Recommendations of National Policies and Standards on Electric 2&3 Wheelers in Indonesia

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The activities from IKI projects range, for example, from advising policy makers on capacity building and technology partnerships to risk hedging through innovative financial instruments. It also includes studies, project preparation advice for infrastructure development, and investment instruments for climate change mitigation or biodiversity conservation.

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The program management, evaluations and technical assistance of the projects, as well as the management of IKI media and communication are supported by the IKI Office at the government owned Zukunft - Umwelt - Gesellschaft (ZUG) gGmbH.

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Recommendations Of National Policies And Standards On Electric 2&3 Wheelers In Indonesia

Supporting E-mobility focusing on Electric Two- and Three-wheelers and Policies on Urban Traffic Integration in Indonesia

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Published on:
October 2022

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ABBREVIATIONS AND ACRONYMS

2&3W	Two- and three-wheelers. The Internal Combustion (ICE) vehicle, including motorcycle and motor scooter powered by fossil fuel
4W	Four-wheelers. The Internal Combustion (ICE) vehicle, including car powered by fossil fuel
ASEAN	Association of Southeast Asian Nations
AVAS	Acoustic Vehicle Alert System
B2B	Business-to-Business
Bappeda	Local Planning Agency
Bappenas	Ministry of National Development Planning of the Republic of Indonesia
BAU	Business As Usual
BBNKB	Motorized Vehicle Ownership Transfer Fee
BEV	Battery Electric Vehicle
BI	Bank Indonesia
BKPM	Investment Coordination Body
BP	British Petroleum
BPPBJ	Procurement of Goods and Services Agency
BPPT	Agency for the Assessment and Application of Technology
BPS	Indonesia Statistics Bureau
BRIN	National Research and Innovation Agency
BRT	Bus Rapid Transit
BSN	Indonesian Standardisation Bureau
BSS	Battery Swapping Station
CKD	Completely Knocked Down
CMEA	Coordinating Ministry of Economic Affairs
CMMIA	Coordinating Ministry of Maritime and Investment Affairs
CMOE	Center for Management & Organization Effectiveness
CO	Carbon Monoxide
CO2	Carbon Dioxide
COP26	United Nations Climate Change Conference 2021
COVID-19	Coronavirus Disease of 2019
DCKTRP	Human Settlement, Spatial Planning, and Land Agency
DPMPTSP	Local Investment and Permit Agency
E-bike	Electric Bike
E-bus	Electric Bus
E-moped	Electric Moped
E-motorcycle	Electric Motorcycle
E-pedicab	Electric Pedicab
E-rickshaw	Electric Rickshaw
E-scooter	Electric Scooter
E2&3W	Electric Two- and Three-Wheelers

ABBREVIATIONS AND ACRONYMS

E2W	Electric two-wheelers, including bike, motorcycle, and scooter powered by battery
E3W	Electric three-wheelers, including rickshaw and pedicab powered by battery
E4W	Electric four-wheelers, including car powered by battery
EV	Electric vehicle, including two, three, and four wheelers powered by battery
FAME	Faster Adoption and Manufacturing of Electric Vehicles in India
FCEV	Fuel Cell Electric Vehicles
GDP	Gross Domestic Product
GHG	Greenhouse Gas
GSEN	Grand Strategi Energi Nasional / National Grand Energy Strategy
GST	Goods and Service Tax
HDV	Heavy Duty Vehicle
HEV	Hybrid Electric Vehicle
IBC	Indonesia Battery Corporation
ICE	Internal Combustion Engine
IDR	Indonesian Rupiah
IEA	International Energy Agency
IKD	Incompletely Knocked Down
Korlantas	Indonesian Traffic Police
KSM	Kredit Sepeda Motor / Credit for Motorcycle
LDV	Light Duty Vehicle
LEZ	Low Emission Zone
LIB	Lithium-ion Battery
LIPI	Indonesian Institute of Sciences
LKPP	National Public Procurement Agency
MECRT	Ministry of Education, Culture, Research, and Technology
MEMR	Ministry of Energy and Mineral Resources
MoCI	Ministry of Communications and Informatics
MoEF	Ministry of Environment and Forestry
MoF	Ministry of Finance
MoHA	Ministry of Home Affairs
MoI	Ministry of Industry
MOL	Ministry of Labor
MoT	Ministry of Transport
MPWH	Ministry of Public Works and Housing
MRT	Mass Rapid Transit
MSOE	Ministry of State-Owned Enterprises
MT	Ministry of Trade
NDC	Nationally Determined Contribution
NEV	New Energy Vehicles
NGO	Non-Government Organization
NOx	Nitrogen Oxides
OEM	Original Equipment Manufacturer

ABBREVIATIONS AND ACRONYMS

OJK	Financial Services Authority
PHEV	Plug-in Hybrid Electric Vehicle
PKB	Pajak Kendaraan Bermotor / Motorized Vehicle Tax
PLN	State Electric Company
PM	Particulate Matter
PMA	Personal Mobility Aid
Polda	Regional Police
POLRI	Indonesian National Police
PSA	Public Service Announcement
R&D	Research and Development
Renstra	Strategic Plans
ROE	Regional-Owned Enterprises
RPJMN	Rencana Pembangunan Jangka Menengah Nasional / National Medium Term Development Plan
RUEN	Indonesia National General Energy Plan
SIM	Indonesian Driver's License
SKCK	Statement of Good Conduct
SNI	Indonesian National Standard
SOE	Stated-owned Enterprise
Solar PV	Solar Photovoltaic
TCO	Total Cost of Ownership
TKDN	Minimum Local Component Level
ULEZ	Ultra Low Emission Zones
UNFCCC	United Nations Framework Convention on Climate Change
IDR	Indonesian Rupiah
USD	United States Dollar
VAT	Value-added tax
VKT	Vehicle Kilometers Traveled
VOC	Volatile Organic Compound
ZEV	Zero Emission Vehicle
ZEZ	Zero Emission Zones

Executive Summary

The transport sector significantly contributes to greenhouse gas emissions in Indonesia, prompting the government to prioritize emission reduction and energy efficiency. This includes promoting non-polluting transport modes such as walking and cycling, promoting public transport, and accelerating the adoption of cleaner vehicles, such as electric two- and three-wheelers (E2&3W). In the project titled "Supporting E-Mobility Focusing On Electric Two-And Three-Wheelers And Policies On Urban Traffic Integration In Indonesia" " the Institute for Transportation and Development Policy (ITDP) Indonesia supported by the United Nations Environment Programme (UNEP) developed three main outputs as follows:

1. **Baseline Assessment of Two- and Three-Wheelers in Indonesia**
2. **Development of National Policies And Standards on Two- and Three-Wheelers Electric Mobility Transition in Indonesia**
3. **Guidelines On The Integration Of Electric Two- and Three-Wheelers In Urban Traffic**

The "Development of National Policies And Standards on Two- and Three-Wheelers Electric Mobility Transition in Indonesia" report focuses on the potential of 2&3W electrification to kickstart the e-mobility ecosystem in Indonesia, analysis of the environmental and social impact of 2&3W electrification, a stakeholder mapping exercise to identify relevant stakeholders on e-mobility focusing on mainstreaming E2&3W, the current status of policies and standards for E2&3W in Indonesia and benchmarks from other Asian countries, the barriers for E2&3W uptake, and proposed policies and standards for E2&3W.

The transition from traditional internal combustion engine (ICE) 2&3W vehicles to cleaner electric modes in Indonesia presents a significant opportunity for reducing greenhouse gas emissions and fossil fuel consumption. With an estimated potential for nearly 175 million tonnes of CO2 savings by 2050, equivalent to 2.4% of global transportation emissions in 2020, full electrification of 2W vehicles in Indonesia promises substantial environmental benefits. Moreover, owning and operating electric 2W (E2W) vehicles over 10 years proves to be more economical than ICE 2Ws, with potential savings of around IDR 2.3 million over the vehicle's lifetime. 2W vehicles, given their widespread use, can serve as a crucial starting point for mass vehicle electrification, laying the foundation for the broader adoption of electric mobility solutions nationwide. However, achieving widespread E2W adoption requires significant investment from both the public and private sectors to replace ICE vehicles and establish charging infrastructure. Government interventions, such as fiscal incentives and subsidies, are crucial in accelerating EV uptake and infrastructure development.

Synergy and collaboration among various stakeholders, including government institutions, businesses, and civil society, are essential for the successful adoption of e-mobility in Indonesia. With numerous institutions involved, strong leadership and clear coordination are paramount to align priorities and streamline efforts. For instance, at the national level of government alone, the E2&3W acceleration efforts involve as many as 20 institutions, including the President, ministries, and non-ministerial institutions such as the Police Department and research, standardization, and procurement agencies.

Despite ambitious government targets, barriers to E2W and EV adoption persist, including higher purchase prices, performance limitations, inadequate charging infrastructure, and low public awareness. Business-to-business (B2B) sales drive current E2W sales, underscoring the importance of targeted incentives for fleet procurement. Standardization of batteries and charging infrastructure is critical for safety and accelerated infrastructure development, with proposed incentives to OEMs to facilitate this process. Government support through direct subsidies, consumer financing, and disincentives for ICE vehicles, along with robust marketing and communication efforts, are vital for overcoming adoption barriers and promoting the benefits of EVs to the public.

The main recommendations for the national and local governments of Indonesia to address demand and supply-side barriers to E2&3W adoption include:

1. **Link clear E2&3W adoption targets and roadmaps with national strategic documents and commit budget:** Align E2&3W adoption goals with strategic plans and allocate budgets accordingly.

2. **Achieve cost parity:** Provide fiscal incentives such as purchase price subsidies and tax incentives for E2&3W, while imposing taxes on ICE vehicles and stimulating financing schemes by offering attractive financing and insurance packages to make E2&3W more affordable.

3. **Ensure safety:** Implement technical and operational standards for vehicles, batteries, and charging infrastructure, including safety regulations and battery waste management.

4. **Make riding E2&3W more convenient than ICE 2&3W:** Improve fuel economy standards, establish Low Emission Zones/Zero Emission Zones, and offer exemptions from road access restrictions for E2&3W.

5. **Incentivize industry players to provide high performance models:** Encourage providing high-performance models through incentives and industry support programs.

6. **Eliminate range anxiety:** Improve access to charging infrastructure by setting national and city-level targets, providing fiscal support, updating building codes to facilitate infrastructure provision, and introducing battery swap station standardizations to allow scale-ups.

7. **Establish public campaign programs to mainstream E2&3W information:** Develop informative campaigns, including PSAs, conventions, and online platforms, to mainstream information on E2&3W safety and operations.

1 Setting the Context: 2&3W Usage in Indonesia

1.1 THE POPULARITY OF MOTORIZED 2&3W

Motorcycles are one of the dominant vehicles in Indonesia. 85 percent of motorized vehicles registered as private and public vehicles are motorbikes, reaching 113 million registered motorcycles nationwide in 2019 (see Figure 1). At least, 8 out of 10 Indonesian households own at least one motorcycle. This number has been constantly increasing by 4.5% annually. As a result, Indonesia is ranked as one of the largest growing markets for motorcycles worldwide.

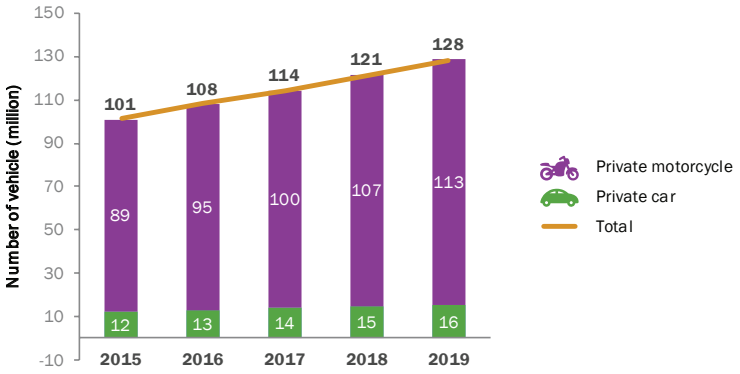


Figure 1. Private vehicle ownership in Indonesia, 2015-2019 (Modified from BPS, 2020)[1]

The figure below presents the main transportation modes in different regions in Indonesia, according to a small-scale survey done by ITDP Indonesia in 2019[2]. Motorcycle usage dominates the mode share in many Indonesian cities, especially outside Jakarta, West Java, and Banten. More than half of the commuters ride a private motorcycle as their main transportation mode in Central Java, East Java, Yogyakarta, and eastern part of Indonesia. Meanwhile, in regions with less private motorcycle shares (e.g., Jakarta), it is shown that there are higher proportions of passengers who travel regularly with motorcycle taxis (i.e., ojek or motorcycle ride hailing). Despite the wider variety of transportation modes available in Jakarta (BRT, MRT, inter/inner city train), the proportion of motorcycle taxi passengers is quite similar with other regions such as West Java, Banten, and Yogyakarta.

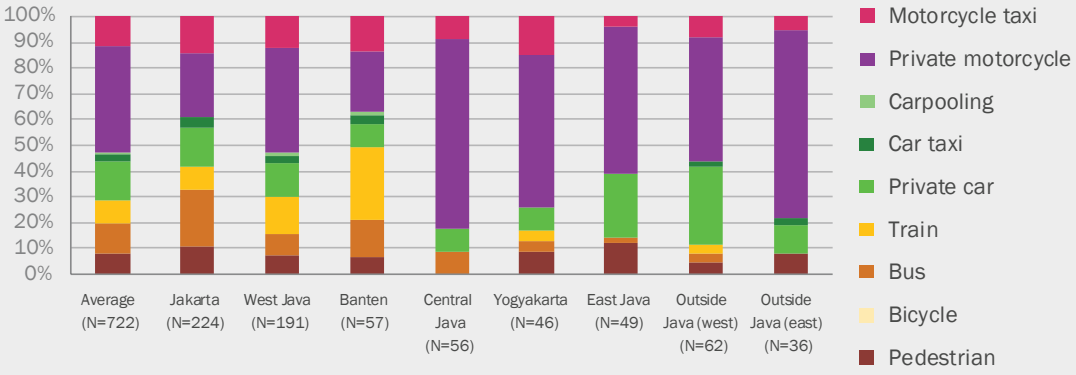


Figure 2. Mode share in different regions in Indonesia (source: ITDP Indonesia, 2019)

[1] BPS-Statistics Indonesia. 2020. *Motorized Vehicles (Unit) 2018-2020.* [Online]. [Accessed 2020]. Available from: https://www.bps.go.id/indicator/17/57/1/jumlah-kendaraan-bermotor.html

[2] In most Indonesian cities, transportation mode share data is not readily available. See Appendix A for further information on the survey.

Motorcycles have these following characteristics that make them attractive as an urban transport mode (Gota, 2018[3]), including in Indonesia:

ROUTE AND SCHEDULE FLEXIBILITY	2&3Ws, both as private and shared modes (the on-demand ride-hailing services), offer flexible door-to-door mobility for their users.
HIGH ACCESSIBILITY	2&3Ws offer the highest accessibility, especially as narrow streets which are inaccessible to cars are widely found within Indonesian cities, especially in residential areas.
AFFORDABILITY	The user costs of two-wheelers, especially private motorcycles, are typically one of the lowest among other motorized transports. A new entry-level ICE motorcycle can be purchased at as low as around IDR 17 million (~USD 1,200) with widely available financing options. The low gasoline price (IDR 7,650/litre or around USD 0.5/liter in June 2022[4]) and low parking fee also contribute to the affordability of motorcycle operations in most Indonesian cities.

Nevertheless, despite all the characteristics of two and three-wheelers that are appealing to riders, it should be noted that some other important characteristics are not taken into account. Some other significant characteristics include the risk of road fatalities and injuries, as well as other externalities with respect to health and the environment.

In Indonesia, motorized two- and three-wheelers usage can be categorized into two main purposes: Private and commercial purposes.

1.1.1 PRIVATE USE

Socio-economic factors and lack of high-quality public transportation availability induce the popularity of private motorcycle usage as a door-to-door transport mode in Indonesia[5]. As public transportation services remain unavailable or unsatisfying in some cities and as there are increases in people's income, people choose to own and use private vehicles. To illustrate, given that Indonesia has almost 100 cities, public transportation (e.g., BRT, inter or intra city trains) only operates in less than 20 cities. In cities with mass public transport systems, such as in the Metropolitan Jakarta area, private motorcycles are also popular for the first mile trips between home and transit station due to many reasons such as the lack of feeder services and good quality pedestrian and cycling infrastructure[6].

The affordability and flexibility of motorcycles prompt the preference for motorcycles compared to other private motorized vehicles in Indonesia. Moreover, in highly congested cities such as Jakarta, using motorcycles lowers the perceived travel time as motorcycles take less space, therefore having easier access to narrow roads and overtaking other vehicles.

[3]Gota, S. (2018). Two-and-Three-Wheelers: A policy guide to sustainable mobility solutions for motorcycles. Sustainable Urban Transport Project (SUTP), Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ), Transformative Urban Mobility and TUEWAS.
[4]Pertalite (Octane 90 gasoline typically used by motorcycles) price on 8 June 2022, accessed from https://finance.detik.com/energi/d-6115920/harga-pertalite-dan-pertamax-terbaru-8-juni-di-seluruh-spbu-cek-di-sini
[5]DailyTrans. (2022). Public transportation problems in Indonesia. [Accessed on 2 June 2022]. Available, from: http://www.transportationissuesdaily.com/masalah-transportasi-umum-di-indonesia/
[6]DailyTrans. (2022). Public transportation problems in Indonesia. [Accessed on 2 June 2022]. Available, from: http://www.transportationissuesdaily.com/masalah-transportasi-umum-di-indonesia/

1.1.2 COMMERCIAL USE

Besides private vehicles, motorcycle usage has broadened as internet technology and advanced communication systems have rapidly advanced. Both passenger transportation and delivery service companies have been expanding their services, particularly by utilizing mobile-based applications. Currently, non-private motorcycle drivers mainly work due to the travel demand from two types of mobile-based applications: Online transportation apps (e.g., Go-Jek, Grab), and e-commerce apps (e.g., Tokopedia, Shopee).

Since the initial launch in 2010, it is estimated that there have been 4 million motorcycle drivers working for online transportation apps companies in Indonesia[7]. The so-called "super-apps" offer ride-hailing services or locally known as 'ojol' or 'ojek online' and personal goods delivery, including food, medicine, groceries, and one-day door-to-door delivery. According to several studies conducted in several big cities in Indonesia[8,9], the majority of drivers belong to the middle-class income (between IDR 5.62–27.34 million[10]). Additionally, drivers in some cities reported incomes around 2 times the local minimum wages[11,12]. On the other hand, from customers' point of view, online motorcycle transportation is more favorable in terms of time travel and punctuality, particularly when traveling through a highly-congested road. E-commerce companies have also been partnering with courier service providers who utilize motorcycles as their first and last mile transport for small and medium-size goods.

Motorcycles are also used commercially to transfer people and goods in a more conventional fashion on a daily basis. Drivers often install additional carriages to transport goods such as fresh vegetables, food, or even people, as can be seen in Figure 3 below. Although it is punishable by law to carry goods or carriages exceeding a certain allowable size by motorcycle[13], the lack of enforcement of the rule spurs this as a common practice in many Indonesian cities.

Figure 3. Examples of conventional commercial motorcycle usage (source from left to right: Suara.com[14], Detik.com[15], Liputan6[16])

2&3Ws are commonly customized in various fashions in different regions. For instance, additional compartments are also common to be installed beside, in front, or at the back of motorcycles to transport more passengers, which are also known by different names, such as *bentor* or *becak motor* in Medan.

[7]Susanty, F. (2020). What about the others? 'Ojol' relief sparks concerns over aid inequality. The Jakarta Post. [Accessed on 29 December 2021]. Available, from: https://www.thejakartapost.com/news/2020/04/16/what-about-the-others-ojol-relief-sparks-concerns-over-aid-inequality.html

[8]Rizki, M., Joewono, T. B., Belgiawan, P. F., & Irawan, M. Z. (2021). The travel behavior of ride-sourcing users, and their perception of the usefulness of ride-sourcing based on the users' previous modes of transport: A case study in Bandung City, Indonesia. IATSS research, 45(2), 267-276.

[9]Watung, M. P., Rotinsulu, D. C., & Tumangkeng, S. Y. (2020). Analisis Perbandingan Pendapatan Ojek Konvensional dan Ojek Online di Kota Manado. Jurnal Berkala Ilmiah Efisiensi, 20(03).

[10]World Bank. (2019). Aspiring Indonesia—Expanding the Middle Class.

[11]Giri, P. C., & Dewi, M. H. U. (2017). Analisis Faktor-Faktor yang Mempengaruhi Pendapatan Driver GOJEK di Kota Denpasar, Bali. E-Jurnal Ekonomi Pembangunan Universitas Udayana, 6(6), 948-975.

[12]The Jakarta Post.. 2018. Go-Jek drivers', partners' earnings total Rp 10 trillion, UI survey finds. [Accessed on 14 December 2021]. Available, from: https://www.thejakartapost.com/news/2018/03/22/go-jek-drivers-partners-earnings-total-rp-10-trillion-ui-survey-finds.html

[13]Government Regulation No. 74/2014 on Road Transport states that motorcycles are prohibited to carry loads exceeding the width of the vehicle's handlebar and 90 cm above the seat

[14]Priambodo, A. R. (November, 2018). Cerita Tukang Sayur di Papua Jualan Pakai Motor Sport, Gokil! suara.com. [Online]. [Accessed 2021]. Available from: Story of sport motorcycle

[15]Setia, D. (2020, 20 September). Kerennya Bang Ipul, Mantan Preman yang Kini Sukses Jualan Bakso. detik food. [Online]. [Accessed 2022]. Available from: Food Detik

[16]Liputan6.com. (November, 2019). The Existence of Motorcycle Rickshaw Motorcycle Taxi in Jakarta. [Online]. [Accessed 2021]. Available, from: Photo of the existence 'becak motor'

1.2 EFFORTS TO IMPROVE NON-MOTORIZED 2&3W USAGE

Figure 4. Becak as a transport mode in Jakarta (source: ITDP Indonesia[17], 2018)

Bicycles and rickshaws ("becak") were once popular daily modes of transportation in many Indonesian cities. Nevertheless, presently their use – especially for daily commuting – has been scarce in big cities such as Jakarta and Surabaya, and rapidly diminishing as well in secondary cities.

In the past few years, however, there have been efforts by local governments to revive the use of bicycles in cities, especially for first and last-mile modes of commuting. There has also been a recent growth in cycling, albeit mainly still for recreational purposes.

Table 2. Study Case 1: Cycling Revival in Jakarta

Study Case : CYCLING REVIVAL IN JAKARTA

Figure 5. Commuting with bicyle in Jakarta city (source: ITDP Indonesia, 2021)

Based on a survey performed by ITDP in June 2020, Jl. Sudirman, one of the major thoroughfares in central Jakarta, experienced an unprecedented growth of 1,000% more cyclists in 2020 compared to the previous year. Beside Jl. Sudirman, several major roads in central Jakarta witnessed 200%-700% increases, e.g. between Bundaran Senayan to Sarinah during this period, amid limited recreational destinations options as social distancing has been implemented since the announcement of the first COVID-19 positive case in March 2020. Several factors such as physical health, avoiding overcrowding, and leisure are found to encourage people to ride bicycles.

As the public enthusiasm for occupying non-motorized mode has been increasing, the Governor of Jakarta announced that there will be an additional 101 km of bicycle lanes to the current 63 km of dedicated bike lanes installed across Jakarta in 2021. A bike-sharing service is also being implemented on a pilot basis, operated by Gowes, a private operator. On a national level, the Government of Jakarta has made a revolutionary action for cyclists, which was installing protected dedicated bicycle lanes on major roads. Although, based on Indonesia Law No. 22/2009 on Traffic and Road Transport, bicycle paths and sidewalks already should be installed on every road.

[17]ITDP Indonesia. (January, 2018). Becak In the Capital City. Institute for Transportation and Development Policy. [Online]. [Accessed 2022]. Available from: Becak In Jakarta

2 Current Landscape of E2&3W

2.1 CURRENT E2&3W UPTAKE IN INDONESIA

Following the footsteps of many countries, Indonesia has started moving towards electric vehicle deployment. In the National General Energy Plan (RUEN), the Indonesian government has targeted 2,200 electric passenger cars and 2.1 million electric motorcycles on roads as well as electrification of 10% of public transport by 2025. In 2019, a new Presidential Regulation was issued to accelerate electric vehicle deployment, specifically to provide a legal framework and focus on the direction of Battery Electric Vehicle (BEV) and its related industry development. The ambition to accelerate the adoption of electric vehicles in Indonesia is largely driven by three main reasons: the country's vision to develop the domestic electric vehicle industry, including other industries in the supply chain; to improve energy security, and to reduce the GHG emission from the transportation sector.

There are also multiple derivative regulations providing incentives for electric vehicles, as will be discussed further in **Section 4**. However, the current uptake is still slow as can be seen in Figure 6 below.

Electric vehicle (EV) adoption targets	E-2W	E-4W	E-Bus
2025 (Source: National General Energy Plan/RUEN)	2.1 million units (1.9% of current population)	2,200 units (1.9% of current population)	10% of urban fleets
2030 (Source: National Grand Strategy for Energy/GSEN)	13 million units (11.5% of current population)	2 million units (11.5% of current population)	90% of urban fleets (Source: MOT)
Target Year for 100% Electrification	100% E2W in domestic market by 2040	100% E4W in domestic market by 2050	2040 (moderate target: 15,546 units)
Current Uptake (March 2022)	13,728 units (0.11% from 2030 target)	1,821 units (0.09% from 2030 target)	14 units (0.09% from 2040 target)

Figure 6. Electric vehicle adoption targets and current uptake in Indonesia[18,19,20] (Source: President Regulation, MOEMR, CNBC, MoT)

On the other hand, when discussing E2&3W, electric micromobility should not be exempted from the discourse. The use of electric micromobility, in particular e-bikes and e-scooters, is mostly limited in Indonesian big cities. In Jakarta, electric scooter usage reached its peak in 2019 when a shared e-kick scooter service (the so-called Grabwheels by Grab Indonesia) was widely available. The e-kick scooter sharing company expected that this service could provide an environmentally friendly alternative for the first-mile and last-mile trips for the people in Jakarta and Bandung, but it was mainly popular for recreational purposes. The shared e-kick scooter operation was halted due to the ban of e-kick scooters on public roads following a series of fatal accidents involving e- kick scooter users in late 2019. Currently, Transportation Ministry Regulation No. 45/2020 on Electric-Powered Transportation allows e-scooters only to operate on dedicated cycling infrastructure. After the issuance of the regulation, the operation of the shared e-kick scooter service resumes only in several designated areas and has yet to regain its popularity.

[18]Perpres No. 22 tahun 2017 tentang Rencana Umum Energi Nasional. 2030. Jakarta. [Online]. [Accessed 2022]. Available from: https://litbang.esdm.go.id/news-center/arsip-berita/kementerian-esdm-ajak-kementerian-dan-lembaga-untuk-mempercepat-program-konservasi-kendaraan-bermotor-listrik
[19]CNBC. 2021. RI Targetkan 2040 Semua Motor Berbasis Listrik. Jakarta. [Online]. [Accessed 2022]. Available from: https://www.cnbcindonesia.com/news/20210805125312-4-266326/ri-targetkan-2040-semua-motor-berbasis-listrik
[20]Kemenhub. 2022. Data Adopsi Kendaraan Listrik Roda Dua. Kementerian Perhubungan Republik Indonesia [Online]. [Accessed 2022]. Available from: www.kemenhub.go.id

On the other hand, the use of e-bikes is growing as goods and food delivery vehicles and as private transport modes, especially for short distances in residential areas. Domestic sales of e-bikes are growing in recent years. According to Selis, one of the domestic manufacturers, up to April 2022 there have been tens of thousands units of e-bikes sold from their production.

Figure 7. Shared electric bicycles in Jakarta (source: ITDP Indonesia, 2021)

Figure 8. Shared electric scooters[21] (source: Merdeka.com / Iqbal Nugroho)

Figure 9. A female food delivery driver on an electric bicycle (source: ITDP Indonesia, 2021)

[21]Nugroho, Iqbal. (November, 2019). Shared Electric Scooters. Merdeka.com. [Online]. [Accessed 2022]. Available from: Electric Scooters

2.2 INDONESIAN E2&3W MARKET

To date, there have been 16 brands identified airing in Indonesia's E2&3W market. The E2W market in Indonesia was valued at over USD 364.42 Million in 2019 and is forecasted to grow at a compound annual growth of 20.96% to reach USD 816.22 Million by 2025[22]. The market size for E3W has not currently been identified, mostly due to the lower uptake and limited data.

Despite the market size, the current update of E2&3W is still considered low, for example, E2W alone is amounting to nearly 17,000 units as opposed to 130 Million ICE 2Ws. Such a forecast is expected to grow even beyond only if ambitious support from the government is made especially by giving incentives both to users and manufacturers.

Among four ASEAN countries that are big in the motorcycle market, none of them managed to reach a 10% of the marketshare as compared to 2W sales including Indonesia in 2020. Vietnam is currently leading player for the cleaner mobility uptake, which is mainly represented from government ambition and the early start the country has made. Indonesia, who is the largest 2W producer and user in the world amounting nearly 130 Million products in 2022 only manage to get 1.1% share for E2W. Various measures are required both from Government and private sector to better improve the uptake that is currently and outlier.

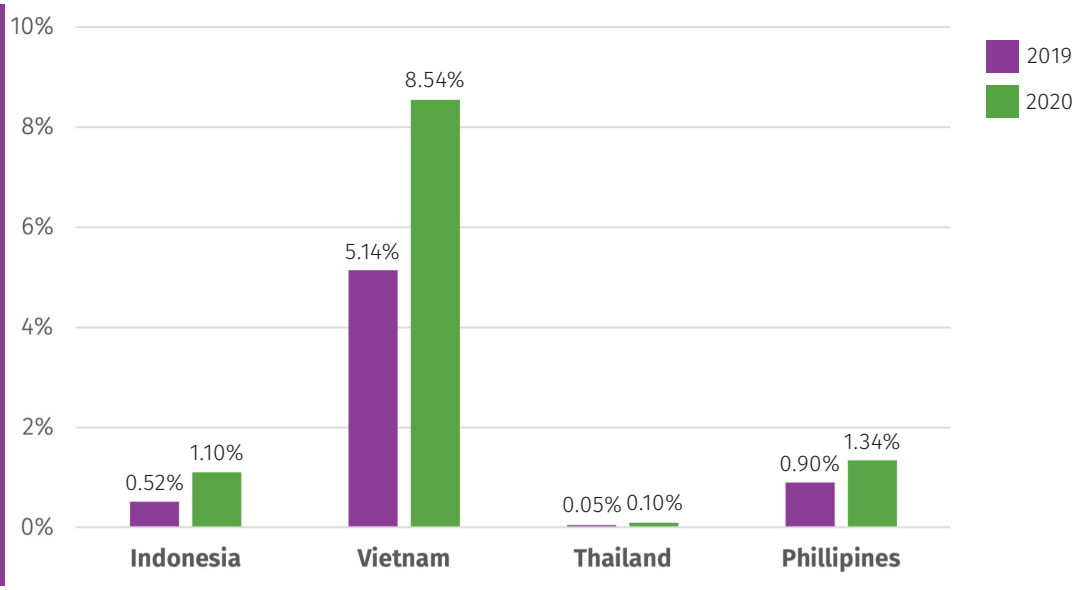


Figure 10. Change in E2W marketshare as compared to 2W sales (source: ICCT, 2022[23])

[22]Research and Markets (2021). ndonesian Electric Two Wheeler Market. [Online]. [Accessed 2022]. Available from: Research and Markets
[23]Le, Yang (2022). Market analysis of two- and three-wheeler vehicles in key ASEAN member states. International Council on Clean Transportation

The following table give the overview of the current product, battery capacity, and its price. In general E2W has a lower battery capacity than E3W, the range is 0.3 - 2 kWh. Price varies among product where higher battery capacity implies higher price.

Table 3. Current Indonesia E2&3W Market based on production base, model, and price (source: Modified from ICCT, 2021[24])

No.	Brand and/ or Model	Domes-tic /foreign	Battery Capacity	Charging Strategy	Plug-in charging duration (hours)	Battery Swap duration (seconds)	Estimated Travel Range (km)	Vehicle Price
1.	Q1 - Viar	Domestic	2kWh	Plugin and battery swap	3-4	30	50 - 70	IDR 16.2 Million
2.	Gesit E-Motorcycle	Domestic	1.98 kW	Plugin and battery swap	4-5	30	60 - 70	IDR 28.7 Million
3.	Smoot Tempur	Domestic	1.44 kWh	Plugin and battery swap	3-4	9	50 - 70	IDR 15 Million
4.	Selis E-motorcycle	Domestic	Eagle Prix: 0.96 kWh Agats: 1.4 kWh Jalak Pro: 1.2 kWh E-max: 1.2 kWh	Plugin and battery swap	5-7	9	55 - 65	Eagle Prix: IDR 15 Million Agats: IDR 19.9 Million Jalak Pro: IDR 18 Million E-max: IDR 16.9 Million
5.	Selis PMD	Domestic	Kid scooter: 0.288 kWh K-Bike: 0.316 kWh Auto Folding: 0.252 kWh	Plugin	5-7	N/A	15 - 20	Kid scooter: IDR 3.8 Million K-Bike: IDR 15.3 Million Auto Folding: IDR 18.5 Million
6.	Selis SPV	Domestic	New Robin: 0.96 kWh Pujasera: 0.42 kWh urban Trike: 0.96 kWh Cargo Bike: 0.96 kWhn	Plugin	5-7	N/A	30 - 35	New Robin: IDR 18.6 Million Pujasera: IDR 15 Million Urban Trike: IDR 28.5 Million Cargo Trike: IDR 25 Million
7.	Selis E-moped	Domestic	Murai: 0.576 kWh Mandalika: 0.432 kWh Butterfly Trike: 0.432 kWh Rinjani: 0.432 kWh	Plugin	5-7	N/A	35	Murai: IDR 7.85 Million Mandalika: IDR 5.4 Million Butterfly: IDR 8.4 Million Rinjani: IDR 8.5 Million
8.	Selis E-bike	Domestic	IOI Pro carrier: 0.576 kWh Swan: 0.3744 kWh Storm: 0.3744 kWh Tornado: 0.3744 kWh Roadmaster 2: 0.3744 kWh SOI: 0.316 kWh	Plugin	5-7	N/A	20 -25	IOI Pro Carrier: IDR 7.5 Million Swan: IDR 15 Million Storm: IDR 55 Million Tornado: IDR 25 Million Roadmaster IDR 15 Million SOI: IDR 14.5 Million
9.	MIGO 2	Domestic	Migo 2: 1.4 kWh	Plugin	3-4	N/A	45 - 55	Migo 2: IDR 12.7 Million
10.	United T1800 E-motorcycle	Domestic	T1800: 1.68 kWh	Plugin	3-4	N/A	45 - 64	T1800: IDR 27 Million
11.	Tomara Semar E-motorcyle	Domestic	Semar: 1.9 kWh	Plugin	7	N/A	50 - 65	Semar: IDR 32 Million
12.	ECGO 2	Foreign	ECGO 2: 1.25 kWh	Plugin	3-4	N/A	45 - 55	IDR 6.9 Million
13.	Volta	Domestic	E-Bikes Volta 100: 0.4 kWh Volta 202: 0.4 kWh Volta 203: 0.4 kWh	Plugin and battery swap	3-4	9	20 - 25	
14.	Volta E-Motorcycle	Domestic	Volta 301: 0.4 kWh Volta 302: 0.4 kWh	Plugin and battery swap	3-4	9	25 - 35	Volta 301: IDR 6 Million Volta 302: IDR 7.8 Million

No.	Brand and/ or Model	Domes-tic /foreign	Battery Capacity	Charging Strategy	Plug-in charging duration (hours)	Battery Swap duration (seconds)	Estimated Travel Range (km)	Vehicle Price
15.	Volta 501 E3W	Domestic	Volta 501: 3.5 kWh	Plugin and battery swap	3-4	9	65 - 70	IDR 17 Million
16.	Sunrace E-motorcycle	Domestic	Jupiter: 1.4 kWh F1: 1.4 kWh Stylish: 0.6 kWh & 0.9 kWh	Plug in	3-4	N/A	45 - 65	Jupiter: IDR 14 Million F1: IDR 14.5 Million Stylish: IDR 5.5 Million
17.	Artas Motorcycle (Rakata Motor)	Foreign	NX8: 3.6 kWh NX3: 1.82 kWh X5: 1.2 kWh S9: 1.2 kWh	Plug in	4.5-6	N/A	55 - 75	NX8: IDR 54.75 Million NX3: IDR 41.1 Million X5: IDR 22.1 Million S9: IDR 17 Million
18.	Gelis Cargo E3W	Domestic	Cargo: 3 kWh	Plug in	5	N/A	65 - 70	IDR 28 Million
19.	Beneli Divo E-motorcycle	Foreign	Divo: 1.56 kWh	Plug in	4	N/A	54 - 66	IDR 39.8 Million
20.	Keeway E-motorcycle	Foreign	E-Zi: 1.2 kWh	Plug in		N/A	53 - 60	IDR 43 Million
21.	Piaggio Ape E3W	Foreign	Ape: 7.5 kWh	Plug in	4	N/A	80 - 100	IDR 115 Million
22.	Kymco Nice E-Motorcycle	Foreign	Nice 100 EV: 1.5 kWh	Plug in	3-4	N/A	55 - 65	IDR 14.8 Million

[24]Mahalana, Yang, Posada (2021). Indonesia transport electrification strategy. International Council on Clean Transportation

Given the various products available in the market, classification is needed to give general overview on the current E2&3W market landscape. Generally, OEMs in Indonesia focus on only one fleet type. For example, it is few to find an OEM who produces E2W which happens to also manufacture E3W. However there are 2 companies identified that become a big player that produce an extensive range of species for example Viar Motor and Selis including e-bikes, e-moped, e-motorcycle/scooter, e-tricycle, and e-rickshaw. Table XX summarizes the information taken from Table above to better understand the categorization in Indonesia. It should be noted that classification varies among countries.

Table 4. General classification among E2W & E3W types in the Indonesian Market

E-Bikes				
· Operated using pedal-assisted · Weight <30 kg · Speed <25 km/h · Battery capacity 0.2 - 0.37 kWh	Viar - Panama			Selis - Tornado
Moped				
· Operated using pedal-assisted and/or throttle · Weight 56 - 110 kg · Speed <25 km/h · Battery capacity 0.4 - 0.6 kWh	Viar - Akasha			Selis - Rinjani
Kick Scooter				
· Operated using throttle or foot-kick · Weight 13 - 18 kg · Speed <25 km/h · Battery capacity 0.2 - 0.3 kWh	Xiaomi - Mijia			Selis - Kid Scooter
Scooter/Motorcycle				
· Operated using throttle · Weight 85 - 95 kg · Speed 40 - 70 km/h · Battery capacity 0.4 - 2 kWh	Viar - Q1			Gesit - G1
E-rickshaw				
· Operated using throttle · Weight 30 - 380 kg · Speed 40 - 70 km/h · Battery capacity 2.7 - 7.5 kWh	Piaggio - Ape			Selis - New Balis
E-tricycle				
· Operated using pedal-assisted and/or throttle · Weight 150 - 200 kg · Speed <25 km/h · Battery capacity 0.42-0.96 kWh	Selis - Pujasera			Selis - Urban Trike

2.3 INITIATIVES FROM THE PUBLIC AND PRIVATE SECTORS

The success of E2&3W adoption could not be achieved without early initiatives from public and public sectors. There have been numerous supports given that facilitate the shift towards cleaner transportation, mainly charging infrastructure and fleet procurement.

On state-owned enterprises (SOE) level there is PLN and Pertamina. PLN as electric company has been operating 275 charging stations scattered in 195 across Indonesia. PLN targets to deploy a total of 4900 battery swap station and 580 charging stations for EV cars[25]. Also, Pertamina who participates in the Indonesian Battery Company joint venture will produce 140 GWh batteries by 2029 and at the same time also develop the EV battery ecosystem including the swapping and charging business. Although Pertamina has been operating 5 charging stations only for cars, the company plans to add battery swap for E2&3W in 2022[26].

Figure 11. Battery swap station provided by Pertamina[27] (Source: Republika.co.id/Intan Pratiwi)

Figure 12. Charging station provided by PLN[28] (Source: Republika.co.id/ Nidya Zuraya)

Various public governments are also found to join in incorporating E2&3W. Viar electric bike used as an operational fleet in the Ministry of Transportation. Budi Karya as a Minister welcomed the support from the company to support MoT in using e-motorcycle for personnel's fleet[29]. Some ministerial levels such as the Ministry of Economy, Ministry of Industry, and regional government are planning to welcome such initiatives. For example, DKI Jakarta plans to procure e-motorcycle next year while at the same time deploying electric bus as a public transportation (more priority).

Figure 13. Transport Minister Budi Karya Sumadi Inaugurates E-motorcycle as MoT's Personnel Fleets (source: Bisnis.com/Dany Saputra[30])

[25]Dananjaya. 2022. Sampai Februari 2022 Jumlah SPKLU Nasional Diklaim Mencapai 267 Unit. [Online]. [Accessed 2022] Accessed from: Otomotif Kompas
[26]Chandra. Pertamina Geber Pembangunan SPKLU di Tengah Serbuan Kendaraan Listrik. [Online]. [Accessed 2022]: Available from: Finance Detik
[27]Pratiwi, Intan. (January, 2022). Pertamina and Grab Plan to Strengthen Electric Vehicle Ecosystem. Republika Online. [Online]. [Accessed 2022]. Available from: Battery Swap Station
[28]Zuraya, N., Pratiwi, I. (July, 2022). Collaboration with ATPM, PLN Commits to Growing Electric Vehicle Ecosystem. Republika Online. [Online]. [Accessed 2022]. Available from: Charging Station Provided by PLN
[29]Saputra. Kemenhub: 2000 Kendaraan Lolos Uji Sertifikasi. [Online]. Accessed 2022]. Available from: Ekonomi Bisnis
[30]Saputra. Kemenhub: 2000 Kendaraan Lolos Uji Sertifikasi. [Online]. [Accessed 2022]. Available from: Ekonomi Bisnis

Ride hailing company is seen as an influential entity to bring significance for this adoption. Grab has been collaborating with Viar, Viar Q1 e-motorcycle is a fleet mainly used down the road. In addition, the partnership has brought Grab to offer e-motorcycle rental (GrabRental) for anyone who wants to be a driver with various degrees of flexibility. The feature that is available in 8 cities, require people to submit a deposit of IDR 200,000, fall within 18 - 55 years old, and credentials (National ID, driver's license, and SKCK). In addition, Gojek and TBS electric created a company named Electrum that focuses on electric mobility. Electrum partnered with Gogoro who are experienced in providing battery swap service worldwide. In urban mobility context, they aim to accelerate the shift from ICE vehicles to e-motorcycle used by their drivers so that Gojek can achieve net zero emission by 2030[23].

Figure 14. Grab rental allows people to become driver using e-motorcycle using Viar Q1 model (source: Grab.com[32])

[31]Herman. 2030, Seluruh Armada Gojek Pakai Kendaraan Listrik. [Online]. [Accessed 2022]. Available from: Beritasatu
[32]Grab Indonesia. (April, 2022). Rent an Electric Motorcycle Through Grab Rental with Easy and Fast Registration. Grab ID. [Online]. [Accessed 2022]. Available from: Grab.com

3 E2&3W to Start and Catalyze The Domestic E-mobility Ecosystem

Given the high population of the 2&3W segment in Indonesia, their shift to cleaner modes will bring significant benefits in terms of GHG emission reduction and fossil fuel consumption reduction. The 2&3W segment can be both a starting point for mass vehicle electrification in Indonesia as well as a catalyst for the whole e-mobility ecosystem.

How Can E2&3W Segments Be A Starting Point for Vehicle Electrification Initiative?

1. **2&3W are generally used for shorter trips compared to cars, hence less range anxiety is expected even with the current low availability of public charging infrastructure.** Range anxiety due to lack of charging infrastructure is cited as one of the major concerns from consumers to shift to electric vehicles[33]. Meanwhile, motorcycles, bicycles, and rickshaws are popular for short distance travels, such as for groceries, workplace commuting, carrying kids to school, and as a means of first-last mile connection. A small-scale survey in Indonesian big cities by ITDP Indonesia in 2019 showed that almost 40% of daily private motorcycle riders spend less than 20 minutes on each trip. These shorter trips suit the current range of E2&3W well; a typical fully charged battery can travel around 50-60 km[34]. Less distance traveled implies less range anxiety risks, even with the current scarcity of public charging infrastructure.

2. **Easier to charge.** Smaller batteries make the recharging much easier as compared to electric cars which require higher wattage or dedicated charging infrastructure. E2&3W owners can easily charge their vehicles or the removable batteries at home or office, without the need to increase their current electricity voltage or have additional dedicated charging space. The current lack of charging infrastructure, which is typical in the early adoption stage of electric vehicles, will be less worrisome for E2&3W users.

3. **Faster charging and the availability of battery swap technology.** A typical E2&3W can be fully charged in only 2-3 hours. Vehicles with swappable batteries can also be repowered as instantly as petrol refueling by exchanging the almost depleted battery with a fully charged one at battery swapping stations, which are getting available in many convenience stores or petrol stations[35]. This instant refueling will introduce lesser change from the ICE 2&3W, compared to cars which might need to be charged several hours or overnight.

4. **Comparable total cost of ownership (TCO) and innovative business models.** The difference in purchase prices between ICE and electric 2W is not as significant as the price differences at the 4W segment in Indonesia[36] and hence present lower price barriers for the consumers. Households with multiple types of vehicles i.e. cars and motorcycles (which are not uncommon in Indonesia[37,38]) can start shifting to electric from their two wheelers given the lower price point and proceed to transition their cars to electric when the affordability improves. There have also been several innovative business models, such as vehicle leasing, charging service subscription, and battery as a service (BaaS) models where the procurement of vehicles is unbundled from the batteries, to lower E2W capital and operational costs. In addition, in the early quarter of 2022, Pertamax-type gasoline price has increased by nearly 1.5 fold[39] which further brings the TCO gap of the vehicle technologies closer. The advancements in battery technology will further reduce the TCO in the near future. The significantly lower price per unit compared to electric cars will be a huge potential for the government to provide direct subsidies targeted to the vehicle segment, since it means that with the same budget allocation the government can subsidize more E2&3W and hence penetrate wider markets compared to providing subsidies for electric cars.

[33]Samosir, G., Devara, Y., Florentina, B., & Siregar, R. (2018). Electric Vehicles in Indonesia: The Road Towards Sustainable Transportation (p. 15). Solidiance.
[34]Yanwardhana, Emir. (2022, 23 February). Lively Electric Motors, How Fast is the Charging Time?. CNBC Indonesia. [Online] [Accessed 2022]. Available from: CNBC Indonesia
[35]A company called Swap.id (which also manufactures e-motorcycles known as Smoot) has launched their battery swap which is easily accessible in minimarket (Indomaret and Alfamart). (Source : Kurniawan, Dicky. (2021, 1 September). Smoot electric motor in Indonesia, the battery can be swapped at the minimarket. Available from: Otomotif Tempo
[36]An estimate from Grab Indonesia stated that while electric cars (in this case Hyundai Ioniq) need 9 operational years to achieve cost parity, the break-even point for e-motorcycle can be achieved in 4.5 years (Source: Ainurrofiq, Uun. (September 2020). Kolaborasi mewujudkan ekosistem kendaraan listrik di masa depan.)
[37]BPS-Statistics Indonesia. 2020. Motorized Vehicles (Unit) 2018-2020. [Online]. [Accessed 2020]. Available from: https://www.bps.go.id/indicator/17/57/1/jumlah-kendaraan-bermotor.html
[38]Wedagama, D. P. W. (2009). The analysis of household car and motorcycle ownerships using poisson regression (Case Study: Denpasar-Bali). Jurnal Teknik Sipil ITB, 16(2), 103-112.
[39]Siswanto, Dedi. (April, 2022). Response to the Price Increase of Pertamax. News Setup. [Online]. [Accessed 2022]. Available from: News Setup Kontan

5	**Presence of large commercial and public motorcycle fleets, i.e. from the ride-hailing services and government fleets.** Although the number of fleets has never been publicly stated by the ride-hailing operators themselves, an estimate in 2020 stated that there are around 4 million ride-hailing drivers in Indonesia[40]. This still excludes other commercial fleets from logistics companies or food delivery services. There are also hundreds of thousand motorcycles being used as government vehicles. The large number of fleets pose an advantage for the shift to electric vehicles since they are centrally coordinated and hence can more easily be regulated by the government or the companies themselves, which might aim to align their mission to provide cleaner mobility by having an electrification target which can prompt and encourage their drivers to shift. In addition, the high vehicle kilometers traveled (VKT) of fleet vehicles multiplies the economic and societal benefits from vehicle electrification, as well as demonstrates electric vehicles' durability and reliability even under high usage.
6	**Availability of many E2&3W models.** There have been numerous E2&3W models with different prices, range, battery capacity, performance, etc. both from domestic and international manufacturers, available in Indonesia. The availability of multiple models will benefit potential customers who can choose specific models to suit their needs. For instance, there are e2W models with smaller batteries for people who mostly have short distance-trip around their neighborhood. There are pedal-assisted E2&3W which also enable riders to pedal their vehicles if preferred. There are also e-motorcycles that have comparable speed and longer distance with ICE motorcycles, such as the ones produced by the state-owned OEM Gesits, which can be used for long-distance travel such as touring, ride-hailing services, and going to distant workplace or school.

Table 5. E2&3W as a starting point for EV initiative

How Can E2&3W Be A Catalyst for Indonesian EV Ecosystem?	
1	**Given the huge potential market, the adoption of E2&3W can provide the exposure needed to familiarize consumers with electric vehicles.** As the most popular mode of travel, motorcycle traffic is widely distributed on almost all roads in Indonesian cities and even rural areas. The shift of this segment to electric can increase public familiarity with the technology itself and its benefits, hence can prompt the shifting of other vehicle segments to electric (i.e. cars).
2	**The EV-related policies and the EV industry will become more mature.** From the policy perspective, incentives and disincentives that will have been proven to be effective to encourage the adoption of E2&3W can be adapted for E4W. From the industrial perspective, although there will be different facilities for electric 4W, charging infrastructure businesses and stakeholders can apply the lessons learned from developing innovative business models for E2&3W charging facilities, given the relatively higher price sensitivity of the two and three wheeler user segment. This also applies for OEMs on the marketing strategy of EVs to boost their vehicle sales.
3	**The increase of demand from the 2&3W segments will boost the domestic EV component industry and its supply chain (e.g. battery pack and its materials) and may bring down the costs for overall EV production** including E4W and e-bus segments. All the factors above will benefit and advance the adoption of the other electric vehicle segments.

Table 6. E2&3W be a catalyst for Indonesian EV

[40]Perwitasari. 2020. Ada 4 juta driver Ojol di Indonesia. [Online]. [Accessed 2022] Access from: Kumparan News

4 Environmental, Social, and Economic Impacts of 2&3W Electrification

4.1 OVERVIEW OF BENEFITS AND DRAWBACKS

If justly managed, the shift from ICE 2&3W to electric vehicles can bring numerous benefits not only from the environmental sustainability perspective, but also can improve road safety, energy security, and mobility inclusivity. Nevertheless, learning from countries that have long been shifting to EV, vehicle electrification may lead to drawbacks, the overview of which can be seen in Table 1 below.

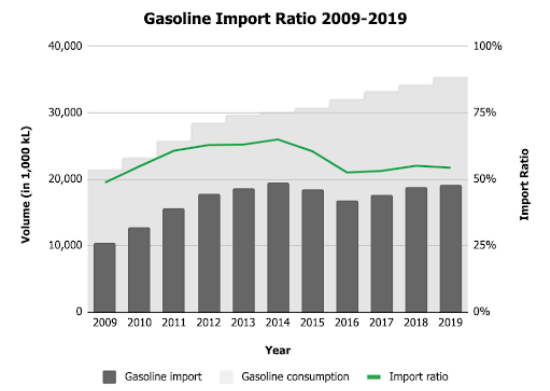
Sector	Benefits	Drawbacks
Environment	**Transport sector decarbonization.** In 2020, 27% of Indonesia's GHG emission was from the transportation system and 91% of the transport sector's GHG emission was contributed by road transportation due to the rapid growth of ICE vehicle usage. Meanwhile, E2&3W produces no tailpipe GHG emission. **Cleaner air.** E2&3W has lower life cycle PM, CO, hydrocarbon, and NOx than ICE vehicles, and even more so if Indonesia's mostly coal-powered electricity generation is shifted to renewable sources or natural gas or equipped with better exhaust treatments. **Lower noise pollution.** ICE motorcycles typically produce 70dB of noise. Although the sound limit for motorcycles in Indonesia is 80 dB, long-term exposure to noise louder than 70 dB may lead to harming people's hearing, increase the risk of heart attack for the vulnerable, bring anxiety, and inability to focus & sleep well. **Shifting emissions to more concentrated sources (i.e., power plants), that are mostly located outside densely-populated areas.** E2&3W uptake will shift transport sector pollution from the vehicle tailpipes themselves to power generation sources[41]. This will bring benefits in terms of fewer people affected by the ambient air pollution and more control of the government to reduce the emissions since they have the authority to improve the energy mix of the Indonesian grid, given the political will to do so.	**More use of carbon-intensive electricity.** In E2&3W, the tailpipe GHG emission is shifted to electricity generation, vehicle and battery manufacturing, and end-of-life treatment[42]. The electricity grid in Java-Madura-Bali and Sumatra still produce 800 and 770 gCO2/kWh respectively in 2019, or around 40% more carbon intensive than the EU grid, which reduce the life-cycle GHG emission reduction of E2&3W. **Battery waste.** Poor quality battery waste recycling plants can leak pollutants and may lead to severe environmental and health consequences, especially for lead battery waste. **More non-renewable material extraction.** Indonesian electricity grid still mainly relies on non-renewable resources such as oil, gas, and coal, with mining primarily located in forest ecosystems. As a consequence, rapid deforestation has been occurring in Kalimantan, reaching a 22% rise from 1990 to 2015. In addition, considering the ambition of the Indonesian government to be a major player in the international battery supply chain, there is a huge risk of natural resource exploitation if the extraction and production activities are not regulated properly.
Energy	**Higher tank-to-wheel efficiency.** Electric motors are significantly more efficient than ICE, hence a 50-90% tank-to-wheel energy savings can be expected[43].	**Well-to-tank energy efficiency contributes more to the life cycle energy use.** The well-to-wheel energy savings can be less significant, depending on the region's electricity mix and supply chain efficiency.

Table 7. Overview of environmental, social, and economic impact

[41]Cherry, C.R. (2007). Electric Two-Wheelers in China: Analysis of Environmental, Safety, and Mobility Impacts. Dissertation. University of California, Berkeley, USA.
[42]Weiss et al. (2015). On the electrification of road transportation – A review of the environmental, economic, and social performance of electric two-wheelers. Transportation Research Part D.
[43]Ibid.

Sector	Benefits	Drawbacks
Social	**More independent mobility options for women, older people, and people with disability.** E2&3W's lower power and speed are suitable for shorter-distanced trips often made by women and the elderly. E3W and electric micromobility, such as an electric wheelchair or personal mobility aid (PMA), are increasingly used by people with disabilities to support their mobility.   **Figure 15.** Electrified two- and three- wheelers for children and elders (credits from top to bottom: Velospeed.co.uk, Els van der Gun/Getty Images) **An increase in road safety.** E2&3W typically have lower speeds (40-70 Km/h at max), compared to ICE motorcycles which can run up to 100 km/h and weigh less than ICE 2&3W. Lower speeds and vehicle weight contribute to less severe collision impacts. On the other hand, motorists traveling over 20 km in a single journey are more likely to be involved in a crash. E2W motorcycles in general have a lower travel range as compared to conventional motorcycles, which can reduce the risk of crashes. **Encourage more cycling.** There is a potential for E2&3W, especially the pedal-assist types, to be a transition for people from using cars and motorcycles to cycling. A study in The Netherlands reported 1.5 times longer trips of people who ride e-bikes than bicycles[44]. However, it should be noted that this should be supported by properly designed facilities such as dedicated lanes.	**Potential shift from zero-emission, more energy-efficient, and more space-efficient modes.** Efforts to accelerate electric two-wheelers, especially e-motorcycles, and three-wheelers adoption may lead to an undesirable drawback if it shifts the shares of commuters who are currently using public transportation or non-motorized mode as their main transportation. Per passenger, they also still occupy more road space overall compared to transit. **Growing safety concerns from other road users.** Although technically the collisions tend to be less severe, unclear regulations in Indonesia concerning e-bikes and other e-micromobility speed limits, and lane allocations incite concerns from road users, both pedestrians and vehicle users alike. Without speed limits, speedings are prone to be done and society's concern is further exacerbated by the lack of minimum age limits for using the modes. Furthermore, for people with visual disabilities, the quiet E2&3Ws can become a safety issue since there will be fewer audio cues alerting them of approaching vehicles.

[44]Heinen, E., Maat, K., & Van Wee, B. (2011). Day-to-day choice to commute or not by bicycle. Transportation Research Record, 2230(1), 9-18

Sector	Benefits	Drawbacks
	Momentum to better manage the traffic. The uptake of E2/3W as new modes can be a momentum to further clarify and enforce maximum speeds, vehicle dimensions, and lane assignments regulations to reduce traffic conflicts. There are many traffic violations and road safety issues by motorcycles because of unclear or unenforced regulations (e.g., motorbikes as public/shared passenger transportation).	
Economic	**Lower operational costs.** The energy and maintenance costs of E2&3W are lower than their ICE counterparts, hence offering a competitive total cost of ownership even with the current higher acquisition price. For example, e-motorcycles with 30 km/kWh energy consumption will require an energy cost of around Rp 3,000 to run for 60 km, while a typical motorcycle in Indonesia requires around 1.5 liter of gasoline which costs Rp 15,000 (implies a saving of 80%). **Reduce dependency on non-renewable, imported fuel.** In 2021, the annual subsidy doubled from the previous year to IDR 83.8 trillion[45] (around USD 5.9 billion), or around 3% of the total national budget[46]. Meanwhile, Indonesia's gasoline import ratio still exceeds 50% in the past decade[47]. Significant uptake of electric vehicles will also contribute to the increase in electricity consumption, which the country's production still has a surplus of more than 30%[48].  **Figure 16.** Gasoline consumption and import ratio in Indonesia[49] **Domestic industry improvement.** The shift to EV, including E2&3W, can help support new domestic industry development. In addition to vehicle and vehicle components manufacturing industries, Indonesia is also gearing up to be a major player in the battery supply chain industry.	**Obsoletion of the current industry workforce.** The shift to new technology vehicles will require a new industrial supply chain due to the different components of EV. Different skill sets for vehicle operations, especially maintenance skills, will also be required. Without any concrete capacity and skill set improvement programs, there are risks of skill obsolescence in the current workforce.

[45]Maesaroh. (2022). Lagi-lagi Subsidi BBM Terancam Bengkak Ratusan Triliun. [Online]. [Accessed 2022]. Available from: CNBC Indonesia
[46]Indonesian Ministry of Finance. (2021). Informasi APBN 2021: Percepatan Pemulihan Ekonomi Dan Penguatan Reformasi. https://www.kemenkeu.go.id/media/16835/informasi-apbn-2021.pdf
[47]Kusdiana, Dadan. (2021). Kebijakan Energi Alternatif di Sektor Transportasi [Webinar]. Indonesian Ministry of Energy and Mineral Resources.
[48]Asaad, M. Ikhsan. (2021). Kesiapan Stasiun Pengisian Kendaraan Listrik Umum di Indonesia [Webinar]. PLN.
[49]Kusdiana, Dadan. (2021). Kebijakan Energi Alternatif di Sektor Transportasi [Webinar].

Environmental concerns often become the driver of zero-emission vehicle initiatives. A study has shown that the only path to limit global warming below 1.50C by 2050 (a critical limit stipulated in the Paris Agreement to avoid disastrous climate change) is to both shift the majority of trips to walking, cycling, and using public transport and massive electrification of the remaining trips, combined with grid decarbonization ("High Shift - High Electrification")[50].

High Shift - High Electrification: The Only Path to 1.5°C

In 2021, ITDP and the University of California Davis modeled four scenarios for change in urban passenger transport:

1. Business-as-usual (BAU) scenario: Reflects current trends in urban passenger transportation; dominated by private vehicle usage with the expense of declining public transport usage, walking, and cycling.
2. High Electrification: Massive shift to EV, with modal share similar to the BAU scenario. The EVs run on clean electricity.
3. High Shift: All cities adopt compact city policies and results in improvements of walking, cycling, and public transport usage
4. High Shift - High Electrification: All cities adopt compact city policies and results in improvements of walking, cycling, and public transport usage. Most of the remaining private vehicle trips use EVs running on clean electricity.

By shifting most trips to non-motorized and public transport trips, and shifting 85% of the remaining private motorized trips to electric vehicles running on clean electricity, the cumulative GHG emission between 2020-2050 can be limited to 60Gt CO2eq. The reduction is sufficient to limit global warming to 20C and possibly below 1.5°C.

Table 8. High Shift - High Electrification

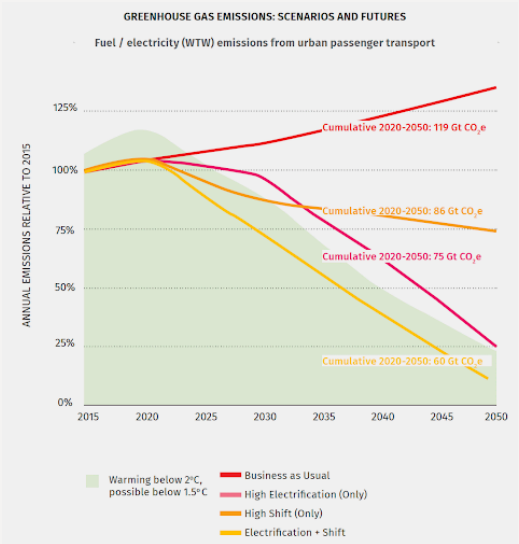


Figure 17. GHG emission forecasts, based on 4 scenarios of urban transportation[51]

[50]Fulton, L., Reich, D. T., Ahmad, M., Circella, G., & Mason, J. (2021). The Compact City Scenario – Electrified (p. 17). Institute For Transportation and Development Policy and University of California Davis.
[51]Ibid.

Study Case :
CHINA'S SHIFT TO ELECTRIC MOTORCYCLES AND BIKES

Figure 18. Electrified two- and three- wheelers for elders and children (Source: www.chinadaily.com)

As one of the world's largest motorists, Indonesia could learn from the neighboring country in shifting to cleaner means of transportation. China, in 2006 banned ICE motorcycles in 148 cities as the air quality worsened. They massively adopt e-bikes in 2017 and managed to reduce global carbon emissions 80% of the 29 million tonnes due to electric bike[52]. The effective reduction of urban air pollution can be achieved by electrification. The substitution of ICE motorcycles to E2W is effective in reducing carbon emissions - Every electric two-wheeler that replaces a ICE motorcycle reduces CO2 emissions by 1.3 tons per vehicle over its lifespan[53]. As the unsustainable electricity plant can contribute to GHG, clean energy utilisation such as solar PV, wind turbine, and geothermal is important to be included in the electrification programme to its externalities; this varies across the world.

Table 9. Study case 2: China's shift to electric motorcycles and bikes

[52]Bakker, S. 2018. Electric Two-Wheelers, Sustainable Mobility and the City. Sustainable Cities – Authenticity, Ambition and Dream, pp.97-110
[53]Rajper, S. Z. and Albrecht, J. 2020. Prospects of Electric Vehicles in the Developing Countries: A Literature Review. Sustainability. 12(5):1906

4.2 THE ADDITIONAL BENEFITS OF E-BIKES

In the E2W segment, the often overlooked e-bikes also offer the mentioned benefits and more. E-bike is defined here as an E2W with pedals. It can be powered by a pedal-assist system, throttle, or both. Given the added benefits of e-bikes, the adoption of the mode should be given as much importance as the e-motorcycles and other non-pedal E2&3W, if not more.

Benefits Compared to Regular Bicycles:

Enable longer cycling journeys with less effort[54], therefore improving bicycle's effectiveness as a door-to-door mobility option and increasing public transport catchment area if used as a first-last mile mode.

Improve cycling accessibility for different types of users for instance for women, the elderly, people with disability, beginner or potential cyclists. The power-assist from the electric motors makes cycling activity require less physical effort.

Enable more trip purposes by cycling. The added power also makes trips with heavy cargo, such as food or goods delivery or passenger transport, or trips on steep slopes more manageable. Multiple studies[55,56] show that e-bikes are more often used for utilitarian trip purposes such as commuting, running errands, or going to schools compared to regular bicycles.

Benefits Compared to E-Motorcycles:

Provide a lower emission and more energy-efficient transport option compared to motorcycles and even e-motorcycles.

More resilient. E-bike users still have the option to pedal in case their batteries are depleted or experience other technical failure with their electric motors.

More accessible for different types of users. E-bikes are generally lighter than e-motorcycles and therefore are more accessible for women and people with limited physical abilities.

More affordable. In general, e-bikes have lower prices compared to e-motorcycles.

Improve road safety. As e-bikes generally have lower speeds and are lighter compared to e-motorcycles, the collision impacts will be less severe compared to e-motorcycles and even more so compared to ICE vehicles. If there are more people riding low-speed, light vehicles like e-bikes or bicycles, the overall road safety will improve ("safety in numbers").[57]

[54]Wild, K., & Woodward, A. (2019). Why are cyclists the happiest commuters? Health, pleasure and the e-bike. Journal of Transport & Health, 14, 100569.
[55]Ling, Z., Cherry, R. C., MacArthur, H. J., & Weinert, X. J. (2017). Differences of cycling experiences and perceptions between E-bike and bicycle users in the United States. Sustainability, 9(9): 1662.
[56]Edge, S., Dean, J., Cuomo, M., & Keshav, S. (2018). Exploring e-bikes as a mode of sustainable transport: A temporal qualitative study of the perspectives of a sample of novice riders in a Canadian city. The Canadian Geographer / Le Géographe Canadien, 62(3), 384–397.
[57]Jacobsen, P. L. (2015). Safety in numbers: more walkers and bicyclists, safer walking and bicycling. Injury prevention, 21(4), 271-275.

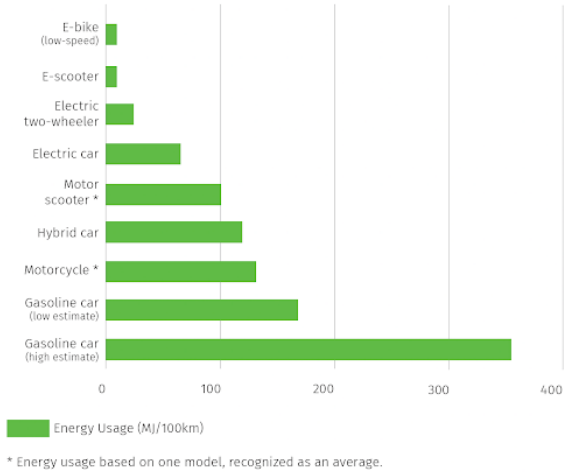


Figure 19. Energy consumption comparison between modes[58]

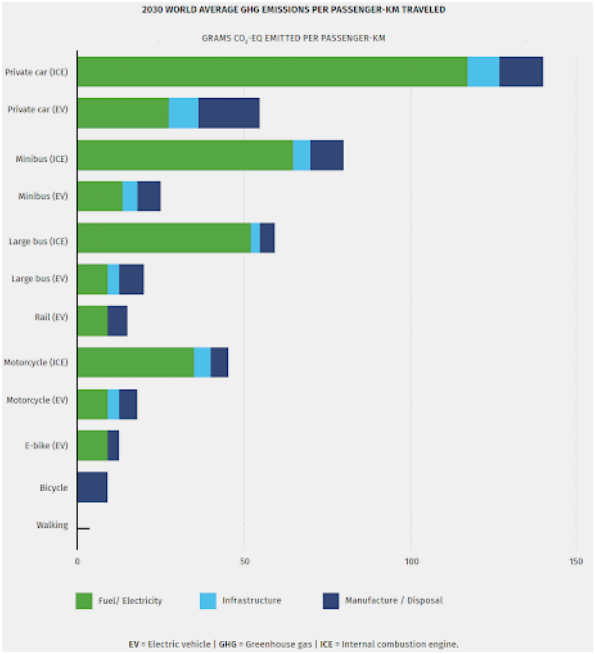


Figure 20. GHG emission comparison between modes[59]

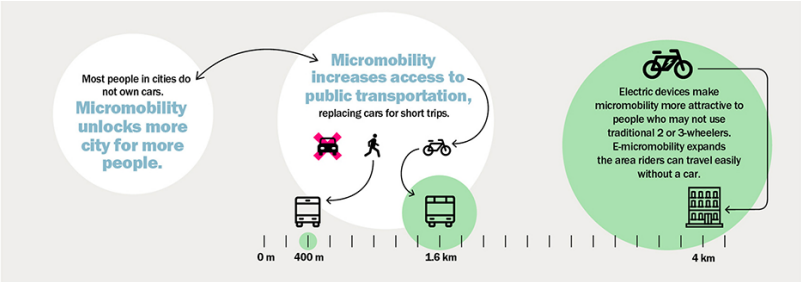


Figure 21. E-bikes enable longer cycling journeys and improve public transport catchment area

[58]Fulton, L., Reich, D. T., Ahmad, M., Circella, G., & Mason, J. (2021). The Compact City Scenario – Electrified (p. 17). Institute For Transportation and Development Policy and University of California Davis.
[59]Fulton, L., Reich, D. T., Ahmad, M., Circella, G., & Mason, J. (2021). The Compact City Scenario – Electrified (p. 17). Institute For Transportation and Development Policy and University of California Davis.

4.3 MITIGATING THE DRAWBACKS

E2&3W electrification plays an important role in transportation decarbonization, air pollutant reduction, energy efficiency improvements, and road safety improvements. Nevertheless, they should not be regarded as the single solution to achieving environmental, economic, and social sustainability, as elaborated in the drawbacks of E2&3W in the previous section. Therefore, the government's efforts of accelerating E2&3W adoption should go hand-in-hand with measures to mitigate the drawbacks.

Drawback 1: More use of carbon-intensive electricity
Mitigation Measure: Improving the share of renewable energy sources

Drawback 2: Battery waste
Mitigation measure: Imposing strict regulations on battery waste treatment

Drawback 3: More non-renewable material extraction
Mitigation measure: Improving the share of renewable energy sources, imposing strict regulations and enforcement on mining activities

Drawback 4: Potential shift from zero-emission, more energy-efficient, and more space-efficient modes
Mitigation measure: Applying the paradigm below in prioritizing initiatives and policies

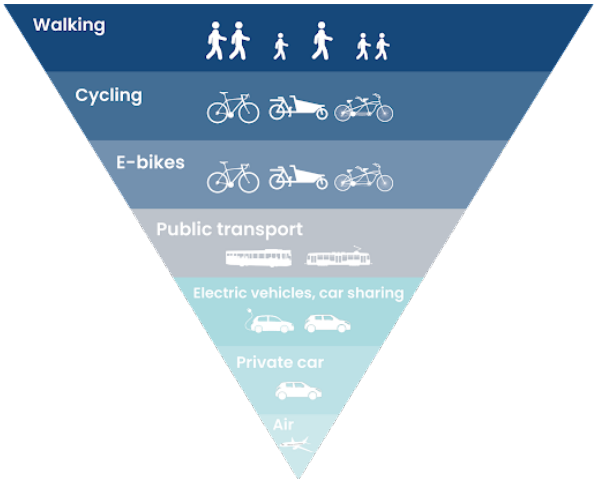


Figure 22. Prioritization for a sustainable transportation system, with electric vehicles[60]

Drawback 5: Growing Safety Concerns
Mitigation measure: Introducing new regulations and policies to accommodate E2&3W uptake in urban traffic or improving the clarity of existing regulations

Drawback 6: Obsoletion of the current industry workforce
Mitigation measure: Conducting capacity and skill-building programs on EV manufacturing, operations, and maintenance for industry workforce. Other countries with strong ICE manufacturing industries, such as Thailand, have been conducting extensive research and development programs to prepare for the industry shift.

[60]Bicycle Innovation Lab. 2017. The reverse traffic pyramid. Copenhagen. [Online]. Accessed from: https://bicycleinnovationlab.dk/

5 Estimating the Impacts of E2&3W Uptake in Indonesia

An analysis to estimate the impacts of the shift to E2&3W was conducted and the results are presented in this chapter. The analysis was done by using the 2W electrification impact toolkit[61], originally developed to estimate the impact of electrifying ride-hailing fleets in Jakarta. Several adjustments on the assumptions were made to allow the model to estimate the national-level 2W electrification impacts[62].

Several parameters were estimated using the toolkit:

1. GHG reduction
2. Air pollution reduction
3. The number of required charging infrastructure
4. Amount of investment required, including vehicle purchase price subsidy to achieve cost parity and investments for public charging infrastructure
5. Cost-benefit analysis

The analysis examined the scenario of achieving 100% E2W penetration by 2050, considering the government's unofficial plan to have 100% E2&3W sales by 2040 in the upcoming National Grand Strategy for Energy ("Grand Strategi Energi Nasional"/GSEN).

5.1 METHODOLOGICAL APPROACH

5.1.1 E2W ADOPTION PHASES

Assuming a constant 5% Y-o-Y 2W growth, the Indonesian government can expect a total of almost 531 million units of 2W in 2050. This number, however, is subject to the simple approach and does not take into account transportation demand management measures which aim to limit the usage and growth of motorized vehicles ownership.

The adoption rate of E2W is assumed to follow Everett Rogers' diffusion of innovation model. This model classifies the starters into innovators (2.5%), early adopters (13.5%), early majority (34%), late majority (34%), and laggards (16%). It is assumed that the time between phases and the phases that have been fully implemented is similar or equal.

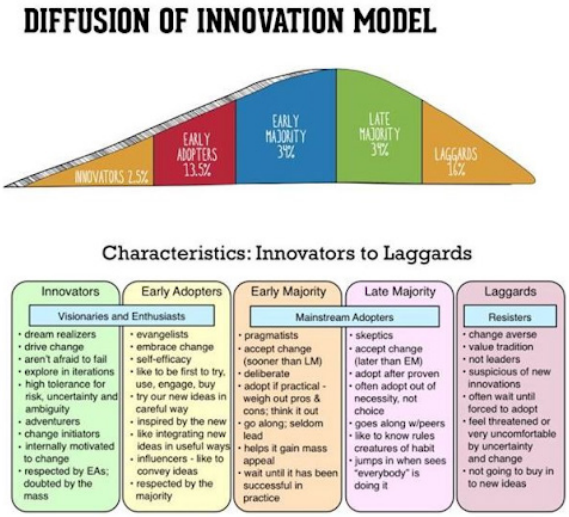


Figure 23. Diffusion of Innovation Model[63,64]

[61]ITDP Indonesia. (2021). Road Map and Timetable of Two-Wheeler Electrification in Greater Jakarta. Study conducted under UK PACT GRCF.
[62]The analysis is limited to 2W segments since they are the dominating mode of transport in Indonesia, hence will expectedly introduce more significant impacts than 3W.
[63]Hanlon, Annmarie. (October, 2013). What is the The Diffusion of Innovation model?. Smart Insights. [Online]. [Accessed 2022]. Available from: Smart Insights
[64]Rogers, E. M. (2003). Diffusion of Innovations, 5th Edition. United Kingdom: Free Press.

Table 10 shows the general variables for the model. In general, the current population of E2W is very low, around 0.01% of the general 2W population. This implies that Indonesia is still in the Innovator stage and still miles away from mainstream EV adoption[65]. The 2W data was collected primarily from the National Statistics Bureau and the Ministry of Transportation.

Table 10. Vehicles variables for Electrification Toolkit Calculation

No.	Vehicle Variables	Assumption Values
1.	Electrification starting year	2022
2.	Current ICE 2W (at starting year)	129,000,000
3.	Current E2W (at starting year)	16,936
4.	Daily distance	36
5.	Average daily trips per user	9
6.	Average user's daily Income (IDR)	100,000
7.	Average annual working days	295
8.	Full electrification target year	2050
9.	Y-o-Y growth	5.0%

Based on the diffusion of innovation model theory and the vehicle variables above, the adoption rates of E2W are assumed to be as follows:

Table 11. E2W adoption assumptions

Phase	Duration (Years)	Electrification Percentage	Start Year	End Year	Annual Growth
Innovators	5	2.5%	2022	2026	0.5%
Early Adopters	5	13.5%	2027	2031	2.7%
Early Majority	5	34.0%	2032	2036	6.8%
Late Majority	4	34.0%	2037	2040	8.5%
Laggards 1	4	13.5%	2041	2044	3.4%
Laggards 2	6	2.5%	2045	2050	0.4%

It is assumed that the uptake will be the slowest during the Innovator phase, since not many people are be fully aware yet of the benefits of shifting to the nascent vehicle technology. The uptake is expected to be gaining traction over the next three phases, i.e. until achieving market majority.

[65]Ibid.

An illustration on the assumed E2W uptake over the years can be seen in Figure 24.

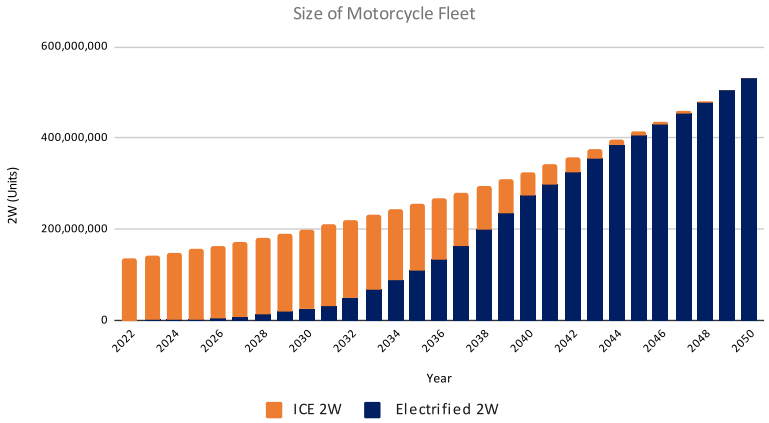


Figure 24. E2W Uptake Assumption

5.1.2 TOTAL COST OF OWNERSHIP

The purchase price, operating costs, and maintenance costs are all included in the total cost of ownership. For the purchase price, this study assumed the prices of E2W models (Gesits, Niu Gova, and Volta 401) that have comparable performance and target similar user segments with Honda Beat 125cc.

Annual calculations of operational costs only take into account the cost of fuel for each model. Aside from the distance travelled, the operational cost would be determined by the fuel efficiency of each model and the cost of energy. The fuel cost in 2022 is IDR 10,075 per liter and was calculated using the average price of combined pertalite (RON 90) and pertamax (RON 92). The price for electricity, on the other hand, is set at IDR 1,445 per kWh. Meanwhile, the fuel economy values are based on the Indonesian 2W fuel economy calculation made in Output 1A. Baseline Assessment On 2&3 Wheelers in Indonesia (ITDP Indonesia, 2022).

Table 12. Economic variables for electrification toolkit calculation

No.	Economic Variables	Values	Sources
1.	Average price of ICE 2W (IDR)	Rp 20,435,000	Honda Beat 125cc
2.	Average price of E2W (IDR)	Rp 23,610,000	Gesits, Niu Gova, and Volta 401
3.	Avg. FUel Economy ICE 2W (km/L)	51.6	Fuel economy calculation
4.	Avg. Fuel Economy E2W, 2021 (km/kWh)	34.7	Fuel economy calculation
5.	Electricity cost (IDR/kWh)	Rp 1,445	MEMR & PLN
6.	Fuel cost (IDR/L)	Rp 10,075	MEMR & Pertamina

Maintenance costs for electric vehicles and ICE vehicles differ. The cost of battery replacement is factored into the maintenance costs of electric vehicles, which are projected to be roughly IDR 6 million for electric motorcycles in 2022. For each type of vehicle, the cost components are as follows:

ICE		ELECTRIC	
Components	**Price/km**	**Components**	**Price/km**
Brake Pads	IDR 2.20	Brake Pads	IDR 2.20
Tire Replacement	IDR 15.00	Tire Replacement	IDR 15.00
Belt Replacement	IDR 3.54	Battery Replacement	IDR 112.9
Lubricant Refill	IDR 17.48		
Spark Plug Replacement	IDR 2.50		
Accumulator Replacement	IDR 5.25		
Total	**IDR 45.97**	**Total**	**IDR 130.1**

Table 13. Cost components of ICE and Electric Vehicle

Other economic factor includes inflation rate, discount rate, and salvage value.

Cost components	Data for TCO calculation	Assumptions
Discount Rate	10%	Discount Rate
Inflation rate	3.07%	Concession Time
Salvage value	6%	Motorcycle average
Annual Running Days	295	Insurance: 2.5% of the CAPEX

Table 14. Economic factors of cost component for EV maintenance cost

5.1.3 BATTERY SWAP STATIONS

To increase the convenience and promote the uptake of E2W, wider availability of battery swapping stations are recommended in addition to home-charging facilities. Following the E2W uptake assumption as elaborated in Chapter 5.1.1, the ideal number of battery swap stations are estimated using the following assumptions:

Swap Station Capacity, Daily (kWh)	89.3
Daily kWh Needs per 2W	1.0

Table 15. Variables for battery swap station assumptions

The daily kWh that can be provided per battery swap station is calculated under the assumptions that a single station has 9 battery slots for 1.44 kWh batteries and is able to fully charge 62 batteries per day within its operational hours of 18 hours. The ideal number of battery swap stations is estimated by simply calculating the daily kWh needs by multiplying the daily kWh needs per E2W with the number of E2W, then dividing it by the battery swap station capacity.

The cost assumptions associated with battery swap station provision are as follows:

Capital costs	Battery Swap Stations, Hardware (Including Battery)	Rp 134,900,000.00	Unit
	Battery Swap Stations, Installation	Rp 6,745,000.00	Unit
Operational costs	Battery Swap Stations, Real Estate Lease	Rp 6,000,000.00	Year/Unit

Table 16. Cost assumptions for battery swap station

5.1.4 ENVIRONMENTAL IMPACT

The analysis only accounts for the reduction in CO2 emissions from two-wheeler electrification. A lifecycle analysis is conducted, meaning that the estimate has taken into account the emissions from vehicle and fuel production, operations, and end-of-life recycling. The CO2 emission would also depend on the energy mix of electricity grid. The RUPTL 2021 projections for emissions and energy mix are then used to determine the carbon intensity (PLN, 2021)[66].

Battery Production

It is assumed that the Li-ion battery type utilized for E2W is NMC (Nickel-Manganese-Cobalt). The energy needed for battery manufacturing is estimated about 350-650 MJ/kWh battery[67]. For this study, 500 MJ/kWh is used representing the average of the range. A 1.44 kWh battery capacity is assumed, according to the standard battery model used by Gesits, and two batteries are required to replace the battery every five years during the vehicle lifetime of 10 years.

Vehicle Manufacturing

The steps included in this stage are resource extraction, material production, part production, and vehicle assembly. It is assumed that the energy needed for the production process is 41.8 MJ/kg vehicle[68].

Fuel Production

In the case of conventional 2W, the fuel production step entails the manufacturing of gasoline, and in the case of E2W, the generation of electricity. The electrical grid emission factors are computed using RUPTL 2021 and a combination of renewable, natural gas, oil, and coal as energy sources. According to Restianti and Gheewala (2012)[69], the transportation between the stages of crude oil extraction, gasoline refining, and manufacture is predicted to yield 0.255 kg CO2/L of carbon dioxide. Additionally, a 0.5% annual improvement in fuel efficiency is predicted (ERIA, 2018)[70].

Vehicle Operation

Since the power consumption for electric 2W is already accounted for during the fuel production (electricity generation) stage and they produce no tailpipe emissions, this segment exclusively addresses tailpipe emissions from traditional 2W. The Ministry of Environment and Forestry Regulation No. 12/2010 served as the source for the emission factor data for conventional 2W gasoline combustion. The information is then translated to kg/l units using the same regulation's fuel economy (28 km/l). The standard 2W fuel burns with a CO2 emission factor of 2.4168 kg CO2/l.

Vehicle End-of-Life

Since Indonesia currently lacks a recycling facility, it is expected that when a vehicle or battery reaches the end of its useful life, it will be discarded and result in emissions that are comparable for both electric and conventional 2W vehicles. The amount of emission does, however, vary depending on the weight. The information from Peshin et al. (2021) is used for vehicle disposal[71]. The emission factor for CO2 compounds is 0.852 kg/kg vehicle weight and is calculated using grid energy consumption data and emissions parameters in India, since limited information is currently available in Indonesia.

[66]Kementerian ESDM, 2021, Rencana Usaha Penyediaan Tenaga Listrik PT. PLN 2021 - 2030, Jakarta, Kementerian ESDM
[67]Romare & Dahllof, "The Life Cycle Energy Consumption and Greenhouse Gas Emissions from Lithium-Ion Batteries, IVL (2017)
[68]Sata & Nakata, "Energy Consumption Analysis for Vehicle Production through a Material Flow Approach", Energies, (2020)
[69]Restianti, Yuda & Gheewala, Shabbir. (2012). Life cycle assessment of gasoline in Indonesia. The International Journal of Life Cycle Assessment. 17. 10.1007/s11367-011-0372-9.
[70]Economic Research Institute for ASEAN and Asia. (2018). Annual Report April 2018 - March 2019. https://www.eria.org/uploads/media/0.Annual_Report_2018.pdf
[71]Peshin et al. (2021). Should India move towards vehicle electrification? Assessing life-cycle greenhouse gas and criteria air pollutant emissions of alternative and conventional fuel vehicles in India. DOI:10.26434/chemrxiv-2021-l0lrr

5.1.5 COST BENEFIT ANALYSIS

Socio-Economic Cost-Benefit Analysis is a quantitative exercise forecasting the impact of the project on all economic actors. The purpose of this analysis is to verify whether the socio-economic benefits are larger than the costs.

Direct Impacts

Capital, Operation and Maintenance Costs
The impact is analyzed by comparing the TCO of conventional 2W with E2W.

Fuel Subsidy
The Government of Indonesia (GoI) spent over IDR 60 trillion on fuel subsidies, according to the Annual Tax Expenditure Report by the Ministry of Finance (2021), while Pertamina (2021) claimed that the consumption of gasoline with subsidies was roughly 7,976,023 KL in 2020. The average annual subsidy per 2W based on average fuel consumption is around IDR 320,000.

Changes in Tax Revenue

- **Income taxes:** In accordance with Law No. 2/2020, the government will begin applying a 22 percent corporate tax rate to the profit made from their revenue in 2022. According to Statistics Indonesia in 2022, the operational profit margin for the automobile sector is 59.66 percent on average[72]. Additionally, the government would get more money from personal income taxes. Since compensation (in the form of bonuses and allowances) would rise if sales increase and fall the opposite way, compensation is taken into account as a variable cost in the socioeconomic benefit-cost analysis. According to Statistics Indonesia, the average pay ratio for the automotive industry is 4.58%, with the assumption that the typical worker's take-home pay falls inside the 15% tax band[73]. The change in both personal and corporate income taxes revenues is analysed considering the increase of E2W sales and the subsequent decrease in conventional 2W sales.
- **Title Transfer Fee Tax:** Electric 2W are exempted from title transfer fee tax. This is considered a loss in government's revenue and is taken into account in the analysis.

Indirect Impacts

The Social Cost of Carbon Reduction
The social cost of carbon is the incremental impact of emitting an additional tonne of carbon dioxide, or the benefit of slightly reducing emissions[74]. The global Social Cost of Carbon is equal to USD 24 per ton of Carbon in 2019[75]. It is suggested that the social cost contributed by Indonesia is around USD 0.85 per ton of carbon. Using the USD/IDR exchange rate in 2022, which was at IDR 14,600 per USD, Indonesia's social cost of carbon value is then projected by adjusting the exchange rate with inflation in Indonesia and the US.

Economic Multiplier Benefit
The income of society as a whole will rise as a result of lower operating and maintenance costs, lower fuel subsidies, more revenues from the E2W industry, and lower costs associated with pollution damage. Figure 25 displays the expected economic multiplier benefit using the economic multiplier value of 3.15[76]. Similar to how the expansion of the electric 2W business would open up new opportunities and have numerous positive effects on the economy, the decline of the conventional 2W industry would likewise have a multiplier effect. The conventional 2W businesses' declining revenue will also affect the income of their workers, investors, and other linked industries.

[72]BPS-Statistics Indonesia. 2022a. Value of Gross Output of Large and Medium Manufacturing by Subsector [KBLI 2009] (Billion Rupiahs), 2010-2019. [Online]. [Accessed 2022]. Available from: https://bps.go.id/indicator/9/737/4/nilai-output-ibs-menurut-kbli-2-digit-kbli-2009-.html
[73]BPS-Statistics Indonesia. 2022b. Labour Cost for Workers of Large and Medium Manufacturing by Subsector [KBLI 2009] 2017-2019. [Online]. [Accessed 2022]. Available from: https://bps.go.id/indicator/9/735/1/pengeluaran-untuk-tenaga-kerja-industri-besar-dan-sedang-menurut-sub-sektor-kbli-2009-.html
[74]Tol, R.S.J. 2019.A social cost of carbon for (almost) every country. Energy Economics.83, pp.555-566
[75]Ibid.
[76]Kuncoro, A. 2021. Perilaku Konsumsi dan Tabungan. Kompas. [Online]. [Accessed 2022]. Available from: https://www.kompas.id/baca/ekonomi/2021/02/02/perilaku-konsumsi-dan-tabungan

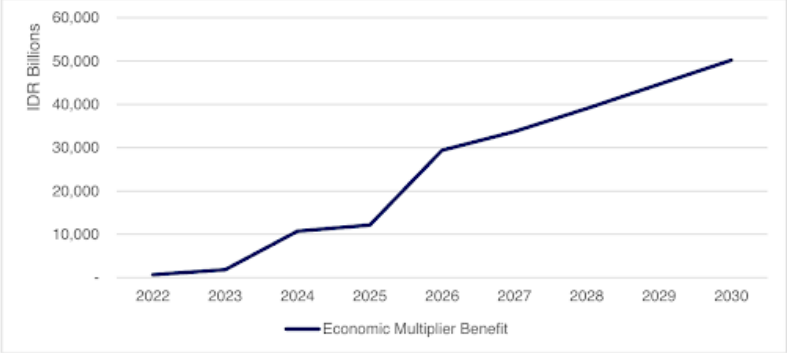


Figure 25. Economic multiplier effect

5.1.6 LIMITATIONS

There are several limitations that have to be considered in the estimations:

- **Charging infrastructure investment cost assessment**: The analysis is limited in the sense that it focuses only on battery swap station provision. It does not include the costs of installing private or public plug-in charging infrastructure, which include charger costs, installation costs, power upgrade cost if needed, etc. Furthermore, the costs of battery swap stations are also scoped into hardware costs, installation costs, and real estate costs.

5.2 TOTAL COST-OF-OWNERSHIP COMPARISON

5.2.1 PLUG-IN E2W AND ICE 2W TCO COMPARISON

During their 10-year lifetime, owning and operating E2W is found to be more economical than ICE 2W. Despite a higher upfront acquisition cost and maintenance costs, attributable to the need of battery replacement every 5 years, E2W shows a significantly lower operational cost (contributed by fuel electricity cost).

In a normal scenario (with no government subsidy) With the current E2W plug-in market prices, a saving of roughly IDR 2.3 million can be realized over the lifetime of E2W. Moreover, given the economy of scale in the future and the prevalence of E2W, the capital and maintenance expenditure will significantly decrease[77] and lead to bigger cost savings for E2W users. Figure 26 exhibits the various TCOs which includes ICE 2W - IDR 38.9 Million, E2W (plug-in) - IDR 36.5 Million, E2W (existing battery swap) - IDR 37.7 Million, and E2W (battery swap-as-a service) IDR 30.6 Million. A saving as much as IDR 8.2 Million can be achieved when a user transitions into E2W.

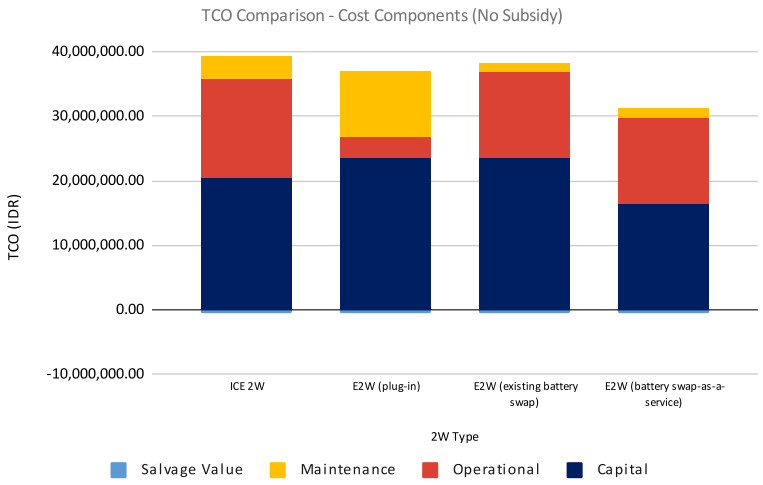


Figure 26. Cost Components of Total Cost Ownership with No Subsidy

[77]Rokadiya, S., Bandivadekar, A., & Isenstadt, A. (2021). Estimating electric two-wheeler costs in India to 2030 and beyond. International Council on Clean Transportation: Working Paper 2021-25.

With a subsidy scenario, users can even get a lower TCO. With current average price gap of E2W against ICE, a 13.45% subsidy scenario can also be introduced to the users an option to alleviate the burden of upfront purchasing cost, in which the projection can be seen in Figure 27. As a comparison to the normal scenario, the price goes down. With a constant ICE 2W price of IDR 38.9 Million, E2W with subsidy results the TCO to become E2W (plug-in) - IDR 33.4 Million, E2W (existing battery swap) - IDR 34.6 Million, and E2W (battery swap-as-a service) IDR 28.5 Million. Significantly, a saving as much as IDR 10.4 Million can be achieved when a user transition into E2W.

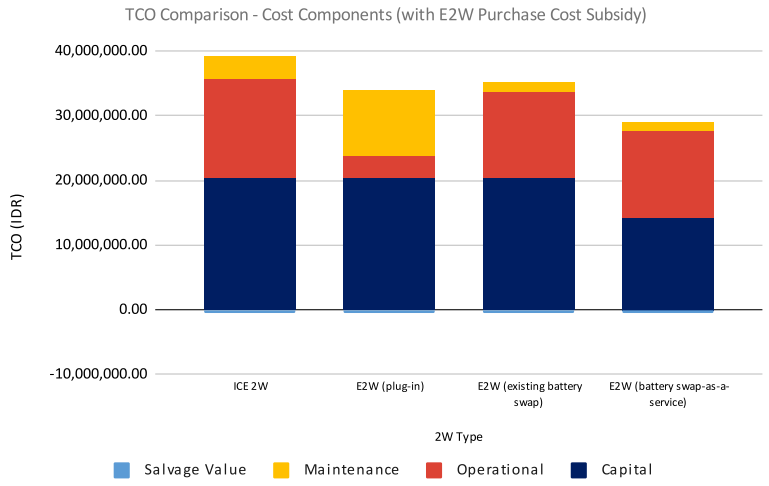


Figure 27. Cost Components of Total Cost Ownership with Purchase Cost Subsidy

5.2.2 PLUG-IN E2W AND BATTERY SWAP E2W TCO COMPARISON

As a further analysis, a comparison is made between the TCO of ICE 2W, E2W using plug-in charging strategy, and E2W using battery swap strategy. Although initially both have higher purchase price than ICE 2W, plug-in E2W is expected to achieve cost parity within 5 years and the battery swap E2W within 7 years.

During its lifetime, with the current market prices, plug-in E2Ws still have TCO advantage compared to E2W with battery swap. Nonetheless, the battery swap model offers an option to users who greatly value time as its refueling takes less than 10 seconds, contrary to the plugin model that can take up to seven hours (three hours with fast charger) from zero percent state-of-charge (SoC) to be fully recharged.

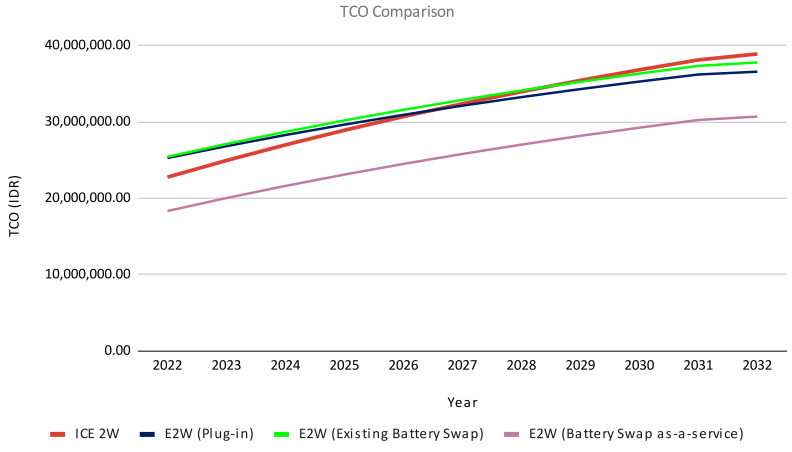


Figure 28. TCO Comparison of the Total Cost Ownership

5.2.3 SENSITIVITY ANALYSIS

A sensitivity analysis is conducted to investigate the impact of cost component changes to E2W TCO. In the analysis, it is assumed that the E2W is using plug-in charging strategy. This scenario requires electricity cost and battery replacement in every 5 years. The sensitivity analysis examined the impact of reducing electricity fare and battery price for 5%, 10%, and 15%, respectively.

The results are as follows:

No.	Base TCO price E2W: Cost component / Reduction scenario	Rp 36,572,264 Cost reduction scenario		
		-5%	-10%	-15%
1	Electricity price reduction	0.44%	0.89%	1.34%
2	Battery price reduction	1.65%	2.86%	4.07%

Table 17. E2W TCO reduction under several scenarios

Figure 29 illustrates the sensitivity effect of electricity price reduction (government subsidy) and battery price reduction (given the economy of scale). Some countries are found to have electricity subsidy up to 15% and battery price reduction over 10 years is also assumed as minimum as 15%, thus three sensitivity analyses are calculated. Operational or maintenance cost are dropped when subsidy or a price-drop is given, allowing a cheaper TCO. As previous calculation shows the ICE accounts a total of IDR 38.8 million of TCO, on E2W, the government subsidy on electricity price can result as low as IDR 36 Million and for battery purchase to be IDR 35 Million only.

The electricity subsidy may attract people to shift, because cost-wise people can choose the most economic way of riding. Such an incentive are possible to be included within faster adoption policy. Also, battery price may reduce given the economy of scale e.g., policy-wise: reduced import fee, local production by IBC holdings and/or manufacturing-wise: Cathode material, electrode thickness, toll-to-roll speed, end-of-line scrap rate, and number of operating days[78].

However, each scenario uses the average purchasing cost of E2Ws in the market, while in reality it varies a lot. More reduction of TCO can also be made when government can introduce a subsidy scheme tailored to the model e.g., what Indian Government has been doing in FAME 2 scheme[79].

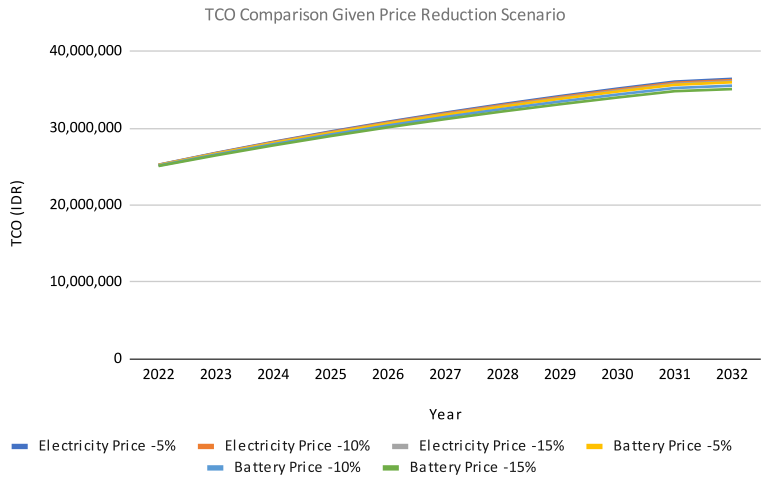


Figure 29. TCO Comparison Given Price Reduction Scenario

[78]Mauler, Duffner, Leker, Economies of scale in battery cell manufacturing: The impact of material and process innovations, Applied Energy, Volume 286, 2021, 116499, ISSN 0306-2619, https://doi.org/10.1016/j.apenergy.2021.116499
[79]Government of India, Fame India Phase II (National Mission on Electric Mobility), 2022, [Online]. [Accessed 2020]. Available from: https://fame2.heavyindustries.gov.in/

5.3 BATTERY SWAP STATION INVESTMENTS

Charging infrastructure availability is crucial for EV uptake. The analysis focus on the provision of battery swap stations, as they will provide a huge advantage in terms of user convenience since they will allow E2W to be refueled on the go.

The number of battery swap station needs follow to the number of E2W on the road. Following the assumed growth of E2W elaborated in Chapter 5.1.1, the ideal number of battery swap stations to be provided are illustrated below.

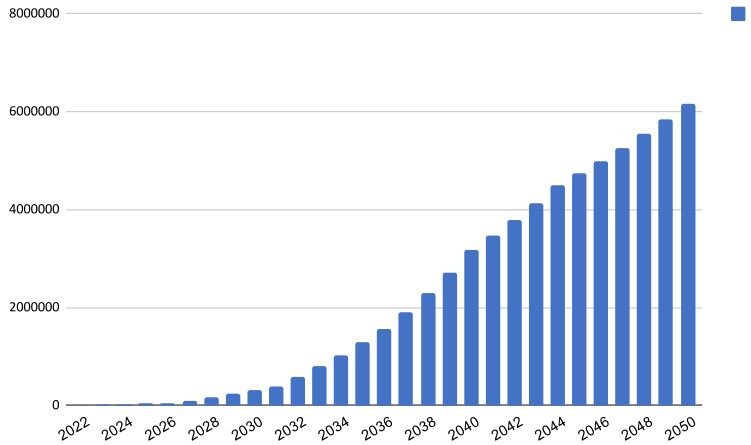


Figure 30. Ideal nationwide number of battery swap stations

The yearly investment costs associated with battery swap stations provision are therefore can be estimated as follows.

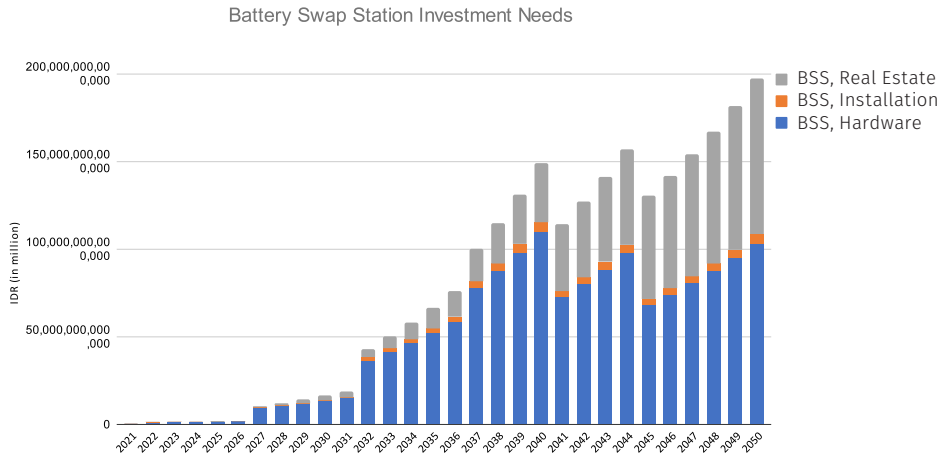


Figure 31. Investment needs of battery swap stations

With the current market prices, a huge investment is required to provide battery swap stations for all E2W in Indonesia especially when the E2W population has grown substantially. More than half of the investment are needed to acquire the battery swap hardware, including the batteries. Although given the technological advancement some cost components of this aspect are expected to decline in the coming years, the high capital cost can become a barrier for private investors to enter the business.

On the other hand, land provision (assumed as real estate lease) costs also contribute largely to the total annual investment costs, especially in the latter years with more charging facilities. Therefore, support from the government or agreements with a third party in providing location for the charging stations can significantly ease the investment burden of the charging infrastructure providers.

5.4 GHG EMISSION REDUCTION

CO2 emission reduction is calculated over the period of 2022 - 2050. The amount of emissions saved is staggering. It is estimated that 100% 2W electrification in Indonesia will result in a total of nearly 175 million tonnes of CO2 savings in 2050, which is equivalent to 2.4% of the total emission produce in 2020 from transportation sector worldwide[80]. This impact will be more significant if Indonesia manages to accelerate the shift to cleaner power sources.

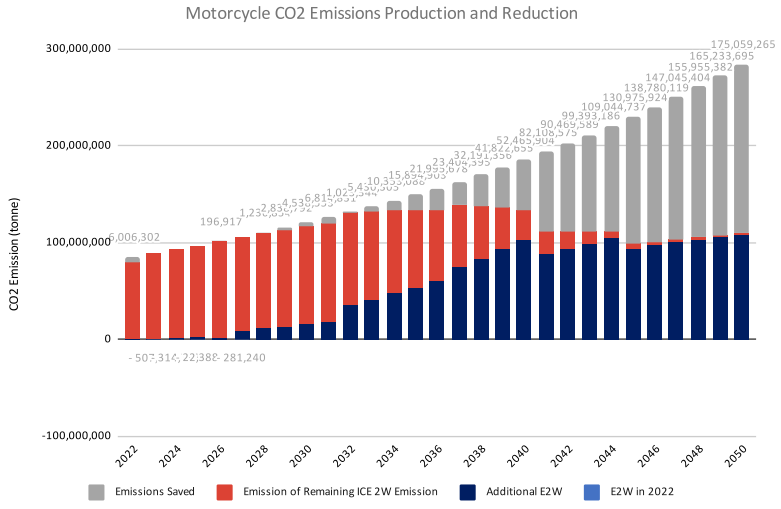


Figure 32. The Motorcycle CO2 emission reduction

5.5 COST BENEFIT ANALYSIS

The section focuses on the results of cost-benefit analysis (CBA) over the course of the electrification period.

The CBA has direct and indirect benefits and costs component. Direct benefits include fuel subsidy savings, operational and maintenance saving, and additional taxes from E2W uptake (corporate and personal income taxes). Indirect benefits include pollution damage reduction (CO2 and other pollutants) and economic multiplier benefits (GDP). Direct cost includes tax revenue decrease from the declining ICE industry (corporate and personal income taxes) and reduction of vehicle title transfer tax. Indirect cost consists of a decrease in GDP from the ICE industry.

[80]iea. (n.d.). Transport Improving the sustainability of passenger and freight transport. [Online]. [Accessed 2022]. Available from: https://www.iea.org/topics/transport

Figure 33 showcases the estimated impacts of 2W electrification over the years to the nationwide economy.

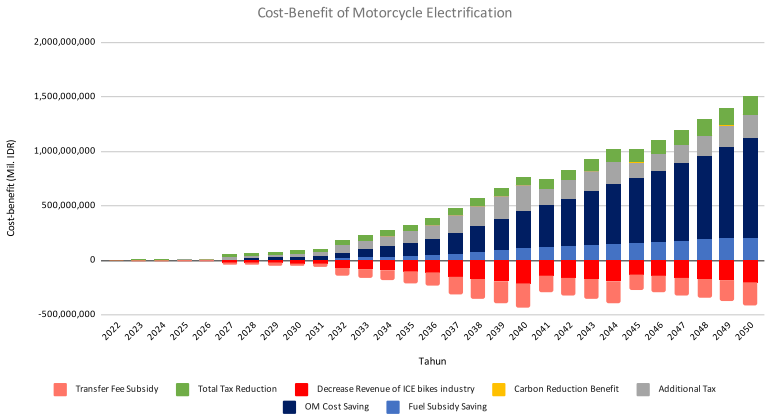


Figure 33. The cost-benefit of nationwide 2W electrification

Some key takeaways from the cost-benefit analysis are as follows:

- The benefit always outweighs the cost when transitioning to E2W, and exhibits a steady increase. Every component, with no negative value, in the direct and indirect benefit positively contributes to the total benefit.
- Indonesian government burden's from subsidizing the non-renewable fuel is reduced and increasing overtime
- In majority, both total tax reduction and additional tax increases overtime. Due to the subsidy and reduction total tax.

Benefit

In terms of benefit in the underlying graph, highest variable and a slight reduction can be identified. Additional tax in 2040 reaches its peak with a value IDR 228.4 Trillion as to directly proportional to E2W phasing where the total number is the all-time high, as referring to Figure 33 (above) on E2W electrification fleet. Also, the total tax reduction and OM cost saving in 2050 reaches its peak amounting to nearly IDR 911.8 Trillion, it is absolutely contributed by a direct proportion to the size of motorcycle fleet (which has been fully electrified in 2050 - with a total of 530 million units).

On the contrary, a slight reduction of total benefit occurs during 2040 - 2041, as it aligns with the reduction of E2W electrified fleet (refer to Figure 33) and the fact that it transitions from Late Majority to Laggards.

Cost

The total cost incurred by tax reduction and transfer fee subsidy is steady until 2040, drops in 2041 with some increases in following years. A similar pattern also occurs in 2044 - 2045. It is directly related to the reduction E2W uptake from the market, which is amounting the total cost incurred from IDR 359 Trillion to 204 Trillion, in 2040 - 2041. Also, a similar pattern occurs during 2044 - 2045 due to the reduction of the number of E2W uptake, amounting a total cost from IDR 282 Trillion to 156 Trillion. It is then followed by a steady increase ahead of 2050. In 2050, the cut-off value of total cost reaches IDR 239 Trillion.

5.6 COST SHARING BETWEEN THE GOVERNMENT AND THE PRIVATE SECTOR

As illustrated in the previous sections, a huge amount of investment is needed both from the general public to replace their ICE 2W to electric and from business entities to establish battery swap station networks. This has not take into account the investment needs from the vehicle and battery manufacturers to grow the domestic industry of electric vehicles.

Government interventions in the form of fiscal incentives have been shown to give catalytic impacts in accelerating EV uptake in many countries. To stay on track with the vision of 100% E2W by 2050, the Government of Indonesia can also provide support to reduce the fiscal barriers currently faced by the private sector.

An exercise was done to investigate the amount of investment the Government needs to allocate, in particular to reduce the purchase price of E2W and reduce the private sector investment for battery swap station provision.

During 2022 - 2036, a steady increase is present and every five years a huge spike occurs. It is caused by the shift in the phasing and directly proportional with the electrification uptake. It implies the increase of E2W will also increase the number of costs to be spent.

E2W purchase incentives are the largest portion of cost while the battery swap station and power are the least. Purchase incentives almost reached its peak in 2040 which is directly proportional with the E2W electrification fleet (See previous explanation on Phasing), reaching almost IDR 1.85 Trillion.

However In 2041, the number of total cost has dropped significantly, it is mainly caused by the reduction of E2W uptake, as it transitions from the early majority to late majority. It allows the total cost to be about IDR 1.35 Trillion.

It is then followed by a series of cost improvements. It drops again in 2045, then in the following years, the cost improvement is recurrent and set its peak at 2050 with a total of IDR 2.24 Trillion.

Eventually, similar to the Figure 34, the electrification cost shares on Figure 35 shows a similar trend. In general, it has a steady increase, a number of spikes within every 4-5 years of uptake, and reaches its peak in 2050. At the peak, total amount of cost that should be borne by the users nationwide, it has always been the largest amounting to IDR 1.86 Trillion, IDR 191 Billion, and IDR 186 Billion, subsequently for users, government, and other parties.

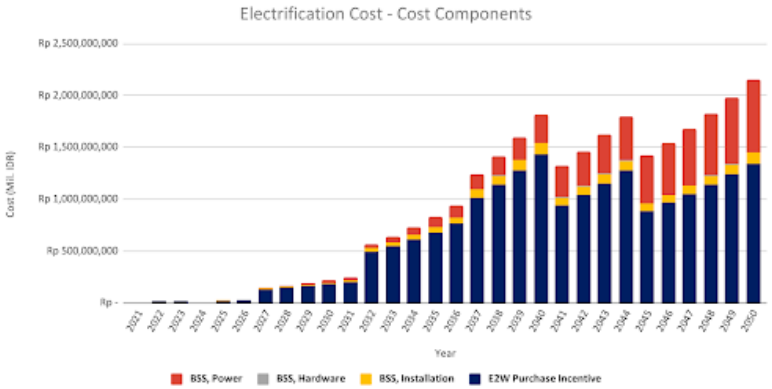


Figure 34. Cost components of E2W

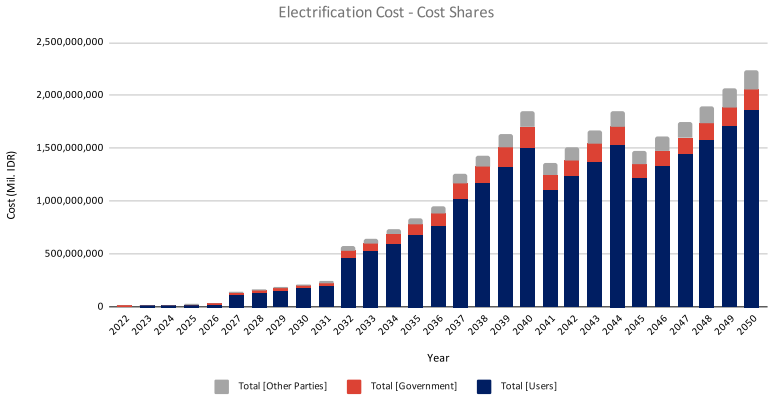


Figure 35. The electrification cost shares amongst users, government, and other parties

6 Stakeholders of 2&3W Electrification Efforts

The efforts to accelerate the shift from ICE to battery electric vehicles (BEV), including the E2&3W segments, require synergy and collaboration from numerous stakeholders from the public and private sectors and most importantly the users. This section aims to list the key stakeholders in the scene, and their current and potential roles and responsibilities.

Stakeholders of the E2&3W adoption initiatives are essentially similar to the stakeholders of the general BEV adoption. Adapting from stakeholder categorization in a previous study[81], the key stakeholders can be classified into three categories: government institutions, business entities, and civil society.

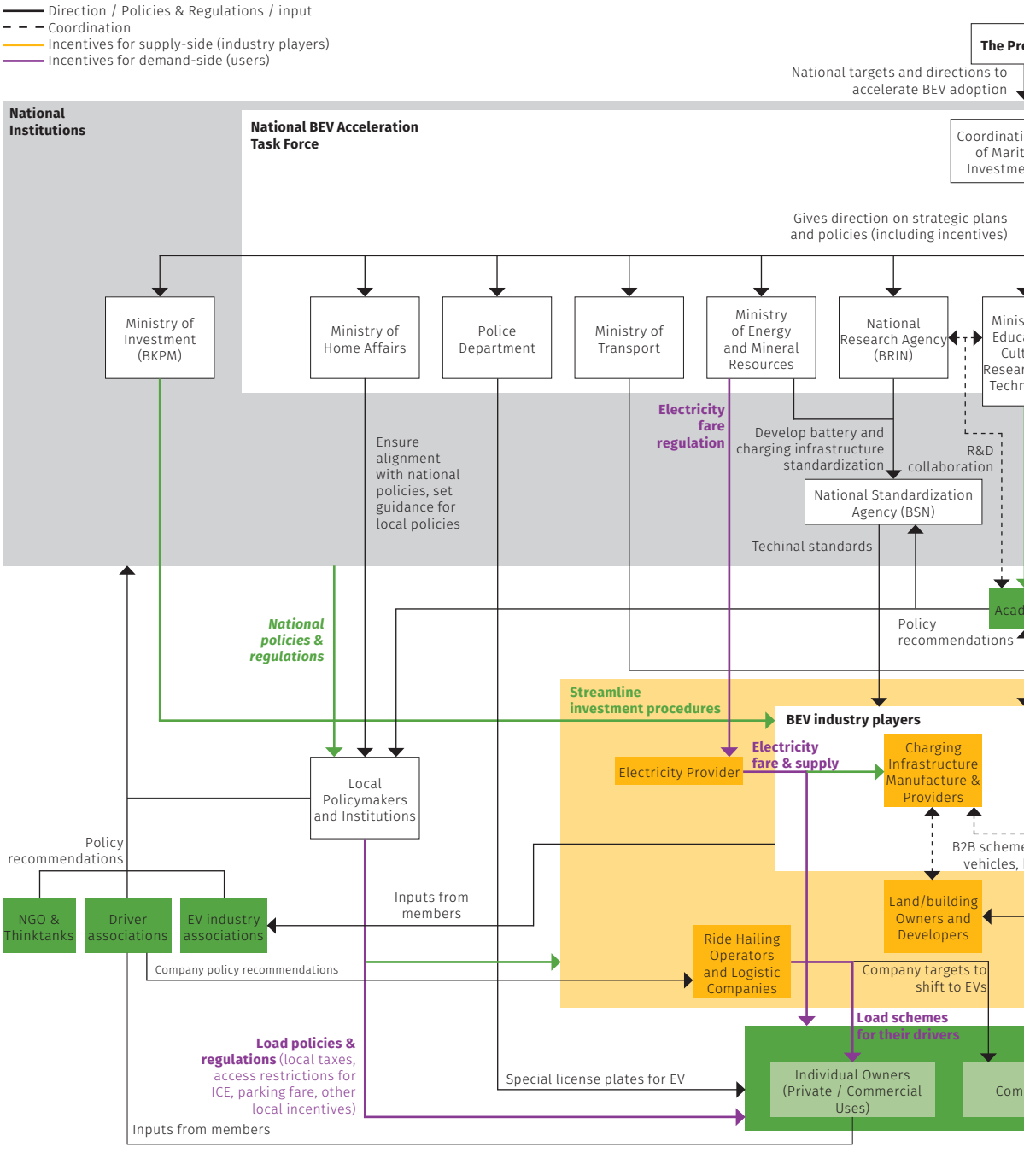
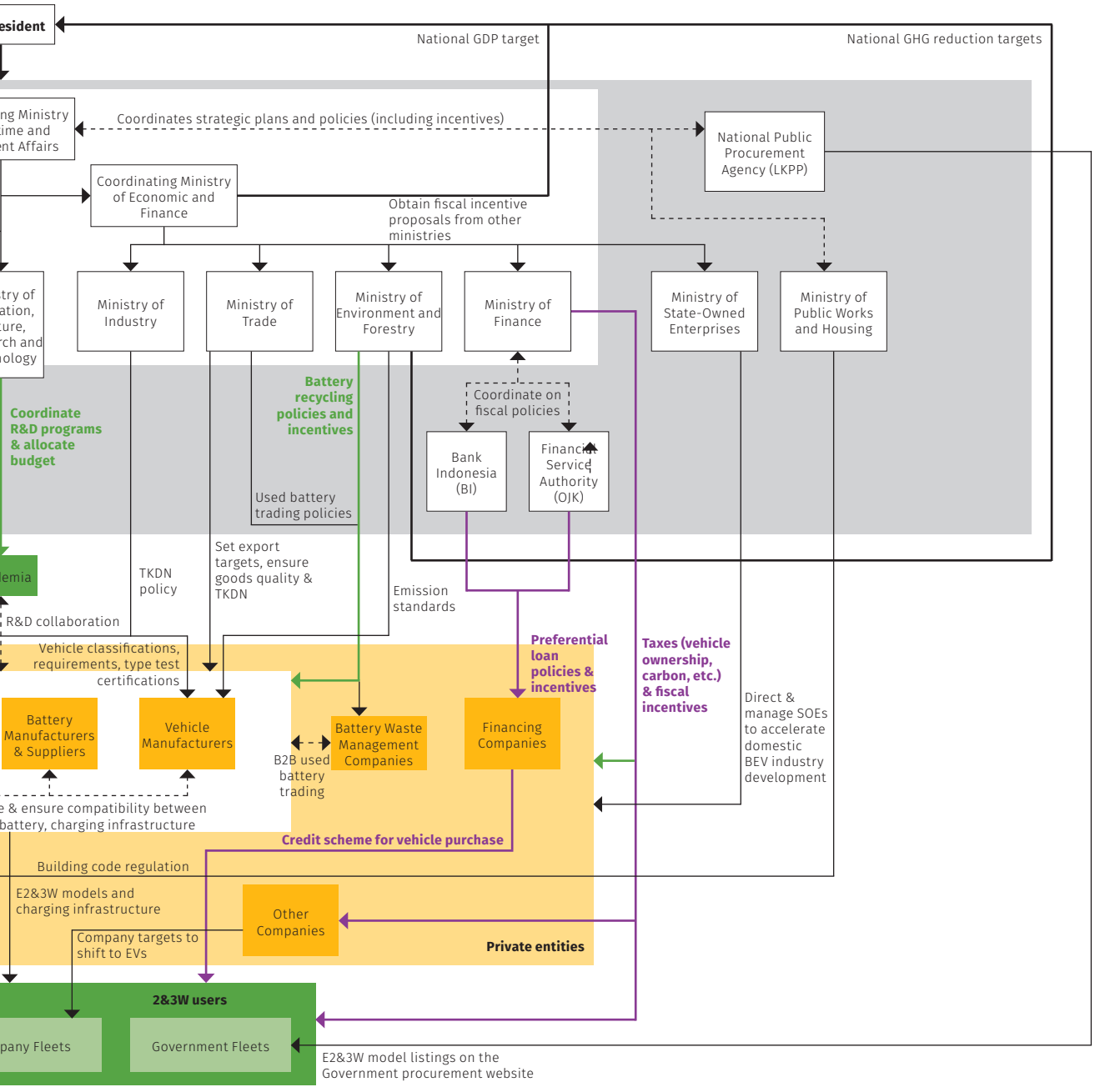


Figure 36. Stakeholders mapping of E2&3W uptake in Indonesia

[81]ITDP Indonesia. (2021). Road Map and Timetable of Two-Wheeler Electrification in Greater Jakarta. Study conducted under UK PACT GRCF.

The stakeholder map below illustrates the various relationships between numerous stakeholders in the E2&3W adoption acceleration efforts. The three different groups of stakeholders (government institutions, business entities, and civil society) are depicted in different colors. The types of relationships between stakeholders are grouped into 1) Direction / Policies and Regulations / Input, 2) Collaboration, 3) Incentives for Supply Side (BEV industry players), and 4) Incentives for Demand Side (users).



A. Government Institutions

National-level government institutions are responsible to issue national-level policies, regulations, and standards related to BEV, battery, and charging infrastructure. Given the regional autonomy policy of the Government of Indonesia, local-level institutions have the authority to issue regional-level policies and regulations to support BEV adoption acceleration, including for the E2&3W segment. Typically in Indonesian regions, specific implementation regulations and policies are set at the city level, while provincial regulations only provide guidelines referring to the national-level policies.

At the national level alone, the E2&3W acceleration efforts involve as many as 20 institutions, including the President, ministries, and non-ministerial institutions such as the Police Department and research, standardization, and procurement agencies. Strong leadership and clear coordination lines are crucial with this many involvements since various alignments and coordination are needed between these institutions that are used to working in silos and have different priorities. In Indonesia, this issue is partly addressed by these two measures:

1. **The President takes the role of the champion of the BEV acceleration program**, by having a clear stance to support BEV instead of HEV, PHEV, and other alternative fuels and issuing PR 55/2019;
2. **The establishment of a National Coordination Team**, led by the Coordinating Ministry of Maritime and Investment Affairs as the leader and the Coordinating Ministry of Economics as the deputy leader. The strong leadership of the Coordinating Ministers and their authority to coordinate and direct most of the relevant ministries, including those who are not part of the Coordination Team, is expected to expedite the policymaking process.

National-level policies and regulations related to E2&3W can directly affect the 2&3W users and industry players or need to be detailed further by relevant local government institutions in local regulations and policies. The type of policies and regulations that can be issued by the government institutions can be grouped into the following:

1. **Strategic plans:**
   - At the national level, this includes national BEV adoption targets, national GHG reduction targets, national domestic BEV production targets, etc.
   - Regional strategic plans, this includes local GHG and air pollution reduction targets and action plans, local public transport electrification targets, etc.
2. **Incentives for BEV and disincentives for ICE vehicles:**
   - At the national level, incentives for E2&3W users can be directly provided by the MOF and MEMR and indirectly by OJK and BI in the form of fiscal incentives, reduced electricity tariffs, and policies to enable more attractive loan schemes from financing institutions. Incentives for BEV industry players and other business entities are provided by BKPM, MOF, MEMR, and MOEF.
   - Relevant local government institutions can also provide demand-side incentives in the form of reduced local tax rates, local transport policies such as access restrictions and parking fee management, or other local incentives. Supply-side incentives such as reduced local tax rates, asset loans, and others can also be provided by the local governments.
3. **Standardizations and certification:**
   - At the national level:
     i. Indonesia has a national standardization system (SNI) issued by the BSN that can be referred to voluntarily by industry players, except for certain obligatory standards set by national institutions based on safety, security, environmental sustainability, and/or economic considerations.
     ii. The MOT issues vehicle type certifications that should be obtained by every vehicle model before being sold in the market.
     iii. The MOEF issues emission standards for vehicles including 2&3 wheelers.
   - Local governments, in particular the Transport Agency, are responsible to conduct vehicle emission tests in coordination with the local Environment Agency, based on the national emission standards.

Presidential Regulation No. 55/2019 on BEV Acceleration Programme instructed several national-level government institutions to support the program and the establishment of a National Coordination Team to coordinate, derive action plans, tackle barriers, and monitor the BEV acceleration program. Nevertheless, there are also several institutions that are not part of the Coordination team but hold some roles in supporting the transition to BEV.

No.	Institution	Task Force Membership	Mandated Roles and Responsibilities in PR 55/2019	Remarks
1.	Coordinating ministry of maritime and investment affairs (CMMIA)	Yes	• Team leader of the National Coordination Team • Determine Coordination Team's working arrangements	• Key stakeholders under CMMIA's authority: MOT, MEMR • The current minister of CMMIA has a very strong position in coordinating and foster collaboration between public and private entities to support BEV acceleration efforts
2.	Coordinating Ministry of Economic Affairs (CMEA)	Yes	Deputy team leader of the National Coordination Team	• Key stakeholders under CMEA's authority: MOF, MOEF, MOI, MT, MSOE • CMEA has a strong position to set the strategic direction of domestic vehicle industry and fiscal policies to focus on BEV
3.	Ministry of Finance (MoF)	Yes	• Provide fiscal incentives for domestic investments on EV battery industry • Issue policies on import duties of Completely Built-Up/CBU BEV	• The MOF needs proposals from sectoral ministries (e.g. MOF, MOI, MT, MEMR, etc) to provide fiscal incentives for each sector • However, MOF can take a more active role in engaging with other ministries in developing fiscal incentives through the Coordination Team
4.	National Research and Innovation Agency (BRIN)	Yes	-	• BRIN (previously BPPT) has been conducting research on battery, charging infrastructure, and electric motor development, as well as TKDN policy and other policy recommendations as inputs for other government institutions • Coordinating with BSN, BRIN can accelerate the standardization of battery and charging infrastructure in Indonesia

5.	Ministry of Industry (MoI)	Yes	• Develop national motorized vehicle industry roadmap, which includes BEV industry
			• Develop TKDN calculation policy and roadmap
			• Issue policies on import duties of Completely Built-Up (CBU) BEV
			• Issue policies on Incompletely Knock Down (IKD) and CBU requirements
			• Determine BEV classification
				• As the ministry responsible for BEV industry development, MOI has issued several key policies (motorized vehicle industry roadmap, TKDN, BEV classification, IKD and CBU import policies)
				• Potential roles:
				  • Coordinating with BSN and BRIN, set standardisation for E2&3W components including battery and electronics
				  • Alleviate customer's acquisition price by subsidizing OEMs production cost

6.	Ministry of Trade (MT)	Yes	Issue policies on import duties of Completely Built-Up/CBU BEV	• MT has issued a regulation on import requirements for used lithium batteries as raw material for lithium battery industries to support the acceleration of BEV industry
				• Potential roles:
				  • Set out target of E2&3W export products in the future
				  • Set regulations on used battery trades

7.	Ministry of Energy and Mineral Resources (MEMR)	Yes	Determine preferential electricity tariff for charging stations	• Directly instructs PLN to initiate charging infrastructure provision
				• MEMR has issued a policy on charging infrastructure and electricity tariff
				• Pioneers ICE motorcycle conversion to electric
				• Potential roles:
				  • Propose gradual petrol fuel subsidy reduction to MOF to fund BEV incentives
				  • Allocate budget to fund/subsidize charging infrastructure initiation
				  • Incentivize usage of renewable energy sources to charging infrastructure

No.	Institution	Task Force Membership	Mandated Roles and Responsibilities in PR 55/2019	Remarks

8.	Ministry of Transportation (MoT)	Yes	> Develop BEV specification and roadworthiness as vehicle testing parameters
			> Conduct BEV type testing
			> Issue permits for institutions to conduct regular BEV testing
				• MOT has issued BEV type test and ICE motorcycle conversion regulations
				• Under the Directorate General of Land Transportation, MoT is developing public transport electrification plan
				• Potential role:
				  • Develop demand for BEV, including for 2&3W segment through transport policies
				  • Integrate BEV adoption plans and programs to road safety improvement programs

9.	Ministry of Environment and Forestry (MoEF)	Yes	Issue policies on appreciation for institutions that conduct battery waste recycling or processi	• MOEF has a crucial role in determining Indonesia's strategies to reduce GHG and pollutants, e.g. through developing NDC commitment
				• Potential roles:
				  • Develop stronger policies on battery waste recycling obligations
				  • Issue more stringent fuel economy and emission standards policies

10.	Ministry of Home Affairs (MoHA)	Yes	Issue policies on local tax reduction/ exemption, i.e. motorized vehicle tax (PKB) and ownership transfer tax (BBNKB)	MOHA has the authority to regulate development programs at the sub-national level (provincial, city, and regency) including for local transport

11.	Ministry of Education, Culture, Research, and Technology (MECRT)	Yes	-	• Support universities and research institutions in developing BEV, battery, and charging infrastructure technology
				• Potential roles:
				  • Hold competition for educational institution for BEV innovation
				  • Establish task force in each potential university across Indonesia
				  • Facilitate the worldwide collaboration among students e.g., student exchange, apprenticeship.

12.	Indonesian National Police (POLRI)	Yes	-	• Has issued a specific plate number color (blue plate) for BEVs for identification purposes • Potential role: Integrate BEV adoption plans and programs to road safety improvement programs
13.	Ministry of State-Owned Enterprises (MSOE)	No	-	MSOE has the strategic position to develop state-owned BEV supply chain to kickstart the ecosystem, such as by directing Pertamina, PLN, MIND ID, and mining industry SOEs to establish a battery industry holding (i.e. IBC/Indonesia Battery Company), support state-owned EV OEM (Gesits), and establish other collaborations between SOEs
14.	Ministry of Public Works and Housing (MPWH)	No	Determine preferential electricity tariff for charging stations	Potential roles: • Modify building codes to regulate charging infrastructure development at certain building types • Include charging infrastructure provision as part of green building certification assessment • Build charging infrastructure at affordable housing projects, rest areas, and other infrastructure projects in coordination with the MOT and MEMR

Table 18. Stakeholders from national-level government institutions

No.	Institution	Task Force Membership	Mandated Roles and Responsibilities in PR 55/2019	Remarks
15.	Ministry of Investment/ Indonesia Investment Coordinating Board (BKPM)	No	-	BKPM has a role in streamlining investment procedures in Indonesia, including for BEV industry and charging infrastructure development
16.	National Standardization Agency (BSN)	No	-	BSN plays a role in developing Indonesian National Standards (SNI) BEV's supporting components, including plug-in types and batteries
17.	Bank Indonesia (BI)	No	-	BI has a role in providing down payment exemption for EV financing which is stated in a BI Circular Letter
18.	Financial Services Authority (OJK)	No	Issue policies on appreciation for institutions that conduct battery waste recycling or processing	OJK supports the BEV acceleration program by providing fiscal incentives such as providing funds for BEV purchase, upstream industries development (battery, charging station, and component industry), and BEV infrastructure production
19.	National Public Procurement Agency (LKPP)	No	-	Lists qualified E2&3W models in the government's procurement website, to enable procurement for the government's operational fleets

Although the setup might be slightly different between provinces and cities, local government institutions' roles for the BEV acceleration program can be as follows:

No.	Institution	Roles and Responsibilities	
		Provincial level	City/district level
1.	Planning agency	Develop provincial-level planning	• Develop city-level planning • Ideally, sectoral agencies should refer to the regional planning documents in implementing any measure. Nevertheless, sectoral agencies can also propose measures and policies to be issued by the local government
2.	Financial and Asset Management Agency	• Coordinate with other sectoral agencies in developing provincial-level fiscal incentives for BEV, including E2&3W • If needed, issue permits for provincial assets to be utilized as charging infrastructure facilities • If needed, issue permits for the province's ICE fleets to be converted to EVs • Instructs ROE banks to develop attractive financing schemes for E2&3W	• Coordinate with other sectoral agencies in developing city-level fiscal incentives for BEV, including E2&3W • If needed, issue permit for city/district assets to be utilized as charging infrastructure facilities • If needed, issue permits for city/district's ICE fleets to be converted to EVs

3.	Transport Agency	• Develop provincial-level (regional) transport planning documents
		• Determines PKB and BBNKB tax rates in coordination with provincial planning agency and financial bureau
		• Devise gradual transition of government operational fleets to BEVs
			• Develop and implement transport policies supporting BEV, including E2&3W, such as:
			  • Special parking fares for BEVs at city-owned parking facilities
			  • Access restrictions, e.g. LEZs, car-free days, odd-even policies, etc.
			• In coordination with City Public Works Agency, develop cycling infrastructure (to also be used by e-bikes or other e-micromobility)
			• Devise gradual transition of government operational fleets to BEVs

4.	Environmental Agency	• Develop provincial-level (regional) GHG reduction plan, in coordination with the planning agency and sectoral agencies • Develop a regional guideline for battery waste processing/recycling	• Develop LEZ in collaboration with the City Transport Agency • Ensure proper battery waste processing/recycling process in the city
5.	Public Works Agency	No significant role at the provincial level	• In coordination with City Transport Agency, develop cycling infrastructure (to also be used by e-bikes or other e-micromobility) • Ensure proper installation of public/semi-private charging infrastructure at residential, retail, or office buildings in accordance to national-level building guideline
6.	Human Settlement, Spatial Planning, and Land Agency (DCKTRP)	Develop a regional guideline for land use and building to regulate charging infrastructure provision and cycling infrastructure network	Develop city/district-level guideline for land use and building codes to regulate charging infrastructure provision and cycling infrastructure network

Table 19. Stakeholders from local-level government institutions

B. Business Entities

The key relationships between business entities group with other stakeholders are as follows:

- Between business entities and the government institutions:
  - Business entities should comply with the policies, regulations, and obligatory standards set by the government. State-owned or regional-owned enterprises (SOEs and ROEs) should also follow the directions set by authorized government institutions, such as the MSOE or local governments as their owners.
  - Business entities may receive incentives from the government, such as reduced tax rates, provided that they fulfill the requirements set by the government institutions that provide the incentives.
  - They can also voice their concerns and aspirations to government such as holding a convention/ conference, consultation meeting, and by an official letter correspondence.
- Business entities collaborate with each other to develop a financially-sustainable BEV ecosystem. Consortiums and other types of B2B agreements are made to make the business process more efficient.
- Business entities provide services and products to the users (end customers), such as electricity, BEV models and private charging facilities, public charging stations or battery swap services, and financing schemes to buy the vehicles.

The business entities include government (state and regional)-owned enterprises and private companies. Some of the biggest institutions are listed by name, while the others are aggregated based on their type of business.

No.	Institution	Relevance to BEV Ecosystem Development
A.	**State-owned Enterprises**	
1.	Indonesian Battery Corporation (IBC)	As a joint venture between several SOEs (MIND ID, Antam, Pertamina, and PLN), the IBC will provide the whole supply chain of battery manufacturing, from raw material mining to battery recycling, as well as charging infrastructure provision
2.	Pertamina	As the national petrol fuel and gas company, Pertamina will lose its revenue due to the shift from ICE to BEVs. Pertamina is currently operating several battery swap stations located at their existing petrol stations and is involved in battery manufacturing under the IBC consortium
3.	PLN	As the only electricity provider in Indonesia, PLN is: > Directly mandated in PR 55/2019 to initiate charging station provision > Has the authority to upgrade electricity power in buildings and install grid connections to charging stations
4.	LEN Industri	Develop and provide charging infrastructure, in collaboration with MEMR, BRIN, and PLN
5.	State-owned banks	State-owned banks including BRI, Bank Mandiri, BNI, BTN, and BSI can provide development of the BEV ecosystem in terms of investment, financing, transaction & cash management, treasury & trade solutions[82].
B.	Regional-owned Enterprises	
1.	Regional-owned banks	Regional-owned banks can also provide financing schemes for BEVs, including E2&3W

[82]Meilanova, D. 2021. Bank Mandiri (BMRI) Siap Dukung Pembiayaan Proyek Jumbo Baterai Listrik. Bisnis. [Online]. [Accessed 2022]. Available from: Finansial Bisnis

C.	Private Companies	
1.	Electric vehicle OEMs/ Manufacturers	There are numerous local Vehicle Original Equipment Manufacturers (OEMs) such as Viar, Smoot, Selis, Gesits (a subsidiary of an SOE) who are investing in E2&3W production. In addition, the current motorcycle giants such as Honda and Yamaha also plan to fulfill the GoI's vision of 100% E2&3W sales by 2040. Also, the company who focuses on retrofitting ICE to EV falls within this category.
2.	ICE vehicle OEMs	ICE vehicle OEMs will lose their market given the transition to BEV
3.	Battery and charging infrastructure manufacturers and providers	In addition to battery manufacturers such as PT International Chemical Industry, charging infrastructure OEMs such as Oyika and Ezyfast play a role in providing plugin charging facilities or battery swap stations for electric motorcycles
4.	Petrol fuel companies	Not only Pertamina, private petrol fuel companies will be negatively affected by the shift to BEVs, as the demand will be reduced. The companies are expanding their businesses to public charging infrastructure, as currently being initiated by Shell, British Petroleum, and AKR Corporindo
5.	Ride-hailing operators and logistic companies	Ride-hailing operators, such as Gojek and Grab, and logistic companies manage a massive number of E2&3W in their fleets, in particular motorcycles. Several companies have their own pledge to reduce carbon emissions through electrification and have conducted on-the-road E2W trials through B2B agreements with OEMs and other private businesses, e.g. battery suppliers/ manufacturers and charging infrastructure providers.
6.	Private financing companies	Private financing companies such as BCA Kredit Sepeda Motor (KSM), CIMB Niaga Syariah, and Adira Finance, coordinate with vehicle OEMs in improving credit schemes for E2W purchases.
7.	Vehicle insurance company	As there will be some dissimilarity between EV and ICE technology, vehicle insurance companies need to develop EV-specific insurance mechanisms.
8.	Electricity companies	Private electricity companies such as Medco Energy, collaborate with PLN and ride-hailing operators to develop EV charging stations, for now in Jakarta and Bali.
9.	Building/land owners/ developers	Landowners, building managers, and developers can collaborate with charging infrastructure providers to establish public or private charging infrastructure.
10.	Battery waste management companies	Conduct the business of battery waste management (recycling and processing)

Table 20. Stakeholders from business entities group

C. Civil Society

Stakeholders from civil society in general can be divided into two:

1. Direct users
2. Non-business entities, such as associations, non-governmental organizations (NGOs) and other non-profit think tanks focusing on sustainable transportation, energy, waste management, and academia.

Several key roles of the non-business entities in advancing BEV, including E2&3W adoption include:

- Advocate the use of BEVs to direct users through public campaigns
- Propose policy recommendations to the governments, based on the inputs from the direct users or from a specific group of stakeholders they represent, such as done by industry player associations or drivers associations
- Conduct R&Ds in collaboration with government research institutions and industry players

Table 21. Stakeholders from the civil society

No.	Group	Relevance to BEV Ecosystem Development
1.	2&3W users	People who use 2W and 3W as their daily modes (personal use) or source of income (e.g. ride-hailing and 3W drivers, logistic couriers). As users, they will be impacted by the availability of 2&3W models, policies, and other measures from the government.
2.	Drivers associations	Fleet drivers (e.g. ride-hailing, logistics, 3W drivers) are mostly part of associations. These associations typically advocate drivers' welfare and often also facilitate vehicle purchases for their members. For example, a 3W driver association was involved in a discussion with an E3W OEM to provide fleets as part of a city's 3W renewal program. Meanwhile, a huge ride-hailing driver association is planning to be a distributor for a Korean e-motorcycle brand. They are also pushing ride-hailing companies and governments to provide more charging infrastructure to support driver operations.
3.	Indonesian EV Industry Association (Periklindo)[83]	The association convenes Indonesian BEV manufacturers and other industry players in the BEV supply chain. Its mission is to improve domestic BEV industry competitiveness by advocating policies to the government and improving production and R&D collaboration between industry players, as well as to improve public knowledge on BEVs
4.	NGOs and other non-profit think tanks	NGOs and other non-profit think tanks, especially those focusing on environmental sustainability (transportation, energy, and waste sectors), provide technical assistance and advocacy for the governments and stakeholders to develop policies and plans in accelerating BEV uptake with clean energy sources
5.	Academia	Universities are involved by developing prototypes of EV, charging infrastructure, and battery technology

[83]Rahman, Faisal. 2022. Try the Variety of EV at the 2022 PEVS Exhibition. Inews id. [Online]. [Accessed 2022]. Available from: inews.id

7 Barriers to Accelerate the E2&3W Demand

As illustrated in Section XX: Current Uptake of E2&3W, the market penetration of E2&3W as well as electric cars and buses are still very low despite the ambitious targets set by the national government. Identification of barriers is important to formulate effective policies to accelerate the uptake.

Cost effectiveness: Higher purchase price

The purchasing price, which may result from incentives, subsidies, and financial access, plays the key factor influencing potential consumers in purchasing a vehicle. In Indonesia, the cost of an e-motorcycle is more expensive than an ICE motorcycle with comparable performances, which is on average IDR 24,000,000 for Electric and IDR 17,000,000 for ICE[84]. On the other hand, ICE motorcycles, which cost 30% lower than electric motorcycles, still offer better specifications, especially regarding speed, power, and travel range. This issue becomes more significant due to the lack of more attractive financing schemes for E2&3W purchases compared to ICE motorcycles.

Performance: Limited performance compared to ICE 2&3W

E2&3W's shorter driving range per refueling compared to ICE account for the major challenges of EV adoption or purchase, which can also be mentioned as "range anxiety". Furthermore, high ambient temperature adversely affects the battery performance which leads to an even shorter driving range. Energy consumption rate is found to increase by around 20% and 25% at an ambient temperature of 300C compared to 20-260C ("normal" temperature)[85,86].

In addition, speed-wise, on average ICE motorcycles can be 30% faster compared to electric motorcycles[87]. With the lax speed limit regulation and enforcement in many Indonesian cities, including on urban roads and residential areas, people still tend to prefer faster vehicles.

Convenience: Lack of public charging infrastructure availability & home charging viability

Range anxiety still hinders people to use E2&3W, although the concern is lower compared to electric cars[88]. Although range anxiety may be relaxed with easy access to public charging stations or battery swap stations, both have not been widely available in Indonesian cities.

Learning from the case in Vietnam, companies have been facing challenges in investing in EV charging stations due to the high minimum investment cost, yet low and slow profit. As a result, most e-bike and e-motorcycle charging in Vietnam remains at home or at the workplace[89]. In Indonesia, although the power needed is lower to charge E2&3W compared to electric cars (charging a 2/3W requires an electricity plug of 350-500W, therefore, a house with minimum of 900 watts of generator power for slow-charging[90,91]), many households still need to upgrade their houses' power capacity. It was reported that around 30% of households with electricity access in Indonesia only have the minimum generator power category of 450-900 watts. To add to that, upgrading to the second category of above 900 watts may take out a substantial amount of monthly electricity subsidy[92].

Additionally, there is still an issue with unstable electricity in many Indonesian regions that affect both the public and private charging infrastructures.

[84]The average price of e-motorcycles is comparable to ICE Honda Beat. The brand including Niu Gova 03, Gesits, and Volta have around one third of Honda beat's travel range i.e., 102 Km. While an e-motorcycle can take 3 - 7 hours to recharge, Honda Beat requires no time to refuel.
[85]Yu, H., Liu, Y., Li, J., & Fu, T. (2020). *Investigation of Energy Consumption Characteristics of Electric Passenger Car under High and Low Temperature Conditions*. 2020 5th Asia Conference on Power and Electrical Engineering (ACPEE).doi:10.1109/acpee48638.2020.9136212
[86]Lindgren, J., & Lund, P. D. (2016). Effect of extreme temperatures on battery charging and performance of electric vehicles. Journal of Power Sources, 328, 37–45. doi:10.1016/j.jpowsour.2016.07.038
[87]Marciano, I. 2020. Mengembangkan Ekosistem Kendaraan Listrik di Indonesia Pelajaran dari Pengalaman Amerika Serikat, Norwegia dan Cina. Institute for Essential Services Reform (IESR).
[88]Kappan, R 2019. Tacking range anxiety with a 240 km per charge EV Motorcycle.[Online]. [Accessed 2022]. Available from: Deccan Herrald
[89]Nguyen, X. T., & Nguyen, Q. H. (2015, December). SERVICE ISSUES: overview of electric vehicles use in Vietnam. In Armand Peugeot Chair International Conference: 3 rd Electromobility Challenging Issues.
[90]Cherry, C., & Jones, L. (2009). Electric two-wheelers in India and Vietnam: Market analysis and environmental impacts.
[91]Agung, F. (2020). Punya kendaraan listrik? Ini syarat untuk pengisian daya di rumah. Kontan. Retrieved December 28, 2021, from https://industri.kontan.co.id/news/punya-kendaraan-listrik-ini-syarat-untuk-pengisian-daya-di-rumah
[92]Kurniawan, D. (2020). Menteri ESDM Pastikan Tak Ada Subsidi Listrik untuk Pengguna 900 VA dan 1.300 VA. VOI. [Accessed on 28 December 2021]. Available from: Voi.id

Awareness: Low public awareness

Knowledge and awareness of EV benefits are suggested to significantly encourage consumers to purchase EV[93,94]. As discussed above, consumers are sensitive to various aspects of EV, such as the EV technology, supporting infrastructure, price, and environmental impact. As a consequent, limited awareness, knowledge and information of these influencing aspects may form a social barrier which deter transition to EV. There are three main aspects of public awareness on EV that need to be improved[95]:

a. Product quality knowledge
Knowledge regarding EV product quality, especially to the technical aspects of EV performance. The lack of this technical information may lead to a perception gap which can create concerns within potential consumers. For instance, although consumers may be aware that EV have shorter driving ranges than ICEs, correct information of the exact distance is an important information to avoid information gaps and overly concern that could disinterest potential consumers. In addition to existing awareness, uncertain information or misinformation, which is common for new technologies, also hinders the adoption (e.g. the concern of being electrocuted when the EV passes flooded roads, the common misconception that all E2W is low powered, or other safety concerns due to lack of information).

b. Product knowledge
Product knowledge refers to a broader understanding of E2&3Ws, such as the availability of nearby charging stations, incentives and subsidies, and other supporting policies and facilities. For instance, a similar type of EV may be purchased with different purchasing schemes or may have more supporting infrastructure in one area than the other.

c. Environmental awareness.
The key point of creating an EV ecosystem is how it holds the potential to improve the environment, thus delivering precise and accurate information about the potential environmental benefit is essential for the public. Recognizing the benefit of EV transitions from the environmental aspects may be challenging as it may not create an instantaneous impact, yet a rather long-term period.

[93]Jia, J. J., Xu, J. H., Fan, Y., & Ji, Q. (2018). Willingness to accept energy-saving measures and adoption barriers in the residential sector: An empirical analysis in Beijing, China. Renewable and Sustainable Energy Reviews, 95, 56-73.
[94]Othman, N. S., Harun, N. H., & Ishak, I. (2021). What Drives Residential Consumers Willingness to Use Green Technology Applications in Malaysia?. The Journal of Asian Finance, Economics and Business, 8(10), 269-283.
[95]Adhikari, M., Ghimire, L. P., Kim, Y., Aryal, P., & Khadka, S. B. (2020). Identification and analysis of barriers against electric vehicle use. Sustainability, 12(12), 4850.

8 Supply-side Perspective: E2&3W Manufacturers in Indonesia

EV industry players, including vehicle Original Equipment Manufacturers (OEM), have a vital role in electric mobility adoption in Indonesia. Domestic vehicle manufacturing industry development is the main objective of the Government of Indonesia in accelerating EV uptake. The shift of technology to EV is seen by the government as an opportunity to boost the competitiveness of domestic vehicle manufacturers and reduce the domination of Japanese OEM brands, which lead the current ICE vehicle market share.

To understand the current E2&3W market and challenges faced by the domestic industry players, interviews were conducted with three local E2&3W OEMs: Gesits, Smoot, and Selis. More details on the interviews can be found in Annexure 1. One of the interviewees requested for certain information to be non-company specific, therefore the OEMs are represented as OEM A, B, and C in the Table 22 and 23.

	OEM A	OEM B	OEM C
Type of Products	E-motorcycle	E-motorcycle	E-motorcycle, e-bike, e-3W
Units sold	1,000 units	7,000 units	E-motorcycle: 5,000 units E-bike: Tens of thousands units
Production	Vehicle assembly. Still imports several parts (engine and electrical parts)	Research and development, manufacture, and assembly	Spare part manufacture and vehicle assembly
Market Penetration Strategy	• Utilizes online channels and offline events for marketing • Expands showroom locations • B2B services with ride-hailing and logistic companies	• Focuses on producing e-motorcycles with comparable performance with ICE motorcycles • Offers trials • B2B services on vehicle provision and charging infrastructure with ride-hailing and energy companies	• Utilizes online channels and offline events for marketing • Expands distributor network and showroom locations • B2B services with ride-hailing, logistic companies, and other companies for operational vehicles • Offers trials • Offers lease scheme • Offers product customization • Offers home service • Offers price transparency • Public education on E2W
Interest in Producing e-bikes	No	No	Already produces e-bikes
Interest in Developing Charging Infrastructure	Yes, included in company roadmap	Yes, already provides chargers for companies and is planning to provide public charging infrastructure under a B2B collaboration	Yes, already provides public battery swap stations
Interest in ICE to Electric Conversion	No	No	Yes, already offers e-bike conversion kit

Table 22. Current production and plans

	OEM A	OEM B	OEM C
Main Incentives Needed	• Financing and incentives for consumers • Positive EV publicity	• Direct (purchase price) subsidy • Battery standardization	• Vehicle component import incentives to support domestic production • ICE bans/area restriction e.g. by low-emission zone implementation • Battery and charging infrastructure standardization
General Perspective on Government Support	Not sufficient yet	Not sufficient yet	Not sufficient yet, especially for independent (non-state-owned) companies
Perspective on The TKDN Policy	No objection, still can comply with the set TKDN	No objection, still can comply with the set TKDN	No objection, still can comply with the set TKDN

Table 23. Perspectives on the government support

8.1 INDUSTRY OVERVIEW AND CHALLENGES

Key takeaways regarding the production aspects and future plans of the E2&3W industry players, as well as their challenges and need for support from the government, are as follows:

1. **The higher price of E2&3W and lack of public knowledge on EV are the main barriers of E2&3W uptake in Indonesia, and current government incentives are considered not yet sufficient.** The government is expected to issue stronger incentives and policies, including direct financial incentives and disincentives to ICE vehicles. Additionally, test drives, positive publications, and positive word of mouth are considered effective in improving the E2&3W market.

2. **Business-to-business (B2B) scheme is a major driver of current E2&3W sales.** B2B sales or service provision of vehicles, such as for ride-hailing, logistics, and delivery companies play important roles in this initial phase of E2&3W uptake. The government can leverage this by having targeted incentives for companies and by having a concrete commitment for gradual procurement of E2&3W for the government's or government-owned companies' own operational fleets.

3. **Battery and charging infrastructure standardization is needed soon, especially when there are still limited players in the market.** Battery and plug-in standardization, including for home charging, should aim to ensure safety. Incident risks involving EVs and batteries, e.g. fire hazards when charging, should be minimized because any negative sentiment can be very harmful to EV uptake especially when it is still at the initial stage. Moreover, having standardized battery dimensions and technical specifications can catalyze faster battery swap station provisions since companies will be able to clearly determine which battery type to provide in the stations. Standardization can be more easily implemented when there are still few players in the Indonesian market.

4. **There is a trend for OEMs to also provide public charging infrastructure, in particular battery swap stations, as part of their business.** This can be leveraged to accelerate public charging infrastructure provision by providing incentives for the OEMs to develop this business model.

5 **There is a hesitation from OEMs to conduct ICE to EV conversion.** High heterogeneity of vehicle conversion (since the build will vary based on the ICE model to be converted) and complexity of the conversion process hinder E2&3W OEMs to provide conversion services. Quality control of the conversion, such as on safety aspects and vehicle performance, can be also questioned if there is no strong monitoring mechanism on conversion shops. Additionally, it was also cited that there will be no significant price difference between similarly performing ICE conversion and new E2&3W.

6 **E-motorcycles and e-bikes are perceived to have different market segments.** OEMs that currently only produce e-motorcycles do not have any immediate plans to produce e-bikes. In developing policies to advance e-bike uptake, government consultations need to be conducted with e-bike manufacturers since they might have a different set of needs and market strategies.

7 **There is a lack of importance placed by the private sector on battery waste recycling.** OEMs have not seen battery waste recycling as an urgent matter, since there has not been much waste or market demand yet. Given this sentiment, battery waste processing and recycling might need to be conducted by other companies, e.g. dedicated battery waste processing companies or energy companies, rather than OEMs.

8.2 THE NEED FOR GOVERNMENT SUPPORT

Several policies and incentives were proposed by the OEMs:

A. Direct (purchase price) subsidy for consumers to buy EVs
The amount of subsidy can be set to reach purchase cost parity with ICE motorcycles with similar performance.

B. Consumer financing
Some examples:
- Oblige leasing companies and other financing institutions, especially starting from state-owned or regional-owned banks, to offer 0% down payment or lower interest rate program for EV financing
- Oblige leasing companies and other financing institutions to allocate a certain minimum of their financing quota to finance EV

C. Disincentives for ICE vehicles
Some examples:
- ICE vehicle bans or access restriction through green zones or low-emission zones (LEZ)
- Higher parking fee compared to EV
- Higher taxes
- Reduce gasoline subsidy budget to fund EV incentives

D. Import incentives for vehicle components that are needed for domestic E2&3W production.
While the TKDN requirement policy is considered already acceptable, component import is still needed.

E. Accelerate battery and charging infrastructure standardization.
The standards should be sufficient enough to ensure safety, but not too restrictive considering the very dynamic nature of current battery technology advancement and domestic manufacturing capacity.

F. Marketing and communication
- Push the media to publicize positive news and disseminate information on EV to the general public
- Initiate other collective public campaigns for E2&3W, e.g. by conducting special events

9 Existing Policies and Regulations in Indonesia

The Government of Indonesia (GoI) has released several policies to speed up the production and adoption of battery electric vehicles (BEV) in Indonesia. On the supply side, the policies are set to increase BEV import and infrastructure in the short term and establish BEV industry in the long term. On the demand side, meanwhile, the policies are mainly in the shape of fiscal incentives to reduce the overall cost of BEV acquisition or ownership.

The earliest policy regarding road transport electrification is issued through the Presidential Decree No. 22 of 2017 on the National Energy Plan (RUEN). It set a national target for electric and hybrid vehicles, as much as 2.1 million motorcycles, 2,200 light vehicles and 10% of the public transportation fleet in 2025. Following this regulation, Presidential Decree No. 55 of 2019 regarding the Acceleration of the Battery Electric Vehicle Program for Road Transportation was issued. This regulation acts as the guide regulation and covers national BEV industry growth, fiscal incentives, BEV infrastructure support, technical provisions for BEV, environmental protection, and implementation coordination. Derivative regulations are then developed by the responsible ministries.

Following are policies that are related to the BEV, especially the two- and three-wheelers.

Document	Content Overview
Strategic document	
Presidential Regulation No. 22/2017 on National General Energy Plan (RUEN)	2025 target for electric vehicle adoption: · 2,200 units electric car · 2.1 million units E2&3W · 10% of public transport fleet
Presidential Regulation No. 55/2019 on BEV Acceleration Program	Main strategic directive for the acceleration efforts of BEVs in Indonesia. Includes fiscal and non-fiscal incentives options and national coordination team establishment
MOI Regulation No. 6/2022 on BEV Specification, Roadmap, and Domestic Component Rate (TKDN) Calculation	Roadmap of minimum TKDN values for BEV eligible for incentives, including E2&3W, as well as policies and strategies for the development of the EVs industry to achieve the minimum TKDN. The domestic content should reach 40% in by 2023, 60% by 2025, and 80% in 2026 onwards. This domestic contents are also aligned with the import policies.
MEMR Regulation No. 13/2020 on Charging Facilities for BEV	Provides direction of charging infrastructure development in Indonesia, mandate for PLN to initiate the provision, business model options, preferential electricity tariff for charging infrastructure providers, and plug-in standards
Fiscal incentives	
Law No. 1/2022 on Financial Relationship between the National Government and Local Governments	BEV including E2&3W is exempted from annual vehicle tax (PKB) and vehicle title transfer tax (BBN-KB)
Government Regulation No. 74/2021 on Luxury Tax Rate for Motorized Vehicles	BEV is exempted from the luxury tax rate. It is applied to BEV (or PHEV and FCEV) with fuel consumption bigger than 28 kilometer per liter or emission factor up tp 100 g CO2 per kilometer. However, 2&3Ws are by default not subjected to luxury tax.
MOF Regulation No. 26/PMK.010/2022 on Goods Classification and Import Tax	Import tax rate for completely knocked-down E2&3W and ICE 2&3W is the same at 10%

BKPM Regulation No. 7/2020 on Pioneer Industries and Tax Allowance	Eligible pioneer industries which include manufacturers of certain types of motor vehicles or components, is granted with tax holiday or deduction on corporate income tax
MOF Regulation No. 130/PMK.010/2020	
MOI Regulation No. 28/2020	Regulates the import of battery electric vehicles in the form of completely knocked down (CKD) and incompletely knocked down (IKD). This allows the manufacturers to imports BEV in those two forms or import the component. However, this option is only available for four wheels or more vehicle. Two- and three-wheelers are only allowed to import in the form of CKD.
Bank of Indonesia Regulation (PBI) No. 22/13/PBI/2020 on Second Amendment to PBI No. 20/8/2018 on LTV Ratio for Property Credit, FTV Ration for Property Financing and Down Payment for Motor Vehicle Credit or Payment	Allows financial institutions to give 0% down payment for BEV. It is however, not clear whether two- or three-wheelers is subject to the regulation or not. Typically, the down payment for a motorcycle is 5% while for a car is around 10-20%.
Vehicle Regulations	
MOT Regulation No. 86/2020 on Electric Vehicle Type Test, which revises MOT Regulation No. 44/2020	Specifies the standardized methodology to conduct type test for electric vehicles, including 2&3W
MOT Regulation No. 45/2020 on Certain Vehicles with Electric Motors	Regulates “Certain Vehicles with Electric Motors” category, which includes personal mobility devices such as e-bikes, electric kick-scooters, hoverboards, and unicycles.

10 Recommendations on Policies, Regulations, and Standards on E2&3W

The policy and regulation landscape in Indonesia related to BEV has been dynamically developing in the past three years since the delivery of Presidential Regulation No. 55/2019 on the BEV Acceleration Programme, which kickstarted the government's BEV adoption acceleration efforts in Indonesia.

To tackle the main demand and supply side barriers identified in the previous sections, the key main recommendations for the national and local governments of Indonesia are as follows:

1. Link clear E2&3W adoption targets and roadmaps with national strategic documents and commit budgets

2. Achieve cost parity by providing fiscal incentives

a. Introduce purchase price subsidy
b. Offer tax incentives for E2&3W and impose tax disincentives for ICE 2&3W
c. Reduce other financial benefits for ICE vehicles
d. Conduct green vehicle replacement program
e. Stimulate attractive financing schemes and insurance packages for E2&3W

3. Ensure safety by implementing technical and operational standards for vehicles, battery, and charging infrastructure

a. Clearly regulate vehicle safety and operational standards, including speed, dimension, and street management
b. Implement charging infrastructure safety standards
c. Ban lead acid batteries
d. Regulate battery waste management

4. Make riding E2&3W more convenient than ICE 2&3W

a. Improve fuel economy standard and establish Low Emission Zones/Zero Emission Zones
b. Offer exemptions from road access restrictions

5. Incentivize industry players to provide high performance models

a. Carefully design purchase price subsidy and industry incentives
b. Set public fleet procurement requirements
c. Provide incentives or programs for research and developments and capacity building

6. Eliminate range anxiety by improving access to charging infrastructure

a. Set national-level vision and city-level targets for charging infrastructure provision
b. Offer fiscal support for charging infrastructure provision
c. Update building codes to facilitate charging infrastructure provision in buildings
d. Allow government assets to be used as charging infrastructure locations
e. Introduce battery swap station standardization in consultation with the industry players

7. Establish public campaign programs to mainstream E2&3W information

a. Develop an accessible one-stop informational website in collaboration with industry players
b. Organize and sponsor offline E2&3W conventions
c. Develop public service announcements (PSAs) on E2&3W safety and operations

This section aims to provide a review of the current landscape of policies, regulations, and standards[96], and identify opportunities to strengthen the framework of BEV adoption acceleration in Indonesia, in particular E2&3W. Best practices from leading EV markets are also presented, such as China and Vietnam which lead the current E2&3W global market, as well as India, Korea, several European countries, and the USA which have high electric car populations or rapid growth of EV sales in recent years.

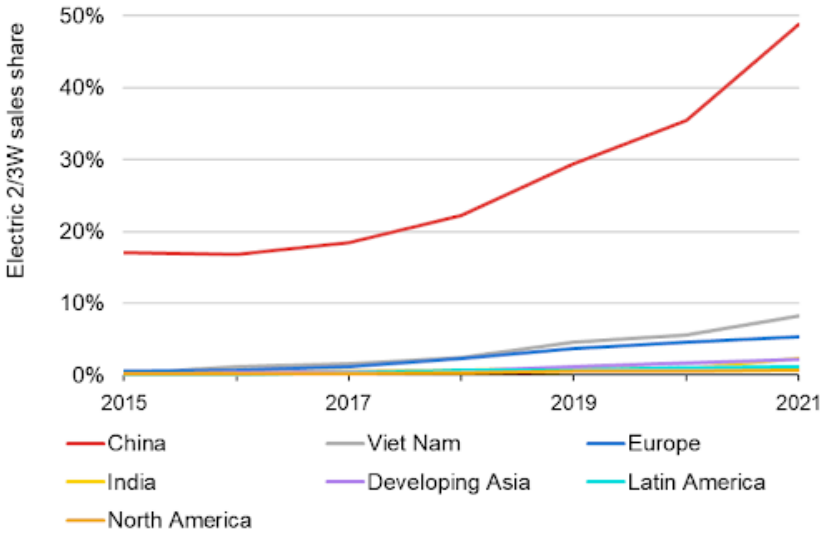


Figure 37. E2/3W sales share (Source: IEA, 2022[97])

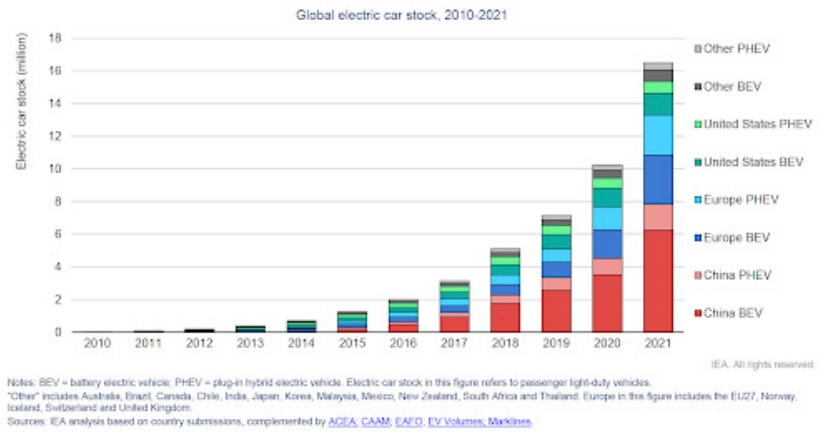


Figure 38. Global electric car stock, 2010-2021 (Source: IEA, 2022[98])

[96]As of June 2022
[97]IEA. (2022). Global EV Outlook 2022.
[98]IEA. (2022). Global EV Outlook 2022.

10.1 LINK CLEAR E2&3W ADOPTION TARGETS AND ROADMAPS WITH NATIONAL STRATEGIC DOCUMENTS AND COMMIT BUDGETS

Barrier addressed: No specific barrier, but rather to enable other policies and regulations to take place.

Current condition and challenges
Indonesia has set a target of having 2.1 million e-motorcycles and 2,200 electric cars population and a stock share of 10% electric public transport by 2025 in its General National Energy Plan (RUEN). There is also an unofficial ambition to have 100% of BEV sales share in the 2&3W segment by 2040 and in the LDV segment by 2050[99]. However, apart from the RUEN, national targets concerning BEV adoption is not yet mainstreamed in national strategic documents such as the 2020-2024 National Medium-Term Development Plan (RPJMN) and 2005-2025 National Long-Term Development Plan (RPJPN) or in international pledges concerning GHG reduction mitigation such as Indonesia's Nationally Determined Contribution (NDC).

Best practices
A number of countries have pledged their transport decarbonization targets in their national strategic documents or international pledges, such as in the UNFCCC's Nationally Determined Contribution (NDC) and COP26 declaration on accelerating the transition to 100% zero-emission cars and vans.

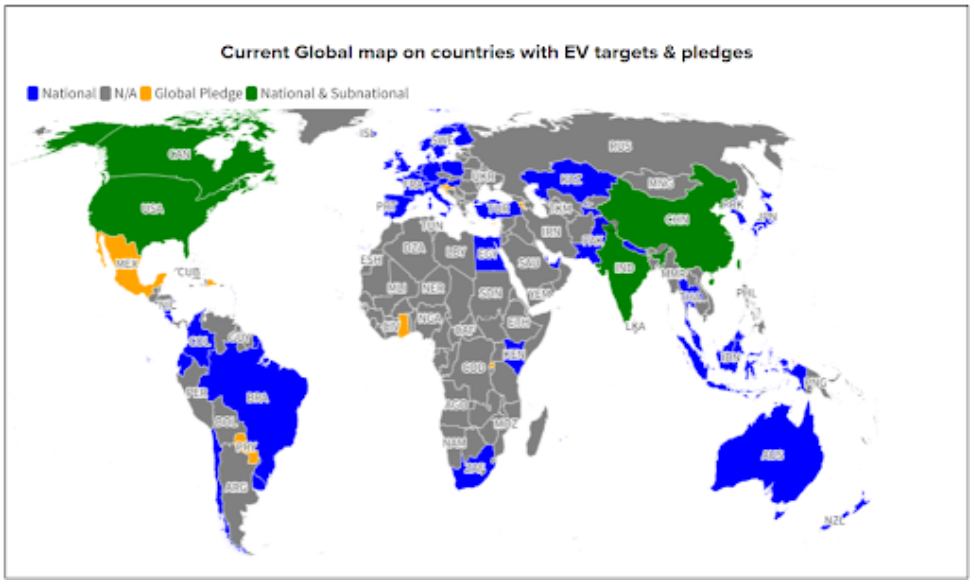


Figure 39. Global EV Policies Spread as of July 2022[100] (Source: International Energy Agency, 2022)

[99]The target was said to be included in the National Grand Energy Strategy (GSEN) document, which is not yet published at the time this report is written. Available from: CNN Indonesia
[100]IEA, 2022

The table 26 below summarizes the examples of EV adoption targets by various countries on within their strategic policies.

Government	Target	Strategic Policy	Year	Institution	Budget Commitment
National Level					
China	• 20% NEV[101] sales by 2025 for LDV and HDV segments • 50% NEV sales by 2035 for LDV segment and the others should be hybrid cars	• Energy-saving and New Energy Vehicle Technology Roadmap 2.0 • New Energy Vehicle Industrial Development Plan for 2021 to 2035	2020	Ministry of Industry and Information Technology (MIIT)	USD 6 billion or IDR 84 trillion (2016-2020), for vehicle purchase subsidies
India	EV market share of 30% of private cars, 70% of commercial cars, 40% of buses and 80% of 2&3W by 2030 (unofficial target based on FAME subsidies)	Faster Adoption and Manufacturing of Electric Vehicles II (FAME II)	2019	NITI Aayog (Ministry of Planning and Development)	USD 1.2 billion or IDR 17 trillion (2019-2021), for vehicle purchase subsidies and charging infrastructureincentives options and national coordination team establishment
USA	50% ZEV sales by 2030	Executive Order on Strengthening American Leadership in Clean Cars and Trucks Bipartisan Infrastructure Law	2021	The White House	USD 7 billion or IDR 98 trillion (2022-2026), only for charging infrastructure provision
City of State Level					
California, USA	1.5 million ZEV by 2025 and 5 million ZEVs by 2030	ZEV Action Plan 2016[102]	2016	Governor's Interagency Working Group on Zero-Emission Vehicles	USD 3.9 billion or IDR 54.6 trillion committed, 10 billion or IDR 140 trillion in total (2022-2028), for vehicle purchase subsidy, charging infrastructure, domestic industry incentives
Delhi, India	25% BEV sales by 2024	Delhi Electric Vehicle Policy[103]	2020	Government of National Capital Territory of Delhi	USD 12 million or UDR 168 billion (2019-2020) purchase incentives and scrappage benefits on older vehicles
Hainan, China	100% EV by 2030	Hainan Province Clean Energy Vehicle Development Plan[104]	2018	Hainan Provincial People's Government	There a special fund allocated under The Hainan Provincial Comprehensive Incentive Fund, but no information about the amount

Table 26. Current production and plans

Recommendations

- **Indonesia has to have clear targets embedded into national strategic documents** to focus the national and regional governments' measures and policies on advancing E2&3W adoption. An institution (e.g. CMMIA) should be tasked to monitor the progress of target achievement.
- **The targets should be accompanied by budgetary commitments** to drive the market, thus sending a positive signal to the private sector to take action. After the national target is set, the regional governments can follow by developing city-level plans.

Table 27. Recommendation 1: EV adoption targets

[101]New Energy Vehicle, which includes battery electric vehicles (BEVs), plug-in hybrid electric vehicles (PHEVs), and fuel cell electric vehicles (FCEV)
[102]Brown Jr. Edmund. (2018). ZEV Action Plan Priorities Update: Governor's Interagency Working Group on Zero-Emission Vehicles. [Online]. [Accessed 2022]. Available from: ZEV Action Plan Update
[103]Seth, Jyoti. (2020). Delhi Electric Vehicles Policy. Government of National Capital Territory of Delhi (Transport Department). [Online]. [Accessed 2022]. Available from: https://transport.delhi.gov.in/sites/default/files/All-PDF/Delhi_Electric_Vehicles_Policy_2020.pdf
[104]Hainan Government. 2019. Hainan Province Clean Energy Vehicle Development Plan. [Online]. [Accessed 2022]. Available from: https://www.hainan.gov.cn/hainan/xnyzcwj/201907/cb9368c30a0f42e7a4cae7dad6651a09.shtml

The documents below should be updated to provide clear strategic directions on BEV uptake:

Document	Level	Key Institutions*	Recommendation
Indonesia's Nationally Determined Contribution (NDC)	International	MOEF	Currently, there is no mention of electric vehicle adoption in the NDC. BEV adoption, including in the 2&3W segment, should be mentioned explicitly as one of the GHG emission mitigation actions from the transport sector in Indonesia's NDC.
The 2020-2024 National Medium-Term Development Plan (RPJMN) and 2005-2025 National Long-Term Development Plan (RPJPN)	National	Bappenas	The current RPJMN only includes the plan to conduct R&D on BEV manufacture and there is even no mention of BEV in RPJPN. National BEV adoption acceleration programs, including E2&3W, should be incorporated into the RPJMN as one of Indonesia's strategic programs. Therefore, it will provide a legal basis for ministries to incorporate BEV programs into their ministerial strategic plans (Renstra). Meanwhile, a more general plan to decarbonize the transport sector, including the shift to electric vehicles, should be incorporated into the RPJPN.
Government Regulation No. 79/2014 on National Energy Policy (KEN)	National	MEMR, MOT	KEN has mentioned electric vehicles as one of the alternative measures to diversify energy consumption. However, amendments need to be made in the document to also include electricity, especially from renewable sources, as one of the energy sources for the transportation sector to reduce dependency on petrol fuel.
Presidential Regulation No. 22/2017 on National General Energy Plan (RUEN)	National	MEMR, MOEF, MOI, MOT, Bappenas, MOF, BRIN	EV (BEV and hybrid) adoption targets are mentioned in the RUEN. However, these targets should be updated to better reflect the current condition of EV uptake and GHG mitigation targets.
Presidential Regulation No. 61/2011 on National GHG Reduction Action Plan (RAN-GRK)	National	CMEA, MOEF, MOT	Indonesia's RAN-GRK should already be updated since its implementation period is limited to 2011-2020. BEV as an alternative fuel vehicle should be included as one of the GHG reduction measures in the transportation sector.
National Transport System Plan (SISTRANAS)	National	MOT	The MOT should clearly define the role of BEVs in achieving a sustainable transport system and incorporate BEV adoption plans into SISTRANAS. Without the ministry setting up a formal plan, it will be difficult for local transportation agencies to develop local implementation actions.
Presidential Regulation No. 55/2019 on BEV Acceleration Programme	National	CMMIA, CMEA, MEMR, MOF, MOT	Quantified targets and a clear timeline of implementation, including a timeline to issue derivative regulations, should be included in this main policy of the BEV acceleration program.
Regional GHG Reduction Action Plan (RAD-GRK)	Province	MOHA, Provincial Governments	BEV as an alternative fuel vehicle should be included as one of the GHG reduction measures in the transportation sector.
Regional General Energy Plan (RUED)	Province	MOHA, Provincial Governments	Although BEV targets have been incorporated into RUEN, derivative regional energy plans (RUED) should also support the national plan of BEV adoption. To date, there are only 18 provinces that have completed their RUED and only one of them (D.I. Yogyakarta) has included plans for BEVs.

Table 28. Recommendation 2: to embed BEV targets in strategic documents

** for documents that are not specific to EVs (also addressing other issues such as energy, environment, etc.) the key institutions listed are only those relevant to EV uptake initiatives*

10.2 ACHIEVE COST PARITY BY PROVIDING FISCAL INCENTIVES

Barrier addressed: Cost-effectiveness (higher purchase price)

The competitiveness of total cost ownership (TCO) of E2&3W to ICE 2&3W should be considered when designing fiscal incentives. Nevertheless, according to the interviews with several domestic OEMs, the purchase price of an E2&3W is still a stronger deciding factor for potential customers, especially during the inception phase of the new technology.

A. Introduce Purchase Price Subsidy

Current condition and challenges
Currently, the price of ICE motorcycles is still lower than E2&3W with comparable performances. No direct subsidies are available to lower the purchase price of E2&3W or other BEV segments. Vehicle purchase price subsidy is also not listed in the incentive options in Presidential Regulation No. 55/2019.

Best practices
Price parity between BEVs and ICE vehicles is a determining factor to accelerate large-scale adoption. In Norway, the country with the highest EV share, the retail price of an EV is comparable to that of an ICE vehicle[105]. Below are some examples of the amount of budget allocated by other governments to subsidize EV purchase prices.

Government	Scheme	Implementation Year	EV purchase subsidy budget for 2&3W and 4W	Amount of subsidy per vehicle
National Level				
India	Faster Adoption and Manufacturing of Electric Vehicles (FAME) I[106]	2015-2019	IDR 1.1 trillion (62% of the total budget allocated for the scheme)[107]	Two-wheelers: IDR 360,000 (PHEV <250W) - IDR 5.8 million (advanced BEV >250W) Four-wheelers: IDR 2.6 million (small car with PHEV <250W) - IDR 27.7 million (>4 meters advanced BEV >250W)
	Faster Adoption and Manufacturing of Electric Vehicles (FAME) II[108]	2019-2022	IDR 13.6 trillion (52% of the total budget allocated for the scheme)	IDR 2 million per KWh, capped at 20% of the total vehicle cost
Regional Level				
California	Clean Vehicle Rebate[109]	2010- ongoing	IDR 11 trillion (2010-2019), and another IDR 3.5 trillion approved for the fiscal year 2019-2020	Two-wheelers: IDR 11 million Four-wheelers: IDR 14 million (PHEV) - IDR 29.4 million (BEV)
	Delhi Electric Vehicle Policy[120]	2020-2025	Unknown	Two-wheelers: IDR 1 million per KWh, capped at IDR 6 million per vehicle Four-wheelers: IDR 2 million per KWh, capped at IDR 30 million per vehicle

Table 29. Vehicle purchase subsidy scheme examples

[105]IEA, 2018
[106]Ministry of Heavy Industries. 2019. FAME India Scheme. [Online]. [Accessed 2022]. Available from: https://pib.gov.in/PressReleasePage.aspx?PRID=1577880
[107]Including demand incentive for light commercial vehicles and buses, since no distinction is made in the regulation
[108]Fame India Scheme Phase II. (2019). Policy Document: National Automotive Board (NAB). [Online]. [Accessed 2022]. Available from: https://fame2.heavyindustries.gov.in/content/english/11_1_PolicyDocument.aspx
[109]California Clean Vehicle Rebate Project. 2022. Cleanvehiclerebate.org. [Online]. [Accessed 2022]. Available from: https://cleanvehiclerebate.org/eng
[110]Seth, Jyoti. (2020). Delhi Electric Vehicles Policy. Government of National Capital Territory of Delhi (Transport Department). [Online]. [Accessed 2022]. Available from: https://transport.delhi.gov.in/sites/default/files/All-PDF/Delhi_Electric_Vehicles_Policy_2020.pdf

Recommendations

- **The MOF and MOI can jointly develop an EV purchase subsidy scheme.** In addition to subsidies from the national government, local governments can also offer complementary subsidies to further reduce the price of E2&3Ws.
- **The subsidy should be designed to benefit the widest group possible and drive the industry to provide high-performance models.** See Box below for a brief guide to designing a vehicle purchase price subsidy program.
- It is recommended that **the purchase price subsidy be designed as a green vehicle replacement program** to limit the additional number of vehicles owned in a household.
- Presidential Regulation No. 55/2019 should also be amended **to include vehicle purchase incentives as one of the incentive options**, in order to provide a regulatory framework for such subsidy provision.

Table 30. Recommendation 3: Vehicle purchase subsidy

Upfront BEV price discounts directly overcome the barrier of the high purchase price. This type of policy is also highly visible and simpler to understand by the market compared to a tax reduction scheme[111].

Purchase price subsidies are mainly needed during the early stages of EV penetration. In the long term, direct subsidies will not be sustainable for the government to offer. Therefore, the government needs to also establish a vast network of charging stations, develop non-fiscal incentives and strong disincentive policies for ICE vehicles, as well as build a strong domestic manufacturing industry to achieve EV-ICE vehicle price parity on the longer horizon.

Assuming that the amount of purchase price subsidy is designed to make E2&3W price comparable to ICE 2&3W until the start of the early majority phase, and the rate of uptake follows a normal distribution until 100% E2&3W stock share in 2050, the amount of subsidy can be roughly estimated as much as IDR 19.9 Trillion or roughly USD 1.3 Billion.

Although the nominals might seem gigantic, to put things into perspective the national government has to provide IDR 96.5 Trillion as compensation for Pertamina to cover the below-market price of petrol fuel between 2017-2019[112]. Which is nearly five folds over only two years of the estimated subsidy for shifting into E2W (over 28 years).

Designing A Vehicle Purchase Price Subsidy Program

I. Setting Eligibility Requirements

Subsidy program design can be a powerful tool to direct the course of BEV adoption to certain vehicles or user segments. It is necessary to ensure that the subsidies effectively benefit the widest user group possible, instead of only enabling a handful of upper-class society members to purchase luxury BEVs. Therefore, it is recommended to set several subsidy eligibility requirements to promote equitable BEV adoption, such as:

1. **Purchase price cap.** The price of BEV eligible for subsidy is capped at a certain price to prevent funding luxury vehicles. This requirement can also affect OEMs' retail prices, as with the case in China where Tesla cuts down the retail price of one of its products to meet the price ceiling requirement[113].
2. **Income cap.** Only buyers with income below the specified threshold are eligible for the subsidy. Another variation of this mechanism is to provide additional incentives for lower-income groups, such as in California[114]. However, this scheme could be more complicated than the BEV price cap scheme since there is an additional step to verify the buyer's stated income.

Table 31. Designing a subsidy program for vehicle purchase price

[111]ICCT (2019)
[112]Dinda, Daniela. 2020. Government Total Debt to Pertamina. CNN Indonesia. [Online]. [Accessed 2022]. Available from: CNN Indonesia
[113]Szymkowski, Sean. 2020. Tesla drops Model 3 prices in China to benefit from EV subsidies. Cnet. [Online]. [Accessed 2022]. Available from: Tesla model prices.
[114]California Clean Vehicle Rebate Project. 2022. Income Eligibility (2016). Cleanvehiclerebate.org. [Online]. [Accessed 2022]. Available from: https://cleanvehiclerebate.org/eng/income-eligibility

3. **Number of vehicle cap.** The government can set the maximum number of vehicles subsidized per year to control the amount of funding or limit the number of vehicles that can be purchased by a person.
4. **Different budget allocations for each vehicle type.** Certain types of vehicles can get a higher subsidy per vehicle and bigger funds allocation to drive the market's preference, based on the government's objective on BEV adoption. For example, India's FAME II scheme allocates almost eight times more funds to subsidize two-wheelers than four-wheelers, since it is the government's priority to accelerate electric motorcycle adoption. In addition to the vehicle's physical type, the policy can also be designed to focus on certain fleet types. For example, India's FAME II four-wheelers subsidy is only eligible for commercial vehicles (taxi and ride-hailing) instead of also financing private users.
5. **Technology requirement.** In order to focus on the BEV market, the government can exclude other EV types from the subsidy as has been suggested in Presidential Regulation No. 55/2019. Other technology requirements, such as range (km), energy efficiency (km traveled/KWh), level of emission (CO2/km), and battery energy density (Wh/kg), can be set as factors to determine the amount of subsidy to push OEMs to produce better BEVs. Additionally, a maximum speed limit can also be added to the requirements to also tackle road safety issues due to speeding, which commonly happens in the 2&3W segment.

Example: Subsidy amount calculation formula in China

$$Subsidy = min\{Subsidy_{ER}, Subsidy_{BC}\} \times F_{BD} \times F_{EC} \times F_{OS}$$

$Subsidy_{ER}$ = base subsidy determined by electric range
$Subsidy_{BC}$ = base subsidy determined by battery capacity
F_{BD} = battery energy density multiplier
F_{EC} = electric energy consumption multiplier
F_{OS} = ownership type multiplier

6. **Minimum domestic component requirement (TKDN).** Minimum domestic component requirements can be set as one of the subsidy eligibility requirements, as has also been suggested in Presidential Regulation No. 55/2019, to support the creation of the domestic BEV industry.
7. **Other requirements.** Other requirements, such as requiring OEMs to provide a minimum warranty period including for the battery, or to have adequate facilities for after-sales service to enable their vehicles to receive the subsidy can also be applied. In India, in order to be eligible for the FAME II subsidy, the vehicles must be fitted with mileage monitoring devices. The data is collected to determine the total fuel savings on a real-time basis and measure the policy's performance in saving fossil fuel and GHG emissions.

It is recommended to evaluate the amount of subsidy each year, considering the traction of BEV uptake, availability of funds, and BEV price decline over time. The subsidy scheme should also consider vehicles that are sold separately with the battery, i.e. those which employ a battery-swap system – a mechanism to distribute the subsidy between vehicle owners and energy operators who bear the costs of the batteries should be put in place.

II. Fraud mitigations

In India and China, end-users get upfront rebates when purchasing EVs and the subsidy is given to OEMs based on submitted sales claims on a monthly basis[115]. However, based on lessons learned from China, this scheme is also prone to fraud. Typical fraud by the OEMs includes[116]:

1. **Overstating the number of vehicles sold to receive more subsidy, by registering vehicles illegally.** Certain manufacturers bribed local vehicle registration authorities to produce vehicle licenses (which was the data used by the subsidy regulatory agency to verify the sales) for vehicles that do not exist. The fraud usually concerns non-private vehicles, since owners of private vehicles register their vehicles themselves.
2. **Using smaller batteries in the sold vehicles, compared to the one used in the vehicle type test.** Since the amount of subsidy per vehicle is subject to its battery capacity, some OEMs install larger batteries in testing vehicles while actually selling vehicles with smaller, cheaper batteries.
3. **Selling vehicles to themselves.** On paper, there are indeed transactions being made, however, the vehicles never reach any end-user on the road.

In the current subsidy scheme, China has added **a number of anti-fraud measures such as[117]:**

1. The government verifies proof of sale, instead of only vehicle registration data, prior to issuing any subsidy.
2. Random checks by a government authority or a third party.
3. Subsidies for non-private EVs will only be given after the vehicles demonstrated at least 30,000 of accumulated mileage in their odometers or through other data.
4. Requiring every new EV to be equipped with an onboard monitoring system to allow real-time data monitoring.
5. Enforce administrative, fiscal, and civil penalties such as revoking production licenses, confiscation of the paid subsidies and other illegal income, and civil charges.

B. Offer Tax Incentives for E2&3W and Impose Tax Disincentives for ICE 2&3W

Current condition and challenges

Based on Law No. 1/2022 on Financial Relationship between the National Government and Local Governments, BEV including E2&3W is exempted from annual vehicle tax (PKB) and vehicle title transfer tax (BBN-KB). This is progress from the previous regulations where the national government still only set a maximum tax rate for BEVs (30% in 2020 and 10% in 2021) for the local governments to decide the exact rate. For the supply side, E2&3W vehicle and battery industries are eligible for a tax holiday scheme (100% business income tax reduction for the first 5-20 years, based on the amount of investment)[118].

E2&3W industries are also eligible for the tax allowance schemes (business income tax reduction), but it is also applicable for ICE 2&3W industries. For import taxes, the import tax rate for completely knocked-down E2&3W and ICE 2&3W is the same at 10%[119]. Furthermore, unlike cars that are subject to luxury goods tax, most motorcycles (only except >250 cc motorcycles) are not considered luxury items and thus are by default exempted from the tax[120]. Hence, no incentives are currently available for E2&3W from the luxury goods tax scheme.

[115]Fame India Scheme Phase II. (2019). Policy Document: National Automotive Board (NAB). [Online]. [Accessed 2022]. Available from: https://fame2.heavyindustries.gov.in/content/english/11_1_PolicyDocument.aspx
[116]Cui, Hongyang. 2017. The International on Clean Transportation: Subsidy Fraud Leads To Reforms For China's EV Market. The ICCT. [Online]. [Accessed 2022]. Available from: Subsidy in China's EV Market
[117]Ibid.
[118]Republic of Indonesia. Regulation of Investment Coordinating Board No. 7 of 2020: Rincian Bidang Usaha dan Jenis Produksi Industri Pionir Serta Tata Cara Pemberian Fasilitas Pengurangan Pajak Penghasilan Badan. Jakarta: Ministry of Investment.
[119]Republic of Indonesia. Regulation of the Minister of Finance of the Republic of Indonesia No.26/PMK.010/2022: Penetapan Sistem Klasifikasi Barang dan Pembebanan Tarif BEA Masuk Atas Barang Impor. Jakarta: Ministry of Finance.
[120]Republic of Indonesia. Government Regulation of Republic of Indonesia No. 74 of 2021: Barang Kena Pajak yang Tergolong Mewah Berupa Kendaraan Bermotor yang Dikenai Penjualan Atas Barang Mewah. Jakarta: Government of Republic of Indonesia.

Best Practices

Government	Tax reduction and exemptions for users
India	• Exempted from fees for issuing or renewing vehicle certificate • Reduced GST/VAT to 5%, compared to 28% GST for other motorized vehicles • Income tax deduction in respect of interest paid on loan taken for the purchase of electric vehicle, up to INR1,50,000 (~USD 1,880)
China	• Vehicle purchase tax exemption for new energy vehicles (others are 10%) • Reduced vehicle registration fee by 50% (fee to obtain license plates)

Table 32. E2&3W tax allowance schemes

Recommendations

- In addition to PKB and BBN-KB exemptions and tax holiday and allowance for E2&3W industry, **MOF should also implement tax disincentives for ICE 2&3W, such as emission-based luxury tax for 2&3W and mandate progressive vehicle tax**. For the E2&3W industry, tax incentives can be offered through **lower import tax exemption** for E2&3W vehicles and battery components for a limited period.
  - **The barrier of entry for small to medium BEV and battery manufacturing industry players should be lowered**, for example by setting a lower minimum investment requirement to obtain tax holidays and tax allowance for domestic capital BEV, BEV components, battery, and charging infrastructure manufacturing companies.
  - **The tax allowance and tax holiday scheme should also be eligible for the industries in the supply chain** of BEV, battery, and charging infrastructure manufacturing.
- **Local governments can offer parking tax reductions for parking providers** that offer a minimum number of E2&3W parking and charging facilities.

Table 33. Recommendation 4: E2&3W tax allowance schemes

In addition to the already offered tax incentives, other tax regulations which could be adjusted to further provide fiscal incentives for E2&3W users are as follows:

1. Central taxes (tax regulations under the jurisdiction of the national government):

- **Emission-based tax for 2&3W.** The tax should be extended for motorized 2&3W of all cylinder capacity class, instead of only for 4-wheeled vehicles and 2&3W with 200 cc or higher, since low cc motorcycles dominate the vehicle population in Indonesia. The policy should be aligned with emission standard improvement policies for motorcycles in the country.
- **Import tax reduction for E2&3W vehicles, vehicle components, and battery components.** Import taxes for E2&3W industries should be lower than those for ICE 2&3W. In addition, the completely knocked-down vehicle import tax for E2&3W and their components should be set lower than ICE 2&3W until the domestic industries have been developed.
- **Mandate local governments to set a progressive vehicle tax for all 2&3W.** Currently, the national policy still allows local governments to decide the amount of progressive tax for vehicles. As a result, many local governments only impose progressive tax policies for motorcycles above 200 cc or even only for four-wheelers.

2. Local taxes (tax regulations under the jurisdiction of provincial or city government):

- **Vehicle tax for ICE 2&3W.** Increase vehicle tax for ICE 2&3W and apply progressive tax for all cylinder capacity classes.
- **Parking tax.** Local regulations on parking tax could incorporate tax reduction clauses for parking facility providers that offered a minimum number of E2&3W parking and charging facilities, which in turn can incentivize parking operators to offer reduced parking fees and designated parking spaces for E2&3W.

C. Reduce Other Financial Benefits for ICE Vehicles

Current condition and challenges

There are still many incentives provided for ICE 2&3W usage in Indonesia, such as petrol fuel subsidy, low parking fees, and lack of road pricing policies for conventional vehicles, which make it even more difficult for E2&3W to achieve cost parity. Although the government is introducing restrictions on subsidized gasoline consumption, the consumption limitation does not apply for 2&3W. Parking is also still very cheap for 2&3W and other vehicle segments in general, due to low parking fares set by the local governments and lack of enforcement of the rules; illegal parking facilities can be found everywhere with flat fees even lower than the regulated fares.

Recommendations

- **Indonesia's gradual phasing out of petrol fuel subsidy also needs to apply for 2&3W soon**. Subsidies for gasoline as a transport sector energy source distort the real market price of the energy source, hence leading to the overuse of motorized vehicles and exacerbating the externalities such as air pollution and health issues.
- **Increase parking fee for ICE 2&3W, provide lower parking fee for E2&3W**. E-bikes should be exempted from any parking fee or have the lowest parking fee, as with other non-motorized vehicles.
- **For cities that are planning to implement road pricing, 2&3W should be included as one of road pricing objects.** E-motorcycles or E3W can be given exemption until the adoption has reached a certain volume, while e-bikes should be exempted.

Table 34. Recommendation 5: Reduce financial benefit for ICE vehicles

However, to implement the preferential parking fee policy, local governments first need to solve the systemic issue of parking management in their jurisdiction areas. Local governments must eradicate illegal parking facilities, setting up local parking management fare collection system, establish higher and progressive parking fares, and finally enforce the set parking fares to all parking facilities.

D. Conduct Green Vehicle Replacement Program

Current condition and challenges

There is no green vehicle replacement program in Indonesia yet.

Best practices

Green vehicle replacement programs have been implemented in several cities to support the replacement of old vehicles to EVs. People must retire their old vehicles in order to be eligible for this program, hence limiting the growth of vehicle ownership. This measure can be an alternative to the new vehicle purchase subsidy, especially in Indonesia where there are already many households that own multiple vehicles. As the program benefactor, the government can design the vehicle replacement policy to drive the market to, for example, domestically manufactured E2&3W.

Government	Green vehicle replacement program description	Program eligibility
California, USA	Under Clean Cars 4 All program, lower income people have the option to replace their old vehicle with an electric vehicle or alternative mobility options such as public transit passes or an electric bicycle[121].	• Only for residents of zip codes impacted by higher levels of pollution • Have an annual household income below the income cap • Only for gasoline or diesel vehicles with model year older than 2005
Egypt	Egyptian MOF incentivize scrappage of vehicles older than 20 years through the Vehicle Replacement Initiative. Owners who retire their old vehicle will be able to buy a new, locally made CNG-powered vehicles with a discounted price. By June 2022, the government has allocated around USD 23 million to finance the program and replaced 20,200 cars[122].	• The vehicle must be 20 years old or older

Table 35. Example of green vehicle replacement program

Recommendations

The MOF, MOI, and MOT can jointly develop a green 2&3W replacement program, in collaboration with the private sector.

- To boost the domestic industries, the government can set the possible replacement to be only domestically-produced E2&3W, including e-bikes, that comply with certain technical and safety requirements.
- The retired old vehicles can be scrapped or upcycled by retrofitting them with electric motors to be E2&3W, which can in turn be sold in second hand markets with lower prices.

Table 36. Recommendation 6: Green replacement program for E2&3W

E. Stimulate Attractive Financing Schemes and Insurance Packages for E2&3W

Current condition and challenges

Motorcycles can be easily procured in Indonesia with the abundance of attractive financing schemes and cheap vehicle insurance packages. On the other hand, although there are already policy from Bank Indonesia allowing financing institutions to provide 0% down payment for BEV credits and incentives from OJK to further encourage financing institutions to provide financing schemes, financing for E2&3W is not yet as attractive nor widely available as those for 2&3W[123]. The nascency of the technology and the rising non performing loans due to the pandemic economic situation impose additional risks that make banks more hesitant to provide financing schemes.

However, there is a recent private sector initiative from several government-owned institutions, i.e. PLN and the State-Owned Banks Association ("Himpunan Bank Negara"/Himbara), that includes Indonesia's four biggest state-owned banks, to collaborate on providing financing schemes for BEV purchases and charging infrastructure provision[124]. The collaboration is expected to make attractive financing schemes more accessible to wider public.

Best practice

A study in India[125] highlighted that E2&3W is particularly an economically attractive segment to finance, especially if supported by the public sector, since they have high sales forecasts and thus scalability, as well as high model availability, livelihood generation potential, socio-economic impact, and closer cost parity to their ICE counterparts.

[121]Moving California: cleaner transport for all communities. 2021. Enhanced Fleet Modernization Plus-Up Program. [Online]. [Accessed 2022]. Available from: https://ww2.arb.ca.gov/sites/default/files/movingca/vehiclescrap.html
[122]The Daily News Egypt. 2022. Egypt spends EGP 465m in green stimulus, as part of an obsolete vehicle replacement initiative: Finance Minister. [Online]. [Accessed 2022]. Available from: Egypt spends in green stimulu
[123]See Annexure 1
[124]Aristi, Santika. 2022. Gandeng Himbara, PLN Permudah Masyarakat Miliki Kendaraan Listrik. PT PLN (Persero). [Online]. [Accessed 2022]. Available from: PLN bersama Himbara
[125]NITI Aayog, RMI, and RMI India. (2022). Banking on Electric Vehicles in India: A Blueprint for Inclusion of EVs in Priority Sector Lending Guidelines. [Online]. [Accessed 2022]. Available from: https://rmi.org/insight/banking-on-electric-vehicles-in-india

Governments are implementing interventions to facilitate banks or other financing institutions to provide attractive and accessible financing schemes for EVs and to scale up the initiatives. Risk-sharing mechanisms between private financing institutions and the governments or even MDBs, such as the World Bank, ADB, and others, have been implemented in various countries to reduce the risks borne by the local private institutions. Risk-sharing mechanisms between private financing institutions and the governments or even MDBs, such as the World Bank, ADB, and others, have been implemented in various countries to reduce the risks borne by the local private institutions.

Table 37. Example of financing program schemes for E2&3W

Government	Institution	Financing Program	Program Description
India	State Bank of India	Green Car Loan scheme[126]	The State Bank of India offers an electric car loan scheme with interest rates up to 0.9% lower than the regular car loan scheme. The loan period is between 3 to 8 years.
United Kingdom	Transport Scotland	Low Carbon Transport Loan[127]	Offers interest-free loan for electric motorcycles and cars with a prepayment term of six years. The program is eligible only for businesses with high vehicle usage such as deliveries. The program is also applicable for used vehicle purchase, provided that it is from a listed dealership.
Australian Capital Territory (ACT), Australia	Local government of ACT	Sustainable Household Scheme[128]	This scheme provides zero-interest loans for buying energy-efficient products, including electric vehicles. The loan repayment period is up to 10 years.

Table 38. Recommendation 7: Financing program for E2&3W

Recommendations

- **The CMOE, MOI, and MOF create a low or zero-interest BEV financing program that includes E2&3W, partnering with state-owned banks.** A risk-sharing mechanism between the government and the banks should be set up to improve the viability of provisioning loans. The government can further have other risk-sharing mechanisms with MDBs or other international green financing institutions.
- The financing schemes should be available for both individuals or businesses. **Businesses with high vehicle mileage, such as delivery companies or ride-hailing, can be given loan priority** due to the higher potential impact per vehicle.
- The financing schemes or loans for E2&3W should **include e-bikes financing**, which will benefit the low-income societies due to the lower prices.

Stakeholders should jointly mitigate associated risks, for instance through the following measures:

1. The MT should mandate OEMs to provide a certain minimum vehicle and battery warranty period and after-sales service facilities to reduce product quality and performance risks

2. Set up risk sharing mechanism:
   - The CMOE sets up a government risk-sharing mechanisms with the banks
   - Fleet aggregators (e.g. ride hailing companies, delivery companies, etc.) should be encouraged to provide credit guarantees for the vehicles used by their drivers and thereby also share the risks

3. The MT collaborating with OEMs or used vehicle dealerships can launch a buy back program for used E2&3W to catalyze the secondhand market of E2&3W and improve resale value certainty. In the future, the financing program can be extended to finance used E2&3W purchase.

4. As for batteries, the MT can collaborate with PLN or battery recycling companies to buy back the batteries to be recycled or repurposed, guaranteeing the batteries' salvage value.

[126]Sbi. (n.d.). Auto Loans - Interest Rates. [Online]. [Accessed 2022]. Available from: https://sbi.co.in/web/interest-rates/interest-rates/loan-schemes-interest-rates/auto-loans
[127]Energy Saving Trust. June, 2022. Low Carbon Transport Business Loan. [Online]. [Accessed 2022]. Available from: https://energysavingtrust.org.uk/grants-and-loans/low-carbon-transport-business-loan/
[128]ACT Government. 2021. Sustainable Household Scheme. Everyday Climate Choice. [Online]. Available from: https://www.climatechoices.act.gov.au/policy-programs/sustainable-household-scheme

10.3 ENSURE SAFETY BY IMPLEMENTING TECHNICAL AND OPERATIONAL STANDARDS FOR VEHICLES, BATTERY, AND CHARGING INFRASTRUCTURE

Barrier addressed: Convenience

A. Clearly regulate vehicle safety and operational standards, including speed, dimension, and street management

Current condition and challenges

Although there have been regulations on speed limits, parking space, and lane usage, enforcement of those rules are still an issue in Indonesia, especially for motorcycle riders. Motorcycles have the highest crash rate in Indonesia which is largely attributed to overspeeding, often ridden on cycling lanes, and parking on sidewalks. In addition to passenger mobility, motorcycles are commonly used for logistic delivery or as moving sales vehicles and hence often carry overdimensioned containers or goods, which risk their drivers' safety as well as other road users. Motorcycles, including underbone and scooter-type motorcycles with relatively small engine capacity, are also used for long intercity trips. These intercity trips surge especially approaching the Ied, when millions of people go to their home cities for the holiday (the "mudik" tradition). The massive event increase the number of street crashes, in particular those involving motorcycles.

In general, E2&3W are classified into two groups: e-bikes and other E2&3W. According to MOT Regulation No. 45/2020 on Certain Vehicles with Electric Motors, e-bikes with a maximum speed under 25 km/h are classified as a certain vehicle with electric motor. E-scooters, hoverboards, and unicycles also fall into this category.

Meanwhile, based on MOT Regulation No. 86/2020 and No. 44/2020 on Electric Vehicle Type Test, other E2&3W with higher speeds such as electric motorcycles and E3W have the same classification groups as their ICE counterparts (L1, L2, L3, L4, L5). In Indonesia, every vehicle including E2&3W that falls into the L1-5 must pass a vehicle type test before they are allowed to be sold.

Although it seems that the regulations are already comprehensive, they also limit the utilization of e-bikes at cycling lanes and certain areas, and hence the potential of e-bikes to replace polluting ICE 2&3Ws.

Classification	E-bikes	L1	L2	L3	L4	L5
Regulation	MOT Regulation No. 45/2020 on Certain Vehicles with Electric Motors	Government Regulation No. 55/2012 on Vehicles MOT Regulation No. 86/2020 and No. 44/2020 on Electric Vehicle Type Test MOT Regulation No. 30/2020 and No. 33/2018 on Motorized Vehicle Type Test				
Defining characteristics						
Type	2W	2W	3W	2W	3W with asymmetrical wheel configuration	3W with symmetrical wheel configuration
Max. design speed	< 25 km/h	< 50 km/h	< 50 km/h	> 50 km/h	> 50 km/h	> 50 km/h
Cylinder capacity	-	< 50 cc	< 50 cc	> 50 cc	> 50 cc	> 50 cc
Operational regulations						
Allowed operational areas	• Cycle lanes • Designated lanes for e-bikes and other vehicles in the Certain Vehicles with Electric Motors category • Certain areas: residential area, tourism area, office area, area around transit points where the vehicle class is integrated as a first-last mile mode system, and off-roads • Sidewalk with sufficient capacity for pedestrians (only when cycle lanes or designated lanes are not available) • Vehicular lanes (only at car-free day events)	Motorized vehicle lane				
Minimum age	12 years old	17 years old				
Driver license	Not needed	Mandatory				
Helmet obligation	Yes	Yes	Yes	Yes	Yes	Yes
Pillion passenger	Allowed with pillion passenger seat	Allowed				
Technical regulations						
Maximum Dimension	Not specified	Maximum width: 1,300 mm Maximum height for goods: 90 cm above the seat Maximum width for goods: Not exceeding the width of handlebar				
Maximum Vehicle Weight	Not specified	Not specified				
Vehicle type test	Not needed	Mandatory, with testing parameters as follows: Electric accumulator Charging equipment, including waterproofing protection Electrical safety (touch protection), for vehicles that: Have a voltage >60V and < 1500 V DC or Have a voltage >30V and < 1000 V DC or Functional safety Hydrogen emission All vehicle type test parameters applicable for ICE E2&3W specified in MOT Regulation No. 30/2020 and No. 33/2018 on Motorized Vehicle Type Test Further details on the testing parameters can refer to MOT Regulation No. 86/2020 and MOT Regulation No. 44/2020 on Electric Vehicle Type Test				
Acoustic Vehicle Alerting System (AVAS)	Not specified	Not required to have Acoustic Vehicle Alerting System (AVAS)				
Other remarks	Any modification to increase motor power is prohibited	None				

Table 39. Existing E2&3W Classification and Operational Regulation

Best Practices

Clear regulations on how the vehicles should be operated on the streets are the key factors to provide a high level of riding convenience and safety for all road users.

In China, the government has strictly regulated the speed limit of 2Ws, licenses, their dimensions, and parking space.

Government	Motivation on safety	Speed	Maximum Dimension	Maximum Dimension
China	Government banned ICE in 2006 and gradually regulate the adoption of E2Ws. regulating technical and operational safety becomes a high priority to reduce crashes and manageable street.	E-bicycle: 25 km/h Moped: 25 - 50 km/h E-motorcycle: > 50 km/h	**E-bicycle:** • Wide - 45 cm (exclude handlebar and pedal) • Weight - 55 kg **E-Moped:** • Wide - 45 cm (exclude handlebar and pedal)	**E-bicycle:** • Operated on the bike lane **E-Motorcycle:** • Outer most lane according to street speed limit
India	India on FAME 1 and 2 introduces BEV acceleration and simultaneously regulate speed category and dimension in some electric vehicles	E-bicycle: 25 km/h E-motorcycle: 50 km/h E-rickshaw: 25 km/h	**E-rickshaws:** WxLxH - 180 x 280 x 100 cm **E-bicycle:** N/A **E-motorcycle:** N/A	**E-bicycle** • Operated on the bike lane and footpath • Outer mosst lane (varied between state) **E-rickshaw** • Bike lane when available
Singapore	Land Transport Authority introduces speed classes to ensure reasonable street while ensuring the safety to all street users.	E-bicycle: 25 km/h Moped: N/A E-motorcycle: 25 - 50 km/h	**E-bicycle:** N/A **E-moped:** N/A **E-motorcycle:** N/A	**E-bicycle** Operated on the bike lane and footpath

Table 40. Safety regulation upon speed, dimension, and street management

Recommendations

- **MoT should further detail specifications of E2&3W based on the maximum design speed and maximum weight for various category of E2&3Ws**. The classification shall be the basis of determining operational policies. The recommendation is as follows:
  - E2&3W with maximum design speed less than 25km/h can be classified as non-motorized transport and weight less than XX, hence can access cycling lanes and certain sidewalks with sufficient capacity. Other regulations applicable for regular bicycles should also be applicable for this group of E2&3W, such as allowance to be ridden on the left-most side of the vehicular lanes if there is no cycling infrastructure available.
  - E2&3W with maximum design speeds exceeding 25km/h and weight exceeding XX must have vehicle type test certificate, have plate numbers, the driver must have driver's license, and obey other regulations applicable for conventional motorized 2&3W.

- **MT to monitor vehicle market compliance with the standards.** It can ensure the technical components are ensured before the product is put on market sale. All products that do not comply with standards are considered illegal to be sold as it will pose a safety threat to end users.

Table 41. Recommendation 8: Safety regulation

B. Implement Charging Infrastructure Safety Standards

Current condition and challenges

Indonesian government through MoEMR has regulated public charging infrastructure through Regulation No. 13 of 2020. The regulation provisions the installation of public charging infrastructure and is currently no adequate provision about safety during installation & construction, possibility of overcharging, and prevention/correction of a fire accident.

Best Practice

In some countries, the massive adoption of E2&3W leads a enormous demand for off-street charging point in residential particularly apartments, which inherents a serious fire safety hazard. Due to a lack of segregated charging space in residential areas, many people carry their e-bicycle upstairs and charge.

There are national and regional-level regulations enacted where many city may slightly vary but it follows the central-level guidance to achieve safety compliance. Although there is no regulation yet to ban the charging in apartment as a whole, government in China bans people to park and charge their vehicle to be charged their E2W in public hallways, evacuation walkways, stairwells, and safety exits of high-rise civil buildings. In high-rise residential quarter, the government encourages the establishment of a centralized storage and charging facilities for E2W. This report tries to identify the current relevant regulation that ensure safety on E2W specifically for E-bikes.

National Level Policies in China

- Ministry of Public Security on Notice on Standardizing Parking and Charging of Electric Bicycle and Strenghtening Fire Prevention
- Ministry of Emergency Management issued the Fire Safety Management Regulations for high-rise civil buildings
- State Council
  - Notice on Standardizing Parking and Charging of Electric Bicycles and Strengthening Fire Prevention
  - Notice of the Office of the Security Committee of the State Council on The Comprehensive Management of Fire Safety of Electric Bicycles

Regional Level Policies in China

- Various provincial and municipal governments issuance of building code for fire safety of E2W parking and charging places.

Government	Standards/Guidelines	Description	Maximum Dimension
China	• Government Notice No. 1454 of 2015 - Guidelines for Developing Electric Vehicle Charging Infrastructure (2015-2020) • Government Notice No. 1611 of 2016 - Accelerating Residential EV Charging Infrastructure Construction	• With the ambition of accelerating EV adoption, Chinese Government introduced guidelines that provisions specific safety information in national and local level • Various local governments/municipalities also regulate the building (new) requirements to have EV parking spots available.	• National Development and Reform Commission (NDRC) China. • National Standards Committee
Guangxi Zhuang, China	Local Standards for the Zhuang Autonomous Region of Guangxi, 2017	This regulation sets out to provide safety provisions for charging infrastructure and safety regulations, consisting of: 1. Electricity infrastructure and and safety requirements • EV parking dan public charging location (outdoor and indoor) • Parking and charging stations for electric bicycles should be built in conjunction with new public and residents buildings • Safety materials installations 2. Charging installation standard (equipment and charging systemation) 3. Fire safety provision in residentials for parking and charging location	Guangxi Zhuang Autonomous Region Quality and Technical Supervision Bureau
Tianjin, China	Tianjin Local Standard, 2020	Government local standards provide safety provision for charging infrastructure and safety for EV. • Parking location and charging spot must suitable for EV charging standard (the location should be selected) • Once the component installed, should should not be disassembled • The provision to park the EV before charging • Safety standards for battery before charging	Tianjin Municipal Market Supervision and Administration Commission
EU countries	• IEC 61851 - Fall under EU Directive on charging points • IEC 62196 - Fall under EU Directive on cable and connector	The EU standards for the safety of the equipment as well as the end user adopted from international electrotechnical commission.	EU Commission
Singapore	Technical Reference 25 (TR 25: 2022)	This regulation is initially set in 2010 to provide technical provision for charging infrastructure and its safety. The latest version updates are: 1. Electrical safety and general requirements • Classify public charging station and single household charging • Safety installation • Charging points inspection at least three times a year 2. Low-powered and high-powered charging safety standard to avoid electrical overloading 3. Safety standards for battery swapping for motorcycles	LTA Singapore

Table 42. Example of charging infrastructure safety standards for E2&3W

Recommendations

- **MEMR to develop a charging infrastructure technical and safety guideline**, which outlines guidelines on the design, construction, and operational safety of charging infrastructure in residential (home and apartment) and non-residential buildings as well as dedicated facilities. The guideline should include requirements such as the minimum space allocated for EV charging infrastructure based on building type, function, size, and location, electricity connection standards, and hazard prevention, especially fire hazard. The guideline structure can be similar to MEMR's existing technical guideline on gas station establishment or embedded in MEMR Regulation No. 13/2020.
- **MoI to regulate technical standards for charging components.** MoI coordinating with BSN to ensure the SNI of charging infrastructure components such as connector, control device, utility, and charger. This is to avoid safety hazards during the installation and the operation of charging.
- **MoT to further regulate the dedicated parking space for EV vehicles.** Many charging points/ spaces will require alignment with urban street management. MoT can create a provision for the planning of charging points in public on-street and off-street parking. It should also mention the consideration of availability of the power grid to build the points over parking space.
- **MoPWH to regulate technical standards for buildings.** Residential areas, malls, cafe, restaurant that have adequate to employ charging infrastructure should have the standard for fire safety including the placement, emergency access, and structural proof in case of fire.

Table 43. Recommendation 9: Charging infrastructure safety standards

C. Ban Lead Acid Batteries

Current condition and challenges

Currently, there is no specific regulation in Indonesia that bans the use of lead-acid batteries.

Best Practice

Not using lead acid battery due to its harmful substances such as lead and sulphuric acid. Lead has been associated with negative health effects in people, especially in young children, and sulfuric acid is a very corrosive substance.

Government	Tax reduction and exemptions for users	Year
China	Banning lead acid on low-speed electric vehicles (LSEV). LSEVs can only use lithium iron phosphate or ternary lithium batteries[129].	2022
EU Countries	European Chemicals Agency has proposed the inclusion of lead acid battery to no longer in the production. It will be the eleventh list on Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH) authorization list	As soon as possible - ongoing discussion

Table 44. Example of ban lead acid battery schemes for E2&3W

Recommendations

MoI to ban lead acid batteries usage on BEV products. The target should be set clear in which the year will no longer be in the production. The banning can be set progressively so that the market can adapt to shifting in a timely manner and not disrupting the market.
MoEF to ban lead-acid manufacturers and facilitate the shift into LIB. Target should be set clear in which the year will no longer be in production. To facilitate the shift. To ensure the smooth transition, MoEF can hold discussions and establish anti lead-acid campaigns.

Table 45. Recommendation 10: Ban lead acid battery for E2&3W

[129]Hampton, Karen. March, 2021. China Moves To Ban Lead Batteries in LSEVS. Batteries International. [Online]. [Accessed 2022]. Available from: Batteries international

D. Regulate Battery Waste Management

Current condition and challenges

To date, there is no regulation on battery waste management specifically from BEV products in Indonesia.

Best Practice

The number of BEV is increasing yearly, the battery end-of-life should be regulated. In developed countries or those who are advanced in the BEV, they are concerned about the dangerous state of battery when it reaches the particular the end of the lifecycle. Waste management such as disposal, reuse and recycling are strictly monitored.

Government	Description	Institution
China	In 2018 government made automakers responsible for the battery recycling. China selected 17 cities and regions to launch a pilot. Cities should collaborate with automakers, as well as battery OEMs and scrap dealers.	Ministry of Industry and IT and Local Government
USA	• Have regulated medium and large-scale battery disposal. Consumers are instructed to contact the automobile dealer or battery OEMs. • EPA has initiated industry groups to create "Avoid the spart. Be Battery Safety Smart" campaign	United States Environmental Agency
EU Countries	Latest revise in 2013, EU has an existing Battries Directive (Directive 2006/66/EC), that regulates and requires a separate collection of EV batteries. Battery producers are made responsible for the collection and recycling of the batteries when they become waste In 2020 proposed, a new Batteries Regulation to replace the existing battery directive, which eventually should make the battery be recycled in full by 2030. It will also facilitate the second-life usage of EV batteries for the use of energy storage or integration into electricity grid	European Parliament and Of The Council
Korea	• Battery producers are made responsible for the • Delegates the Korea Environment Corporation (KECO) for the operation of four EV battery collection centres across the country	Ministry of Environment Korea

Table 46. Example of regulation of battery waste management for electrical vehicles

Recommendations

- **Cross ministries including MoEF, MoI, and MoEMR to create the regulation of battery recycle.** The regulation should require OEMs to provide technical procedure for battery handling & disposal to general public and to companies specializing in in battery recycling
- **MoEF to set standards regarding the collection, logistics, and recycling infrastructure.** Based on safety standards and environmental protection directive, OEMs and recycling companies should banned from landfill disposal of battery and its harmful components. To be legally operating on waste management, they should obtain permit from MoEF.
- **MoI to regulate the data sharing for battery information to be used by the second-hand party.** It is not uncommon for the battery to be used for second-hand use such as powering other devices and used as an energy storage. In most cases, it is hard to judge the condition of the battery which can only be done by unlocking the working data (charging cycle, health, etc). The regulation of data sharing for further use of the BEV retired battery should be regulated.

Table 47. Recommendation 11: Regulation of battery waste management

10.4 MAKE RIDING E2&3W MORE CONVENIENT THAN ICE 2&3W

Barrier addressed: Performance (limited performance compared to ICE 2&3W)

A. Improve fuel economy standard and establish Low Emission Zones/Zero Emission Zones

Current condition and challenges

2&3W in Indonesia enjoys unparalleled mobility flexibility and convenience since it can access most roads, including narrow alleys or residential streets. However, they are also causing externalities such as excessive sound and air pollution. The lax fuel emission standards for 2&3W in Indonesia, which is still kept at Euro 3 for new motorcycles greater than 50 cc since 2015 and Euro 2 for 3W[130], factor to the air pollution caused by the vehicles. Meanwhile, disincentives for ICE vehicles, which can accelerate the compliance for more stringent fuel emission standards, including road access restriction such as low emission zones or zero emission zones are also very scarce.

Best Practices

Government	Measures	Description	Implementing Institution
Singapore	Singapore Environmental Zones	• Will be introduced in 2023 • Motorbikes registered before 2003 will not be allowed to drive in Singapore by 2028 • Newly registered motorbikes should comply to Euro 4 fuel standard with maximum sound of 77 dB from April 2023	Ministry of Sustainability and the Environment
London, UK	Low emission zones (LEZ) and Ulra Low emission zones (ULEZ)	• Introduced in 2008 • Includes motorcycles, mopeds, motorised tricycles, and quadriclces • All vehicles must need to meet Euro 3 emission standards for NOx • Motorcycles is charged £12.50. Penalty: £160 (reduced to £80 if paid within 14 days) • Provide emission testing facility • Encourage users to use vehicle that meet standards and use public transport rather than pay a daily charge	TFL London

Table 48. Example of improving fuel economy standard for LEZ and ZEZ

Recommendations

- **MoEF to set a more stringent fuel emission standards** for 2&3W and the implementation year
- **MoT to roll out vehicle restriction policies for LEZ/ZEZ implementation guideline in cities**, for example the list of vehicles that do not meet the emission standard such as two-stroke engine, diesel engine, etc. In contrast, create an exemption for E2&3W. Also develop criteria to consider cities/areas/roads that are eligible to be sanctioned
- **MoT to coordinate with MPWH that have established LEZ/ZEZ in several old towns in various cities and at regional level, the Municipality (Transport Agency, Environment Agency, and Public Works Agency)** that further determine the LEZ/ZEZ area.
- **Local governments to create LEZ/ZEZ implementation plans**, which include implementation area and implementation phases.

Table 49. Recommendation 12: Improving fuel economy standard for LEZ and ZEZ

[130]Ministry of Environment and Forestry. 2018. Indonesia: Motorcycles; Emissions. TransPolicy.net. [Online]. [Accessed 2022]. Available from: Standard Indonesia Motorcycle

B. Offer exemptions from road access restrictions

Current condition and challenges

In addition to LEZ/ZEZ, push strategies in Traffic demand management (TDM) that restrict certain vehicle from accessing certain roads include odd-even policy and congestion charge. There have been implementation of odd-even policies in particular in big cities in Indonesia and congestion charges are being planned in two major cities according to the MOT's Strategic Plan, although are mainly implemented to address traffic congestion issues.

Best Practices

Government	TDM Measures	Description	Implementing Institution
Singapore	Singapore Environmental Zones	• Allows electric motorcycle and scooter to pass the environmental zone	Ministry of Sustainability and the Environment
London, UK	Low emission zones (LEZ) and Ulra Low emission zones (ULEZ)	• EV are exempted from LEZ/ULEZ. • The regulation will be abolished by 2025	TFL London
Oslo, Norway	Congestion charges	• EV are exempted from congestion charges • The exemption will be abolished by 2023	Oslo Municipality and *Fjellinjen*

Table 50. Example of road access restrictions

Recommendations

- **Local government to exempt E2&3W from road access restriction policies**, such as odd-even policy and road charging
- **The exemption period should have a clear limit, for example until 2030 when the E2&3W uptake has been sufficient.** This should be done to prevent the E2&3W causing too much traffic in the longer run.

Table 51. Recommendation 13: Road access restrictions

10.5 INCENTIVIZE INDUSTRY PLAYERS TO PROVIDE HIGH-PERFORMANCE MODELS

Barrier addressed: Performance (limited performance compared to ICE 2&3W)

A. Carefully design purchase price subsidy and industry incentives to drive production of high-performance models

Current condition and challenges

There is no purchase price subsidy available for E2&3W. As for industry fiscal incentive eligibility, the MOI Regulation No. 6/2022 on Specification, Roadmap, and Domestic Component Requirement (TKDN) Calculation of BEV sets the following requirements for E2&3W industries:

- The E2&3W has a minimum battery capacity of 1.3 kWh
- Fulfils the minimum domestic component requirement (TKDN) rate as stipulated in the BEV roadmap

There is no other technical requirement for the incentives. Additionally, given the minimum battery capacity requirement of 1.3 kWh, most e-bike industries are not eligible for fiscal incentives. As presented in Table 52, the current e-bike models produced in Indonesia have battery capacities between 0.3 - 0.96 kWh.

Best practice

BEV subsidy schemes in India and China include a set of vehicle technical requirements for the vehicle manufacturers to be eligible for the scheme.

Government	Scheme	Description
India	FAME II	For e-motorcycles: • Top speed > 40 km/h • Motor power > 250W • Range > 80 km in a single charge • Maximum energy consumption: 8 kWh/100km • Acceleration > 0.65m/s2 • Must have sufficient domestic component rate • • Must have type test certification
China	Fiscal Subsidies for Promoting New Energy Vehicles (NEVs)	For passenger car (battery electric): • Top speed > 100 km/h • Range > 300 km in a single charge • Battery energy density > 125 Wh/kg • Maximum energy consumption (as a function to curb mass)

Table 52. Example of technical requirements for BEV manufacturers

Recommendations

- **A technology improvement roadmap should be developed jointly by MOI, MOT, and BRIN, that specifies how the requirements shall improve over the years.** To develop the roadmap, MOI and MOT should engage with industry players to ensure that the thresholds are feasible to be achieved by them, yet also are stringent enough to push performance competitiveness and safety.
- **Vehicle purchase subsidies and fiscal incentives for industry players should be designed to stimulate the E2&3W industries to produce better performing and safe vehicles.** MOF, MOI, and MOT should coordinate in designing the scheme.
- **The MOI Regulation No. 6/2022 should be amended** to include the requirements above, annul the battery capacity requirement since the "minimum range" requirement better conveys the push for better-performing vehicles, and ensure e-bikes manufacturers are eligible for incentive schemes.

Table 53. Recommendation 14: Technical requirements for BEV manufacturers

In addition to minimum TKDN, other requirements that should be included in vehicle purchase subsidy and fiscal incentives eligibility designs are:

- Minimum range (km), to improve performance compared to ICE
  - This aspect can differ between E2&3W segments (e.g. e-motorcycle, e-bikes)
- Minimum battery energy density (Wh/kg), to improve battery performance
- Maximum energy consumption (kWh/100km), to improve fuel efficiency
- Compliance with safety standards
- Top speed range (maximum and minimum km/h) instead of only minimum top speed, to improve performance while also improving road safety by regulating the speed
  - For e-bikes, a maximum top speed of 25 km/h should be set to be able to safely use cycling lanes
  - For other E2&3W, a maximum top speed of 50 km/h should be set to comply with the maximum speed allowed at urban roads

B. Set public fleet procurement requirements

Current condition and challenges

The CMMAI is developing targets for electric fleets procurement by the national government. Several BEVs, including E2&3W models, have been listed on the government's procurement website and thus are readily available for procurement.

Best practice

Using electric fleets as government fleets can reduce operational and maintenance costs, as well as create a massive demand that can stimulate BEV production and shape the domestic market.

Recommendations

- **LKPP should ensure that any E2&3W and other BEVs listed in the government procurement website comply with a set of requirements** based on a national technology improvement roadmap (see Table 53).
- In the case when the roadmap is not yet available, **the MOI, MOT, and BRIN should develop a set of minimum performance and safety requirements** for the government fleets.

Table 54. Recommendation 15: Public fleets procurement requirements for E2&3W

C. Provide incentives or programs for research and developments and capacity building

Current condition and challenges

BRIN and the MECRT are mandated to conduct researches on battery, charging infrastructure, and electric motor development. Funds for the research and development activities have been allocated for BRIN in the RPJMN, albeit still very limited.

The Presidential Regulation No. 55/2019 has included R&D activities as one of the industry activities eligible for fiscal incentives, yet no derivative regulation has been issued for the mechanism.

Best practice

India's FAME I scheme dedicated USD 24 million to support R&D activities, in order to advance the country's domestic EV industry. An R&D working group, comprising of 40 researchers and industry professionals is established to oversee the R&D programs.

Recommendations

- **MECRT and BRIN should jointly develop and establish a flagship R&D program** that foster collaborations with the industry players, in addition to academia
- **MECRT and BRIN to allocate funds for patent transfer of crucial technologies** needed for BEV industry development
- **MECRT, BRIN, and MOI should establish a research council**, that should include members from the industry, researchers, and the public sector. The council can be part of the current research council of electric cars ("Molina" or "Mobil Listrik Nasional") which comprises several universities.
- **CMOE and the MOL, coordinating with MOI, can offer industry skill training programs** to improve domestic labor skills

Table 55. Recommendation 16: Provide incentives or programs for R&D

The flagship R&D program, which should be led and developed by MECRT and BRIN, can include:

- Providing research grants that are eligible for both industry players and academia
- Providing start-up funds for startups working on BEV research and development projects.
- Developing mechanisms and eligibility requirements for fiscal incentives (developed in coordination with MOF) for industries that conduct R&D
- Establishing technology incubator centers
- Facilitating skill sharing events between industry players and academic researchers

The skill training program, where the CMOE and MOL can take the lead role and coordinate with MOI on the industrial skill needs, can be:

- Training program organized by industry players. The government then provides partial reimbursement of companies' expenses related to skill training, including BEV, battery, and charger maintenance, repairment, and other relevant skill sets. The reimbursement scheme can be made available to incentivize institutions to improve their employees' capabilities.
- Training courses centrally organized by the government. The program can be embedded into the existing Work Preparatory Card ("Kartu Prakerja") program or the MOL's existing training program.

10.6 ELIMINATE RANGE ANXIETY BY IMPROVING ACCESS TO CHARGING INFRASTRUCTURE

A. Set national-level vision and city-level targets for charging infrastructure provision

Current condition and challenges

At the national level, there has not been any targets yet on charging infrastructure provision, and hence the absence of derivative policies at the city-level. The lack of city-level target for charging infrastructure provision translates to the lack of local-level programs to improve charging infrastructure availability. Meanwhile, an EV penetration modeling study in Indonesia has predicted that achieving a ratio of 16 charging stations per vehicle could triple passenger car BEV market share[131]. In addition, the study also suggested that before price parity is reached, tax exemption measures will fail to kickstart electric motorcycle penetration without widespread provision of public charging stations. Ease of access to public and workplace charging or battery-swapping stations, in addition to residential chargers, is crucial to eliminate users' range anxiety, which is a major barrier of EV uptake in Indonesia[132].

Best practice

In many cities, city-level targets are also set for charging infrastructure provision in addition to the electric vehicle uptake itself. The targets serve as guide for the municipalities to form incentives and programs to improve charging infrastructure availability. Studies in EV leading cities in the US, Europe, and China have shown that sufficient provision of charging infrastructure is a major driving force of EV uptake[133].

As a rule of thumb, a ratio of 1 public charging station per 10 electric vehicles is recommended[134], although the number can vary based on the availability of private home chargers in the city. The charging infrastructure target can be based on absolute numbers of chargers, chargers to EV ratio, chargers per square kilometer, or chargers per kilometer of road[135].

[131]IESR (2020)
[132]Solidiance (2018)
[133]ICCT (2017); ICCT (2018); ICCT (2020); Kim & Heo (2019); Sierzchula et al. (2014)
[134]Zorzoană, I. A. (2019).The Activity Of Transposing Directive 2014/94/EU Of The European Parliament And Council Of 22 October 2014 On The Deployment Of Alternative Fuels Infrastructure. The Post-Transposing Attributions Of The Romanian Energy Regulatory Authority. Challenges of the Knowledge Society, 855-861.
[135]ICCT (2019)

The table below shows charging infrastructure targets in several countries and cities[136]:

Government	Charging Infrastructure Provision Target	Source	Year Issued	Regulator
Country Level				
China	• 88 pilot cities are required to provide 1 charging station per 8 EVs, and should be able to be accessed within 1 kilometer from any given point in the city center area • Other cities are required to provide 1 charging station per 15 EVs	Guide to the development of electric vehicle charging infrastructure 2015-2020[137]	2014	Chinese Ministry of Industry and Information Technology and Ministry of Housing and Urban-Rural Development
France	• 7 million public and private charging points for electric vehicles by 2030 • One charging station per 10 electric vehicles	• French Law no 2015-992 of 17 August 2015, "Law on Energy Transition for Green Growth" (LTECV) • Contrat stratégique de la filière Automobile 2018-2022 (Auto sector strategic contract 2018-2022)[138]	2015	French Ministry of Sustainable Development
Germany	1 million public chargers by 2030	Masterplan Ladeinfrastruktur der Bundesregierung (Masterplan for charging infrastructure for the Federal Government)[139]	2019	Federal Ministry of Economics and Technology
City or State Level				
Delhi	Providing accessible public charging facilities within 3 km travel from anywhere in Delhi	Delhi Electric Vehicle Policy[140]	2020	Government of National Capital Territory of Delhi
Hainan	• One public charging station per 7 electric vehicles by 2025 • By 2025, the average service radius of the charging network in key leading areas will be less than 1 km, the priority development area will be less than 3 km, and the area will be actively promoted to be less than 5 km	Hainan Province Clean Energy Vehicle Development Plan[141]	2018	Hainan Provincial People's Government

Table 56. Example of charging infrastructure schemes target

[136]ICCT (2017); SLOCAT (2020)
[137]National Development and Reform Commission. (October 2015). The issuance of "Electric Vehicle Charging Infrastructure" Notice of Development Guidelines (2015-2020). [Online]. [Accessed 2022]. Available from: https://www.ndrc.gov.cn/xxgk/zcfb/tz/201511/t20151117_963500.html?code=&state=123
[138]Francois, H., Manuel, V., Segolene, R., & Sylvia, P. (2015). Law nr 2015-992 of the August 17, 2015 related to energy transition for a green growth.
[139]German Federal Government. Master Plan Charging Infrastructure. Goals and measures for charging infrastructure development by 2030. [Online]. [Accessed 2022]. Available from: https://www.bmvi.de/SharedDocs/DE/Anlage/G/masterplan-ladeinfrastruktur.pdf?__blob=publicationFile
[140]Seth, Jyoti. (2020). Delhi Electric Vehicles Policy. Government of National Capital Territory of Delhi (Transport Department). [Online]. [Accessed 2022]. Available from: https://transport.delhi.gov.in/sites/default/files/All-PDF/Delhi_Electric_Vehicles_Policy_2020.pdf
[141]Hainan Government. 2019. Hainan Province Clean Energy Vehicle Development Plan. [Online]. [Accessed 2022]. Available from: https://www.hainan.gov.cn/hainan/xnyzcwj/201907/cb9368c30a0f42e7a4cae7dad6651a09.shtml

Recommendations

- **The CMMIA and MEMR should lead the development of a national charging infrastructure roadmap including private, semi-private, and public plug-in and battery swap stations,** which should align with BEV adoption target and roadmaps. The roadmap should include:
  - List of priority cities for the provision
  - Target number of charging infrastructure, based on charger-EV ratio or maximum distance between charging infrastructure. This target can vary between priority cities and non-priority cities
  - Guideline for determining priority locations to be provided charging infrastructure from the municipalities
  - Supporting national level policies and policy guideline for the local-level governments
- **The targets should be accompanied by budgetary commitments** to drive the market, thus sending a positive signal to the private sector to take action. After the national target is set, the regional governments can follow by developing city-level plans.

Table 57. Recommendation 17: Charging infrastructure target

B. Offer fiscal support for charging infrastructure provision

Current condition and challenges

According to McKinsey (2021)[142] the hidden cost of charging infrastructure installation such as civil engineering and construction, grid updates, and electrical installations and othe onsite upgrades comprise 50-70% of the total cost of the installation.

Through the MEMR Regulation No. 13/2020 on Charging Infrastructure Provision, MEMR has provided a Business Entity Bulk Tariff Incentive of IDR 714 per kilo Watt Hour (kWh) for charging business entities for resale with a special service rate up to IDR IDR 2,475/kWh. In addition to the incentive, PLN as the sole electricity provider in Indonesia that is given mandate to initiate charging infrastructure provision offers:

- Reduction of Connection Fees or Subscription Guarantees as well as Minimum Account Exemption for the first two years for Public Charging Infrastructure Business Entities and owners of Private Electrical Installations used for Charging Public Transportation
- Incentives for connection fees as follows: Rp. 150,000 for additional power up to s.d. 11,000 VA (1 Phase) and Rp. 450,000, - for additional power up to s.d. 16,000 VA (3 Phase)
- Home Charging Tariff Incentive in the form of a tariff reduction of 30% outside of Peak Load Time, which is 22.00 - 05.00, when the majority of BEV owners charge at home.

[142]Hoover, Z. Nägele, F. Polymeneas, E., & Sahdev, S. (2021). Electric Power & Natural Gas: How charging in buildings can power up the electric-vehicle industry. McKinsey & Company. [Online]. [Accessed 2022]. Available from: How Charging in Buildings

Best practice

Some examples of charging infrastructure programs which include fiscal incentives and subsidies are:

Government	Type of incentive	Source	Implementation Year	Budget
Country Level				
Canada[143]	Public charger subsidy	Up to 50% project cost reimbursement for Level 2 and fast chargers, to a maximum of CAD 2 million per project	2019 - 2024	CAD 130 million / IDR 1.4 trillion
India	Private charger for public transport	Fund one slow charger per electric bus and one fast charger for every 10 electric buses	2019-2022	INR 10 billion/ IDR 2 trillion
Germany[144]	Private charger subsidy	10-30% subsidy for private charger purchase and installation	2019-2030	EUR 2.5 billion / IDR 43 trillion[145] (include budget for EV and battery R&D)
	Public charger subsidy	Up to €3,000 for purchasing charging stations of up to 22 kW. Up to €12,000 for purchasing DC chargers up to 100 kW. Up to €30,000 for purchasing DC chargers above 100 kW. Up to €5,000 for low voltage and up to €50,000 for medium voltage grid connections		
City or State Level				
California[146]	Charger subsidy	Up to $7,500 per Level 2 charger, up to $80,000 per DC fast charger	Ongoing	USD 71 million[147] / IDR 1 trillion
Delhi	Private charger subsidy	100% grant (up to INR6,000/IDR 1.2 million per charging point) for the first 30,000 shared charging points in housing complexes or multistory apartments	2020 - ongoing	Unknown
	Private charger subsidy	Provision of a capital subsidy for the cost of chargers installation expenses for mandated energy operators		
	Electricity tariff	Preferential tariff for public and captive charging stations for commercial use (i.e. charging facilities used by fleet owners) and private chargers that are BEVC-AC001 compliant and are connected to the Central Management System (CMS)		
Linyi	Private charger subsidy	CNY 3,600/IDR 7.8 million subsidy for home charger installation	2015	Unknown
Shenzhen[148]	Charger subsidy	CNY 400/KW for DC charging facilities, CNY 200/KW for AC chargers over 40 kW and CNY 100/kW (USD 15) for AC chargers under 40 kW	2019	Unknown

Table 58. Example of charging infrastructure programs schemes

[143]Government of Canada. (July, 2022). Zero Emission Vehicle Infrastructure Program. [Online]. Available from: nrcan.gc.ga
[144]The Walbox Team. (June, 2021). EV and EV Charging Incentives in Germany: A Complete Guide. EVOLVE. [Online]. [Accessed 2022]. Available from: Wallbox.com
[145]Germany Federal Ministry of Finance. (June 2020). Emerging From the Crisis With Full Strength. Bundesministerium der Finanzen. [Online]. [Accessed 2022]. Available from: https://www.bundesfinanzministerium.de/Content/EN/Standardartikel/Topics/Public-Finances/Articles/2020-06-04- fiscal-package.html
[146]California Clean Vehicle Rebate Project. 2022. Electric Vehicle Charging Overview: Clean Vehicle Rebate Project. Cleanvehiclerebate.org. [Online]. Available from: https://cleanvehiclerebate.org/eng/ev/technology/fueling/electric
[147]CSE for the California Energy Commission. About CALeVIP: CALeVIP. [Online]. [Accessed 2022]. Available from: https://calevip.org/about-calevip
[148]IEA (2020)

Recommendations

- **The MEMR coordinates with MOF to develop subsidy program for both private and public charging infrastructure**
  - The program can be rolled out by PLN
  - The program should align with the national charging infrastructure roadmap
  - The subsidy amount should be differentiated based on the charging infrastructure type (Level 1, level 2, DC fast charging) and should be designed to ensure compliance of charging infrastructure to safety standards
  - The subsidy should also consider the hidden costs of charging infrastructure installation, such as electricity grid updates, civil works, and additional electrical installations.

- **The MEMR coordinates with MOF to develop fiscal support policies** for public charging infrastructure provision, such as:
  - Preferential loan offer for operators
  - Tax holidays and allowance for operators
  - Import duty exemptions for suppliers
  - Land and building tax exemption for operators for a limited period for charging infrastructure

Table 59. Recommendation 18: Charging infrastructure programs

C. Update building codes to facilitate charging infrastructure provision in buildings

Current condition and challenges

The current building and parking codes, both at the national and local levels, have not included mandatory provision for charging infrastructure nor any guideline for the provision in buildings. While private charging at homes can be more easily installed, there is a potential permit challenge for semi-private and public charging infrastructure installations in apartments, offices, or other public buildings given the unclear regulation of charging infrastructure provision in buildings.

Best practice

Cities are including charging infrastructure provision requirements in their building parking regulations. The International Energy Agency (IEA) published a report stating the need for policies to support updating building codes to promote EV readiness. An “EV-Ready” building is one that has the necessary wiring and electrical capacity to sustain the future installation of EV charging stations. Countries and localities are working on implementing these code changes. For example, Iceland plans to update building codes so they require charging outlets for EVs in new and renovated buildings.

One of the arguments surrounding “EV-Ready” codes is that in existing buildings, adding wiring to deliver electricity to a parking stall represents over half of the cost of installing an electric vehicle charger. Therefore, installing the necessary infrastructure components at the time of building construction prevents the need for post-hoc trenching and repaving or increasing the electric capacity.

Government	Requirement
Singapore	All new buildings with carparks will have to install electric vehicle (EV) charging points in at least 1% of their total car and motorcycle parking lots in future, and have to provide sufficient electrical load to support EV charging with 7.4 kilowatt chargers for 15 per cent of the total parking spaces (upcoming LTA regulation)[149].

Guangzhou, China	• New residential building
	  • New public buildings and residential buildings should be built at the same time as electric bicycle parking and charging places, and the area should be in line with the local planning and administrative department
	  • Set aside at least 18% parking spots for future charging point construction and installation
	  • Building should comply with fire safety standard that including:
	  • GB 13495.1 Fire safety signs Part 1: Signs
	  • GB 17945 Fire emergency lighting and evacuation indication system
	  • GB 20517 Independent fire detector alarm
	  • GB 50016 Fire protection Specification for Architectural Design
	  • GB 50067 Fire protection specification for the design of car garages, repair garages, and parking lots
	  • GB 50084 Automatic sprinkler system design specification
	  • GB 50116 Automatic fire alarm system design specification
	  • GB 50140 Building fire extinguisher configuration design specification
	  • GB 50974 Fire water supply and fire hydrant system

UK	• Existing residential building (more than 10 parking spaces)
	  • Installation of one chargepoint
	  • Installation of cable route extension at each five parking space
	• Existing Non-residential building (more than 10 parking spaces)
	  • Installation of one chargepoint
	  • Installation of cable route extension at each five parking space
	• Existing (large) Non-residential (more than 20 parking spaces)
	  • Installation of at least one chargepoint by 2025
	
	The fire safety provision has been regulated in UK Fire Safety (England) Regulations 2022 which risk of EV are already included

Denver, USA	• New Family home
	  • Single unit - at least one EV-ready space per dwelling unit
	  • Multi unit - at least 5% for EV space, 15% to be EV-ready, and 80% for EV-capable
	  • New commercial buildings
	• At least 5% for EV-space

Table 60. Example of installation of components to facilitate charging infrastructure provision

Recommendations

- **MPWH to update building code guideline in MPWH Regulation No. 29/2006 to include guidelines on EV charging infrastructure provisions and update grid connection requirement to make residential and non-residential buildings "EV-ready"**
  - The building code shall refer to MEMR's technical guideline on charging infrastructure establishment (See Box XX) and include adjustments in the MEL and minimum grid connection requirements to ensure the new developments are "EV ready"
  - New developments and renovations should adhere to the new building code, hence ensuring safe and adequate provision of charging infrastructure in both residential and non-residential buildings
  - EV charging infrastructure shall be allowed on existing buildings with or without the request from dwellers, given its compliance to the technical guideline on charging infrastructure.
- **Local governments, in particular Local Investment and Permit Agency (DPMPTSP) and Public Works Agency to update local building permits accordingly** to ensure safe and adequate provision of charging infrastructure in buildings

Table 61. Recommendation 19: installation of components to facilitate charging infrastructure provision

[149]Tjoe, Lee Nian. (June, 2022). All new buildings could have to install EV chargers in their carparks under proposed laws. AsiaOne. [Online]. [Accessed 2022]. Available from: AsiaOne Singapore

D. Allow government assets to be used as charging infrastructure locations

Current condition and challenges

Access to land and parking space to install charging infrastructure, especially public charging infrastructure, can be a significant barrier for charging operators. The scarcity of land and building spaces in city centers, where most of the public charging stations are expected to be located, will drive land acquisition costs sky-high without any intervention from the government.

The MOF Regulation No. 115/PMK.06/2020 has allowed utilization of government land and building assets by the private sector to reduce idle assets. The policy opens opportunities for public charging infrastructure operators to access the spaces.

Best practice

Table 62. Delhi public charging infrastructure scheme

Government	Policy	Implementing Institution
Delhi, India	All departments under Delhi municipality must install semi-private or public charging infrastructure in their premises. A subsidy is available for the installation costs under the Transport Deparntment's EV fund[150].	Transportation Department of Delhi

Recommendations

Table 63. Recommendation 20: Public charging infrastructure

- **CMMIA mandates several national institutions to install public or semi-private charging infrastructure in their premises.** The provision of charging infrastructure can be a collaboration between the institutions and PLN or other private entities in charging infrastructure provision business.
- **The local Investment and Permit Agency (DPMPTSP) coordinates with the local Public Works Agency, Transport Agency, and Finance and Asset Bureau to streamline the procedure to enable the utilization of local government assets** i.e. vacant land, parking spaces in buildings, or even on-street parking spaces for public charging infrastructure.
- **The local DPMPTSP coordinates with Finance and Asset Bureau** to offer concessional rates for the land lease for public charging infrastructure.

E. Introduce battery swap station standardization in consultation with the industry players

Current condition and challenges

Battery swap charging system offers a major benefit in terms of convenience for E2&3W users, since by swapping batteries their vehicles can be instantly "recharged" as opposed to plug in stations where it can take several hours to recharge. The business model also allows the decoupling of batteries with the vehicles ("Battery as a Service"/BaaS) which can reduce the capital cost of E2&3W.

There is no standard set yet for battery dimension and charging interface for battery swap stations. Hence, the compatibility of different E2&3W models to battery swap stations is limited.

[150]Livemint. (February, 2022). Delhi govt to build electric vehicle charging stations at all state-run offices. Mint. [Online]. [Accessed 2022]. Available from: Livemint

Battery swap provider	Compatible E2&3W brands
Swap.id	Smoot
Gogoro	GESITS, Gogoro
Oyika	Oyika, Selis
Ezyfast	Viar
Volta (SGB)	Volta
Kymco	Kymco

Best Practice

Country	Policy/Initiative
India	In developing battery swapping policies and standards, Niti Aayog as the national planning institution of India conducted a public consultation period. The consultation process resulted in five key requirements for the policy framework: 1. Given the nascency of our battery-swapping market, policy measures should facilitate the phased development of a swapping ecosystem that is linked to the EV market's stage of maturity 2. The policy must take a targeted approach, identifying priority vehicle segments and enabling an accelerated adoption of swapping solutions in those segments where battery swapping could have the most value. 3. The policy must find a balance between standardization and encouraging innovation. 4. The policy should provide equitable growth opportunities for multiple technologies, solutions and business models, and let the market pick the winner among these. 5. The policy must offer flexibility to various stakeholders, including state governments, to devise battery-swapping ecosystem development strategies that are best suited to their needs.
Japan	Four major motorcycle manufacturers (Honda, Suzuki, Yamaha, and Kawasaki) have agreed on common specifications for swappable batteries according to the JASO TP21003 guideline. The big four manufacturers with Eneos, an energy company, also formed a joint venture "Gachaco" to offer a sharing service for standardised exchangeable batteries of electric two wheelers utilizing the Honda Mobile Power Pack (MPP)[151] and corresponding infrastructure[152].

Recommendations

- **CMMIA to lead the development of battery swap ecosystem in Indonesian cities**, given battery swapping stations' strategic role to accelerate E2&3W uptake
  - The initiative should proactively involve battery swap and battery industry players
  - The initiative should aim to promote interoperability between battery providers and ensure the safety of battery and swap station usage
- **MEMR to develop further policies and standardization on battery swapping system soon, which should focus on fundamental safety and performance requirements**

Table 64. Recommendation 21: Develop battery swap system and introduce battery swap station standardization

[151]Honda. (2018). International Consumer Electronic Show. [Online]. Accessed on 14/09/2022 from: https://global.honda/innovation/CES/2018/005.html
[152]Electrive. (2022). Gachao Battery Swapping Service Launched by Japanes Bike Manufacturers. [Online]. Accessed online on 14/09/2022 from: https://www.electrive.com/2022/03/30/gachaco-battery-swapping-service-launched-by-japanese-bike-manufacturers/

The fundamental safety and performance requirements for battery swap standards should include:

PERFORMANCE REQUIREMENTS	• The batteries should enable Battery Management System (BMS) to reduce risks of thermal runaway and other battery performance issues • A minimum battery cell requirement (e.g. Advanced Chemical Cell/ACC) should be stipulated
PERFORMANCE MONITORING REQUIREMENTS	• The batteries should be equipped with remote monitoring and control system (IoT based system) • Battery manufacturers should monitor and store the performance and usage data of each battery as well as ensure the traceability of each battery, which can be done by establishing a unique battery identification system • Specified performance data should be able to be accessed by authorized government institutions
SAFETY	• Every battery and swapping station infrastructure should be tested and approved by authorized institutions
DATA SHARING AND COMMUNICATION	• Open standard communication protocol to allow backend interoperability • A list of data which should be able to be shared among battery providers to improve information exchange on battery health and performance

10.7 ESTABLISH PUBLIC CAMPAIGN PROGRAMS TO MAINSTREAM E2&3W INFORMATION

Barrier addressed: Awareness (low public awareness)

A. Develop an accessible one-stop informational website in collaboration with industry players

Current condition and challenges

Although various ministries through BEV task force have created initiatives to accelerate the adoption of BEV in Indonesia, there is currently no one single platform that gather all fundamental information to the public to raise awareness about the regulation, incentives, and importantly connect the manufacturers and users.

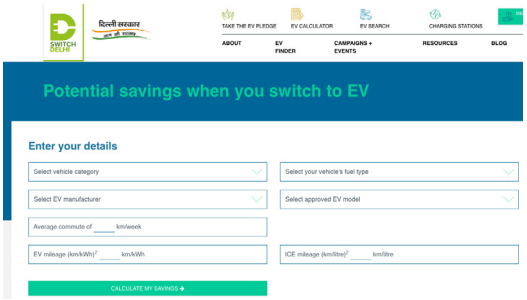


Figure 40. The cost-benefit of Motorcycle Electrification (Source: ev.delhi.gov.in)

Figure 41. Snapshot of EV product's real-time incentive database by Ministry of Heavy Industries India (Source: fame2.heavyindustries.gov.id)

Government	Feature	Implementing Institution

Delhi, India	Website: ev.delhi.gov.in (Switch Delhi)
	
	An online platform developed by Delhi government to facilitate exchange of information for customers, industry players, and government.
	
	• Provides information regarding
	  • Connects EV buyers and manufacturers
	  • Charging infrastructure development, charging points, and equipments
	  • Circulars and notifications issued by Delhi Government
	• EV calculator that is able to:
	  • Compare fuel/energy consumption of ICE and EV
	  • Calculate money saved of shifting vehicle
	  • Calculate maintenance and operation cost of EV
	• Grievance reporting:
	  • Customer can send email about EV related issues or complaints to Delhi Government
		Delhi Municipality

India	Website: https://fame2.heavyindustries.gov.in/
	
	As part of faster adoption of EV in India, the national government has created a website that connects OEMs and helps end-users to keep updated about FAME II scheme. The following are major feature on the website:
	• Information provided:
	  • Circulars and notification issued by Government
	  • Press release
	  • EV related manuals and tutorials
	• Policy
	  • Policy documents - for OEMs and users to keep track of specific enacted regulations
	  • Policy procedure - for OEMs and users to apply incentives
	• Scheme
	  • Models - list E2W, E3W, and E4W products that are eligible for incentives. The table provides information including model, variant, vehicle type, incentive amount, incentive status, and details.
	  • OEM and dealers information database
		Ministry of Heavy Industries and National Automotive Board

Table 65. Example of an informational website scheme to improve public campaign for E2&3W

Recommendations

- **BEV task force to create a national website that provides one-stop information for both customers and manufacturers** including information on E2&3W and other BEV products available in the domestic market, charging infrastructure locations, information on available incentives and other regulations concerning BEV, economic comparison of ICE & EV, FAQ page, as well as a central contact point for the public to communicate feedbacks or complaints.
- **The MEMR should be tasked in maintaining the website's updated information**, by coordinating with MOT, MOI, and industry players

Table 66. Recommendation 22: Websites to improve public campaign for E2&3W

Even in leading regions, many people remain unaware or misinformed regarding BEVs. A single information hub by the national government should be made accessible, compiling information from different ministries and other institutions involved. Some useful information which should be presented in the website includes:

- Benefits of BEVs compared to ICE vehicles
- Incentives available, including the steps to apply and eligibility requirements (if any), for:
  - End-users (private users and fleet owners)
  - Investors
  - OEMs
- Government's existing policies, plans and programs on accelerating BEV adoption, to provide a sense of assurance for potential users to procure BEVs
- Available BEV models and their specifications
- Map and real-time availability of charging stations
- GHG emissions reductions and other environmental benefits achieved by BEV deployment in the area. The data can be gathered by tracking the mileage of each EV deployed in the country. India's FAME website[153] can provide a good example of a government EV website which highlights the environmental objective achievements of EV programs deployed.
- Other frequently asked questions, for example how BEVs operate, how to plug in BEVs to chargers, the option to charge BEVs at home, safety concerns of short circuits in the event of floods and range anxiety during traffic jams, etc.

The website should be regularly maintained and updated with recent, reliable information.

B. Organize and sponsor offline E2&3W events

Current condition and challenges

Although various ministries through BEV task force have created initiatives to accelerate the adoption of BEV in Indonesia, there is currently no one single platform that gather all fundamental information to the public to raise awareness about the regulation, incentives, and importantly connect the manufacturers and users.

Best Practices

Government	Event	Implementing Institution
Karnataka, India[154]	Karnataka Electric Vehicles Exhibition 2022 was held in Chamara Vajra, Palace Grounds, Bengaluru. The event that lasted from 1-3 July 2022 was participated by more than 100 table stands. Industry that involves: • E-bikes • E-scooters • E-tractors • Battery products, charging devices, and other EV equipments Support from Government: • Organizing and sponsoring the event	Karnataka Government and BESCOM Ltd
UK[155]	EV Energy Taskfoce "Charging the Future Conference" was held in One Birdcage Walk, Westminster, London. On 31st March 2022, the event brings an illustrious panel of industry experts and government officials. The conference aims to: • Determine the perfect public charging network delivery to end user • Identify industry actions and government interventions to deliver a public charging network • Determine the number of charging point and its type Support from Government: • Organizing and sponsoring the event	Hosted by UK EV Energy Taskforce (Part of Department for Transport and Department for Business, Energy, & Industrial Strategy)

[153]National Automotive Board. (n.d.). Data of Sold Vehicles in India. FAME-India (National Mission on Electric Mobility). [Online]. [Accessed 2022]. Available from: https://www.fame-india.gov.in/
[154]TNN. (July, 2022). E-tractors, Foldable Scooters And More At 3-day Ev Expo. The Times of India. [Online]. [Accessed 2022]. Available from: India EV Expo
[155]EV Energy Taskforce. (November, 2019). EV Energy Taskforce Phase Three Conference: Charging The Future. Electric Vehicle Energy Taskforce. [Online]. [Accessed 2022]. Available from: https://evenergytaskforce.com/charging-the-future/

Government	Event	Implementing Institution
G20, Multilateral Governments[156]	Indonesia is the main organizer of the 17th Global 20 (G20) 2022 summit in Bali. The BEV convention lies under two Sherpa working groups i.e., Energy transition and Environment and Climate Sustainability. Prior to the summit, there are G20 process and intense work carried out within Ministerial Meetings, Working Groups, and Engagement Groups throughout the year. During G20, there are various conventions related to BEV: Main events: • B20 Task force: energy, sustainablity, and climate meetings • Energy Transtition Working group meetings Side events: • Jakarta E-Mobility • PLN E-Mobility day • EV Ecosystem Smart Mobility Joint Project Support from G20 member: • Organize and sponsor the event • The 17th G20 Troika countries (predecessor and successor of the event) are now Italy, Indonesia, and India	Global 20 member states, Ministeries, OEMs, Municipalities, State-owned enterprises.
India[157]	EV International India Show was held in Mumbai, Pune, Goa. The first start of the India EVI Show was in Goa on 2-4 December 2021. The event bring the illustrations to aims: • Support government initiatives in public interest • Provide a platform from market players to showcase their products (2,3, and 4 wheelers) • Determine cost efficient & pollution free of highway, personal, industrial, and public transport The next EV International Show will be held in 2022 with Trinity Group committed to a greener step and holding a conference regarding the E-charging ecosystem and open for forum for exchange and discussion. The expo will also hold a battery expo for automotive, manufacturing, medical Tech, defense & telecom. Support from Government: • Releasing of Goa EV Policy • Organize and sponsor the event	India & States Ministries of governments, Union Minister of State, State-owned enterprises, and The Chamber for Import, Export & Health.

Table 67. Example of offline events for E2&3W

Recommendations

BEV task force to organize and sponsor offline BEV-related events, particularly E2&3W. It also means the various ministries that are included within, should set budget allocation and the commitment to hold events that can connect industry players, governments, agencies, and organizations. At a regional level, municipalities can also organize and sponsor offline BEV-related events.

Table 68. Recommendation 23: Organize and sponsor for BEV offline events

Several possible events are as follows:

- **Exhibition** - OEMs to showcase various products of BEV including E2&3W OEMs to potential end-users. Users can also conduct a test drive during the event. A good exhibition should encourage the prospective users to shift from ICE and attract investment in BEV acceleration.
- **Convention** - Invites decision makers, industry players, drivers association, non-governmental organizations, etc., to answer key challenges and opportunities for BEV including E2&3W faster adoption e.g., battery swap and interoperability, charging infrastructure planning, technical standards, etc. A high quality convention should generate outcome such as pledges, substantive input to affect law/regulation and standards.
- **Conference** - Invites academic institutions, decision makers, and industry players to conduct a formal discussion. A high quality conference should generate recommendation aspects including but not limited to technical issues, laws & regulation, business practice, research and development, etc.

[156]N G20 Indonesia 2022. (2021). Workstreams – G20 Presidency of Indonesia. [Online]. [Accessed 2022]. Available from: https://g20.org/workstreams/
[157]India's Complete Electric, Eco-Hybrid Transport B2B & B2C Event. (2021). Highlights – EV INTERNATIONAL SHOW. [Online]. [Accessed 2022]. Available from: https://www.evinternational.in/highlights/

C. Develop public service announcements (PSAs) on E2&3W safety and operations

Current condition and challenges

There is currently no public service announcement about the safety and operations of BEV in general including E2&3W. Regulation about speed limit, use of helmet, and safety & good riding behavior are not effectively implemented. Also, many people leave their e-bike or e-motorcycle being charged overnight, which is risky to cause fire.

Best Practices

Government	Event	Implementing Institution
USA	• Not to text while driving/riding - "On My Way" • Proper use of e-kick scooter, wear helmet, comply speed and traffic rules - CPSC Micromobility	US Department of Transportation US Consumer Product Safety Comission
Australia	• Riders to wear a protective jacket proper shoes - Protect your body on every ride	Transport Accident Comission
Canada	• To Reduce speed decreases probability of crashes - "Slowing Down Won't kill you"	City of Edmonton
China	• Comply with traffic lights, maximum speed, and wear helmet - General Safety on E-bikes • E-bike user to wear a helmet - Road Safety: E-bike helmet, Consequence	WHO China, Various Municipalities, and Ministry of Transport and CCTV, Vital Strategies
Vietnam	• Not to get drunk when riding a motorcycle - "To Curb Drink Driving"	Traffic Safety Committee of Ho Chi Minh City

Table 69. Example of public service announcements on E2&3W safety

Recommendations

- **MOT and its stakeholders** to develop campaigns about safety riding and operation of EV in general and specifically E2&3W. Campaign can be made in public including but not limited through online and public television, videotrons, radio, etc. The information at least should also deliver risk or damage within the campaign message to bring a deterrent effect.
- **BEV Task Force or particularly MOT and MOI** could also mandate the OEMs to create dedicated E2&3W-related awareness campaigns to the public as part of their responsibility to provide reliable and open information to the public but also a way to bring nuances about a cleaner vehicle shift tailored to their products.

Table 70. Recommendation 24: Public service announcements on E2&3W safety

11 Recommendations on 2&3W Charging Infrastructure Planning

The availability of public charging infrastructure is one of the keys to accelerating EV adoption in many cities. While the provision of public charging infrastructure is largely undertaken by the private sector, governments must play a role in providing not only incentives to support charging station providers, but also guidance or policies to enable equitable access to citizens.

In general, the E2&3W charging strategy can be classified into plug-in charging (with non-removable batteries) and battery swap (removable batteries). Referring to the market overview in Table 70, the Indonesian E2&3W market are currently still dominated by plug-in charging E2&3W models. Nevertheless, the E2W models used by ride-hailing companies, which constitute a large segment of the current national E2&3W fleets, mainly use battery swapping to optimize their operational uptime.

11.1 CURRENT E2&3W PUBLIC CHARGING INFRASTRUCTURE PROVISION INITIATIVES

There are currently several major initiatives in battery swap station provisions, especially for public uses. The current initiatives are all business-driven, where the private sector leads the implementation.

No	Institutions	Number of stations	Cities	Main locations	Battery Specification
1	· PLN (State Utility Company): The national electricity company · Smoot: A domestic E2&3W manufacturer · Swap.id: A battery swap station provider · ABC Lithium: A battery company	Almost 500 stations	Greater Jakarta (400 stations), Bali (100 stations), Yogyakarta, Makassar, Surabaya, Riau, Belitung	Minimarkets (Alfamidi, Alfamart), petrol stations (Shell, BP)	**Power:** 64V 21,5Ah **Cell**: LFP Lithium-ion **Cycle**: Up to 1,500 cycles Certification: IP67, CE **Dimension**: 176.8 x 140 x 338.2 mm **Weight**: 11 kg
2	· PLN (State Utility Company): The national electricity company · Volta: A domestic E2&3W manufacturer · SiCepat: A logistic courier company	128 stations	Greater Jakarta, Solo, Bali, Bandung, Semarang	SiCepat pick-up point/ logistic hubs, Pos Indonesia offices	**Power**: 60V, 23Ah **Cell**: LFP Lithium-ion **Dimension**: 240x150x200 mm
3	· Pertamina: The national oil and gas company · Electrum: EV ecosystem integrator company (a joint venture between GOJEK and PT TBS Energi Utama (TOBA), an energy company) · GESITS: A domestic E2&3W manufacturer · Gogoro: Taiwanese E2W manufacturer and battery swap station provider	14 stations (plans to have 100 stations by the end of 2022) and more at GOJEK's driver points	Jakarta, Bali	Petrol station (Pertamina)	**Power**: 1.3 kWh **Cell**: Lithium-ion **Cycle**: Up to 2,000 cycles Weight: 9 kg

Table 71. Charging Infrastructure Provision Initiatives[158,159,160]

[158] Swap. (n.d.) Swap.id. [Online]. [Accessed 2022]. Available from: https://www.swap.id/
[159] PT. Pertamina (Persero). (August 2022). Minister of Energy and Mineral Resources Reviews Readiness of Pertamina's Green Energy Station in Bali for G20 Summit. Pertamina.com. [Online]. [Accessed 2022]. Available from: Pertamina.com
[159] Anggita, Vina. (July 2022). Volta and PLN Develop Electric Vehicle Battery Swap Station. Swa.co.id. [Online]. [Accessed 2022]. Available from: Volta and PLN Development

1. **Swap-Smoot-PLN collaboration:** Swap.id (a battery swap station provider) has partnered with PLN to build a network of battery swap stations in Indonesian cities. The collaboration includes the integration of Swap.id stations into PLN's charging station locator mobile app. On the other hand, Swap.id has also formed a partnership with International Chemical Industry (Baterai ABC Lithium), a major battery company in Indonesia. There are nearly 400 Swap.id battery swap stations in Greater Jakarta, nearly 100 in Bali, and a few in other cities, mostly at convenience stores and gas stations. A battery exchange station is available for the Smoot Tempur E2W model from the Smoot brand. The partnership with Grab Indonesia is also formed to utilize the Smoot Tempur model as part of the ride-hailing company's E2W fleets.

2. **Volta-SiCepat-PLN collaboration:** Volta, a domestic E2W OEM paired up with SiCepat, a logistics company to provide battery swap stations at the logistic company's logistic hub network. Similar to Swap.id, Volta also collaborates with PLN to integrate its battery swap stations into PLN's charging station mobile app. In addition to supplying SiCepat's delivery E2W fleet, Volta also collaborates with Grab Indonesia.

3. **Pertamina-GOJEK-GESITS-Gogoro collaboration:** The national oil and gas company, Pertamina, teamed up with Electrum, a joint venture company between GOJEK (one of the two main ride-hailing companies) and PT TBS Energy Utama (a private energy company) to establish battery swap stations. The venture also involves Gogoro, a major OEM and battery swap provider from Taiwan, and GESITS, a state-owned E2&3W OEM. Pertamina, through its subsidiary company Pertamina Patra Niaga, acts as the battery swap station provider and operator.

The above three main measures show that the cooperation between battery swap station providers and E2&3W manufacturers has become a typical pattern to establish a network of battery swap stations. The collaborations also typically involve the demand-side, i.e companies that own or manage large fleets, such as carriers or logistics couriers. Instead of becoming a battery swap station provider and cited to plan on operating 4,900 battery swap stations by the end of 2022[161], PLN still mainly takes the role of information aggregator by making a mobile application that can identify battery swap locations from various providers.

Unfortunately, as mentioned in a previous section, the lack of battery swap standardization results in uninteroperable battery swapping between battery swap station providers.

The current initiatives have three trends for the battery swap station locations:
- Petrol stations
- Fleet transit points, such as ride-hailing driver shelters or logistic courier hubs
- Minimarkets, especially road-side minimarkets with storefront parking spaces

The choice to install battery swap stations at fleet transit points is due to the current main market segment, which are the fleet vehicles. Another consideration factor is also to reduce real estate (location rental/ownership) costs, since the fleet owner or management companies are typically part of the joint initiative.

11.2 PLANNING E2&3W BATTERY SWAP STATION LOCATION

The typical locations for charging stations may vary according to the type of charging infrastructure, which determines the charging time.

[161]Santikaaristi. (July 2022). Strengthening the Electric Vehicle Ecosystem, PLN Will Provide 4,900 Battery Swap Stations. PT PLN (Persero). [Online]. [Accessed 2022]. Available from: PLN Multiply Battery Swap Station

Type of charging infrastructure	Charging power	Type of vehicle	Charging time to reach 80-100% capacity	Typical locations
· Level 1: AC slow charger	< 7.4 kW	2W, 3W, 4W	Up to 16 hours or overnight	Private usage (can be detachable or non-detachable batteries for 2&3W) · Residential houses · Apartments
· Level 2: AC fast charger	22 - 43 kW	2W, 3W, 4W	3.5 - 8 hours	Private usage at residential houses or apartments (can be detachable or non-detachable batteries for 2&3W) Public/semi-private facilities: Locations with more than 1 hour dwelling time · Offices · Shopping or recreational centers · Hotels or apartments · Park & ride facilities
· Level 3: DC fast charger	CHAdeMO: <100 kW CCS: <350 kW*	4W	+/- 30 minutes	· Public facilities: Locations with short dwelling time or high visitor turnover · Central Business Districts · Rest areas at intercity highways
· Battery swap	N/A	2W, 3W	5 minutes or less	Public facilities: Locations with short dwelling time or high visitor turnover · Petrol stations · Minimarkets · Ride-hailing shelters at transit stations or shopping centers · Park & ride facilities

Table 72. Typical locations for charging stations

* Note: Most EVs can only receive upto 50 kW charging power

Demand level is one of the main factor in prioritizing battery swap station locations. In Indonesian cities, there are two approaches that can be taken, among others:

1. **Proximity to roads with highest traffic volume.** This approach aims to capture the high number of drivers passing through the roads. The roads with high traffic volume can be identified from municipalities' data or direct observation.

2. **Transit stations with high number of passengers.** This is particularly relevant for cities with a high number of ride-hailing fleets acting as a last-mile mode, such as Jakarta. A huge number of ride-hailing drivers can be typically found at these locations to pick-up or drop-off passengers.

3. **Fleet vehicle heatmap.** Fleet companies can use their driver heatmap data to identify where their drivers are often aggregated. Unfortunately, this kind of data is often not available for the public, even the municipalities themselves.

4. **Park and ride facilities.** This also encourages the use of E2&3W for a first-mile mode in multimodal journeys instead of for single modal journeys.

STUDY CASE: AN EXERCISE FOR BATTERY SWAP STATION LOCATION PLANNING IN JAKARTA

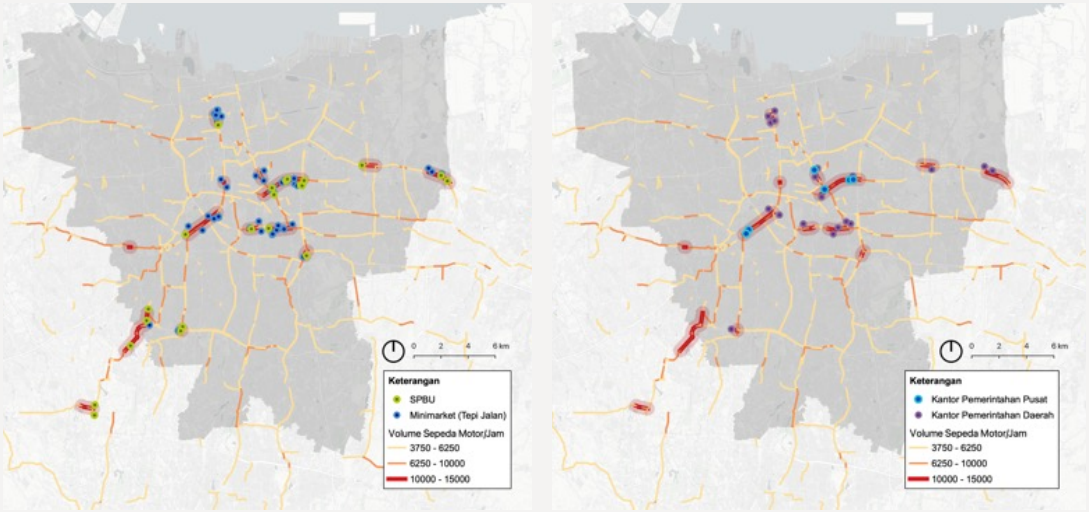
An exercise was done to identify priority locations for battery swap stations in Jakarta, based on two approaches: proximity to roads with high traffic volume, and transit stations with high number of passengers. The traffic volume data was from a 2018 traffic model[162] and the number of passengers per transit station were estimated according to passenger tap in and tap out data from Transjakarta and Commuter Line.

Approach 1. Proximity to roads with highest traffic volume

a. Identify roads with highest traffic volume: Based on the traffic data, there are six road segments with the highest motorized 2W traffic which are Jl. Jend. Sudirman (Bundaran Senayan - Flyover Karet), Jl. Pramuka (Simpang Jl. Proklamasi - Simpang Jl. Jend. Ahmad Yani), Jl. KH Abdullah Syafei, Jl. Ciputat Raya, Jl. Raya Bekasi (Simpang Jl. Raya Pulo Gebang - Simpang Kota Harapan Indah), Jl. Gajah Mada dan Hayam Wuruk (Simpang Jl. Raya Mangga Besar - Simpang Jl. Sukarjo Wiryopranoto).

b. Identify potential locations located within 500 m radius from the roads above. Using GIS, a 500 m radius buffer along the listed roads were made. Petrol points, minimarkets, and government offices located within the buffer were identified as priority locations. The government offices are also identified since there is an opportunity of support from the government to install battery swap stations at their offices for free or at a lower price compared to commercial buildings. There are six potential national government offices (Ministry of Education, Ministry of Social Affairs, Ministry of State Employees, Judicial Commission, BNPB, and BPKP offices) Kementerian Pendidikan, Kebudayaan, Riset, dan Teknologi and 19 local government offices for initial battery swap station locations.

Figure 42. (left). Priority locations at petrol stations and roadside minimarkets
Figure 43. (right). Priority locations at government offices



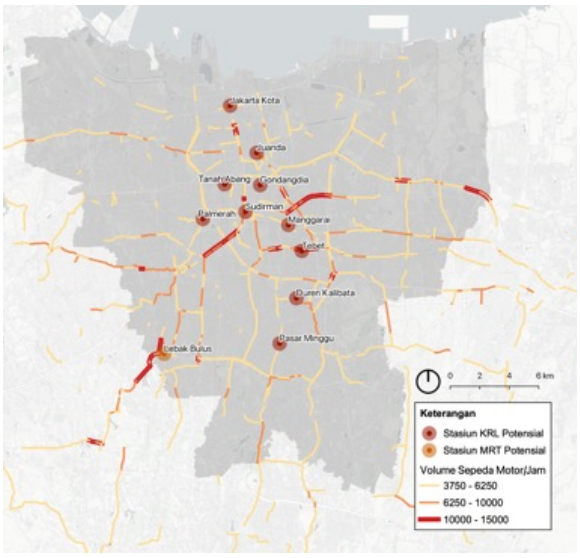
[162]JUTPI (2019), accessed from Jakarta Transport Agency.

Approach 2. Transit stations with high number of passengers

a. Gather passenger volume data per transit station from transit operators. In this exercise, passenger tap in and out data from Transjakarta and Commuter Line was utilized.

b. Rank top transit stations with highest number of passengers and availability of a ride hailing shelter nearby. The dataset showed that the potential transit locations include Tanah Abang, Manggarai, Palmerah, Sudirman, Gondangdia, Juanda, Jakarta Kota, Tebet, Duren Kalibata, and Pasar Minggu train stations, and MRT Lebak Bulus (Shelter Poins Square)

Figure 44. Priority locations at transit points



Annexure 1. OEM Interview Report

A. PARTICIPANTS

ITDP conducted a total of three OEMs: Gesits, Smoot, and Selis. All the OEMs manufacture e-motorcycles, while Selis produces a more extensive range of E2&3W vehicles.

Table 73. List of interviewed OEMs

No	Entity	Products	Interviewee Name	Title	Discussion Date
1	Gesits	E-motorcycle	Abdulllah Alwi	General Manager Sales	19-04-2022
2	Smoot	E-motorcycle	Irwan Tjahaja	Chief Executive Office	21-04-2022
3	Selis	E-motorcycle, e-bike, e-moped, Power Mobility Device (PMD), E-rickshaw, etc.	1. Robin K.H. 2. Reagan Pantja	1. General Manager Commercial 2. Head of B2G and B2B	27-04-2022

B. INTERVIEW METHOD AND QUESTIONS

Separate online interviews were conducted for each OEM and each session took 45-60 minutes to complete. A list of questions were prepared in advance for the interviews. The questions were categorized into six categories: production, technical aspects, charging infrastructure, maintenance, government support, and marketing penetration.

Table 74. OEM interview questions

No	Question
A	**Production**
1	How many of your motorcycles/electric bicycles have been sold and tested in Indonesia?
2	Regarding production, do you have any plans to focus on manufacturing your own or imported electric motorcycles/bikes? What about the current production capacity and expansion?
3	Based on your company's target/current market conditions, how long will it take for Indonesia to fully switch to electric motorcycles and provide an equitable charging infrastructure?
4	Can your motorcycle/electric bicycle be purchased without a battery? Is there a price difference?
5	What is the capital/financing scheme needed for production scale-up? And how can the government support it?
6	Does your company have any plans to produce electric bicycles in the near future?
B	**Technical Aspect**
1	What are the potential electric motorcycle models to be marketed in Indonesia?
2	What are the technical specifications regarding your electric motorcycle model? **Battery capacity (kWh), battery weight (kg), and practical range (km)** **Type of electric motorcycle (automatic/gear transmission)**
3	What is the estimated energy consumption for electric motorcycles and future targets? (kWh/km)

4	What types of batteries are generally used in electric motorcycles and future developments?
5	What is the energy density of the battery used by your product (kg/kWh)?
6	Is there a battery warranty from the company and what are the terms/warranty periods? Does this warranty apply to all driving purposes, for example: ride-hailing?
7	Can your motorcycle/electric bicycle use batteries from other companies? Is there a standard specification of the required battery used in your motorcycle/electric bicycle?
8	How will technology advance in the near future? (fast charging, range extension, speed boost, etc.)
9	What is the expected battery life? Or how many charge cycles? How much does it cost to replace the battery?
10	**Do you have a strategy for battery waste management?**
C	**Charging Infrastructure**
1	What is the charging method commonly used for this electric motorcycle (plug in, swap batteries) and the ideal method?
2	For motorcycles, is it necessary to have a public charging station available or is it enough to do it at home considering the relatively small charging power? How to mitigate safety issues if home charging is done?
3	Does your company provide charging stations to the public or only to private? Are there other manufacturers compatible with your electric motorcycle model?
4	What do you think about the need for standardization of batteries and plug-in connectors for electric motorcycles?
5	If plug-in is used for charger on this electric motorcycle, what is the type and power output method of charging? Is there a maximum power output limit for battery charging?
6	How long does it take for the battery to be fully charged in your electric motorcycle model? (overnight & fast charging)
7	How much does it cost to develop a plug-in terminal or swap batteries? What are the components?
D	Maintenance and battery preservation
1	Describe the maintenance plan (and cost) for the motorcycle/electric bicycle? Do you provide maintenance services nationwide? If not, what are the alternatives for the owner? Are there plans to expand after-sales service?
2	What kind of training do you have for maintenance personnel in your company?
3	What knowledge and skills should the owner have to maintain a motorcycle/electric bicycle?
4	How to maintain battery life to make it last longer?
E	**Government Support**
1	In your opinion, are the current government regulations sufficient to accelerate the transition to the use of electric motorcycles (including production incentives/regulations, financing, SNI standards, etc.)? What policies/regulations and incentives need to be provided to accelerate the transition?
2	What do you think about the current TKDN provisions and the applicable targets?
3	What components still require import and what is the import percentage of your product? What are the incentives or what is needed to facilitate the import of these components?
4	What kind of transportation/traffic policies need to be added to facilitate the use of electric motorcycles?

F	**Marketing Penetration**
1	What are your plans regarding marketing strategies and approaches to the wider community? How do you encourage people to switch to electric bicycles/electric motorcycles?
2	Do you have a plan regarding market segmentation? What is the profile of potential customers for your product?
3	What kind of partnerships do you have with other business entities (B2B schemes) or the government? (ride-hailing, e-commerce, logistics companies, operational/service vehicles, etc.) and how can this encourage the use of electric bicycles/motorcycles?
4	How do you maximize your offline and online marketing outlets?
5	5. What is the purchase scheme that you offer to consumers (0% down payment, low interest installments, long tenure)?
G	Inputs for the Study
1	What are your expectations from this study?
2	Do you have any suggestions on our outputs (eg to support your electrification efforts, policy recommendations)?

C. INTERVIEW INSIGHTS

The following section contains the interview results. One of the interviewees requested for certain information to be non-company specific, therefore the information below is presented by aggregating the results from all the interviews.

1. Production

To date, the units sold from each OEM varies ranging from 1,000 to 7,000 units for e-motorcycles. E-motorcycles are the most popular vehicle in the E2&3 segment. In general, they have their own battery standards, it differs from each company so currently there is no interoperability. Swap.id, a collaborative entity with Smoot provides battery swap services that are available largely in supermarkets in Jakarta, Surabaya, and Bali. Regarding the minimum local component level set by the Ministry of Industry (TKDN) all companies managed to comply with it. Some companies feel that imports on some electrical components should be less cumbersome, not to mention local manufacturers are unable to scallably produce a standardised battery pack such as Li-ion (a critical component for E2&3W). OEMs' manufacturing ability is determined by multiple factors such as capital reserves, market demand, technological selection, business model, and government support/policy.

2. Technical aspects

The technical aspects comprises a vehicle standard, battery, warranty, and waste management. In general all companies have complied to SNI standard. One company uses the Japanese motorcycle standard, which is one of the highest manufacturing standards.
Especially for e-motorcycle, the battery capacity ranges from 1.4 to 2 kWh, the weight of the battery ranges from 8 to 12 kg. In general, the-motorcycle can run up to 50 to 60 km per 1 kWh with the speed up 70 Km/h. The lifetime of the battery ranging from 4 to 5 years. Most battery used are lithium ion. The price ranges from IDR 6,000,000 to IDR 7,500,000. One company is found to use rechargeable lead acid batteries in some of their non e-motorcycle types.

Unfortunately, battery waste management is not currently in place, this is mostly because the battery manufacturing for EVs is not prevalent yet in Indonesia. Some company argue that when the battery reaches its end-of-life it can be used to power many electrical components other than EV. They advise the government to encourage the establishment of battery recycling services or second-hand industry to grow before the excessive battery dump emerges.

In addition, each company provides a warranty for electrical components and battery. For the electrical component, customers can just come to the nearest dealer can fix it. One company also offers Home service, where the maintenance personnel can come the owner's house.

3. Charging infrastructure

According to most OEMs, charging infrastructure is something not necessarily important but good to have. All E2W types are adequate to charge using home charging facilities, as long as the power outlet is available. Unlike electric cars that require higher power, the usage of DC adapter makes E2W more accessible to lower wattage. It is also possible to recharge E3W using home charging, but since it has larger capacities it depends to the model. For example, auto rickshaw requires large wattage e.g., above 1300 VA to be used at home.

The type of charging infrastructure that is friendly for Indonesian users is battery swap - it is fast. Available mainly in minimarkets, battery swap requires less than 10 seconds for users to switch battery pack. The leading battery swap is now swap.id a Smoot's subsidiary company. Despite the current fast charging technology (2-3 hours), users still consider that it takes longer to recharge the battery in a station, unlike refueling gasoline at petrol stations which only require up to five minutes (in peak hour). However the current battery swap service is only available to smoot/swap.id E2W related products.
Non-dedicated station charging by using adapter also works. Some Gesit users are found to prove the ability to drive long range. Trips from Jakarta-Aceh and Jakarta Mandalika (more than 1500 km), were conducted by users voluntarily, in which they brought eight battery packs. They stopped in cafes, restaurants, and small shops along the roads where they managed to recharge the battery whenever the electric plug is available.

4. Maintenance

To provide maintenance most OEMs provide an offline service through dealers. They are now present in many big cities including but not limited to Jakarta, Surabaya, and Bali. Two companies are found to have nearly 50 dealers scattered nationwide. In addition to on-site service, one company appears to provide a home service, where the technicians can come to the customer's house.

The E2&3W should undergo routine maintenance, mainly the electrical components (most companies have various warranty periods). Like ICE motorcycles, users are instructed to always regularly check technical parts including brakes, timing belt, propeller, front fork, bearing, and frame clamps.
To prolong the battery lifetime, the company advice to not to discharge the battery down to zero percent before next charging, especially in a prolonged period as it can make the battery in a sleep mode forever. Overcharging is also unallowed, it can reduce the battery health and cycle count. However, one company implements the IP55 technology which allows the battery to overcome such fears.
Many people are worried about crossing the flooded area - they should not. Electric motorcycles are designed to be resilient to water flooding. However, users should ensure that the motorcycle are not inundated for a long period of time, otherwise short circuit can occur when it is being used.

5. Government support

Government support mainly should come in terms of production and financing. Some parts are imported from other countries because local companies are there yet to manufacture EV electric components, particularly battery packs and dynamo. As mentioned about TKDN, companies need a support where they need an access for imports, and the government can put an ease on it e.g., not imposing excessive tax.
Traffic demand management measures that restrict electric vehicles should be lifted and low emission zones should be considered. Measures such as odd-even policy that restricting E2&3W should always be included during the adoption efforts. Also, Jakarta has been planning for the implementation of Electronic Road Pricing (ERP), just to make sure that E2&3W are not imposed. The restriction from entering certain areas will belittle the adoption efforts. The introduction of low emission zones could also make the adoption of E2&3W more pervasive because they can only cater vehicles that emit low tailpipe emissions. It can benefit the users and expedite the adoption of E2&3W but also make the area friendlier for all street users given the air quality improvement.

Government should reaffirm their commitment to shift into ICE vehicles. The adoption effort should be tied together with the subsidy of electric vehicles. Right now the subsidy to lower the production price of E2&3W is not there yet. The reduction of E2&3W implies a significant acquisition price reduction by users. Also, it should be aligned with the reduction of fuel subsidies because it can basically lead to double standards in political choice. The Indonesian government can try to adapt what has been implemented in

China, where motorcycles are banned to operate and E2&3Ws are incentivised.
In addition to that, the government should encourage people to shift to E2&3W by giving people a chance to have a riding experience. As many customers considered E2&3W could not give a comparable experience against ICE motorcycles, Gesit reported a change of customer interest after they decided to have people try their product to get a riding experience. Inspired by similar practices in India, it has been proven well and expedites the adoption. The way the Indonesian government can do this is basically to hold EV events where society is invited, explained, and facilitated to debunk the myth of E2&3W performance.

6. Marketing and market penetration

To enter the market, OEMs participate in offline and online marketing. In general, attending in offline events is preferred so that they can have interaction with customers and have a test ride. They prefer to participate in exhibitions and road shows such as Indonesia International Motor Show, Gaikindo Jakarta Auto Week, Indonesia Electric Motorshow, and Periklindo Electric Vehicle Show. In addition, to maximise the offline presence, they always strive to add dealers in any potential location nationwide, starting from major cities. One company apparently managed to have 50 dealers scattered across Indonesia
For online marketing campaigns, they use websites and social media. They ensure the website is as informative and attractive as possible for customers because they google it to retrieve information about E2&3W. A good website returns its page on the top list which strongly determines based on search engine optimization capability. In addition, to maximise customer acquisition, social media platforms such as facebook, instagram, and tiktok have been utilised to execute marketing campaigns. Since social media is powerful, they consider it as a multiplier effect because customers who like the product are likely to voluntarily share it, also many influencers are targeted to influence their followers.
In addition to B2C, they are also in favour of B2B and B2G. Some companies are found to have partnered with private companies such as ride hailing companies such as Grab and Gojek, Airport operators, and Golf Park operators. They also plan to get partnered with government offices where they can provide their products as personnel's vehicles, such as the Ministry of Transportation and Transport Agency. For example, a collaboration has been made between a company with the Government of Bogor, a garbage fleet (E2&3W) funded by a state-owned bank.

7. Key takeaways

In accordance with the sources that have been obtained, e-motorcycles are the most favourite vehicles sold in the market. The production of the battery standards of each OEM is different, one of which is a smoot that collaborates with entities such as swap.id successfully provides battery services available at several supermarkets. Even so, the production of the components themselves is still quite difficult because imports are needed and the absence of local producers that can quickly produce important components of the battery, namely standard batteries such as Li-Ion. E-Motorcycle has a battery capacity from 1.4 to 2 kWh, with battery weight ranging from 8 to 12 kg and the life span of the battery ranges from 4 to 5 years. The journey taken can reach 50 to 60 km per 1 kWh with a speed of 70 km/hour.
So far, according to OEMS, the current battery waste management is not currently in place and there is encouragement from the company that encourages the government to form a battery recycling service to avoid excessive battery dumps.

Charging infrastructure for E2W and E3W does not require complicated facilities, charging can be done at home, but for E3W depends on the model that allows it to require greater power. With charging a battery that takes 2-3 hours, some users still assume that the charging of electric vehicles still takes quite a long time compared to filling gasoline at gas stations. Each company provides a warranty for electrical and battery components, the service can be reached by visiting the nearest dealer or service from home with personnel coming to the owner's house. Most companies have various warranty periods for routine maintenance on electrical components. When charging it is expected not to release the battery up to zero percent and not overcharging, because it will cause the battery in sleep mode and reduce the battery health and cycle.

In its marketing, OEM participates in marketing offline and online. Where for offline is done by attending events so that they can have interaction with customers and have a test ride. As for online marketing itself they do marketing through websites and some social media such as Facebook, Instagram, and Tiktok. Social media itself is considered to have a big role in marketing because for customers/influencers who are interested in products tend to share it voluntarily, which can expand marketing. Some companies have also partnered with ride-hailing companies such as Grab and Gojek, airport operators, as well as planning to cooperate with government offices such as the Ministry of Transportation and Transport Agency. This can also encourage the government to provide support for the adoption of E2W and E3W in terms of production and financing. Efforts are needed from the government to provide vehicle subsidies and traffic

demand management steps to encourage low emission zones that make the area more friendly for all road users given the improvement of air quality. In addition, the government's movement in introducing the public to the approach of EVs needs to be more brought closer and facilitated in order to encourage people's desire to use electric vehicles instead of ICE vehicles.