

RIDING THE ELECTRIC WAVE

POLICY LANDSCAPE AND OPPORTUNITIES IN THE GROWING ELECTRIC TWO-WHEELER MARKET OF INDIA, INDONESIA, AND VIET NAM

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Abstract

The electrification of vehicles continues to gain traction worldwide, with governments taking strategic actions to decarbonize the transport sector. In Asia, this transition prominently features electric two-wheelers (E2Ws). Two-wheelers have predominantly been used for daily commutes, as shared mobility, i.e., bike-rental and bike-taxi services, as well as urban deliveries. In this growing and competitive electric mobility market, traditional automotive original equipment manufacturers (OEMs) and start-ups, including small and medium enterprises (SMEs), will find potential opportunities to capture value during the transition towards electric mobility.

The objective of this article is to present the policy landscape supporting the E2W transition across three emerging electric vehicle (EV) markets in Asia – India, Indonesia, and Viet Nam. The article begins by highlighting the evolution and challenges of the two-wheeler population in these markets. Following, we explain the necessity for the transition to E2Ws and provide an overview of the current status of E2W adoption. Next, a summary of the regulatory and policy actions to promote E2Ws in the three countries is presented. Finally, policy recommendations to encourage the growth of the entire electric vehicle ecosystem are described.

Introduction

The transport sector is a key contributor to the emission of greenhouse gases (GHGs), with estimates suggesting it will account for over 30% of total emissions in the future (United Nations Environment Programme). In Viet Nam, the transportation industry is accountable for 18% of the total national GHG emissions (Oh, et al., 2019). The sector is also a leading cause of air pollution and short-lived climate pollutants. Therefore, incorporating electric mobility solutions into modern transport systems in Asian countries presents an opportunity to achieve more sustainable mobility by promoting well-connected cities, improved mass transit, and active mobility.

While electric vehicles (EVs) alone cannot solve all transport-related issues, their

implementation can align with larger development goals. Adopting EVs is crucial to meeting the objectives of the Paris Climate Agreement and reducing air pollution. Therefore, low and middle-income countries must adopt zero-emissions electric mobility to achieve these objectives.

Transition to electric two-wheelers

Two-wheelers (2Ws) have become a popular mode of transportation in Asian countries due to their socioeconomic advantages, including lower costs for purchase and operation compared to cars. These vehicles are particularly practical in cities that are expanding, lack public transportation, and suffer from traffic congestion.

Electrification of two-wheelers offers the potential to reduce emissions and noise

pollution, as electric versions produce zero tailpipe emissions and emit minimal noise levels. Adopting electric two-wheelers (E2Ws) is a crucial strategy for reducing GHG emissions, mitigating climate change effects, and achieving a more sustainable transport system. In addition, E2Ws offer many potential applications, including last-mile delivery of goods and cost-effective mobility solutions in remote areas.

The rise of E2Ws has also led to the growth of service industries and created employment opportunities for drivers. Since the onset of the COVID-19 pandemic, E2Ws have experienced a surge in demand primarily due to individuals opting to avoid public transportation. Thus, the development of shared mobility and micro-mobility solutions has boosted E2W sales in Southeast Asia and India. For instance, electric bike sales skyrocketed in India in 2020, and manufacturers faced difficulty keeping pace with the demand (Khan, 2023).

Purpose of this article

The market for E2Ws presents a variety of opportunities for players across the value chain, in addition to established automotive original equipment manufacturers (OEMs). Small and medium enterprises (SMEs), start-ups, and other industry participants can capture value in this dynamic and competitive market. For instance, original equipment suppliers and new entrants can explore various opportunities, including electric power trains, retrofits for ICE-to-electric conversions, cell and battery technologies, and user platforms, among others.

For the electric mobility industry to thrive, it is important to have a combination of regulations that encourage demand and sale models that attract consumers. The article examines current policies, regulations, and standards

related to E2Ws in India, Indonesia, and Viet Nam, identifies areas where progress on two-wheeler electrification may be impeded, and offers suggestions to address these issues. The article aims to provide insights and guidance for industry participants looking to capitalize on the growing E2W market.

Popularity of two-wheelers in Asia

Urban transportation systems, particularly in Asia, are undergoing significant changes due to rapid urbanization and increased vehicle ownership. Developing markets have the largest portion of the micro-mobility market, with two-wheelers being the dominant mode of transportation.

There exist variations in the definitions and classifications of two-wheelers across various countries. In order to maintain consistency, the definitions of 2Ws (based on body type) have been sourced from MotorCycles Data and are presented in Figure 1.

India, Indonesia, and Viet Nam are significant markets for two-wheelers in Asia and are among the largest markets in the world after China. In Viet Nam, over 65 million registered two-wheelers served around 80% of the country’s travel demand in 2020 (Le & Yang, 2022). Figure 2 shows the annual sale of 2Ws from 2016 to 2022 in the three markets. The sales of 2Ws experienced a notable decline in 2020 and 2021 due to the COVID-19 pandemic. Nonetheless, the 2W market in Indonesia

is recuperating gradually, with a growth rate of 3.2%; however, the pace of recovery is not as rapid as that observed in India and Viet Nam, where the growth rate has been approximately 20%.

Decarbonizing the transport sector through electric two-wheelers

Asian nations are confronting numerous environmental challenges. Among the top 100 most polluted cities worldwide, 93 are located in Asia, and of the ten countries with the highest vulnerability to climate risks, six are in Asia (Farmer, et al., 2022). The transportation sector is one of the principal contributors to these challenges. Despite existing commitments to decarbonize the sector, global traffic

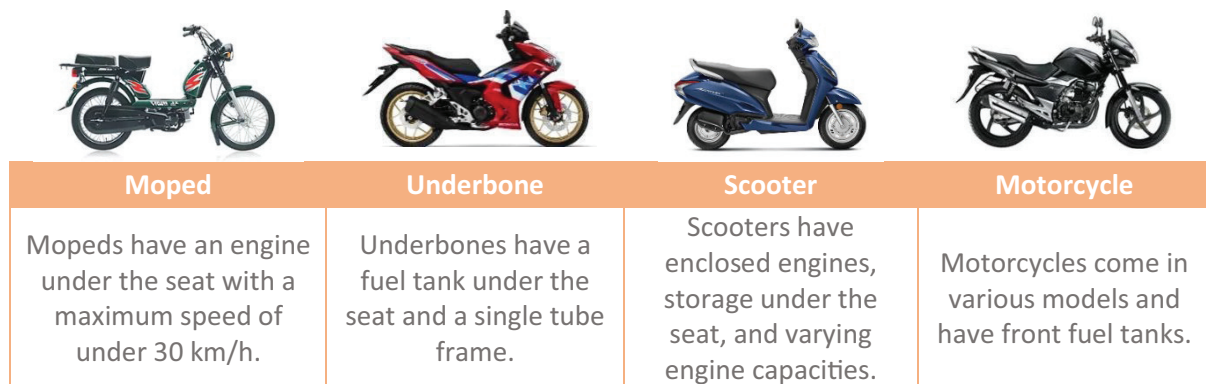
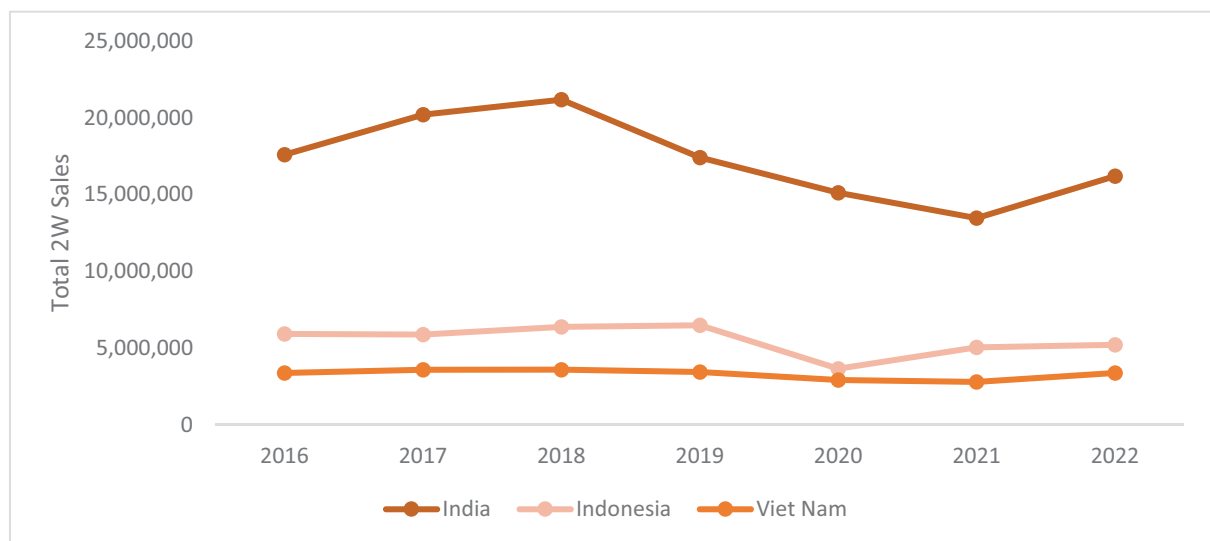


Figure 1. Types of two-wheelers, based on body type



Data sources: Society of Indian Automobile Manufacturers, Association of Indonesia Motorcycle Industry, International Council on Clean Transportation (ICCT), Motorcycles Data.

Figure 2. Annual sale of two-wheelers

emissions are expected to increase by 16% by 2050 compared to the levels in 2015 (Kloth, 2021).

This increasing use of motor vehicles leads to negative consequences such as increased GHG emissions, severe traffic congestion, hazardous levels of air pollution, and a growing number of traffic accidents. For instance, in India, two-wheelers constitute over 70% of the 200 million plus registered vehicles, resulting in roughly 20% of the total carbon dioxide (CO₂) emissions and nearly 30% of particulate emissions (Gulia & Thayillam, 2020).

The transportation sector's advancement is crucial in achieving the climate objectives in Asia since robust policies can significantly reduce in transport emissions. Electrifying the vehicle fleet holds the potential to lower CO₂ emissions, exhaust emissions, fuel consumption, and vehicular noise. Governments worldwide have established ambitious targets for

electrifying all vehicle segments to take advantage of this decarbonization prospect. Figure 3 shows the selected three countries' commitment to the electrification of vehicle fleets, especially electric two-wheelers.

Electric two-wheelers are gaining popularity as a means of transportation worldwide, particularly in densely populated urban areas of Asia where air pollution and traffic congestion are major concerns. In Indonesia, for example, the replacement of 12.5 million internal combustion engine (ICE) vehicles with E2Ws by 2030 could lead to a reduction of 6.1 million tons of CO₂ emissions, which is equivalent to 4% of the country's total transport emissions (Meyer, et al., 2022).

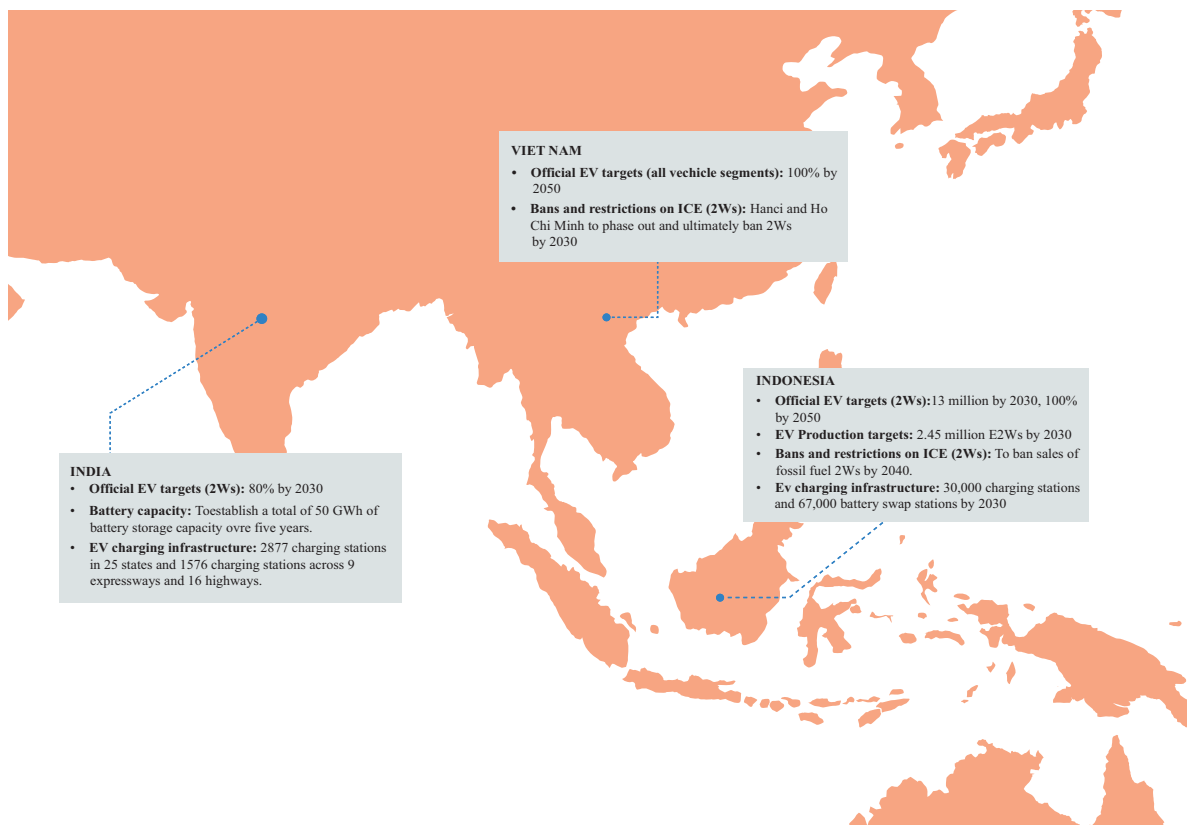
The batteries used in e-bikes and E2Ws are usually low-voltage, with a capacity ranging from 0.3 to 3.3 kWh, as illustrated in Figure 4. It is common for EV owners to charge their vehicles at home, and in

India, for example, low-powered AC chargers rated at 3kW are often used to charge E2Ws. Some E2W models also offer the option of a portable battery, which can be charged using a 5-amp socket. E2Ws also use battery swapping, wherein a discharged battery is replaced with a fully charged one at dedicated service stations.

Advantages and disadvantages of electric two-wheelers

Aside from the significant potential for mitigating GHG emissions when paired with low-carbon electricity generation, electric vehicles, including E2Ws, offer advantages such as no exhaust emissions and higher energy efficiency than traditional fossil fuel-based vehicles.

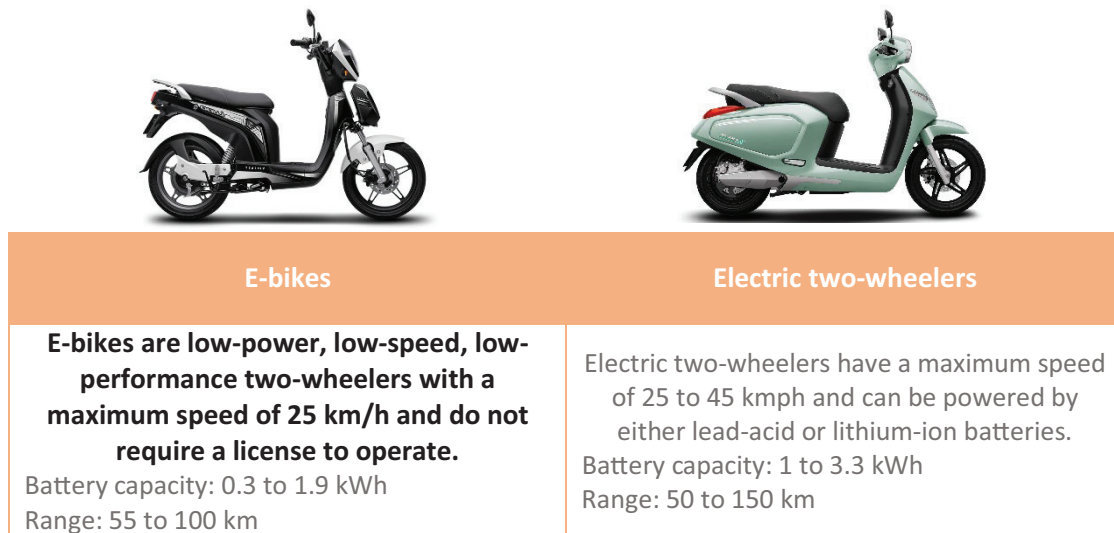
While E2Ws have benefits in promoting clean and affordable transport systems, certain challenges still need to be addressed. While EVs are typically labeled as clean modes of transport during their usage (tank-to-wheel), the production



Disclaimer: The boundaries and names shown and the designations used on this map do not imply official endorsement or acceptance by the United Nations.

Data source: NITI Aayog, Press Information Bureau – Government of India, ICCT, International Energy Agency. Boundary shapefile source: Opendatasoft.

Figure 3. Electrification targets for two-wheelers



Data source: ICCT, market research of available models.

Figure 4. Defining electric two-wheelers

and disposal of EV battery packs may create significant environmental challenges. Being plugged into the local electricity grid, EVs may still rely on fossil fuels depending on a particular country's prevailing electricity generation mix.

E2Ws are also confronted with safety challenges concerning potential battery fires. In India, there have been several instances of E2Ws catching fire, which is attributed

to the inadequate thermal management of lithium-ion batteries, and high temperatures and faulty packaging of cells. Singapore addressed this issue by implementing a ban on e-scooters that fail to comply with the UL2272 fire safety standard in 2019 (Asokan, 2019). This safety standard pertains to the electrical drive train system, which encompasses

the battery system, of personal mobility devices.

Electric two-wheeler sales and market share by region

The adoption of electric vehicles differs among Asian countries, with emerging markets like India and ASEAN falling behind compared to countries such as China and Japan. In 2021, the market share of EVs in

Advantages of electric two-wheelers



Reduction in GHG emissions

EVs, including electric bikes and cars, reduce GHGs significantly, and this can be further reduced by integrating clean or renewable sources for electricity generation. For example, Ampersand, an electric two-wheeler taxi fleet company in Rwanda, has the potential to reduce carbon dioxide equivalent (CO₂e) emissions by 450,000 tonnes over the course of the next ten years (Scheerooren, et al., 2021).



Lower tailpipe emissions

E2Ws achieve zero tailpipe emissions due to their electric motors, which do not produce any pollutants while operating. This is unlike ICE two-wheelers, which discharge hazardous pollutants such as carbon monoxide and particulate matter (PM₁₀) through their tailpipes while in use (Dai, et al., 2005).



Mitigation of traffic noise pollution

EVs can potentially reduce road traffic noise owing to their propulsion systems emitting considerably less noise than ICE vehicles. Specifically, for E2Ws, their usual operation is at lower speeds, below 45 km/h. This results in minimal rolling noise from the tire-road contact, contributing further to noise pollution mitigation (Huang, et al., 2022).



Economically viable

EVs may have a higher initial cost but significantly lower maintenance and operating costs, making them more cost-effective in the long run. When considering the total cost of ownership (TCO), EVs are particularly well-suited for high daily utilization applications, such as last-mile delivery and ride-hailing fleets. Adopting E2Ws can reduce operational costs for fleet operators, a business opportunity for commercial operations.

Thailand, India, Malaysia, and Indonesia was less than 1% (Farmer, et al., 2022). Despite this, India and Indonesia are predicted to become the second and third biggest markets for E2Ws by 2030, respectively, trailing behind China. The growth rate for these markets is projected to be over 60% per year (Farmer, et al., 2022).

Figures 5 and 6 illustrate the sales and market share of E2Ws in India, Indonesia, and Viet Nam. Viet Nam emerged as the leading market for E2Ws among the three countries, with sales of over 280,000 units in 2021, indicating a 10% increase compared to the previous year.

In contrast, the market share of E2Ws in India and Indonesia remained relatively low in 2021, constituting less than 3% of all two-wheelers sold. In contrast, the corresponding figure for Viet Nam was approximately 10%.

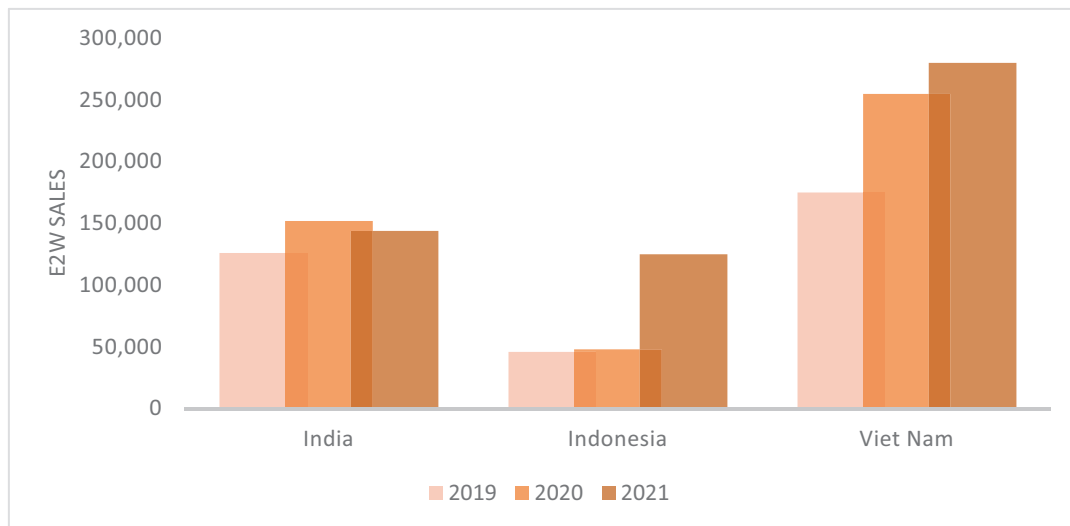
Policy landscape to promote electric two-wheeler adoption

In emerging Asian countries, developing a robust electric vehicle ecosystem is crucial to promote consumer adoption and achieve climate objectives. The development of such an ecosystem requires the establishment of a complete EV value

chain, which involves promoting both the supply and demand aspects. It requires significant policy and technical efforts, thus making government intervention critical.

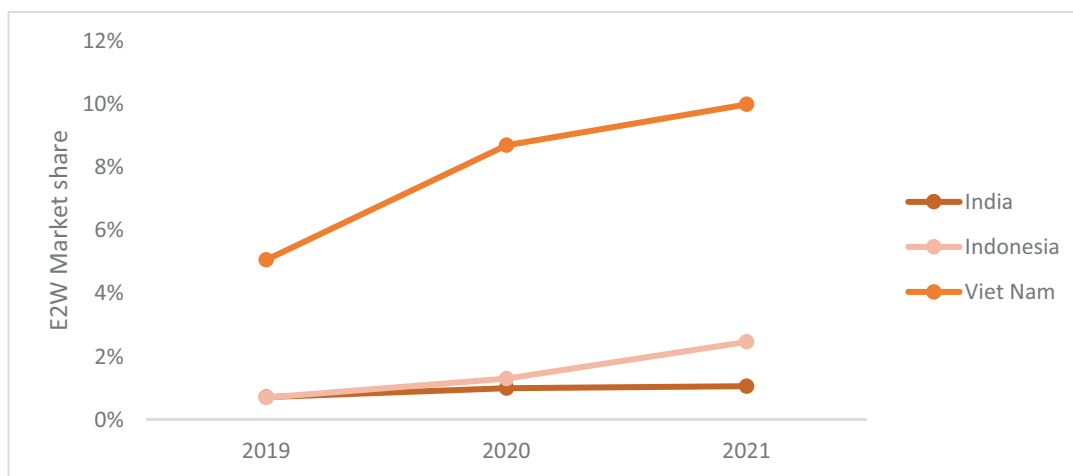
This section outlines the policies implemented in India, Indonesia, and Viet Nam to facilitate the adoption of E2Ws. It summarizes the national policies, highlights local policies and industry activities, and presents global best practices undertaken to promote the uptake of EVs.

In established EV markets, policies are classified into three main themes:



Data source: Society of Manufacturers of Electric Vehicles, ICCT, Deloitte.

Figure 5. Sale of electric two-wheelers



Data source: Estimated based on 2W and E2W sales.

Figure 6. Market share of electric two-wheelers

demand-side incentives, supply-side incentives, and support for charging infrastructure. Thus, the policy interventions discussed in this section are grouped based on these three categories.

Demand-side policies

Given the growing significance of the EV market on both a global and Asian level, providing incentives to consumers is an essential component for stimulating the initial market growth. Such incentives may be in the form of either purchase or operational incentives.

Governments offer purchase incentives for EVs to make them more competitive with traditional ICE vehicles. These incentives aim to surmount obstacles to adoption and promote the nascent development of the EV market. For example, in Taiwan, a province of China, purchase incentives have been extended until 2026. These subsidies range from NT\$5,100 to NT\$7,000 (approx. USD 170 to USD 320) for the purchase of mini E2Ws and heavy or lightweight E2Ws (Wang et al., 2022). Furthermore, an additional scrapping incentive of NT\$1,000 (about USD 33) is provided to those who decommission their old scooters (Wang, et al., 2022).

Complementary policies to discourage ICE vehicles' use by implementing regulations restricting their sales or users can also hasten the transition. An example of this is the ban on the sale of ICE scooters in China, which was implemented in 2011, and this has been a contributing factor to the widespread adoption of E2Ws in the country (Hertzke, et al., 2020).

Table 1 compares the demand-side policy measures adopted by the three countries in focus. Examples of these measures include:

- The government of Indonesia has announced an incentive of Rp 7 million (approx. USD 460) for E2Ws, which will be implemented in March 2023. In contrast, India already has a purchase incentive of INR 15,000/kWh (equivalent to USD 240/kWh), which is based on the battery size.
- In Viet Nam, Hanoi and Ho Chi Minh City are currently strategizing to phase out and ultimately ban ICE motorbikes by 2030.

Supply-side policies: Industry incentives

Industry incentives are designed to promote the production of EVs and components within the EV value chain by OEMs, battery manufacturers, and other associated entities. These incentives can be in the form of tax exemptions, subsidies, and support for infrastructural development. In Indonesia, for instance, a 25% reduction in import taxes on EVs is estimated to increase EV penetration up to 24% by 2035. If local manufacturing is also supported, this could go up to 63% (Farmer et al., 2022).

Additional measures to encourage the production of EVs include setting targets or credits for EV manufacturers. One example is the California Zero-Emission Vehicle (ZEV) regulation that mandates manufacturers of intermediate and large

Electric two-wheeler ambitions

Numerous OEMs, start-ups, shared mobility, and last-mile delivery companies have unveiled plans to shift to electric. Examples include:

Ride-hailing companies - Grab and Gojek have pledged to transition entirely to an EV fleet. Gojek has collaborated with more than one million drivers and aims to exclusively deploy EVs by 2030.

VinFast, an EV manufacturer based in Viet Nam, has set a goal to manufacture 500,000 cars and one million E2Ws per year by 2025.

Hero Electric, an EV manufacturer in India, aims to sell more than five million E2Ws within the next three years.

Data source: Reuters, ICCT, Business India

volume vehicles to ensure a certain percentage of their sales in California consist of zero-emission vehicles or plug-in hybrid electric vehicles. Additionally, a business-friendly environment with streamlined regulatory processes can encourage companies to establish EV-related businesses easily.

Moreover, battery recycling initiatives are crucial to extract critical minerals from used batteries, reduce the demand for new mines, and mitigate harmful environmental and health effects. This is especially beneficial in countries like Indonesia and Viet Nam, which have abundant nickel and lithium mineral reserves. The

Country	Purchase incentives	Tax incentives	Access to financing	Scrapping & Retrofit	Preferential access
India					
Indonesia					
Viet Nam					
Level of promotion	Not addressed	Low	Medium	High	

Table 1. Policy measures to encourage demand for electric two-wheelers

Note: The indicated level of promotion is assessed based on the official announcement of the policy, its implementation, and the presence of any accompanying local-level (state or city) measures.

- Low - The policy has not been officially announced yet, but there are intentions to implement it in the future.
- Medium - The policy has been announced, but it is only implemented locally (in certain cities).
- High - The policy is implemented across the country and at the local level.

EU regulation, for example, mandates OEMs to collect over 70% of EV batteries (Tschödrich, et al., 2022).

In addition, various measures are required to support the growth and advancement of EV technology, including skills development and training programs, research and development initiatives for innovations, and collaborative efforts between public and private stakeholders. One such collaborative effort is the plug-and-play EV Park in Telangana, India, established in partnership with manufacturer MG Motors (PTI, 2022). This facility offers EV manufacturing infrastructure and a startup incubation center. These interventions can facilitate knowledge sharing and resource pooling among innovators, contributing to the development of the EV industry ecosystem.

Table 2 compares the supply-side policy measures implemented by the three countries to foster the development of the EV industry. Examples of measures implemented in these countries include:

- In India, the Bureau of Indian Standards (BIS) has implemented new performance standards for EV batteries in India, which include updated safety standards. These standards require additional safety measures for various aspects of EV battery design and operation, including battery cells, battery management systems, battery pack design, thermal propagation, and on-board charger.

The rise of electric mobility startups in India

Electric mobility startups are paving the way in the future of urban transportation systems. In India, for instance, over 550 startups have been established in the electric mobility sector as of 2022, with 63% focused on electric vehicle manufacturing. Of these enterprises, more than half are dedicated to the development of electric two- and three-wheelers, including companies such as Ola and Ather Energy.

Data source: WRI India

- The Indonesian government allows duty-free import of electric vehicle components, which are assembled domestically.
- The Viet Nam government offers exemptions on import taxes for raw materials and components utilized in the manufacturing and assembly processes that are not produced within the country. In addition, industry zones have also provided tailored incentives (including income tax and land rental reductions) to attract investments from automobile companies.

Charging infrastructure development

A comprehensive network of EV charging points can increase owners' confidence in charger availability and alleviate range anxiety. Governments

Global policy measures to support EV charging infrastructure deployment

Singapore plans to deploy EV chargers in public car parks and introduced the EV Common Charger Grant to subsidize installation costs in private residential buildings.

Guangzhou (China) has mandated new buildings to allocate 18% of their parking spaces to be equipped with EV charging or made EV-ready for future installation.

The State of California intends to deploy solar-powered EV chargers to charge its zero-emissions state fleets.

Data source: Land Transport Authority Singapore, IEA, CleanTechnica

have a role in developing charging infrastructure by providing financial incentives, such as equipment subsidies, installation grants, and land provision at concessional rates.

Furthermore, EV-ready building codes that mandate the integration of charging infrastructure in buildings for existing and newly constructed structures can be implemented. Additional measures involve offering concessional EV tariffs on charging stations accessible to the public or individual EV owners and integrating the administration of the public charging

Country	Manufacturer incentives	Performance standards for EVs	Battery recycling	Skill development	R&D support
India					
Indonesia					
Viet Nam					

Level of promotion	Not addressed	Low	Medium	High
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Table 2. Policy measures to foster the development of EV industry

Note: The indicated level of promotion is assessed based on the official announcement of the policy, its implementation, and the presence of any accompanying local-level (state or city) measures.

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- Medium - The policy has been announced, but it is only implemented locally (in certain cities).
- High - The policy is implemented across the country and at the local level.

network to disseminate data on the accessibility of charging amenities and allow electronic payment methods.

EV charging infrastructure can either be public or private. EV owners, especially individual E2W owners, prefer to charge their vehicles at home or their destination and may not need battery swapping services unless they are traveling long distances. However, commercial E2W fleet owners tend to rely more on public charging points, such as bike rental, bike taxis, and last-mile delivery services.

Commercial users prefer battery swapping due to its time-saving advantage and lower downtime, as they tend to cover more daily mileage. However, to provide battery-swapping solutions, standards are needed to enable compatibility between EVs, batteries, and swap stations from different vendors. Moreover, it is essential to strategically place these swapping and public charging stations in locations with high volumes of E2W traffic to maximize access and usage and minimize additional infrastructure costs.

Table 3 presents a comparison of the policy measures undertaken by the three countries to facilitate the development of EV charging infrastructure. Examples of these measures include:

- The Indian government has dedicated INR 1000 cr (approx. USD 134 million) towards the expansion of EV charging

under phasell of the Faster Adoption and Manufacturing of (Hybrid &) Electric Vehicles (FAME) policy. This policy has authorized the deployment of 2,877 EV charging stations in 68 cities (PIB Delhi, 2022).

- The government of Indonesia is currently exploring the possibility of reducing electricity tariffs for charging station operators, with proposed rates of Rp 714/kWh for medium-voltage stations and Rp 1,650/kWh for low-voltage stations. It should be noted, however, that this measure is yet to be implemented.

Barriers to electric two-wheeler growth

In emerging markets that are transitioning to EVs, there are typically three main obstacles that hinder this: (1) the high initial cost of EVs, (2) limited access to charging infrastructure, and (3) concerns about range anxiety, as highlighted in multiple government reports and consumer surveys (Batra, et al., 2022).

In Viet Nam, for instance, safety concerns, travel distance, and vehicle cost were found to be the primary factors leading to the low adoption of EVs (Le, et al., 2022). Similarly, in Indonesia, the high upfront cost of EVs remains a primary concern, as the purchase price and down payment requirements for E2Ws continue to exceed those of ICE vehicles (Le, et al., 2022).

Based on the analysis of policy measures in India, Indonesia, and Viet Nam, it is evident that there are significant barriers that hinder the development and adoption of E2Ws in these countries. Figure 7 outlines the obstacles to the growth of the E2W industry in the selected countries.

Viet Nam has the potential to develop a strong EV sector through policy actions due to the need to reduce emissions in its densely populated cities. Deploying EVs in public transport and commercial fleets can be effective in shifting away from ICE vehicles. However, the lack of a charging station network and funding for infrastructure poses challenges. Viet Nam also has limited expertise and capacity in producing original equipment for EVs and a shortage of necessary research, experience, and technology to leverage its mineral reserves for EV production.

Indonesia’s E2W industry is currently in its infancy, and there is potential for the market to grow. However, despite some policy measures in place, challenges still hinder the industry’s growth. On the demand side, obstacles include the higher cost of EVs, inadequate vehicle specifications, and limitations in charging infrastructure. On the supply side, challenges include low demand and high capital expenditure requirements for vehicle manufacturing and infrastructure development.

Country	Charging equipment subsidies	Land provision for charging infrastructure	EV charging tariffs	EV-ready building codes
India				
Indonesia				
Viet Nam				

Level of promotion	Not addressed	Low	Medium	High
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Table 3. Policy measures to support the development of EV charging infrastructure

Note: The indicated level of promotion is assessed based on the official announcement of the policy, its implementation, and the presence of any accompanying local-level (state or city) measures.

- Low - The policy has not been officially announced yet, but there are intentions to implement it in the future.
- Medium - The policy has been announced, but it is only implemented locally (in certain cities).
- High - The policy is implemented across the country and at the local level.



Consumer demand

- Limited purchase incentives: In Viet Nam, E2Ws are not granted purchase subsidies and are subject to equivalent taxes and fees as their ICE counterparts. In Indonesia, discussions are still ongoing regarding the implementation of purchase incentives for E2Ws.
- Limited financing options: In India, private domestic banks offer financing options for high-end personal E2Ws. Most domestic and international banks are not financing commercial fleets due to a limited understanding of the technology and associated risks.



Industry constraints

- Challenges in securing capital investments: In Indonesia, the development of a local EV production base has been hindered by the need for significant capital investments and limited domestic demand.
- Insufficient support for manufacturing: In Viet Nam, the dearth of supportive policies for EV manufacturers and their supply chains, and the lack of technical standards and regulations impedes the investment of ICE 2W manufacturers in EVs.
- Challenges in local manufacturing and sourcing of EV Components: In Viet Nam, the growth of local E2W industries has been shielded by the high cost of imported E2Ws compared to locally produced or assembled units. This, however, leads to a temporary price hike in components such as advanced batteries which are not produced locally. Meanwhile, Indonesia is experiencing a scarcity of local EV part suppliers, resulting in higher logistics costs and an increased tariff burden associated with importing parts.
- Lack of effective battery recycling initiatives: None of the three countries have extensively implemented effective battery recycling initiatives for E2Ws. In Viet Nam, where lead-acid batteries power the majority of E2Ws, these batteries are often disposed of without any recall or exchange by the manufacturing and trading enterprises. This is due to the absence of battery-recall stations/points in most industrial facilities, leading to significant challenges in the sustainable management of batteries in the region.



Charging infrastructure access

- Insufficient regulatory framework to promote residential charging: In India, the absence of regulations has created challenges for E2W owners seeking to charge their vehicles at residential complexes, as opposition from homeowners or Residential Welfare Associations (RWAs) often arises.
- Lack of government-led business models: In Indonesia and Viet Nam, there is a dearth of effective business or partnership models from the government for establishing EV charging infrastructure.
- Inadequate integration of EV charging and renewable energy: Across three countries, there appears to be a significant disconnect between the integration of EV charging and renewable energy sources.
- Lack of technical standards and regulatory framework: In Indonesia and Viet Nam, the lack of framework for public E2W charging infrastructure and battery swapping systems impedes progress in this area. As a result, most users are still charging their vehicles at home.

Figure 7. Policy gaps hindering the E2W transition

The analysis of India's booming EV market can provide valuable insights for emerging markets, such as Indonesia and Viet Nam, that are currently in the early stages of their electric vehicle journeys. Key lessons learned from India's experience include:

Achieve total cost of ownership parity between EV and ICE vehicles	Focus on domestic production	Investments in EV charging infrastructure
The FAME-II scheme's subsidy expansion in 2019 significantly boosted the EV industry, especially in the 2W and 3W segments. In addition, the launch of EV policies by 26 states aimed at achieving EV penetration, attracting investments, and creating employment opportunities, has further accelerated EV market growth.	The country has shifted its focus towards domestic production, with tax reductions for EV batteries and production-linked incentives.	Government and private sector investments in charging infrastructure have been critical for supporting the targeted number of EVs on the road. These investments were made at a large scale, with the aim of making EV charging convenient and accessible to a growing number of EV owners.

Policy recommendations

Different markets can contemplate additional policy backing to attain electrification objectives and address current challenges. Major opportunities for developing the E2W industry are highlighted below:

Consumer demand measures

- Incentivize EVs and disincentivize polluting vehicles:** Financial incentives are crucial in creating demand for EVs, particularly in the absence of purchase subsidies. Tax exemptions can also complement these incentives. Additionally, implementing disincentives for ICE vehicles, such as fuel taxes, carbon taxes, and emission charges, can help to reduce pollution. Governments can also provide purchase subsidies for those who scrap their fossil fuel-based vehicles. Non-financial incentives, such as EV parking areas and access to low-emission zones, are also important for promoting EV adoption.
- Aggregate demand through EV deployment in public and private fleets:** Fleet conversion mandates can be instrumental in encouraging EV uptake within the commercial sector. It is important to involve commercial fleet operators in spearheading this transition. Moreover, expediting the electrification of government fleets utilizing mandates and incentives can furnish the essential impetus for the extensive adoption of EVs.

- Increase availability of EV financing:**

Government intervention plays a significant role in enhancing the availability of debt financing for EVs at lower interest rates than ICE models.

- Focus on consumer awareness:** As EVs gain competitiveness with ICE vehicles in terms of cost and performance, the primary obstacle to their widespread adoption remains the insufficient knowledge of EV technology among consumers. To address this issue promptly, raising consumer awareness about EVs and incentives through campaigns such as test drive events and exhibitions and establishing a knowledge-sharing platform is crucial.

Industry measures

- Support the E2W industry and its supply chains:** To support OEMs in ramping up EV production, governments can provide preferential loans and reduce company income taxes. Regulations such as fuel economy or CO₂ emission standards on 2Ws could incentivize manufacturers to invest in EV manufacturing and components. Mandating EV production could also encourage ICE vehicle manufacturers to shift investment and production to EVs. This will particularly help in Viet Nam, as ICE manufacturers are not keen on investing in EVs. Indonesia, with its large nickel reserves, holds the potential to appeal to manufacturers seeking to cater to the growing demand for EVs within the country and

the wider region. The development of the domestic EV industry can be bolstered through collaborations with international producers, investment incentives, and export tax subsidies.

- Promote E2Ws equipped with lithium-ion batteries:** E2Ws utilizing lead-acid batteries have unfavorable environmental impacts as they require frequent battery replacements and have lower durability. Regulatory measures could promote the adoption of lithium-ion batteries, which offer greater energy density and range. This could enhance Viet Nam's competitiveness as an E2W exporter, given its lead-acid E2W market. Furthermore, India can develop import policies to enhance access to battery raw materials such as lithium.
- Address sustainability concerns in the EV battery supply chain:** As mining and manufacturing of EV batteries contribute significantly to GHG emissions, recycling and reusing EV battery packs can be more environmentally sustainable. Policy measures should focus on ensuring a sustainable supply chain and mitigating risks related to labor, health and safety, and the environment.
- Ensure vehicle safety through stringent standards:** As the market for EVs continues to develop, it is crucial to address concerns regarding vehicle safety by implementing rigorous standards. In addition, manufacturers of EVs can demonstrate their commit-

ment to safety by sharing information about the measures they are taking to ensure the safe operation of their vehicles and by making data about their safety records publicly available. These actions can help to increase consumer confidence in EVs and encourage investment.

- **Support R&D and innovations in EV and battery technologies:** Prioritizing the development of training and certification programs focused on battery manufacturing and EV infrastructure could empower the industry and drive growth. Secondly, allocating R&D funds throughout the EV value chain, with a particular emphasis on battery technology as a critical component, has the potential to stimulate significant progress.
- **Support industry workers' skill upgradation:** Developing new skills is crucial for industries, particularly those undergoing a transformation like the EV industry. A comprehensive system for upskilling and reskilling can create more job opportunities. It should include training in areas of EV driving and maintenance, product design, battery and vehicle assembly, and charger installation. Collaboration among academia, industry, and the government is crucial to upskill the EV workforce.

Charging infrastructure measures

- **Support investments in the rollout of public charging infrastructure:** Government funding is anticipated to be an essential factor in facilitating extensive infrastructure deployment. The deployment of charging infrastructure is a crucial domain where oil marketing corporations and utility companies have the potential to offer vital support through patient capital.
- **Enable framework for scaling up EV charging network:** It is essential to collaborate with private sector companies, such as charging point operators, to enhance the availability of EV charging infrastructure and battery swapping. Public-private partnerships can be established through government tenders to install charging infrastructure at public locations. This approach is particularly relevant in Viet Nam, where a private enterprise, VinFast, is taking the lead by partnering with entities to install chargers on their premises.
- **Establish operational framework for battery swapping facilities:** Regulations should specify the operational standards to ensure the smooth operation of battery-swapping facilities. Specifically, manual swapping stations for E2Ws require battery pack designs that are lightweight, compact, and ergonomically designed for easy swapping. Additionally, it is important to develop guidelines on battery swapping facility safety and reliability, as well as standardize batteries.
- **Support integration of EV charging points in residential complexes:** It is recommended that regulations be established mandating that 100% of parking spaces in existing buildings have EV charging installed to facilitate EV charging. Housing societies should be encouraged to cooperate by providing no-objection certificates for EV owners to install and charge their vehicles. Moreover, emphasis should be placed on formulating building regulations that mandate the inclusion of requisite electrical infrastructure during the construction of new buildings, which would not only facilitate EV charging but also minimize retrofit expenses.
- **Support integration of renewable energy sources in power generation:** Renewable energy sources play a vital role in achieving decarbonization in transportation, as EVs have the potential to considerably reduce transport emissions alongside the expansion of renewable energy generation. For example, charging point operators can consider utilizing clean sources such as solar photovoltaic (PV) systems for



India

- Implement measures to support EV financing: Develop policies to support EV financing for commercial operators in India. A limited understanding of technology and associated risks is preventing financing options for commercial fleets.
- Focus on developing policies for battery raw materials and battery recycling: India can strengthen its battery industry by developing import policies for lithium and other raw materials. Additionally, policy measures should prioritize battery recycling to promote a sustainable and circular economy.
- Enable private charging and integrate clean energy for power generation: India can overcome challenges faced by E2W owners seeking to charge their vehicles in residential complexes by implementing policy measures such as No-objection certificates or mandates to install private chargers. Integrating clean energy sources for power generation can also reduce carbon footprint while supporting EV charging demand.



Figure 8. Country-specific policy recommendations to promote electric two-wheelers

captive electricity generation to enable EV charging. Furthermore, EV and battery manufacturers can also utilize renewable energy sources to power their plants instead of relying on coal.

Conclusion

The promotion of electric vehicles is considered an important strategy to mitigate environmental issues associated with

transportation in many countries, including India, Indonesia, and Viet Nam. This article highlights how these countries have taken concrete steps toward electrifying their transportation sector. Various incentives and measures are recommended to overcome obstacles and promote the development of electric two-wheelers in the future.

India's flourishing E2W market provides a strong foundation for implementing effective national and local-level actions toward electric mobility. Indonesia and Viet Nam still have room to establish comprehensive policies to promote the growth of E2Ws, with good potential to become leading producers of EVs and batteries by leveraging their mineral reserves and local manufacturing capacity. With the

deliberate effort to promote both EV adoption and EV industry, the transition towards electric two-wheelers can be realized much sooner.

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