IESR
Institute for Essential Services Reform

Indonesia Electric Vehicle Outlook 2023

Electrifying Transport Sector:
Tracking Indonesia EV Industries and Ecosystem Readiness

Imprint

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Electrifying Transport Sector: Tracking Indonesia EV Industries and Ecosystem Readiness

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Foreword

Decarbonizing Transport

In 2018, the transport sector contributed to 28% of Indonesia's energy sector emissions, and it is rapidly increasing. Emissions from the transport sector are expected to rise by 53% from 2015 levels by 2030, and nearly double between 2030 and 2060. Achieving net-zero emission will not be possible without addressing fossil fuel combustion in the transport sector.

Today, electric vehicles is seen as one of technology for the decarbonization of road transportation. Electric vehicle sales have increased exponentially in recent years, with improved range, performance, and model. BNEF forecasts that global sales of EVs will reach a record of 10.6 million vehicles in 2022, despite supply chain bottlenecks and inflation. This is an increase of nearly 60% over last year. EV sales are expected to reach 21 million by 2025.

Electric vehicles have been included in the mitigation action of our country. To meet the emission reduction target under Indonesia's Nationally Determined Contribution (NDC), 2-electric wheelers must reach 1.8 million by 2025 and 13 million by 2030, while 4-electric wheelers must reach 0.4 million by 2025 and 2 million by 2030. However, this target is still far from meeting the Paris Agreement's 1.5°C warming target. According to the IESR study, in order to do so, EVs must reach 110 million E2Ws and E4Ws by 2030, followed by 3 million Low Duty Vehicles (LDV) and 2.4 million buses.

It is an ambitious target, but one that must be met if we are to wean ourselves off fossil fuels. To achieve this, the government must direct its efforts toward creating an enabling environment for the adoption of electric vehicles. Many countries begin with a clear target, supported by policies to increase demand for EVs, develop their infrastructure, gradually develop manufacturing by strengthening supply chains, and push for mass adoption.

The latter has proven to be successful in Indonesia. Indonesia has been able to gradually build a supply chain based on nickel processing to produce batteries since the enactment of the Presidential Regulation No. 55/2019. This strategy has attracted EV battery and manufacturer companies to locate their manufacturing facilities in the country. If everything goes according to plan, we could see the first Indonesian-made EV battery by 2024. Hopefully, more domestic E2W, E4W, and E-bus production will follow.

Upstream focus alone will not transform EV demand. Since EVs are a newer technology, they compete with internal combustion engine vehicles. To change consumers' preferences, the government must make EVs more appealing, particularly in terms of economics. Consumers evaluate the costs, benefits, monetary gains, and convenience of any decision they make. The logic will differ depending on the type of vehicle. In our case, E2W offers a better chance of rapid transformation than E4W. By focusing on enabling policies and incentives for E2W, consumers' preference for electric vehicles could be unlocked.

Aside from the policy and regulatory framework for EVs, the government should avoid making policies that encourage the use of internal combustion engines. Unfortunately, policy inconsistency occurs, as evidenced by the tax incentive provided to consumers to purchase an ICE vehicle during the pandemic, as well as the continuation of fuel subsidies. The government must make the difficult decision to go in one direction rather than pursue two competing goals. If we want to successfully decarbonize the transportation sector, we must adopt a no-regrets policy.

So here it is, IEVO 2023 as one of IESR's flagship reports. IEVO intends to track and monitor the progress of the energy transition in the transportation sector. This report is our contribution to raising awareness and understanding among all stakeholders, as well as shaping priorities and policy enhancements of actions toward transportation decarbonization to meet the net-zero emission target by 2050.

IESR thanks all partners and collaborators to make this report available.

February, 21st 2023

Fabby Tumiwa
Executive Director IESR

Abbreviations

AC : Alternating Current
ADMF : Adira Dinamika Multi Finance
AMC : Advanced Market Commitment
APNI : *Asosiasi Penambang Nikel Indonesia* (Indonesia Nickel Miners Association)
ASI : Avoid-Shift-Improve
B2B : Business-to-business
BBNKB : *Bea Balik Nama Kendaraan Bermotor* (Transfer of Motor Vehicle Title Fee)
BEV : Battery Electric Vehicle
BI : Bank Indonesia
BLDC : Brushless Direct Current
BMS : Battery Management System
BNEF : Bloomberg New Energy Finance
BPS : *Badan Pusat Statistik* (Statistics Indonesia)
BRT : Bus Rapid Transit
BTS : Buy-The-Service
CAPEX : Capital Expenditure
CCS : Combined Charging System
CNAF : CIMB Niaga Finance
CPOS : Current Policy Scenarios
DC : Direct Current
E-HAPI : Electric and Hybrid Aircraft Platform for Innovation
E2W : Electric 2 Wheelers
E3W : Electric 3 Wheelers
E4W : Electric 4 Wheelers
ESS : Energy Storage Systems
EV : Electric Vehicle
GDP : Gross Domestic Product
GEF : Grid Emission Factor
GHG : Greenhouse Gas
GT : Gross-Tonnage
HFO : Heavy Fuel Oil
HPAL : High Pressure Acid Leaching
IA-CEPA : Indonesia-Australia Comprehensive Economic Partnership Agreement
IBC : Indonesia Battery Corporation
ICAO : International Civil Aviation Organization
CCT : International Council on Clean Transportation
ICEV : Internal Combustion Engine Vehicle
IEA : International Energy Agency
LCCP : Low Carbon Scenario Compatible
LCR : Local Content Requirements
LFP : Lithium Ferro-Phosphate
LiB : Lithium Battery
LSB : Lithium-Sulfur Battery
MEMR : Ministry of Energy and Mineral Resources
MHP : Mixed Hydroxide Precipitate
MoEF : Ministry of Environment and Forestry
MoI : Ministry of Industry
MoT : Ministry of Transportation
MSP : Mixed Sulphide Precipitate
MTF : Mandiri Tunas Finance
NCA : Nickel-Cobalt-Aluminum
NDC : Nationally Determined Contributions
NiMH : Nickel–metal hydride
NMC: : Nickel-Manganese-Cobalt
OJK: : *Otoritas Jasa Keuangan* (Financial Services Authority)
OTR : On The Road
P3DN : *Pusat Peningkatan Penggunaan Produk Dalam Negeri* (Center for Accelerating Domestic Product Use)
PLI : Production Linked Incentives
PMSM : Permanent Magnet Synchronous Motor
PPnBM : *Pajak Penjualan atas Barang Mewah* (Sales Tax on Luxury Goods)
R&D : Research and Development
RAD : Regional Action Plan
RFNBOs : Renewable Fuel of Non-Biological Origins
RKEF : Rotary Kiln Electric Furnace
RON : Research Octane Number
RWA : Risk Weighted Assets
SME : Small Medium Enterprise
SPBKLU : *Stasiun Penukaran Baterai Kendaraan Listrik Umum* (Battery Swapping Station)
SPKLU : *Stasiun Pengisian Kendaraan Listrik Umum* (Electric Vehicle Charging Station)
SPLU : *Stasiun Penyedia Listrik Umum* (General Charging Station)
STAL : Step Temperature Acid Leach
SUT : *Sertifikat Uji Tipe* (Type Test Certificate)
SUV : Sport Utility Vehicles
TCO : Total Cost of Ownership
TRNS : Transition Scenario
VTOL : Vertical Take-Off and Landing
WRI : World Resources Institute
YoY : Year-over-Year
ZEV : Zero-Emission Vessels

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Executive Summary

- Indonesia's greenhouse gas emissions are almost 600 $MtCO_2$-eq in 2021. The largest source of emissions is from the supply side, namely energy industries (power generation), which account for around 50% of total emissions. In the demand side, the transport sector is the largest source of emissions, accounting for 23% of total emissions. In the transport sector, road transportation is the largest contributor with over 90% share.

- From 2015 to 2020, imported gasoline accounted for 52% of total gasoline consumption. The consumption of gasoline increased by 1.2 million kiloliter per year between 2015 and 2020, except when the pandemic hit in 2020. High dependence on imported gasoline makes our energy security vulnerable to fluctuating price of global commodities. Rising fossil fuel prices in 2022 forced the government to increase subsidized gasoline prices, leading to inflation starting at the end of Q3 2022.

- Decarbonization of road transport is achieved by changing travel behaviour to reduce demand, which includes reducing unnecessary travel (avoid), shifting to low-carbon modes (shift), and transitioning to clean energy vehicles (improve). The improve strategy, such as switching to EV, is easy to implement as everyone can easily participate. The adoption of EV also opens the opportunity to accelerate the deployment of renewable energy, and in the long term can provide flexibility in the demand side through vehicle-to-grid operation.

- EVs have 7% less emission and 14% lower cost per km than their ICEV counterparts. Grid emissions factor, fuel production emissions, vehicle efficiency, fiscal incentives by government, traveled distance, and fuel price play an important role in EVs' GHG emissions and total cost of ownership calculation.

- Lack of infrastructure, high upfront cost, and low performance hinder the adoption of EVs. EVs that have competitive prices compared to ICEVs are more likely to be adopted. Another way to boost EV adoption is by retrofitting the vehicle through a conversion program. However, consumer confidence in conversion programs is low due to shorter warranty periods and a lack of knowledge and experience in converted vehicles.

- With limited access and high gasoline costs, EVs are the solution for remote areas. In addition, the availability of charging infrastructure and government tax exemptions are also important to support EV adoption. However, the reliability of electricity could be a problem in rural areas.

Executive Summary

- EV policy in Indonesia comprises of fiscal and non-fiscal policies. Existing non-fiscal policies mainly stipulate the rules of the game for EVs, such as standardizing battery charging/swapping stations and local content requirements. On the other hand, existing fiscal policies are mainly implemented to incentivize consumers to make EV more attractive. Currently, fiscal policies to incentivize the EV industry (supply) are limited as the government focuses on boosting sales (demand). Following the national government, several sub-national governments began to introduce EV policies since 2019. The notable provinces are Bali and DKI Jakarta. Other regions are catching up by introducing tax discounts for EVs and electrifying their bus rapid transport fleets.

- The government is planning to give cost reduction incentives for EVs to reduce their upfront costs. The amount of the incentive depends on the type of the vehicles. However, despite the reduced cost, some vehicles are still too expensive to purchase for most people. For instance, some mid-class EV cars (E4W) are still priced at IDR 500 - 600 million after cost reduction, which is affordable by less than 0.1% of consumers. On the other hand, cost reduction incentives for motorcycles are more effective since they make E2W prices much cheaper.

- Battery charging station (SPKLU) installations are advancing quickly in 2022 with more than 200% growth than the previous year. However, the installation is not well-distributed since 88% of total SPKLUs are installed in Jakarta and Bali. The distribution locations of fast chargers and slow-medium chargers need to be evaluated, since currently at least in Jakarta, most fast chargers are located in state-owned enterprises (SoE). Fast chargers are more suitable to be located on highways rather than office buildings, where users have much less waiting time. SPKLU regulation also needs to be evaluated as it still obliges SPKLUs to install 3-port charger, which is very expensive. Revising this regulation will attract investments in SPKLU installation.

- Battery swapping station (SPBKLU) utilization rate can be optimized with battery standardization. This is because currently SPBKLUs are owned by E2W brands, therefore users can only use a specific SPBKLU that matches with their E2W brand. This does not help to alleviate range anxiety that consumers still have. Despite the reports that SPBKLUs in Indonesia are mainly used by commercial users such as ride-hailing and logistics drivers, standardization is still needed because it could alleviate range anxiety issues as this issue is still a dominant barrier in Indonesian EV market.

- The ban on nickel ore exports has resulted in the rapid growth of upstream battery-grade nickel refining facilities, with at least 2 HPAL facilities already in operation and 3 more expected to be built in the next few years. However, the MHP produced, with an estimated production rate of 657 kiloton/year, has not yet been absorbed by the midstream industry to continue in the local battery precursor industry.

Executive Summary

- In an effort to become an end-to-end producer of nickel-based EVs, the local industries initiate partnerships with battery companies, although the planned COD is still three years away. The delayed development of the midstream EV battery industry is crucial, as the domestic EV industry has an increasing demand. Additionally, the government is promoting the growth of the domestic industry through public procurement and EV subsidies to ensure that the industry meets local content requirements for participating in the government's program.

- Maritime battery-powered vessels are currently limited by their low energy density compared to other alternatives. This results in a reduction in cargo space, making battery-powered boats practical only for short-distance trips and small gross tonnage. Several SMEs in Indonesia have innovated by developing battery-powered boats for the small-scale fishery sector, which is economically challenged by reduced access to subsidized fuel.

- In the aviation industry, electric aircrafts are also limited by the low energy density of batteries, which affects the cruise range. The current certified electric aircraft has an energy density of 144 Wh/kg, but research into advanced battery technologies is aimed at increasing this to 500 Wh/kg. Aircraft manufacturers worldwide are developing electric aircraft designs, particularly in the VTOL segment, which are expected to enter the commercial market in the next few years.

- Commercial (B2B) and government adoption could provide a viable initial market for the EV industry. Currently, several businesses (ride-hailing and logistics companies) start electrifying their fleets and set a target of 100% by 2040. This could ensure that the EV adoption in the domestic EV industry grows years before the retail (individual) market develops. However, for now, some businesses are still opting for ICEVs with higher power than EVs (mainly in motorcycles), which could be a barrier to B2B adoption. For the government, some sub-national governments are advancing in the adoption of EVs as official vehicles.

- E2W adoption increased 5 times between 2020 and 2022. With the impending IDR 7 million cost reduction, the E2W adoption outlook is expected to be higher from 2023 onwards, especially since some E2W models are priced at the same price range as their best-selling ICEV counterparts. As the domestic industry is also growing, mainly the E2W battery industry and E2W manufacture, costs are expected to decrease year by year. The total cost of ownership (TCO) of E2W is expected to decrease by 9% per year between 2022 and 2030 (ADB, 2022).

Transport Emission Overview

Faris Adnan Padhilah

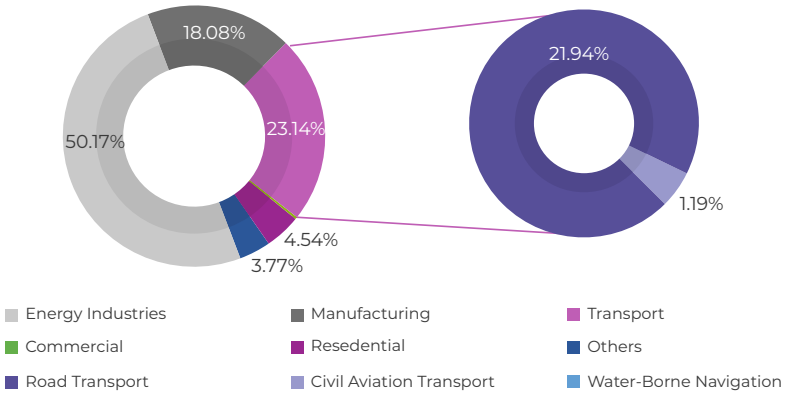
Contents:

- Transport emission and energy security
- Road transport and fuel consumption growth
- Impact of electrification in transport sector

Decarbonization of the transport sector is crucial to limit temperature rise below 1.5°C

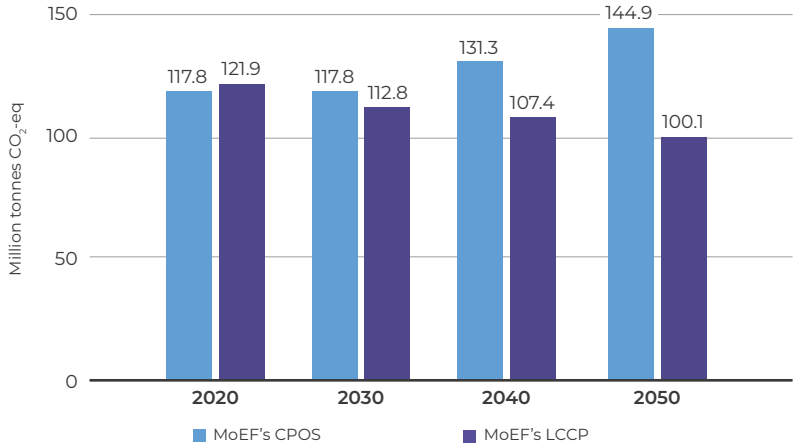
- Indonesia's energy sector emitted almost 600 $MtCO_2$-eq in 2021, primarily from energy industries (power generation), which accounts for 50% of emissions. Transportation and manufacturing are the second and third largest sources of emissions, accounting for 23% and 18% of emissions, respectively. In the transport sector, road transportation is the largest contributor with over 90% share.
- In the Long Term Strategy for Low Carbon and Climate Resilience (LTS-LCCR), the Ministry of Environment and Forestry (MoEF) projected that under the current policy scenario (CPOS), GHG emissions from the transport sector will reach 145 $MtCO_2$-eq in 2050, an increase of 23% compared to 2020. Meanwhile, under the LCCP scenario aligned with the government's target for net-zero by 2060, emissions from transportation is projected to decline to 100 $MtCO_2$-eq in 2050, a mere 31% reduction from the CPOS scenario. The emission reduction under LCCP is expected to come from demand reduction and high utilization of biofuel and electricity at 46% and 30% of 2050 transportation energy mix, respectively.
- IESR (2021) suggests that emissions from the energy sector, including transportation, need to reach near zero by 2050 to keep the global temperature rise below 1.5°C. To achieve that, electrification will be the key strategy, supported by better urban planning and modal shifting to reduce energy demand, and complemented by the utilization of other sustainable fuels. The study projected that around 50% of the total energy demand for transportation will come from electricity.

GHG emissions from energy sector by sources in 2021



Sources: MoEF, 2022

Transport sector GHG emission projections on various scenario

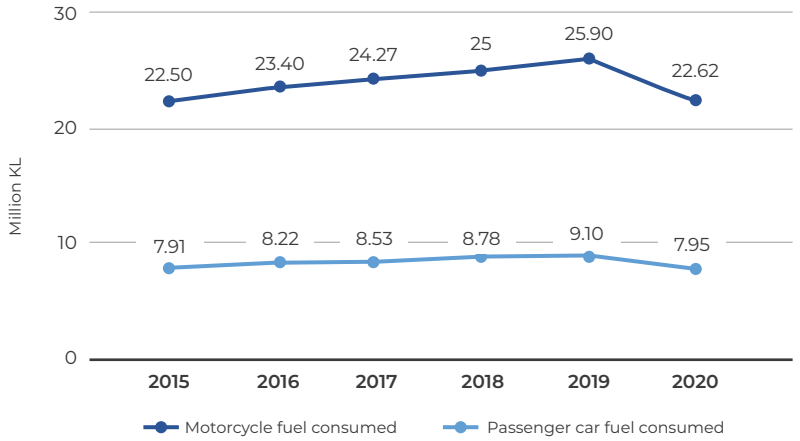


Sources: MoEF, 2021

Energy transition in transport sector will improve energy security by reducing fuel imports

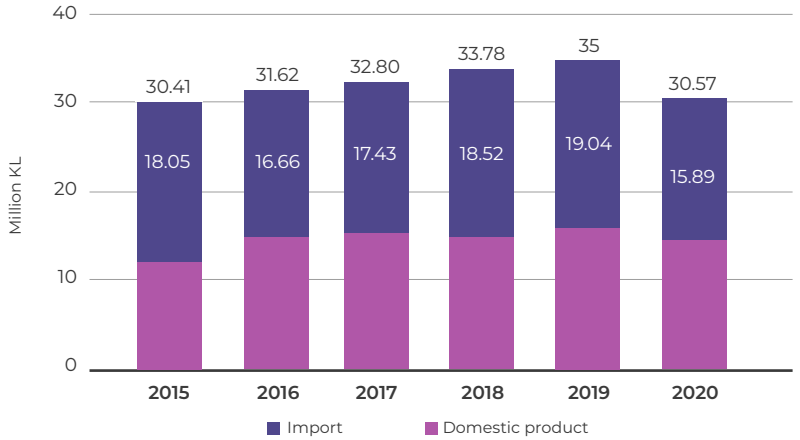
- The increase in GHG emissions from transport sector is mainly due to increased consumption of fossil fuels. Fuel consumption increased by 1.2 million KL per year between 2015-2020, except in 2020 when the pandemic hit and suppressed fossil fuel consumption.
- Contrary to the increasing fuel demand, refinery capacity has stagnated over the past decade. Consequently, Indonesia's domestic production could not cover the increasing gasoline demand and Indonesia has become a net oil importer since 2004 and with ever increasing import value. From 2015 to 2020, imported gasoline has supplied around 52% of total gasoline consumption each year.
- Indonesia's production of crude oil has been in declining trend. From 2016 to 2022, the crude oil production has declined by 25%. As a result, the share of imported crude oil in refinery input has been increasing. In 2021, about 20% of the crude oil used in domestic refineries was imported[1].
- High reliance on imported fuels and crude oil has posed risks to Indonesia's energy security as they are global commodities with fluctuating price. Rising fossil fuel prices in 2022 forced the government to spend about 3 times more on energy subsidies than initially budgeted. The government's decision to increase the subsidized gasoline retail price in mid-2022 resulted in an inflation, causing the consumer price index to increase by 5.95% in September 2022 and 5.71% in October 2022 YoY. Switching from petroleum fuels to less fluctuating energy sources such as electricity in transportation could help mitigate this issue in the future.

Fuel consumption in the road transportation (2015-2020)



Sources: Statistic Indonesia, IESR analysis

Gasoline consumption by source (2015-2020)



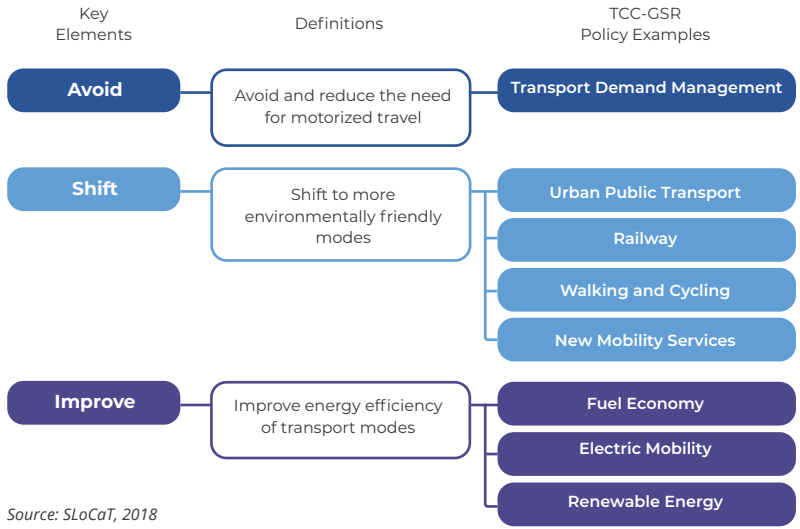
Sources: MEMR Statistic Books, 2021

[1] The share here refers to net-import divided by total refinery input. Actual share of imported crude oil in refinery input is higher, but as Indonesia also exports crude oil, the net-import is used here.

Electrification of road transport as a quick and ready-to-implement strategy of transport sector decarbonization

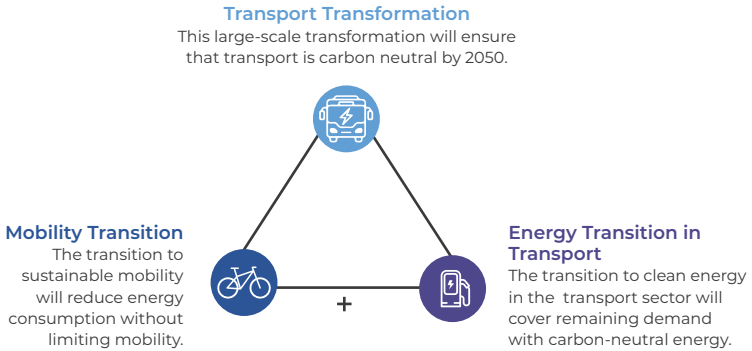
- Road transport is the biggest source of emissions in the demand side of energy sector in Indonesia. Decarbonization of road transportation requires both changes in traveling behavior to reduce demand and transition to clean energy to cover the remaining demand (Agora Verkehrswende, 2017). Similar concept is also suggested by the Avoid-Shift-Improve (ASI) strategy (SLoCaT, 2018). Changes in traveling behavior are achieved by reducing unnecessary travel (*Avoid*) and shifting to low-carbon modes (*Shift*), while transition to clean energy is achieved by improving efficiency and switching to electric vehicles or low-carbon fuels (*Improve*).
- Switching to electric vehicles (EV) is a key strategy to road transportation decarbonization, as it has the potential to reduce emissions concurrently with the power sector decarbonization. The increased electricity demand from EVs would provide an opportunity to accelerate the deployment of renewable energy (RE). In the long term, it could facilitate the deep integration of RE by providing flexible demand through vehicle-to-grid operation.
- The emission reduction potential of EVs can be obtained at low cost, or even negative cost. The total cost of ownership (TCO) of a passenger EV could be lower than a comparable internal combustion engine vehicle (ICEV). For ride-hailing service providers, switching to electric 2-wheelers allows them to save up to IDR 700 thousand per month. In addition, unlike the Avoid and Shift strategy, which requires the government's systematic planning, everyone can participate in the Improve strategy by purchasing EVs.

Avoid - Shift - Improve Strategy



Source: SLoCaT, 2018

The geometry of the transport transformation

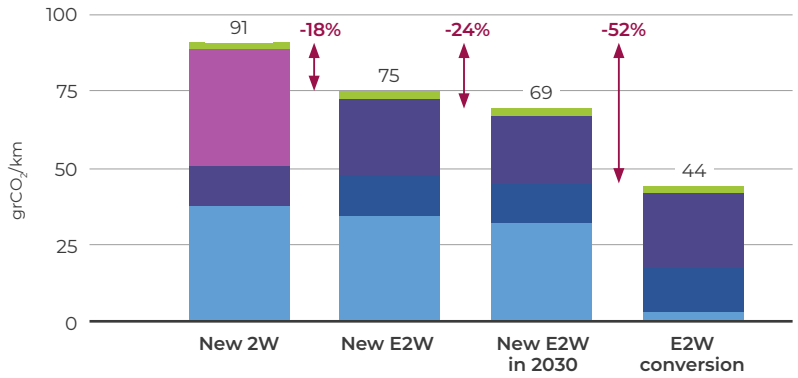


Source: Agora Verkehrswende, 2017

EVs already emit less GHGs than conventional vehicles, but more aggressive RE penetration is needed to decarbonize road transport

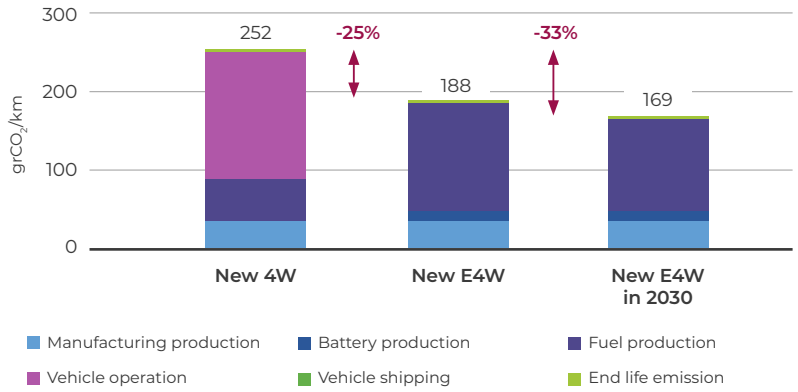
- At the moment, EVs have lower emissions per km than ICEV counterparts. The source of electricity generated is an important factor in reducing emissions from EVs. With the current power generation mix (national average), electric two-wheelers (E2W) and electric four-wheelers (E4W) typically emit 18% and 25% less CO_2 per km over their lifetime than their ICEV counterparts. However, due to the lack of RE in PLN's electricity planning, by 2030, there will be only a further 6% and 8% reduction of emissions by E2W and E4W, assuming constant vehicle efficiency.
- In conventional two-wheelers (2W) cases, well-to-wheel (WTW) emissions from vehicle operation (including fuel combustion and fuel production) account for around 60% of total CO_2 emissions, while manufacturing accounts for the remaining 40%. In E2W, WTW emissions from operation (electricity production) are lower, while emissions from manufacturing increase due to battery production. Emissions from the manufacturing process could be significantly reduced by converting existing 2W to E2W, resulting in over 50% reduction of lifecycle emissions compared to 2W.
- In conventional four-wheelers (4W) cases, the biggest contributor of emissions is vehicle operation (WTW). WTW emissions from 4W vehicle operation contribute to over 80% of total emissions. In E4W, WTW emissions are lower, but still account for around 70% of total CO_2 emissions, followed by manufacturing process and battery production at around 20% and 10%, respectively.

CO_2 emissions per km of E2W and conventional 2W
(average value within 40 thousand km operation)



Source: IESR analysis

CO_2 emissions per km of E4W and ICEV
(average value within 200 thousand km operation)

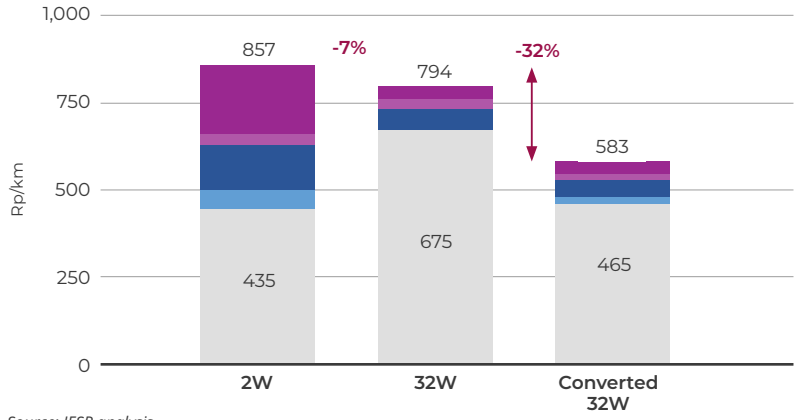


Source: IESR analysis

Despite having a higher upfront cost, EVs already have a lower total cost of ownership than comparable ICEVs

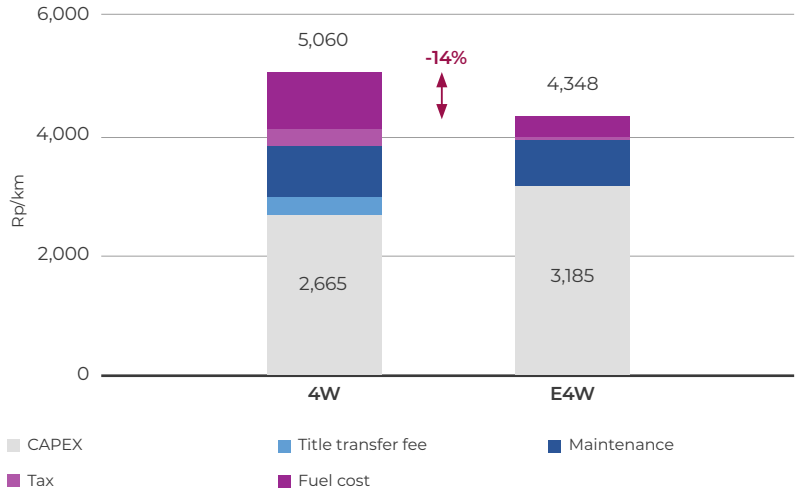
- EVs have a higher upfront cost compared to their ICEV equivalent. However, battery, as the main component of EVs, has shown a price reduction trend in recent years, thus, EV price is expected to be more affordable in the next few years.
- Despite their higher upfront cost, EVs have a lower TCO than their ICEV equivalent. The lower TCO is mainly due to significantly lower maintenance fees and fuel costs. In addition, several incentives provided by the government, such as the reduction/exemption of vehicle title transfer fee (BBNKB) and tax, also play a role in further lowering EVs' TCO. In the 2W market, the conversion program could further reduce the TCO of E2W.
- In contrast to petroleum fuel, the government strictly regulates the electricity price and has been postponing the electricity price adjustment for the past few years. Meanwhile, gasoline prices, especially in 2022, have seen some fluctuations in line with the global market price. As a result, the cost of electricity per kilometer traveled in an EV could be 1.5 to 7 times cheaper than the cost of gasoline per kilometer traveled in an ICEV.
- It should be noted that TCO and emission calculation is very sensitive to several factors such as price, vehicle efficiency, total traveled distance, fuel and electricity price, and taxes and incentives. For example, comparing the TCO of the cheapest EV and the most popular ICEV will show less favorable results for EVs regardless of performance and class differences. Meanwhile, increasing the total traveled distance will be more favorable to EVs due to greater savings in fuel costs.

TCO comparison of E2W and conventional 2W for 40 thousand km



Source: IESR analysis

TCO comparison of E4W and conventional 4W for 200 thousand km



Source: IESR analysis

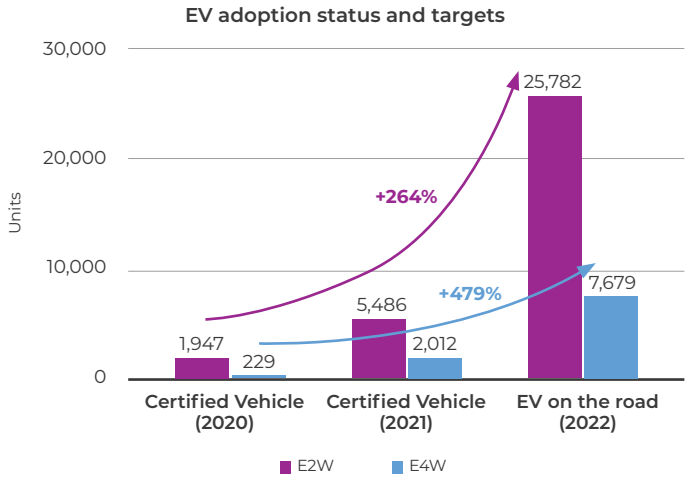
Electric Vehicle Adoption Status

Faris Adnan Padhilah
Ilham Rizqian Fahreza Surya
Pintoko Aji

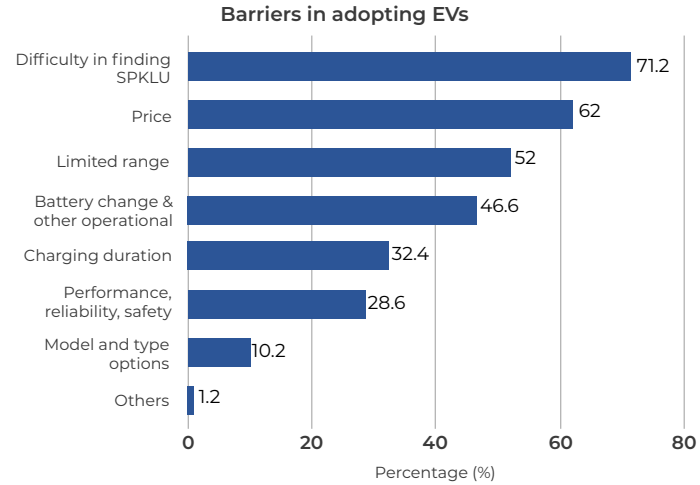
Contents:

EV adoption is hampered by a lack of infrastructure, high upfront costs, and low performance

- EV adoption has been increasing in recent years. In 2022 alone, the number of E2W and E4W on the road increased by almost 5 and 4 times, respectively, compared to 2021[1]. However, despite such a huge growth in 2022, the EV adoption rate is still far from the target of Indonesia's NDC. Inadequate charging infrastructure, high upfront cost, and limited driving/riding range are the main barriers to EV adoption. In addition, long charging duration, low performance, and limited travel range of EVs are also somewhat considered as hindrances (IESR, 2022). Consumer perception and lack of understanding about EVs also obstruct EV adoption (Candra, 2022; Maghfiroh, 2021; IESR, 2020).
- Both E2W and E4W have higher upfront cost compared to their ICEV counterparts. Most E2Ws cost more than IDR 25 million, while the majority of motorcycles sold in Indonesia cost less than IDR 20 million. The gap is even more pronounced for E4W, most of which cost more than IDR 600 million, while the majority of ICEV 4Ws sold cost less than IDR 300 million. Meanwhile, to be considered affordable and attractive for consumer, an E4W should be priced around 1.2–1.4 times higher than ICEV (Khoirunurrofik, 2021). The introduction of the new E4W model in 2022 at a lower price range of IDR 200-300 million has attracted more than 5,000 purchase orders, equivalent to 65% of the total E4W sales to date.
- The availability of charging infrastructure plays an important role in EV adoption, as it reduces consumer range anxiety since most EVs have lower driving/riding range compared to ICEV. The range limitation issue is especially relevant for E2W ride hailing drivers, as most E2Ws only have 50-60 km per charging cycle, which is insufficient for their daily coverage.



Sources: MoT, MEMR



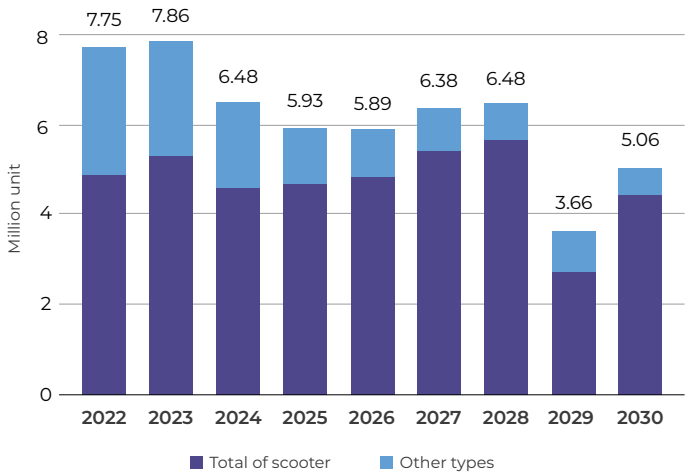
Sources: IESR, 2022

[1] Figures for 2020 and 2021 are based on certified vehicle only, so there might be fewer EVs on the road that year than that figure.

Intended to lower upfront costs and boost adoption, E2W conversion program is hampered by high conversion costs and poor consumer confidence

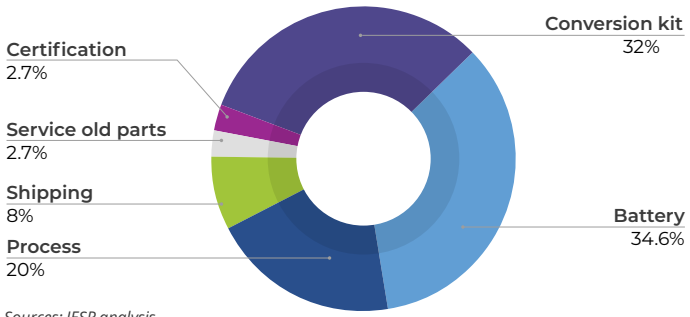
- To boost the E2W adoption, MEMR launched a motorcycle conversion program back in 2020. The program aims to provide lower upfront costs and greater market flexibility for E2W, as existing markets only have limited E2W options with high upfront costs. By 2022, in collaboration with other government institutions, including the police force, MEMR has licensed 13 conversion workshops and established cooperation with 3 conversion component manufacturers to reduce conversion costs. Yet, until December 2022, the total number of registered conversions only reached 126 units, far below the targeted 1000 units (MoT, 2022).
- If the program is successful, between 2022 and 2030, an average of 6 million 2W units per year will be ready to be converted to E2W. This figure is from 2W purchased from 2012 to 2020, assuming 2W has a useful life of 10 years before becoming a suitable candidate for E2W conversion.
- Although expected to reduce upfront costs and increase adoption, the cost of the conversion program is around IDR 15-23 million per unit, which is only about 20% lower than buying a new 2W. With such a high cost, the program struggled to enter the market as the consumer willingness to pay for the conversion program is around IDR 5 to 8 million. Batteries and conversion kits are usually imported and account for around 60% of the total cost. For comparison, the conversion cost in Indonesia is more expensive than the price of a new E2W in India. Furthermore, the conversion cost in India is only ⅓ of the price of a new E2W.
- Apart from the high upfront cost, there are other factors contributing to the slow adoption of converted E2W. The converted E2W has a shorter warranty period, ranging from 6 months to 1 year, and some even have no warranty period. As a comparison, spare parts for new E2Ws usually come with a 2-year warranty. In addition to the short warranty period, lack of knowledge about the conversion program and lack of experience in trying a converted motorcycle lead to low consumer confidence in the conversion program.

E2W conversion program potential



Sources: IESR analysis

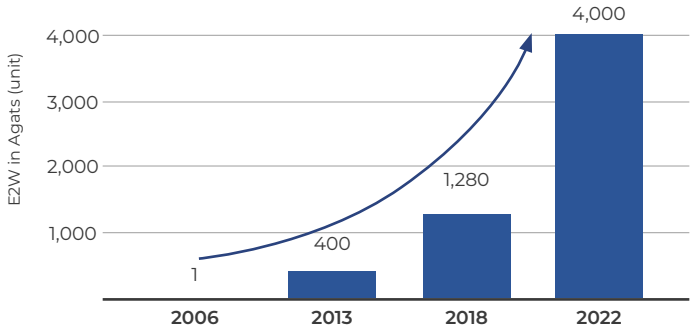
2W conversion component cost percentage



Sources: IESR analysis

Opportunities for early adoption of EVs arise in remote areas, but a lack of reliable electricity supply may hinder their realization

Number of E2W in Agats, Asmat, South Papua



Sources: GNFI (2022), Detik (2019), Bisnis (2018), Kumparan (2022)
(Notes: The number of E2W in Agats was excluded from the E2W on the road data)

E2W adoption drivers in remote areas

Fuel (operation)	Lack of supply and expensive petroleum fuel
Infrastructure	SPLU (*Stasiun Pengisian Listrik Umum*) as an E2W charging station (~IDR 5,000 per charge).
Incentives	Have no tax and license plate *local government determined as parking retribution (membership per year)
Others	• Lighter than ICE and appropriate for plank road (contextual with road condition) • No noise • Non-flammable

- While EV adoption is generally perceived as costly with little performance benefits, there are cases where EVs are preferred by consumers due to their advantages compared to ICEV. In Agats, a remote district in Asmat, South Papua, more than 4,000 E2Ws have been organically adopted by consumers since 2006. The main reason for widespread adoption is the limited access and high cost of gasoline, making E2W a more economical alternative. In addition, there are other factors supporting the successful penetration of EVs, such as the availability of charging infrastructure and government policies to exempt EVs from taxes and license plate requirement.
- The case in Agats could serve as an example of EV's potential to replace ICEV in remote areas where access to fuel is limited. However, a lack of reliable electricity access could inhibit EV adoption in those areas. The case also highlights the potential to reduce the policy costs associated with maintaining uniform fuel prices and redirect those resources to ensure reliable electricity access in remote areas.

Electric Vehicle Ecosystem

Faris Adnan Padhilah
Ilham Rizqian Fahreza Surya
Pintoko Aji

Contents:

Fiscal policy is the most feasible and effective, but it can be strengthened

- Since the issuance of the Presidential Regulation for the acceleration of BEV adoption in 2019, there have been various supporting policies and regulations issued by the government. While fiscal incentives are needed to reduce the price gap between EV and ICEV to accelerate adoption, they are limited to exemptions from luxury tax (PPNBM), title transfer and ownership fee (BBNKB), and vehicle tax (PKB). Recently, the government included the exemption of EVs from BBNKB and PKB taxes in the Law No. 1/2022, although it will only take effect in 2025. Furthermore, the government is yet to introduce additional disincentives for ICEVs aside from the existing PPNBM scheme.
- In 2022, the government issued three non-fiscal policies to support EVs. The first policy is the instruction to adopt EVs as government's official vehicles. The second one is the regulation to expand ICEV to EV conversions beyond 2W segment, complementing the 2020's E2W conversion policy. Lastly, to support the local component manufacturers, the Ministry of Industry (MoI) also issued a regulation on technical requirements, the national EV roadmap, and the local content requirement (LCR) guidelines.

Existing non-fiscal policies

- **MoT Reg. No. 15/2022**: Regulate the conversion of other than 2W vehicles.
- **MoI Reg. No. 6/2022**: Technical requirements and LCR guideline.
- **Presidential Instruction No. 7/2022**: Adoption for government official vehicle
- **MEMR Reg. No. 13/2020**: Standardization of charging plugs and electricity tariff policy for public electric vehicle charging station and public electric battery vehicle replacement.
- **MoT Reg. 44/2020**: EV testing and certification process.
- **MoT Reg. No. 45/2020**: Regulates special vehicle with electrical motor including safety requirement, riding behaviour, and vehicle lane.
- **MoT Reg. No. 65/2020**: Legitimates the conversion of 2W to E2W, and regulates the component of conversion vehicle, requirement to convert to conversion shop for Small Medium Enterprises (SME) workshop, along with safety requirements and administration process.

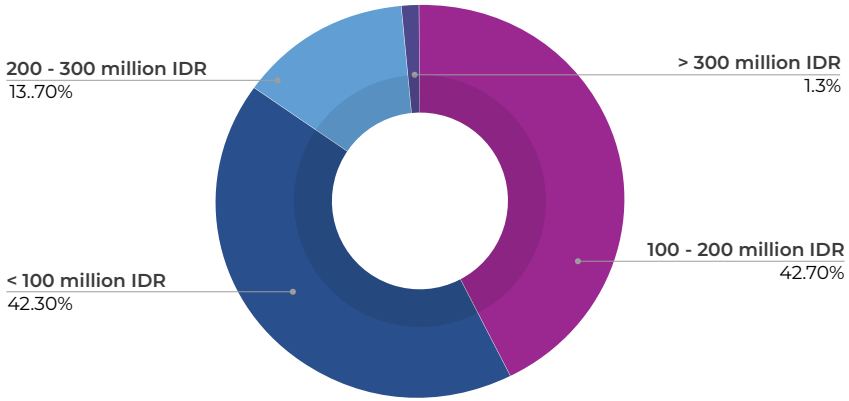
Existing fiscal policies

- **Law No. 1/2022**: BBNKB and PKB exemption starting in 2025.
- **OJK (*Otoritas Jasa Keuangan*) Circulation:**
  - Risk Weighted Assets (RWA/ATMR) for EV financing (producing and buying) is reduced from 75% to 50%.
  - EV credit purchase payment could cost 0% (without down payment).
- **Government Reg. No. 74/2021**: Battery electric vehicle (BEV) is exempted from sales tax on luxury goods (PPnBM).
- **Ministry of Home Affair** (MoHA) Reg. No. 1/2021: BEV maximum yearly tax (PKB) and title transfer fee (BBNKB) is only 10% of its imposition fee calculation.
- **MoF Reg. 138/PMK.02/2021**: Vehicle Type Test cost for BEV is cheaper than ICEV; IDR 4.5 million for E2W, IDR 13.2 million for E4W and E-bus.

  Type Test Certification (*Sertifikat Uji Tipe*/SUT) for E2W is 25 times cheaper, while for E4W and E-bus is 6 times cheaper than ICEV.

Cost reduction incentives are likely to be more impactful for E2W than E4W

Four-wheelers (all type) OTR price range and their market share in Indonesia (2022)



Sources: Gaikindo, 2022

EV cost reduction incentive benchmark (2022)

Country	GDP per capita (USD)	Mid-class E4W price (USD)	E4W incentives (%)
Singapore	84,500	140k	24%
India	2,690	42k	23%
Thailand	8,270	29k	15%
Indonesia	5,010	44k	10%

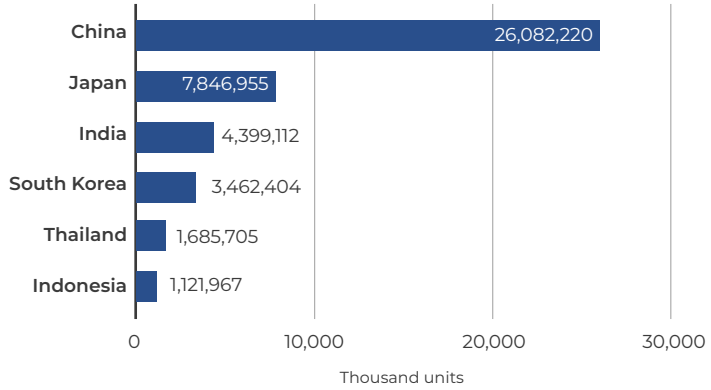
Sources: IESR analysis, 2023

- Compared to the more developed EV markets, Indonesia's EV policy still lacks cost reduction incentives. More developed EV markets allow 15–25% price reductions for average EVs, depending on the type and performance of the EV. Indonesia plans to reduce the price of E2W by about 20 - 40% (IDR 7 million) and E4W by about 10% (IDR 80 million) in 2023. However, the 10% incentive for E4W is likely to be ineffective considering that after the 10% reduction, a mid-class E4W still costs more than IDR 500 million and only 0.1% of the market can afford it (Gaikindo, 2021). The purchasing power of EV in Indonesia is lower than that of other major EV markets, as indicated by the difference in GDP per capita (Gaikindo, 2021). More developed EV markets either have higher GDP per capita or provide significantly higher cost reduction.
- For E2W, the incentive could almost halve the on-the-road price of several E2W models in the market, hence could have a greater impact on adoption. Moreover, motorcycle is one of the most commonly used transportation modes to drive economic activities. However, there should be clear eligibility criteria for the recipient to avoid excessive incentive for EVs with low specification. The incentive should only be provided to, for example, models that comply with LCR regulations and have a larger battery capacity and longer riding range. The implementation of such criteria could incentivize manufacturers to build E2W with higher specifications. Such policy has been implemented, for example,in the US through the Inflation Reduction Act, which restrict the eligibility for incentives only to brands that meet the LCR criteria.

Upstream incentives are crucial to unlock the massive potential to become EV manufacturing hub

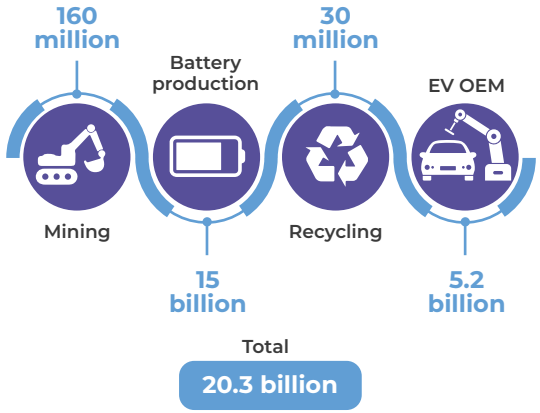
- Indonesia's car manufacturing industry is the second largest in Southeast Asia with close to 1.5 million car production in 2022 (Gaikindo, 2022). Also, the motorcycle manufacturing is the biggest in the region with around 6 million production in 2021. This fact indicates that Indonesia also has the potential to become EV manufacturing hub, especially when an integrated supply chain is available.
- With 21 Mt nickel reserves, Indonesia is the only EV manufacturing country that has the main raw material resource for EV. This advantage over natural resources is attractive for automakers to establish manufacturing sites in Indonesia, because cost of raw materials, which affects up to 25% of final battery price, is one of the biggest uncertainties automakers face today (Transport & Environment & BNEF, 2021). Furthermore, the Indonesian government has banned nickel ore exports to secure supplies for the domestic industry.
- However, the domestic EV supply chains are not fully integrated yet. Around USD 20 billion has been invested across the whole supply chains, but several battery producers and recycling factories will not be operational until at least 2025.
- To unlock the potential of becoming an EV manufacturing hub, the government needs to incentivize the EV upstream industry to help the industry become more competitive, accelerate price decline and create big multiplier effects on the economy. Currently, the existing upstream incentive is limited to reducing Risk Weighted Assets (RWA) for EV financing (producing and buying) from 75% to 50%.
- Various forms of incentives have been implemented in more advanced EV markets to drive the manufacturing industry, such as the Advanced Chemistry Cell Production Linked Incentives (ACC PLI) in India. India exempts taxes, tariffs, and duties for its battery industry. In the sub-national level, this policy is combined with job creation allowances package (ICCT, 2021).

Top car manufacturing countries in Asia (2021)



Source: OICA, 2022

Total EV supply chain investment (USD)



Source: Rigel Capital (2022) & IBC (2021)

EV support policies at the sub-national level are growing, with DKI Jakarta and Bali remaining the leading provinces

Sub-national EV policy

Sub-national	Fiscal policy	Non-fiscal policy				
	BBNKB (vehicle title transfer fee) discount	Bus electrification	Odd-even traffic exemption	EV zones/sites	SPKLU obligation for buildings	Government official vehicle
DKI Jakarta	✓	✓	✓		Proposed	Proposed
Bali	✓			Proposed		
Surabaya		✓				Proposed
Bandung		✓				Proposed
Medan		Proposed				Proposed

✓ Legalized Proposed

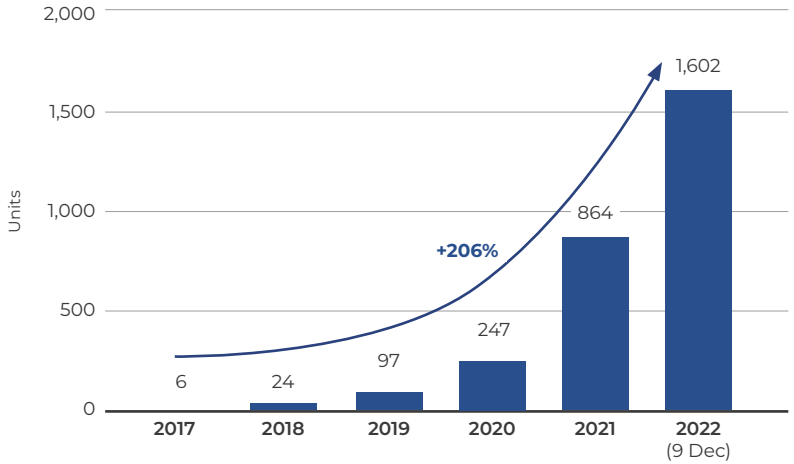
Sources: IESR analysis

- Fiscal incentive in the form of BBNKB discount is the most common policy adopted by sub-national governments to promote EV adoption following the issuance of MoHA Ministerial Regulation No. 1/2021. Each province has a different tax reduction rate; 30% in Central Java, West Nusa Tenggara, East Kalimantan, and Special Region of Yogyakarta, 10% in Bali, Banten, and East Java, unspecified in South Sulawesi, and 10% for E4W and 2.5% for E2W in West Java.
- DKI Jakarta has implemented a number of additional non-fiscal regulations. Currently, through TransJakarta, the province operates more than 30 units of E-bus, accounting for almost half of the total E-buses in Indonesia. Jakarta is looking to add another 300 units by 2023 and has signed a MoU to retrofit hundreds of ICEV buses into E-buses. Other cities such as Bandung, Surabaya, and Medan are becoming pilot regions for bus rapid transport (BRT) electrification. On top of that, starting 2023, Bandung and Surabaya will also receive 30 units of E-bus that were used in G20 events. MoT will manage the e-bus allocation by using the buy-the-service (BTS) mechanism.

Rapid growth of EV in Bali as a result of an intensive campaign and a supportive ecosystem

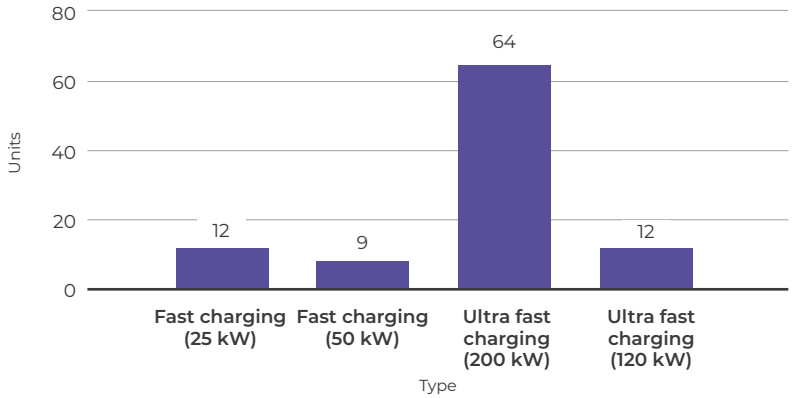
- Bali was the only province to follow-up the Presidential Regulation No. 55/2019 by enacting a stand-alone EV policy, i.e. Bali Governor Reg. No. 48/2019. Since then, Bali's EV adoption increased from 24 to 1600 vehicles in 2022, around 6% of the national EV adoption. During the G20 events in Bali, EVs were vigorously promoted and used as official vehicles, and about 300 vehicles were registered on the road since then (Department of Transportation Bali, 2022). The G20 and its "EV-only zone" policy has increased people's awareness towards EV (WRI, 2022).
- Bali's ecosystem also facilitates the development of converted EV. For example, Bali currently hosts 2 licensed E2W conversion workshops out of a total of 13 workshops in Indonesia. The Governor of Bali plans to use the converted E2W in tourist destination areas in 2023. In addition, the presence of EV community clubs in Bali helps to spread awareness about EV conversion and supports the growth of EV conversion workshops. There are also EV enthusiast groups willing to pay significantly more than the standard conversion price, even up to 5 times higher (WRI, 2022).
- Bali is working towards implementing the Regional Action Plan (RAD) for EVs in 2023 (WRI, 2022). The plan includes the establishment of 5 EV Zones, where hard and soft infrastructure for EVs is prepared. The hard infrastructure is SPKLU/SPBKLU, while the soft infrastructure is people's awareness about EV. According to WRI (2022), Balinese culture's emphasis on the importance of living in harmony with nature and therefore the need for more sustainable transportation modes have played a role in accelerating the adoption of EVs in Bali.

EV (2W and 4W) growth in Bali



Source: Department of Transportation Bali, 2022

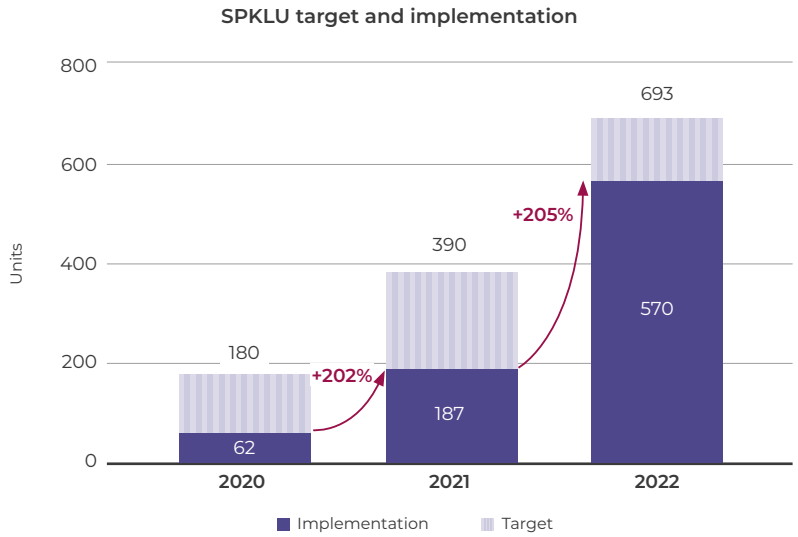
Number of charging infrastructure in Bali by types (Jan 2023)



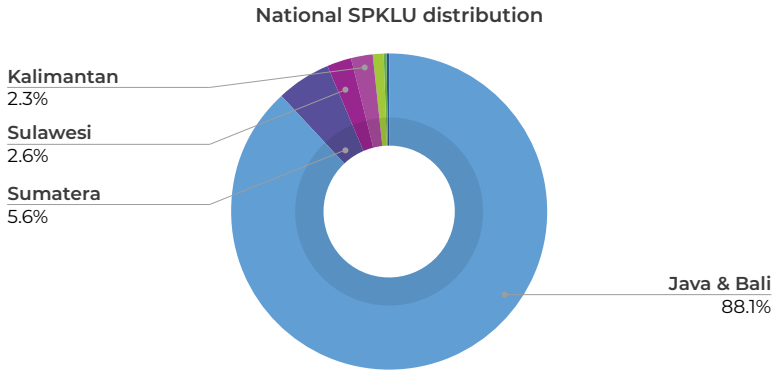
Source: WRI, 2023

Regulatory change, attractive business scheme, and port standardization are needed to encourage SPKLU investment

- In 2022, the number of SPKLUs has tripled from the previous year, reaching a total of 570 installed. However, the total number of installed SPKLUs is still around 20% below the government target. PLN stated per 2022, a total of 570 SPKLU has been installed which is 82% from the target in 2022, making it the biggest realization as compared to last two years. Despite that, they are not well-distributed as more than 88% of SPKLU is located in Java and Bali.
- Jakarta and Bali have the highest number of SPKLUs compared to other regions. One of the main drivers for the installation SPKLU is the G20 event, whose official vehicles are EVs. As a result, aside from Jakarta as the capital, a lot of SPKLUs can be found in Bali, where the G20 event was held. Except for these regions, the number of SPKLUs is relatively low.
- A government-initiated charging infrastructure deployment strategy is 4-7 times more cost-effective than offering incentives to consumers to encourage EV adoption (Foster et al., 2021). This is because each charger type caters to different needs of consumers. In Jakarta areas, almost 50% of the charging stations are slow charging stations, while the fast charging stations are operated by state-owned enterprises and located at their own sites, away from where they are most needed, i.e. highways/tolls. Therefore, a strategic deployment plan is needed to optimize SPKLU investment.



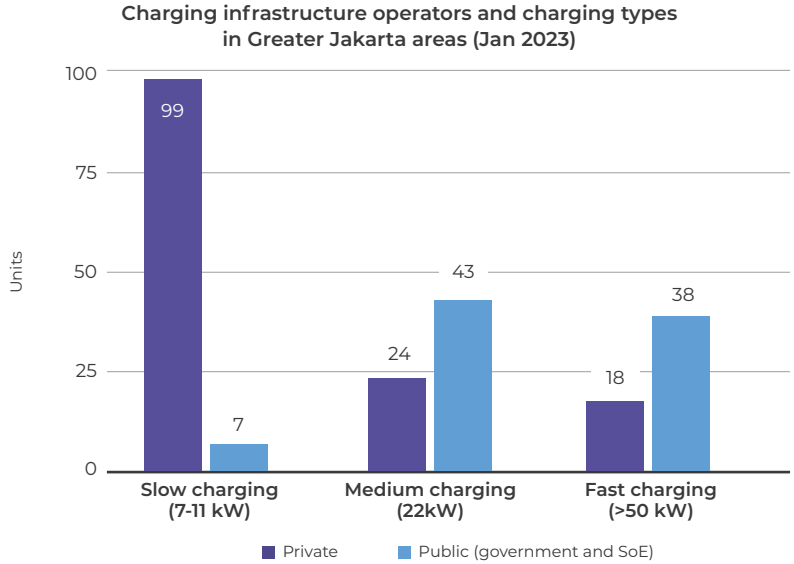
Source: PLN 2022, IESR 2021



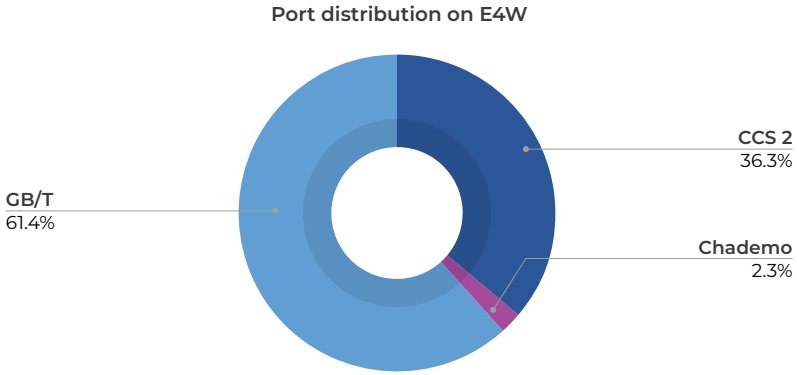
Source: PLN 2022

SPKLU is not well-distributed, hence strategic deployment is needed

- The existing regulation, MEMR Reg. No. 13/2020, is one of the main barriers of SPKLU development. It obliges every SPKLU to have 3 types of port: AC Type 2 port, DC charging CHAdemo, and DC charging CCS 2, which makes investment for SPKLU is unnecessarily expensive. It is estimated that investors need to invest between IDR 750 million and 1.5 billion per unit to build a SPKLU that complies with this regulation. However, some locations might be more suitable for slow or medium charging (<22 kW AC) that only cost IDR 25 - 50 million per unit.
- To attract investors, especially to invest in fast and ultra-fast chargers, PLN has introduced a business scheme called Investor Owned Investor Operate (IO2), which consists of 3 investment packages: medium charger, fast charger and ultra-fast charger. The offered scheme promises a gross income of IDR 7.6 to 20.3 million per month with capital investment of IDR 360 million to IDR 1.1 billion. However, the expected gross income in some of the offered schemes is too low and may not be able to cover operating expenses such as electricity tariffs, salaries, land rent, and interests.
- Port standardization also plays an important role in SPKLU investment. At the moment, E4W with GB/T type port dominates the market. However, this port does not support the fast-charging charger. Therefore, DC charging CCS 2 can be nominated as a standard port for fast charging in Indonesia, while the GB/T can be a standard port for medium charging. With converters between different port types widely available, standardization of charging ports should not be an issue for consumers.



Source: IESR analysis

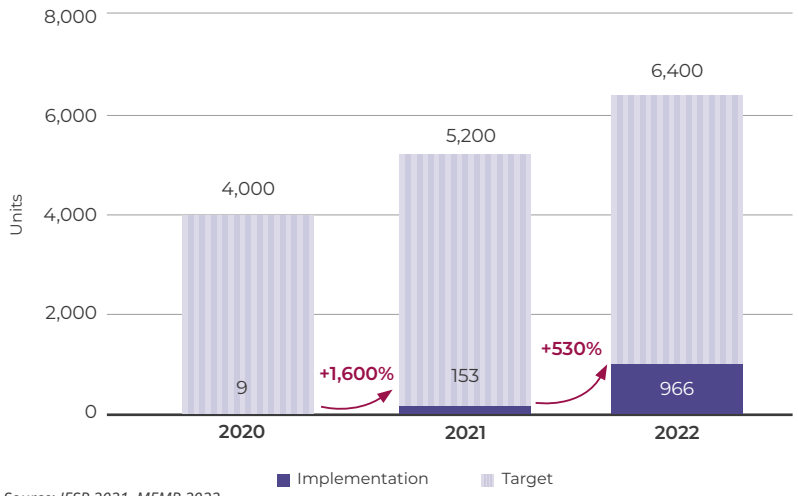


Source: Gaikindo (2022); IESR analysis
(Notes: Exclude Tesla)

Battery standardization could improve SPBKLU utilization rate, as it is still mainly utilized by commercial users

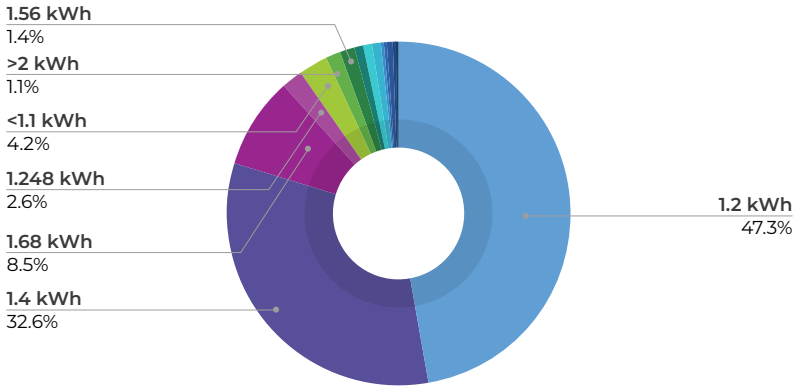
- E2W users have 3 options to recharge their batteries; home charging, destination charging or battery swap at SPBKLU. SPBKLU is more suitable for intensive users who do not have the time to charge the battery, such as ride-hailing or logistic drivers. On the other hand, private users with shorter travel distances could charge at home or at their destination, i.e. office. The growth of SPBKLU does not really affect their charging behavior, although it helps alleviate their range anxiety.
- The number of SPBKLUs in 2022 has increased by five-fold compared to the previous year. From the investment point of view, each unit of SPBKLU costs much lower than SPKLU. Most of the SPBKLUs are owned by E2W brands, especially those that work with ride-hailing companies. They own up to 700 SPBKLUs with a total of 180 thousand swaps over 1.5 years, an average of 330 swaps per day or 1 swap every 2 days per station. This is far below the expected utilization of 100 swaps per day per station (ADB, 2022).
- Although its number is growing significantly, each SPBKLU can only be utilized by a specific E2W model, because the battery capacity and size are designed for a specific model/brand. Battery standardization could be imposed to reduce the need for SPBKLU overextension and increase SPBKLU utilization rate. With standardized batteries, any E2W model could swap its battery at any swapping station.
- Currently, battery swapping stations could focus on 1.2 kWh and 1.44 kWh batteries, as these capacities are used by most E2Ws. In the future, battery specifications, such as size and electrical configuration, should be standardized to allow interchangeability across brands. However, the government needs to increase the battery standardization performance from time-to-time to raise the E2W performance standard.

SPBKLU target and implementation



Source: IESR 2021, MEMR 2022

Battery capacity distribution based on E2W type

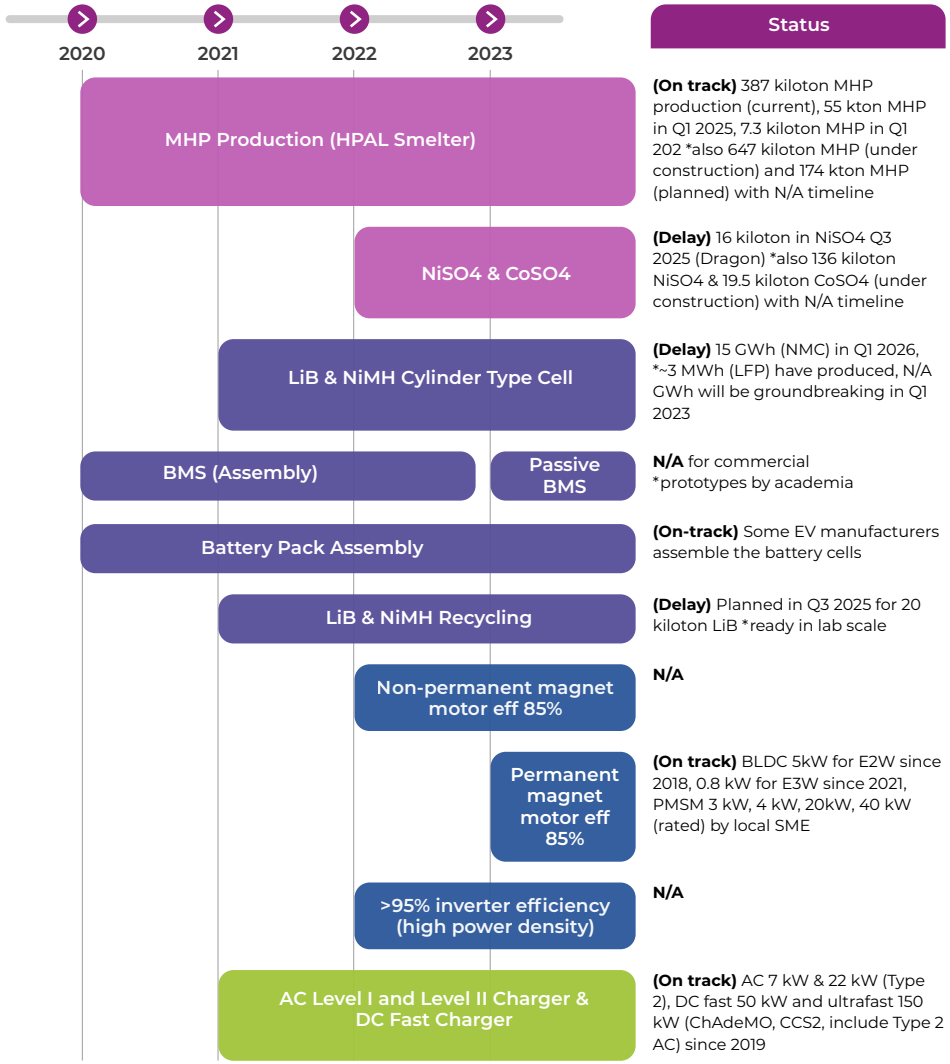


Source: MoT (2022), IESR analysis

MHP nickel-cobalt refinery of EV battery upstream sector leads the charge in achieving the government's electric vehicle industry roadmap

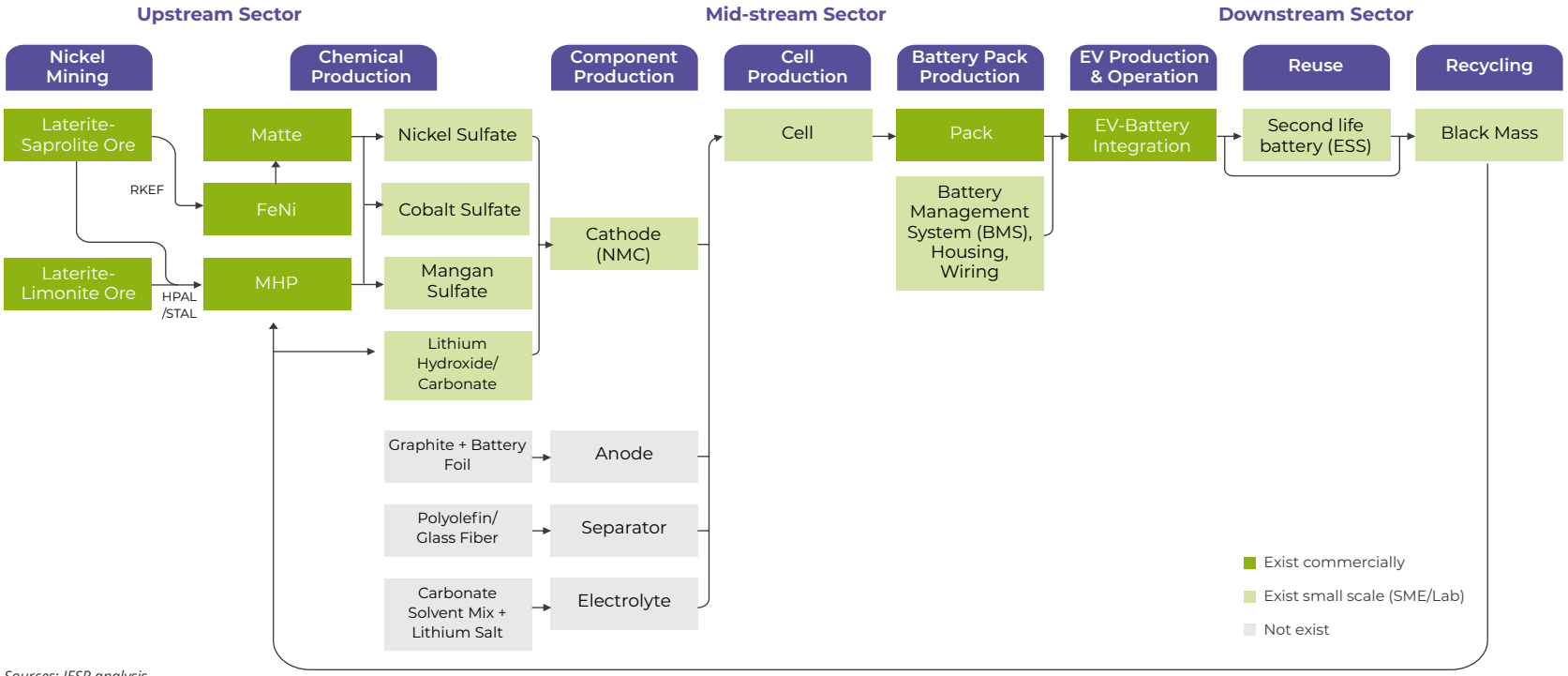
- Indonesia's growing nickel production sector is well-positioned to meet the demand for nickel-based batteries for EVs, driven by the Indonesian government's ban on nickel ore exports of ore with Ni content <1.7% (MEMR Regulation 11/2019). This has encouraged industries to invest in hydrometallurgical nickel refining facilities in the country, with at least 2 operating High Pressure Acid Leach (HPAL) nickel refineries and 5 more planned. The current HPAL facilities require 9.14 megaton/year of saprolite ore. Upon completion of the planned facilities, the total saprolite demand could reach 50.6 megaton per year, and the demand for limonite (<1.5% Ni) could reach 1.2 megaton per year.
- The existing HPAL facilities have the capacity to produce 386 kiloton/year of mixed hydroxide product (MHP). Upon completion of the constructed HPAL facilities, total MHP production is expected to increase by 657 kiloton/year, NiOH by 316 kiloton/year, which will be continued into 136 kiloton/year of nickel sulfate and 19.5 kiloton/year of cobalt sulfate.
- One of the refining industries is utilizing a proprietary technology and method, namely the Step Temperature Acid Leaching (STAL) modular reactor. The plant is planned to commence operations in Q2 2025, utilizing limonite ore with around 1.5% Ni content to produce MHP. The technology developer, a subsidiary company, is also exploring the potential of acid leaching and NCM technology to further process the MHP into NCM precursors.

Indonesian electric vehicle industry development roadmap progress



Sources: MoI Regulation 6/2022, APNI (2022), IESR analysis

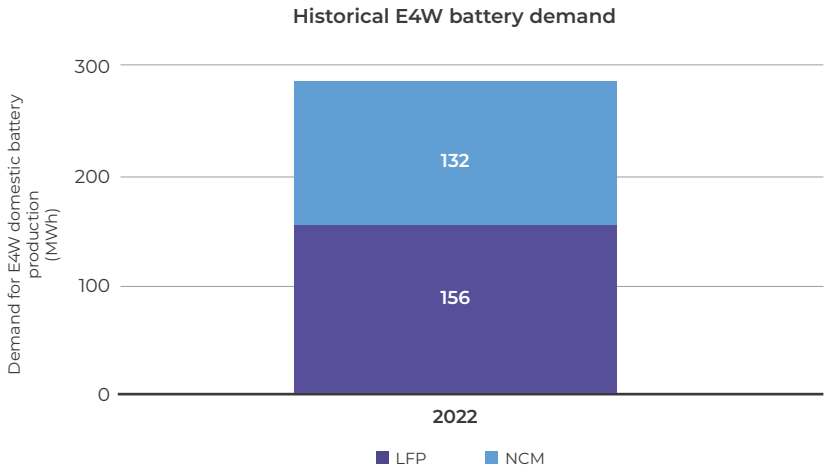
Indonesia's midstream industry is lagging behind in becoming a complete end-to-end producer of nickel-based EV batteries



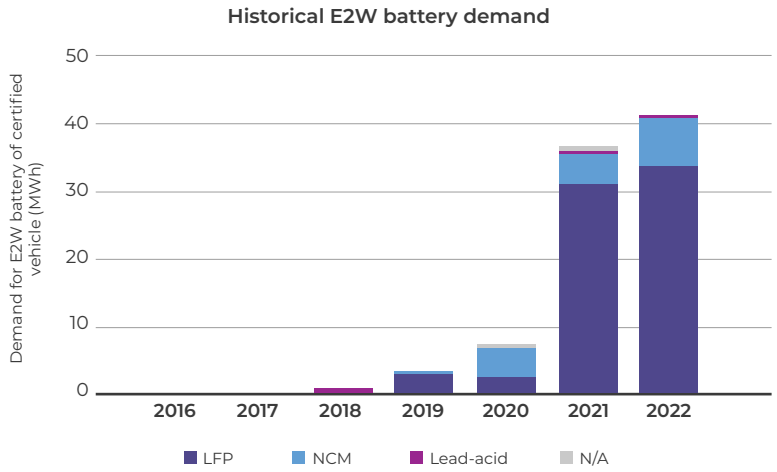
Sources: IESR analysis
(Notes: based on interview)

- The Indonesian government is securing lithium hydroxide supply through IA-CEPA and building a 60 kiloton/year lithium refinery for the midstream industry. However, a planned battery industry partnership (IBC-LGES) with a capacity of 30 GWh faces potential cancellation. Another project (IBC-CBL) is underway to set up active material production facilities with a planned start date in Q3 2025 and battery production facilities with a capacity of 15 GWh in Q2 2026. Investments from Foxconn-Indika and potential investments from Tesla offer growth opportunities for the industry, but uncertainty about the start date of battery production facilities still limits the absorption of MHP upstream products by the domestic EV battery midstream industry.

Accelerating the growth of Indonesia's domestic battery industry is crucial to meet current domestic demands



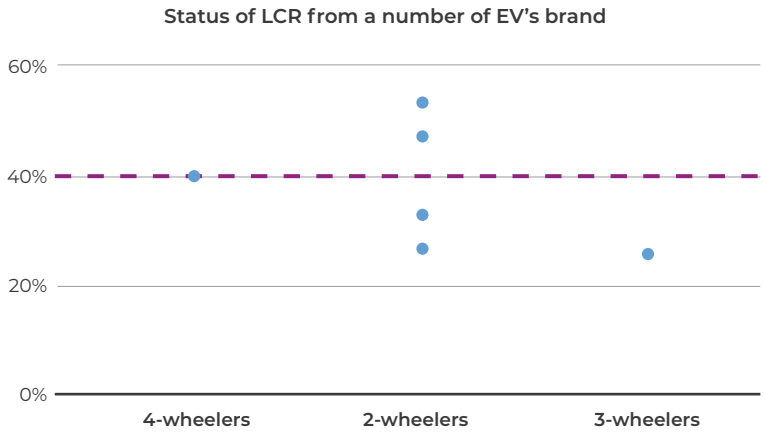
Source: Gaikindo (2022)
(Notes: November 2022; domestic production)



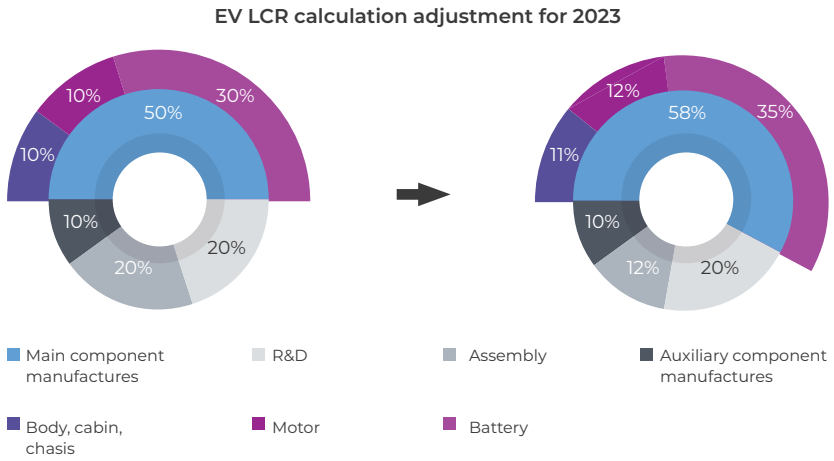
Source: MoT (2022)
(Notes: November 2022; not all of the E2W produced domestically; certified vehicle)

- Indonesia, a significant producer of nickel, promotes the development of high-nickel nickel-manganese-cobalt (NMC 811) batteries, which have a composition of 80% Ni, 10% Mn, and 10% Co. At the same time, lithium ferrous-phosphate (LFP) batteries are favored for their safety and longevity, despite having lower energy density. In the E4W market, NMC batteries are primarily used for SUVs, while LFP batteries are preferred for hatchbacks. In the E2W market, NMC batteries are employed for high-power motors (>2 kW) to make vehicles lighter.
- In 2022, the demand for batteries has reached 329 MWh, with LFP accounts for 57.7%, followed by NCM (42.2%) and lead acid (0.1%). However, the available domestic battery production capacity is only a fraction of that demand. Domestic LFP battery factories and SMEs have an estimated annual capacity of 4 MWh, or 31 thousand battery cells per day. One SME has sourced its active material cathode from another SME within the Universitas Sebelas Maret ecosystem. The potential of the NMC or LFP battery industry in Indonesia is still huge, and the growth potential can be seen from the comparison of the total available market with the existing production.

Challenges in underdeveloped battery industry hinder the government's efforts to promote the EV industry through LCR weighting adjustments



Source: P3DN MoI (2022)



Source: MoI Regulation No. 6/2022

- Currently, various E4W and E2W brands have achieved the government's LCR target of 40% by 2022. The targets will gradually increase to 60% for both E2W & E4W in 2024, 80% for E2W in 2026, and 80% for E4W in 2030. However, some EV industries could choose not to comply with the LCR assessment as it is not necessary for B2C sales. Opportunities to enforce the LCR emerge with the recent government plans to conduct public procurement for government official vehicles and provide customer incentives through Presidential Instruction No. 7/2022. To benefit from these government programs, manufacturers need to comply with the LCR.
- Encouraging the local production of main EV components is a crucial step for the industry as the weight of the LCR calculation in 2023 will shift from assembly to main components manufacturing. The weight of assembly will be lowered by 8% while the weight for battery, motor, and chassis manufacturing will increase by 5%, 2%, and 1%, respectively. This shift aims to accelerate the production of batteries and other main components. However, the implementation of a domestic end-to-end supply chain to meet the LCR criteria may face difficulties, given the lack of operational and even unbuilt battery manufacturing facilities.

Electrification in Aviation and Maritime Transport

Pintoko Aji

Contents:

Electric boats could emerge as a potential solution in Indonesia's small-scale fisheries

- In marine transportation, battery-powered vessels are not yet the most appealing option for zero-emission solutions due to their low energy density compared to other alternatives such as biofuels or synthetic fuels. This low energy density results in a reduction in cargo space, particularly for larger vessels such as cruises, tankers, containerships, bulk carriers, or RoPax. At present, battery-powered boats are only practical for very short-distance trips and small GT.
- In Indonesian context, electric boats seem to have a promising market in small-scale fisheries. This sector is currently facing economic challenges due to reduced access to subsidized fuel for fishing boats (*ketinting*). To address this challenge, several SMEs in Nusa Tenggara Barat, Bali, Batam, and Bangka Belitung have innovated by developing electric boats with low gross tonnage, ranging from 1 to 5 GT to replace their *ketinting*. These boats are powered by outboard, inboard, or *ketinting* engines. The switch to electric motors offers several advantages over standard motors, including lower fuel and maintenance costs, longer engine life, and reduced noise.
- While electric boats offer many advantages over conventional boats, their development faces several challenges. One of the major challenges is the high cost of batteries, which significantly contributes to the high upfront cost of the boat, which can be 11 times higher than conventional boats. However, the savings in operating and fuel costs could offset the higher upfront cost in the long run. The conversion to an electric boat is estimated to break even after 6 years of use.

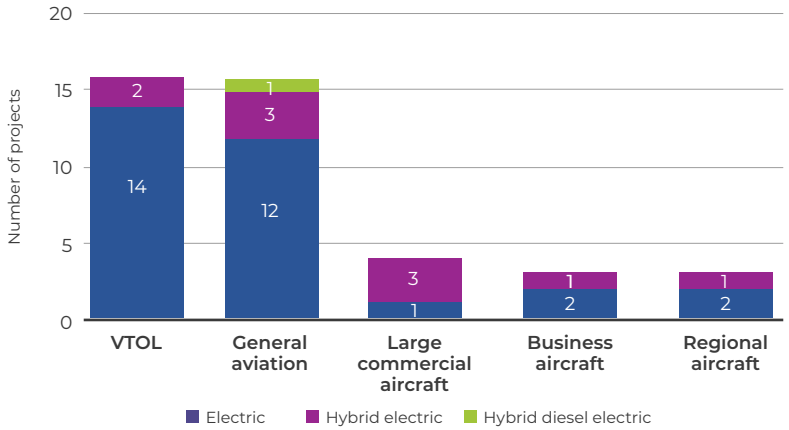
Electric *ketinting* fishing boat specification

Motor	1.5 kW
Battery	2.5 kWh (18 kg Li-On, 100A BMS)
Charging	1.5 hour
Mileage	15 nautical miles (~27.8 km)

Source: Azura Indonesia

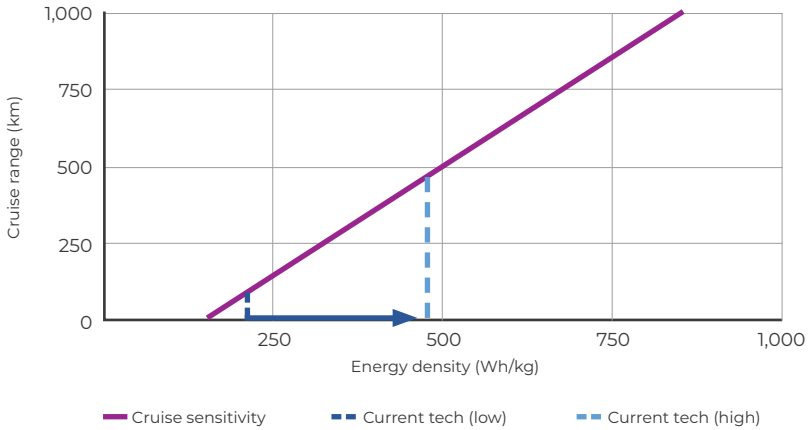
The aviation industry will still rely heavily on gas engines, but electric VTOL aircraft might be suitable for Indonesian context

Global electric/hybrid development projects



Source: E-HAPI ICAO

Cruise range sensitivity to battery energy density



Source: Volta Foundation, ICCT
(Notes: 9 bolt specification: weight 7.5 t, structure 4t, battery 2.6 t, payload 0.8 t)

- Globally, the aviation industry relies on sustainable fuels as an alternative to conventional fuels in its climate mitigation strategies. Adoption of electric aircraft still faces technical obstacles, particularly related to the energy density of the batteries. The reduced air density at high altitudes further exacerbates this constraint for battery-powered propeller. Thus, most of the global development of electric aircraft is focused on small aircraft such as VTOL and general aviation.
- Although the current generation of certified electric aircraft relies on batteries with an energy density of 144 Wh/kg, research into advanced battery technologies such as NCM 811, LSB, and solid-state batteries holds a promise to significantly increase the energy density to 500 Wh/kg. This could greatly enhance the cruise range of the electric aircraft.
- Despite the challenges, electric aircrafts have a potential market in Indonesia, particularly in the form of VTOL aircraft for areas with limited take-off and landing infrastructure. Aircraft manufacturers around the world are developing electric aircraft designs, especially in the VTOL segment, and these aircrafts are expected to enter the commercial market in the next few years.

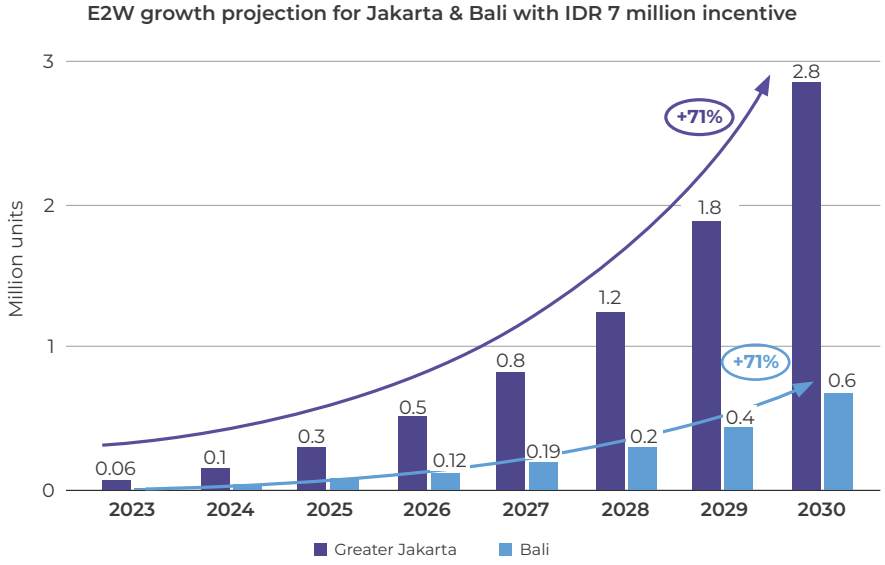
Outlook and Recommendations

Faris Adnan Padhilah
Ilham Rizqian Fahreza Surya
Pintoko Aji

Contents:

Huge adoption of E2W is expected, but a stronger regulation on the upstream and midstream industry is still needed to reduce prices

- Based on the historical growth of E2W, with 6 to 7 million motorcycles sold annually and 82% of Indonesian households owning a motorcycle, E2W adoption is expected to increase, especially considering the proposed IDR 7 million incentive. The incentive could result in approximately 40% price reductions on the market in 2023 for the average 1.5 kW models, 25% for the average 2 kW models and 22% for the average 3 kW models.
- With the IDR 7 million incentive, the Greater Jakarta area (Jabodetabek) is expected to adopt 67,000 E2W units in 2023, followed by 301,000 units in 2025, and 2,869,000 units in 2030 (ADB, 2022). While in Bali, 16,000 E2W will be adopted in 2023 and 677,000 in 2030 under the same scenario.
- To achieve the 2.1 million target (RUEN) in 2025, the government needs to invest USD 1.1 billion, which accumulates from upfront cost incentives and the installation of SPBKLUs. Meaning, the government is not only relying on brands to install SPBKLU.



Source: ADB, 2022

- Between 2022 and 2030, it is predicted that the TCO for E2W will decline by 9% per year due to competition and reduced battery prices (ADB, 2022). In 2023, IBC will supply 50,000 battery packs for domestic E2W use. The expansion of E2W will encourage manufacturer competition in the market, potentially driving E2W to lower prices, better features and quality. To maximize the growth of E2W and SPBKLU, the government must regulate battery standardization and force to increase the share of LCR, particularly in light of the fact that range anxiety continues to be a major concern for Indonesian private users.

Increasing interest from financing institutions based on historical trends and positive outlook

Financing for EVs credit payment (IDR billion)

Multifinance	2021 (EV only)	2022 (EV only)	2023 Outlook EV only	2022 (EV + ICEV)	Total financing	EV percentage (2022)
CNAF	14	50	100	9,200	9,200 (2022)	0.5%
ADMF	2	29.6	60 - 70	25,600	31,700 (2022)	0.09%
MTF	35.8	165.9	N/A	N/A	16,300 (2021)	1%

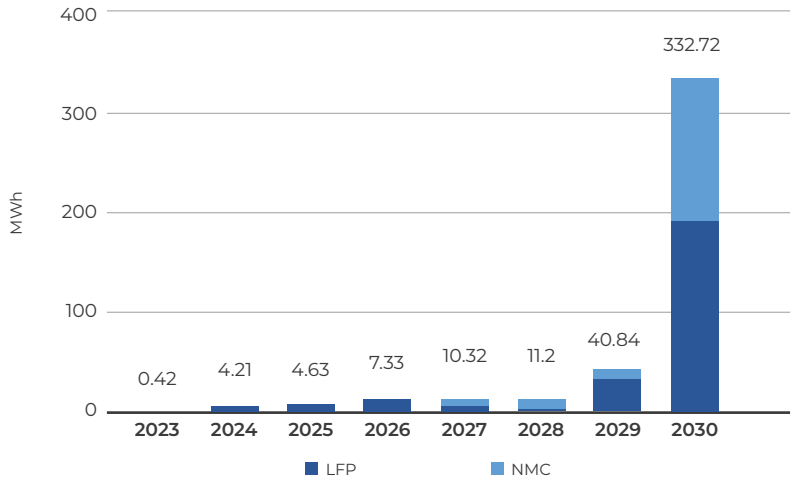
Sources: IESR analysis

- Between 2020 and 2022, EV financing for credit purchases added up to between IDR 600 billion and IDR 700 billion as financing companies started to finance EVs. These institutions predict that financing for EVs will boom by 2 - 3 times in 2023. More than three financing institutions to offer various payment schemes. Since OJK issued a Circular in 2022 stating that EVs could be bought on credit without a down payment (0%), this triggered notable multi-finance institutions to offer different payment scheme with incentives to customer. The incentives vary, for example 0% interest in the first two years, 0% interest for the first year but the down payment is only 10% and the term is longer (7 years), lower interest rates for E4W credit purchases in some areas, lower down payments than ICEV car purchases and price subsidies of IDR 2.5 million for some E2W brands.
- Despite the likely boom, there are several challenges in EV financing in both E2W and E4W related to the risks. The risk profile of EVs is different from ICEVs, because for EVs, vehicle values and battery values are separated. There is also uncertainty about battery reliability, future technological advancements, and residual value calculations, especially for E4W.

The government needs to enact several regulations and take actions to promote EV adoption and further decarbonize the transport sector

- Indonesia could learn from India's Faster Adoption and Manufacturing of Electric Vehicles (FAME) to incentivize EVs. Incentives should include specific parameters related to EV performance as considerations for giving incentives, such as motor power, battery capacity, distance traveled on a single battery cycle, and top speed to force the industrial sector to adopt the most recent technology. Higher performance makes the EVs eligible for more discounts. Incentives for public transportation could also be designed to get more discounts than private vehicles.
- The government should prioritize EV incentives for public transportation, E2W (new build or retrofit), and charging infrastructure. Public transportation incentives are intended to further support decarbonization strategies by making the shift strategy more attractive and affordable. Incentives for E2W might significantly benefit those who use it to earn a living, such as ride-hailing or logistic drivers, as the driver can save more money for the user and a quicker payback period from the government. Providing incentives for investment in charging infrastructure has been proven to be 4–7 times more effective than direct EV incentive programs. The government must take the lead in driving infrastructure investment in key locations.

Battery waste potential based on certified EVs historical data



Sources: IESR analysis

- The mandatory of three charging ports in SPKLU needs to be changed to one standard port in Indonesia to encourage investment in charging stations. Standardization of battery size, shape, and other electrical specifications is also necessary for SPBKLU to allow interchangeability across brands. The government can start by formulating the battery standard specifications and the interchangeability of the battery in the ministerial regulation.
- The government needs to enact regulations to address the accumulation of EV battery waste. It is estimated that the battery waste could reach 410 MWh by 2030. The three options to handle this challenge are disposal in a junkyard, extraction of the raw materials, and refurbishing the battery so that it can be used as a stationary energy storage system in various applications.

B2B and government adoption as early adopters could provide a viable initial market

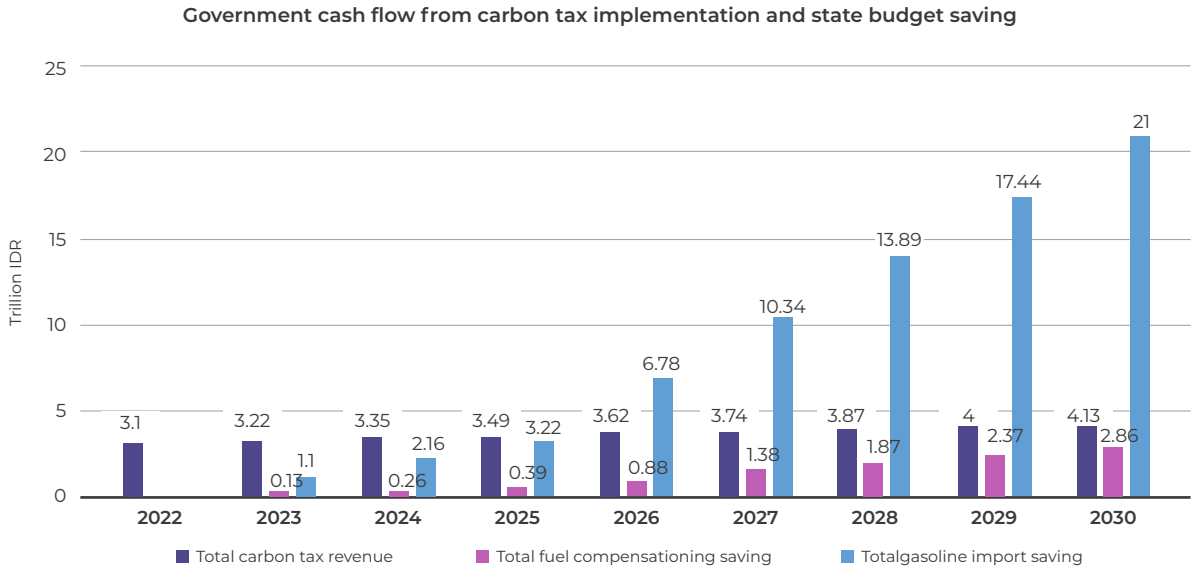
2022 B2B adoption status (selected brands)

Sector	Total fleet size	EV fleet size
Ride-hailing	5,000,000	9,000
Conventional transportation	17,787	120
Expedition	62,700	10,348
Other	N/A	260

Sources: IESR analysis

- The B2B adoption will come before the retail adoption (commercial use). Even though there are not any rules yet, ride-hailing and logistics companies have set their own goals to be carbon neutral by 2030 or 2040. Two of the largest ride-hailing service companies have promised to have all of their vehicles electric by 2030 or 2040. According to reports, the two companies operate about 5 million vehicles in the country, which means that they will purchase more than 290,000 electric vehicles (mostly E2W) per year until 2040.
- E-bus is also getting incentives. E-buses will help BRT electrification, but it remains to be seen whether the infrastructure and management in sub-national regions, especially outside of Jakarta and Bali, are ready to support BRT electrification. In Surabaya, the ex-G20 E-bus service was stopped after only two weeks due to battery and charging problems. In the same way, Bandung had temporary problems with administration and spare parts. Improving the capacity of local governments to manage E-Bus fleets should be a top priority.
- One benefit of the B2B approach is that it provides a viable initial market for EV manufacturers. In fact, more than 19,000 EVs or around 57% of total registered EVs by 2022 are for B2B use. Other benefits of B2B adoption include the fact that fleet managers understand vehicle lifetime costs better than retail buyers, centralized refueling (charging), a high rate of vehicle purchases (bulk buying), heavy use, fixed routes (logistics companies), compliance with government regulations, and a better public image (Khan et al., 2021; Sierzchula, 2014). However, businesses still prefer ICEVs with high power and speed due to their efficiency, which slows down B2B adoption (ADB, 2022).
- The government can also be considered as an early adopter, since it buys new cars every year. Due to the Presidential Instruction No. 7/2022 and other sub-national initiatives, the government will buy more electric vehicles in 2023. The retail market can then begin to grow as B2B and government adoption makes the market more mature.

Carbon tax could provide funds to incentivize EV and build charging infrastructure



Source: IESR Analysis
Note: Assuming constant price with no inflation

- Disincentivize ICEV through a carbon tax provides the government with additional funding to support road transport decarbonization plans without burdening the state budget. Carbon tax has been regulated in the Law on Harmonization of Tax Regulations No. 7/2021. The tax price is IDR 30,000 per ton of CO_2 or IDR 30 per kg of CO_2, assuming the same price as for coal-fired power plants in the mentioned regulation and will apply to ICE vehicle operation (tank-to-wheel emissions). However, this regulation needs supporting regulations to ensure that the carbon tax works as intended.

- Assuming ICEV consumers are liable to pay the carbon tax every year during the annual payment period of vehicle registration, they should pay the carbon tax every year for as long as they still own the ICEV. 2W and 4W owners should pay around IDR 11,495 and IDR 96,350 each year, respectively. The total carbon tax revenue can reach around IDR 3 trillion per year.

- If consumers decide to switch to EVs, the government will lose the revenue that the transport sector receives from the carbon tax policy. However, the government can save the state budget from fuel subsidy compensation costs and import costs starting from around IDR 1 million and IDR 3 million per 2W and 4W shifted to EVs, respectively. In this case, it is estimated that switching one 2W to E2W will save around IDR 1.38 million, and for the case of 4W to E4W, it can save around IDR 2.98 million for each 4W switched to E4W per year.

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APPENDIX - Other Asian countries are advancing their EV policies to encourage more adoption

Country	EV Targets	Ban/Restrictions/Disincentives on ICEV	Incentives: tax exemptions (TE), tax reduction (TR) and/or cost reductions (CR)	Charging infrastructures (units)
China	100% EV by 2035	2035 ICEV ban (50% EV:50% hybrid)	1. CR: USD 1500 - 3600 2. TR: 50% vehicle registration fee 3. TE: USD 1000s TE 4. CR: USD 72,000 for FCEV bus/truck	1.1 million in 2022
Singapore	1. 100% vehicle running on cleaner energy by 2040 2. 100% zero-emission vehicle (ZEV) sales by 2030	1. 2040 ICEV ban 2. Stopped issuing licenses for diesel-powered cars & taxis in 2025	1. CR: USD 34,000 2. TR: 34% road taxes for 90-230 kW EV	1. 3,000 in 2022 2. 60,000 by 2030
South Korea	33.3% EV by 2030 (3.62 million units)	2035 ICEV ban	CR: USD 7,867 - 23,601	1. 170,000 in 2022 2. 1.8 million by 2030
India	1. E4W: 30% by 2030 2. E2W: 40% by 2030	2030 ICEV ban	1. CR: USD 244 each for 100,000 E2Ws 2. CR: USD 1800 for 35,000 E4Ws 3. CR: USD 158 - 244 for HEVs	1. 1,640 in 2022 2. 23,524 by 2030
Thailand	1. 5.4 million units by 2030 2. 50% of total EVs are domestically produced by 2030	2035 ICEV ban	1. CR: USD 2,100 (10 - 30 kWh) - 4,500 (>30 kWh) for E4W 2. CR: USD 550 for E2W	1. 2,572 in 2022 2. 12,000 by 2030
Malaysia	Undefined	Undefined	1. TE: for CBU (2023) and CKD (2025) EVs 2. TR: 590 USD	1. 700 in 2022 2. 10,000 by 2025
Vietnam	3.5 million units by 2040	1. Motorbike restrictions in major cities in 2030 2. ICEV registration fee increase 50% by 2027 3. Nationwide ICEV ban by 2050	TE: Registration fee exemption until 2027	1. 40,000 in 2022 2. 150,000 target
Indonesia	1. E2W: 13 M by 2030 2. E4W: 2M by 2030	Undefined (did not sign the 100% EV pledge during COP26)	1. TE: Luxury Goods Tax 2. CR: USD 470 for E2W (proposed)	1. 570 in 2022 2. 25,000 by 2030

Source: Adapted from McKinsey (2022)

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