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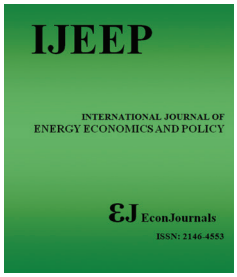

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The Business Analysis of Electric Vehicle Charging Stations to Power Environmentally Friendly Tourism: A Case Study of the Khao Kho Route in Thailand

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ABSTRACT

The growing demand for electric vehicle charging stations is due to the increasing number of electric vehicles due to the rapid development of electric vehicle production and people buying more. This has also increased the demand for electric vehicle charging stations to travel between cities. This is because most combustion cars nowadays use fossil fuels. It harms clean air, producing carbon dioxide (CO_2), PM2.5, and greenhouse gas emissions, resulting in climate changes and natural environmental impacts. Directly affect people in terms of health, living, and present life. By emphasizing the participation of business and government sectors, Thailand has encouraged investment in producing and importing electric vehicles to replace fossil fuel combustion. They also promoted the development of electric cars to be more efficient and run longer distances. The cumulative number of electric vehicles from 2017 to the present is increasing, making business opportunities for EV charging stations available in Thailand. From business model analysis was designed in 3 scenarios, resulting in Scenario 1 Normal charger 6 outlets, in which the cost is low, the cost recovery time is the most, and it has a low net profit margin installed in shopping malls, restaurants, and residential condominiums. Scenario 2 Quick charger 6 outlets take less time to charge. A high charging and increased investment cost have a short payback period installed in front of convenience stores and the current gas station. Scenario 3 is a combination of an electric vehicle charging station with a normal charger and quick charger total of 2 outlets, installed in large areas such as current gas stations, logistics centers, and department stores with souvenir shops and convenience stores. This information can help analyze costs and plan investment decisions on the ownership of electric vehicle charging stations. In addition, electric vehicle charging station scenarios can be compared to predict the net profit margin of the business model.

Keywords: Electric Vehicle, Charging Station, Energy Operation Model, Business Model, Transport Sector
JEL Classifications: G0, M2, Q4

1. INTRODUCTION

The transport sector in Thailand is a major user of fossil fuels, particularly gasoline, diesel, and LPG, and is one of the significant sources of GHG emissions. The use of private vehicles, such as cars, is the major source of GHG emissions in the transport sector. Passenger car is the largest share of vehicles in road transport. (Pita et al., 2020). Fuel-switching option could significantly reduce GHG emissions in a relatively short time frame. (Pongthanaisawan and Sorapipatana, 2013). The policy provides the efficiency of impact mitigation required to respond to the increase in CO_2 amounts (Vatanavongs and Jomnonkwao, 2015). Electric vehicles will play an essential role in the GHG mitigation of the transportation sector. Promoting the use of

electric vehicles requires the development of battery charging systems throughout the country.

Electric vehicle charging stations are the essential infrastructure that must be prepared to create the correct knowledge and understanding of electric vehicles. It is another issue that all business stakeholders must consider the common interests of the environment. The Thai government has announced an energy efficiency plan for 2018-2037 to reduce energy intensity (Insan and Thanarak, 2020). According to the Electric Vehicle Association of Thailand report, in June 2022, there were 855 electric charging stations, and the number of plugs was 2,459. The cumulative number of electric vehicles between 2017 and June 2022. BEV 18,644 units, PHEV 37,075 units and HEV 228,894 units.The number of electric vehicles with such charging stations represents a limitation in customer demand not yet balanced. The factor supporting the market growth in the future will be the government and private sector‘s ability to increase consumers‘ confidence to use electric vehicles in the market. In particular, the networking of charging stations to cover is an interesting measure to increase charging stations and the cost of charging electric vehicles. Based on the existing review and current situation, there is still a lack of a business model that will help strengthen or guide investors interested in owning charging stations, especially in the route of the tourism mountain area. The technical process of production costs, expenses, tax rates, and electric cars is small; it will not be enough to use the service. The breakeven point on the cost of investing in electric vehicle charging stations was one of business decision-making. This research explored the investment and idea of the ownership cost model of electric vehicle charging stations to power environmentally friendly tourism. It is a part that supports smart mobility to have the basic integrity of the city’s development and the public system.

2. ELECTRIC VEHICLE CHARGING OUTLOOK

An investigation of the impact of electric vehicle charging systems on the grid in the present and future pays attention to the relevance of using a fast electric charger. The possibility of systems with grid disturbances is examined for flexibility in the power system management area. The benefits of electric vehicle charging station models have been examined in the effects on charging point operators and electric vehicle owners. The research supports the ambitions of accelerating the launch of electric charging stations and increasing the number of cost-effective charging points. There are implications related to the shift to fossil-free transport and the electrification of locally produced renewable energy (Ilieva and Bremdal, 2021). Past studies found that the increasing number of electric vehicles will significantly impact urban air quality pollution. Higher dependence on oil has been created for Western countries. For most people from different countries worldwide, incentives are being launched to promote the use of electric engines. Change the solution to manage environmental problems, pollution, oil dependence, and cleaner air quality (Carranza et al., 2013). Many problems concerning the charging infrastructure have appeared. Developing strategies to manage this problem efficiently is essential for the charging infrastructure. One problem is the queuing times at EV charging stations; another is power-demand management (Abuawad, 2019). Electric charging stations with mobile platforms and robots working together. Navigation for detection by connecting the electrical wires from the wall socket to the car. Wall plug when the car battery charger reaches the required level to operate the electric charging system (Harik, 2021).

The new approach involves charging stations directly connected to medium-voltage power lines. This eliminates the process of converting multi-stage power electronics and low-frequency transformers. In summary, the benefits of the technology are used to consider the high-speed charging rate. It identifies key technological gaps in the wide acceptance of electric chargers (Srdic and Lukic, 2019). Much research has focused on developing fast DC chargers and off-board able to quickly recharge electric vehicle batteries. The use of service transformers at the charging installation points in existing fast-charging architectures increases the cost and size of the charging system. This complicates the system’s installation process as it connects directly to the medium voltage line (Ronanki et al., 2019). The current battery usage is insufficient for traveling. As a result, electric vehicles have to be charged for a short distance of about 150 kilometers. Departure and arrival times are scheduled for electric charging services. Therefore, electric cars are better suited to city buses than regular cars on schedule (Terzi et al., 2020). Workplace charging locations and public charging locations. Home charging and workplace charging systems are designed according to building control regulations. Public charging points are inspected according to the rules of general reconstruction plans (Sezer and Arpacioglu, 2020). Analysis of the charging mode of each electric charging station. According to Spanish regulations and the type of connectors required at each charging station. The current electric vehicle’s access to charging stations to the charging system points is assessed, and the development of new strategies for using electric charging stations is assessed (Montoya et al., 2016).

Electric vehicle infrastructure and charging are the main growing requirements in the electric vehicle market. The current situation with a lack of charging infrastructure and rising battery prices. It is a problem in adapting electric vehicles. The analysis describes the factors affecting the scaling of EVs. The existing charging infrastructure in India has the standard for electric charging. It is a growing challenge for electric vehicles, electric charging infrastructure, and electric vehicle development needs (Nair et al., 2017).

2.1. Charging Infrastructure Policies and Regulations in Thailand

2.1.1. Boosting the electric vehicle through the policies

The Energy Policy and Planning Office (EPPO), Ministry of Energy, Thailand, launch the promotion policy to promote electric vehicles 30 percent use by 2030 (30@30) and charging stations as shown in Table 1. EPPO has presented the goals for infrastructure development to support the expected volume of electric vehicles in the future, as follows:

- Encouraging the development of an adequate charging station network. The goal is to develop public charging stations to distribute more than 12,000 chargers nationwide by 2030

Table 1: Target of electric vehicle use in Thailand

Year	Car and Pickup		Motorbike		Motorbike Taxi	
Target	Collective Use (Million)	Fast charger	Collective Use (Million)	Station	Collective Use (Thousand)	Station
2025	0.4	2200–4400	0.6	1600	12	260
2030	2.0	12,000	3.2	8000	65	1450
2035	6.4	36,500	8.8	20,000	176	4000

- Creating rules and standards to support the development of charging stations
- Promoting Smart Grid technology to connect and manage integrated charging.

The policy to promote the use of electric vehicles under Policy 30@30 is a significant policy in the future to support Thailand in achieving the country's long-term greenhouse gas emission targets by improving energy efficiency in the transport sector to become more efficient Increased ability to convert fossil fuels into green electricity and help solve the weather problem from PM 2.5 dust. Following the government's policy, the Energy Regulatory Commission (ERC) launch the requirements to permitting installation the EV charging station along with the standards and criterias of connecting to grid from Provincial Electricity Authority (PEA) and Metropolitan Electricity Authority (MEA). Furthermore, the Energy Regulatory Commission (ERC) set EV charging rate at 2.63 THB/kWh to encourage relevant agencies to set up more EV Charging station in the provinces. The current situation of service providers and the number of locations as of June 2022 is presented in Table 2 (EVAT, 2022).

Table 2: Current service providers and number of locations in Thailand

Service providers	Number of Locations	Number of outlets			Total
		AC Type 2	DC CHAdeMo	DC CSS 2	
EA Anywhere	406	579	-	576	1,155
EV Station	112	150	82	90	322
Evolt	99	169	9	16	194
PEA	73	76	137	138	351
SHARGE	68	193	5	8	206
Elex by EGAT	42	37	2	49	88
MEA EV	28	50	2	-	52
ONION	13	49	-	-	49
PUMP CHARGE	6	18	-	-	18
CHOSEN	4	7	-	-	7
HAUP	4	15	-	2	17
Total	855	1,343	237	879	2,459

Electric vehicle association of thailand (EVAT) also presents the EV Stations Map for Thailand in more detail at https://www.gridwhiz.io/evat/

2.1.2. Investment promotion challenge for incentives in charging stations

As of April 2022, the Thailand Board of Investment (BOI, 2022) has benefits to the electric vehicle charging station business. To encourage continued investment in key infrastructure to support electric vehicles with the following conditions, to enable smaller companies and startups accessibility to the BOI benefits.

- Must propose the business plans for sourcing parts and equipment
- Must submit one of the following plans: an EV smart charging system implementation plan or a plan to connect to the central or integrated EV charging network platform
- Must comply with laws and regulations according to the requirements of the national security agency
- In the case of projects, investment in charging stations with at least 40 chargers and 25% of which are DC type (Quick charge), Corporate income tax (CIT) exemption for 5 years
- In case of projects investment in smaller charging stations, CIT exemption for 3 years
- This type of project can also be able to receive any tax and financial support from other agencies
- Must be able to obtain ISO 18000 within 3 years from the date of issuance of the promotion certificate
- In case of projects approved for promotion or projects that have applied for promotion in Type of service station for charging electric vehicles for electric cars to be able to apply to amend the project to change to a type of electric charging service station for this new electric vehicle.

They are entitled to the A3 benefit, a 5-year corporate income tax exemption, and an exemption from import duty on machinery. Exemption of duty on raw materials for export and other non-tax benefits.

BOI Secretary General Ms. Duangjai Asawachintachit announced that after a Board meeting the approval of revised incentives and conditions for investments in EV charging stations and reported that the total value of foreign and local investment promotion applications during the first quarter of 2022 amounted to a total of 110.7 billion baht (USD3.4 billion) (BOI, 2022).

3. CHARGING STATION DESIGN AND MODEL FOR THE TOURISM MOUNTAIN ROUTE

3.1. Khao Kho Mountain Area, Phetchabun Province, Environmentally Friendly Tourism Thailand

The environmental tourism area of Khao Kho has several transportation routes by car. Nevertheless, there is no rail transport route. The main route is Highway 21, the Saraburi-Lom Sak route, and Highway 12, the East-West Economic Corridor, linking Myanmar-Thailand-Laos-Vietnam. The economic cooperation development project in the Greater Mekong Sub-region (GMS) creates opportunities for economic development in trade, investment, and tourism. It also connects the North-South Economic Corridor to China-Myanmar-Malaysia. The distance is

Figure 1: Number and location of charging station from phitsanulok to phetchabun province

approximately 1,280 kilometers through the Indochina Intersection in Phitsanulok Province, and the ASEAN Intersection at Lom Sak District, Phetchabun Province. The number and location of charging station in Khao Kho route presents in Figure 1. Impact CO_2 of using electric cars on tourism routes in Wang Thong District, Phitsanulok Province, to the route Khao Koh District, Phetchabun Province. It was assumed that the number of electric vehicles would increase by 5% with a reduction in CO_2 emissions of 2.88%, but the assumption of an increase in electric vehicles of 10% had a decrease in CO_2 emissions of 5.77%. Based on the data, the more EVs run, the greater the balance in the clean-air environment.

3.2. Energy Operation Model

This electric vehicle charging station study aims to understand the scenario of electric vehicle charging stations that use different services in need of speed and convenient service using three design features and show in Figure 2:

- Scenario 1 Design a normal charging station using an electric vehicle charging station. The charging time is relatively slow, approximately 180–240 min
- Scenario 2 Design an electric charging station with a Quick charging station that takes about 40–60 min to fast charge
- Scenario 3 There are two types of electric vehicle charging stations, Normal charging stations and Quick charging stations, which combine both types of electric vehicle charging stations to serve both fast and slow customers. To compare the cost of EV charging stations from the Design of 3 types of EV charging stations.

Scenario 1: Design a normal charging station component to analyze the equipment used to calculate the cost of charging stations per station. There are 6 outlets of AC 22 kW chargers in each charger.

Scenario 1 = Electric Vehicles Cost Normal Charger

$$1 = NC_{AC22(1)} + ..NC_{AC22(1=n)} + insur_{AC22} + fee_{AC22} + ec_{AC22} + pt_{AC22} + other_{AC22} \quad (1)$$

Where;

NC_{AC22}= Normal Charger 1–6 outlets
$insur_{AC22}$= Insurance Electric
fee_{AC22} = Fee Electric
ec_{AC22}= Electric Charge
pt_{AC22} = Power transformer
$other_{AC22}$= Other express 30%

Scenario 2: Design a quick charging station component to analyze the equipment used to calculate the cost of charging stations per station. Each item has 6 outlets of DC 50 kW chargers.

Scenario 2 = Electric Vehicles Cost Quick Charger

$$1 = QC_{DC50(1)} + ..QC_{DC50(1=n)} + insur_{DC50} + fee_{DC50} + ec_{DC50} + pt_{DC50} + othrer_{DC50} \quad (2)$$

Where;

DC_{DC50}= Quick charger 1–6 outlets
$insur_{DC50}$= Insurance electric
fee_{DC50}= Fee electric
ec_{DC50} = Electric charge
pt_{DC50} = Power transformer
$other_{DC50}$= Other express 30%

Scenario 3: Design the normal charging station components. Each charger has 6 outlets of AC 22kW and Quick charging stations. Each item has a DC 50kW of 6 outlets to analyze the equipment used to calculate the cost of the next charging station. The station has 12 outlets.

Scenario 3 = Large charger Normal and Quick 12 outlets (3)

1= [Scenario 1 + Scenario 2]

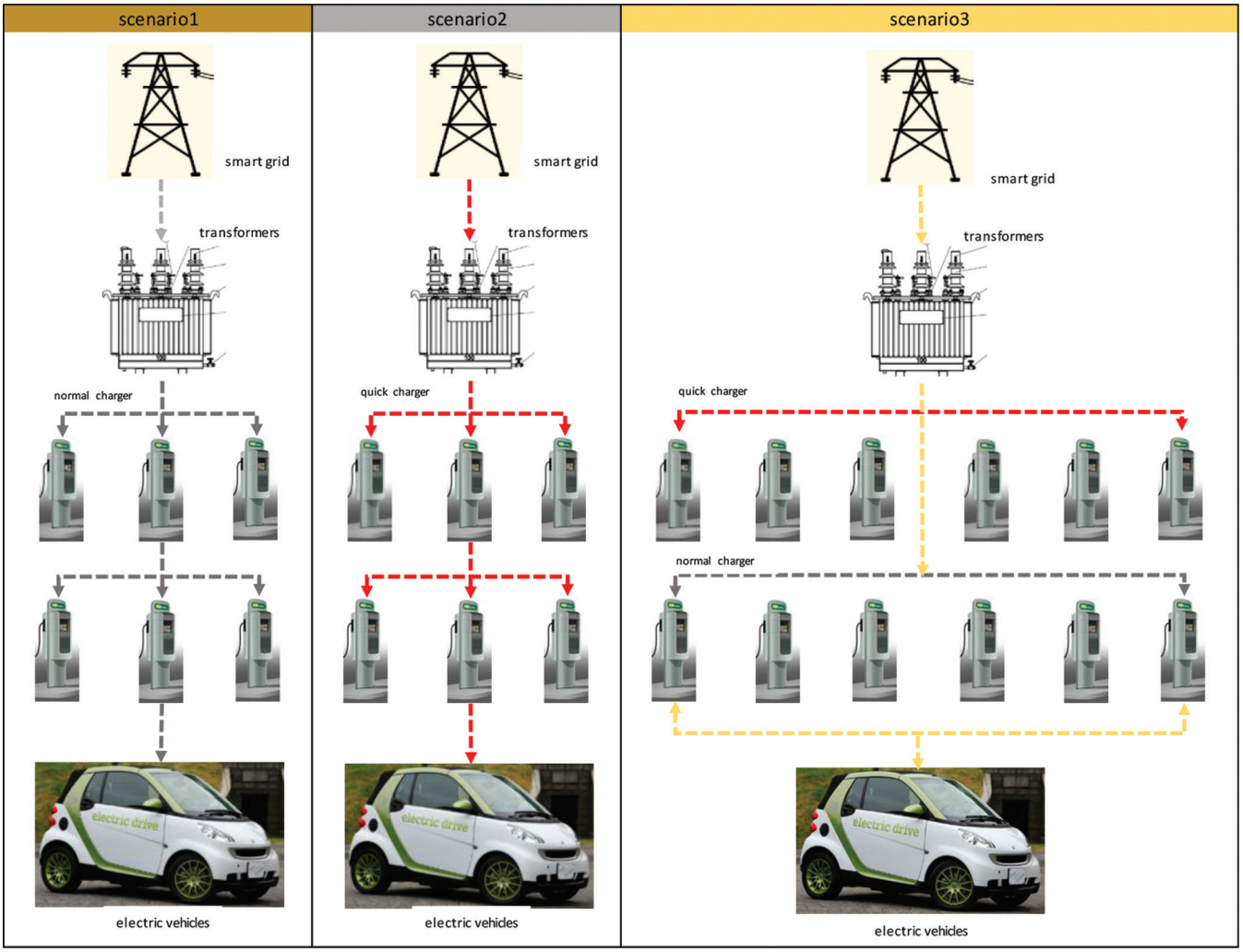
3.2.1. EV Charger for the car park at department stores, restaurants, and residential

Normal Charging station

Scenario 1 = Normal Charger 6 outlets

There is no need to rush when charging for customers with regular electric vehicle charging; there are 6 outlets. Pay for customers

Figure 2: Electric vehicle charging flows chart



who use the parking area residential condominium, department store, and restaurant.

AC Destination 22 kW 32A

$$EVNC_{AC} = \frac{BEV_{AC(1=n)} \quad h}{EVNC_{AC22}} \tag{4}$$

Where;
$EVNC_{AC}$ = Electric Vehicles Normal Charging on Time
$BEN_{AC(1=n)}$ = Battery of Electric Vehicles AC (1=n)
$EVNC_{AC22}$= Electric vehicles normal charging head size AC22

3.2.2. EV Charger for the car park at the convenience store, coffee cafe, and oil station

Quick charging station

Scenario 2 = Quick Charger 6 outlets

For customers who need to recharge their electric vehicle in a hurry and take less time, there are 6 charger outlets. Electric vehicle charging points are available to convenience stores and gas station customers.

The - DC Quick charger 50kW 100A

$$EVQC_{DC} = \frac{BEV_{DC(1=n)} \quad h}{EVNC_{DC50}} \tag{5}$$

Where;
$EVQC_{DC}$= Electric Vehicles Quick Charging on Time
$BEV_{DC(1=n)}$ = Battery of Electric Vehicles DC (1=n)
$EVQC_{DC50}$ = Electric Vehicles Quick Charging Head Size DC50

3.2.3. EV Charger for the car park at the department store and oil station

Normal charging station and quick charging station

Scenario 3 = Large charger Normal and Quick 12 outlets

To support customers who use regular and express services in EV charging services. An EVs charging station with an extensive service point is installed in the current oil station or electric vehicle parking station with various vehicles. The charging station will need more facilities, such as coffee shops, restaurants, souvenir shops, clothing stores, and convenience stores.

Scenario 3 = AC Destination 22 kW 32A + DC Quick charger 50kW 100A

3.3. The Methodology Assigns Variable Charging Station

Scenario 1 Normal charging station, customized design 6 outlets, AC size 22 kW, ABB brand, price about 990,000 baht, calculated power transformer size 315 kVA, price about 227,910 baht, electric insurance price 126,000 baht, com fee price 1,260 baht, electric charge price 10,000 baht, another expense price 68,373 baht and total 1,423,543 baht.

Scenario 2 Quick charging station, customized design 6 outlets, DC size 50 kW, SETEC brand, price about 3,060,000 baht, calculated power transformer size 630 kVA, priced about 354,063 baht, electric insurance price 252,000 baht, com fee price 2,520 baht, electric charge price 10,000 baht and another expense price 106,218.90 baht total 3,784,801.90 baht.

Scenario 3 Normal charging Design 6 outlets and Quick charging Design 6 outlets total of 12 outlets available in both AC 22 kW Brand ABB and DC size 50 kW Brand SETEC total price approximately 4,050,000 baht calculated Power transformer size 1000 kVA price approximately 455,606 baht, Electric insurance price 400,000 baht, com Fee price 4,000 baht, Electric charge price 10,000 baht and another expense price 136,681.80 baht total 5,056,287.80 baht.

[Data ABB is taken from www.pmk.co.th/shop/ev-charger, SETEC data is taken from www.alibaba.com//trade/search, Transformer data is taken from http://transformae.wordpress.com, electric data insurance, com fee, electric charge taken from www.pea.co.th and other expense 30% set-up cost according to transformer price] data year 2019.

3.4. The Methodology Assigns Variable Income and Expense

Scenario 1 Income Normal charging station 6 outlets charging schedule 10 h @ 50 baht income 90,000 bant/month. The electricity expense is based on the number of electricity units multiplied by the unit price multiplied by the number of hours 60,492.59 baht, Salary of 15,000 baht, and Rent place of 18,000 baht, total expense of 93,492.59 baht, profit before tax –3,492.59 baht/month, as shown in Table 3.

Scenario 2 Income Quick charging station 6 outlets charge schedule 10 h units@ 8 baht calculated based on the number of electricity units multiplied per unit price multiplied by hours paid income 547,200 bant/month. Expense electricity based on the number of electric units multiplied by unit price times number of hours 325,245.50 baht, Salary 15,000 baht and rent place 18,000 baht, total expense 358,245.50 baht, profit before tax 188,954.50 baht/month.

Scenario 3 Income Normal charging 6 outlets and Quick charging 6 outlets total 12 outlets 2 types charge schedule 10 h h @ 50 baht income 90,000 bant/month and charge units@ 8 baht calculated by the number of electricity units multiplied by the unit price multiply the number of hours paid income 547,200 bant/month, total income 637,200 baht. The electricity expense is calculated by the number of electricity units multiplied by the unit price multiplied by the number of hours 385,447.71 baht, salary 30,000 baht and rent place 36,000 baht, total expense 451,447.71 baht, profit before tax 185,752.29 baht/month. (Information from the interview with the owner of the current gas station, the service time is 10 h per day. Expense electricity information is taken from www.pea.co.th).

Assumption, income cost, and net profit, resulting from investment action, data analysis, electric car charging rate takes about 10 h a day-divided into 3 Scenario Normal Charger, Quick Charger, and Normal + Quick. To calculate the study of the opening period, the same is different: the speed of the electric car charging and thinking of income according to the electric charge.

Time on charger

There are two types of electric vehicle charging stations, normal charge and quick charge, which are used to charge electric vehicles using the EV charger cabinet that converts AC to DC in the normal charge type, charging via an onboard charger, and quick charge, supplying DC directly to the electric vehicle battery. The time it takes to charge varies according to the size of the electric charger and battery size kWh electric vehicle.

$$\text{Time on charger} = \frac{\text{BkWh}}{\text{ACDCkW}} \quad (6)$$

Where;
B_kWh= Battery kWh for Electric Vehicle
AC_DC_kW= AC or DC Fast Charging Station kW

A study of EV charging stations calculates the number of EVs for 10 h of service/charging stations. There will be enough electric cars to break even: Net present value yield and return period. To analyze 5 Brands of electric cars with different battery sizes, selecting the sales of electric cars is relatively high in 2020-2021. The number of electric vehicles is more than other electric car models; the MG EV will have a Battery size of 44.5 kWh, as shown in Table 4. At the same time, it will enter the battery-size charging station, which can charge approximately 80% of the electricity according to the size of Battery Scenario1 of 37 EVs, Scenario2 of 84 EVs, and Scenario 3 amounts to 121 EVs. Income and expenses of each scenario are presented in Table 5. The number of electric cars more or less depends on the battery size of each electric vehicle. Moreover, the number of electric vehicles currently running.

Net profit margin compared to the electric car charging station, presented in Table 6. Analyze expenses compared to income from the

Table 3: Cost investment model EV charging station (Unit: Thai Baht)

Cost investment	Scenario 1	Scenario 2	Scenario 3
Model EV charger	Normal 6 outlets	Quick 6 outlets	Normal and quick 12 outlets
Cost EV charging station	990,000	3,060,000	4,050,000
Electric Insurance	126,000	252,000	400,000
Com fee	1,260	2,520	4,000
Electricity charge	10,000	10,000	10,000
Power transformer	227,910	354,063	455,606
Other expenses	68,373	106,219	136,682
Total	1,423,543	3,784,802	5,056,288

Table 4: Study of the EV battery size for time on the charger

BEV	Battery Size (kWh)	Charging 80%	Time Charge/kW (22 AC/min)	Time Charge/kW (50 AC/min)	Scenario 1 6 Outlets (EV/day)	Scenario 2 6 Outlets (EV/day)	Scenario 3 12 Outlets (EV/day)
MG	44.5	35.60	97.09	42.72	37	84	121
Tesla	62	49.6	135.27	59.52	27	60	87
Porsche	79	63.2	172.36	75.84	21	47	68
MINI Cooper	32.6	26.08	71.13	31.30	51	115	166
Nissan	40	32	87.27	38.40	41	94	135

investment operation; the electric car charging rate takes about 10 h a day. To calculate the analysis of the same opening period differently, the speed of charging electric cars, thinking of income according to the charging time, is calculated as a percentage. According to the Normal Charger, Quick Charger, and Normal + Quick scenarios.

Each analysis of scenario BEP/Month break-even point the shortest period, NPV/Bath the highest net value, IRR/Percent the most yield, PB/year the shortest duration, as shown in Table 7.

3.5. Business Model Canvas

3.5.1. Value propositions

Strengths: A quality charging system and standardized charging station certification from government agencies PEA, MEA, and ERC are open 24 h daily.

At present, the former gas station has a large vacant area. The electric vehicle charging station can be rented because it is suitable to install an electric vehicle charging station to make it easy for drivers to park and easily recognize them. Because nowadays most drivers still use petrol cars and know about gas stations. Two chargers will be installed during the first phase, a Normal charger and a Quick charger at the petrol stations. The optional add-on will install an electric charging station at Convenience stores, and restaurants will use a Quick charger to charge electricity; it takes only 40–60 min to charge, and areas of shopping malls, hotels, and residential condominiums. Install an electric charging station with a Normal charger. Charging time is not urgent; it takes from 180 to 240 min.

Scenario 1. Normal charger for customers with a normal electric vehicle charging; there is no need to rush for a long time when charging the electric bill. Chargers 6 outlets pay for customers who use the service will be installed in the parking area condominiums, residences, hotels, and department stores.

Scenario 2. Quick chargers are installed in electric vehicle charging stations or the current gas station. In convenience stores and restaurants (quick) such as McDonald‘s or KFC, charging time will take approximately 40–60 h. For customer service customers who come to electric vehicle charging stations in a hurry, charging time six outlets are charging points for customers who use convenience stores and oil stations. Electric vehicle charging stations in countries like Norway are installed like gas stations.

Scenario 3. Normal chargers with six outlets and Quick chargers with six outlets are two electric vehicle charging stations with large service points. To make customers convenient, choose normal and fast charging installed in the current oil station or motorway travel point. There is a spacious area with a variety of cars and trains.

Table 5: Income and expenses model (Unit: Thai Baht)

Income and expenses	Scenario 1	Scenario 2	Scenario 3
Model EV charger	Normal 6 outlets	Quick 6 outlets	Normal and quick 12 outlets
Time charger	10hrs. @ 50THB	10hrs. @8THB/kWh	10hrs. @ 50THB and 8THB/kWh
Income	90,000	547,200	637,200
Electric expense	60,493	325,245	385,448
Labor	15,000	15,000	30,000
Rental venue	18,000	18,000	36,000
Total	(–3,492)	188,955	185,752

Table 6: Net profit comparison between income model (Unit: Thai Baht)

Net Profit compare Income	Scenario 1	Scenario 2	Scenario 3
Model EV charger	Normal 6 outlets	Quick 6 outlets	Normal and quick 12 outlets
Time charger	10hrs. @ 50THB	10hrs. @8THB/kWh	10hrs. @ 50THB and 8THB/kWh
Income	100	100	100
Expenses	104	65	71
Net profit	–4	35	29

Table 7: Analysis of BEP, NPV, IRR, and PB

Indicator	Scenario 1	Scenario 2	Scenario 3
BEP (Number of vehicles)	n/a	50,476	98,811
NPV (THB)	n/a	10,147,721	8,640,121
IRR (%)	n/a	59.34	42.84
PB (year)	n/a	1.67	2.27

The charging station area will have additional facilities such as coffee shops, restaurants, souvenir shops, clothing stores, and convenience stores to support customers who use regular and express services to charge electric vehicles, as detail shown in Table 8.

3.5.2. Customer segments

Customer groups focusing on electric vehicle drivers, tourists, travelers, company employees, civil servants, and families can charge with an electric car, sedan, or SUV.

3.5.3. Customer relationships

Focus on easy accessibility for convenience. There is a call center service. There is an App Location and Maps station to travel to the

Table 8: Business model canvas

Key partners	Key activities	Value propositions	Customer relationships	Customer segments
Utilities PEA/EGAT Bank Petro Station PTTOR/PT/Bangchak/ ESSO/Shell Shopping store Central/BigC/Lotus/ FamilyMart/7-11/Coffee Cafe/Restaurant Car Showroom BMW/GWM/MG	Service research and development Software Development Maintenance and build the charging station Design charging station	Charging Station quality and standards Price standard and security Open 24 h Convenience location Service Normal charge EV charging on hotel and shopping store Service quick charge EV charging at petrol stations, convenience stores, and restaurant	Call center Discounts Referral to member Maps charging station and location environmental APPs order time	EV Users Tourist and Travel Company employee Government Office Local
Key resources			**Channels**	
Raw material Reputation Capital Crew Tools			App charging station Website of charging station Line Facebook Telephone Google maps	
Cost structure			**Revenue streams**	
Cost of electricity Cost of charging station Cost of electric system	Employee salary Production cost Taxes	Run station raw material cost	Income of charging EV Advertising revenue	

Table 9: Sensitivity analysis of three scenarios

Scenario	Indicator	Investment cost		Price		Electricity expense		Ft		9 h	11 h
		10%	−10%	10%	−10%	10%	−10%	10%	−10%		
1	NPV	8.47	−8.47	−39.48	39.48	26.43	−26.43	−0.03	0.03	13.07	−13.07
2	NPV	−3.73	3.73	39.76	−39.76	−23.64	23.64	0.02	−0.02	−16.15	16.15
	IRR	−5.62	6.81	17.66	−18.13	−10.69	10.53	0.01	−0.01	−7.28	7.21
3	NPV	−5.85	5.85	54.38	−54.38	−32.90	32.90	0.03	−0.03	−21.51	21.51
	IRR	−4.30	5.17	15.78	−16.72	−9.94	9.61	0.01	−0.01	−6.44	6.31

charging station easily. This electric vehicle charging station is also promoted as an electric charging station to protect the environment. Customers who regularly receive service have added value using discounts and referrals to member service.

3.5.4. Channels

The electric vehicle charging station has an app order time charging service to reserve a queue for service. There is a website of charging stations in line, Facebook and google maps. So that customers can receive benefits in a variety of channels, the location of the electric vehicle charging station should be on the main road. There is a high volume of traffic in the car.

3.5.5. Revenue streams

The electric charging station will have income from charging electric vehicles and payment from advertising revenue at the electric charging station and the website of the charging station.

3.5.6. Key partners

Electric vehicle charging stations are integrated with PEA, MEA, ERC, EVAT, BANK, PTT, PT, Bangchak, Esso, Shell, CENTRAL BigC Lotus's, 7-11, FamilyMart, Restaurant, and Coffee cafe.

3.5.7. Key activities

Emphasis on comprehensive quality service with research and development. Software Development takes care of Maintenance, Building charging station, and designing new charging stations.

3.5.8. Key resources

Investments must use personal funds in whole or in part because part of them will request a credit line from the bank at 30: 70 or 50:50. For liquidity in investment in expanding the area, there is a service point covering the value for customers, suitable for a distance of 50-100 km. Employees have the training, knowledge, and experience to understand electric vehicles' work systems and charging processes. The equipment is installed at the electric vehicle charging station.

3.5.9. Cost structure

The cost of electricity is calculated, including electric vehicle charging stations, electrical infrastructure systems employee payroll, tax payable, and electric charging station rental fee.

3.6. Sensitivity Analysis for the Investment of Charging Station

To analyze investment projects and the uncertainty of the current economic conditions that affect investment decisions. Sensitivity analysis of the electric vehicle charging station investment project show analyze the risks consider the impact of various factors on changes in costs and income. The break-even point may be changed, net present value, rate of return and payback period.

Therefore, the sensitivity of electric vehicle charging station investments must be analyzed. The results are presented in Table 9.

Scenario 1: In the 10-h-per-day analysis, scenario1 has a negative NPV, and the IRR cannot be calculated; the project is unsuitable for investment and cannot be compared. Scenario1 is, therefore, suitable for an introduction to the use of electric vehicle charging stations, which may be free or promotional charging services in an environmentally sound area.

Scenario 2: In the 10-h-per-day analysis scenario2, with a positive NPV and an IRR greater than the cost of financing, it is an investment-friendly project. To make the data analysis more realistic, there is a high-profit potential. Therefore, a sensitivity analysis of the charging service time of 10 h per day was analyzed. Compared to 9 and 11 h of electric charging service time per day. An increase and decrease in the positive and negative ratio of investment costs are assumed to increase by 10%, resulting in a negative NPV of 3.73% and a negative IRR of 5.62%. Suppose a decrease in investment costs by 10% results in an increase in NPV of 3.73%, an IRR of 6.81%. Make it known that the increase or decrease in investment costs affects NPV and IRR. The charge price increases by 10%, causing NPV plus 39.76% and IRR plus 17.66%. If the charge price decreases by 10%, NPV decreases to negative 39.76%, and IRR decreases to negative 18.13%. It makes me know if the price drop greatly impacts the NPV and IRR values. Electricity charge increases by 10%, causing NPV to be negative 23.64% and IRR negative to 10.69%. If the charging electricity bill decreases by 10%, NPV is 23.64%, and IRR is positive by 10.53%. It lets you know if your electricity bill increases. It can harm NPV and IRR. A 10% increase in Ft negative leads to 0.02% NPV positive and 0.01% positive IRR. A 10% decrease in Ft charge raises 0.02% NPV negative, 0.01% positive IRR. Nevertheless, if Ft is positive, then NPV and IRR are opposite, so we know if Ft harms NPV and IRR. Scenario 2 Based on a comparative analysis of the increase in the price of charging fees and the decrease in the cost of electricity. Compared to 9 and 11 h of charging time, they have higher NPV and IRR values.

Scenario 3: In the 10-h-per-day analysis scenario3, with positive NPV and IRR greater than the cost of financing, it is an investment-friendly project. To make the data analysis more realistic, there is a high-profit potential. Therefore, a sensitivity analysis of the charging service time of 10 h per day was analyzed. Compared to 9 and 11 h of electric charging service time per day. An increase and decrease in the positive and negative rate of investment costs are assumed to increase by 10%, resulting in a negative NPV of 5.85% and a negative IRR of 4.30%. Suppose a decrease in investment costs by 10% results in an increase in NPV of 5.85%, an IRR of 5.17% is assumed. Make it known that the increase or decrease in investment costs affects NPV and IRR. The charge price increases by 10%, causing the NPV value to increase by 54.38%. The IRR value increases by 15.78%. If the charge price decreases by 10%, the NPV value decreases by negative 54.38%. The IRR value decreases to negative 16.72%. It has a high impact on NPV and IRR. Electricity charge increases by 10%, resulting in a negative NPV of 32.90% and a negative IRR of 9.94%. If the charge of electricity decreases by 10%, NPV is positive by 32.90%, and IRR is positive by 9.61%. This lets you know if your electric bill increases. It can harm NPV and IRR. If Ft is negative, a 10% increase makes NPV positive by 0.03%. IRR is positive at 0.01%. If Ft charge decreases 10%, NPV is negative 0.03%, IRR is 0.01% positive. Adding NPV and IRR are opposite, so we know if Ft harms NPV and IRR.

The sensitivity analysis increases and decreases investment cost, service cost, electricity cost, and ft. charging time of 9 and 11 h. Start the hypothesis and analysis of Scenario 1, 2, and 3. The results of the analysis are as follows. Scenario 2 is the first model Business Model electric vehicle charging station interested in investment, value for money, and return on ownership of the business. Scenario3 is second only to Scenario 2 with Business Model electric vehicle charging station, interested in investment, value for money, and good return. Scenario1 is an investment-friendly disregard as the NPV is negative, the IRR cannot be calculated, and therefore does not support investment. However, if it is a secondary electric vehicle promotion to lay the basis for using the electric vehicle for customers interested in receiving electric vehicle charging station service, Scenario 1 is recommended. Due to low investment cost, not the for-profit focus is on helping society, reducing pollution, and protecting the environment. The limitation of electric vehicle charging station equipment is still a new market and must be imported from abroad, which may be one of the factors that cause high investment costs, thus affecting NPV and IRR.

4. CONCLUSION

Based on model energy and business model, according to the charging station situation model, starting from the analysis.

Scenario1 Normal charger 6 outlets is a normal charging system and time. They were installed to charge electricity in shopping malls, restaurants, and residential condominiums. The cost and price are low, and the payback period is time-consuming due to the low net profit margin.

Scenario 2 Quick charger 6 outlets is a fast-charging station for electric vehicles that takes very little time to charge the battery fully. Charging costs are high. High investment cost and has a short payback period. Install electric charging points in front of convenience stores and the current gas station.

Scenario 3 is an electric vehicle charging station with a normal charger, 6 outlets, and a quick charger, 6 outlets total 12 outlets, and fast, available within minutes. It is installed to take up a large area like the current gas station and various service shops such as coffee shops, restaurants, souvenir shops, clothing stores, and convenience stores.

The analysis in the business model used in the study calculates BEP, a project period of 10 years, which is divided into 3 scenarios. BEP analysis results of investment scenarios 1, 2, and 3 breakeven point, investment scenario2 has the shortest optimal investment and the fastest return on investment. IRR analysis in investment scenario2 provides the best rate of return on profit. Calculation of

NPV in investment scenario 3 gives the most immediate current cash value.

The Three Investment Scenario Model Summary: Investment Scenario2 is the investment's net present value with the best results, the 10-year IRR investment analysis results. Investment Scenario2 is suitable for investment. The results of the analysis of the 10-year PB investment project Scenario2 is ideal for investment. In the analysis, the best PB in an investment scenario2 has a short payback period.

The government's policy is to support EV production, reduce taxes, establish EV charging stations and drive investment in the electric vehicle industry. The booster will increase the number of EVs or charging stations. This will increase the number of EVs and improve charging stations. The rise of electric vehicles and charging stations must be widely distributed across the country. The payback rate will be faster; the investment cost will be lower. However, the growth rate of electric vehicles and electric charging stations is still relatively slow, requiring more government stimulation.

Solution scenario electric vehicle charging station from scenario normal Charger analysis normal charging system to install electric charging stations in department stores, restaurants and condominiums, housing, lowest costs, lowest income and shortest return period. Scenario Quick Charger is a fast-charging station with a high cost. High charge fee And the duration of the fastest cost, installation of electric charging stations, convenience stores, and gas stations. Scenario mixed with structure, use large areas, current gas stations. There are coffee shops, restaurants, souvenir shops, clothing stores, and many convenience stores. The investment must depend on the number of EVs and the number of electric vehicles. If it is by the government policy support electric vehicles in 2030, the number of electric cars will increase to 1.20 million units, suitable for investment. There is still a low growth rate, which is not ideal for investment.

The sensitivity analysis increases and decreases investment cost, service cost, electricity cost, and Ft charging time of 9 and 11 h. The results of the analysis are as follows. Scenario2 is the first model Business Model electric vehicle charging station interested in investment, value for money, and return on ownership of the business. Scenario3 is second only to Scenario2 with Business Model electric vehicle charging station, interested in investment, value for money, and good return. Scenario1 is an investment-friendly disregard as the NPV is negative, the IRR cannot be calculated, and therefore does not support investment.

Nevertheless, if it is a secondary electric vehicle promotion to lay the basis for using the electric vehicle for customers interested in receiving electric vehicle charging station service, Scenario1 is recommended. Due to low investment cost, not the for-profit focus is on helping society, reducing pollution, and protecting the environment. The limitation of electric vehicle charging station equipment is still a new market and must be imported from abroad, which may be one of the factors that cause high investment costs, thus affecting NPV and IRR.

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