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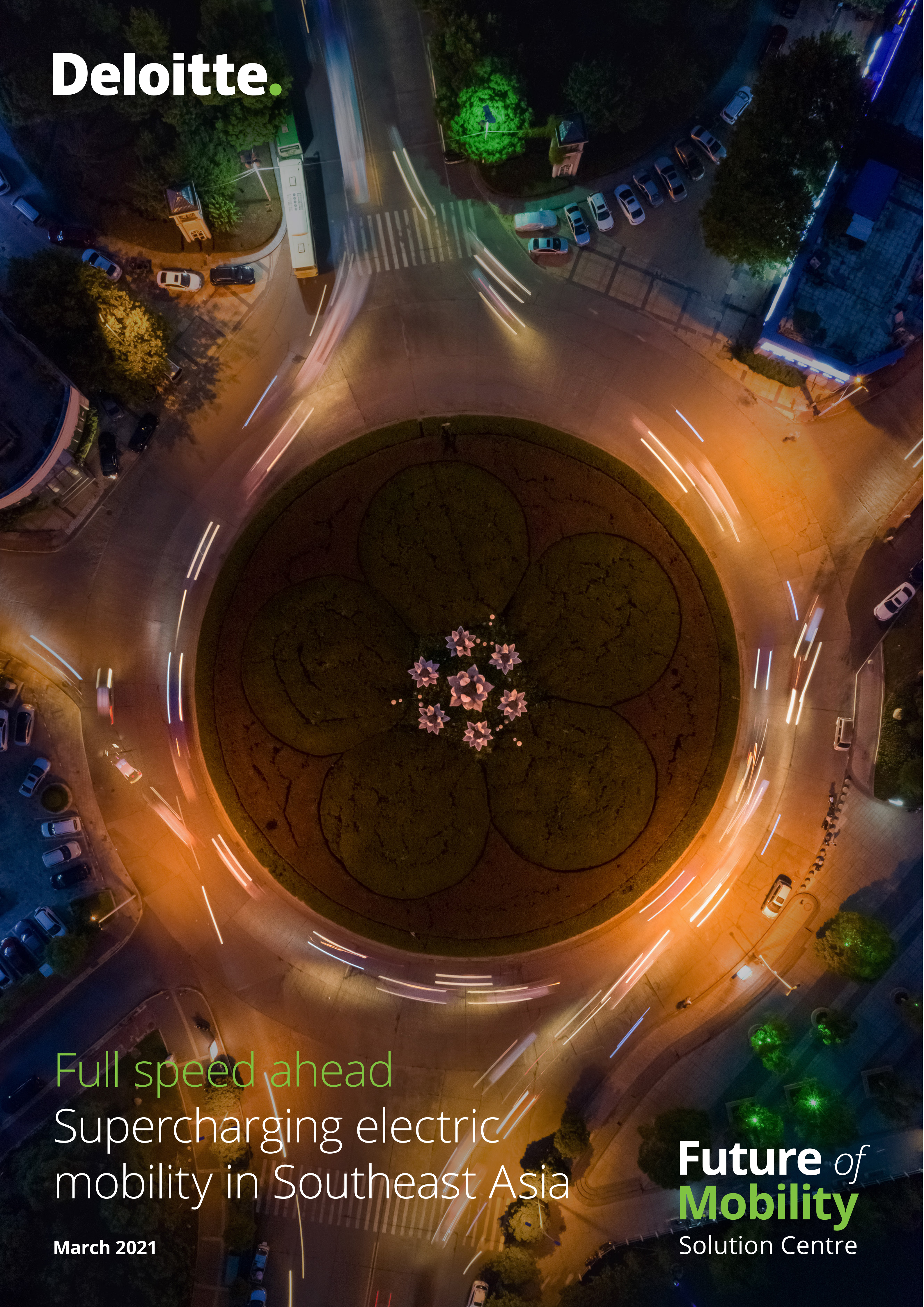

Full speed ahead
Supercharging electric mobility in Southeast Asia

March 2021

Future of Mobility Solution Centre

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Supercharging electric mobility in Southeast Asia

Despite the impact of the COVID-19 pandemic on global automotive sales, the journey to electrification remains on track. Across the globe, regulators and industry players alike recognise the rare opportunity that the transition to electric vehicles (EVs) presents for their economies to simultaneously advance their goals for economic growth and sustainable development.

Within Southeast Asia, the benefits of electrification are tangible and wide-ranging. Apart from enabling economies to meet their climate change commitments, reduce air pollution, and increase energy security, electrification also offers many opportunities along the value chain for economies with established automotive manufacturing hubs – such as Indonesia and Thailand – to extend their footprint in EV and battery production, and for economies with less developed automotive manufacturing capabilities to catch up with, or even leapfrog, industry players in more established automotive manufacturing hubs.

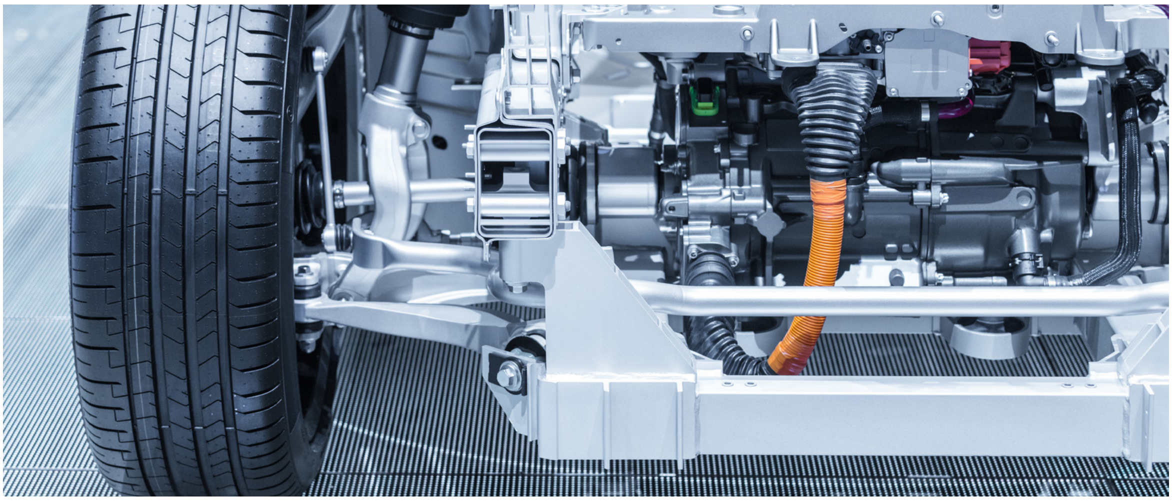
In this report, we will take a closer look at six key mobility markets in Southeast Asia – Indonesia, Malaysia, Philippines, Singapore, Thailand, and Vietnam – and explore five different enablers that we believe are crucial in enabling them to realise the full potential benefits of electrification: total cost of ownership; battery range and life; charging networks, regulatory environment; and value chain potential.

For each of these enablers, we will assess the level of maturity for their respective levers, calculate their total weighted average scores, and assign them to one of four categories – Emerging; Aspiring; Contender; and Top Performer – that will enable us to make relative comparisons on the levels of maturity across the various regional markets.

Later, we will also assess the feasibility of several use cases – including two-wheelers, four-wheelers, light commercial vehicles, and passenger buses – and analyse some of the areas of opportunities for the six Southeast Asian markets to provide some recommendations for industry players and other stakeholders as they make their transition to EVs.

We hope that this report will provide you with some insights into the electrification journey, and the considerations that you will need to make as you steer your organisations in supercharging electric mobility in Southeast Asia.

A pragmatic approach



From a practical perspective, the transition to electric vehicles will enable Southeast Asian economies to simultaneously advance their goals for economic growth and sustainable development.

Economic priorities are, more often than not, perceived to be in conflict with environmental and climate change goals. For many Southeast Asian economies, however, the transition to electrification presents the rare opportunity for them to advance their goals along both dimensions at once. Specifically, the shift to EVs will not only contribute to the overall reduction of carbon emissions, but also create substantial macroeconomic opportunities as automotive players rethink their conventional internal combustion engine vehicle (ICEV) value chains.

Electrification as an economic driver

Broadly, the economic advantages of electrification stem from the new sources of value creation across the entire supply chain, from the sourcing of raw materials to the introduction of new aftersales business offerings. These include, for example, the sourcing of essential raw materials for the sustainable production of EV batteries, such as cobalt, lithium, manganese, and lithium, at lower costs; the know-how for the production of batteries and battery recycling, as well as economies of scale and revenue opportunities from simplified EV manufacturing processes and flexible vehicle design.

Other wider ecosystem advantages could also include the creation of service industries to support EV ownership, such as charging infrastructure, integrated energy management, micro-grid optimisation, mobility services, roadside assistance, and insurance, as well as the creation of new business models for second-life batteries and the disposal of electronic waste.

Southeast Asian markets that are already important automotive manufacturing hubs – such as Indonesia and Thailand, which have outputs of more than 1 million and 2 million vehicle units respectively – may recognise the opportunity to extend their footprint in EV and battery production, whereas those with less developed automotive manufacturing capabilities may also view EVs and the rise of alternative mobility models as viable ways of leapfrogging industry players in more established automotive manufacturing hubs.

Electrification's role in sustainable development

While there remains a level of uncertainty regarding the level of contribution of EVs to emissions reduction, several studies have estimated the lifecycle of EV emissions to be around three times lower than that of ICEV emissions[1]. Through the reduction of overall carbon emissions, as well as the use of more economically, socially, and environmentally sustainable business practices, the shift towards electrification could ultimately enable Southeast Asian economies to relieve some of the pressure that the push for greater manufacturing activity has exerted on its goals for sustainability[2], including:

- **Climate change commitments:** With mounting concerns over climate change, Southeast Asian governments are becoming increasingly supportive of efforts to phase out ICEVs in favour of EVs to meet their commitments for emissions reduction[3]. However, this will entail an overhaul of existing energy generation and transmission networks to support renewable energy sources, as well as a pivot towards environmentally friendly production and supply chain networks for EVs and their component parts.
- **Air pollution:** Across Southeast Asia, numerous regional megacities are grappling with severe air pollution issues that are largely attributable to the transportation sector. Not only are many cities behind the targets set by the World Health Organisation (WHO) for air quality standards, several of the region's largest cities also rank amongst the most polluted globally: Jakarta and Hanoi, for example, have been ranked the fifth and seventh most polluted cities respectively. With particulate pollution-related health problems, such as asthma, lung cancer, and heart disease, becoming a significant source of morbidity, EVs are likely to become an essential part of cities' plans to combat air pollution in dense urban areas.
- **Energy security:** Transportation and fast-growing vehicle ownership are some of the largest drivers of Southeast Asia's oil demand and fuel consumption needs. With domestic oil production unable to keep pace, the region's dependence on imported oil is set to soar. Currently, fuel subsidies totalling some USD 17 billion continue to play a vital role in helping Southeast Asian consumers cope with the sudden fluctuations in oil prices. In Thailand, for example, the State Oil Fund announced in May 2018 that it would absorb 50% of any increase in retail oil prices. Reducing Southeast Asia's dependence on imported oil through the reallocation of resources towards alternative drivetrain technologies and away from fossil fuel dependent modes of transportation is therefore likely to become an increasing priority for many Southeast Asian markets in consideration of their energy security needs.
- **Social inclusivity:** Apart from environmental benefits, an expansion of the EV industry could also enable Southeast Asian economies to achieve greater social inclusivity with the creation of additional high-quality jobs along the value chain. In the European Union (EU), for example, the EV industry is expected to create up to an additional two million jobs by 2050[4]. The degree to which Southeast Asian economies can similarly benefit will, however, depend on their overall readiness and ability to capitalise on this momentum.

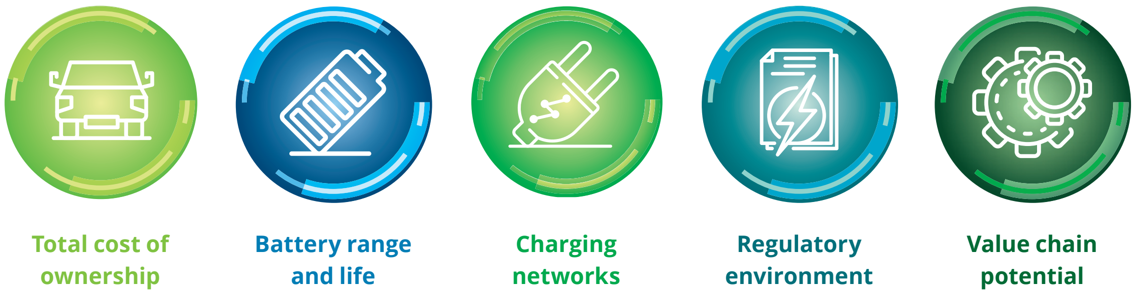
1. "Factcheck: How electric vehicles help to tackle climate change". CarbonBrief. 13 May 2019.
2. "ASEAN progress towards sustainable development goals and the role of the IMF." Association of Southeast Asian Nations. 11 October 2018.
3. "Thailand". Climate Policy Tracker.
4. "How will electric vehicle transition impact EU jobs?". Transport & Environment. September 2017.

Five enablers for electrification

In order for Southeast Asia to realise the full potential benefits of electrification, there are five different enablers that it should address to increase the feasibility and attractiveness of EV adoption within the region: total cost of ownership; battery range and life; charging networks, regulatory environment; and value chain potential.

Overview of the five enablers

In the sections ahead, we will take a deeper dive into each of these enablers and their respective levers, and evaluate the level of maturity of six EV markets in Southeast Asia – Indonesia, Malaysia, Philippines,Singapore, Thailand, and Vietnam – within each of these areas.



1. Total cost of ownership

The total cost of ownership is the most relevant financial indicator for both private and fleet deployment decisions, and its components – including but not limited to tax, electricity costs, and vehicle price – are the key financial levers that will drive adoption. To offset the disproportionately high purchase value and low resale value of EVs, Southeast Asian economies will need to introduce new forms of financing instruments, and increase the price competitiveness of the total cost of ownership through higher vehicle utilisation, for example, with the implementation of fleet use cases.

2. Battery range and life

Consumer education and ownership experience will be key to addressing range anxiety, which continues to be one of the top concerns hindering greater EV adoption across both private and commercial use cases in Southeast Asia. Furthermore, the evolution of high density batteries and fast-charging technology will also enable new fleet operating models, and provide greater lifetime certainty of battery range and life – and therefore, EV residual values.

3. Charging networks

The accessibility and interoperability of charging infrastructure is a major source of concern not only for EV users, but also governments and public utilities. To increase the return on investment, Southeast Asian economies should consider the implementation of demand-optimised location prioritisation for public charging facilities, and introduce digital solutions and load-shifting incentives for consumers.

4. Regulatory environment

The regulatory environment is a pre-requisite for the financial and operational viability of EVs, and has an important role to play in enhancing the attractiveness of the region's markets for the industrialisation of the EV sector. Apart from financial incentives, governments could also consider introducing other usage incentives to drive EV adoption, providing greater clarity on the relevant policy frameworks, and harmonising fragmented governance structures.

5. Value chain potential

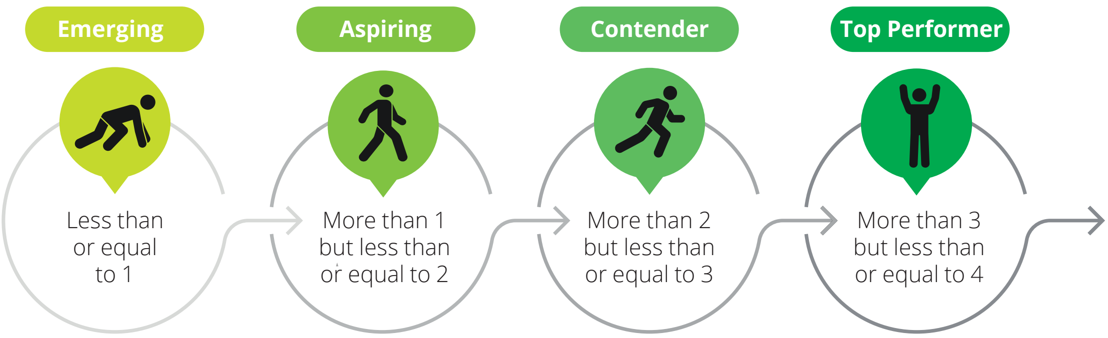
Given the automotive value chain's importance in driving economic competitiveness and job creation in many Southeast Asian markets, there is the need for more concerted efforts to provide a differentiated mix of push-pull incentives for localisation, and a more cohesive integration of value chain stages with existing capabilities from adjacent sectors, such as raw material sourcing, manufacturing, and research and development (R&D) talent.

Scoring rubric

Over the course of this report, we will apply a scoring rubric to enable us to make relative comparisons on the levels of maturity for each of the five different enablers across the six Southeast Asian markets.

For each lever under the five enablers, we will assign each market a score between 0 and 4 based on our assessment of their respective levels of maturity, with 0 indicating the lowest level of maturity, and 4 indicating the highest level of maturity. The weighted average score of these levers will then translate into the final score for each enabler.

Based on these final scores, we will assign each market to one of the four categories: Emerging; Aspiring; Contender; and Top Performer.



Total cost of ownership

To compare the true financial competitiveness of EVs against conventional, fossil fuel-powered ICEVs, and understand how financing and ownership models can help to tackle some of the uncertainty surrounding residual values, we need to deploy a total cost of ownership approach.

Regardless of the use case – whether private, fleet, or transit – the switch to EVs is often perceived to be "expensive" due to the higher costs of batteries, and therefore higher purchase price of the vehicle. But rather than focusing only on the purchase price, it may be more worthwhile considering the total cost of ownership – or the entirety of all the costs incurred along a vehicle's lifecycle – in our comparison between EVs and ICEVs.

In our analysis below, we will examine four components of the total cost of ownership from the owner or operator's perspective – namely, vehicle cost, taxes, energy costs, and maintenance costs.

1. Vehicle cost

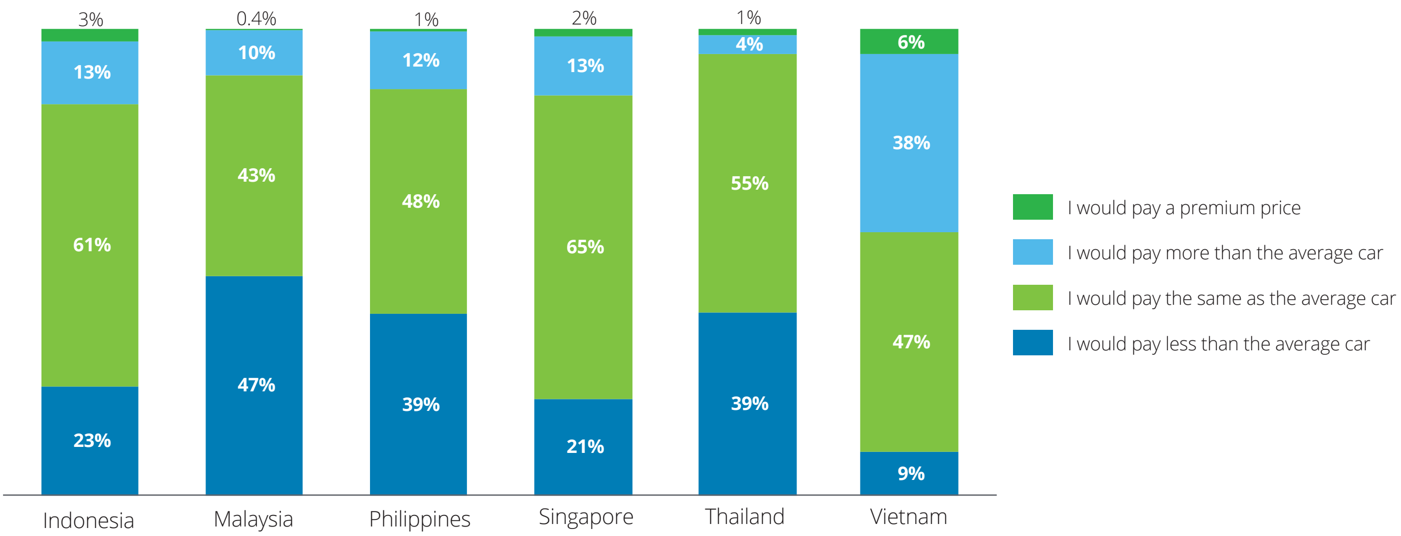
Assuming linear depreciation, three major factors – vehicle purchase price, one-time taxes, and resale value – have to be considered in the calculation of a periodic vehicle cost according to the formula:

$$\text{Periodic vehicle cost} = \frac{(\text{Purchase price} + \text{One-time taxes}) - \text{Resale value}}{\text{Usage period}}$$

Purchase price

While car ownership is on the rise in Southeast Asia, the purchasing power of the average Southeast Asian consumer is still relatively lower than consumers in most other developed economies. Given the significant purchase price differentials between Battery Electric Vehicles (BEVs) and ICEVs, the majority of consumers in Southeast Asia are still not willing to pay more to choose an EV over the average ICEV (see Figure 1).

Figure 1: Consumers' expected EV price range after incentives



Source: Deloitte's 2021 Global Automotive Consumer Study

In Indonesia, for example, the purchasing capacity of most middle-income consumers for a four-wheeler is about IDR 300 million (or approximately USD 21,400), which is significantly lower than the price of mid-size electric car at about IDR 800 million[5]. Similarly, LCVs and passenger buses also have large purchase price differentials, with the purchasing price of a battery electric bus (BEB) coming in at about twice that of a conventional diesel bus[6].

However, the purchase price differential narrows for two-wheelers between comparable EVs and ICEVs. Given that 80% of households own two-wheelers in Indonesia, Thailand, and Vietnam, electric two-wheelers may be the most promising use case to catalyse the electrification shift. Another course of action could also be for automotive manufacturers to design and build vehicle models that are better suited for the region's needs both in terms of features and price competitiveness.

One-time taxes

One-time taxes include registration fees, luxury taxes, and value-added taxes that are paid during the initial car purchase as a percentage of the initial purchase price. Given that taxes fall within the purview of regulators, governments who are looking to promote the adoption of EVs will typically offer significant tax incentives to lower the overall vehicle cost and drive demand.

These tax incentives come in two main forms: direct subsidies, and tax exemptions. An example of a direct subsidy is the Electric Car Rebate in the US state of California, which offers consumers a tax credit of at least USD 2,500 for the purchase of an electric car[7], while an example of a tax exemption is China's exemption on vehicle purchase taxes for new energy vehicles that is currently in force until 2022[8].

Resale value

The resale value presents the residual value of the vehicle as a function of its periodic value depreciation, and has significant impact on the total cost of ownership. Currently, the differentials in resale values is one of the largest ownership cost differences between EVs and ICEVs, as a result of the industry's lack of experience in residual value development for EVs, and the rapid technological progress of EVs which acts to dilute their values on second-hand markets. Furthermore, prospective EV owners also do not have a viable method of assessing and planning for the expected degradation in their vehicles' battery performance[9].

2. Taxes

Annual taxes are a significant contributor to the total cost of ownership, and therefore could be used as a significant lever to drive EV adoption for both private and fleet use case applications. Broadly, there are two main types of taxes: road tax, and variable toll charges.

Road tax

Road tax refers to the annual recurring tax on car ownership. This can either take the form of a fixed value or, in most instances, a percentage of the initial purchase price. Given the higher purchase price of EVs, it is therefore likely that the corresponding road taxes will be higher for these vehicles. Government incentivisation in the form of lower road tax rates for EVs will consequently be important in encouraging their uptake.

5 "Consumers' concerns haunt Indonesia's electric vehicle agenda". The Jakarta Post. 5 December 2019.
6 Quarles, Neil; Kockelman, Kara M.; Mohamed, Moataz. "Costs and benefits of electrifying and automating bus transit fleets". 2020.
7 "California electric car rebate: Everything you need to know". Car and Driver.
8 " Recent changes to NEV incentive policies in China". Sustainable transport in China. 18 May 2020.
9 "Forecasting the residual value of electric vehicles". Urban Foresight.

Toll charges

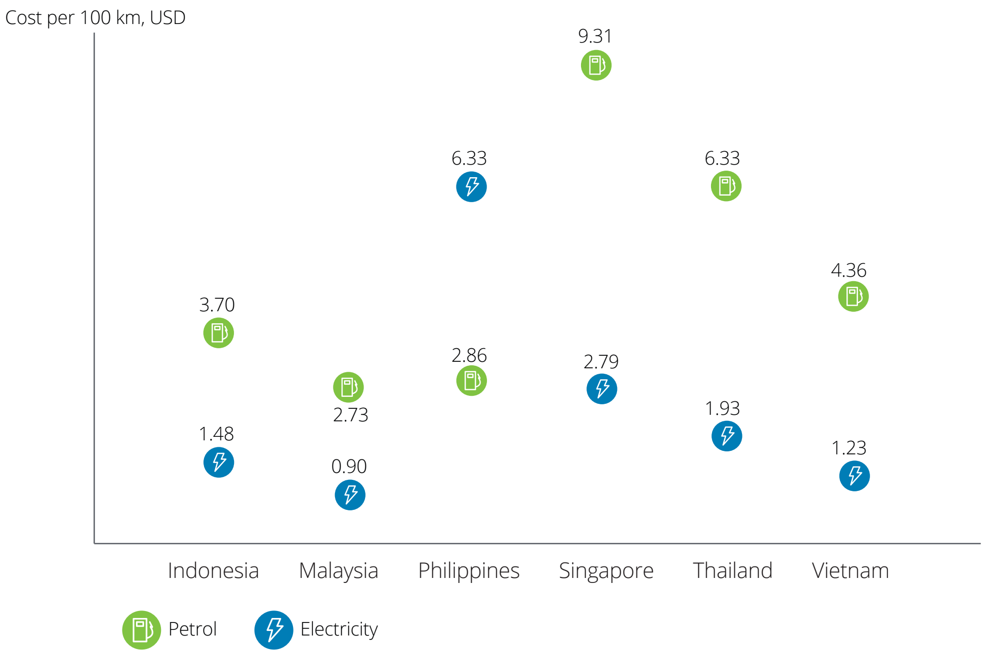
Toll charges, otherwise known as road fees, are the direct charges levied for the usage of roads. These are typically designed to discourage the use of certain vehicle classes and fuel sources, or reduce traffic congestion during peak hour travel. Singapore, for example, implemented the Electronic Road Pricing (ERP) system to manage congestion, where drivers are required to pay a fee when they travel on certain routes during operational hours. These charges, which are optimised based on peak hour usage, serve to reduce traffic congestion by disincentivising users from utilising these routes. A similar concept may also be applied to the designation of low-emission zones.

3. Energy costs

Another major cost differential between EVs and ICEVs stems from the difference in the cost of conventional fuel and the cost of electricity. Specifically, the average cost per kilometre of electricity is significantly lower than the cost per kilometre of conventional fuel, and therefore results in a lower average cost of operation for EVs. However, the level of this cost differential differs significantly across the various Southeast Asian markets, and therefore results in different amounts of time required for EVs to break even against the cost of ICEVs (see Figure 2).

Given the lower operating costs of EVs, use cases with higher mileages may benefit the most from a lower total cost of ownership, which will in turn enable them to more quickly recoup the higher upfront purchase prices of EVs. In several Southeast Asia markets, however, diesel prices may be lower than electricity, resulting in longer payback periods for BEVs. For such markets, it is therefore crucial that energy prices are reviewed from a policy level to ensure that they are in line with the economy's objectives for electrification[10].

Figure 2: A comparison of the costs of conventional fuel and electricity



4. Maintenance costs

There are two key components of maintenance costs: vehicle maintenance cost, and potential battery replacement cost.

Vehicle maintenance cost

Although there is still a level of uncertainty regarding the level of vehicle maintenance cost and other repair services in Southeast Asia, the vehicle maintenance cost for EVs has been estimated to be about one-third that of the vehicle maintenance cost for ICEVs in other markets[11]. This is a result of two key features of EVs: fewer moving components, and fewer fluid changes.

10 "Study on electric vehicle penetrations' influence on 3Es in ASEAN". Economic Research Institute for ASEAN and East Asia. August 2019.

EVs generally contain fewer moving components – for example, an electric motor contains only one moving component, whereas a combustion engine may contain dozens – and are therefore slightly more resistant to wear and tear, and require fewer repairs. At the same time, EVs only require the periodic replacements for the coolant, whereas ICEVs require periodic replacements for the oil, transmission fluid, and coolant. An oil change, for instance, is typically required once per year for most ICEV models, with some requiring more frequent changes[12], whereas a Tesla Model 3 would only require coolant replacements once every four years – although it must be noted that system-flush intervals vary widely between EV models.

Potential battery replacement cost

While EVs generally require less frequent vehicle maintenance, they incur higher expenses for the replacement of batteries. EV batteries are generally considered to be below performance standards when they reach about 70-80% of their total usable capacity. Nevertheless, given the impending improvements to battery technology and EV architecture that we are likely to witness within the next decade, replacement batteries are expected to be able to extend the overall lifespan of an EV.

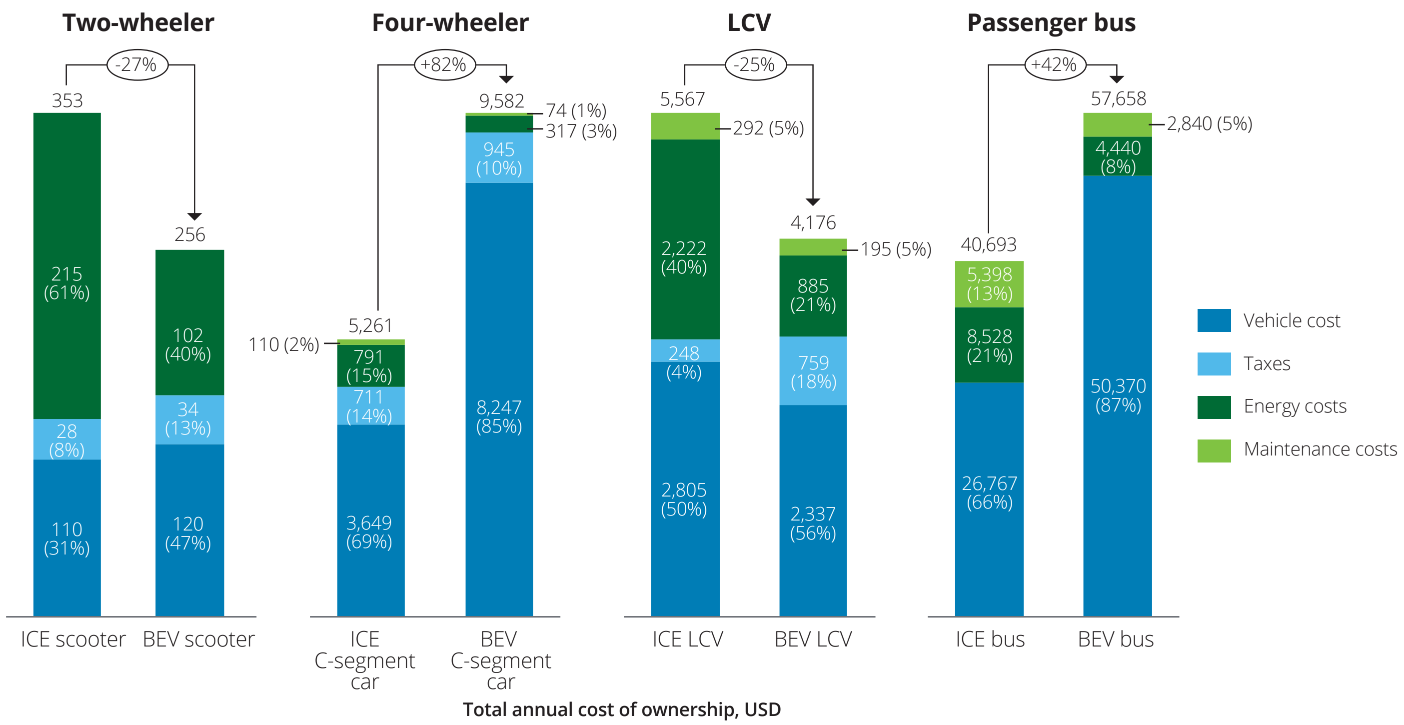
Total annual cost of ownership for each vehicle type

Putting all the components together, we have estimated the total annual cost of ownership across four different vehicle types. For each vehicle type, a representative ICE model has been matched with a comparable BEV model that is currently in operation in Southeast Asia.

Specifically, the conventional two-wheeler use case will be represented by the 110cc ICE scooter segment; the four-wheeler use case by the compact segment; the logistics light commercial vehicle (LCV) use case by the four/five-door van segment; and the public transport use case by a single-deck passenger bus segment.

Overall, we observed that while the total cost of ownership for EVs may be higher for the four-wheeler and public transport use cases, total cost of ownership for EVs is in fact significantly lower for the two-wheeler use case, and slightly lower for the LCV use case (see Figure 3).

Figure 3: Overview of annual cost of ownership for the various use cases



11 "Costs of the electric car". OliNo Renewable Energy.
12 "Maintenance costs for electric vehicles vs. fossil cars". eMove360°. 26 February 2020.

Market scorecards: Total cost of ownership

Indonesia

The price of an average EV in Indonesia continues to remain higher than its ICEV counterpart despite the removal of the luxury tax, which was previously pegged at 30% of the purchase price. Nevertheless, the price differential of about 33% is still lower that of most other Southeast Asian markets, with the exception of Vietnam. As the annual tax is calculated as a percentage of the initial purchase price, the annual tax for an average EV is also approximately 33% higher than the annual tax for an equivalent ICEV.

Vehicle cost	●○○○
Taxes	●○○○
Energy costs	●●○○

Malaysia

Overall, Malaysia has a high total cost of ownership as there is a lack of purchase incentives. However, vehicles in Malaysia are generally affordable, and the price differential between EVs and ICEVs is less stark as compared to other Southeast Asian markets. Furthermore, taxes are also generally affordable, and therefore the reduction in annual taxes for EVs does not present significant cost savings for consumers (annual taxes are MYR 70 and MYR 50 for ICEVs and EVs respectively). Nevertheless, Malaysia's low cost of electricity enables its EV users to reap significant cost savings.

Vehicle cost	●○○○
Taxes	●●○○
Energy costs	●●●○

Philippines

EVs in the Philippines are about 155% more expensive than ICEVs in terms of the initial purchase price. Road taxes are calculated based on gross vehicle weight, and since EVs tend to be heavier than ICEVs on average, EVs are subject to taxes that are about 56% higher than ICEVs. In absolute terms, however, this difference translates to only about USD 45, which may not be significant for many users.

Vehicle cost	○○○○
Taxes	●●○○
Energy costs	●●○○

Singapore

Singapore has the highest purchase prices for both EVs and ICEVs in Southeast Asia. Despite multiple subsidies of up to SGD 45,000 offered by the government through the EV Early Adoption Initiative and Vehicle Emission Scheme, the price differential between EVs and ICEVs remains significant. As EV drivers will not be subject to petrol taxes, they will be required to pay an annual additional lump sum tax of SGD 700 from January 2023 onwards, which will significantly increase the overall one-time taxes.

Vehicle cost	○○○○
Taxes	○○○○
Energy costs	●●●○

Thailand

Despite tax exemptions, the purchase price of an average EV is about twice that of its ICEV equivalent in Thailand. This is likely a result of the market saturation of ICEV OEMs: as many automotive players have located their manufacturing plants in Thailand, users do not need to pay any additional import fees, which helps to keep the relative cost of ICEVs low.

Vehicle cost	●○○○
Taxes	●●○○
Energy costs	●●●○

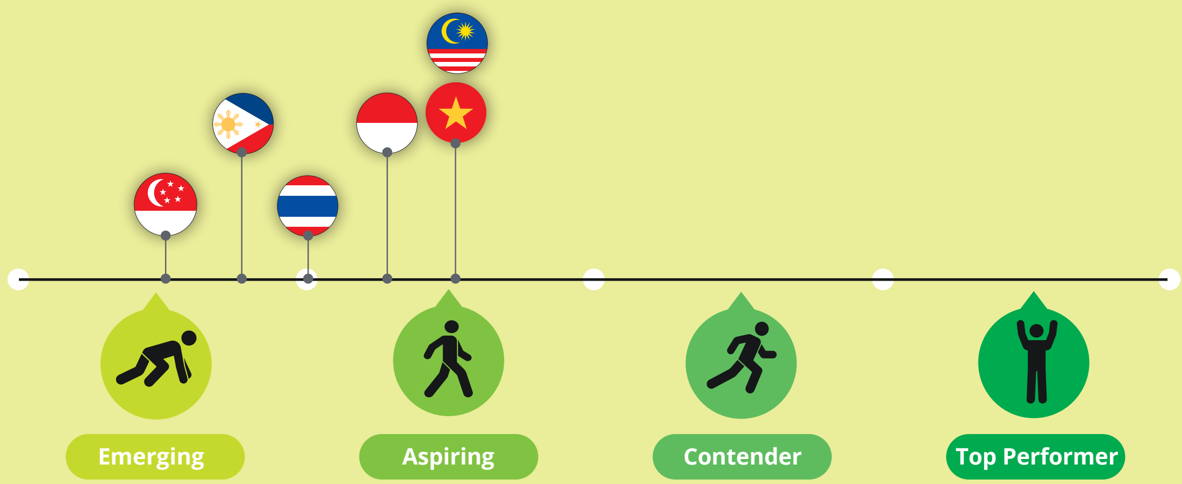
Vietnam

In recent years, the government has been encouraging the purchase of locally manufactured vehicles over imported vehicles. The main determinant of a vehicle's total cost of ownership therefore depends more heavily on its country of origin than its fuel type, and as a result Vietnam currently has the lowest price differential between ICEVs and EVs. In terms of energy costs, Vietnam also has the most significant cost differential between fuel and electricity of about 67%.

Vehicle cost	●○○○
Taxes	●●○○
Energy costs	●●●○

Overall evaluation

Based on the final weighted scores, we have categorised Philippines, Singapore, and Thailand as Emerging; and Indonesia, Malaysia, and Vietnam as Aspiring. Overall, Malaysia and Vietnam are deemed to be leading for the total cost of ownership enabler given their relatively lower price differentials between ICEVs and EVs.



Battery range and life

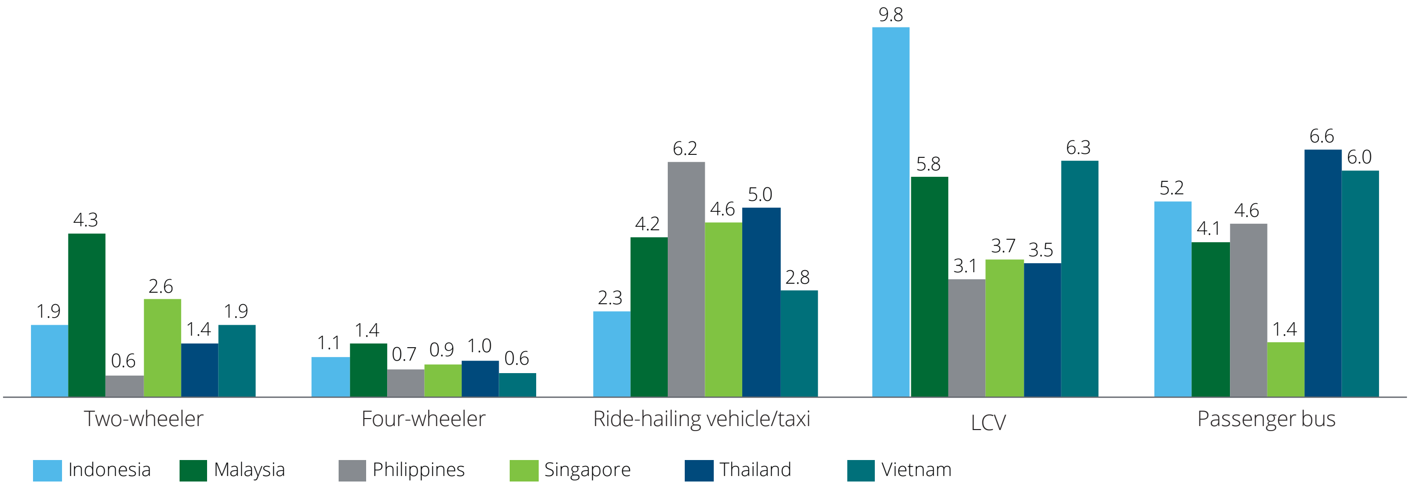
Southeast Asia is home to some of the most congested and humid cities in the world, where commuting times are often longer than expected and air-conditioning is in constant usage. Range anxiety, driven by concerns over battery range and life, is therefore a key consideration in the shift to electric drivetrains.

Across all EV use cases, there remain concerns over battery range and life, which is often measured in terms of a vehicle's driving range on a full battery charge. Typically, range needs are highly dependent on the specific use case, including the average vehicle kilometres travelled (VKT), charging behaviour, and other specific features of the location in which the EV is operating.

Private vehicles, such as two-wheelers and four-wheelers, are usually driven for relatively shorter distances, and therefore should present fewer range anxiety issues. However, EV adoption in these use cases remain hindered by the relatively higher initial purchase prices as compared to their ICEV equivalents.

On the other hand, commercial vehicles, such as taxis, LCVs, and passenger buses have a lower total cost of ownership due to their high mileages, but present more issues about battery range and life (see Figure 4). This is of particular concern to many markets in Southeast Asia, where urban sprawl is expanding and suburban areas are undergoing rapid development, resulting in commuters needing to travel greater distances to reach their homes, offices, malls, and other destinations every day.

Figure 4: Average number of charges required per week of usage for different use cases



Private vehicles

For many markets across Southeast Asia, two-wheelers are the preferred vehicle choice, as they cost relatively less than four-wheelers[13]. However, electric motorcycles tend to have lower ranges than gas motorcycles. This downside may inhibit EV adoption in locations where motorcycles are often used for long-distance travel, such as Malaysia, as they will require more frequent charges[14]. In such instances, battery-swapping may be a viable time-saving alternative to conventional EV charging for two-wheelers.

Overall, our calculations reveal that existing EV models for the two-wheeler and four-wheeler use cases are able to meet most of the average commuter's daily needs across six selected Southeast Asian markets, with an average of about one charge per week (see Figure 5 and 6).

Figure 5: Average charges required for representative EV model in the two-wheeler use case

Based on a representative BEV model with a **95 kilometre** range

	ID	MY	PH	SG	TH	VN
Average daily usage, km	26	59	7.7	35	19.5	26
Number of charges per day	0.27	0.62	0.08	0.37	0.27	0.21
Number of charges per week	**1.92**	**4.34**	**0.57**	**2.58**	**1.91**	**1.44**

Figure 6: Average charges required for representative EV model in the four-wheeler use case

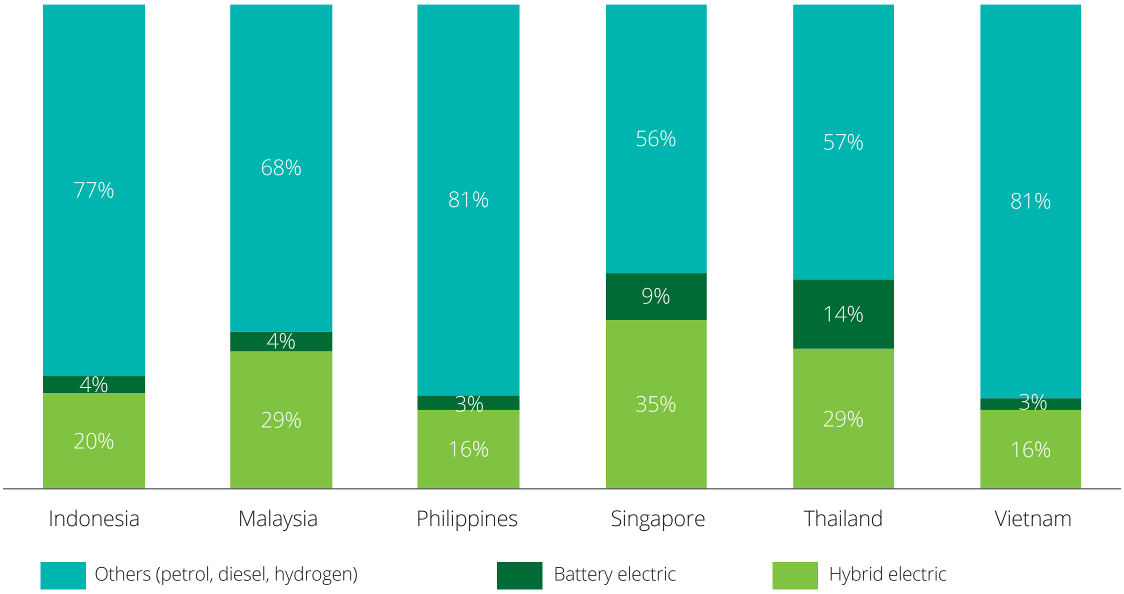
Based on a representative BEV model with a **390 kilometre** range

	ID	MY	PH	SG	TH	VN
Average daily usage, km	58.5	78.3	41.6	47.9	54.2	35.9
Number of charges per day	0.15	0.20	0.11	0.12	0.14	0.09
Number of charges per week	**1.05**	**1.41**	**0.75**	**0.86**	**0.97**	**0.64**

13 "Car, bike or motorcycle? Depends on where you live". Pew Research Centre. 16 April 2015.
14 "Top 5 reasons why electric motorcycles beat gas motorcycles". Electrek. 20 June 2019.

Despite the theoretical sufficiency, however, consumers continue to indicate a preference for a range that is approximately three times higher than their average daily trip[15]. In Southeast Asia, we have observed a majority preference for conventional ICEVs across all of the major markets in the region (see Figure 7). In this regard, we believe that a combination of several practical and psychological reasons are at play.

Figure 7: Consumer preference for engine type in next vehicle purchase



Source: Deloitte's 2021 Global Automotive Consumer Study

Practically speaking, long-distance driving continues to account for a significant proportion of total trips for commuters in Southeast Asia. Apart from their usual daily commutes between homes and workplaces, up to 7% of total trips are long-distance commutes averaging more than 150 kilometres, although the exact distances vary by location. As many intra-country travel networks within the region are not yet sufficiently developed to replace the security, comfort, and convenience of private vehicles, consumers continue to rely on their own private vehicles to make these long commutes – and many of the BEV models currently on the market are unable to meet these range expectations.

Furthermore, many private consumers are not accustomed to the need to refuel their vehicles daily, and may perceive the use of EVs to be cumbersome as it requires planning ahead to accommodate longer charging periods. Encouraging the uptake of EVs will therefore require a combination of behavioural change for consumers and fleet drivers, as well as development of high-speed chargers and enhanced battery capacities to reduce the range differential between BEVs and ICEVs.

Commercial vehicles

Use cases for commercial vehicles differ from that of private vehicles due to their different travel patterns and range requirements. Taxis and ride-hailing vehicles, for example, spend many hours in operation and travel much further distances than private vehicles (see Figure 8). They are therefore likely to require more frequent charges, and a dynamic utilisation optimisation system that would reduce operational downtimes. Given their generally high utilisation rates, especially for multi-shift vehicles with no overnight charging options, and wide variability in travel patterns, fast on-demand charging may be the most suitable option for this use case.

15 "Key drivers behind the adoption of electric vehicle in Korea: An analysis of the revealed preferences". 2019.

As e-commerce and last-mile delivery networks continue to expand throughout Southeast Asia, we are likely to see an increase in delivery density for the LCV use case, which will enable LCVs to deliver their payload with lower mileage[16]. Currently, EV models are already able to cover the entire range with a single charge, but a reduction in mileage may facilitate greater uptake in certain markets, such as Indonesia where the delivery network may still require significantly longer travel distances (see Figure 9).

For the passenger bus use case, current battery capacities require about one charge per day at the depot (see Figure 10). Given the higher predictability of travel routes for this use case, passenger buses serving fixed routes could be prioritised for electrification if their specific route length, service level, and trip frequency are able to be adequately served by EV models. The selection of EV models with the appropriate battery capacities could also help to minimise the need for multiple charges, and overall disruption to bus operating schedules[17]. As high-density batteries and fast-charging technology continue to evolve, we could also expect to see the introduction of new operating models for both line and on-demand passenger buses.

Figure 8: Average charges required for representative EV model in the ride-hailing vehicle/taxi use case

Based on a representative BEV model with a **390 kilometre** range

	ID	MY	PH	SG	TH	VN
Average daily usage, km	127.00	235.62	347.10	258.50	280.00	157.00
Number of charges per day	0.33	0.60	0.89	0.66	0.72	0.40
Number of charges per week	**2.28**	**4.23**	**6.23**	**4.64**	**5.03**	**2.82**

Figure 9: Average charges required for representative EV model in the LCV use case

Based on a representative BEV model with a **160 kilometre** range

	ID	MY	PH	SG	TH	VN
Average daily usage, km	224.66	133.15	71.23	83.56	81.12	143.00
Number of charges per day	1.40	0.83	0.45	0.52	0.51	0.89
Number of charges per week	**9.83**	**5.83**	**3.12**	**3.66**	**3.55**	**6.26**

Figure 10: Average charges required for representative EV model in the passenger bus use case

Based on a representative BEV model with a **250 kilometre** range

	ID	MY	PH	SG	TH	VN
Average daily usage, km	185.25	146.92	164.00	51.37	234.74	214.57
Number of charges per day	0.74	0.59	0.66	0.21	0.94	0.86
Number of charges per week	**5.19**	**4.11**	**4.59**	**1.44**	**6.57**	**6.01**

16 "Electrify your LCV fleet". LeasePlan. 2019.
17 "Electrification of a city bus network – An optimisation model for cost-effective placing of charging infrastructure and battery sizing of fast-charging electric bus systems". 2017.

Market scorecards: Battery range and life

Indonesia

The LCV use case may be less viable in Indonesia, as the EVs are likely to require more than one charge per day to sustain average usage levels. This is a result of the significantly longer average distance that LCVs travel in Indonesia, which is approximately 57% higher than that in Vietnam, the next-highest market.

Two-wheeler	●●●○
Four-wheeler	●●●○
Ride-hailing vehicle/taxi	●●●○
LCV	○○○○
Passenger bus	●○○○

Malaysia

With the exception of the passenger bus use case, vehicles in Malaysia are typically driven for longer average distances than other markets in Southeast Asia, and will therefore require a greater number of charges to fulfil their weekly usage needs.

Two-wheeler	●●○○
Four-wheeler	●●●○
Ride-hailing vehicle/taxi	●●○○
LCV	●○○○
Passenger bus	●●○○

Philippines

With the lowest average daily distance for personal vehicles across all Southeast Asian markets, both the two-wheeler and four-wheeler use cases in the Philippines will require less than one charge per week. However, the Philippines also has the highest average daily distance for ride-hailing vehicles/taxis, which will require daily charges to sustain their usage. To facilitate this, fleet operators may require the use of a central depot for overnight charging.

Two-wheeler	●●●●
Four-wheeler	●●●●
Ride-hailing vehicle/taxi	●○○○
LCV	●●○○
Passenger bus	●●○○

Singapore

With shorter distances travelled across all use cases, Singapore has a relatively good battery range coverage. In particular, the passenger bus use case requires only an average of 1.5 charges per week due to the short average distances that they cover.

Two-wheeler	●●●○
Four-wheeler	●●●●
Ride-hailing vehicle/taxi	●●○○
LCV	●●○○
Passenger bus	●●●○

Thailand

Thailand has the highest average daily usage for the passenger bus use case, which will require an estimated 6.6 charges per week. To facilitate this, fleet operators may require the use of a central depot for overnight charging.

Two-wheeler	●●●○
Four-wheeler	●●●●
Ride-hailing vehicle/taxi	●○○○
LCV	●●○○
Passenger bus	●○○○

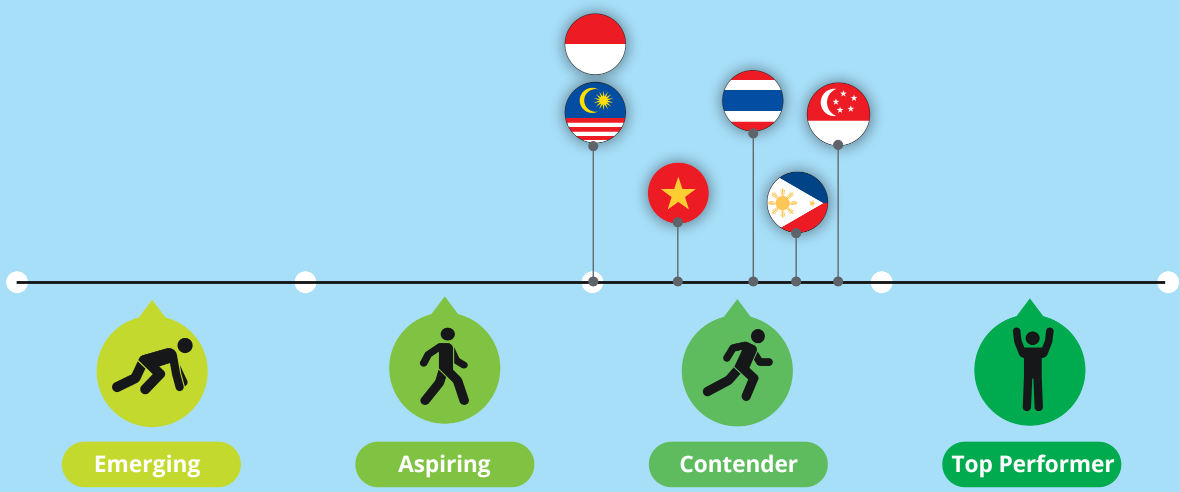
Vietnam

Across all the Southeast Asian markets, the four-wheeler use case has the lowest average daily distance, and will therefore require only about one charge every two weeks to sustain its usage. However, the LCV and passenger bus use cases may require daily charges, which can be managed through use of a central depot for overnight charging.

Two-wheeler	●●●○
Four-wheeler	●●●●
Ride-hailing vehicle/taxi	●●●○
LCV	●○○○
Passenger bus	●○○○

Overall evaluation

Based on the final weighted scores, we have categorised Indonesia and Malaysia as Aspiring, and Philippines, Singapore, Thailand, and Vietnam as Contenders. Overall, Singapore is deemed to be leading for the battery range and life enabler given the short average distances travelled by vehicles in this market.



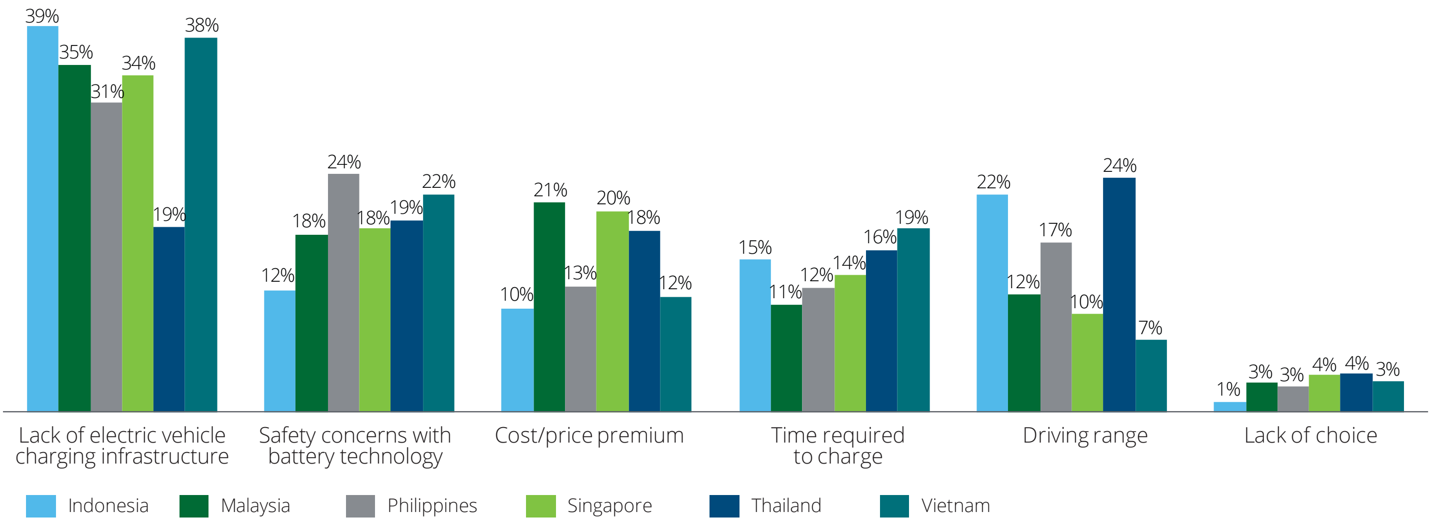
Charging networks

Apart from improvements to battery capacities and charging technology, a comprehensive and widely accessible charging network is one way to reduce range anxiety, and ensure that EVs are able to adequately meet the mileage needs of their use case.

Broadly, there are three main EV charging segments that differ by location and charging needs: residential, public, and fleet. In the residential charging segment, charging facilities are located within the off-street parking compound of an individual consumer's home. On the other hand, the public charging segment refers to charging facilities located at kerbsides and destinations within a city, or at fast-charging hubs and motorway service areas on inter-city routes, while the fleet charging segment refers to charging facilities under the purview of car-sharing fleet and public transport operators.

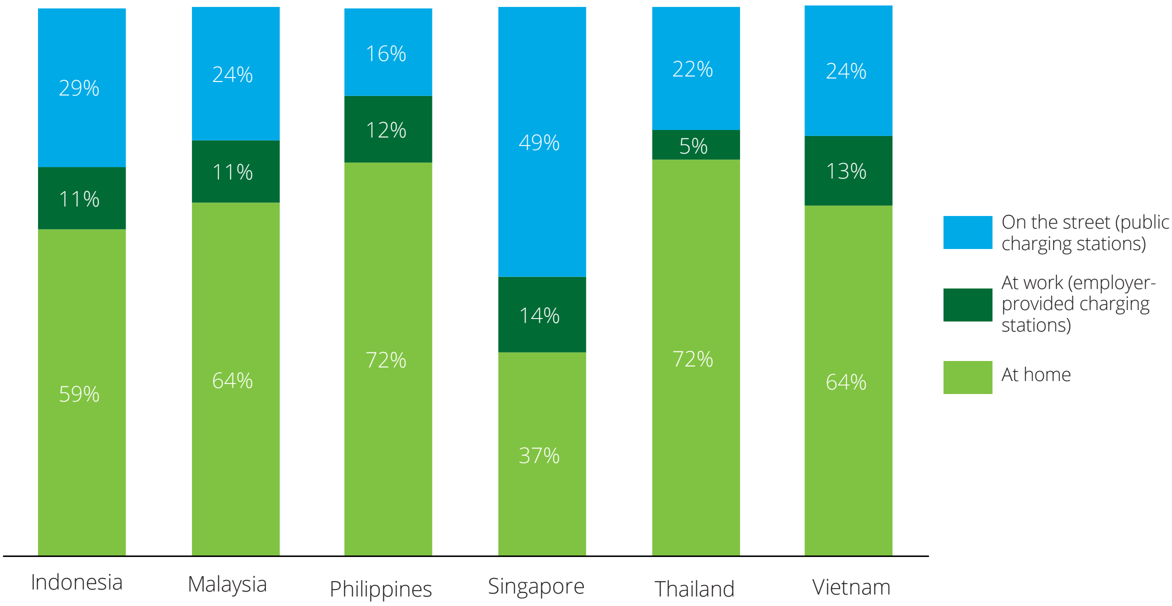
Overall, we found that across most Southeast Asian markets, the lack of extensive charging networks continues to be one of consumers' top concerns for the adoption of EVs (see Figure 11). With the exception of consumers in Singapore, where there is a relatively more developed public charging network, the majority of Southeast Asian consumers expect that EV charging facilities will only be available to them at home (see Figure 12).

Figure 11: Consumers' top concerns for the adoption of EVs



Source: Deloitte's 2021 Global Automotive Consumer Study

Figure 12: Consumers' expectations for the availability of EV charging facilities



Source: Deloitte's 2021 Global Automotive Consumer Study

Public charging networks

Unlike forerunners such as China and Norway, many markets in Southeast Asia currently do not possess the necessary charging networks to support consistent EV usage. Improvements in the coverage of public charging networks – which include charging facilities located at kerbsides and destinations within a city, and those located at fast-charging hubs and motorway service areas on inter-city routes – will be necessary to serve the needs of EV users who may have insufficient access to residential charging facilities.

There are two aspects of public charging networks that will require consideration: accessibility, which refers to the number of public charging facilities, as well as their affordability and speed of charging; and interoperability, which refers to the ability of consumers to benefit from seamless access to charging facilities regardless of their specific EV model.

Accessibility

The number of public charging facilities required will largely depend on the specific location, density of EV adoption, and the speed of the chargers. Where EV users have greater access to residential or workplace charging facilities, fewer public charging facilities are required. In California, for instance, there is a public charger for every 25 to 30 EVs; in the Netherlands, where private parking spaces are limited, there is a public charger for every 2 to 7 EVs[18].

In terms of cost, the most economical way to charge an EV with minimum downtime is to do so overnight as off-peak electricity and slow chargers are more affordable. In Southeast Asia, where multi-family buildings are common, the complexity of allocating shared charging points increases as it is difficult to manage the priority of a greater number of EVs requiring chargers in the evening[19].

Given the region's high urban density, users in Southeast Asia are likely to rely heavily on public charging networks that would enable them to make frequent charges quickly and flexibly. The idea of being able to "charge an EV within an hour" is increasingly becoming a pre-requisite for the consumer adoption of EVs.

Interoperability

For EVs to successfully proliferate across Southeast Asia, interoperability is key. Regardless of a battery's range, there will always be concerns about the number of charging stations along a user's subscribed network on long-distance routes[20]. The technical standardisation of charging equipment, as well as harmonisation of registration and interoperability standards for charging facilities, will therefore play an important role in improving the user experience of EVs. In the EU, for example, public charging networks are required to include a Mennekes Type 2 connector where Level 2 or rapid alternating current (AC) charging is provided, and a combined charging system (CCS) connector where Level 3 charging is provided[21].

Furthermore, EVs also generate massive amounts of data through their operations, and data standards and communication protocols that will enable data-sharing – between charging points and the vehicle; manufacturer and the vehicle; charging network providers and charging points; or charging network providers and utilities providers – could also help to strengthen the overall EV ecosystem and promote greater collaboration.

Fleet charging networks

For fleets, charging could either be carried out in depots and delivery hubs, or opportunistically at public charging stations. To reap economies of scale, fleet operators could consider building their own charging networks as they will be able to benefit from the high utilisation rates of the chargers, as well as low downtimes for the EVs. From the perspective of utilities providers, EV fleets also provide the grid with greater flexibility as charging times can be scheduled[22].

Depot charging

As the cost of installation for chargers is fairly substantial, it is important that depot charging infrastructure is structured around the specific types of EVs that require charging, and the timeframes within which they are required to be fully charged, so as to minimise any downtime as a result of time lost waiting for charging to be completed. Furthermore, fleet operators will also need to deal with grid limitations, balance their peak loads, and manage charging times which may now come into competition with time previously spent on preventive maintenance and repairs. For fleets with predictable routes, charging could be also be scheduled at the completion of every route.

18 "e-Mobility options for ADB developing member countries". Asian Development Bank. March 2019.
19 "How growing cities can support at-home electric vehicle charging". Eco-Business. 26 January 2019.
20 "Electric vehicle adoption and public charging". Siemens.
21 "Standardisation of EV charging in the EU". CleanTechnica. 16 February 2019.
22 "Electric vehicle adoption and public charging". Siemens.

Opportunistic charging

Fleet operators, especially those with ride-hailing models, could also consider engaging in partnerships with charging point operators to achieve high utilisation of charging facilities and secure preferential rates for users. This could, in turn, help to increase the coverage of such commercial fleets which do not possess predictable routes or fixed travel patterns, and which have limited opportunities for overnight charging sessions, such as multi-shift or last-mile logistics fleets.

Power grid

In addition to the charging infrastructure, a robust power grid must also be in place to cater to the increased demand for electricity and high-speed charging requirements. Indeed, the increased usage of EV charging facilities may have substantial impacts on grid stability, particularly when feeder capacities are inefficient or when uncoordinated charging increases the peak demand load.

For example, travel patterns may result in private vehicles opportunistically leveraging public en-route fast chargers in the evening, coinciding with peak demand on the power grid[23]. Furthermore, depot charging also often involves the charging of multiple vehicles at once, which may potentially strain local capacity.

To cope with these challenges, stakeholders will need to strategically determine the most appropriate EV charging locations by taking into account available grid capacities, and adopting a least-cost approach to mitigating the impacts on the grid. Smart charging infrastructure could also be used to reduce the need for investments in physical infrastructure: digital solutions and load-shifting incentives for consumers could potentially help to reduce investment in physical infrastructure by up to 50% per car; furthermore, peak demand load would also see a lower increase of only 0.5 GW if smart charging is implemented, as compared to 3GW with unsupported charging[24].

Uncoordinated high-speed charging will also lead to a quicker degradation of power infrastructure, which will then require more frequent replacements. In the US cities of Los Angeles and Vermont, for example, uncoordinated high-speed charging resulted in the breakdown and burnout of medium voltage distribution transformers[25]. In particular, it was noted that uncoordinated Level 2 high-speed charging causes distribution transformers to age about seven times faster, whereas uncoordinated Level 1 low-speed charging causes distribution transformers to age about three times faster[26].

Battery Swapping

Given the high costs of building charging networks and facilities, Southeast Asian markets should also consider exploring other alternatives to facilitate greater electrification. In many regional cities, where two-wheelers or three-wheelers are the dominant form of transportation, battery swapping could be an especially viable option: as these vehicles are smaller in size, they tend to have batteries that are easier to handle, and these can be quickly manually changed to save users time that would otherwise be spent waiting for a full charge[27].

A battery-as-a-service model may also be highly compatible with the consumer mindset in many of Southeast Asia's developing cities, where consumers prefer to purchase items in smaller and affordable quantities, as well as attractive for commercial vehicle users who stand to benefit from lower vehicle downtimes, and reduced battery degradation – and therefore lower vehicle depreciation.

23 "Mitigation of vehicle fast charge grid impacts with renewables and energy storage". Centre for Transportation Technologies and Systems. 15 May 2013.
24 "Electric vehicle adoption and public charging". Siemens.
25 "Study of PEV Charging on Residential Distribution Transformer Life". IEEE Transactions on Smart Grid. March 2012.
26 "Estimating the acceleration of transformer aging due to electric vehicle charging". IEEE Xplore. 2011.
27 "Power surge for electric vehicle ecosystem". Mint. 31 May 2020.

Market scorecards: Charging networks

Indonesia

Local power producers have been working on the expansion of public and fleet charging options, with charging tariffs regulated by the Ministry of Energy and Mineral Resources (MEMR). Battery swapping trials are also being carried out by several industry players for the two-wheeler use case.

Public charging networks	●○○○
Fleet charging networks	●●○○
Power grid	●○○○
Battery swapping	●○○○

Malaysia

Malaysia has plans to build 25,000 public charging points and 100,000 private charging points by 2030. Currently, its power grid can support up to 10% electrification with uncontrolled charging, but full electrification will require cable resizing and coordinated smart charging.

Public charging networks	●●○○
Fleet charging networks	●●○○
Power grid	●●○○
Battery swapping	○○○○

Philippines

There are over 4,300 registered EVs in Philippines, but only 40 public charging stations as of 2018. To make EVs more attractive for users without access to private charging stations, an expansion of public charging networks will be required. In the fleet segment, over 200 charging stations have since been installed for e-trikes, e-jeepneys, and EV buses to support their increased adoption.

Public charging networks	●○○○
Fleet charging networks	●●○○
Power grid	●○○○
Battery swapping	●○○○

Singapore

There are about 1,800 public charging points available across Singapore, with plans to install 60,000 charging points by 2030. However, most of these locations are close to high-traffic areas such as the central business district, rather than residential neighbourhoods. To address this issue, the government will be setting aside SGD 30 million between 2021 and 2025 for initiatives to promote the increased adoption of EVs, which includes increasing the number of chargers at private properties. Fleet operators also have their own extensive charging networks. Although Singapore's power grid currently has excess capacity, it is also exploring renewable energy sources to ensure that it can sustainably support future EV charging requirements.

Public charging networks	●●●○
Fleet charging networks	●●○○
Power grid	●●●○
Battery swapping	○○○○

Thailand

Thailand has a relatively extensive public charging network, with about 1,000 charging stations installed throughout the country within 200 kilometres of one another. However, fleet charging networks remain limited, with only 30 charging stations in Bangkok for EV taxis. Thailand aims to obtain 25% of its power needs from renewable energy sources by 2021. To support its electrification needs, it will need to augment its existing grid with energy storage infrastructure.

Public charging networks	●●○○
Fleet charging networks	●○○○
Power grid	●●○○
Battery swapping	●○○○

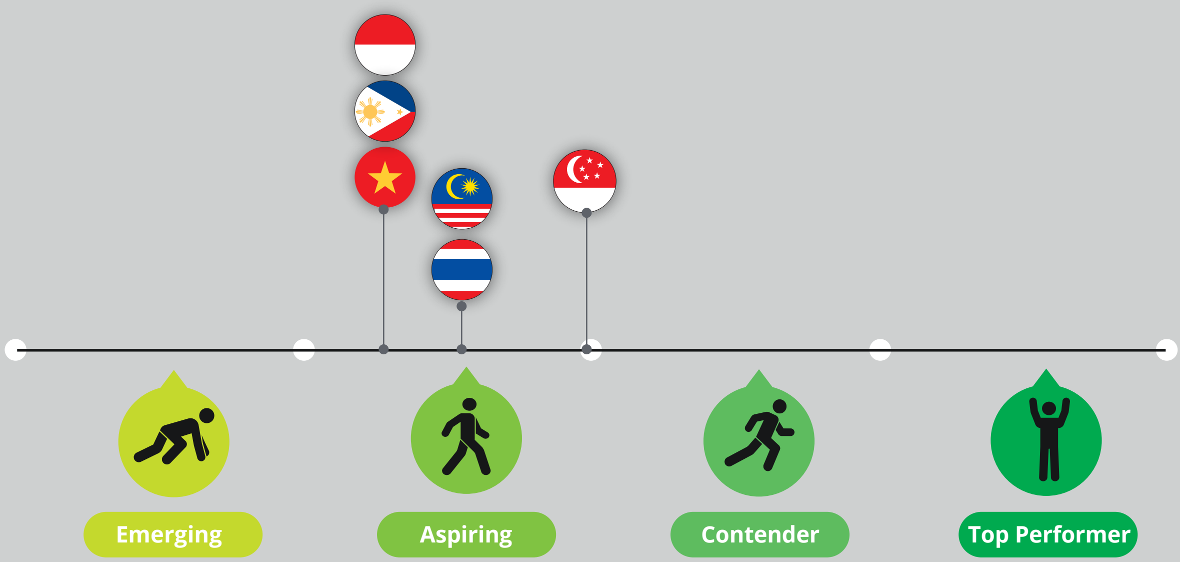
Vietnam

EV adoption continues to be hindered by a lack of public charging stations in Vietnam. Based on grid simulation exercises, Vietnam can expect to experience a 3% to 32% overload in selected transmission lines under normal operating conditions.

Public charging networks	○○○○
Fleet charging networks	●●○○
Power grid	●○○○
Battery swapping	●●○○

Overall evaluation

Based on the final weighted scores, we have categorised all six Southeast Asian markets as Aspiring. Overall, however, Singapore is deemed to be leading for the charging networks enabler given its relatively more extensive public and fleet charging networks, as well as its power grid's ability to support future electrification needs.



Regulatory environment

While the level and design of incentives for EV adoption may vary significantly across markets due to other wider policy considerations, what is clear is that a well-articulated framework and coherent structure of governance are needed to support stakeholders in developing long-term EV transition roadmaps.

In more developed EV markets, governments typically provide financial incentives – including subsidies, tax incentives, and other rebates for EV owners – and the necessary legal and regulatory infrastructure to support the development of public charging networks. In emerging EV markets, however, the approach tends to favour more modest import duty reductions, purchase subsidies, battery swapping and charging stations programs, as well as the adaptation of EVs for the local context.

For many Southeast Asian markets, bilateral and regional trade agreements are also an important means by which governments can incentivise automotive manufacturers to set up local production facilities. As free trade agreements (FTAs) help to promote greater trade flows by addressing some of the barriers that might otherwise impede the flow of goods and services[28], jurisdictions which have established a larger numbers of FTA with stronger trade partners would therefore be better positioned to capitalise on opportunities along the EV value chain with greater foreign direct investments.

As Southeast Asian regulators mull over their approach for the electrification journey, it might also be worthwhile for them to consider localising some of the best practices – both incentives and disincentives – from some of the more developed EV markets.

Incentives

Subsidies may be distributed to incentivise both the adoption and manufacturing of EVs within a market. These could be distributed at various stages along the value chain, from R&D to production, purchase, and usage.

Production incentives

Production incentives are intended to encourage original equipment manufacturers (OEMs) to set up production facilities in the market. By lowering the cost of production through cash incentives or the reduction of import tariffs, countries seek to firmly establish their positions in the downstream EV market.

In Canada, Fiat Chrysler has announced that it will invest up to USD 1.5 billion to manufacture electric or hybrid vehicles at its Windsor, Ontario plant, fuelled by unspecified government incentives[29]. As Southeast Asian markets, such as Indonesia and Vietnam, pursue targets to boost their local EV manufacturing sectors, such supply-side incentives disbursed at different points along the value chain may help to incentivise OEMs to boost their EV production. These cost savings may also be passed down to the end consumer, and in turn help to boost purchase demand.

R&D subsidies and grants

R&D subsidies and grants work to encourage innovation in EVs, and the diversification of product lines. In India, for example, the government has decided to fund up to 60% of the R&D cost for the development of a local low-cost electric technology that will help to power two-wheelers, three-wheelers, and commercial vehicles operating in public spaces, with the overall objective of promoting collaborative innovation in the production of lithium battery technology, motors and drivers, charging infrastructure, drive cycle and traffic pattern, and light weighting of EVs[30].

Purchase incentives

Purchase incentives help to bridge the gap between an OEM's pricing and the consumers' willingness to pay. These may be directly provided to the consumer through subsidies and tax exemptions, or indirectly as cost savings which are passed on to the consumer, such as a reduction of tax and tariffs on EV imports.

28 "The benefits of free trade agreements". Australia Government Department of Foreign Affairs and Trade.
29 "Canada's electric dream: Are government incentives and smart R&D enough to build a domestic EV industry?". The Logic. 16 October 2020.
30 "Government to fund up to 60 per cent R&D cost for e-vehicles". The Economic Times. 11 January 2017.

In Norway, EV purchases have been exempted from the 25% value-added tax (VAT) since 2001. Furthermore, there are no other purchase or import taxes, and company car taxes have been reduced to 40%[31]. In order to be effective, such fiscal incentives need to be sufficiently high to offset the cost differences between EVs and conventional ICEVs. As a result, direct purchase subsidies could prove to be a heavy burden on public finances for many Southeast Asian markets.

Usage incentives

Usage incentives help to reduce operating costs or increase the market prices of second-hand EVs relative to ICEVs. These include parking fee incentives, discounts on highway toll charges, charging fee caps for electricity, installation subsidies for charging points, and dedicated lanes and parking infrastructure. In Norway, for example, EV users have had access to bus lanes since 2005, and only pay up to a maximum of 50% for ferry fares and other locally implemented parking fees[32].

Disincentives

To increase the relative attractiveness of EVs, governments may also impose taxes and other regulation to discourage the purchase, usage, production, or importation of ICEVs.

Purchase disincentives

Purchase disincentives for ICEVs include registration quotas, and taxes that vary with fuel economy or emission levels. In more developed EV markets such as Sweden, however, regulators are looking to shift the burden of vehicle taxes onto more pollutive vehicles. Buyers of new gasoline and diesel cars with CO2 emission values of above 95 g/km will be liable to pay an increased annual ownership tax during the first three years, while owners of diesel-powered vehicles will be subject to another additional surcharge[33].

Usage disincentives

Usage disincentives for ICEVs include licence plate restrictions, and the implementation of low emissions zones to compel individuals and commercial fleets to switch to vehicles that are in compliance with these standards[34]. Across Europe, we observe the proliferation of low emissions zones: in the 12 EU states, there are currently more than 260 low emissions zones[35].

Similar efforts can be observed in several Southeast Asian markets, although the results vary. Jakarta, for example, has already implemented an odd-even licence plate policy, which aims to alleviate the city's notorious traffic congestion by restricting access to selected roads to vehicles with odd-numbered licence plates on odd-numbered dates, and to vehicles with even-numbered plates on even-numbered dates. However, as a workaround, many individual consumers simply purchase vehicles with different licence plate numbers.

Production and import restrictions

Production and import restrictions could take many forms, but they typically act as a form of cross-subsidy for the production of EVs. In China, for example, the new energy vehicle (NEV) credit score program requires OEMs to earn credits equivalent to 10% of their ICEV sales. These credits may be earned through the sale of NEVs, including BEVs, plug-in hybrid electric vehicle (PHEVs), and fuel cell vehicles (FCVs), or purchased from other companies with excess credits. Failure to comply could lead to sanctions, such as production halts, withholding of approvals for new models, or even the cancellation of licences to sell and operate[36].

It remains to be seen, however, how markets in Southeast Asia – especially those with established automotive manufacturing hubs – can navigate such a shift in their production mix.

31 "The incentives stimulating Norway's electric vehicle success". CleanTechnica. 28 January 2020.
32 "The incentives stimulating Norway's electric vehicle success". CleanTechnica. 28 January 2020.
33 "Sweden's new bonus-malus scheme: From rocky roads to rounded fells?". The International Council on Clean Transportation. 8 October 2018.
34 "Low emission zones and the impact on fleets". LeasePlan. 2017.
35 "City bans are spreading in Europe". Transport & Environment. October 2018.
36 "Philippine electric vehicle policy analysis report - Draft report". De La Salle University. July 2019.

Market scorecards: Regulatory environment

Indonesia

High import tariffs may continue to play a part in deterring EV adoption in Indonesia, although vehicles arriving from other ASEAN countries, China, and South Korea are tariff-exempt. Recent proposals by the Ministry of Finance include suggestions to cut tariffs levied on EVs with fewer than nine seats from the current 70% to 50% in order to boost adoption. Indonesia is also currently finalising a new EV policy that will offer fiscal incentives, such as tax cuts, to foreign automotive manufacturers as it ramps up its efforts to become a lithium-ion battery hub.

Purchase incentives	●●●○
Usage incentives	●●○○
Trade regulations	●●○○

Malaysia

With high duties imposed on imported cars, the uptake of EVs continues to remain limited. However, the launch of Malaysia's Low Carbon Cities 2030 plan, which entails the establishment of 200 low carbon zones across the country, may bring about a greater push for green vehicle options, including EVs.

Purchase incentives	○○○○
Usage incentives	●○○○
Trade regulations	●●○○

Philippines

To encourage the transition to e-trikes, the government has implemented several legislations, including a "no upfront cash" system that enables users to purchase e-trikes without the need to make down payments. Instead, users pay a monthly instalment using the money that they would save from not needing to purchase gasoline. With changes to the automotive tax structure under the Tax Reform for Acceleration and Inclusion Act (TRAIN), ICEVs are subject to an excise tax of between 4% and 50% of their initial purchase price. EVs, however, will be exempt from this tax. Other initiatives include a Public Utility Vehicle (PUV) modernisation plan to replace public transport vehicles that are 15 years or older with modern vehicles that are able to meet the low-emission Euro 4 standards – or produce no emissions at all, like e-jeepneys.

Purchase incentives	●●○○
Usage incentives	●●○○
Trade regulations	○○○○

Singapore

In Singapore, the government has implemented the EV Early Adoption Incentive, which offers consumers purchasing fully electric cars a tax rebate of 45% for the additional registration fee (ARF), which is capped at SGD 20,000. The Vehicle Emission Scheme also offers EV buyers an additional rebate of up to SGD 25,000 depending on the EV model. Singapore is also a fairly attractive location for EV manufacturing operations given its conducive trade regulations, and high number of FTAs.

Purchase incentives	●●○○
Usage incentives	●●○○
Trade regulations	●●●●

Thailand

To promote its local EV industry, Thailand has lowered the vehicle excise tax from the usual 10% to 30% for conventional ICEVs to between 2% and 10% for domestically produced EVs. Apart from incentives to entice automotive investors, such as corporate income tax exemptions of up to 15 years and financial incentives for investments in R&D, innovation, or human resources development, the government has also committed to devoting parts of its budget to the purchase of EVs.

Purchase incentives	●●●○
Usage incentives	●○○○
Trade regulations	●○○○

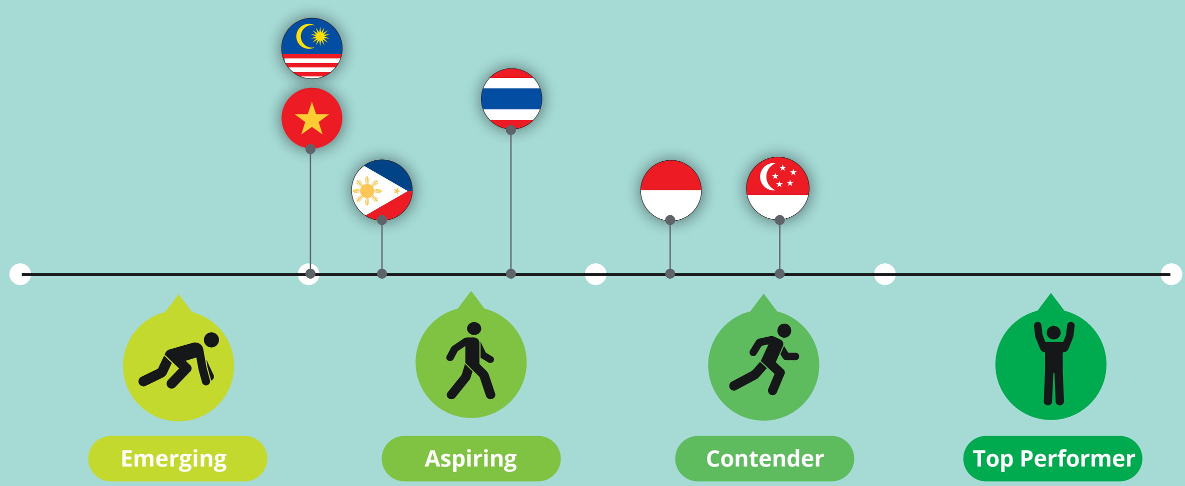
Vietnam

To reduce traffic congestion, Vietnam has begun implementing city taxes on two-wheelers, with the objective of ultimately phasing out two-wheelers in city areas by 2030. Currently, ICEVs and EVs are subject to the same level of import taxes, as the focus is less on the specific fuel type, but more on supporting the local car manufacturing industry and encouraging the purchase of domestically produced vehicles.

Purchase incentives	●●○○
Usage incentives	○○○○
Trade regulations	●○○○

Overall evaluation

Based on the final weighted scores, we have categorised Malaysia and Vietnam as Emerging; Philippines and Thailand as Aspiring, and Indonesia and Singapore as Contenders. Overall, Singapore is deemed to be leading for the regulatory environment enabler as a result of its conducive trade regulations and extensive FTAs, whereas Indonesia appears to have an edge in terms of purchase incentives, such as its proposed reduction of tariffs for EVs.

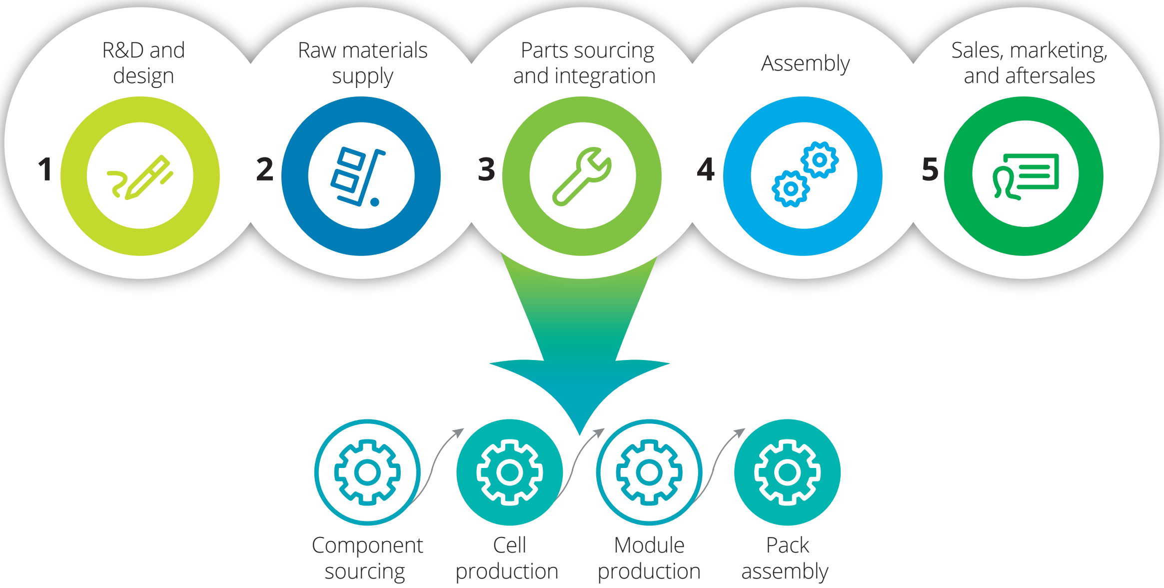


Value chain potential

Identifying a market's existing competencies and key competitive advantages within the overall EV value chain is an important step for automotive industry players who are determining whether to enter or expand their operations within specific markets.

There are five main stages in the EV value chain – R&D and design; raw materials supply; parts sourcing and integration; assembly; and sales, marketing, and aftersales – each with their own set of key success factors that will determine the strength of the market's competitive advantage in these areas (see Figure 13).

Figure 13: Five main stages in the EV value chain



Stage 1: R&D and design

In this stage, OEMs conduct market research, develop EV concepts, and design specifications for its key systems. While the existence of a local R&D centre may not always be necessary for a market to signal the growth of an EV ecosystem, its presence could indicate the market's long-term commitment towards the local and regional EV ecosystems.

From the perspective of automotive manufacturers, local R&D and design facilities could enable them to capitalise on local talent and research capabilities for a better overall understanding of the local context that could inform the development of their EV models, and also test their prototype and products with their intended target market.

Hyundai, for example, has signed a memorandum of understanding with Indonesia to invest about USD 1.55 billion by 2030 in its EV manufacturing sector. Part of this long-term investment plan will also include the building of an EV R&D centre between 2022 and 2030 to tap on other existing EV capabilities within the market[37].

37 "Opportunities in Indonesia's electric vehicle segment". Oxford Business Group.

Stage 2: Raw materials supply

In this stage, raw materials are sourced and supplied to the manufacturers of various EV components. These raw materials include mainly lithium, nickel, cobalt, manganese, and graphite for electric batteries[38], and rare earth elements such as neodymium and dysprosium, and cobalt for permanent-magnet EV motors.

As the development of EV technology progresses, sourcing strategies may also need to evolve. For example, while lithium-ion batteries are most commonly used at present, the next generation of batteries, such as solid state batteries, are likely to rely less on nickel and cobalt, and more on lithium due to sourcing constraints[39].

Furthermore, as rare-earth elements can be extremely difficult to extract due to their labour-intensive refinement processes, many industry players are also trying to reduce their dependence on these elements. Toyota, for example, has managed to reduce its requirements for neodymium by 20% by replacing it with other, less sought-after rare earth elements[40]. Globally, the shortfall in global mining capacity for rare-earth elements is also linked to the lack of legal compliance and risk management by miners, who have come under pressure for their human rights violations and reliance on child labour[41].

As a result, several markets in Southeast Asia with rich sources of cobalt, such as Indonesia and Philippines, are increasingly gaining the attention of EV component manufacturers[42]. Not only do these markets carry fewer geo-political risks, but their proximity to local and regional EV production facilities may also be a lucrative pull factor for OEMs who stand to benefit from significantly reduced importation costs. At the same time, other regional markets, such as Singapore, who may lack a natural supply of raw materials but possess high levels of technical expertise may also see value in entering various parts of the downstream value chain, for example, in the recycling of rare-earth elements.

Stage 3: Parts sourcing and integration

In this stage, component specialists conduct the mass production of modular EV parts, assemble key modules and systems according to the requirements set by standardisers, and deliver the finished modules to assemblers. Broadly, the production and assembly of EV batteries comprise four stages:

01. **Component sourcing:** To support the production of battery cells, which are the basic units of lithium-ion batteries, component specialists will need to source for the necessary active materials to produce the anodes, cathodes, binders, electrolytes, and separators[43].

02. **Cell production:** Battery cells are produced by inserting the active materials into an aluminium case[44]. Major cell manufacturing locations include China and US, which account for 84% of lithium-ion cell production volumes as of 2020[45], in addition to Japan and South Korea.

03. **Module production:** Battery modules are produced by assembling multiple battery cells in cases, and attaching them with terminals. Depending on the EV model, each module could contain between 4 and 444 cells. Such modules are usually produced in the same facility as battery packs[46].

04. **Pack assembly:** Battery packs are produced by assembling modules, battery management systems, and electrical connections. Not every step of the pack assembly process can be automated, with some processes still requiring manual labour[47]. Packs are often designed specifically for each vehicle module, and are usually assembled near the final vehicle assembly plant.

38 "The supply chain for electric vehicle batteries". Journal of International Commerce and Economics. December 2018.
39 "Powering the future: Sourcing raw materials for electric vehicle batteries". Linklaters.
40 "The materials needed to build an electric car's motor are insanely difficult to harvest". Car and Driver. 7 November 2018.
41 "The materials needed to build an electric car's motor are insanely difficult to harvest". Car and Driver. 7 November 2018.
42 "Indonesia may provide answer for electronic industry's growing cobalt problem". PRNewswire. 19 July 2018.
43 "Battery global value chain and its technological challenges for electric vehicle mobility". RAI Revista de Administração e Inovação. October-December 2017.
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45 "Breaking down the lithium-ion cell manufacturing supply chain in the US to identify key barriers to growth". Materials Science. 2018.
46 "The supply chain for electric vehicle batteries". Journal of International Commerce and Economics. December 2018.
47 "Robotic automation for electric vehicle battery assembly: digital factory design and simulation for the electric future of mobility (Working Paper)". OSF. 10 September 2019.

Each of these four abovementioned stages can be conducted in different geographical locations. For example, while the BMW i3 model is assembled in Germany, its battery packs are assembled by the battery manufacturer Samsung SDI in Hungary, and its battery cells are produced in South Korea[48].

As compared to the vehicle assembly stage, the parts sourcing and integration stage is less automated and more labour-intensive. Locations of battery cell production plants are therefore generally correlated with the existence of lower labour costs, as well as the availability of raw materials as stakeholders seek to reduce shipping and tariff costs. For example, Hyundai Motor Group and LG Chemical are planning to open an EV battery manufacturing plant in Indonesia to leverage its availability of raw materials such as nickel[49] for the production of lithium-ion batteries.

On the other hand, locations for module production and pack assembly facilities tend to be situated closer to the OEMs, where the final assembly of the EVs is conducted.

Stage 4: Assembly

In this stage, the assembly of EVs is conducted by the OEMs, typically through a joint venture or contract manufacturing agreement. Depending on their factor endowments, this process could take place locally or regionally.

To maintain a lean assembly process that would help to speed up production, EVs comprise fewer electronic control units (ECUs) with more well-integrated systems than conventional ICEVs. While the engine for an average four-wheeler ICEV would consist of about 2,000 moving parts, its electric equivalent would contain only about 20[50]. With the reduced mechanical complexity, there is also a lower reliance on labour, and a higher degree of automation[51].

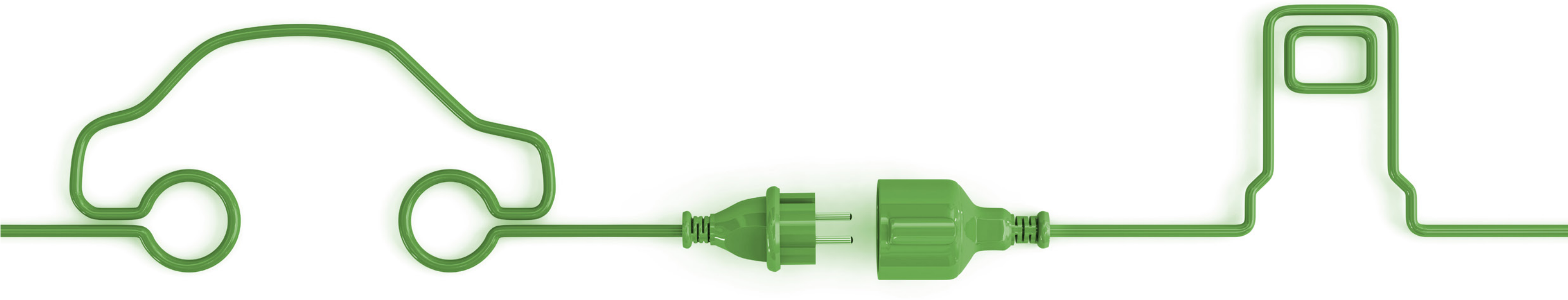
For many OEMs, the focus is also shifting towards greater R&D and design to produce more integrated components[52], with some players looking to set up new manufacturing plants in locations with the necessary technical expertise. For example, Hyundai Motor has decided to set up an EV assembly factory in Singapore to produce 30,000 EVs per year with an automated assembly process that integrates artificial intelligence, robotics, and the Internet of Things[53].

48 "The supply chain for electric vehicle batteries". Journal of International Commerce and Economics. December 2018.
49 "Hyundai, LG Chemical to set up EV factory in Indonesia". The Insider Stories. 23 June 2020.
50 "What is an EV?". Drive Electric.
51 "Electric vehicle makers rethink assembly processes". Assembly. 6 November 2019.
52 "The new trend in EV manufacturing: integrating components". Essentra Components. 30 July 2018.
53 "Hyundai unveils plans for smart mobility lab in Jurong Innovation District". The Business Times. 31 March 2020.

Stage 5: Sales, marketing, and aftersales

In this final stage, the OEMs conduct their sales, marketing, and aftersales activities to ensure that their finished products reach the end-users. After-sales, in particular, is one area which presents several potential growth opportunities for EV players. These include:

- **Repair expertise:** Supporting end-users in overcoming their complications with the use of EVs is key to encouraging greater adoption. Even in markets with more advanced EV systems, repair expertise remains an important issue, as many ground technicians lack sufficient knowledge of EV systems. Efforts that OEMs are investing in this area include the replacement of workshops with bodyshops in markets such as Norway, where bodyshop technicians – unlike repair technicians – are required to undergo the Advanced Driver Assistance Systems (ADAS) training program to perform battery transplants. Quite possibly, we may be moving towards a model where there will be no servicing of engines, and only the batteries and electric components will be replaced and repaired[54].
- **Insurance:** As EVs are a relatively new vehicle type and more costly than conventional ICEVs, users are likely to be more concerned about their safety aspects and other related cost issues that may arise. Insurance coverage may therefore be a key consideration in the purchase decision. Currently, many insurance players have already begun integrating EVs into their quotation systems[55], although the premium rates for EVs are still relatively higher than conventional ICEVs due to the higher associated repair costs[56].
- **Second-life market for batteries:** The recycling of used electric batteries is a significant feature of the sustainability benefits of EV adoption. For example, about 75% of EV batteries can be remanufactured into other vehicles or stationary energy systems. Given an average value of USD 45 per kWh, this translates into a market value of some USD 45 billion over a period of 12 years[57]. To tap into this immense potential and capitalise on the scarcity of lithium and other rare-earth elements, Southeast Asia will need to develop its second-life market by building the necessary technical capabilities.



54 “Lack of EV-trained repairers may pose a problem for fleets’ uptime”. FleetNews. 17 March 2020.
55 “Electric car insurance”. Pod Point.
56 “Everything you need to know about insuring an electric vehicle”. Bankrate. 24 April 2020.
57 “China to ‘dominate recycling and second life battery market worth US$45bn by 2030’”. Energy Storage. 4 November 2019.

Market scorecards: Value chain potential

Indonesia

Indonesia is a hinterland for many of the raw materials essential for the manufacturing of EV batteries, including nickel, cobalt, and copper. To support the EV battery manufacturing sector, the government has put in place regulations to halt the exportation of unprocessed nickel ores. Furthermore, the government is committed to increasing the proportion of EVs to 20% of its total car production by 2025, and has been able to successfully attract investments from major EV players. While EV adoption is still in its early growth stage, ride-hailing operators have already begun adopting EVs, and public transport operators are also planning to procure EV passenger buses.

R&D and design	○○○○
Raw materials supply	●●●○
Parts sourcing and integration	●●○○
Assembly	●●○○
Sales, marketing, and aftersales	○○○○

Malaysia

With the introduction of the National Automotive Policy 2020, Malaysia has also been able to leverage its copper reserves to increase its momentum in the manufacturing of lithium-ion batteries and battery packs. While there are currently only three OEMs involved in the manufacturing of EVs, there has been a palpable shift towards EV production. For example, the Malaysia Automotive, Robotics and IoT Institute (MARii) is collaborating with a consortium to build the first electric bus assembly plant in Malaysia. Although EV adoption is low across all use cases, fleet operators have also been increasing their usage of EVs.

R&D and design	●○○○
Raw materials supply	●○○○
Parts sourcing and integration	●○○○
Assembly	●○○○
Sales, marketing, and aftersales	○○○○

Philippines

Home to 5% and 4% of global nickel and cobalt reserves respectively, Philippines has plans to participate more actively in the EV battery production value chain. Currently, there are 11 companies involved in the manufacturing of EV components, but no EV battery manufacturers. Its activities in the assembly and sales of EVs are mostly centred around e-trikes and e-jeepneys that are used by fleet and public transport operators.

R&D and design	○○○○
Raw materials supply	●●○○
Parts sourcing and integration	●○○○
Assembly	●○○○
Sales, marketing, and aftersales	○○○○

Singapore

Singapore's key competitive advantage lies in R&D. Although the high costs of labour and land continue to discourage OEMs from setting up parts sourcing and assembly facilities in Singapore, its overall nationwide push for innovation and digitisation is likely to entice EV players whose focus is on automation. While EV adoption is currently low, there has been a recent uptake on the back of government incentives, especially by fleet operators in the ride-hailing and public transportation sectors.

R&D and design	●●○○
Raw materials supply	○○○○
Parts sourcing and integration	○○○○
Assembly	●●○○
Sales, marketing, and aftersales	●○○○

Thailand

Despite recent efforts to scale up R&D, battery production, and other assembly activities in the EV value chain, Thailand's EV sector continues to be dominated by PHEVs rather than BEVs. As a result, adoption of BEVs remain low, although there are promising plans to increase adoption by fleet and public transport operators, as well as logistic providers.

R&D and design	●○○○
Raw materials supply	○○○○
Parts sourcing and integration	●○○○
Assembly	●○○○
Sales, marketing, and aftersales	○○○○

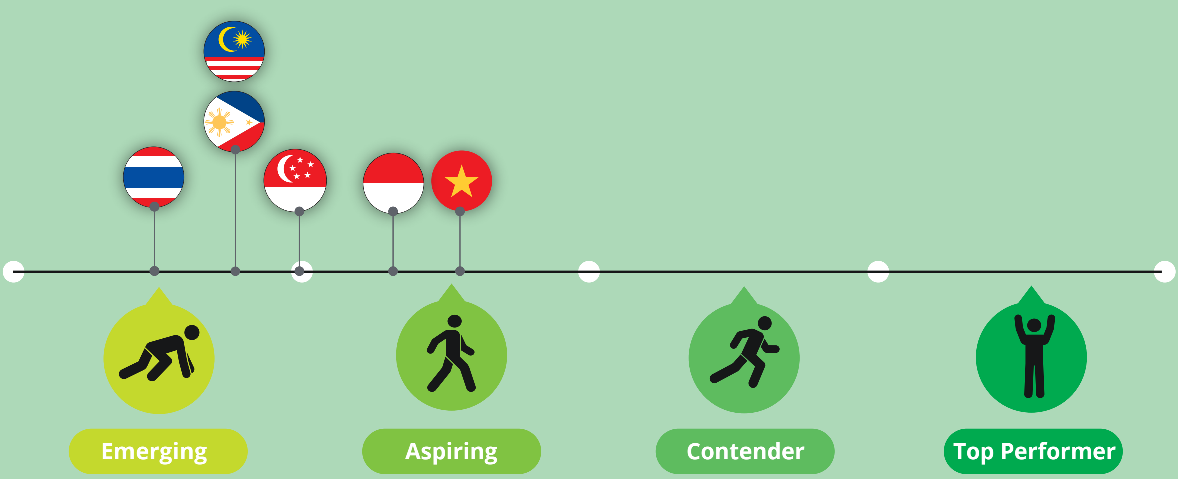
Vietnam

Vietnam's EV sector is dominated by a single automotive manufacturer, VinFast, whose production covers electric two-wheelers, four-wheelers, and passenger buses. It also has plans to expand its EV manufacturing and research operations, as well as establish a supplier park, development complex, and battery manufacturing plant. To boost domestic demand, high levels of discounts are offered on VinFast's EVs. Looking ahead, Vietnam is well-positioned to become a low-cost nickel sulphate producer for the region's EV lithium-ion battery market given its endowment of nickel, cobalt, and other mineral ores.

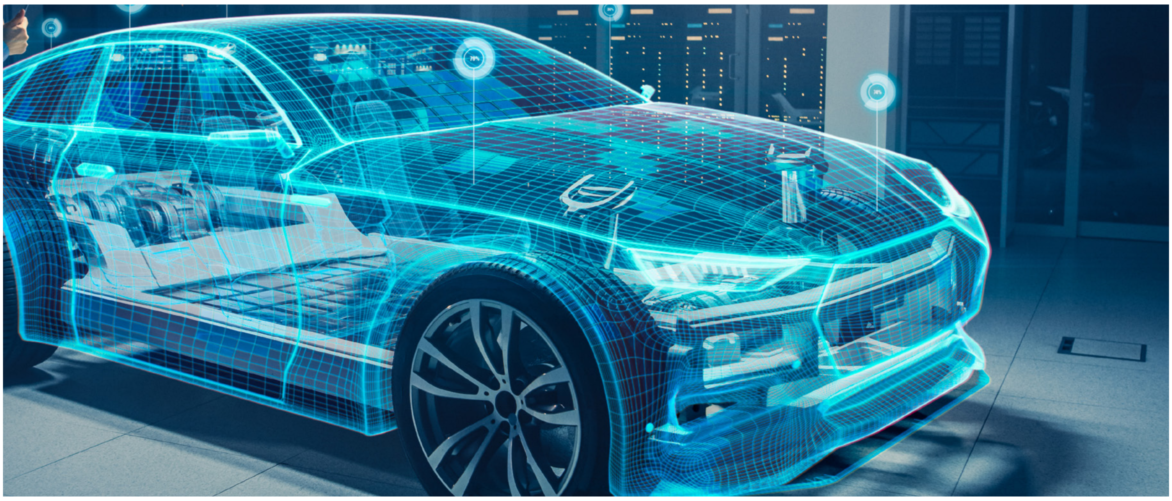
R&D and design	●○○○
Raw materials supply	●●○○
Parts sourcing and integration	●●○○
Assembly	●●○○
Sales, marketing, and aftersales	●○○○

Overall evaluation

Based on the final weighted scores, we have categorised Malaysia, Philippines, Singapore, and Thailand as Emerging, and Indonesia and Vietnam as Aspiring. Overall, Vietnam is deemed to be leading in terms of the value chain potential enabler given the ambitious expansions plans by its national automaker VinFast, strong government support for its initiatives, and endowment of mineral ores.



Overall market analysis



Based on our evaluation of the five enablers, we have assessed the feasibility of the various use cases, and analysed the areas of opportunities for each of the six Southeast Asia markets to provide some recommendations for industry players and other stakeholders to consider as they accelerate their electrification journeys.

Indonesia

While the EV adoption rate for private vehicles is currently low, an increased focus on local EV manufacturing, coupled with increased incentives – such as exemptions on luxury taxes – may help to push future demand. On the bright side, EVs are seeing greater adoption by ride-hailing operators, such as Grab, which recently announced a partnership with local power company PLN to develop its fleet charging infrastructure[58], as well as public transport operators, such as Transjakarta, which plans to expand its electric bus fleet to 10,000 units over the next decade[59].

However, the use case for logistics LCVs remains less clear. Currently, no known logistic companies have cited an interest in switching to EVs. This is likely due to the fact that logistics vehicles in Indonesia travel an average daily mileage of 224 kilometres, and would therefore require more than one charge a day. To reduce range anxiety, logistics fleet operators could consider installing standardised on-route charging points for their trucks and fleets.

Overall, an expansion in EV manufacturing and battery production capabilities would also require Indonesia to make a broad-based shift towards high-value manufacturing, by investing in its Industry 4.0 capabilities and talent, as many of the technological processes are highly integrated. It would also need to scale up its power grid to support large-scale electrification plans, including the potential construction of solar-powered charging stations with energy storage that do not need to be powered by the grid, and installation of battery swapping outlets along travel routes for quick and easy battery replacement.

58 "Grab has announced a partnership with local power company PLN to develop its fleet charging infrastructure.". DealStreetAsia. 16 December 2019.
59 "Jakarta bus operator wants 10,000 electric buses in service by 2030". The Star. 30 December 2020.

Malaysia

The EV adoption rate for private vehicles is currently low, as a result of limited regulatory incentives and high import duties, although fleet use cases may be more promising. In March 2020, the Malaysian-German Chamber of Commerce & Industry announced the signing of a memorandum of understanding that aims to introduce 100 electric buses to Malaysia's public transport system[60].

Few logistics companies, however, have cited an interest in switching to EVs. One reason for this could be the fact that Malaysian users tend to travel further distances than other Southeast Asian markets, especially for fleet use cases. Range anxiety associated with the need for frequent charges is therefore a key barrier to adoption. To alleviate this issue, Malaysia would need to establish an integrated charging network across the country, and push for greater data transparency amongst charging network operators to achieve greater locational efficiency in the placement of chargers.

In terms of the value chain, Malaysia should look to develop other segments where they have existing capabilities, such as the production of lithium-ion batteries. This would enable local manufacturers to develop the know-how that could help pave their future transition to EV production. As Malaysia’s grid is currently unable to fully support large-scale electrification, it should also consider the development of battery storage facilities to charge and store power from the grid during periods when electricity costs are lower, to be used when demand is higher. This would help to balance the peak loads as it makes its transition to a more stable power grid.

Philippines

Currently, the EV adoption rate for private vehicles remains low, as many of the incentives have been focused on commercial and fleet use cases, such as e-jeepneys and e-trikes. There is therefore a need to increase usage incentives to improve the total cost of ownership, for example, with lower toll charges, or perhaps increase the convenience of using EVs by offering additional advantages, such as allowing EVs to use bus lanes.

To support private jeepney operators in switching their large fleets of legacy ICEVs to e-jeepneys, the government could also explore ways to lease e-jeepneys to these operators during a transition phase. Furthermore, it should consider how it can tap on its cobalt and nickel reserves to expand its EV battery manufacturing footprint and in turn develop greater capabilities in the manufacturing of electric parts.

Singapore

Although the EV adoption rate for private vehicles remains low, the introduction of attractive incentives and a strong public charging infrastructure could help to boost the future demand. Across all fleet use cases, including ride-hailing and logistics, traction can also be observed as government incentives have resulted in lower vehicle purchase prices and electricity cost savings. The public transport use case, in particular, is set to witness an increased uptake of EVs, as the government continues to procure electric and hybrid buses to achieve its goal of a 100% clean energy vehicles by 2040[61].

Overall, Singapore’s charging infrastructure is well-equipped to meet growing fleet sizes. However, public charging network providers have been working in siloes thus far, leading to an inefficient distribution of charging stations. To overcome this, the government could consider streamlining inter-agency processes to facilitate greater data-sharing across network providers. Singapore has also managed to successfully establish itself as an R&D leader, and should therefore work to anchor itself as the R&D epicentre for the Southeast Asia region’s EV industry, for example, by facilitating investments from multinationals and start-ups to build a strong local EV talent pool.

60 “Malaysia targets 100 electrical buses on road”. OpenGov Asia. 11 March 2020.
61 “All new public buses will be electric or hybrid”. The Straits Times. 6 March 2020.

Thailand

Although EV adoption for private vehicles has increased in recent years, it remains low. Overall, EVs in Thailand have significantly higher vehicle costs as compared to their ICEV equivalents. An increase in incentives, including lower excise taxes, as well as an increase in the convenience of EV usage, such as the introduction of EV-only lanes, may be required to stimulate greater demand.

Fleet use cases are also set to witness an increase in adoption. Key initiatives include, for example, plans for 53,000 electric motorcycle taxis by 2022 and 5,000 electric buses by 2025[62]. However, Thailand's limited fleet charging networks may pose a barrier to its fleet electrification plans. To overcome this, it will need to improve the stability of its charging infrastructure, for example, by implementing battery swapping systems for two-wheelers, and adapting its power grids for solar-powered chargers.

Currently, Thailand's value chain capabilities and customer demand are also mostly focused on PHEVs, rather than BEVs. Industry players should consider ways to leverage the initial interest in PHEVs to generate a stronger BEV network by integrating EV charging infrastructure at existing gas stations.

Vietnam

EV adoption for private vehicles is increasing in Vietnam, as a result of effective government subsidies that promote greater uptake of domestically produced EVs over imported ICEVs. While the fleet adoption of EVs is currently low, this is also likely to see some uptake with plans by VinBus, a subsidiary of VinFast, to introduce up to 200 electric buses[63], and the testing of electric motorbikes by DHL eCommerce as it pursues its goal of cutting gas emissions to zero by 2050[64]. Given the lack of charging stations to support full-scale electrification, current fleet use cases typically depend on chargers located in depots.

To incentivise ride-hailing fleets and taxi operators to pilot EV programs, more efforts are required to reduce the total cost of ownership and increase the coverage of the charging network. To expand public charging networks, Vietnam could also consider pushing for more industry partnerships between OEMs and charging network providers.

62 "Cities on the move: Driving Asia's mobility revolution". Shell. 2020.
63 "Star Charge & VinBus to electrify Vietnam's bus system". electrive.com. 20 Oct 2020.
64 "DHL eCommerce goes green in Malaysia and Vietnam". DHL. 29 August 2018.

Full speed ahead

Broadly, Southeast Asian markets are in a unique position to draw on learnings from more advanced first-mover EV markets, such as China and the Nordics, as they build their own unique approaches to electrification – taking into account their specific local customer requirements, natural resource availability, industrialisation progress, and value chain potential.

There are four key takeaways. Firstly, fleet electrification is driven in large part by the cost savings that users gain from the use of an EV. This is, in turn, derived largely by the cost differences between electricity and fuel: the greater the distance travelled by a vehicle, the shorter its breakeven period. In Southeast Asia, vehicles in fleet use cases – including ride-hailing, logistics, and public transport – tend to travel distances of up to 450% that of private vehicles.

Such fleet use cases are therefore better able to benefit from the cost savings derived from the use of EVs than private vehicle use cases. Businesses with commercial fleets should also collaborate with OEMs on the mass electrification of their fleets, leveraging bulk purchase agreements for discounts on the initial vehicle purchase prices.

Secondly, new financing structures and ownership models may be necessary to increase EV uptake. Given their higher upfront purchase costs, and uncertain hidden costs over time – for example, costs associated with battery repairs – EVs may be perceived by consumers and leasing companies as too risky an investment.

In this context, leasing schemes could help to spread out the cost of the investment over the entire lifespan of the EV, and bring total annual costs to a level that is comparable with conventional ICEVs. Battery swapping models could also be used to help the industry to decouple battery ownership from vehicle ownership by enabling users to pay only when they utilise such battery swapping services. Given that the battery pack constitutes 40% to 60% of the price of an EV, this can also help to reduce the overall purchase price and make EVs more affordable for Southeast Asian consumers.

Furthermore, as consumers shift away from ownership towards mobility, new business models – such as mobility-as-a-service, ride-hailing, and car-sharing – may pave the way to the future. As the residual value of batteries improve, automotive players and fleets may be more willing to adopt or experiment with such newer EV subscription or leasing models.

Thirdly, usage incentives may prove to be more pivotal in encouraging EV uptake than purchase incentives. While most efforts in Southeast Asia are currently focused on purchase incentives, usage incentives could work to reduce the total cost of ownership or increase the convenience of using EVs for consumers. These include, but are not limited to, access to traffic lanes typically reserved for buses or carpoolers, that would help EV users reduce their travel times, especially during peak hour traffic.

Finally, with Southeast Asian governments pushing for increased vehicle electrification, data standardisation will be crucial. Currently, many charging network providers are working in siloes as they propel themselves towards capturing the largest share of the market. This has resulted in a saturation of EV chargers in high-traffic, downtown and central areas, and a lack of EV chargers in residential areas where it may be more convenient for EV users to conduct overnight charging.

To overcome this crowding effect, and increase charging network coverage for the many underserved consumers across Southeast Asia, governments will need to encourage greater data standardisation, for example, by promoting greater transparency amongst charging network providers. By developing an open data platform, charging network providers can also better optimise the locations of their EV chargers to enable them to benefit from a larger customer base and higher utilisation rates.

It is less a question of "if", but more a question of "how" the switch to alternative drivetrains will take place across Southeast Asia. To accelerate with full speed ahead, industry players will need to adopt an ecosystem view as the industry lines continue to blur in the transition from a vertically-integrated automotive industry towards a multifaceted mobility landscape.

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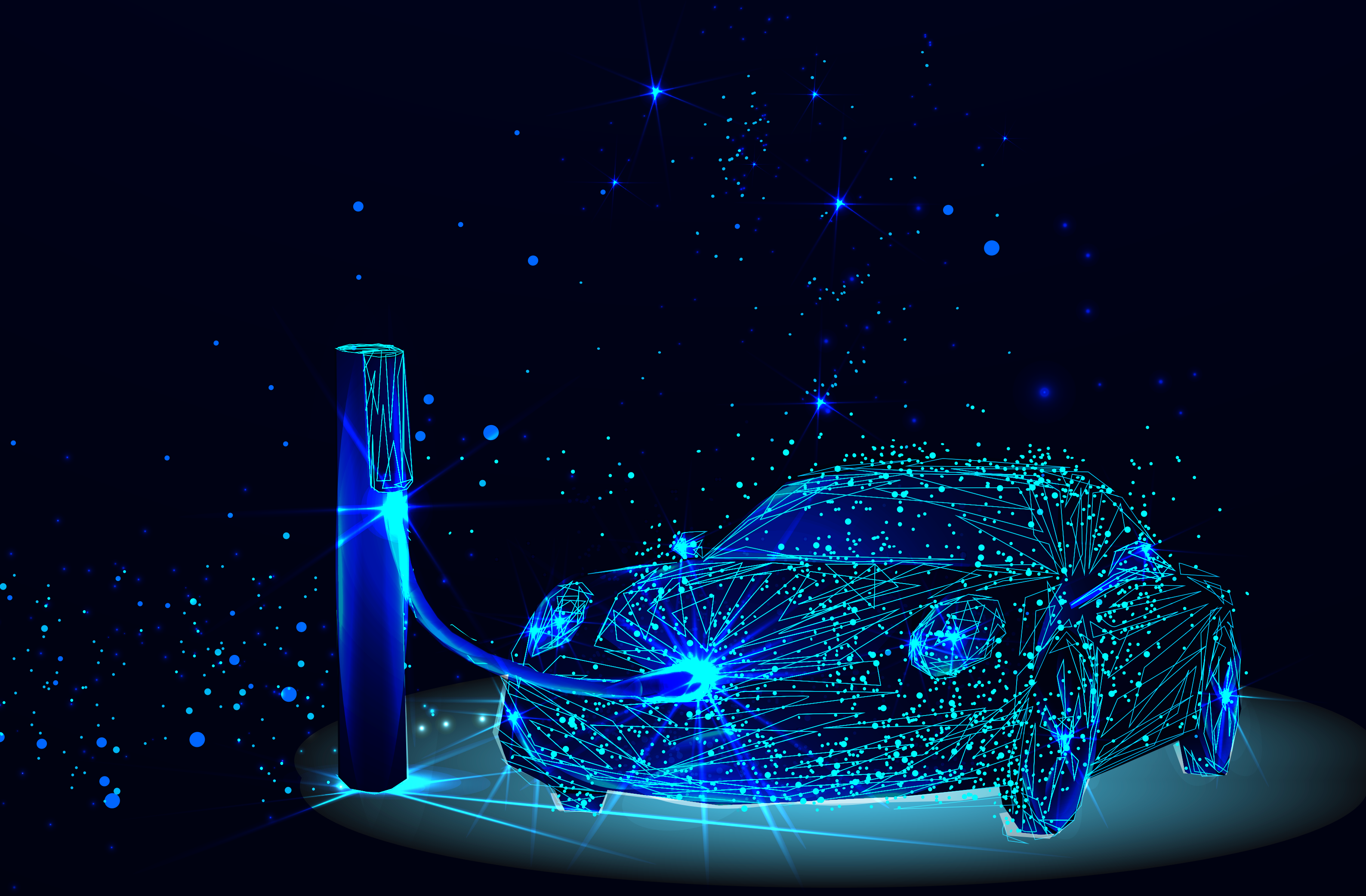

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