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Directions and Prospects for the Development of the Electric Car Market in Selected ASEAN Countries

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Abstract: The purpose of this article is to present the current situation and evaluate the opportunities for the development of the electric car market in selected Southeast Asian countries in the context of the current situation in the rest of the world. Currently, the electric car market is at an advanced stage of development in regions such as Western Europe, the USA, and China. It should be noted, however, that the number of electric cars in a given country results not only from market demand and access to vehicle charging networks but also from nonmarket mechanisms such as subsidies and tax or administrative solutions. It turns out that these are important elements that influence the final shape of a country's market. This article analyses the current situation on the electric car market taking into account the legal, administrative, and tax conditions that affect the final number of vehicles and the infrastructure necessary for the operation and use of electric cars in selected Asian countries.

Keywords: electric cars; Asia; ASEAN; tax incentives; development forecasts

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1. Introduction

Despite the negative impact of the COVID-19 pandemic on many spheres of daily economic life, electric car sales and the construction of infrastructure for their charging and use are accelerating worldwide. Around the world, governments and representatives of vehicle manufacturers alike are recognising that the transition to electric vehicles can be an opportunity to simultaneously pursue two fundamental, often mutually exclusive, goals, namely economic growth and sustainable development that address issues related to the reduction in negative environmental impact [1].

In Southeast Asia, as in other regions, the benefits of vehicle electrification are tangible and widespread. In addition to favourable regulations, governments desire to fulfil obligations regarding the changes in climate, reduction in pollution (including air), and visible improvement of energy supply security. It should also be noted that the Asian market offers many possibilities due to the presence of well-established automotive manufacturing centres in countries such as Korea, Japan, Indonesia, and Thailand [2].

This article attempts to analyse the current market situation in selected Asian countries and presents potential directions of development. Furthermore, this article presents the benefits of transition to electric cars [3]. When exploring electric vehicles, it is important to consider how to deal with the growing global demand for vehicles and, thus, fuel consumption and air pollution, as well as emission of greenhouse gases and other harmful substances such as particulate matter (PM), nitrogen oxide (NO_x) and sulphur oxide (SO_x) in some urban areas. Gradually deployed EV technology can ultimately lead to improved energy efficiency and positively impact the environment and human health [4].

However, it should be clearly indicated that the source of electricity generation is the most important factor for electric vehicle policy, and in some cases BEV production may emit more CO_2 than conventional vehicles [5]. For example, a joint research project between Mazda and Kogakuin University estimated the CO_2 emission of conventional and electric vehicles in Japan, China, Australia, Europe, and the USA [6]. The results of the study showed that BEVs in Australia do not emit less CO_2 than conventional vehicles due to the country's heavy reliance on fossil fuels for electricity generation. In Japan, China, Europe, and the USA, some conventional vehicles, under certain conditions, generated less CO_2 than BEVs. Thus, the implementation of electric vehicle development policy must be comprehensive, taking into account a number of economic, environmental, technological, and administrative and legal factors [7].

The article is an innovative attempt to analyse, evaluate, and present possible prospects for the development of the electric vehicle market of the ASEAN group of countries from various perspectives (regulations, consumer approach, infrastructure challenges, etc.). Although these countries are relatively rich and developed, they remain, at least in the electric car market, overshadowed by China, which has quickly become not only a local but also a global leader in this industry.

It is worth noting that China, Korea, and Japan have recently announced a number of targets for the decarbonisation and complete elimination of conventionally powered vehicles in the upcoming decades. Other countries in the region, including in particular ASEAN countries, are expected to make similar decisions. This, in turn, will mean a rapidly progressing revolution both in the overall industry and in other sectors of the economy, including an important branch—transport.

Changes, apart from the progressive decisions of individual governments, will also be forced by global decisions made at cyclical climate conferences, which define various goals. ASEAN, which is an organization of economic and political cooperation between 10 countries, can be expected to take coordinated actions, such as those undertaken in Europe by the European Union, imposing specific and ambitious climate goals on individual members within the electric car industry.

The article presents collective data from specialist studies, reports, and analyses. The study was supplemented with an analysis of the literature using the methods of deduction and inference as well as a data analysis comparison method. The article combines the use of scientific methods with quantitative data from industry reports.

Prior to analysing the situation of electric vehicles, including data on the volume of sales and the structure of the electric car market, as well as legal and administrative conditions for the operation of infrastructure related to electric vehicles, first of all, it is important to draw attention to the definition of an electric car [8]. This is because different agencies and research institutes define this concept differently [9]. With the above in mind, it should be acknowledged that among the cars that today are, in principle, considered to be electric cars, three basic types of vehicles can be distinguished. These include the following types of vehicles [10]:

- BEV (Battery Electric Vehicle)—an all-electric vehicle with an installed battery, which is the sole source of power;
- PHEV (Plug-in Hybrid Electric Vehicle)—a hybrid vehicle (i.e., with a gasoline internal combustion engine and an electric motor) with the possibility to recharge electricity from the grid;
- FCEV—Fuel Cell Electric Vehicles—cars powered by hydrogen fuel cells. Such cars, similar to BEVs, use an electric motor, but they acquire energy in a completely different way. Instead of charging a battery, the FCEV stores hydrogen gas in a tank. The fuel cell in the FCEV combines hydrogen with oxygen from the air. The energy created as a result of this reaction reaches an electric motor that powers the vehicle as is the case in BEVs; and

- HEV Hybrid Electric Vehicle)—a hybrid vehicle without the ability to recharge electricity from the grid (electricity is generated by installing a traditional internal combustion engine in the vehicle).

The HEV group does not allow the car to be recharged from an external source (the primary driving motor is the combustion engine, while the electric motor is only a supporting unit—the energy to power it is acquired from the vehicle's braking—so-called hybrid vehicles) [11]. For the purpose of this article, the authors only considered the first three types of vehicles, i.e., BEVs, PHEVs, and FCEVs. However, it is worth noting that the production and sales of FCEVs is very small, and often the number of these vehicles is not even included in official statistics (Figure 1).

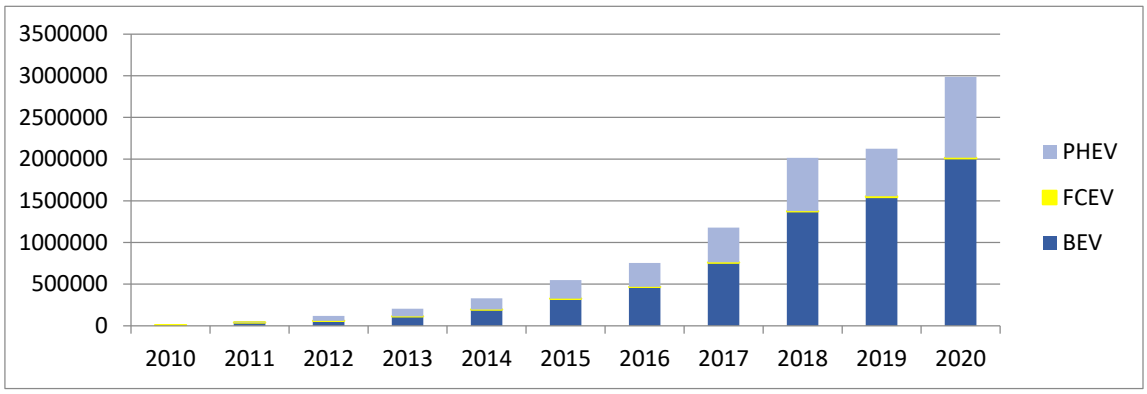

Figure 1. PHEV, BEV, and FCEV sales cars worldwide, 2010–2020. Source: https://www.iea.org/articles/global-ev-data-explorer (accessed on 10 October 2021).

2. Current Situation in Global Markets

According to data from the International Energy Agency (IEA), sales of various electric vehicles amounted to three million in 2020. Currently, China has the largest electric vehicle market, boasting 1.29 million EVs sold in 2020, which is an 8.3% year-over-year increase and constitutes as much as 40.5% of global sales in 2020 (Figure 2) [12].

By the end of 2020, a total of 10 million electric cars had been registered worldwide. In 2020, electric car registrations increased by 41%, despite a pandemic-related worldwide decline in car sales, which saw global car sales drop by 16% [2].

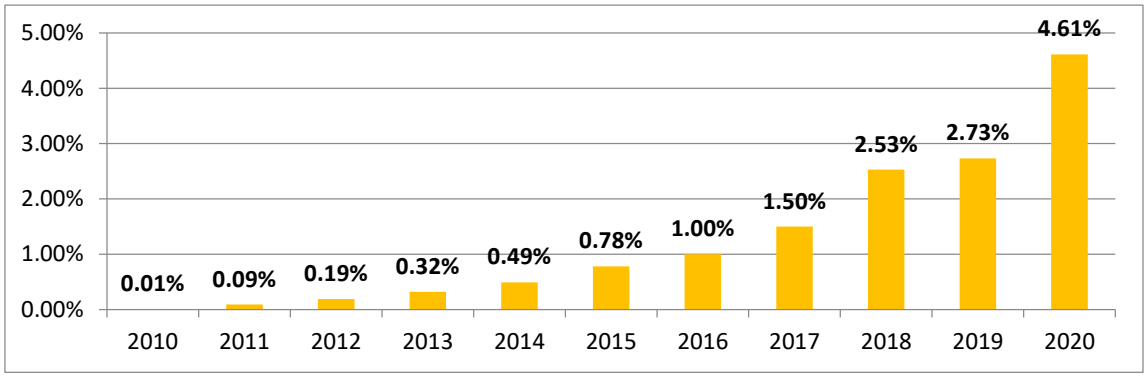

Figure 2. EV sales' share among cars worldwide, 2010–2020. Source: https://www.iea.org/articles/global-ev-data-explorer (accessed on 10 October 2021).

It should be noted that in 2020 electric cars were reported to account for 4.61% of total passenger car sales globally. This was, however, mainly thanks to the European market (in Europe, the share of electric vehicles in new car sales in 2020 was 10%); in Norway the share in vehicle sales reached a record value of 75%, that is about 30% more than in 2019 [13]. High shares of electric car sales were also recorded in Iceland (50%), Sweden (30%) and the Netherlands (25%) (Figure 3) [2].

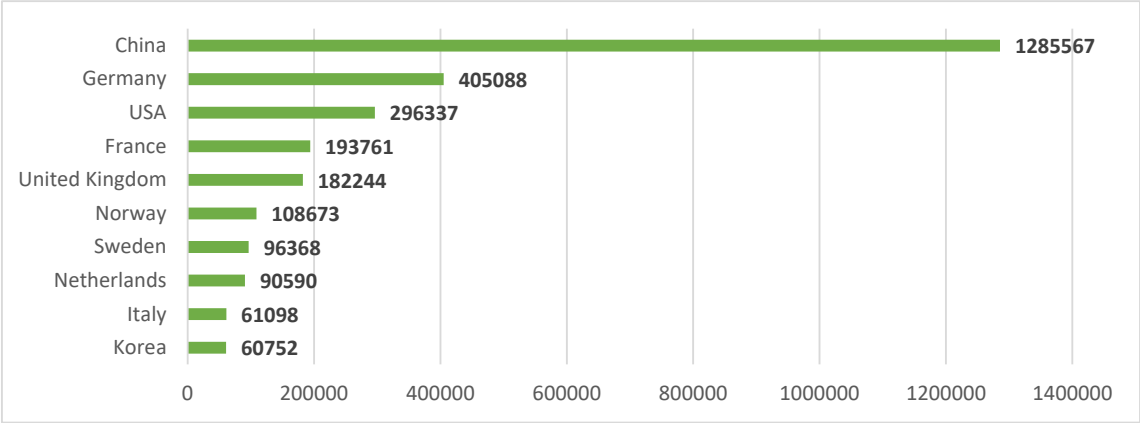

Figure 3. Top ten markets for electric vehicles by unit sales in 2020. Source: https://www.iea.org/articles/global-ev-data-explorer (accessed on 10 October 2021).

Outside China, it is Europe and the USA that account for the largest sales volume. Among the top 10 electric car consuming countries in 2020, there was only one Asian country, i.e., South Korea. Interestingly, in 2020, the European conventional vehicle market saw sales decline by 22%. Yet electric car registrations more than doubled to 1.4 million. This means that the electric car market was clearly immune to the negative effects of the COVID-19 pandemic. Currently, the highest sales volume in Europe was recorded in countries such as Germany, France, Great Britain, and Norway. For years, Norway had occupied first place; however, due to the rapid increase in the number of electric vehicles in the country in recent years, the Norwegian market has saturated and demand has decreased (Figure 4) [2,13].

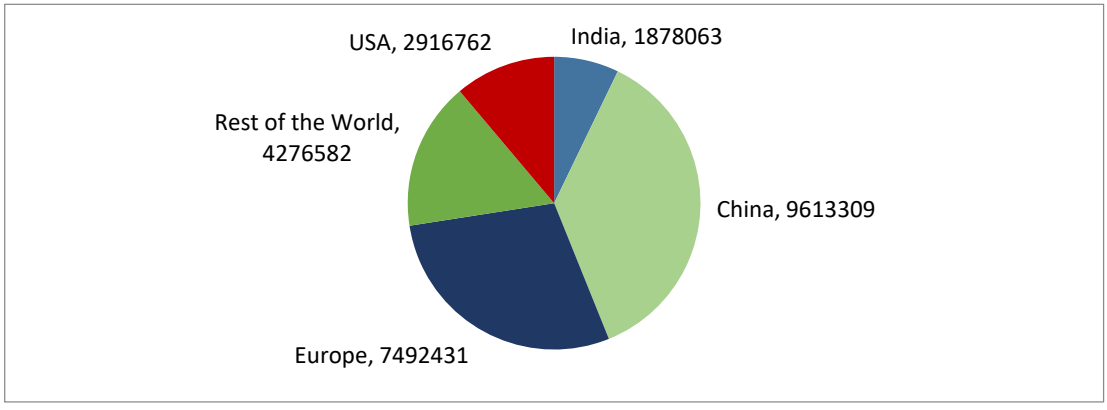

Figure 4. Global electric vehicle sales: market share in 2030 (forecast). Source: https://www.ubs.com/global/en/asset-management/insights/emerging-markets/2021/electric-vehicles-asia-investing.html (accessed on 10 October 2021).

China is projected to become the worldwide largest electric vehicle market by 2030, based on IEA forecasts of annual sales of 9.61 million of EV. It should be noted that the forecasts do not cover regions such as South America, Africa, and other Asian countries (Figure 5) [14].

It should also be emphasised that electric vehicle sales continue to grow even in the face of the pandemic due to three key factors [15–17]:

1. Support in the form of legal and administrative regulations—many countries are increasing the environmental requirements for new vehicles sold, which naturally promotes low-emission vehicles. Further, in 2020, more than 40 countries (including EU countries) announced that they would soon introduce a policy to phase out vehicles with conventional engines, up to and including a complete ban on their sale (it is forecasted that by 2035, the two key markets of China and Europe will be affected by this ban).
2. Additional tax incentives and direct subsidies to boost or maintain the levels of electric vehicle sales (some European countries have increased economic incentives; China, for example, has delayed withdrawing its subsidy programme).
3. Continuous increase in the number of EV models on offer, decrease in battery manufacturing costs (an important part of the total cost of a vehicle), increase in vehicle range, and increase in the number of publicly available chargers.

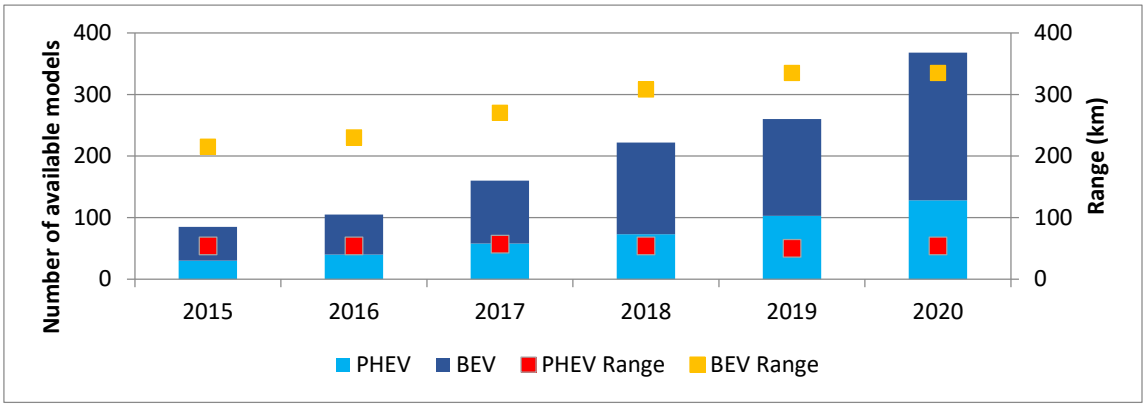

Figure 5. Electric car models available globally and average range, 2015–2020. Source: https://iea.blob.core.windows.net/assets/ed5f4484-f556-4110-8c5c-4ede8bcba637/GlobalEVOutlook2021.pdf (accessed on 10 October 2021).

Not without significance is the last abovementioned factor, namely the growing number of available models and increasing vehicle range [18]. Until a few years ago, the range of an electric vehicle (BEV) oscillated around 200 km, which made such a car unsuitable outside a city. Now that the average range of this type of vehicle has increased significantly, it positively affects decisions on the purchase of this type of car. In addition, potential buyers also have the option to choose from a growing number of models offered [19].

For the promotion of electric vehicle deployment policy, it is also important that these cars are considered environmentally-friendly. Below is a graph showing the overall environmental benefits of introducing electric cars.

It should be noted that with each passing year the amount of conventional fuel saved increases but so too does the demand for electricity needed to charge the cars. At this point, it should be stressed that for an electric car deployment policy to be considered ecological, it is also necessary to obtain electricity from renewable or low-emission energy sources. Otherwise, electric cars cannot be considered fully zero-emission and environmentally friendly (Figure 6) [20].

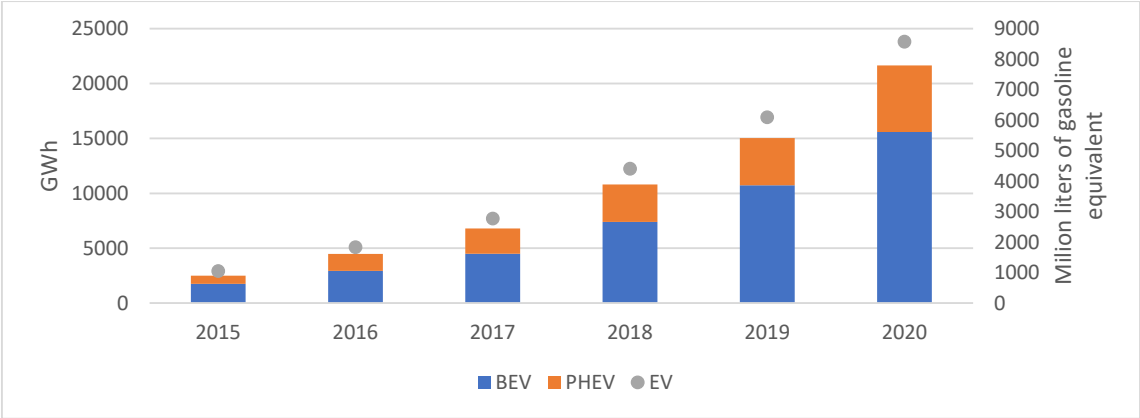

Figure 6. Electricity demand vs. oil displacement among cars, worldwide between 2015 and 2020. Source: https://www.iea.org/articles/global-ev-data-explorer (accessed on 10 October 2021).

3. Analysis of the Situation in Selected Southeast Asian Countries

As mentioned before, there are several key countries in the global electric car market at present. Some countries have achieved high sales volume through extensive policy to support vehicle purchase and maintenance (e.g., government subsidies, tax incentives, as well as participation in the construction and upkeep of a publicly accessible electric car charging infrastructure) [8]. It should be noted, however, that a number of countries are not even mentioned in multiple reports and statistics because of negligible or virtually nonexistent sales of electric vehicles (often not exceeding even a 0.1% share in total car sales) [21].

Currently and, as forecasts assume, also in the near future, China will remain the world leader in electric vehicle sales. In Asia, however, unlike in Europe, there are no strong international organizations that would firmly harmonize individual economic processes. Nevertheless, individual countries of Southeast Asia see both bottom-up and group processes for implementing policy to promote electric vehicles [22].

The largest organization of Southeast Asian countries is the Association of Southeast Asian Nations (ASEAN). Currently, the group comprises 10 countries—Philippines, Indonesia, Malaysia, Singapore, Thailand (founding members—1961), Brunei (since 8 January 1984), Vietnam (since 28 July 1995), Laos and Myanmar (since 23 July 1997), and Cambodia (since 30 April 1999) [23]. Interest in electric vehicles among the ASEAN countries is growing. However, there is a shortage of accurate statistics related to electric car sales [24]. According to the ASEAN Automotive Federation, a specialized agency that analyses the automotive market, in 2019, the total volume of electric vehicle sales in ASEAN member states was 3.4 million in 2019. However, this number includes HEVs, which are not analysed in this article. Some of the member states have attempted to define desired directions for the development of the electric car market. In the following discussion, the authors of this study present the current and planned achievements in the deployment of electric cars in selected ASEAN countries, as well as in some countries that have also prepared specific policies in this area [25].

When analysing the current situation of the electric vehicle market in selected ASEAN countries, it should be noted that, firstly, access to data is significantly limited, and secondly, market development is at a very early stage (Table 1).

Table 1. Sales volume in selected ASEAN countries and countries of the region.

Group	Country	2015	2016	2017	2018	2019	2020
PHEV	Japan	12,413	5365	31,504	19,761	14,965	11,315
EV		10,356	15,203	17,441	26,127	20,424	12,976
FCV		411	1055	849	575	644	717
PHEV	Korea	273	281	233	3434	2436	8548
EV		3025	5483	13,766	30,100	29,480	33,342
FCV		0	80	61	17	0	79
PHEV	Taiwan	0	0	0	0	0	0
EV		20	2	14	40	71	31
PHEV	Thailand	0	0	17	0	13	1
EV		0	0	0	0	126	1071
PHEV	Malaysia *	0	0	0	0	0	0
EV		11	95	0	0	0	0
PHEV	Indonesia	0	0	7	1	4	82
EV		0	0	0	0	0	5
PHEV	Philippines	0	0	12	3	19	21
EV		0	0	0	0	1	0
PHEV	Singapore						
EV		2	5	236	185	281	22
PHEV	India	0	0	0	0	0	0
EV		0	0	0	434	50	1148
PHEV	Australia	69	32	29	206	563	540
EV		286	134	120	202	675	830
PHEV	New Zealand	0	0	0	0	0	0
EV		21	24	244	254	802	593

* limited access to data from Malaysia, which may mean that it is not accurate between 2017 and 2020. Source: https://www.marklines.com/en/vehicle_sales/search_country/search/?searchID=1701312 (accessed on 4 November 2021).

As can be seen from the presented data, the highest sales have been recorded in countries such as Japan and Korea (and Thailand from ASEAN countries), the lowest in Philippines and Indonesia [26].

Due to limitations in access to data, the authors decided to present countries not belonging to the ASEAN group, such as India, New Zealand, Australia, and Japan, since these are countries from the same region characterized by a similar level of development. Therefore, comparisons can be made to a limited extent.

It is thus worth noting that ASEAN, as an organization promoting cooperation in the region, can build common policies for supporting and promoting the purchase of electric vehicles, taking advantage of the common competitive advantage and the synergy effect.

In addition, in most of the ASEAN countries, consumers tend to choose alternative versions of vehicles such as two-, and three-wheeled units that are not listed as a typical electric car (Table 2).

Table 2. GDP and GDP per capita in ASEAN countries in 2020.

	Country	Population in Million	GDP Nominal (Millions of USD)	GDP Nominal (per Capita USD)
1	Indonesia	272.270	1,158,783	4256
2	Thailand	69.947	538,735	7702
3	Philippines	110.432	402,638	3646
4	Malaysia	33.358	387,093	11,604
5	Singapore	5.840	374,394	64,103
6	Vietnam	98.328	354,868	3609
7	Myanmar	53.545	76,195	1423
8	Cambodia	15.836	27,239	1720
9	Laos	7.371	20,44	2773
10	Brunei	0.461	15,278	33,097
	ASEAN in total	667.393	3,355,655	4849

Source: World Economic Outlook database: April 2021, International Monetary Fund. https://www.imf.org/en/Publications/WEO/weo-database/2021/April/weo-report (accessed on 1 November 2021).

ASEAN countries have different levels of wealth, calculated as nominal GDP and GDP per capita. The level of the most important economic indicator characterizing the level of wealth of a country and its citizens has a significant impact on consumer decisions, including the decision to buy an electric vehicle, which is usually more expensive than a traditional vehicle. The fact that wealth is extremely differentiated in the analysed countries will also undoubtedly affect the tendency of individual consumers to purchase an electric vehicle. It should be assumed that in countries where GDP per capita is low (Cambodia, Myanmar, and Laos), the propensity to buy an electric vehicle will be much lower than in countries with high GDP per capita (Singapore, Brunei, and Malaysia). Such inference may be an oversimplification, and the decision to purchase an electric vehicle will be influenced by a number of other factors, which are analysed below [27].

3.1. Brunei

Currently, Brunei has a small fleet of electric vehicles. The latest available data show that in 2017 only 18 BEV units were registered in the country (the total number of cars in the country was about 300,000) [21].

Therefore, when comparing this data with the total number of vehicles, the share of electric vehicles in the overall automotive market is symbolic. Brunei has made an attempt to promote electric vehicles as a part of the Land Transport Master Plan (LTMP) of 2014 [28]. This strategy includes goals to be achieved by 2035.

Currently, a new policy of The Brunei Darussalam National Council on Climate has been introduced. This is the first comprehensive climate policy of the country. The main goal is to increase the share of electric cars to 60 percent of the total amount of vehicles, but a specific date was not mentioned in the strategy [29].

Brunei's electric vehicle policy can only change if the government of the country changes its energy policy, including electricity generation, and pursues renewable energy sources.

3.2. Indonesia

In Indonesia, attempts have been made to implement electric vehicle policies. In 2012, then President Yudhoyono was a supporter of the idea of a national electric vehicle to be developed by the national universities. The next president, Joko Widodo, also supports the introduction of electric cars in the country [21].

Indonesia is also postulating legal and tax advantages for EV buyers, e.g., reduced VAT, luxury vehicle and goods tax, and import duties. It should also be pointed out that

electric vehicles can be supported under the existing Low Carbon Energy Programme (LCEP) [30].

In 2019, President Widodo introduced a law on the promotion and support of electric vehicles. Competing with Thailand, Indonesia wants to establish an electric vehicle centre in the region by providing tax incentives and legal and administrative facilitation for potential HEV and PHEV manufacturers [31].

The Indonesian market focuses currently on the so-called electric two-wheeled units (mainly motorcycles) rather than on cars. There were nearly 16,000 such units in 2019.

It would be difficult for Indonesia to quickly increase the number of electric cars, as the charging infrastructure has only 20 charging station in the country—all of which are state-owned.

When analysing Indonesia's policy, it is important to acknowledge that the country has formulated a specific scope of action. Its potential has also been recognised by international automotive corporations such as BYD, Hyundai, JAC, and Toyota, which plan to start producing electric cars or components (batteries, motors) in the near future.

3.3. Malaysia

Compared with other countries of the region, Malaysia launched a policy to support the purchase and maintenance of electric vehicles early. Proposals to support this market were included back in 2009 as a part of the National Green Technology Policy.

The policy is based on four pillars that represent energy, environment, economy, and a social perspective. The strategy notes that the support for EVs is considered to be a part of a major transformation towards a sustainable economy and society [32]. The Malaysian government has adopted specific objectives, which covered, in particular, the construction of a charger network and the total number of electric vehicles in the country. However, the implementation of the assumed policy is at risk, as most of the goals have not been achieved so far, and the achievement of some of the goals (such as the vehicle fleet or the construction of a common charging network) has been postponed from 2020 to 2030 [33].

Currently in Malaysia there are 500 available charging points [34]. However the government has ambitious plans to install up to 25,000 public and 100,000 charging points by 2030 [35].

3.4. Philippines

In the Philippines, EVs have been supported by public policy since 2006. This could be characterized as very early in comparison to other countries of the region. The early regulations allowed duty-free import of EV components to encourage local manufacturing. While it would seem that the country would gain an early advantage in the region due to the rapid implementation of measures, this has not been the case. As the analysis shows, in 2006, the Philippines only granted benefits for suppliers, without addressing issues of demand or infrastructure. What is more, in 2014, further measures were implemented to support the production of electric vehicles. This strategy entitles investors to a six-year tax exemption, among other things.

However, this means that the country seeks foreign investment or public-private partnerships, rather than being interested in supporting domestic demand for the purchase and maintenance of electric vehicles. Indeed, it should be noted that currently the charging infrastructure is largely absent and the market itself should be described as undeveloped. Moreover, the experience so far does not give rise to optimism. For example, at the beginning of the decade, the government initiated a program to subsidize the purchase of three-wheeled EVs. The program was supported by the Asian Development Bank (ADB) and the World Bank's Clean Technology Fund, as well. It was assumed that, by the end of 2017, a fleet of 100,000 three-wheeled alternative fuel vehicles would be replaced with similar electric vehicles. However, the program was halted in 2016 after 3000 three-wheeled EVs were produced but did not attract drivers, because the initial costs and

maintenance proved too expensive for operators. Another major reason for the failure was the insufficient number of charging stations in the planned deployment areas in Manila.

Moreover, there is also a narrow selection of electric vehicles in the Philippines, as the country's existing electric vehicles have been distributed mainly by the Chinese manufacturer BYD. Thus, it should be pointed out that at this stage the Philippine government is mainly interested in attracting foreign investors willing to manufacture EVs and their components in the country, rather than in supporting local individual demand.

3.5. Singapore

Singapore adopted an electric car policy relatively late, i.e., 2021, with financial incentives mainly. However, in early 2010, the national Land Transport Authority (LTA) and the Energy Market Authority (EMA) initiated a series of tests and feasibility studies for specific scenarios [36]. However, apart from the abovementioned measures, so far no detailed strategy for electric car deployment has been defined [37].

According to LTA data, all electric vehicles constituted a fraction of the 930,000 vehicles in total (2018 data). In 2020, as few as 1125 electric vehicles were registered in the country. So, despite Singapore being one of the richest countries in terms of GDP per capita, still relatively expensive electric vehicles remain only a niche product [21].

The low share of PHEVs and BEVs in the EV fleet may be due to the low availability of common charging stations. Currently, there are 1800 publicly available charging points with ambitious plans to increase the number to 60,000 by 2030 [35].

Recently, the Singaporean government has implemented several measures that support the use of electric vehicles. The country's government allowed the French Bolloré20 Group to launch a car-sharing service. The service, called blueSG, debuted in December 2017 and aims to deliver 1000 BEVs. The French investor additionally decided to install 2000 charging points (divided into 500 charging stations) across the country by 2020, 400 of which should be available not solely to the company's customers [38].

In addition, LTA has begun to shift its public transport procurement policy to electric vehicles. LTA has purchased, inter alia, 50 hybrid buses and plans to acquire 60 BEV buses [39].

Further, the Singaporean government adopted legislation that increased the cost of purchasing cars with conventional engines through additional fiscal burdens. This has resulted in an increase in hybrid vehicle sales but has not directly translated into a rise in the number of electric vehicles in the country [40].

Meanwhile, the government in Singapore imposed a law to stop issuing new registrations for diesel cars from 2025 and announced that internal combustion cars will be withdrawn from the country by 2040 [38].

3.6. Thailand

Thailand is a significant car manufacturer—across the globe (according to the International Organization of Motor Vehicle Manufacturers—OICA [41]). Therefore, when constructing a policy for the deployment of electric cars, the country must pay attention to its own automotive market whilst also offering a number of amenities for potential buyers. First, Thailand has revised taxation in a way that makes electric vehicles more attractive to consumers (excise tax is no longer based on motor size but on CO_2 emission, which led to much lower taxes on electric cars and hybrids). In addition, and somewhat against protecting its national automotive market, Thailand has decided to abolish duty on all-electric vehicles imported from overseas [42].

However, it should be noted that a number of incentives have been created to encourage vehicle manufacturers in Thailand. Special administrative and tax facilitations are provided for manufacturers (exemption from corporate income tax for eight years with the possibility of extension for additional years if production scales up), but the potential investor must ensure the production of at least 100,000 vehicles or a certain number of other components (batteries or motors for HEVs, PHEVs, BEVs, and FCEVs) [21].

In addition, the Thai government also wants to attract electric bus manufacturers by exempting companies from income tax for three years (extendable for another three years if production scales up) and reducing import duties on machinery needed to start production [43].

From the infrastructure point of view, Thailand had about 647 charging points in 2020. These were operated by 10 companies [37]. Due in part to this, Thailand has currently one of the largest fleets of EV in the analysed ASEAN countries region.

In 2020, Thailand expanded its electric vehicle development plan, which aims to produce 250,000 electric vehicles and develop an ASEAN electric vehicle hub by 2025 [44].

4. Key Considerations for the Development of the Electric Car Market in Southeast Asia

The final shape of the electric vehicle market depends on many factors, and the most important of them include:

4.1. Total Cost of Ownership (TCO)

TCO is the most important indicator influencing vehicle purchase decisions for both private and fleet customers. The indicator is affected by, among other things, taxes, electricity costs and, above all, vehicle price and its maintenance costs (repairs, servicing, and inspections). It should be noted that Southeast Asia will have to follow the example of other countries and introduce new forms of financing facilities as well as increase the price competitiveness of TCO through direct state involvement, e.g., by reducing taxes or introducing tax relief mechanisms [45].

4.2. Battery Range and Life

This is a key element that affects the ability to use the vehicle, especially outside of the city. As already mentioned, the range of electric cars is increasing, which is an optimistic indicator. It should be noted, however, that the problem for consumers may be the vehicle charging time, which, depending on the technology used, varies between 20 min and several hours [46].

4.3. Charging Networks

The availability of charging infrastructure (especially the so-called fast chargers) is the main factor affecting the development of electric vehicles. To increase interest in these vehicles in Southeast Asian countries, individual governments should consider co-funding private charging stations, and, in the early stages of the market development, fund stations in key urban locations and between cities (e.g., on motorways) [47].

4.4. Regulatory Environment and Subsidies

In European markets and the USA, which have some of the highest sales volumes, the increase in sales has often been the result of government intervention and not solely a consequence of price, functionality of the vehicles, or construction and financing of charging infrastructure. International examples show a significant acceleration of the EV market development upon the launch of direct subsidies for EV purchases. Economic priorities are usually considered to be in conflict with the environment and climate. However, for many Southeast Asian economies, the transition to automotive electrification is undoubtedly an opportunity to achieve their goals in both these dimensions simultaneously [8].

It should be noted that the first attempts to introduce and promote electric vehicles can be traced back to the 1990s. The forerunner of these measures was Norway, which is also an example of a country where stimulating the demand for electric cars through a package of national regulations yielded very good results. The country's electric car history began in 1994, when Norwegian corporation PIVCO began using 12 EVs to service the 1994 Winter Olympics in Lillehammer [48]. The first incentives from the government

started appearing soon after: in 1996, the registration fee was reduced; in 1997, EVs were exempted from road tax; in 2001, a 0% VAT rate was introduced; in 2003, bus lanes were made available for electric cars; and in 2009, construction of a public charging network began. In 2011, the first fast charger was installed in Norway [49].

It is worth noting that the vast majority of countries that record the highest levels of electric car sales tend to offer, especially at the beginning, a system of incentives of an economic and administrative nature for those who decide to purchase and use electric vehicles. It can be concluded that the introduction of special advantages causes more consumers to decide to purchase this type of car, due to the fact that it is cheaper, and its use grants, among other things, access to zones that exclude regular traffic, or to publicly available charging terminals.

The subsidies are a key tool to maintain EV policy due to the higher costs of vehicles in most countries. For example, in 2021, Japan has set aside a budget of JPY 8 billion (USD 77.1 million) in electric vehicle subsidies, which can be used for up to JPY 800,000 (USD 7710) per vehicle to fund 10,000 BEVs [50]. Meanwhile, the USA provides a maximum of USD 7500 in federal and USD 1500–5000 in state grants per vehicle [51].

5. Consumer Survey Results in Selected Southeast Asian Countries

The consumer interest in electric vehicles is also the subject of much research and analysis. Until recently, no such studies had been conducted in Asian countries (Figure 7).

For example, a study carried out by Frost & Sullivan on behalf of Nissan showed that consumers in Southeast Asia are very enthusiastic about owning an electric vehicle [26,52]:

1. of the total respondents, 64% say they are more likely to consider an electrified vehicle than they were five years ago;
2. moreover, 66% believe they will inevitably adopt electrified mobility as a part of their lives in the near future;
3. finally, 37% say they would definitely consider an electrified vehicle as their next car purchase in the next three years.

Other surveys, conducted by Deloitte, address issues of the main factors that influence the final purchase decision, among others [53].

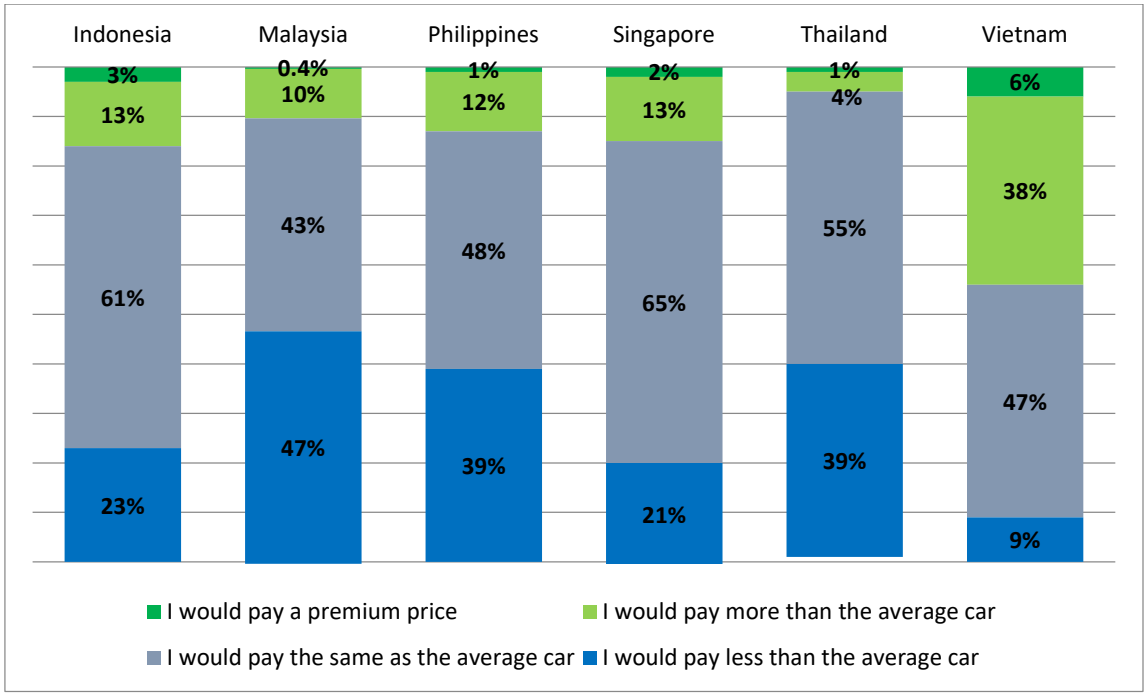

Figure 7. Consumers' expected EV price range after incentives in selected ASEAN countries. Source: https://www2.deloitte.com/content/dam/Deloitte/sg/Documents/strategy/sea-strategy-operations-full-speed-ahead-report.pdf (accessed on 4 November 2021) [53].

It should be noted that the first and most important criterion for choosing an electric car is its price. As the results of the survey in the selected countries show, the majority of respondents believe that the price of an electric vehicle should be lower than or close to that of a standard vehicle. The vast majority of the respondents are not willing to pay a premium price or significantly more than for a standard vehicle. The exception are the respondents in Vietnam, who are willing to pay a price higher than the price of a standard vehicle. Such survey results may indicate that a significant barrier in the development of electric vehicle market is the price, which is generally higher than that of standard vehicles (Figure 8).

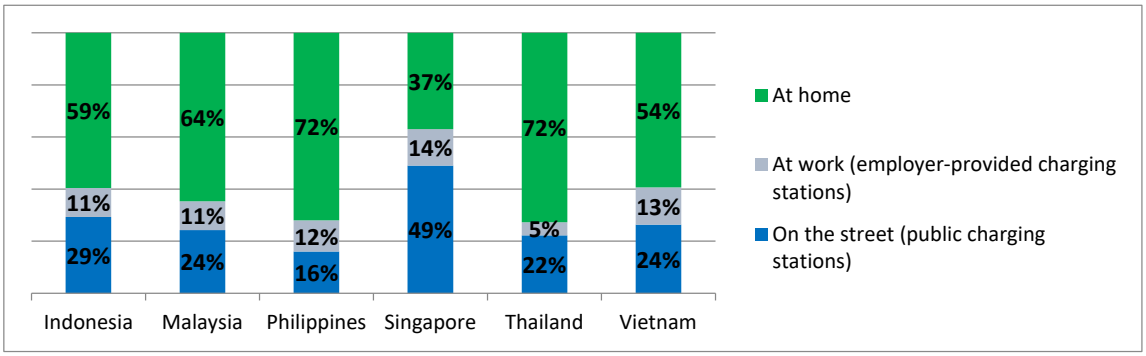

Figure 8. Consumers' expectations for the availability of EV charging facilities in selected ASEAN countries. Source: https://www2.deloitte.com/content/dam/Deloitte/sg/Documents/strategy/sea-strategy-operations-full-speed-ahead-report.pdf (accessed on 4 November 2021) [53].

A major factor inhibiting the development of electric vehicles is the charging method. As mentioned, depending on the technology used, charging takes from a dozen minutes (the so-called fast chargers—usually available in city centres) to a few hours (usually at home). As the survey results indicate, most respondents expect to be able to charge their vehicle at home. Different results were reported in Singapore, where the majority of respondents would like to be able to charge their car at public charging stations. This may be due to the specific urban structure of this city-state (Figure 9).

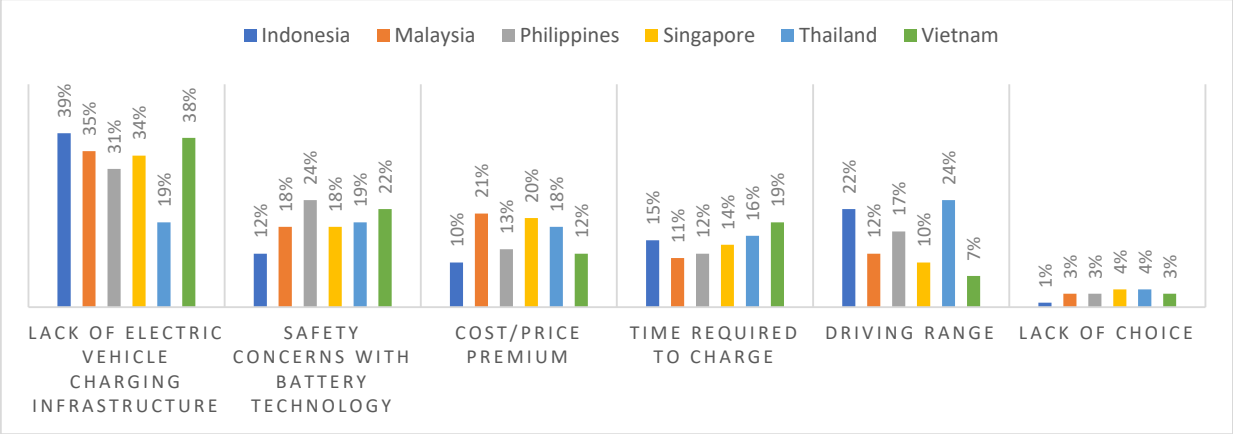

Figure 9. Consumers' top concerns for the adoption of EV in selected ASEAN countries. Source: https://www2.deloitte.com/content/dam/Deloitte/sg/Documents/strategy/sea-strategy-operations-full-speed-ahead-report.pdf (accessed on 4 November 2021) [53].

The survey also asked potential consumers about their top concerns associated with the purchase and use of electric vehicles. The most important concerns include (in order of mention):

- no charging infrastructure,
- safety issues related to battery use,
- vehicle purchase price,
- charging time,
- vehicle range, and
- small number of models available.

6. Conclusions

The development of the electric vehicle market in Southeast Asian countries, as in other regions of the world, depends on many factors. The most important ones include the cost of purchasing and maintaining a car, access to charging infrastructure, and other amenities for electric car users. Cost-effectiveness remains an important criterion for buyers when deciding to purchase a vehicle. The costs of acquiring and operating an electric car currently exceed the costs incurred in the case of combustion engine vehicles. With their experiences and highly developed industry, Southeast Asian countries have an opportunity to achieve excellent results. However, for this to happen, it is worth considering the introduction of incentives similar to those that have contributed to the rapid development of the market in some European countries. The most commonly mentioned incentives include: tax reduction, investor facilitation, user amenities, and, most importantly, government commitment to building and maintaining a widespread charging network. Due to the fact that Asia is a very dynamically developing region, it should be noted that the pace of development of the electric vehicle market may be very high.

An important issue concerning the ASEAN countries is the fact that within a united organization, these countries can impose, following the example of the European Union

countries, common rules for introducing, supporting, and promoting electric vehicles. It should also be noted that ASEAN countries can imitate their neighbour, China, which has a strong and highly developed electric vehicle market.

Moreover, ASEAN countries such as Thailand and the Philippines are not only a potential demand market but also an important supply market, as they are already producing both electric vehicles and components such as motors and batteries.

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