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Roadmap to zero

The pace of Indonesia's electric vehicle transition

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FOREWORD

Indonesia pledged its target of net-zero emissions by 2060 or sooner as part of global efforts to curb the negative impacts of climate change. In achieving the net-zero target, the transportation sector, as the second-largest emissions contributor in Indonesia, needs to be transformed so that the emissions trajectory from the transport sector is aligned with a net-zero pathway. Electric vehicles (EVs) are an important component of achieving Indonesia's net-zero emissions goal, as they emit no tailpipe emissions and are the future of clean mobility. Indonesia has seen EV market growth over the last few years, and this can be seen as a good signal that the country is on the right track to decarbonize its transportation sector.

However, the transition to EVs demands both vision and action. As we embark on this journey, the creation of a clear, strategic roadmap is essential to navigate the challenges and opportunities ahead. This roadmap document could be used as a comprehensive guide, as it outlines the key steps and milestones necessary for achieving Indonesia's goal of decarbonizing its transport sector. The development of this roadmap was a collaborative effort between the Coordinating Ministry for Maritime Affairs and Investment, where I was previously Deputy Coordinator for Infrastructure and Transportation, and the International Council on Clean Transportation. This also reflects our commitment to fully charge the EV transformation in Indonesia.

Lastly, I hope that this roadmap will not only inspire all stakeholders and decisionmakers to continue building policies to enable rapid adoption of EVs, but to also consider this as a blueprint for future action related to transport decarbonization and subsequently contribute to the achievement of the net-zero emissions target.

Jakarta, February 2025

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WORKING PAPER

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INTRODUCTION

Road transport contributes to substantial environmental and public health challenges in Indonesia. It accounts for about 22% of total energy-related greenhouse gas (GHG) emissions in the country and is also a major source of air pollution (International Energy Agency [IEA], 2022; Government of Indonesia, 2021), with road vehicles estimated to be responsible for 4,500 premature deaths annually as of 2015 (Anenberg et al., 2019). Given the rapid growth in Indonesia's vehicle stock—from 2015 to 2024, it grew by an average of 5% annually despite a slowdown during the global pandemic (Indonesia Statistics, 2016, 2022, 2024)—GHG emissions and air pollution are likely to continue to increase unless there is a shift to new, clean vehicle technologies.

Table 1 summarizes characteristics of the road transport sector in Indonesia by vehicle type.[1] The analysis in this paper was conducted in 2024, and 2023 was used as the base year for all assumptions. While two-wheelers are the vast majority of the vehicles on Indonesia's roads, four-wheelers (passenger cars and light commercial vehicles [LCVs]) and medium and heavy trucks are responsible for much larger shares of transport fuel consumption and associated carbon dioxide (CO_2) emissions. Additionally, although the table indicates that zero-emission vehicles (ZEVs) were a small share of new vehicles sold in 2023, other data show that electric sales increased in 2024 for all vehicle types (Kurniawan & Kurniawan, 2024; KumparanOTO, 2024).

Table 1
Characteristics of Indonesia's road transport sector as of 2023

Segment	Two- and three-wheelers	Passenger cars	Light commercial vehicles and medium and heavy trucks	Buses
Share of road transport energy use[a]	15%	28%	56%	1%
Cumulative registered vehicles[b] (millions)	133	19.7	6.1	0.27
Number of new sales[c] (thousands)	6,185	791	77.6	6.3
Number produced in Indonesia[d] (thousands)	6,807	1,180	209	6.7
ZEV share of new registrations[e]	1%	2%	<1%	1%

[a] Projection using ICCT's Roadmap Model (2024)
[b] Indonesia statistics (2024)
[c] Shared with authors by Indonesia's Ministry of Energy and Mineral Resources (two-wheelers) and Gaikindo (2024) for all others
[d] Asian Automotive Analysis (2024a) and Asian Automotive Analysis (2024b)
[e] Shared with authors by Indonesia's Ministry of Energy and Mineral Resources

1 Vehicle types are defined herein as: two- and three-wheeled vehicles; passenger car (four-wheeled passenger vehicle with gross vehicle weight [GVW] < 3.5 tons); light commercial vehicle or light truck (commercial vehicle with GVW < 3.5 tons); medium truck (commercial vehicle with GVW 3.5–15 tons); heavy truck (commercial vehicle with GVW >15 tons); and bus (passenger vehicle with GVW ≥ 3.5 tons). GVW includes the empty weight of the vehicle and passenger/cargo capacity.

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Transitioning to ZEVs is a key strategy that, if expanded and accelerated, could significantly contribute to reaching Indonesia's goal of net-zero emissions by 2060 (Government of Indonesia, 2021; Sen & Miller, 2023). At the same time, the government has signaled an intent to expand domestic ZEV manufacturing as an industrial strategy by setting production targets for ZEVs in different vehicle segments (Ministry of Industry, 2022). The wide variability in technical characteristics, use, and emissions across vehicle types means that Indonesia's transition will unfold differently for each vehicle category. This paper presents ambitious-but-feasible timelines for the transition to zero-emission two- and three-wheelers, four-wheelers (cars and LCVs, which are vans and light trucks), buses, and medium and heavy trucks in Indonesia. For each vehicle type, we start with a brief review of the market and key factors driving the pace of the transition (e.g., vehicle cost and infrastructure needs). We then provide trajectories for the ZEV share of new vehicle sales in Indonesia from 2025 to 2060 under four scenarios.[2]

Based on the four scenarios, we project ZEV sales and stock for each category, and also energy consumption and CO_2 emissions from road transport using ICCT's Roadmap Model version 2.9 (2024). This is complemented by additional analyses of avoided fossil fuel consumption and energy subsidies. This paper is the first in a series that provides a roadmap for an ambitious transition to ZEVs in Indonesia.

DESCRIPTION OF SCENARIOS

We modeled four scenarios: two that reflect ZEV growth that could put Indonesia on a pathway to reach net-zero emissions from road transport by 2060 (Net Zero and Best Practice) and two reference scenarios (Reference and Announced Targets 2050) that are generally consistent with the levels of ZEV uptake in the Stated Policies Scenario (STEPS) and Announced Pledges Scenario (APS) from the IEA and Ministry of Energy and Mineral Resources 2022 report, *An Energy Sector Roadmap to Net Zero Emissions in Indonesia*. The Reference scenario is generally consistent with the ambition of the 2022 STEPS scenario and reflects a conservative outlook for ZEV uptake in which only two-wheelers and buses achieve substantial ZEV sales shares by 2060. The Announced Targets 2050 scenario is generally consistent with the ambition of the 2022 APS and signals the aspirations of the Indonesian government at that time to reach 100% ZEV sales by 2050 for all vehicle types except medium and heavy trucks. It assumes vehicles that are powered by gasoline engines transition to ZEV technology and reach 100% ZEV sales by 2050, while trucks continue to be predominantly internal combustion engine technologies.

The other two scenarios result in a faster transition to ZEVs than the Reference and Announced Targets 2050 scenarios. The Best Practice scenario sets out ambitious-but-feasible trajectories for ZEV sales shares that would align Indonesia with other major markets and with international commitments for achieving 100% ZEV sales. Here ZEV trajectories climb swiftly to reach a 100% sales share for all vehicle types no later than 2040. These ZEV sales share trajectories are broadly consistent with the ambition of the ICCT's global Ambitious scenario, which is compatible with limiting warming to under 2 °C (Sen & Miller, 2023). For four-wheelers, buses, and trucks, ZEV uptake is modeled assuming S-curve pathways. Although government targets were an important defining feature of this scenario, total cost of ownership (TCO) and upfront price forecasts and considerations about the difficulty of constructing charging infrastructure were incorporated into our assessment of feasible ZEV trajectories. To reach net-zero emissions from road transport by 2060, the Best Practice scenario assumes a scrappage program is phased in from 2055–2060 to ensure removal of any remaining internal combustion engine vehicles by 2060.

2 In all scenarios, ZEVs are assumed to include only those vehicles with zero tailpipe emissions: battery electric vehicles and hydrogen fuel-cell electric vehicles. Hybrids and plug-in hybrids are not included, although they may play a part in providing incremental reductions in emissions from the non-ZEV fleet. Additionally, we do not assume that any kind of powertrains would be prohibited ahead of reaching 100% ZEV sales.

The Net Zero scenario is a more gradual approach in which ZEV sales ramp up slower than in the Best Practice scenario but still reach 100% in time to align with Indonesia's 2060 goals. This scenario is not designed to meet other government targets such as 2030 ZEV stock targets, nor does it consider international commitments on ZEV adoption. In this scenario, ZEV sales share trajectories for all vehicle types follow an S-curve pathway and reach 100% no later than the latest year that is consistent with Indonesia's 2060 net-zero target. Four-wheelers, buses, and trucks are assumed to reach 100% ZEV sales no later than 2045, based on the assumption that a 15-year age limit could be put in place to scrap any remaining internal combustion engine vehicles by 2060. Two-wheelers are assumed to reach 100% ZEV sales in 2040, earlier than cars, coaches (which are part of the bus category), and trucks because they cost less to purchase and have simpler infrastructure needs.

TRAJECTORIES FOR THE ZEV TRANSITION BY VEHICLE TYPE

TWO- AND THREE-WHEELERS

Two-wheelers are the backbone of Indonesia's passenger transport system and make up over 80% of all vehicles on the road. Even though each two-wheeler consumes less fuel than a car or truck, two-wheelers still represent about one-fourth of road transport GHGs, and they are a major source of air pollution in urban environments (IEA, 2022; Institute for Transport & Development Policy, 2024a).

The zero-emission two-wheeler market in Indonesia is growing—it tripled from 2022 to 2023—but ZEVs were still only around 1% of total new two-wheeler sales in 2023. In other countries, the electric two-wheeler market is more advanced. In India, electric two-wheelers were 5% of new two-wheeler sales in 2023, Vietnam reached a 9% electric two-wheeler sales share that year thanks to strong electric moped sales, and China soared to 35% of new sales in 2023 (IEA, 2024).

The Indonesian Ministry of Industry (2022) established production targets for electric two- and three-wheelers for 2020–2035, in alignment with Presidential Regulation 55/2019 on battery electric vehicles, and it aims to reach an annual production of 12 million electric two- and three-wheelers in 2035. To jumpstart this, the government introduced Rp 7 million (approximately US$430, based on an exchange rate from October 2024 that we used throughout this paper) purchase incentives for two-wheelers through Ministry of Industry Regulation 6/2023; criteria for the incentive were widened in 2024 after initial interest was low (El Rizani, 2024).[3] Over 65 electric models are available for purchase in Indonesia, and they come in a variety of styles and ranges. As of 2024, 59 factories in Indonesia were producing electric two-wheelers, and their total production capacity exceeded sales volume by more than tenfold (Shah & Dalal, 2023; CNN Indonesia, 2024). This suggests a growing market could support additional domestic jobs and investment.

Considerations for the pace of electrification

As of 2023, electric two-wheelers in Indonesia had a roughly 50% higher upfront price than gasoline two-wheelers. However, under current policies, the Institute for Essential Services Reform (2023) estimated that electric two-wheelers already have a slightly lower TCO over 40,000 km; this is due to lower fuel and maintenance costs and exemption from the title transfer fee. Two-wheelers that have been converted from gasoline to electric have an even lower TCO when incorporating government subsidies (Institute for Essential Services Reform, 2023). An Asian Development Bank (2022)

3 The exchange rate used was US$1 = Rp 15,535.

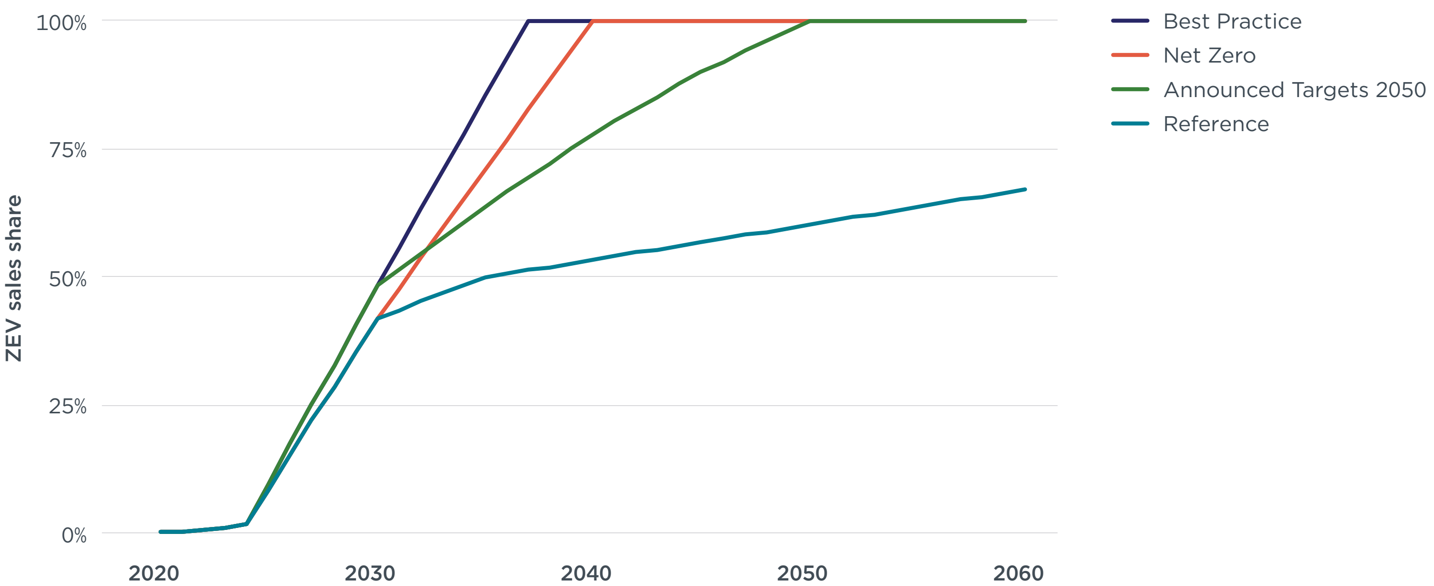
report projected that the TCO of electric two-wheelers will decline by 9% annually through 2030 and that electric two-wheelers will have lower purchase prices than conventional models by 2030.

Among all vehicle types, two-wheelers have the lowest hurdles to charging. Different models of two-wheelers may use battery swapping or direct charging, and in either case can use a standard 230V household power outlet. Some companies are also constructing battery-swapping stations for commercial drivers, particularly ride-hailing and delivery services (Asian Development Bank, 2022). This suggests that this segment could electrify quickly.

Trajectories for electrification

Figure 1 shows the four trajectories that we modeled for the electric sales share of new two- and three-wheelers from 2020 to 2060. These are projected to grow steadily across all scenarios after 2025. In the Reference scenario, sales grow to 40% by 2030, with growth then increasing at a gradual pace to a 67% share by 2060. The other scenarios show stronger sustained growth for electric two- and three-wheelers, with sales shares approaching 50% by 2030 (by which point electric options are projected to have roughly similar purchase price) and increasing linearly to reach 100% by 2037, 2040, and 2050 in the Best Practice, Net Zero, and Announced Targets 2050 scenarios, respectively.

Figure 1
Modeled zero-emission vehicle sales shares for two- and three-wheelers



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FOUR-WHEELERS

Four-wheelers—passenger cars and LCVs—are a major contributor to road transport energy demand and GHG emissions in Indonesia, and this sector is growing rapidly, with new sales projected to increase by up to 6% annually through 2030 (Hall et al., 2024).

Considerations for the pace of electrification

Most battery electric four-wheelers sold in Indonesia in 2023 were made by foreign brands, and at least four manufacturers headquartered in China and two Korea-headquartered automakers have committed to setting up or increasing their ZEV manufacturing in Indonesia (Antara, 2024). Because Chinese manufacturers offer the lowest electric vehicle prices globally, this dynamic could allow Indonesia to see less expensive electric vehicles while developing local jobs and electric vehicle supply chains, as seen in Thailand (JATO Dynamics, 2025; Wakabayashi & Fu, 2024). In 2023, 60% of new battery electric vehicles sold in China were less expensive than the most similar gasoline vehicle (IEA, 2024). Research suggests that by the late 2020s, electric cars and sport utility vehicles in China with ranges of up to 600 km will be less expensive to purchase than gasoline equivalents (Lutsey et al., 2021). In Indonesia, the electricity cost on a per-kilometer basis for an electric four-wheeler is only 31% of the cost of fueling a gasoline vehicle (Mahalana et al., 2023).

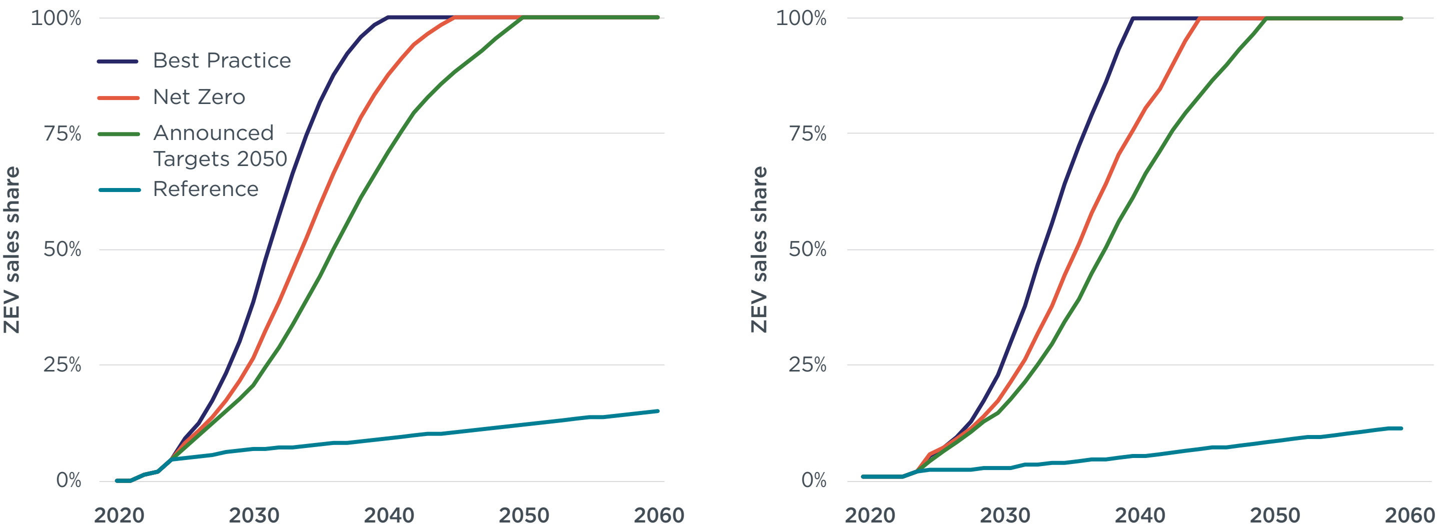
Because Indonesia's housing stock is primarily single-family houses rather than apartment complexes, most drivers will be able to meet most of their charging needs from home using the portable charger provided with the vehicle at a standard outlet, or they can charge more quickly using a wall charger they purchase for an additional cost (Kristiana et al., 2024). Nonetheless, a robust public charging network will be required to enable long-distance travel and support those without access to home charging.

Trajectories for electrification

For four-wheelers to contribute to a net-zero road transport sector by 2060, ZEV sales shares would have to continue to grow and reach 100% by 2040 or soon after. Figure 2 shows the four modeled ZEV sales share trajectories for two four-wheeler segments in Indonesia, passenger cars on the left and LCVs on the right. Although cars and LCVs reach 100% ZEV sales in the same year (2040 in Best Practice, 2045 in Net Zero, and 2050 in Announced Targets 2050), cars see slightly higher ZEV sales shares than LCVs leading up to that point; this matches trends in other markets. In the Reference scenario, cars and LCVs electrify at a slower rate, and both remain below 20% through 2060.

Figure 2

Modeled zero-emission vehicle sales shares for passenger cars (left) and light commercial vehicles (right)



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In the Best Practice scenario, passenger cars surpass 50% ZEV sales by 2032 after reaching TCO parity with conventional combustion engine cars in the mid-2020s. Purchase price parity is also expected around 2030, depending on segment and range, and that paves the way for continued growth to 100% ZEV sales in 2040. This trajectory would put Indonesia a few years behind leading markets such as the European Union, the United Kingdom, Canada, and California, which have committed to reaching 100% ZEV sales for cars in 2035 (some of these governments also allow certain plug-in hybrids; EV-Volumes, 2025; Accelerating to Zero Coalition, n.d.; ZEV Transition Council, n.d.). Although China has not set long-term targets, its electric vehicle market is likely to move at a similar or faster pace at least through 2030 as a result of falling prices and consistent policy support from national, provincial, and local governments. The Net Zero scenario shows passenger cars electrifying at a slower pace, surpassing 50% ZEV sales in 2034 and achieving 100% ZEV sales in 2045.

MEDIUM AND HEAVY TRUCKS

Medium and heavy trucks are the source of a higher share of fuel consumption, GHG emissions, and air pollution in Indonesia than their share of the vehicle stock (IEA, 2022). As with four-wheelers, their activity is expected to grow rapidly as Indonesia's economy expands in the coming decades: in our modeling, the number of trucks on Indonesia's roads increases by over 300% by 2060. Trucks also tend to remain on the road longer than smaller vehicles.

Considerations for the pace of electrification

This category of vehicles (defined as N2 and N3 in the UN Economic Commission for Europe vehicle classification system) contains a wide variety of sub-segments and use cases, and electrification of each sub-segment will proceed at a different pace. The electric truck industry in Indonesia is nascent: There are no models available for sale and no real-world data on costs. In other markets in Asia, electric trucks tend to cost more upfront than diesel equivalents but offer savings in fuel and maintenance costs (Kaur et al., 2024; Mao et al., 2021). Studies have shown that operating costs exceed the vehicle's purchase costs over a diesel truck's lifetime (Basma et al., 2021; Mao et al., 2021), and fleet owners/operators are highly motivated by TCO rather than purchase price. In Indonesia, electric truck adoption is expected to occur first in segments like urban delivery vehicles and short-haul trucks, which are expected to have smaller upfront price premiums, shorter range requirements, and higher prevalence of depot-based charging. In other markets, existing zero-emission products already provide the same performance as diesel trucks in these segments, and there are more electric vehicle models available for sale than there are for larger trucks (CALSTART, 2024a).

In China, hundreds of thousands of electric trucks are in service across diverse applications, particularly in major cities and in industrial settings, where battery swapping is being deployed to enable high utilization of the trucks (Mao et al., 2024; McKerracher, 2024).

Beyond China, zero-emission trucks are produced by almost all major truck manufacturers, including Mitsubishi (the eCanter), Isuzu (NRR EV), Tata (Ultra T7), Hino (L6e and M5e), Daimler (many models, including the eActros and the all-electric Rizon brand), and Volvo (FM and FMX Electric); there are also many newer manufacturers seeking to expand globally (CALSTART, 2024b; Shen et al., 2024). Though primarily distributed in markets with strong supply-side regulations like the European Union and the United States, hundreds of medium and heavy electric trucks have been sold in other countries, including Brazil, Japan, India, New Zealand, and Thailand (EV-Volumes, 2025).

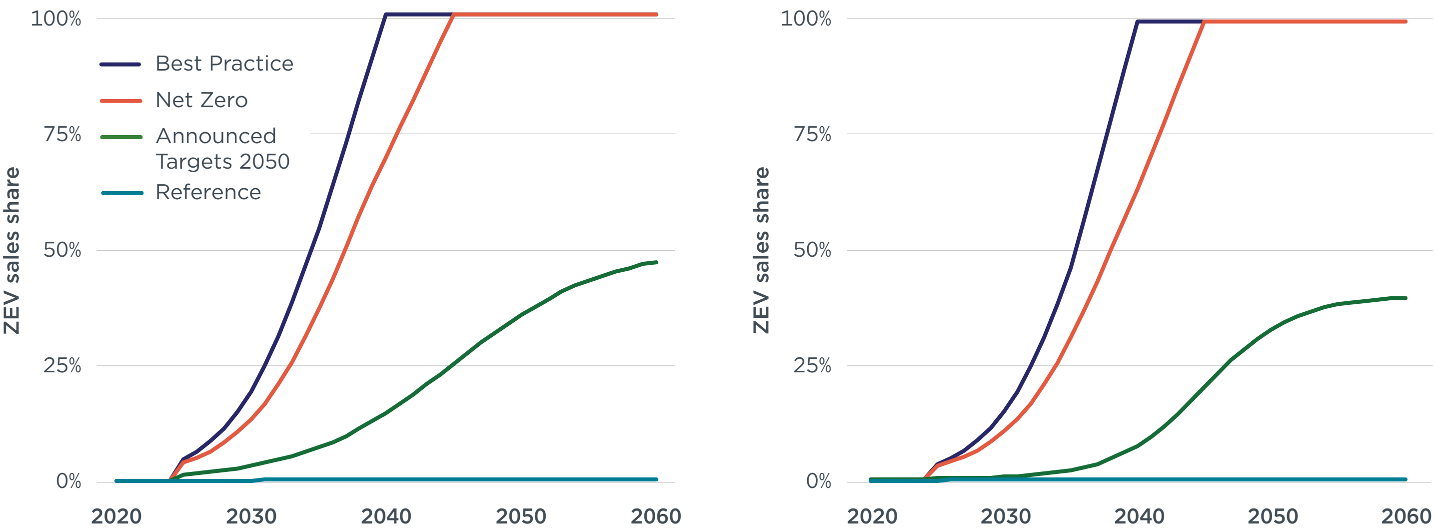
Charging infrastructure is more challenging for medium and heavy electric trucks than for four-wheelers. While electric four-wheelers typically use chargers from 3–200 kW, heavy electric trucks generally require chargers of 50–1,000 kW that are more costly and more complex to connect to the electricity grid. In China, battery swapping is also gaining popularity as a solution for electric trucks; note, though, that implementing this technology requires extensive coordination between government and industry stakeholders to establish swapping standards. Following China's notable achievement of a 14% market share for battery electric medium and heavy trucks in June 2024, its swap-capable truck fleet expanded to 2,500 vehicles, an 87% year-over-year increase and substantial growth from fewer than 100 vehicles in early 2021 (Mao et al., 2024). This was facilitated by policy initiatives in 2024 that established deployment targets for battery-swapping stations and compatible vehicles, and established technical and safety specifications (Mao et al., 2024). Unlike charging stations, battery swapping is a battery-as-a-service business model; energy companies typically show more capability and more interest in participating in the service model than do vehicle manufacturers, which generally do not produce batteries or operate swapping stations.

In our scenarios, the earliest fleets to transition are expected to be medium trucks, particularly those that drive shorter distances in urban areas, because they require smaller batteries and smaller electric grid connections. The transition is expected to proceed at a slower pace through the 2020s for vehicles carrying the highest payloads and traveling the longest distances, but this pace then accelerates as the business case for electrifying these segments strengthens over time.

Trajectories for electrification

Figure 3 shows the modeled ZEV sales share trajectories for medium and heavy trucks in Indonesia. As with passenger cars, ZEVs reach 100% of new medium and heavy truck sales in 2040 for the Best Practice Scenario and 2045 in the Net Zero scenario. While these two segments reach 100% at the same time, medium trucks see higher ZEV sales shares than heavy trucks in each intervening year (e.g., 54% vs. 46% in 2035 in the Best Practice scenario). In the Announced Targets 2050 scenario, medium and heavy trucks see a gradual increase in adoption; ZEV sales shares remain below 10% through 2037 and slowly climb to approximately 47% for medium trucks and 40% for heavy trucks by 2060. In the Reference scenario, medium and heavy trucks see negligible ZEV uptake through 2060.

Figure 3
Modeled zero-emission sales shares for medium (left) and heavy trucks (right)



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In the Net Zero and Best Practice scenarios, ZEV uptake for medium and heavy trucks begins to accelerate after TCO parity is reached in the late 2020s; ZEVs reach 10% (Net Zero) and 15% (Best Practice) of truck sales in 2030 and reach 50% in the mid-2030s (Best Practice) and the late-2030s (Net Zero). Uptake in the mid-2030s is enabled by the improving TCO benefit (ZEV Transition Council, 2024), narrowing purchase price differential, and increased availability of charging infrastructure. Both segments reach a 100% ZEV sales share in 2040 in the Best Practice scenario, as the most demanding applications with long and unpredictable routes take longer to electrify, regardless of truck size. Although these Best Practice trajectories are slower than California's world-leading Advanced Clean Trucks regulation, which reaches 100% zero emission truck sales in 2036 (California Air Resources Board, 2023), they are similar to the expected trajectories for countries that signed on to the Global Memorandum of Understanding on Zero-Emission Medium- and Heavy-Duty Vehicles, which targets a 30% sales share in 2030 and 100% in 2040 (Global Commercial Vehicle Drive to Zero, n.d.).

Different types of trucks will electrify faster according to their typical duty cycles, weight, and ancillary power needs. To achieve the ambitious pace set out in the two net-zero scenarios we developed, it will be important to drive fast progress in the fast-moving segments (e.g., delivery trucks, yard tractors, drayage trucks, and vocational vehicles with depots) while also investing in infrastructure to support vehicles that are carrying the heaviest payloads along the longest routes. These scenarios are most likely to be realized if infrastructure is planned for and invested in, and such plans and investments can begin immediately with a focus on major ports, industrial zones, and freight corridors where the business case for electrification is strongest today.

BUSES

Buses are one of the fastest-growing ZEV segments globally. This is particularly true in China, where close to 800,000 electric buses were delivered through the first half of 2024 and where major cities like Guangzhou, Shanghai, and Shenzhen have electrified their entire bus fleets (EV-Volumes, 2025). India, Korea, Thailand, and Chile have emerged as other frontrunners and have deployed thousands of electric buses. Buses, particularly urban buses, are easier to electrify than other heavy-duty vehicles because they have consistent routes and parking locations and their ownership models can prioritize lifetime costs. They also offer an opportunity to reduce air pollution in urban areas and improve the public transport experience through reduced noise and vibration. Electric buses have the potential to play a similar frontrunner role in Indonesia.

Considerations for the pace of electrification

In Indonesia, Transjakarta has been the leader in electric bus deployment: Over 100 electric buses have been purchased thus far, and the agency has committed to electrifying all buses in its fleet by 2030 (Institute for Transportation & Development, 2024; United Nations Environment Programme, 2023). Analysis by the ICCT found that it is feasible to electrify many of Transjakarta's routes in 2024 with existing technology and that electric buses are cost-competitive with diesel when using a 15-year contract (Triatmojo et al., 2024).

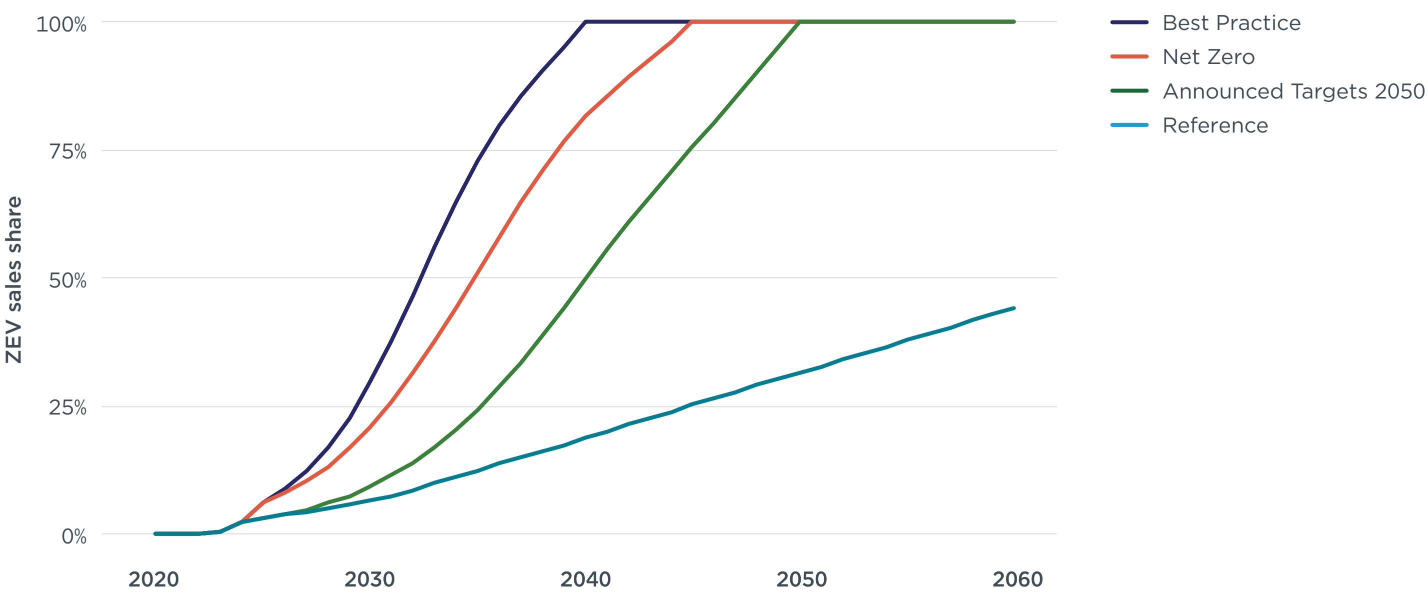
With supportive financing and procurement frameworks, and infrastructure planning from key government agencies and the state-owned electric company, PLN, other urban bus fleets could follow a timeline like Transjakarta's and purchase primarily electric buses beginning in the mid-2020s (Xie et al., 2023). This would align with the government's goal of having 90% of new bus procurements be electric by 2030. However, as coach buses drive longer distances at higher speeds, they are more like heavy trucks and may face similar challenges related to higher upfront price and the need for larger investments in charging infrastructure. The bus market may bifurcate, with urban buses reaching close to a 100% ZEV share for new sales by 2030 and coach buses not seeing high electric vehicle penetration until the mid-2030s.

Trajectories for electrification

Figure 4 shows the modeled ZEV sales share trajectories for new buses. Unlike medium and heavy trucks, the Reference scenario for buses grows consistently after 2030 and reaches nearly 50% in 2060; such a trajectory could materialize if urban buses see high rates of electrification, but some intra-city and coach buses continue to rely on diesel engines. In the Announced Targets 2050 scenario, ZEV adoption begins to pick up after 2030 and increases at a linear pace up to 100% in 2050. In both the Best Practice and Net Zero scenarios, adoption follows an S-curve pattern and electric buses reach 50% of new sales by 2033 and 2035, respectively. This early growth is expected to be driven by urban buses, which present a strong TCO case. Like medium and heavy trucks, buses achieve 100% electrification by 2040 in the Best Practice scenario and by 2045 in the Net Zero scenario; this allows time to build the necessary infrastructure for more challenging applications like coaches.

Figure 4

Modeled zero-emission sales shares for buses



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SUMMARY OF ZEV SALES AND STOCK

Figure 5 compares the trajectories for each of the vehicle segment in the Net Zero scenario (top) and the Best Practice scenario (bottom). The annual ZEV sales shares for each vehicle type by scenario are also detailed in Appendix Tables A1–A4. For two- and three-wheelers, the Net Zero scenario lags the Best Practice scenario in reaching 50% ZEVs by only a year (2032 versus 2031). Meanwhile, for passenger cars, the Best Practice scenario reaches nearly 40% ZEV sales in 2030, versus just over 25% in the Net Zero scenario. Nonetheless, in both scenarios, two-wheelers and passenger cars see the fastest growth; buses follow, and medium and heavy trucks begin a rapid transition to ZEVs in the 2030s. In both net-zero scenarios, all vehicle types reach 100% ZEV sales in or before 2045.

Figure 5

Modeled zero-emission sales shares for all vehicle types in Indonesia in the Best Practice and Net Zero scenarios

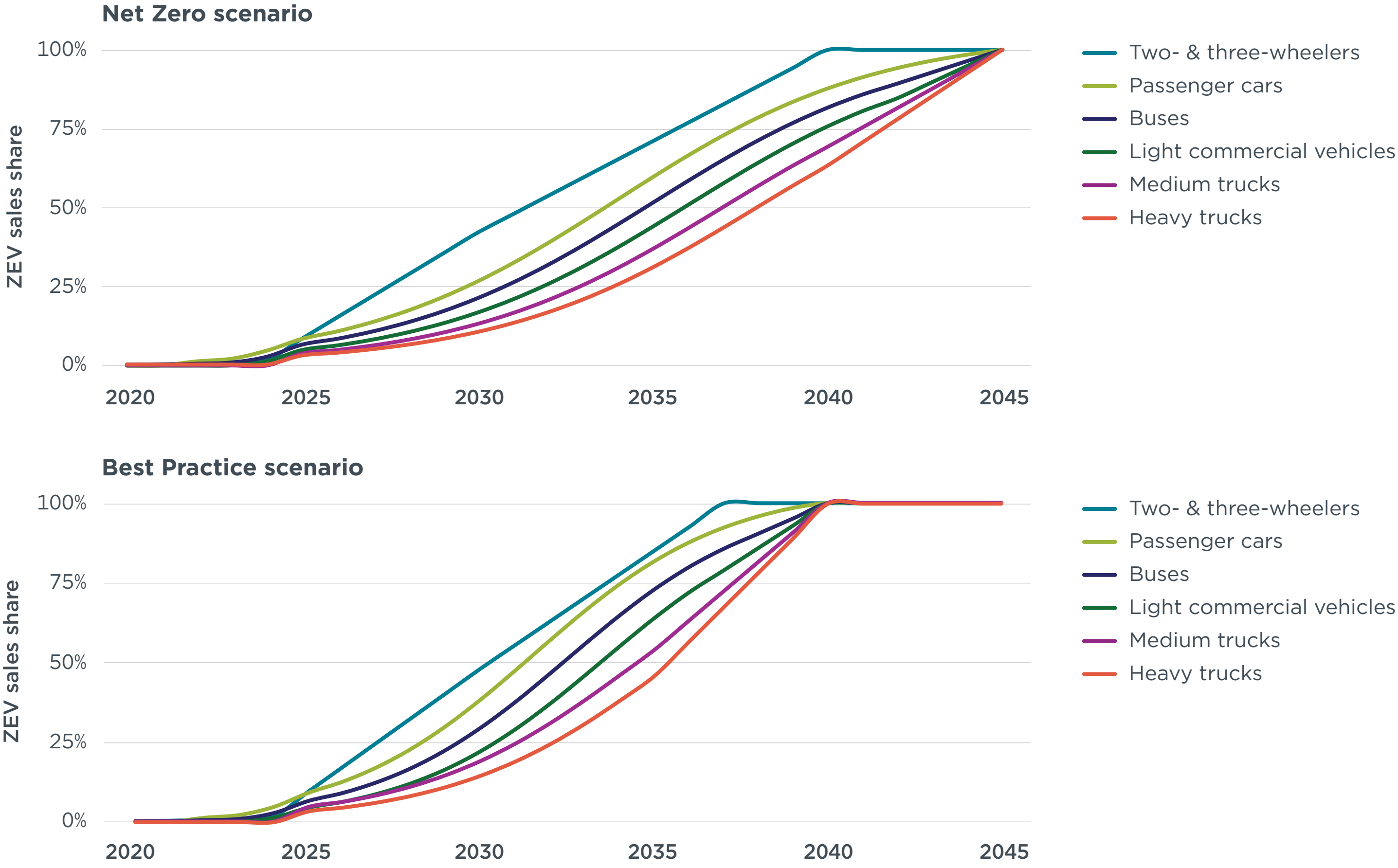

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Table 2 summarizes the years in which different vehicle segments reach 100% ZEV sales in the Best Practice, Net Zero, and Announced Targets 2050 scenarios. The year of internal combustion engine phaseout is the same as that of 100% ZEV sales; we assume that any kind of vehicle with a combustion engine (including hybrids and plug-in hybrids) may be sold until the specified year. In the Reference scenario, no vehicle segments reach 100% ZEV sales by 2060.

Table 2

Summary of 100% ZEV sales years in different scenarios

Vehicle type	Net Zero	Best Practice	Announced Targets 2050
Two- and three-wheelers	2040	2037	2050
Four-wheelers (cars and light-commercial vehicles)	2045	2040	2050
Buses	2045	2040	2050
Medium trucks	2045	2040	—
Heavy trucks	2045	2040	—

All four scenarios for ZEV uptake use the same projections of total vehicle sales, stock, and mileage. Table 3 details our assumptions for the annual rate of growth in new vehicle sales and the percent change in total vehicle stock (i.e., vehicles on the roads) from 2023–2060. Additional details on modeling assumptions are in Appendix Table A5.

Table 3
Assumptions for annual growth in new vehicle sales and percent change in vehicle stock from 2023–2060

Segment	Annual rate of growth in new vehicle sales	Change in vehicle stock in 2060 from 2023
Two- and three-wheelers	-1% 2025–2050; 0% 2051–2060	–13%
Passenger cars	7% in 2025, declining to 2.6% in 2060	+376%
Light commercial vehicles	1% 2025–2050, 0.3% 2051–2060	+33%
Medium trucks	3% in 2025 declining to 1.2% in 2060	+120%
Heavy trucks	9% in 2025 declining to 2.3% in 2060	+413%
Buses	10% in 2025, declining to 2.4% in 2060	+210%

Figure 6 and Figure 7 show the projections for the percentage and number of ZEVs, respectively, on the roads in Indonesia from 2020–2060 under the four scenarios for each of the six vehicle types.

Figure 6

Projected ZEV stock share in Indonesia by vehicle type under each scenario

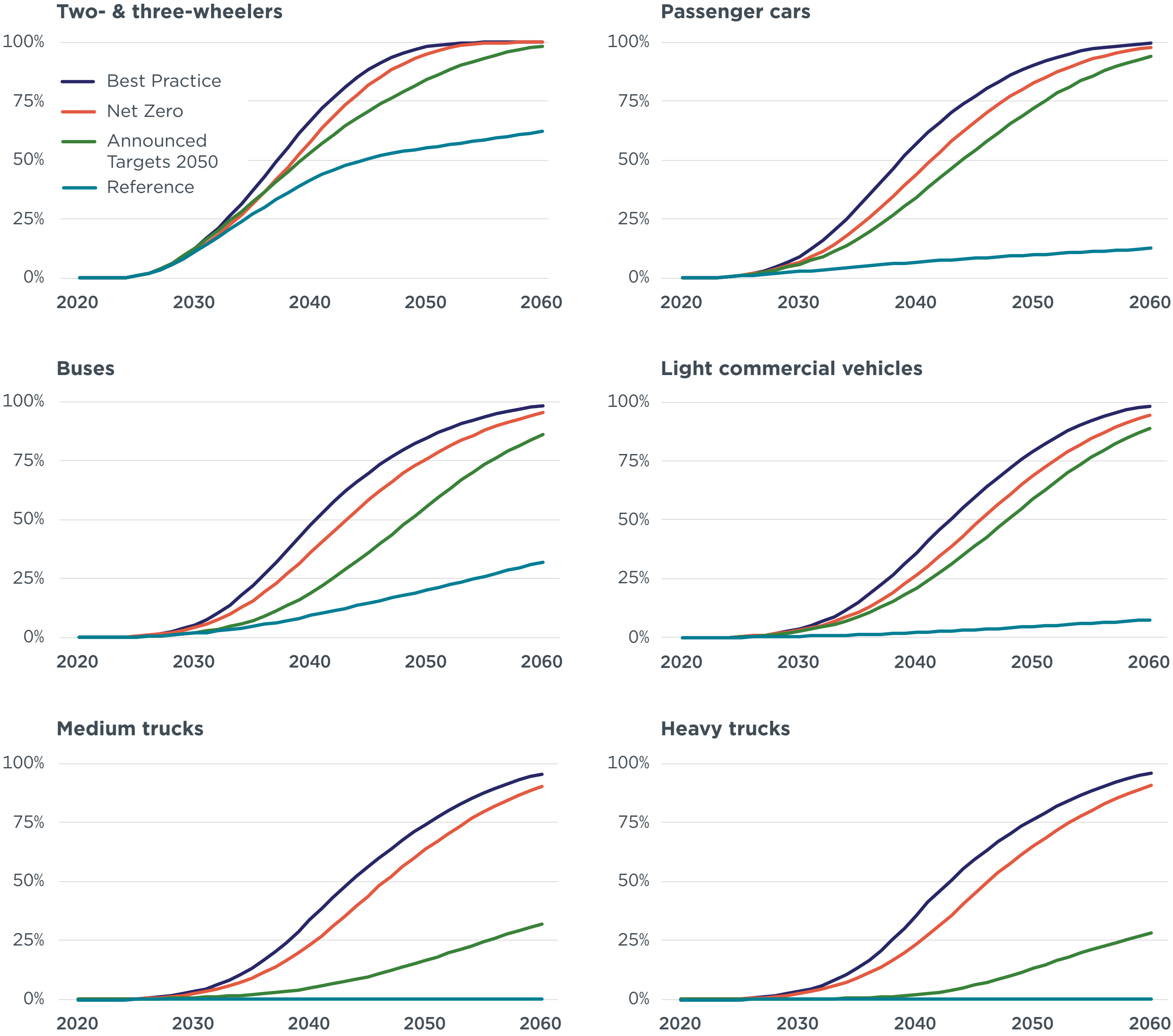

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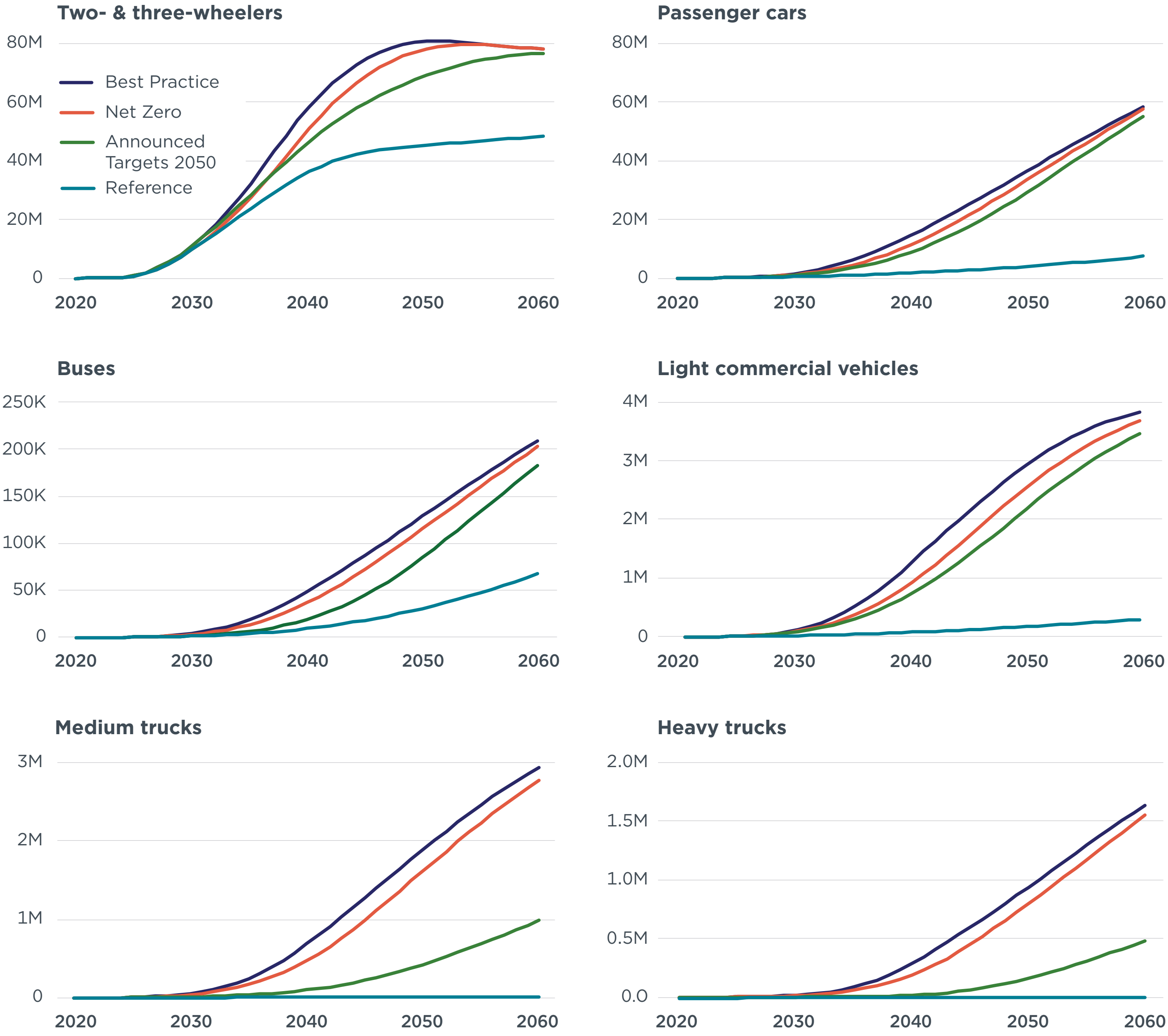
Figure 7

Projected ZEV stock in Indonesia by vehicle type under each scenario



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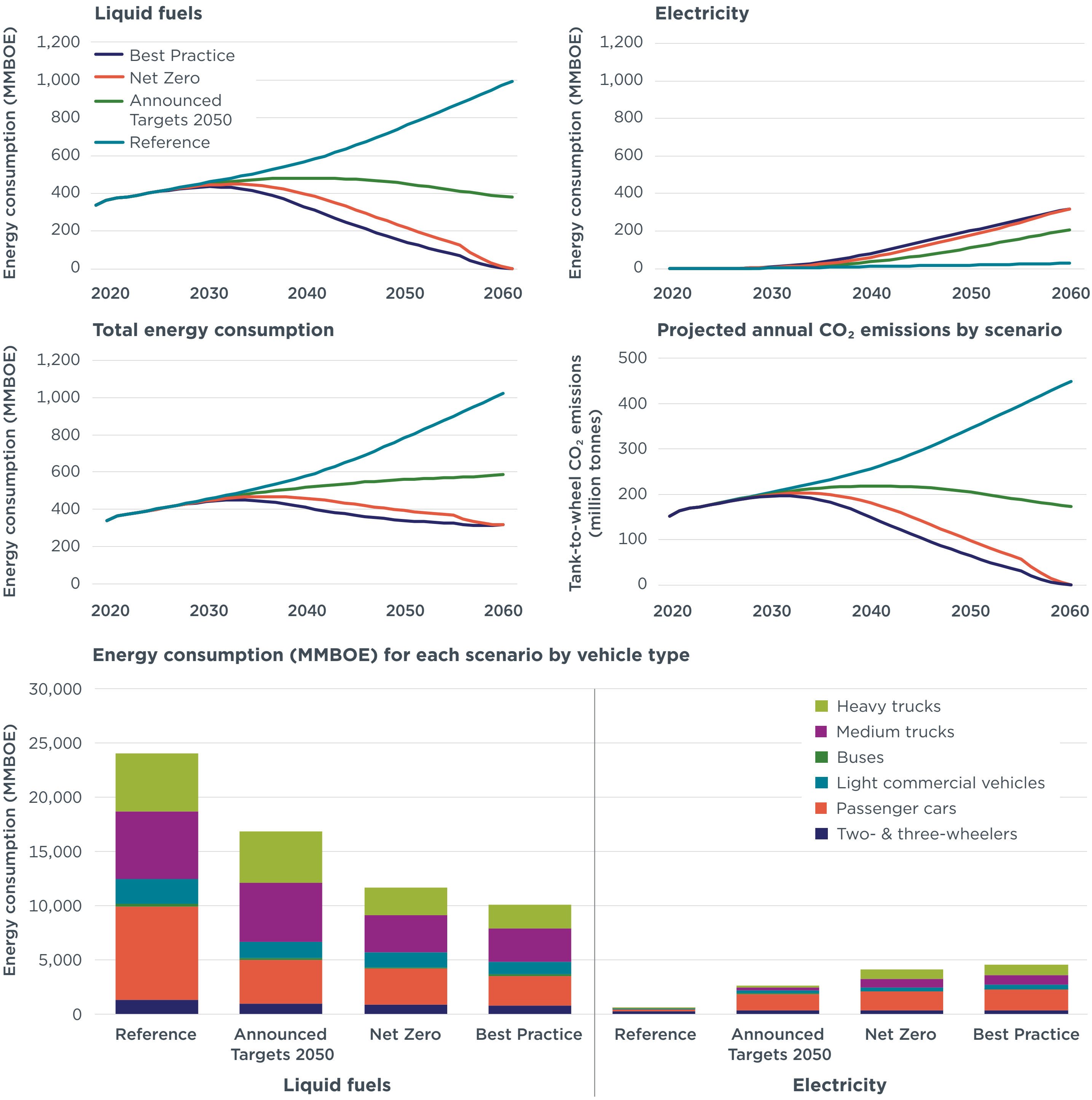
ENERGY CONSUMPTION

From 2015 to 2024, Indonesia's vehicle stock grew by an average of 5% annually (Statistics Indonesia, 2023) and led to increased imports of refined petroleum products. The $23.2 billion worth of refined petroleum products imported in 2022 made Indonesia the 12th largest importer in the world that year (The Observatory of Economic Complexity, n.d.).

An accelerated shift to ZEVs would have profound impacts on energy consumption and the fuel sources for Indonesia's road transport sector. The upper panels of Figure 8 compare energy consumption for road transport across the four scenarios for liquid fuels (left panel), electricity (middle panel), and total (right panel), all converted to million barrels of oil equivalent (MMBOE). The bottom-left panel shows the cumulative energy demand for liquid fuels and electricity from 2023–2060 under the four scenarios, disaggregated by vehicle segment. The bottom-right panel shows the annual CO_2 emissions from road transport (combining all vehicle types considered) in each of the four scenarios. Note that the CO_2 figure includes only tank-to-wheel emissions, or emissions directly from the vehicles; it does not include emissions from generating the electricity or upstream emissions from petroleum and biofuel production and refining. All scenarios use the same projections for the total number of vehicles on the road and their mileage in each year (described in Table 3).

Figure 8

Projected energy demand for liquid fuels and electricity and annual tank-to-wheel CO_2 emissions by scenario



Note: Data labels in the bottom-left chart show cumulative energy consumption from 2023 to 2060 and data labels on the bottom-right chart show the percent change in annual tank-to-wheel CO_2 emissions from 2023 to 2060.

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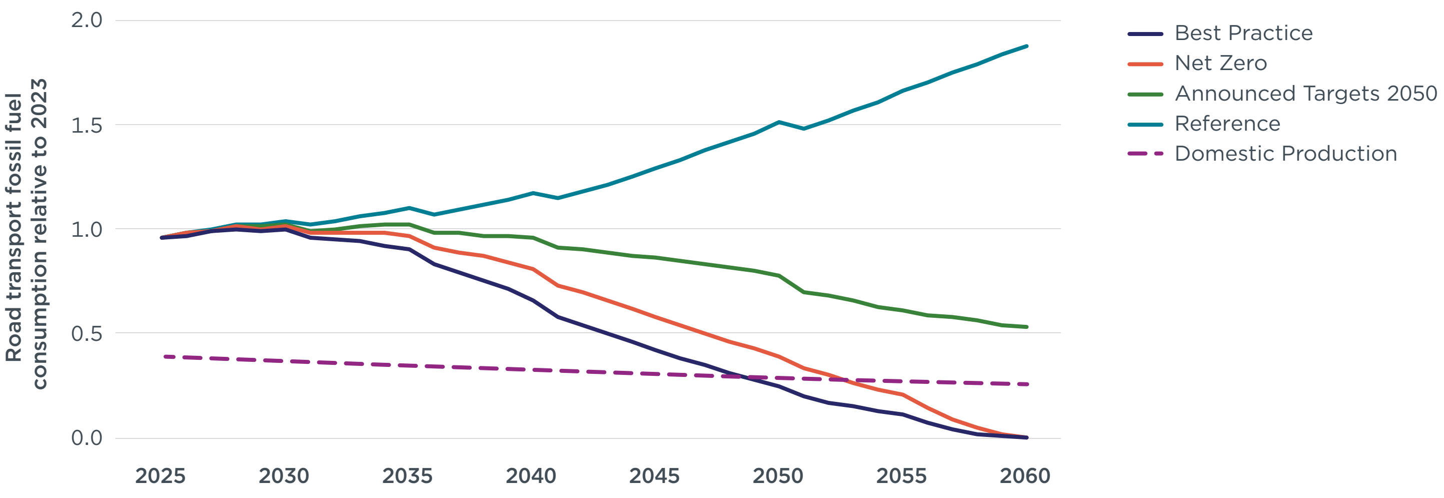
In the Reference scenario, limited ZEV uptake—especially for four-wheelers and trucks—allows tank-to-wheel CO_2 emissions from road transport to nearly triple from 2020–2060. In the more optimistic Announced Targets 2050 scenario, tank-to-wheel CO_2 emissions from road transport peak around 2040 and then decline to near 2023 levels by 2060. In contrast, in the two net-zero scenarios, tank-to-wheel road transport CO_2 emissions peak in the early 2030s then decline to zero by 2060 with the aid of a scrappage program that is assumed to shift vehicle activity from any remaining conventional vehicles to ZEVs by 2060. This program is assumed to phase in starting with the elimination of 20% of remaining conventional vehicle activity in 2056, 40% in 2057, 60% in 2058, 80% in 2059, and 100% in 2060. Without such a scrappage program, road transport CO_2 emissions in the net-zero scenarios would reach 84%–94% below 2023 levels by 2060.

Figure 9 illustrates the effect of ZEV uptake on fossil fuel consumption in the road transport sector under the four scenarios, excluding biofuels used in internal combustion engines. Consumption is shown relative to 2023 fossil fuel consumption and all scenarios begin at roughly one, with the Reference Scenario generally increasing to almost two (twice the 2023 total road transport fossil fuel consumption) in 2060 and the other three scenarios generally decreasing. In 2023, 60% of fossil fuels for road transport were imported (Perdana, 2023). Domestically produced fossil fuels accounted for the other 40%, with production declining by 1.2% per year (Ministry of Energy and Mineral Resources, 2024a; Ministry of Energy and Mineral Resources, 2024b). The dotted line illustrates this forecast for domestic production of fossil fuels for road transport, again indexed to 2023 consumption.

Figure 9

Road transport fossil fuel consumption in each scenario and domestic production of fossil fuels for road transport, relative to 2023



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Several observations emerge from these projections. First, the shift to ZEVs would result in large energy savings in absolute terms because ZEVs are much more efficient than ICE vehicles. In the Reference scenario, meanwhile, road transport fossil fuel consumption continues to increase, and is nearly 90% above 2023 levels by 2060. The growth trend is punctuated by periodic increases in biodiesel and ethanol blends, which temporarily cut fossil fuel demand (similar effects are observed for the other scenarios). In the Announced Targets 2050 scenario, road transport fossil fuel consumption is relatively stable from 2023–2040 and then decreases to roughly half of 2023 levels by 2060.

The Government of Indonesia has set a target to eliminate reliance on fossil fuel imports by 2045 (Government of Indonesia, 2024; Tempo, 2023). Neither the Reference nor the Announced Targets 2050 scenario would achieve this target within the time frame of this modeling exercise. In contrast, the Net Zero scenario is projected to achieve this target 8 years late (2053), whereas the more ambitious Best Practice scenario would achieve this target with a delay of 3 years (2048). Complementary strategies such as improving the efficiency of conventional vehicles and accelerating the retirement of older conventional vehicles could likely achieve this target by 2045, if combined with the Best Practice scenario.

Electricity demand projections grow in all scenarios. Consumption is expected to reach the 2023 electricity oversupply level (i.e., excess generation capacity) by 2029 in the Best Practice scenario and by 2030 in the Net Zero scenario (Ministry of Energy and Natural Resources, 2024a). In 2060, annual electricity consumption in the Best Practice scenario would be 288 MMBOE (489 terawatt hours [TWh]) higher than in the Reference scenario; this increase is equivalent to 138% of Indonesia's total electricity production in 2023 of 350.6 TWh (Ministry of Energy and Natural Resources, 2024a).

Although two-wheelers account for the most ZEVs in number, four-wheelers and trucks are responsible for the bulk of avoided fuel consumption to 2060. However, two- and four-wheelers account for most of the avoided fuel consumption through 2035, given the slower initial uptake of electric trucks.

As illustrated in the bottom-left panel of Figure 8, the net-zero scenarios reduce cumulative liquid fuel consumption by 5.1–6.7 billion barrels of oil equivalent through 2060 compared with the Announced Targets 2050 scenario. This results in cumulative CO_2 emission reductions of 2.4–3.1 billion tonnes (Gt). Savings compared with the Reference scenario are even greater: An accelerated ZEV transition (Best Practice scenario) in Indonesia could mean an approximately 5.6 Gt reduction in tank-to-wheel CO_2 emissions from 2025 to 2060 compared with the Reference scenario. This is the area between the Reference projection and Best Practice curves in Figure 8. These reductions in tank-to-wheel CO_2 emissions would be only partially offset by additional electricity generation emissions, which range from 0.6 Gt CO_2 (using projections of grid carbon intensity from the IEA's APS) to 1.0 Gt CO_2 (using PLN's projections) over the same period.[4] PLN's Accelerated Renewable Energy Development long-term projections show an approximately 25% reduction in grid carbon intensity from 2024 to 2035 and a 100% reduction by 2060 (PLN, 2024). The IEA's APS is similar but slightly more ambitious: It shows a 38% reduction in grid carbon intensity from 2024 to 2035 and an 83% reduction by 2060.

AVOIDED ENERGY SUBSIDIES

Indonesia has provided fuel subsidies since the late 1970s, and the World Bank highlighted fuel subsidies as one of the country's fiscal policy challenges (Ihsan et al., 2024). Despite reforms to the subsidy system in 2015 and fuel price hikes in 2022, the Ministry of Energy and Mineral Resources shared that targets for energy subsidies in 2024 are 17% higher than in 2023, at nearly Rp 187 trillion (US$12 billion; Argus Media, 2024). Fossil fuel subsidies, which cover gasoline, diesel, and liquefied petroleum gas, are approximately 60% of total energy subsidies in Indonesia (Badan Pemeriksa Keuangan, 2024).

4 Based on PLN's presentation in Jakarta on August 9, 2024. The focus was on electrification in the transportation sector to support the net-zero by 2060 target, and it was part of the Strategy and Supporting Policy Focus Group Discussion held by the Coordinating Ministry of Maritime Affairs and Investment (PLN, 2024).

Since 2023, liquid fuel in Indonesia is supplied in seven grades that can be grouped into three categories: gasoline, diesel, and biodiesel blend. Within each category, one fuel grade receives government disbursement (Table 4). The Financial Audit Board of the Republic of Indonesia (Badan Pemeriksa Keuangan, 2024) reported that Rp 143 trillion was allocated to subsidize and compensate a portion of fuel consumption for road transportation in 2023. This expenditure covered 30 million KL of gasoline and 31 million KL of diesel and biodiesel combined (Ministry of Energy and Mineral Resources, 2024a). As of 2024, the subsidized fossil diesel grade receives a fixed subsidy of Rp 1,000/L and diesel compensation of Rp 3,966/L.[5] The fossil diesel blended with biodiesel also gets biodiesel incentives from the Palm Oil Estate Fund, known as BPDPKS (Ihsan et al., 2024). The government did not allocate a fixed subsidy for gasoline but gave it compensation of Rp 1,596/L.[6] The current gasoline market has limited blending of ethanol as a pilot project. However, the government plans to reallocate gasoline compensation to ethanol (Wahyudi, 2024). Using ethanol index market prices from the Ministry of Energy and Mineral Resources, we estimate an average subsidy of Rp 5,491/L of blended fuel.[7]

Table 4
Fuel type, price classification, and volume in Indonesia in 2023

Fuel category	Fuel grade	Price classification	Consumption volume in 2023 (million KL)	Share of fuel category that is subsidized fuel in 2023
Gasoline	RON 90	Subsidized	30.22	84%
	RON 92	Unsubsidized	5.44	
	RON 95+98+100	Unsubsidized	0.36	
Diesel	CN 48	Subsidized	0.33	22%
	CN 51	Unsubsidized	0.83	
	CN 53	Unsubsidized	0.37	
Biodiesel blend	Blend of diesel and at least 30% biodiesel	Subsidized	31.19	100%

Source: Ministry of Energy and Mineral Resources (2024a)

The Net Zero and Best Practice scenarios would reduce consumption of liquid fuels (fossil and biofuel) by 0.9 billion KL and 1.2 billion KL, respectively, compared with the Announced Targets 2050 scenario; the reduction is more than doubled when compared with the Reference scenario. Using the above subsidies Rp/L for diesel, biodiesel, and blended gasoline/ethanol, we calculate the total avoided subsidy relative to the Announced Targets 2050 during the 2025–2060 time frame would amount to approximately Rp 3,960 trillion (US$255 billion) and Rp 4,984 trillion (US$321 billion) in the Net Zero and Best Practice scenarios, respectively. Compared with the Reference scenario, the total subsidy savings reach Rp 7,617 trillion (US$490 billion) and Rp 8,641 trillion (US$556 billion).

5 Based on a calculation conducted by the Coordinating Ministry of Maritime Affairs and Investment in October 2024. The Indonesian government provides fuel subsidies in two forms: (1) fixed per-liter reimbursements to Pertamina, the state-owned oil and gas company, that enable lower fossil fuel prices for low-income households and industry and (2) compensation to Pertamina for the difference between market procurement costs and regulated consumer prices for both subsidized and unsubsidized fuels.

6 As above, based on CMMAI calculation conducted in October 2024.

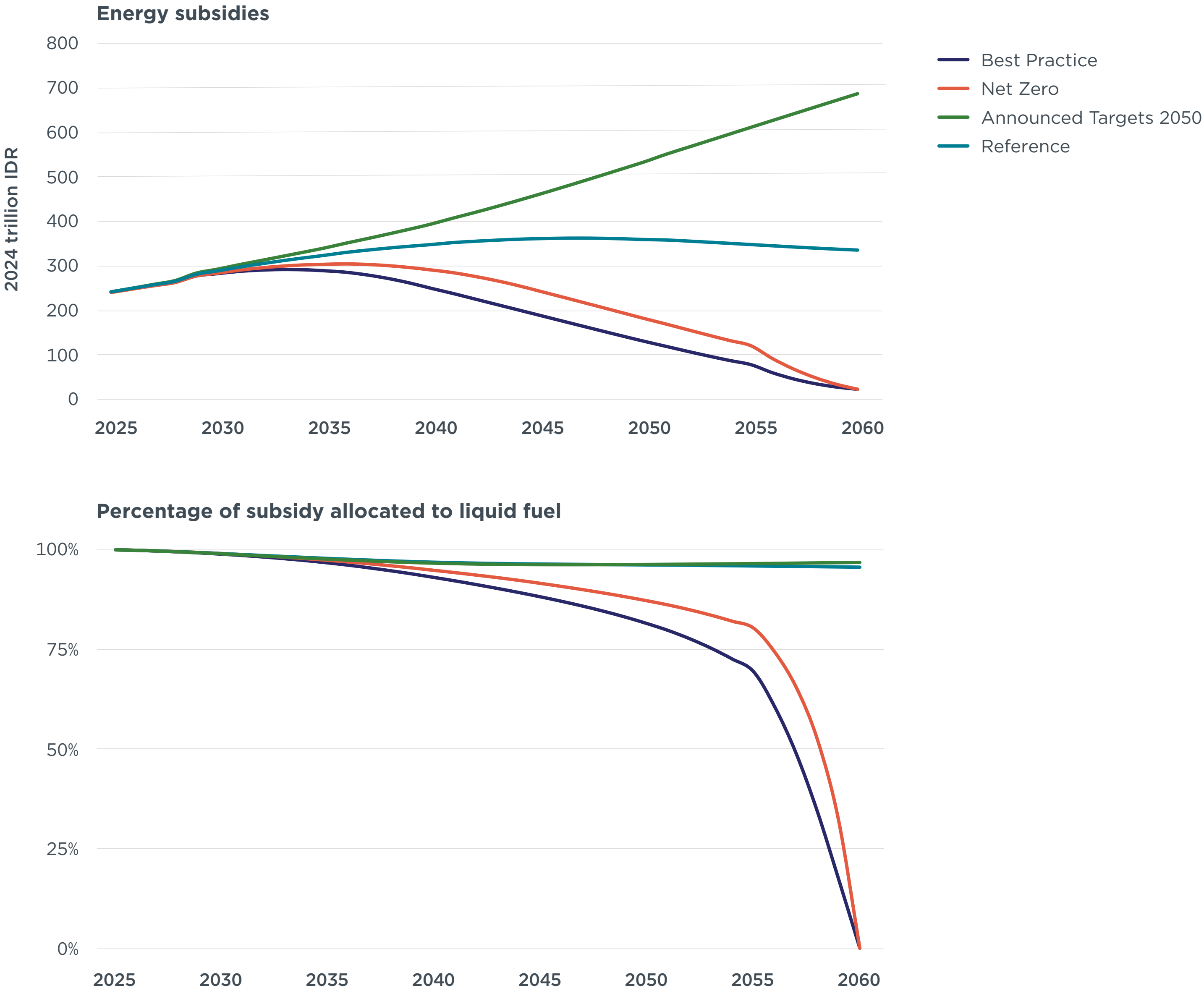
7 We compare the ethanol index market price from Ministry of Energy and Mineral Resources (2024c) with the gasoline MOPS price at the wholesale level. We took gasoline prices from Pertamina (2024).

We also considered the electricity price subsidies that would be allocated to electric vehicles, assuming no changes to the current subsidy scheme. Today, the government classifies household consumer electricity tariffs into 13 types based on their power capacity in volt-amperes (VA) to determine the tariff amounts. As stipulated by the Ministry of Energy and Mineral Resources (2024d) regulation, all household consumers with 450 VA and a portion of the 900 VA group are eligible for subsidized tariffs of approximately Rp 1,000/kWh and Rp 700/kWh, respectively, and PLN statistics show that in Indonesia, most consumers are registered under this category (PLN, 2022). Unlike cars, which typically charge at 3,300 VA or greater, two- and three- wheelers are expected to be eligible for these electricity subsidies, as they can be charged at home with a power capacity of 900 VA or below (PLN, 2023). Our estimates of electricity subsidies are conservatively high, as we use the higher subsidy of Rp 1,000/kWh for all electricity consumed by two- and three-wheelers; in practice, though, two- and three-wheelers charged in unsubsidized households and public facilities would not be eligible for the subsidy, and those charged in households with 900 VA connections would receive the lesser of the two subsidies (Ministry of Energy and Mineral Resources, 2024d; CNN Indonesia, 2023).

Figure 10 illustrates the projected government disbursement for road transport, assuming no changes in the current structure of fiscal support. While total outlays in the Reference scenario are estimated to continue increasing until 2060, the Announced Targets 2050 scenario shows a gradual decline after 2046 with outlays settling at Rp 333 trillion by 2060, still 58% above 2023 levels. In contrast, the Net Zero and Best Practice scenarios could cause government disbursements for road transport energy to peak earlier, in 2036 and 2033, respectively, and drop to approximately Rp 24 trillion in 2060, 89% below 2023 levels.

Figure 10

Government disbursement for energy, liquid fuel and electricity (top), and percentage of this disbursement allocated to liquid fuel from 2025 to 2060 (bottom)



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CONCLUSIONS

This analysis outlined two scenarios for ZEV growth that could put Indonesia on a path to reach net-zero emissions from road transport by 2060 and cement itself as a global leader in ZEVs: Net Zero and Best Practice. In these, two- and three-wheelers are expected to lead ZEV uptake, reaching 100% of sales by 2040 in the Net Zero scenario and by 2037 in the more ambitious Best Practice scenario. For four-wheelers (passenger cars and LCVs), buses, and trucks (medium and heavy), 100% ZEV sales shares are achieved by 2045 in the Net Zero scenario and by 2040 in the Best Practice scenario. In both net-zero scenarios, steady ZEV sales growth would be needed in all vehicle segments—particularly two- and three-wheelers, urban buses, and four-wheelers—beginning in 2025. These scenarios were compared with an Announced Targets 2050 scenario in which two- and three-wheelers, four-wheelers, and buses reach 100% ZEV sales by 2050, whereas medium and heavy trucks remain below

50% ZEV sales through 2060. We also considered a Reference scenario in which ZEV uptake remains limited and no segments reach 100% ZEV sales by 2060.

Both net-zero scenarios would deliver substantial climate and economic benefits. Compared with the Announced Targets 2050 scenario, we estimate the net-zero scenarios could reduce cumulative liquid fuel consumption through 2060 by 5.1–6.7 billion barrels of oil equivalent, avoid Rp 3,960 trillion–Rp 4,984 trillion (US$255–$321 billion) in energy subsidies, and avoid 2.4–3.1 Gt of tank-to-wheel CO_2 emissions. These benefits are substantially greater if comparing with the Reference scenario that assumes limited ZEV uptake.

This paper is the first of a series. Future work will describe how advances in ZEV technology globally set the stage for electric vehicles to not only deliver net-zero emissions but also bring cost savings to Indonesian drivers and generate new manufacturing opportunities. Achieving either of the net-zero scenarios is likely to require a suite of regulatory, fiscal, and infrastructure policies. Future ICCT studies will explore how the Indonesian government could develop new fuel economy or ZEV standards, charging infrastructure plans, and other policies to achieve the trajectories outlined here and realize the promise of net-zero road transport by 2060.

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APPENDIX

Tables A1-A4. Annual ZEV sales share for each vehicle type and scenario

Vehicle types are defined as:
Bus: passenger vehicle with gross vehicle weight (GVW) ≥ 3.5 tons
HDT: heavy truck (commercial vehicle with GVW > 15 tons)
LCV: light commercial vehicle or light truck (commercial vehicle with GVW < 3.5 tons)
MC: two- and three-wheeled vehicles
MDT: medium truck (commercial vehicle with GVW 3.5–15 tons)
PC: passenger car (four-wheeled passenger vehicle with GVW < 3.5 tons)

A1. Best Practice

Year	Bus	HDT	LCV	MC	MDT	PC
2025	6%	3%	5%	9%	5%	9%
2026	9%	5%	6%	17%	6%	13%
2027	12%	6%	9%	25%	8%	17%
2028	17%	8%	12%	33%	11%	23%
2029	23%	11%	17%	41%	15%	30%
2030	30%	15%	22%	48%	19%	39%
2031	38%	19%	29%	56%	25%	48%
2032	47%	25%	37%	63%	31%	57%
2033	56%	31%	46%	70%	38%	66%
2034	65%	38%	55%	78%	46%	75%
2035	73%	46%	64%	85%	54%	82%
2036	80%	57%	72%	93%	63%	88%
2037	86%	68%	79%	100%	72%	92%
2038	91%	78%	86%	100%	82%	96%
2039	95%	89%	93%	100%	91%	98%
2040	100%	100%	100%	100%	100%	100%

A2. Net Zero

Year	Bus	HDT	LCV	MC	MDT	PC
2025	6%	3%	5%	8%	4%	9%
2026	8%	4%	6%	15%	5%	11%
2027	11%	5%	8%	22%	6%	14%
2028	13%	6%	10%	28%	8%	17%
2029	17%	8%	13%	35%	10%	22%
2030	21%	10%	17%	42%	13%	27%
2031	26%	13%	21%	48%	17%	32%
2032	32%	17%	26%	54%	21%	39%
2033	38%	21%	31%	59%	25%	45%
2034	44%	25%	37%	65%	31%	53%
2035	51%	31%	44%	71%	37%	60%
2036	58%	37%	51%	77%	43%	66%
2037	65%	43%	58%	83%	50%	73%
2038	71%	50%	64%	88%	57%	78%
2039	77%	57%	70%	94%	63%	83%
2040	82%	63%	76%	100%	69%	88%
2041	86%	71%	81%	100%	75%	91%
2042	89%	78%	85%	100%	82%	94%
2043	93%	85%	90%	100%	88%	97%
2044	96%	93%	95%	100%	94%	98%
2045	100%	100%	100%	100%	100%	100%

A3. Announced Targets 2050

Year	Bus	HDT	LCV	MC	MDT	PC
2020	0%	0%	0%	0%	0%	0%
2021	0%	0%	0%	0%	0%	0%
2022	0%	0%	0%	0%	0%	1%
2023	1%	0%	0%	1%	0%	2%
2024	3%	0%	1%	2%	0%	5%
2025	3%	0%	4%	9%	1%	7%
2026	4%	0%	6%	17%	2%	10%
2027	5%	0%	8%	25%	2%	13%
2028	6%	0%	10%	33%	2%	15%
2029	8%	0%	12%	41%	3%	18%
2030	10%	0%	14%	48%	3%	21%
2031	12%	1%	17%	51%	4%	25%
2032	14%	1%	21%	54%	4%	29%
2033	17%	1%	25%	58%	5%	34%
2034	21%	1%	29%	61%	6%	39%
2035	25%	2%	34%	64%	7%	44%
2036	29%	3%	39%	67%	8%	50%
2037	34%	3%	44%	69%	10%	56%
2038	39%	4%	50%	72%	11%	61%
2039	44%	6%	56%	75%	13%	66%
2040	50%	7%	61%	78%	14%	71%
2041	56%	9%	66%	80%	16%	75%
2042	61%	12%	71%	83%	18%	79%
2043	66%	14%	75%	85%	21%	83%
2044	71%	17%	79%	88%	23%	86%
2045	75%	20%	83%	90%	25%	88%
2046	80%	23%	86%	92%	27%	91%
2047	85%	26%	90%	94%	29%	93%
2048	90%	28%	93%	96%	32%	95%
2049	95%	31%	97%	98%	34%	98%
2050	100%	33%	100%	100%	36%	100%
2051	100%	34%	100%	100%	37%	100%
2052	100%	36%	100%	100%	39%	100%
2053	100%	37%	100%	100%	40%	100%
2054	100%	37%	100%	100%	42%	100%
2055	100%	38%	100%	100%	43%	100%
2056	100%	39%	100%	100%	44%	100%
2057	100%	39%	100%	100%	45%	100%
2058	100%	39%	100%	100%	46%	100%
2059	100%	39%	100%	100%	46%	100%
2060	100%	40%	100%	100%	47%	100%

A4. Reference

Year	Bus	HDT	LCV	MC	MDT	PC
2020	0%	0%	0%	0%	0%	0%
2021	0%	0%	0%	0%	0%	0%
2022	0%	0%	0%	0%	0%	1%
2023	1%	0%	0%	1%	0%	2%
2024	3%	0%	1%	2%	0%	5%
2025	3%	0%	1%	8%	0%	5%
2026	4%	0%	2%	15%	0%	6%
2027	5%	0%	2%	22%	0%	6%
2028	5%	0%	2%	28%	0%	6%
2029	6%	0%	2%	35%	0%	7%
2030	7%	0%	2%	42%	0%	7%
2031	8%	0%	2%	44%	0%	7%
2032	9%	0%	3%	45%	0%	7%
2033	10%	0%	3%	47%	0%	8%
2034	11%	0%	3%	48%	0%	8%
2035	13%	0%	3%	50%	0%	8%
2036	14%	0%	3%	51%	0%	8%
2037	15%	0%	4%	51%	0%	8%
2038	16%	0%	4%	52%	0%	9%
2039	18%	0%	4%	53%	0%	9%
2040	19%	0%	5%	53%	0%	9%
2041	20%	0%	5%	54%	0%	10%
2042	22%	0%	5%	55%	0%	10%
2043	23%	0%	5%	55%	0%	10%
2044	24%	0%	6%	56%	0%	10%
2045	25%	0%	6%	57%	0%	11%
2046	27%	0%	6%	57%	0%	11%
2047	28%	0%	7%	58%	0%	11%
2048	29%	0%	7%	59%	0%	12%
2049	30%	0%	7%	59%	0%	12%
2050	32%	0%	8%	60%	0%	12%
2051	33%	0%	8%	61%	0%	13%
2052	34%	0%	8%	62%	0%	13%
2053	36%	0%	9%	62%	0%	13%
2054	37%	0%	9%	63%	0%	13%
2055	38%	0%	9%	64%	0%	14%
2056	39%	0%	10%	64%	0%	14%
2057	41%	0%	10%	65%	0%	14%
2058	42%	0%	10%	66%	0%	15%
2059	43%	0%	10%	66%	0%	15%
2060	44%	0%	11%	67%	0%	15%

A5. Energy consumption and CO_2 emissions calculation inputs

Parameter	Source and Description
New vehicle sales market share by powertrain type	The Reference scenario: generally consistent with the ambition of the 2022 STEPS scenario published by the International Energy Agency (IEA) and Ministry of Energy and Mineral Resources report, “An Energy Sector Roadmap to Net Zero Emissions in Indonesia,” in 2022. The Announced Targets 2050 scenario: generally consistent with the ambition of the 2022 APS scenario published by the IEA and Ministry of Energy and Mineral Resources report, “An Energy Sector Roadmap to Net Zero Emissions in Indonesia,” in 2022. It signals the aspirations of the Indonesian government at that time to reach 100% ZEV sales by 2050 for all vehicle types except medium- and heavy-duty trucks. The Net Zero scenario: aligns Indonesia’s road transport sector with its commitment to reach net-zero emissions in 2060 and with the Paris Agreement. ZEV uptake is modeled assuming S-curve pathways. The Best Practice scenario: sets out ambitious-but-feasible trajectories for ZEV sales shares and aligns Indonesia with other major markets and with international commitments for achieving 100% ZEV sales.
New vehicle sales	Historical: Gaikindo, AISI, EV-Volumes, IEA. Projection: Result of calibrating historical data to achieve government passenger car ownership targets in Indonesia; other vehicle types adjusted to IEA World Energy Outlook projections.
Average annual vehicle kilometers traveled (VKT) by vehicle type	Historical: Calibrated to match energy consumption statistics; no changes are assumed for future years.
Average vehicle retirement age	Calculated based on historical sales and base year (2023) vehicle stock with age limits (lower and upper bounds) applied to ensure consistency with regional and global trends. The average retirement ages used are 15 years for two- and three-wheelers, 22 years for four-wheelers, 25 years for trucks, and 24 years for buses.
New vehicle energy intensity in megajoules per km	IEA Mobility Model database
Carbon intensity of electricity	IEA World Energy Outlook and PLN long-term projections
Annual biofuel blend share for diesel and gasoline	NZE 2060 Roadmap and Bioethanol Roadmap of the Ministry of Energy and Mineral Resources. Biodiesel: 45% in 2031; 50% in 2036; 55% in 2041; 60% in 2051. Bioethanol: 5% in 2023; 10% in 2029.

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