23.99	26.05	23.49	26.65
3	18.49	21.15	20.79	22.35	21.19	22.75	22.09	24.25	23.59	25.75	23.49	26.65
4	17.99	20.65	20.79	22.35	21.19	22.75	22.49	24.65	23.59	25.75	23.49	26.65
5	18.59	21.05	20.79	22.35	21.19	22.75	22.49	24.65	23.59	25.75	23.49	26.65
6	18.59	21.05	20.79	22.35	21.19	23.45	22.79	24.95	23.59	26.05	23.49	26.65
7	18.89	21.35	20.79	22.35	21.19	23.45	22.79	24.95	23.59	26.05	23.49	26.65
8	18.89	21.35	20.79	22.35	21.19	23.45	22.79	24.95	23.59	26.05	23.49	26.65
9	18.89	21.35	20.79	22.35	21.49	23.55	22.79	24.95	24.19	26.65	23.49	26.65
10	19.29	21.35	20.79	22.35	21.49	23.55	23.29	25.45	24.19	26.65	23.49	26.65
11	19.29	21.35	20.79	22.35	21.49	23.55	23.29	25.45	24.19	26.65	23.49	26.65
12	19.89	21.85	20.79	22.35	21.49	24.05	23.29	25.45	24.19	26.65	23.49	26.65
13	19.89	21.85	20.79	22.35	21.49	24.05	23.29	25.45	24.19	27.05	23.49	26.65
14	19.89	21.85	20.79	22.35	21.89	24.05	23.29	25.45	24.19	27.05	23.49	26.65
15	19.89	21.85	21.19	22.75	21.89	24.05	23.29	25.45	24.19	27.05	23.49	26.65
16	19.89	21.85	21.19	22.75	22.29	24.45	23.29	25.45	24.19	27.05	23.49	26.65
17	19.89	21.85	21.19	22.75	22.29	24.45	23.79	25.45	24.59	27.65	23.49	26.65
18	19.89	21.85	21.19	22.75	22.29	24.45	23.79	25.45	24.19	27.25	23.49	26.65
19	19.89	21.45	21.59	23.15	22.09	24.25	23.79	25.45	24.19	27.25	23.49	26.65
20	19.89	21.45	21.59	23.15	22.09	24.25	23.99	26.05	23.89	26.85	24.09	27.25
21	19.89	21.45	21.59	23.15	22.09	24.25	23.99	26.05	23.89	26.85	24.09	27.25
22	19.89	21.45	21.59	23.15	22.09	24.25	23.99	26.05	23.89	26.85	24.09	27.25
23	19.89	21.45	21.59	23.15	22.09	24.25	23.99	26.05	23.89	26.85	24.09	27.25
24	19.89	21.45	21.19	22.75	22.09	24.25	23.99	26.05	23.59	26.55	23.69	26.85
25	20.19	21.75	21.19	22.75	22.09	24.25	23.99	26.05	23.59	26.55	23.69	26.85
26	20.19	21.75	21.19	22.75	22.09	24.25	23.99	26.05	23.59	26.55	23.69	26.85
27	20.79	22.35	21.19	22.75	22.09	24.25	23.99	26.05	23.19	26.15	23.69	26.85
28	20.79	22.35	21.19	22.75	22.09	24.25	23.99	26.05	23.19	26.15	23.69	26.85
29	20.79	22.35	21.19	22.75	22.09	24.25			23.19	26.15	23.69	26.85
30	20.79	22.35	21.19	22.75	22.09	24.25			23.19	26.15	24.09	27.25
31			21.19	22.75	22.09	24.25			23.49	26.65		
Weighted AVG	**19.6**	**21.5833**	**21.0739**	**22.6339**	**21.7674**	**23.8565**	**23.3114**	**25.3857**	**23.8255**	**26.5403**	**23.63**	**26.79**

	May-64		Jun-64		Jul-64		Aug-64		Sep-64		Oct-64	
	Diesel	**Gasohol**	**Diesel**	**Gasohol**	**Diesel**	**Gasohol**	**Diesel**	**Gasohol**	**Diesel**	**Gasohol**	**Diesel**	**Gasohol**
1	24.09	27.25	25.09	27.95	25.99	29.05	26.49	29.95	25.79	29.25	28.29	31.15
2	24.09	27.25	25.09	27.95	25.99	29.05	26.49	29.95	25.79	29.25	28.29	31.15
3	24.09	27.25	25.09	27.95	26.29	29.45	26.49	29.95	25.79	29.25	28.29	31.15
4	24.09	27.25	25.09	27.95	26.29	29.45	26.49	29.95	26.09	29.25	28.29	31.15
5	24.09	27.25	25.09	27.95	26.29	29.45	26.49	29.95	26.09	29.25	28.29	31.15
6	24.09	27.25	25.09	27.95	26.29	29.45	26.49	29.95	26.09	29.25	28.29	31.15
7	24.59	27.75	25.09	27.95	26.29	29.45	25.99	29.45	26.09	29.25	28.29	31.15
8	24.59	27.75	25.09	27.95	26.29	29.45	25.99	29.45	26.09	29.25	28.29	31.15
9	24.59	27.75	25.09	27.95	26.29	29.45	25.99	29.45	26.09	29.25	28.29	31.15
10	24.59	27.75	25.09	27.95	25.79	29.45	25.99	29.45	26.09	29.25	28.29	31.15
11	24.59	27.75	25.59	28.25	25.79	29.45	25.99	29.45	26.09	29.25	28.29	31.15
12	24.59	27.75	25.59	28.25	25.79	29.45	26.39	29.85	26.09	29.25	28.29	31.15
13	24.29	27.35	25.59	28.25	26.29	29.75	26.39	29.85	26.09	29.25	28.29	31.15
14	24.29	27.35	25.59	28.25	26.29	29.75	26.39	29.85	26.09	29.25	28.29	31.15
15	24.29	27.35	25.59	28.25	26.29	29.75	26.39	29.85	26.59	29.55	28.89	31.15
16	24.29	27.35	25.59	28.25	26.29	29.75	26.39	29.85	26.59	29.55	28.89	31.15
17	24.29	27.35	25.59	28.25	26.29	29.75	26.39	29.85	26.59	29.55	28.89	31.15
18	24.29	27.35	25.59	28.25	26.29	29.75	25.89	29.35	26.89	30.05	28.89	31.15
19	24.79	27.85	25.59	28.25	26.29	29.75	25.89	29.35	26.89	30.05	29.49	31.75
20	24.79	27.85	25.59	28.25	26.29	29.75	25.89	29.35	26.89	30.05	29.29	31.55
21	24.79	27.85	25.59	28.25	26.29	29.75	25.29	28.75	26.89	30.05	29.29	31.55
22	24.29	27.35	25.59	28.25	26.29	29.75	25.29	28.75	26.89	30.05	29.29	31.55
23	24.29	27.35	25.59	28.25	25.69	29.15	25.29	28.75	26.89	30.05	29.29	31.95
24	24.29	27.35	25.79	28.75	25.69	29.15	25.29	28.75	27.04	30.35	29.29	31.95
25	24.29	27.35	25.79	28.75	25.69	29.15	25.29	28.75	27.04	30.35	29.29	31.95
26	25.09	27.95	25.99	29.05	25.69	29.15	25.79	29.25	27.04	30.35	29.29	31.95
27	25.09	27.95	25.99	29.05	25.69	29.15	25.79	29.25	27.04	30.35	29.29	31.95
28	25.09	27.95	25.99	29.05	26.09	29.55	25.79	29.25	27.69	30.75	29.69	32.55
29	25.09	27.95	25.99	29.05	26.09	29.55	25.79	29.25	27.69	30.75	29.69	32.55
30	25.09	27.95	25.99	29.05	26.49	29.95	25.79	29.25	28.29	31.15	29.69	32.55
31	25.09	27.95			26.49	29.95	25.79	29.25			29.69	32.55
Weighted AVG	**24.5126**	**27.5726**	**25.5033**	**28.3167**	**26.1255**	**29.5113**	**26.0029**	**29.4629**	**26.5767**	**29.75**	**28.8448**	**31.5177**

	Nov-64		Dec-64		Jan-65		Feb-65		Mar-65		Apr-65	
	Diesel	**Gasohol**	**Diesel**	**Gasohol**	**Diesel**	**Gasohol**	**Diesel**	**Gasohol**	**Diesel**	**Gasohol**	**Diesel**	**Gasohol**
1	29.54	32.55	28.24	30.45	28.44	31.15	29.94	34.05	29.14	36.55	29.94	39.45
2	29.54	32.55	27.84	29.95	28.44	31.15	29.94	34.55	29.74	36.55	29.94	38.95
3	29.54	32.55	27.84	29.95	28.44	31.15	29.94	34.55	29.74	36.55	29.94	38.95
4	29.54	32.55	27.84	29.95	28.44	31.15	29.94	34.55	29.94	37.15	29.94	38.95
5	29.54	32.55	27.84	29.95	29.04	31.75	29.94	34.55	29.94	37.75	29.94	38.35
6	29.54	32.55	27.84	29.95	29.04	31.75	29.94	34.55	29.94	37.75	29.94	38.35
7	29.54	32.55	27.84	29.95	29.04	31.75	29.94	34.55	29.94	37.75	29.94	38.35
8	29.54	32.55	27.84	29.95	29.44	31.75	29.94	35.05	29.94	38.35	29.94	38.85
9	29.54	32.55	27.84	29.95	29.44	31.75	29.94	35.05	29.94	39.35	29.94	38.25
10	29.79	32.55	28.24	30.55	29.44	31.75	29.94	35.05	29.94	40.15	29.94	38.25
11	29.79	32.55	28.24	30.55	29.84	32.15	29.94	35.05	29.94	40.15	29.94	38.25
12	29.79	32.55	28.24	30.55	29.84	32.15	29.94	35.55	29.94	40.15	29.94	38.25
13	29.79	32.55	28.24	30.55	29.84	32.15	29.94	35.55	29.94	40.15	29.94	38.25
14	29.79	32.55	28.24	30.55	29.84	32.65	29.94	35.55	29.94	40.15	29.94	38.25
15	29.79	32.55	28.44	30.95	29.84	32.65	29.94	35.55	29.94	39.75	29.94	38.25
16	29.59	32.35	28.44	30.95	29.84	32.65	29.94	36.15	29.94	39.75	29.94	38.25
17	29.59	32.35	28.44	30.95	29.84	32.65	29.94	36.15	29.94	38.75	29.94	38.25
18	29.59	32.35	28.44	30.95	29.84	32.65	27.94	36.15	29.94	38.75	29.94	38.25
19	29.39	32.05	28.44	30.95	29.84	32.65	27.94	35.75	29.94	38.75	29.94	39.05
20	29.09	31.65	28.44	30.95	29.94	33.15	27.94	35.75	29.94	38.75	29.94	39.05
21	29.09	31.65	28.44	30.95	29.94	33.15	27.94	35.75	29.94	38.75	29.94	39.05
22	29.09	31.65	28.04	30.65	29.94	33.15	27.94	35.75	29.94	39.35	29.94	39.05
23	29.09	31.65	28.04	30.65	29.94	33.15	27.94	35.75	29.94	39.95	29.94	39.65
24	28.69	31.05	28.44	31.15	29.94	33.15	28.54	36.15	29.94	39.95	29.94	39.65
25	28.69	31.05	28.44	31.15	29.94	33.55	28.54	36.15	29.94	39.95	29.94	39.65
26	28.69	31.05	28.44	31.15	29.94	33.55	29.14	36.55	29.94	40.55	29.94	39.65
27	28.69	31.05	28.44	31.15	29.94	33.55	29.14	36.55	29.94	40.55	29.94	38.85
28	28.69	31.05	28.44	31.15	29.94	34.05	29.14	36.55	29.94	40.55	29.94	38.85
29	28.09	30.45	28.44	31.15	29.94	34.05	29.14	36.55	29.94	40.05	29.94	39.65
30	28.09	30.45	28.44	31.15	29.94	34.05	29.14	36.55	29.94	40.05	29.94	39.65
31			28.44	31.15	29.94	34.05	29.14	36.55	29.94	39.45		
Weighted AVG	**29.2917**	**32.0033**	**28.2206**	**30.6435**	**29.5819**	**32.5823**	**29.3077**	**35.5661**	**29.9013**	**39.1016**	**29.94**	**38.8167**

Appendix 2:

PEA charging station data

จำนวนสถานี	วันที่เปิดให้บริการ	ชื่อสถานี	
1	5/04/2564	PEA VOLTA พะเยา	PEA VOLTA Phayao
2	5/04/2564	PEA VOLTA แพร่	PEA VOLTA Phrae
3	31/05/2564	PEA VOLTA หล่มสัก	PEA VOLTA Lom Sak
4	5/04/2564	PEA VOLTA ร้อยเอ็ด	PEA VOLTA Roi Et
5	20/08/2564	PEA VOLTA อุบลราชธานี	PEA VOLTA Ubon Ratchathani
6	20/08/2564	PEA VOLTA สระแก้ว	PEA VOLTA Sa Kaeo
7	7/12/2564	PEA VOLTA บางจาก ห้างฉัตร	PEA VOLTA Bangchak Hang Chat
8	7/12/2564	PEA VOLTA บางจาก ดอยหล่อ	PEA VOLTA Bangchak Doi Lo
9	20/08/2564	PEA VOLTA บางจาก ซุปเปอร์ไฮเวย์เชียงใหม่	PEA VOLTA Bangchak Chiang Mai Super Highway
10	7/12/2564	PEA VOLTA บางจาก แม่ริม	PEA VOLTA Bangchak Mae Rim
11	7/12/2564	PEA VOLTA บางจาก ดอยสะเก็ด	PEA VOLTA Bangchak Doi Saket
12	20/08/2564	PEA VOLTA บางจาก แม่สาว	PEA VOLTA Bangchak Mae Lao
13	5/04/2564	PEA VOLTA บางจาก เมืองพิษณุโลก (ข้างเซ็นทรัล)	PEA VOLTA Bangchak Mueang Phitsanulok (Near Central Plaza)
14	5/04/2564	PEA VOLTA บางจาก เมืองพิษณุโลก (ทล.11 กม.228)	PEA VOLTA Bangchak Mueang Phitsanulok (H11 KM 228)
15	5/04/2564	PEA VOLTA บางจาก คลองขลุง	PEA VOLTA Bangchak Khlong Khlung
16	5/04/2564	PEA VOLTA บางจาก เมืองตาก	PEA VOLTA Bangchak Mueang Tak
17	13/09/2564	PEA VOLTA บางจาก บึงนาราง	PEA VOLTA Bangchak Bueng Na Rang
18	31/05/2564	PEA VOLTA บางจาก อินทร์บุรี (ขาออก)	PEA VOLTA Bangchak In Buri (Outbound)
19	13/09/2564	PEA VOLTA บางจาก พยุหะคีรี	PEA VOLTA Bangchak Phayuha Khiri
20	31/05/2564	PEA VOLTA บางจาก พล	PEA VOLTA Bangchak Phon
21	31/05/2564	PEA VOLTA บางจาก เมืองขอนแก่น (แยกเมืองเก่า)	PEA VOLTA Bangchak Mueang Khon Kaen (Mueang Kao Intersection)
22	20/08/2564	PEA VOLTA บางจาก เมืองขอนแก่น (มิตรภาพ กม.348)	PEA VOLTA Bangchak Mueang Khon Kaen (Mittraphap KM 348)
23	31/05/2564	PEA VOLTA บางจาก เมืองอุดรธานี	PEA VOLTA Bangchak Mueang Udon Thani
24	31/05/2564	PEA VOLTA บางจาก เมืองหนองคาย	PEA VOLTA Bangchak Mueang Nong Khai
25	13/09/2564	PEA VOLTA บางจาก ขุขันธ์	PEA VOLTA Bangchak Khukhan
26	5/04/2564	PEA VOLTA บางจาก ปากช่อง	PEA VOLTA Bangchak Pak Chong
27	5/04/2564	PEA VOLTA บางจาก สีคิ้ว (มิตรภาพ กม.92)	PEA VOLTA Bangchak Si Khio (Mittraphap KM 92)
28	5/04/2564	PEA VOLTA บางจาก เมืองนครราชสีมา (มิตรภาพ กม. 141)	PEA VOLTA Bangchak Mueang Nakhon Ratchasima (Mittraphap KM 141)
29	20/08/2564	PEA VOLTA บางจาก เมืองโคราช (มิตรภาพ กม. 134)	PEA VOLTA Bangchak Mueang Nakhon Ratchasima (Mittraphap KM 134)
30	13/09/2564	PEA VOLTA บางจาก ประโคนชัย	PEA VOLTA Bangchak Prakhon Chai
31	13/09/2564	PEA VOLTA บางจาก เมืองบุรีรัมย์ (คูเมือง-พุทไธสง)	PEA VOLTA Bangchak Mueang Buriram (Khu Mueang-Phutthaisong)
32	5/04/2564	PEA VOLTA บางจาก บางปะอิน (สายเอเชีย กม. 62 ขาออก)	PEA VOLTA Bangchak Bang Pa-In (AH KM 62 Outbound)
33	5/04/2564	PEA VOLTA บางจาก แก่งคอย	PEA VOLTA Bangchak Kaeng Khoi
34	11/11/2564	PEA VOLTA บางจาก วังน้อย (พหลโยธิน กม.57)	PEA VOLTA Bangchak Wang Noi (Phahon Yothin KM 57)

จำนวนสถานี	วันที่เปิดให้บริการ	ชื่อสถานี	
35	5/04/2564	PEA VOLTA บางจาก บายพาสชลบุรี	PEA VOLTA Bangchak Chonburi Bypass
36	5/04/2564	PEA VOLTA บางจาก บ้านบึง	PEA VOLTA Bangchak Ban Bueng
37	5/04/2564	PEA VOLTA บางจาก นาเกลือ	PEA VOLTA Bangchak Na Klua
38	11/11/2564	PEA VOLTA บางจาก เมืองชลบุรี	PEA VOLTA Bangchak Mueang Chonburi
39	11/11/2564	PEA VOLTA บางจาก วังจันทร์	PEA VOLTA Bangchak Wang Chan
40	7/12/2564	PEA VOLTA บางจาก แกลง	PEA VOLTA Bangchak Klaeng
41	20/08/2564	PEA VOLTA บางจาก ท่าใหม่	PEA VOLTA Bangchak Tha Mai
42	11/11/2564	PEA VOLTA บางจาก เขาสมิง	PEA VOLTA Bangchak Khao Sa Ming
43	11/11/2564	PEA VOLTA บางจาก เมืองระยอง	PEA VOLTA Bangchak Mueang Rayong
44	7/12/2564	PEA VOLTA บางจาก สามพราน	PEA VOLTA Bangchak Sam Phran
45	7/12/2564	PEA VOLTA บางจาก เมืองนครปฐม (เพชรเกษม กม. 61 ขาเข้า)	PEA VOLTA Bangchak Mueang Nakhon Pathom (Phetkasem KM 61 Inbound)
46	7/12/2564	PEA VOLTA บางจาก ท่าม่วง (ติดโฮมโปร กาญจนบุรี)	PEA VOLTA Bangchak Tha Muang (Near HomePro Kanchanaburi)
47	7/12/2564	PEA VOLTA บางจาก นาโคก (ขาออก)	PEA VOLTA Bangchak Na Khok (Outbound)
48	12/03/2564	PEA VOLTA บางจาก วังมะนาว (เพชรเกษม ขาออก)	PEA VOLTA Bangchak Wang Manao (Phetkasem Outbound)
49	12/03/2564	PEA VOLTA บางจาก ชะอำ	PEA VOLTA Bangchak Cha-Am
50	12/03/2564	PEA VOLTA บางจาก ละแม	PEA VOLTA Bangchak La Mae
51	20/08/2564	PEA VOLTA บางจาก ทับสะแก	PEA VOLTA Bangchak Thap Sakae
52	31/05/2564	PEA VOLTA บางจาก ท่าแซะ	PEA VOLTA Bangchak Tha Sae
53	12/03/2564	PEA VOLTA บางจาก เมืองกระบี่	PEA VOLTA Bangchak Mueang Krabi
54	12/03/2564	PEA VOLTA บางจาก คลองท่อม	PEA VOLTA Bangchak Khlong Thom
55	12/03/2564	PEA VOLTA บางจาก ทุนพิน	PEA VOLTA Bangchak Phunphin
56	20/08/2564	PEA VOLTA บางจาก ทุ่งสง	PEA VOLTA Bangchak Thung Song
57	11/11/2564	PEA VOLTA บางจาก ชะอวด	PEA VOLTA Bangchak Cha Uat
58	31/05/2564	PEA VOLTA บางจาก เมืองพังงา	PEA VOLTA Bangchak Mueang Phangnga
59	31/05/2564	PEA VOLTA บางจาก กะทู้	PEA VOLTA Bangchak Ka Thu
60	31/05/2564	PEA VOLTA บางจาก เมืองภูเก็ต	PEA VOLTA Bangchak Mueang Phuket
61	11/11/2564	PEA VOLTA บางจาก เมืองตรัง	PEA VOLTA Bangchak Mueang Trang
62	20/08/2564	PEA VOLTA บางจาก หาดใหญ่	PEA VOLTA Bangchak Hat Yai
63	1/09/2563	PEA VOLTA นครราชสีมา	PEA VOLTA Nakhon Ratchasima
64	1/09/2563	PEA VOLTA นครชัยศรี	PEA VOLTA Nakhon Chai Si
65	1/09/2563	PEA VOLTA สำนักงานใหญ่	PEA VOLTA Head Office
66	1/09/2563	PEA VOLTA เมืองชลบุรี	PEA VOLTA Chon Buri
67	1/09/2563	PEA VOLTA บางจาก วังมะนาว (เพชรเกษม ขาออก)	PEA VOLTA Bangchak Wang Manao (Phetkasem Outbound)
68	1/09/2563	PEA VOLTA หัวหิน	PEA VOLTA Hua Hin
69	1/09/2563	PEA VOLTA พัทยาใต้	PEA VOLTA South Pattaya
70	1/09/2563	PEA VOLTA สมุทรสาคร	PEA VOLTA Samut Sakhon
71	1/09/2563	PEA VOLTA ปากช่อง	PEA VOLTA Pak Chong
72	1/09/2563	PEA VOLTA รังสิต	PEA VOLTA Rangsit
73	1/09/2563	PEA VOLTA พระนครศรีอยุธยา	PEA VOLTA Phra Nakhon Si Ayutthaya

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