



The Future Of Electric Car In Thailand

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Abstract

In this paper, we want to know whether or not electric car have a future in Thailand. Greenhouse effect from CO₂ emission makes our world get warmer and price of oil is increasing every day. To sustain energy for our descendant in the future, we have to cooperate to reduce energy consumption or invent the new technology that consumes less energy. In Thailand power generation sector is the major CO₂ emission produce follow by transportation sector. If we can reduce CO₂ emission in one of this sector, Thailand will become a part in saving our world from global warming. We learn that people afraid to use new thing but this research will prove that sometime people have to change for something better. Electric car might be a solution to reduce CO₂ emission in transportation sector because it produces 0 CO₂ emission to our world. To calculate, we use the CO₂ emission from conventional cars compare to CO₂ emission from power plant in Thailand. We collect the number of Thailand registered cars in past 5 years to calculate by changing all of them into electric cars. The result from calculate will depend on the characteristic of power plant in that country because power plant generate electric power for electric car. In the end, the future of electric car in Thailand would not depend solely from the result from calculation, but also rely on the government policy to determine the direction of electric car in Thailand.

Introduction:

The first electric car was built in 1884 by Thomas Parker but it is still not popular because it can travel in very limited distance and gasoline for conventional car at that time still very cheap (Cowan, R., and Hulten, S.,2000). Until late 19th century electric car become more popular by oil price crisis that price of gasoline increase like a double. Nowadays electric car can travel longer distance and their price is reasonable compare to price of conventional car. Everyone can easily buy electric car. Electric car has zero emission so it good for an environment but if you think more closely where emission from electric transfer to. The answer is emission transfer to the power plant that generates electric power for electric car. So, if we compare the emission from electric car to conventional car we have to compare from well-to-wheel process. Well-to-wheel is like you calculate the emission from the beginning of the resource through the process until it transfers to electric power for electric car and gasoline for conventional car.

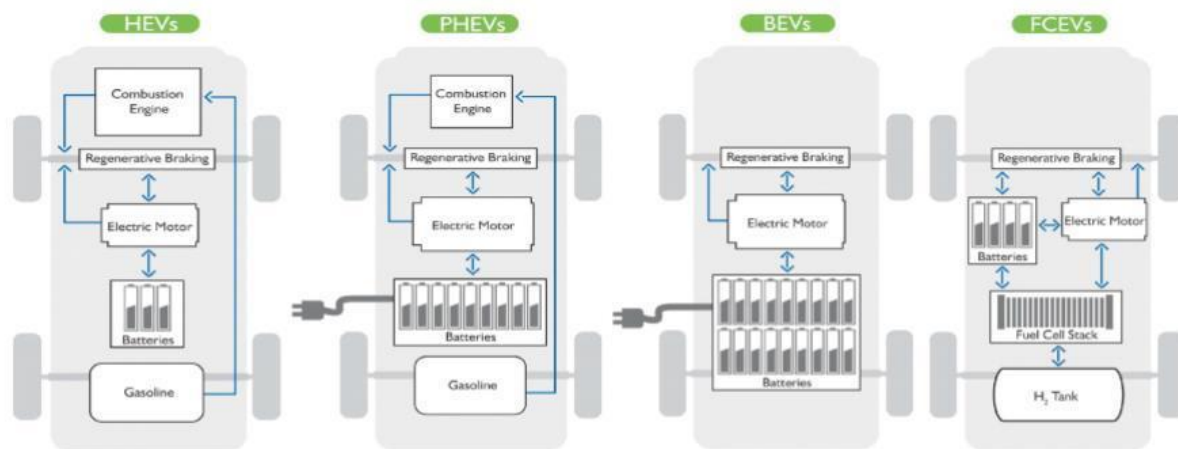
In Thailand, from Laoonual (2013) said that 89% of population are using conventional car while hybrid and electric car are less than 1%. Electric car is still in experiment process by PTT Public Company Limited and Metropolitan Electricity Authority (MEA). They try to study about possibility to introduce electric car for Thai people daily use by setting electric car charging in Bangkok. This is a good signal for Thai people to use more electric car which can reduce CO₂ emission instead of conventional car. But if we look at the power plant in Thailand that generates electric power for Thai people, we need to consider more because most of the power plants use non-renewable resource to generate electric power like Natural gas and coal. Together government and company can corporate to change the country to use more renewable energy not only to gain the maximum benefit from electric car but also prepare for non-renewable energy that will run out in next 20-30 years.

This research would be focused on electric car possibility in Thailand that will it worth or not to introduce electric car to Thai people. We compare electric car to conventional car by comparing CO₂ emission. The study will represent the possibility and the future of electric car. Moreover, it might let the government know their way to make electric car more efficiency and their plan to make our country to use more green energy than before.

Literature Review:

Greenhouse effect is the major problem in our world. Greenhouse gases trap the heat from the sunlight and make our world warmer. This is bad for our world. Carbon dioxide (CO₂) is one of the major greenhouse gases that make greenhouse effect. Human make CO₂ in many way for example in industrial sector, transportation sector, and electricity sector. In transportation sector, car that we drive is the major generate CO₂ emission. In electricity sector, power plants in our world are using a lot of non-renewable resource for example coal, petroleum, and natural gas to generate electric power which also the major generate CO₂ emission. We can decrease CO₂ emission for these two sectors in many ways like change to drive an electric car that generate zero CO₂ emission or use renewable resource for an example biofuel, biomass, geothermal, hydropower, solar energy, tidal power, wave power, and wind power to generate electric power.

From King Mongkut's University of Technology Thonburi and Nation Metal and Materials Technology Center (2011) there are many types of electric car for example:



HEV = Hybrid electric vehicle PHEV = Plug-in hybrid electric vehicle BEV = Battery electric vehicle FCEV = Fuel cell electric vehicle

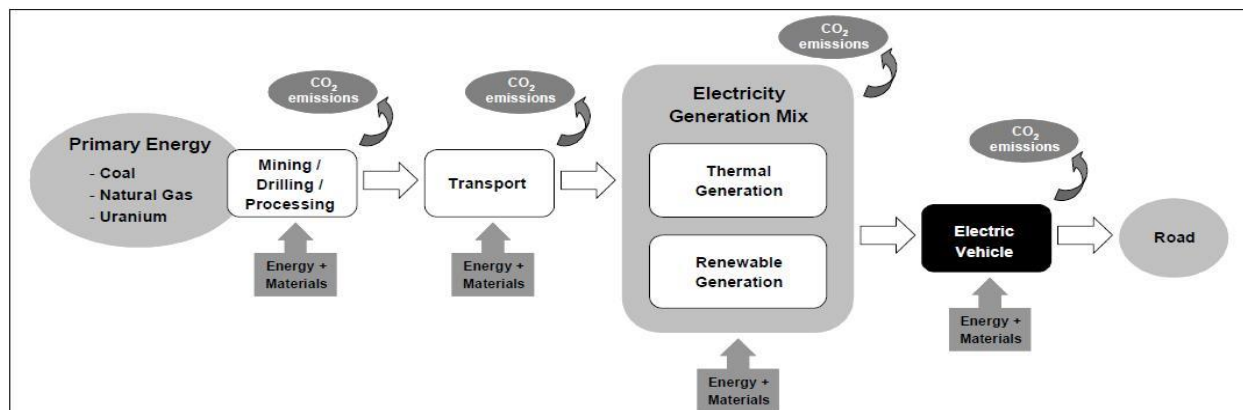
Hybrid electric vehicle (HEV), Plug-in hybrid electric vehicle (PHEV), Battery electric vehicle (BEV), and Fuel cell electric vehicle (FCEV). In our study we select only Battery electric vehicle because it not use gasoline to run the vehicle while other type of vehicle like Hybrid electric vehicle and Plug-in hybrid electric vehicle use electric power combine with gasoline to run the vehicle. For the Fuel cell electric vehicle, it use hydrogen as a resource to run the motor which generate electric power for the vehicle so it hard to find hydrogen station for now. BEV is more

popular, it use electric power store in battery to run the motor that make vehicle run and when it run out of electric power, it can charge from charging station. BEV can travel about 160 KM, if it was fully charge. Conventional car can travel about 400-500 Km, if it was fully tank. It is hard for BEV to compete with conventional car about the range but BEV still have positive side like it use electric power which has zero CO₂ emission, it reduce traffic noise and price of electric power is very cheap compare to price of gasoline for conventional car.

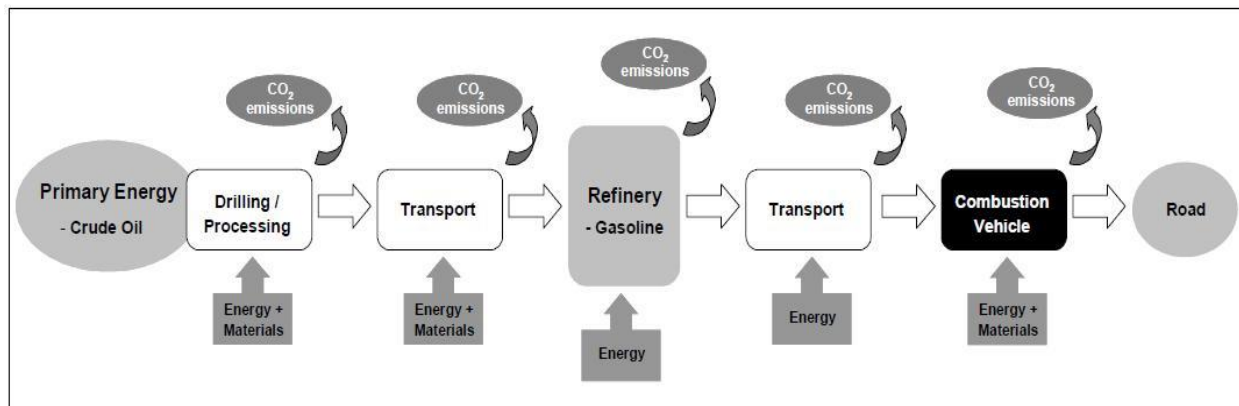
If we compare Electric car to Conventional car you will see that conventional car has more emission than electric car because it use gasoline to run an engine while electric car use only electric power. We are now know that electric car is better than conventional car but why electric car still not popular. Because electric car has a limited distance to travel and when it run out of electric power, it has to find charging station to charge so it can use only in the urban area where charging station located (Lee, H., and Lovellette, G.,2011) .

Faias, Sousa, Xavier, and Ferreira (2009) have compared the conventional car and electric car by using Portuguese statistic. They test CO₂ emission through Well-to-wheel analysis. Well-to-wheel is the specific Life Cycle Assessment (LCA) used for car. The analysis will tell each step of the energy transfer from the beginning like power plant generate electric power transfer to electric car and crude oil transfer to generate gasoline for conventional car. Each step will have CO₂ emission from the process.

For electric car Life Cycle Assessment



For conventional car Life Cycle Assessment



The result from the test is electric car can reduce the consumption only 38% compare to conventional car because Portuguese power plant use a lot of non-renewable energy to generate electric power. The result may be difference if it test on the countries that have a lot of renewable power plant.

Electric car has zero emission but how about their electric power where does an electric power come from. Electric car seem to have zero emission but it transfer emission to the power plant. Davis (2011) also said that “CO₂ emission of electric car depends on power plant of each country that generates electric power”. If electric car is used by Chinese driver, it may has CO₂ emission than conventional car because Chinese power plant are coal fired which make the most CO₂ in every power plant type. Electric car must drive in the country that have clean energy power plant.

In Wilson (2013) research the countries with coal-fired power plant supplies electric cars generate CO₂ emissions four times more than countries with low-carbon power plant. The different between electric car and conventional car will be indifferent if electric car is drive in the country that coal-fired power plant dominate. So to maximize efficiency from electric car that can reduce CO₂, electric car must use together with low-carbon power plant.

Kliesch (2011) article has argued that the cleanest type of electric power is generated from renewable energy. While natural gas power plant is in the middle and coal-fired power plant has the highest CO₂ emission. If we compare the electric car to conventional car, electric car can stored about 75% of the chemical energy to generate mechanical energy that run the car but conventional car can stored only 20%. From the comparison we all know that electric car is

more efficient than conventional car and if electric power came from the renewable source, the future of electric car will be brighter.

From all of the literature, they all argue the same way that electric car has not zero emission because it transfers emission to power plant. Even if conventional car has more CO₂ emission than electric car, electric car with electric power came from non-renewable resource may have more CO₂ emission than conventional car. If you want electric car to be more efficient and can really reduce CO₂ for real, electric car must use electric power from renewable energy resource power plant.

CO₂ emission also has a good side for some country that use less of CO₂ emission. Every countries or companies have a limited emission that can produce according to the regulation and CO₂ emission is the only one greenhouse gas that can trade. So, countries or companies that use less of CO₂ emission can trade the permit to the countries that want to use more CO₂ emission (Barnsley, I.,2008). If our countries use more, we have to pay more. This encourages everyone to reduce CO₂ emission.

For Thailand, numbers of the electric car registration in 2013 are about 0.001% of all type of car (Laoonual, Y., 2013). In the future Thailand electric car will be more support from the government like in National Industrial Development Master Plan 2012-2031 by Ministry of Industry (2013) said that automotive industry will improve by

1. Increase more skill labor in order to support new technology
2. Develop product and production to compete with other countries and rely on technology in the country more than before for example 2.1 Build and export hybrid car part like charger system, battery, and charging station 2.2 Attract more Auto part maker from other countries for pass on knowledge to our Auto part maker 2.3 build the security and environment standard equal to European countries 2.4 prepare for Fuel Cell innovation in next 20 years
3. Connect each industry and build stability to raw material in order to support automobile industry expansion
4. Improve structure to support entrepreneur in Thailand to compete with other countries.

If we can follow the plan that we target, Thailand will be the center of Asia Pacific to produce electric car and electric car part. Also Thailand has new Tax scheme based on CO₂ emission. This new scheme will introduce in 2016 and will tax the car from CO₂ emission that car produce. It is good for Thai people because we can buy low CO₂ emission car in cheap price and urge people in Thailand to realize the problem from CO₂ emission.

Type	Current scheme						New scheme (To be effective on 1 st January 2016)					
	Engine size (<220HP)	Gasoline Gasohol (E10)	E20	E85	NGV	HEV, PHEV, BEV, FCEV	Engine size	CO ₂	E0 – E20	E85, NGV	HEV	PHEV, BEV, FCEV
Passenger cars	< 2,000 cc.	30%	25%	22%	20%	10%	< 3,000 cc.	< 100 g/km			10%	10%
	2,001 – 2,500 cc.	35%	30%	27%	20%			101-150 g/km	30%	25%	20%	
	2,501 – 3000 cc.	40%	35%	32%	20%			151 – 200 g/km	35%	30%	25%	
								> 200 g/km	40%	35%	30%	
	> 3,000 cc. or 220 HP	50%	50%	50%	50%		> 3,000 cc.		50%	50%	50%	
Eco-car	Gasoline < 1,300 cc.	17%					Gasoline < 1,300 cc.	< 100 g/km	14% (12% for E85)			
	Diesel < 1,400 cc.						Diesel < 1,400 cc.	101 - 120 g/km	17%			

In term of Thailand power plant, from Energy statistics of Thailand by Ministry of Energy (2013) power plants in Thailand are use Natural gas 67%, Coal lignite 20%, import 6%, Hydro 5% and Renewable for only 1%. Thailand rely on non-renewable power plant a lot, we use a little of renewable energy. If we look at the CO₂ emission data in Thailand, power generation sector has CO₂ emission about 40% while transportation and industry sector have 26% and 25% respectively. From the Thailand Power Development Plan 2010-2030 by Ministry of Energy (2012) things may be different if we can follow the plan.

1. By the end of 2030, we reducing 25% of energy demand by energy saving programs and energy efficiency promotion.
2. By the end of 2021, we will use renewable energy and alternative energy about 25% instead of non-renewable energy by replacing the non-renewable power plants to renewable power plants like solar power, wind power, hydro power, biomass, biogas, and municipal solid waste

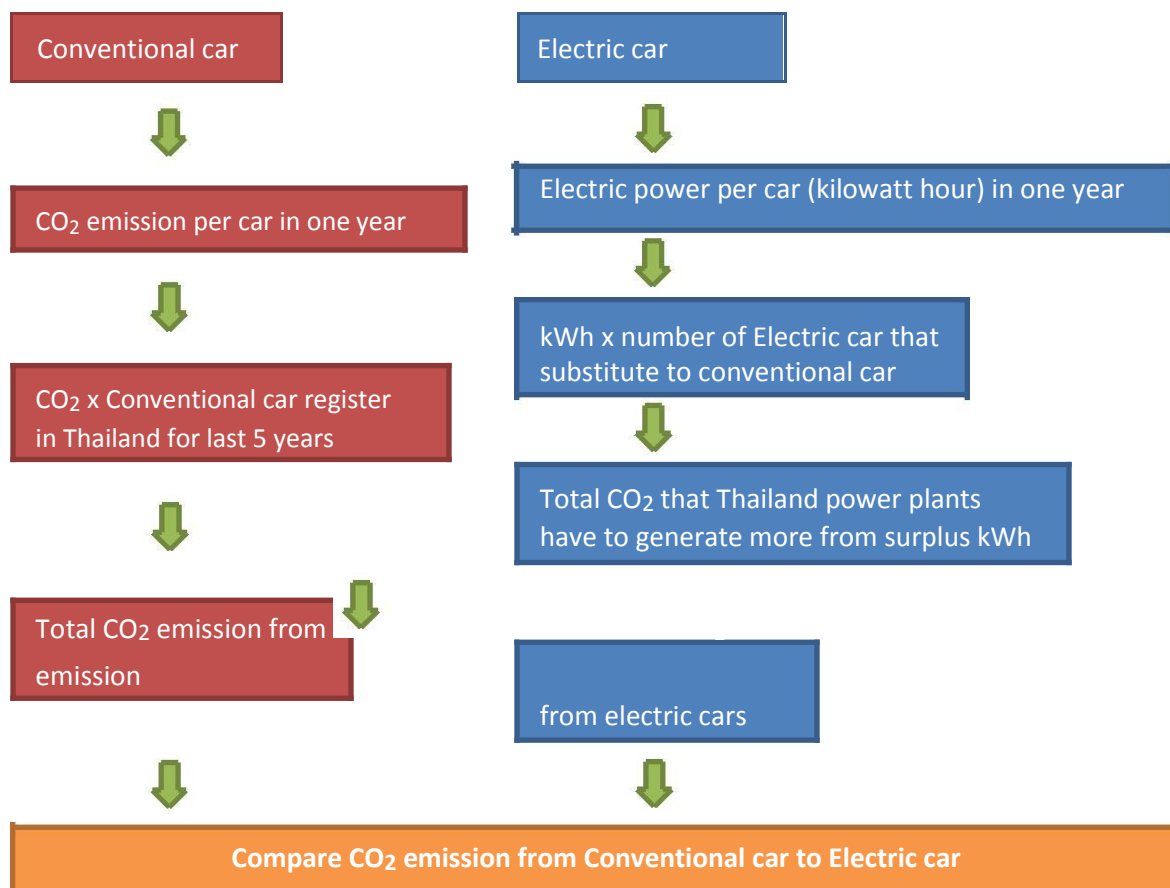
Following the Thailand Power Development Plan will make CO₂ emission decrease from decreasing non-renewable power plant and Thai people will use electric car with less CO₂ emission following well-to-wheel approach.

Methodology:

In this research we can use the secondary data from fact sheet in the internet. The data contain about number of registered conventional car in past 5 years, electric power that electric car use, and CO₂ emission from power plant in Thailand. We assume that we can change all conventional cars registration into electric cars. We compare CO₂ emission from conventional car to CO₂ emission which electric car transfer to power plant. Which type of cars have CO₂ emission more and what benefit we can use from this if we change to use electric car instead of conventional car?

How can we calculate and compare CO₂ emission from conventional car and electric car?

Overview



Conventional car

First get the number of all conventional cars that we want to calculate from 2009-2013 Thailand registered passenger cars by choosing 5 years range because after 5 years car will be more pollute than it used to be or produce more CO₂ emission more than manufacturer claim. Year 2014 registered cars will be not count in this calculation because 2014 is not end yet and the number of registered cars is still counting.

Table 1. Number of registered car from 2009-2013

Year	2009	2010	2011	2012	2013
Registered passenger conventional cars	293,560	444,156	517,454	872,121	908,390
				Total	3,035,681

Second, finding the average CO₂ emission from Conventional car that sale in Thailand by ranking the 2013 sale volume of each car brand and times with CO₂ emissions performance of each car manufacturers to get the average CO₂ emission (European Environment Agency., 2012).

Table 2. Average CO₂ emission from 1 Conventional car

Brand	Sale Total (2013)	Market share	Average CO ₂ emission per manufacturer (g/km)	Average CO ₂ emission x Market share (g/km)
Toyota	445,074	34.10%	104	35.46
Honda	213,155	16.33%	121	19.76
Isuzu	206,233	15.80%	220	34.76
Mitsubishi	104,687	8.02%	122	9.78
Nissan	98,187	7.52%	122	9.18
Chevrolet	56,389	4.32%	134	5.79
Mazda	52,914	4.05%	128	5.19
Ford	51,223	3.92%	116	4.55
Suzuki	45,292	3.47%	131	4.55
Benz	10,217	0.78%	124	0.97
BMW	8,240	0.63%	124	0.78
Hyundai	4,123	0.32%	118	0.37
Tata	2,893	0.22%	134	0.30
Subaru	2,822	0.22%	183	0.40
Volvo	2,717	0.21%	121	0.25
Volkswagen	594	0.05%	119	0.05

KIA	547	0.04%	129	0.05
Total	1,305,307	100.00%	2250	132.19

In calculation

1. Total registered conventional car in Thailand 3,035,681 cars
2. Average CO₂ emission from conventional car 132.19 g/km
3. Assume that Thailand people is driving a car about 20,000 kilometers in 1 year Table 3. Total CO₂ emission that all conventional cars produce

Total Conventional car	Average CO ₂ emission (g/km)	Average CO ₂ emission per 20,000 km (g)	Total car x Average CO ₂ emission per 20,000km (g)
3,035,681	132.19	2,643,896.85	8,026,027,421,362.13

Electric car

At first, finding the average of electric power that 1 electric car use. Calculation all of electric car models that sell in the market and find their range and battery size. The range and battery size are used to calculate for electric power use per kilometer. Lastly as we assume that Thai people is driving 20,000 kilometers in 1 year therefore estimate the electric power use per 20,000 kilometers.

Table 4. Electric power of all electric car models (12 models) use in 20,000 kilometer

Model	Range	Battery size (kW)	Electric power use per km (kWh)	Electric power use per 20,000 Km (kWh)
BMW i3	130	22	0.169230769	3,384.62
Chevrolet Spark EV	130	19	0.146153846	2,923.08
Ford Focus electric	120	23	0.191666667	3,833.33
Fiat 500E	140	24	0.171428571	3,428.57
Kia Soul EV	148	27	0.182432432	3,648.65
Mitsubishi I-miev	100	16	0.16	3,200.00
Mercedes B-Class Electric Drive	136	28	0.205882353	4,117.65
Nissan Leaf	135	24	0.177777778	3,555.56
Smart electric drive	108	17	0.157407407	3,148.15
Tesla Model S	425	85	0.2	4,000.00

Tesla Model X	368	85	0.230978261	4,619.57
Volkswagen E-Golf	133	24	0.180451128	3,609.02
			Total	43,468.18

To find the average electric power use per electric car by divided total electric power that all of electric car models use with the number of electric car model that sell in the market (43,468.18/12). The average electric power was for one electric car. The total amount of electric power for electric car has been derived by multiplying the number of 5 years registered passenger conventional cars with the average electric power use per 1 electric car (3,035,681 x 3,622.35).

Table 5. Total electric power for electric car

Total Average	3,622.35 kWh
Substitute electric car to conventional car	10,996,295,087.17 kWh

CO₂ emission from conventional car cannot compare to electric power from electric car. So, electric power (kilowatt hour) must be converted into CO₂ emission by calculate from power plants that generate electric power for electric car.

Table 6. Characteristic of power plant in Thailand

Thailand power plant	Power generation (GW)	Market share
Hydro Electricity	5,412	3.10%
Fuel Oil	1,238	0.70%
Coal & Lignite	35,257	19.90%
Natural Gas	119,313	67.30%
Diesel	179	0.10%
Imported	12,572	7.00%
Others	3,427	1.90%

In Thailand, government provides only Fuel Oil, Coal & Lignite, and Natural Gas power plant CO₂ emission data. Finding other type of power plant CO₂ emission data from other resource like Hydro Electricity power plant produces 4 g/kWh. For Diesel power plant, we assume that it has CO₂ emission g/kWh equal to Fuel Oil power plant. For imported and others power plant, Thailand has mainly imported electric power from Laos and Myanmar. The electric power from those countries is mostly produced from Coal & Lignite and Hydro Electricity power plant. Eventually, It would be the worst-case scenario by all Imported and others power plant that have CO₂ emission g/kWh equals to Coal & Lignite power plant. Therefore, we can acknowledge CO₂ emission g/kWh from each type of power plants in Thailand.

Table 7. CO₂ emission from each power plant in Thailand

Thailand power plant	2013 Electric power generation (GWh)	1 GWh = 1,000,000 kWh	CO ₂ emission (Tons)	1 Tons = 1,000,000 grams	Total CO ₂ emission (g/kWh)
Hydro Electricity	5,412	5,412,000,000	-	-	4
Fuel Oil	1,238	1,238,000,000	1,288,350	1,288,350,000,000	1,040.67
Coal & Lignite	35,257	35,257,000,000	37,573,060	37,573,060,000,000	1,065.69
Natural Gas	119,313	119,313,000,000	57,284,490	57,284,490,000,000	480.12
Diesel	179	179,000,000	-	-	1,040.67
Imported	12,572	12,572,000,000	-	-	1,065.69
Others	3,427	3,427,000,000	-	-	1,065.69

In Calculation

1. Total electric power for electric cars 10,996,295,087.17 kilowatt hour
2. Total Co₂ emission g/kWh from each type of Thailand power plants

Table 8. Total CO₂ emission that all electric cars produce

Thailand power plant	Market share	Electric power for electric car (Market share x 10,996,295,087.17 kWh)	Total CO ₂ emission (g/kW)	CO ₂ emission from each type of electric power plant (g)
Hydro Electricity	3.10%	340,885,147.70	4	1,363,540,590.81
Fuel Oil	0.70%	76,974,065.61	1,040.67	80,104,634,433.67
Coal & Lignite	19.90%	2,188,262,722.35	1,065.69	2,332,011,417,945.40
Natural Gas	67.30%	7,400,506,593.67	480.12	3,553,127,035,274.95
Diesel	0.10%	10,996,295.09	1,040.67	11,443,514,408.37
Imported	7.00%	769,740,656.10	1,065.69	820,304,919,801.23

Others	1.90%	208,929,606.66	1,065.69	222,654,192,517.48
			Total CO ₂ emission from electric cars	7,021,009,254,971.91

From table 3. and table 8. Conventional cars produce 8,026,027,421,362.13 g of CO₂ emission and Electric cars produce 7,021,009,254,971.91 g of CO₂ emission. To decide whether Thai people should change to drive electric car instead of conventional car or not? By comparing CO₂ from two types of car to get the result.

Table 9. Compare CO₂ emission from conventional car to electric car.

Emission from conventional car	8,026,027,421,362.13 g
Emission from electric car	7,021,010,027,837.94 g
Total surplus CO ₂	1,005,017,393,524.18 g
	1,005,017.39 tons

Result:

From 3,035,681 conventional cars that change to electric cars. Electric cars have produced less CO₂ emission than conventional cars about 1 million tons. Therefore, we have surplus CO₂ emission about 1 million tons.

What can we do for the surplus CO₂ emission?

The price of carbon credit in the market is about 7 euro per tons or 280 baht per tons. If we can sell all of the surplus CO₂ emission that we got from not using conventional cars, we can earn more about 280,000,000 million baht. We can use this surplus money in many ways for example to build more electric charging station or to support more green energy project in the future.

In reality, 280,000,000 baht may not be worth for Thai people to change from conventional cars to electric cars. Price of electric charging station is about 600,000 - 1,000,000 baht per station. If we use all of the money to build more electric charging station, we can build more 280 stations. Comparing to the gas station in Thailand that have 23,478 stations, more 280 electric charging stations may not enough to recharge more 3,035,681 electric cars.

Table 10. Compare new electric cars to electric charging stations

	Gas station in Thailand	New electric charging station
	23,478 stations	280 stations
1 station has responsible for	129 cars	10,842 cars

For gas station, 1 gas station has responsible to add fuel for 3,035,681 about 129 cars. For electric charging station, 1 electric charging station has responsible to charge for new 3,035,681 cars about 10,842 cars and to charge 1 electric car it take about 30 minute. Therefore, more 280 electric charging stations will not be enough to charge all new electric cars.

Conclusion:

From the calculated research carried out it can be seen that power plants in Thailand have to produce more CO₂ emission about 7 million tons to power up all electric cars to run 20,000 kilometers in 1 year. For conventional cars, they produce CO₂ emission about 8 million tons. Therefore, If Thai people change to drive electric car, electric car can reduce CO₂ emission from not driving conventional car about 1 million tons of CO₂ emission. It is hard to find more information to calculate more precisely by limiting of time. However, changing one factor might affect the outcome. In reality it is difficult to change to drive electric car immediately because we have to consider a lot of factor. The electric charging station is the main factor because we have only 16 stations now in Bangkok and to charge 1 electric car it use 15 minute or more (Laoonual, Y.,2013). Another factor is the price of electric car which is higher than the conventional car. In the future, emerging power plants in Thailand might consume more renewable energy, electric car is expected to sold at cheaper price with longer driving range, conventional car might produce less CO₂ emission. With the government new excise tax scheme based on CO₂ emission, the results might change but one thing that we can assure is the success of electric car in approaching future in Thailand

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