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Zero-Emission Trucks in Indonesia: A Policy and Regulatory Roadmap for Heavy-and Medium-Duty Freight

Market dynamics, technology assessments, and regulatory pathways for Indonesia's electric truck transition

Imprint

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Foreword

Decarbonizing Trucks for Economic and Energy Security: Act Now

Indonesia's economy runs on trucks. From ports to plantations, factories to cities, heavy-duty vehicles carry the weight of national logistics, and represent one of the country's biggest structural risks.

Trucks account for just 4% of Indonesia's vehicle fleet, yet they produce nearly one-third of transport emissions. That imbalance makes freight the single most powerful lever for decarbonizing transport, and the stakes are rising. The truck fleet is projected to grow 2.5 times by 2060, with freight activity tripling. On the current trajectory, diesel consumption, oil imports, and emissions will all climb sharply. Inaction has a cost, and that cost is growing.

Indonesia already spends billions on refined petroleum imports, leaving the economy exposed to volatile global oil markets, and every price shock ripples through the logistics system, raising costs for businesses and households alike. For a country trying to strengthen industrial competitiveness, that dependence on diesel is a real vulnerability.

Decarbonizing trucking offers a direct answer: shifting freight from imported fuel to domestically generated, increasingly renewable electricity turns a point of exposure into a foundation for energy security.

The case for zero-emission trucks goes beyond strategy: it makes economic sense on its own. Electric trucks already beat diesel on total cost of ownership: lower energy and maintenance costs bring operating costs down to as low as IDR 2,000–3,200 per kilometer, with payback periods of 3–14 years, with the right scheme and incentives. Nationally, the savings are larger still: replacing diesel trucks with electric ones could cut fuel subsidy spending by hundreds of trillions of rupiah a year, roughly IDR 5,000 trillion in cumulative savings by 2060. Few climate measures pay for themselves quite this directly.

The health gains are just as immediate. Diesel trucks are a major source of air pollution along Java and Sumatra's busiest freight corridors, contributing to respiratory illness and lost productivity, while zero-emission trucks eliminate tailpipe pollutants altogether.

None of this happens on its own. Indonesia's truck fleet is aging—about a third of vehicles are more than 20 years old, and renewal is slow. The market is concentrated among a handful of manufacturers, with few electric models on offer. The biggest barrier remains cost: electric trucks can run up to four times the price of diesel equivalents, with steeper monthly payments under standard financing, while charging infrastructure remains scarce, the top concern fleet operators consistently raise. Left unaddressed, these conditions risk locking Indonesia into inefficient, high-emission trucks for decades.

Policy can change that. Three steps matter most.

First, incentives should be technology-neutral. Restricting support to specific battery chemistries risks slowing adoption just as cheaper alternatives are gaining ground worldwide.

Second, fuel economy and emissions standards need to be far more ambitious. Incremental tightening would not bring major manufacturers into the zero-emission market.

Third, Indonesia needs a national charging backbone for freight, focused on high-traffic corridors like Java and Sumatra. Even a modest network, spaced roughly every 100 kilometers, could unlock electrification at scale.

Financing can help close the remaining gap: longer loan tenors, battery-as-a-service models, and carbon markets all ease the upfront burden without changing the underlying economics. Large shippers can help too by aggregating demand to lower risk for operators making the switch.

Put together, the case is straightforward: decarbonizing Indonesia's trucks is economically sound, fiscally rewarding, and strategically necessary. Get the policy right, and the country can build a freight system that is cleaner, more efficient, less exposed to global shocks, and more competitive.

This is one of Indonesia's clearest opportunities to align economic growth with sustainability. It is time to take it.

Fabby Tumiwa
Chief Executive Officer of IESR

Table of Contents

Abbreviations

ACFTA	ASEAN-China Free Trade Area
B40	Biofuel blending of 40%
B50	Biofuel blending of 50%
BaaS	Battery as a service
BAU	Business-as-usual
BBNKB	Title transfer tax
BEI	*Bursa Efek Indonesia* (Indonesia Stock Exchange)
BET	Battery electric trucks
BEV	Battery electric vehicle
BoE	Barrel of oil equivalent
BPDPKS	*Badan Pengelola Dana Perkebunan Kelapa Sawit* (Indonesia Oil Palm Plantation Fund Management Agency)
BPS	*Badan Pusat Statistik* (Central Bureau of Statistics)
CAPEX	Capital expenditure
CBU	Completely built-up
CKD	Completely knocked-down
CNG	Compressed natural gas
CO_2	Carbon dioxide
CO_2e	Carbon dioxide equivalent
COPD	Chronic obstructive pulmonary disease
CPO	Crude palm oil
DLUC	Direct land-use change
DRAM	*Dokumen Rencana Aksi Mitigasi* (Mitigation Action Design Document)
E4W	Electric four-wheelers
ENDC	Enhanced Nationally Determined Contributions
EoL	End of Life
EPS	environmental priority strategies
EU	European Union
FAME	Fatty acid methyl ester
FE	Fuel economy
GAIKINDO	*Gabungan Industri Kendaraan Bermotor Indonesia* (Association of Indonesian Automotive Industries)
GHG	Greenhouse gases
GRDP	Gross regional domestic product
GVW	Gross vehicle weight
GW	Gigawatt
GWh	Gigawatt-hour
HDV	Heavy-duty vehicle (truck)
ICE	Internal combustion engine
IDR	Indonesian Rupiah
Jalintim	*Jalan Lintas Timur* (Sumatra's East Cross Road)
JAMALI	*Jawa, Madura, dan Bali*
KEN	*Kebijakan Energi Nasional* (National Energy Policy)
KPBB	*Komite Penghapusan Bensin Bertimbel* (Joint Committee forLeaded Gasoline Phase-out)
KW	Kilowatt
KWh	Kilowatt-hour
LCA	Life cycle assessment
LCR	Local content requirements
LDV	Light-duty vehicle

LFP	Lithium iron phosphate
LTS-LLCR	Long Term Strategy for Low Carbon and ClimateResilience
LVV	*Lembaga Validasi dan Verifikasi* Validation and VerificationBody)
MDV	Medium-duty vehicle (truck)
MEMR	Ministry of Energy and Mineral Resources
MMBOE	Million barrels of oil equivalent
MoT	Ministry of Transportation
$MtCO_2$	Megatonne of carbon dioxide
MW	Megawatt
MWh	Megawatt-hour
NCA	Nickel cobalt aluminum
NDC	Nationally Determined Contributions
NEK	*Nilai Ekonomi Karbon* (Carbon pricing)
NMC	Nickel manganese cobalt
NO_x	Nitrogen oxide
NZE	Net zero emission
OD	Origin-destination
OEM	Original equipment manufacturer
OJK	*Otoritas Jasa Keuangan* (Financial Service Authority)
OTR	On the road
Pantura	*Pantai utara* (North Coast of Java)
Perpres	*Peraturan Presiden* (Presidential Regulation)
PKB	*Pajak Kendaraan Bermotor* (Motorized Vehicle Tax)
PM	Particulate matter
PPnBM	*Pajak Penjualan atas Barang Mewah* (Sales Tax on Luxury Goods)
PSR	*Peremajaan Sawit Rakyat* (Oil Palm Replanting Program for Smallholders)
PTBAE-PU	*Persetujuan Teknis Batas Atas Emisi Pelaku Usaha* (TechnicalApproval of Upper Emission Limits for Business Actors)
R&D	Research and development
RUKN	*Rencana Umum Ketenagalistrikan Nasional* (National ElectricityMaster Plan)
SoC	State of charge
SPE-GRK	*Sertifikat Pengurangan Emisi Gas Rumah Kaca* (GreenhouseGas Emission Reduction Certificate)
SPKLU	*Stasiun Pengisian Kendaraan Listrik Umum* (Public Electric VehicleCharging Station)
SPM	*Standar pelayanan Minimum* (Minimum service standards)
SRUK	*Sistem Registri Unit Karbon* (Carbon unit registry system)
TaaS	Trucking as a service
TCO	Total cost of ownership
TKDN	*Total Komponen Dalam Negeri* (Local content requirements)
TTW	Tank-to-wheel
USD	US Dollar
USD/bbl	USD per barrel
VAT	Value added tax
VKT	Vehicle kilometer traveled
YOLL	Years of life lost
ZET	Zero emission truck

Executive summary

- Indonesia's transport sector is the third largest contributor to energy sector emissions, reaching 168 $MtCO_2e$ in 2024 (roughly 25% of the national total) and growing at 1.56% annually. Road transport heavily dominates the sector, accounting for ~88% of these emissions (148 $MtCO_2e$). Within the road segment, freight trucks—despite representing only 4% of the national on-road vehicles contribute 33% of road-specific emissions (~48 $MtCO_2e$), which accounts for 28.8% of the entire transport sector's carbon footprint. This impact is overwhelmingly driven by medium-duty vehicles (MDVs) at 51% and heavy-duty vehicles (HDVs) at 13% of total freight emissions, while trucks as a whole also generate 11% of all motorized vehicle air pollutants. Propelled by a rapid post-2020 rebound averaging 11.7% growth annually, the freight trucking sector stands out as one of the highest leverage intervention points for decarbonization in Indonesia's transportation system.
- The scale of the challenge will only grow, with total truck stock projected to reach 12 million units by 2060 (a 2.5-fold increase) while freight activity triples to roughly 150 billion vehicle-kilometers per year. Under a business-as-usual (BAU) trajectory, this operational intensity will push oil demand for MDVs and HDVs to 260 million barrel of oil equivalent (BOE) by 2060, worsening the refined petroleum import burden that already reached USD 25.9 billion in 2024.
- IESR's modeling shows that a 100% zero-emission truck (ZET) adoption scenario by 2060 would cut total final energy demand by 78% compared to BAU and reduce tailpipe emissions by 99% through full fleet electrification. Electric trucks are 62–87% more efficient than diesel equivalents, replacing 207.5 MMBOE of liquid fuel with just 29.2 MMBOE of electricity. Furthermore, as the fleet shifts from diesel to electricity, energy demand becomes increasingly supplied by Indonesia's evolving power system, which is expected to become progressively less carbon-intensive over time under national power sector planning.
- ZET remain more expensive than diesel trucks on subsidized fuel across all weight segments over a 20-year, 100,000 km/year lifecycle, driven by high capital expenditure (CAPEX)— comprising 42–56% of ZET total cost of ownership (TCO) versus 17–39% for diesel — as the primary barrier. Battery swapping can reduce ZET CAPEX by around 60% and lower overall TCO by 28–49%, though full competitiveness with subsidized diesel still requires additional fiscal incentives such as Pajak Kendaraan Bermotor (PKB) and Title Transfer Tax (BBNKB) exemptions.
- From a fiscal savings perspective, each deployed ZET avoids around IDR 21 million per year in subsidies and compensations by 2030—a figure projected to rise to IDR 50 million per unit annually by 2060. Scaled to a national fleet of 7.6 million ZETs, this generates IDR 650 trillion in annual fiscal relief by 2060 and a cumulative saving of IDR 5,000 trillion between 2025 and 2060—nearly double the 2025 Indonesian state revenue (IDR 2,750 trillion). This underscores the urgency of decoupling logistics from diesel, especially since the Strait of Hormuz disruption scenario pushing crude to USD 114/barrel would spike per-truck subsidy burdens by 63% in 2026 alone.
- ZET adoption also delivers critical public health benefits along the Java–Sumatra corridor, where emissions from diesel fueled MDVs drive 60 annual asthma cases among 243 monitored residents per km^2 surrounding area. While biodiesel alternatives fail to resolve these respiratory illnesses due to elevated NO_x levels, ZETs eliminate tailpipe NO_x, CO_2, and $PM_{2.5}$ entirely, removing the primary driver of these severe community health impacts.
- Java–Sumatra freight corridors account for roughly half of Indonesia's national cargo activity—300 out of 598 million tons per month—and are projected to double past 600 million tons by 2030. Java alone drives 36% of national freight (±217 million tons/month), concentrated in West and East Java's consumer and industrial cargo, while Sumatra contributes 14% (±83.6 million tons/month) led by commodities like chemicals and crude oil. Because 92% of national freight is carried by road, establishing these two corridors as the initial milestones for ZET pilots is critical to avoid locking in carbon-intensive patterns that would undermine broader climate goals.

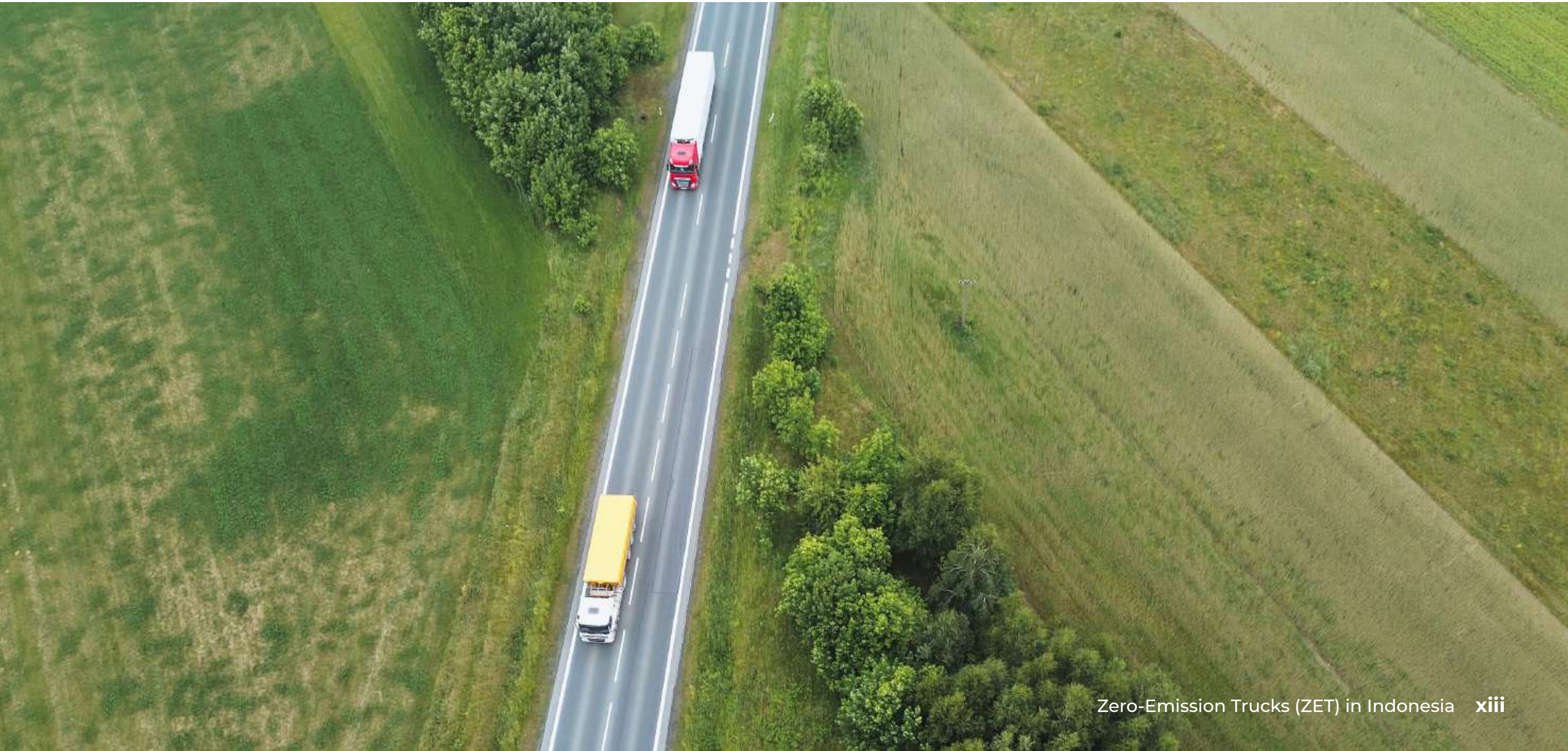
- Several barriers to ZET adoption remain. Around 33% of Indonesia's MDV and HDV fleet is over 20 years old, which prevents faster fleet turnover. The ZET market is currently dominated by startup brands, with only one mainstream OEM offering an electric truck that is twice as expensive as its diesel counterpart. Over 80% of operators surveyed cite charging access as a major barrier. The government's proposed tiered battery incentives for nickel-based batteries (100% reduction of VAT for nickel-based and 40% reduction for lithium iron phosphate (LFP)-based), risk locking out the LFP batteries that currently account for 72–86% of global ZET sales and are approximately 30% cheaper per kWh.
- To support ZET adoption, IESR also recommends implementing fuel efficiency (FE) standards that increase by 10% for every year. This tightening is necessary to drive meaningful OEM ZET offering. This regulation tracks performance of the fleet and sets a limit on the average FE of all vehicles a manufacturer sells within a given period. This regulation is enforced through a type-approval and sales-tracking system annually. ZETs are credited as zero emission vehicles in fleet-average calculations. Hence, OEMs facing tighter aannual targets have a strong incentive to increase their ZET model offerings. Improved energy efficiency from trucks could help decouple Indonesia's transport activity from energy consumption, with energy demand increasing 50% slower than the rate of increase in tonnes transported per kilometre.
- To expand ZET offerings, the government should incentivize OEMs already operating in Indonesia to bring their overseas ZET models into the market. One of the pathways is by re-opening the 0% completely built-up (CBU) import duties for electric passenger vehicles; Indonesia should extend a comparable incentive to ZETs. However, these duty exemptions should be conditioned on ecosystem-building obligations such as charging infrastructure investment.
- Additionally, from charging infrastructure aspect, the charging spots must be built for every 100 km intervals across national road corridors. This will be requiring 230 kW chargers across 27 indicative sites in Java and Sumatra in 2030. This potentially generates a simultaneous peak demand of 16.9 MW and signals where grid reinforcement investments must be prioritized.
- Carbon market mechanisms under Perpres No. 110/2025 legally enable truck fleet operators to monetize emission reductions through Greenhouse Gas Emission Reduction Certificate (SPE-GRK) certification and carbon trading, but three operational gaps (undefined truck baseline methodology, unclear sectoral approval process, and an untested international trading pathway) limit near-term accessibility for private fleets. Acknowledging this, reforming other financing instruments such as concessional leasing rates, battery swapping models, and giving longer tenor periods are needed.
- Truck electrification can substantially cut freight emissions, but the level of ambition is important. Under the ZET pathway, emissions fall to near zero by 2060, whereas under current RUKN projections, there remains around 60 $MtCO_2eq$ of tailpipe emissions. Achieving a net-zero freight trajectory requires 100% ZET sales by 2040. Measures like sales mandates must accelerate in the 2030s, particularly for MDV and HDV segments in high-activity corridors like Java and Sumatra.
- By 2030, around 940,000 electric four-wheelers (E4Ws) and 500,000 ZET will trigger a nighttime grid deficit (19:00–06:00) on the JAMALI network if generation capacity remains unchanged. This can be averted without building new power plants by shifting charging demands to the daytime via traffic-ban windows or distributed rest-break sessions.
- IESR identified two strategic ZET pilots: HDV port operations in Patimban (factory-port automotive cargo) and MDV mining quasi-shuttles in Muara Enim (depot-mine-train station). ZETs are competitive in these setups because continuous, high-utilization schedules maximize daily mileage to spread over the high upfront CAPEX. Further, fixed closed-loop routes keep charging infrastructure highly manageable via depot-based or targeted en-route chargers. However, these operational efficiencies only achieve true commercial viability when paired with diesel subsidy reforms that bring fuel prices to at least IDR 8,000–9,000 per liter.

Ringkasan eksekutif

- Sektor transportasi Indonesia merupakan penyumbang emisi sektor energi terbesar ketiga, mencapai 168 $MtCO_2e$ pada 2024 (sekitar 25% dari total nasional) dan tumbuh rata-rata 1,56% per tahun. Transportasi jalan mendominasi emisi sektor ini dengan porsi sekitar 88% (148 $MtCO_2e$). Di dalamnya, truk angkutan barang hanya mewakili 4% stok kendaraan nasional, tetapi menghasilkan 33% emisi transportasi jalan atau sekitar 48 $MtCO_2e$, setara dengan 28,8% jejak karbon seluruh sektor transportasi. Kontribusi terbesar berasal dari truk sedang (MDV) sebesar 51% dan truk berat (HDV) sebesar 13% dari total emisi angkutan barang. Truk juga menyumbang 11% polutan udara kendaraan bermotor nasional. Dengan pertumbuhan pascapandemi yang mencapai rata-rata 11,7% per tahun sejak 2020, sektor truk angkutan barang menjadi salah satu titik intervensi paling strategis untuk dekarbonisasi transportasi Indonesia.
- Tantangan ini akan semakin besar. Stok truk diproyeksikan mencapai 12 juta unit pada 2060 (naik 2,5 kali lipat), sementara aktivitas angkutan barang meningkat tiga kali lipat menjadi sekitar 150 miliar kilometer kendaraan per tahun. Dalam skenario business-as-usual (BAU), intensitas operasi tersebut akan mendorong permintaan minyak untuk MDV dan HDV hingga 260 juta barel setara minyak (BOE) pada 2060, menambah beban impor BBM yang pada 2024 sudah mencapai USD 25,9 miliar.
- Pemodelan IESR menunjukkan bahwa skenario adopsi 100% truk tanpa emisi (ZET) pada 2060 dapat menurunkan kebutuhan energi akhir sebesar 78% dibanding BAU dan memangkas emisi knalpot hingga 99% melalui elektrifikasi penuh armada. Truk listrik 62–87% lebih efisien dibanding truk diesel, menggantikan konsumsi 207,5 MMBOE bahan bakar cair dengan hanya 29,2 MMBOE listrik. Peralihan ke listrik jaringan juga memungkinkan integrasi otomatis dengan sistem kelistrikan yang direncakanan makin rendah karbon.
- Biaya kepemilikan total (TCO) ZET masih lebih tinggi dibanding truk diesel berbahan bakar bersubsidi pada seluruh segmen berat kendaraan, dengan asumsi siklus hidup 20 tahun dan jarak tempuh 100.000 km per tahun. Hambatan utama berasal dari tingginya biaya investasi awal (CAPEX), yang mencapai 42–56% dari TCO ZET dibanding 17–39% pada truk diesel. Skema battery swapping dapat menurunkan CAPEX sekitar 60% dan mengurangi TCO keseluruhan sebesar 28–49%, meskipun untuk menjadi lebih kompetitif dibandingkan diesel bersubsidi tetap membutuhkan insentif fiskal tambahan seperti pembebasan PKB dan BBNKB.
- Dari sisi fiskal, setiap truk listrik yang beroperasi diperkirakan dapat menghindari beban subsidi dan kompensasi sekitar Rp 21 juta per tahun pada 2030, meningkat menjadi Rp 50 juta per unit per tahun pada 2060. Jika diterapkan pada armada nasional sebanyak 7,6 juta truk tanpa emisi, potensi penghematan fiskal mencapai Rp 650 triliun per tahun pada 2060 dan secara akumulatif Rp 5.000 triliun sepanjang 2025–2060 — hampir dua kali lipat penerimaan negara Indonesia tahun 2025 sebesar Rp 2.750 triliun. Temuan ini menegaskan pentingnya memutus ketergantungan logistik pada diesel, terutama karena skenario gangguan Selat Hormuz yang mendorong harga minyak mentah menjadi USD 114 per barel dapat meningkatkan beban subsidi per truk hingga 63% hanya dalam tahun 2026.
- Adopsi ZET juga memberikan manfaat kesehatan masyarakat yang signifikan, khususnya di koridor Jawa–Sumatra, di mana emisi dari MDV truk dengan bahan bakar diesel menyebabkan 50 kasus asma tahunan di antara 243 penduduk per km persegi area sekitar yang dipantau. Alternatif biodiesel tidak menyelesaikan masalah ini karena emisi NO_x tetap tinggi, sedangkan truk listrik baterai menghilangkan emisi NO_x, CO_2, dan $PM_{2.5}$ dari knalpot sepenuhnya.

- Koridor angkutan barang Jawa–Sumatra menangani sekitar setengah aktivitas kargo nasional, yaitu 300 dari 598 juta ton per bulan, dan diproyeksikan meningkat menjadi lebih dari 600 juta ton pada 2030. Pulau Jawa menyumbang 36% angkutan nasional (sekitar 217 juta ton per bulan), terutama dari barang konsumsi dan industri di Jawa Barat dan Jawa Timur, sedangkan Sumatra menyumbang 14% (sekitar 83,6 juta ton per bulan) yang didominasi komoditas seperti bahan kimia dan minyak mentah. Mengingat 92% angkutan barang nasional masih bergantung pada transportasi jalan raya, kedua koridor ini perlu menjadi tonggak awal untuk pilot ZET. Hal ini sangat penting untuk mencegah ketergantungan aktivitas logistik yang tinggi karbon karena dapat menghambat pencapaian target iklim nasional.
- Beberapa hambatan masih menghalangi adopsi ZET di Indonesia. Sekitar 33% armada truk sedang dan berat berusia lebih dari 20 tahun, sehingga memperlambat peremajaan armada. Pasar ZET saat ini juga masih didominasi oleh merek start-up, sementara hanya satu OEM tradisional yang menawarkan truk listrik dengan harga sekitar dua kali lipat dibandingkan model dieselnya. Selain itu, lebih dari 80% operator yang disurvei menyebut keterbatasan akses pengisian daya sebagai hambatan utama. Di sisi lain, usulan insentif baterai berjenjang yang memberikan pembebasan PPN 100% untuk baterai berbasis nikel dan 40% untuk baterai LFP berisiko menghambat penggunaan teknologi LFP. Padahal, baterai LFP ini menguasai 72–86% penjualan truk listrik global dan memiliki biaya sekitar 30% lebih rendah per kWh.
- Untuk mendorong adopsi ZET, IESR merekomendasikan penerapan standar efisiensi bahan bakar (fuel efficiency/FE) yang meningkat 10% setiap tahun. Regulasi ini menetapkan batas rata-rata konsumsi energi armada yang dijual setiap pabrikan dalam periode tertentu dan diawasi berdasarkan tipe kendaraan serta pelacakan penjualan tahunan. Mengingat ZET dihitung sebagai kendaraan nol emisi dalam perhitungan rata-rata armada, target yang semakin ketat akan mendorong OEM memperluas penawaran model ZET. Peningkatan efisiensi ini juga dapat membantu memutus keterkaitan antara pertumbuhan aktivitas transportasi dan konsumsi energi, sehingga kebutuhan energi meningkat jauh lebih lambat dibandingkan pertumbuhan tonase angkutan barang.
- Untuk memperluas pilihan kendaraan, pemerintah perlu mendorong OEM yang telah beroperasi di Indonesia agar membawa model ZET yang sudah dipasarkan di luar negeri ke pasar domestik. Salah satu langkah yang dapat dipertimbangkan adalah mengaktifkan kembali insentif bea masuk 0% yang pernah diterapkan pada kendaraan listrik penumpang impor (CBU) ke segmen ZET. Namun, insentif tersebut perlu disertai kewajiban pengembangan ekosistem, seperti investasi infrastruktur pengisian daya.
- Dari sisi infrastruktur, pembangunan stasiun pengisian daya perlu dilakukan setiap 100 km di sepanjang koridor jalan nasional utama. Kebutuhan awal pada tahun 2030 memerlukan pengisi daya berkapasitas 230 kW yang tersebar pada 27 lokasi indikatif di Jawa dan Sumatera. Infrastruktur ini berpotensi menimbulkan beban puncak simultan sebesar 16,9 MW dan memberikan indikasi lokasi prioritas untuk penguatan jaringan listrik.
- Mekanisme pasar karbon dalam Peraturan Presiden Nomor 110 Tahun 2025 secara hukum memungkinkan operator armada truk memperoleh pendapatan tambahan dari pengurangan emisi melalui sertifikasi SPE-GRK dan perdagangan karbon. Namun, pemanfaatannya masih terkendala oleh tiga hambatan operasional utama, yaitu belum adanya metodologi baseline khusus truk, belum jelasnya mekanisme persetujuan sektoral, serta belum terujinya jalur perdagangan karbon internasional. Oleh karena itu, reformasi instrumen pembiayaan lain tetap diperlukan, termasuk skema leasing berbunga rendah, model battery swapping, dan tenor pembiayaan yang lebih panjang.
- Elektrifikasi truk dapat secara signifikan mengurangi emisi sektor angkutan barang, namun tingkat ambisi kebijakan menjadi penentu utama. Dalam skenario ZET, emisi mendekati nol pada 2060, sementara proyeksi RUKN saat ini masih menyisakan sekitar 60 $MtCO_2eq$ emisi. Mencapai target angkutan barang nol emisi membutuhkan 100% penjualan truk listrik pada 2040, sehingga langkah-langkah seperti mandat penjualan harus dipercepat di periode 2030-an, khususnya untuk segmen MDV dan HDV di koridor bervolume tinggi seperti Jawa dan Sumatera.

- Menjelang 2030, populasi sekitar 940.000 kendaraan listrik roda empat (E4W) dan 500.000 ZET akan memicu defisit listrik pada malam hari (19.00–06.00) di jaringan JAMALI jika kapasitas pembangkit tidak tumbuh. Risiko ini dapat dicegah tanpa membangun pembangkit baru dengan menggeser pengisian daya ke siang hari, memanfaatkan jendela waktu pembatasan jalan (traffic-ban) atau saat sesi istirahat pengemudi.
- IESR mengidentifikasi dua lokasi pilot ZET yang paling strategis, yaitu operasi HDV di kawasan Pelabuhan Patimban untuk angkutan kendaraan dari pabrik ke pelabuhan, serta MDV pada rantai logistik pertambangan di Muara Enim dengan rute depo-tambang–stasiun kereta. Pada kedua kasus ini, tingkat utilisasi kendaraan yang tinggi memungkinkan biaya investasi awal yang besar tersebar ke jarak tempuh harian yang lebih panjang. Selain itu, rute tertutup memberikan kemudahan penyediaan infrastruktur pengisian daya melalui fasilitas depot maupun titik pengisian khusus di sepanjang rute. Namun, efisiensi operasional tersebut akan mencapai kelayakan komersial yang lebih kuat apabila disertai reformasi subsidi diesel yang mendorong harga bahan bakar menuju kisaran minimal Rp 8.000–9.000 per liter.



CHAPTER 1

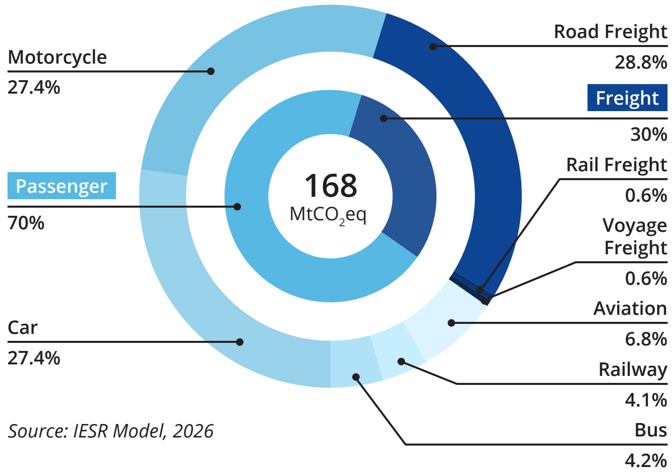
The urgency and benefits of zero-emission truck adoption

Contents

Despite representing only 4% of on-road vehicles, trucks contribute to high emissions and fuel usage, positioning electrification as a high-impact decarbonization strategy

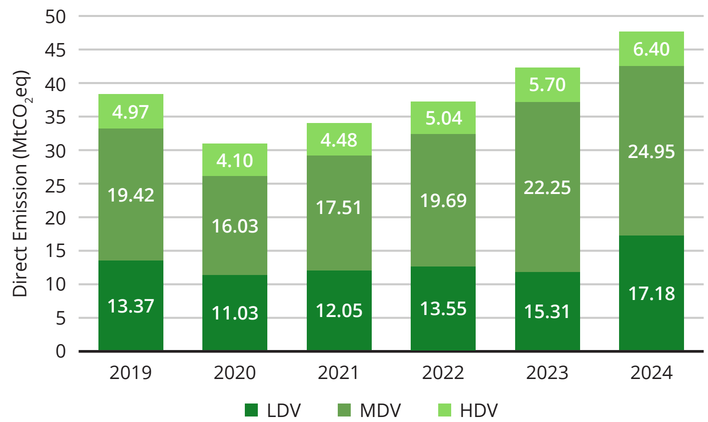
- The transport sector is the third largest contributor to Indonesia's energy sector emissions, growing at 1.56% annually and reaching 168 $MtCO_2$ in 2024 — roughly 25% of total national emissions. Road transport emissions dominate this sector, accounting for ~88% of transport emissions (148 $MtCO_2e$). Within road transport, freight trucks contribute 33% of road-specific emissions (~48 $MtCO_2e$), equivalent to roughly 28.8% of the entire transport sector's footprint.
- Trucks are also responsible for approximately 11% of motorized vehicle air pollutants (KPBB, 2024). This makes freight trucking one of the largest emission sources within the transport system.
- Truck emissions have steadily increased since the 2020 dip, growing by an average of 11.7% annually to reach a new peak of roughly 48 $MtCO_2eq$ in 2024. This expansion is overwhelmingly driven by medium-duty vehicles (MDVs), which account for approximately 51% of total freight emissions as of 2024, while heavy-duty vehicles (HDVs) contribute 13%.
- Together, MDV and HDV dominate freight-related emissions due to their higher utilization rates. This also implies overreliance on trucks compared to rail and maritime modes for moving goods. Therefore, targeting MDV and HDV is essential for emission reduction in the freight sector.
- While rail freight expansion remains a long-term decarbonization option, its current share in Java is only 1.74% of total freight volume and faces persistent barriers related to cost, transit time, and reliability (GIZ, 2021). The most optimistic scenario projects emissions reductions of only up to 20% by 2060 through shifting freight to rail (Halim, 2023; IESR, 2025). Therefore, accelerating zero-emission truck (ZET) adoption is a faster and more actionable pathway to freight decarbonization while rail infrastructure is being developed.
- Despite accounting for only 4% of road vehicles, trucks generate a disproportionate share of emissions and fuel use. Their high impact and concentrated fleet size make MDVs and HDV a high-leverage entry point for decarbonization. Electrification offers a comparatively mature and scalable solution relative to other challenging sectors.

Indonesia's transport emission (2024)



Source: IESR Model, 2026

Historical truck emissions

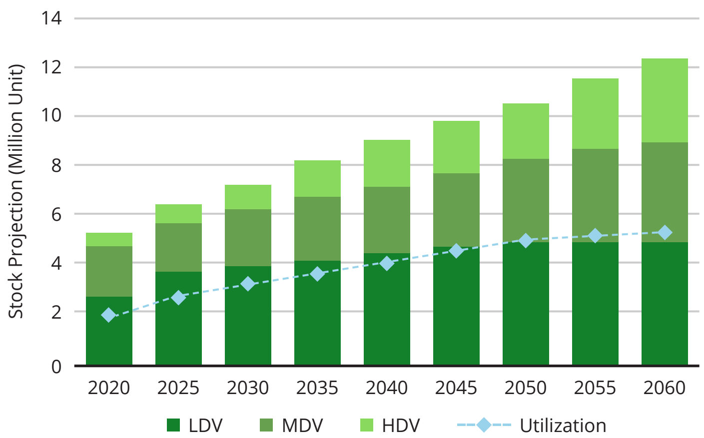


Source: IESR Model, 2026

Freight growth could quadruple energy demand, which would remain largely oil-based without intervention, requiring a decoupling from oil use

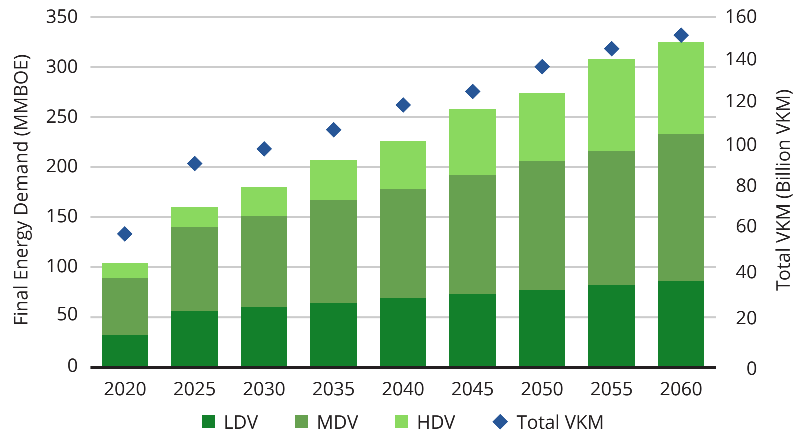
- Total truck stock is projected to increase by around 2.5 times, reaching approximately 12 million units by 2060 (up from around 5 million in 2024). HDVs show the most significant growth (+410%), followed by MDVs (+115%), compared to their 2024 levels.
- Average truck fleet utilization is estimated at around 38% (Truck Magazine, 2016), calculated as a composite of total truck stock, typical annual mileage by vehicle class, and calibrated against national final energy consumption data for 2019–2024.
- Freight activity is projected to grow faster than vehicle stock, indicating rising intensity of operations, roughly three times from approximately 50 billion km per year to around 150 billion km per year by 2060. This reflects structural growth in goods movement and economic expansion. As Indonesia's economy grows, supported by goods-producing sectors like manufacturing, agriculture, and mining, the volume of goods requiring trucking grows proportionately.
- The combined effect of higher vehicle activity and shifts in fleet composition implies that freight transport energy demand could increase by approximately twofold by 2060 compared with 2024 levels.
- The increasing vehicle demand subsequently raises oil demand for MDVs and HDVs to up to 260 million barrel of oil equivalent (MMBOE) in 2060, reflecting a 165% increase over 2025 consumption. This growing dependence on oil underscores the need to decouple freight-driven economic growth from rising emissions and fossil fuel consumption.
- Continuing to rely on fossil fuel-based trucking means remaining entangled with the increasing risks of global oil price volatility and geopolitical shocks. Even with biodiesel blending, meeting a projected demand of 260 million BOE by 2060 would require a significant increase in feedstock supply, raising concerns over land use, feedstock supply, and potential competition with food systems, land availability, and export markets.

Truck stock projection



Source: IESR Model, 2026

Final energy demand and vehicle-km (VKM) projections

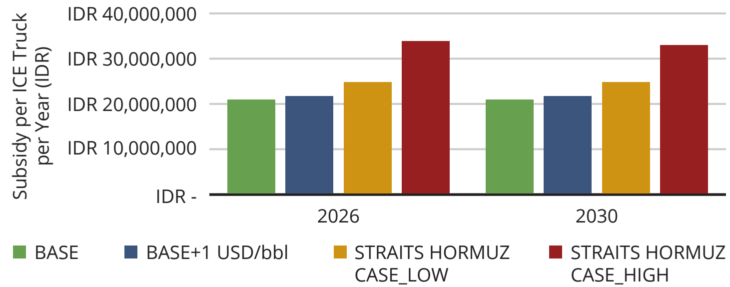


Source: IESR Model, 2026

Heavy-duty freight electrification would reduce fiscal burden and strengthen energy resilience by decoupling from diesel dependence

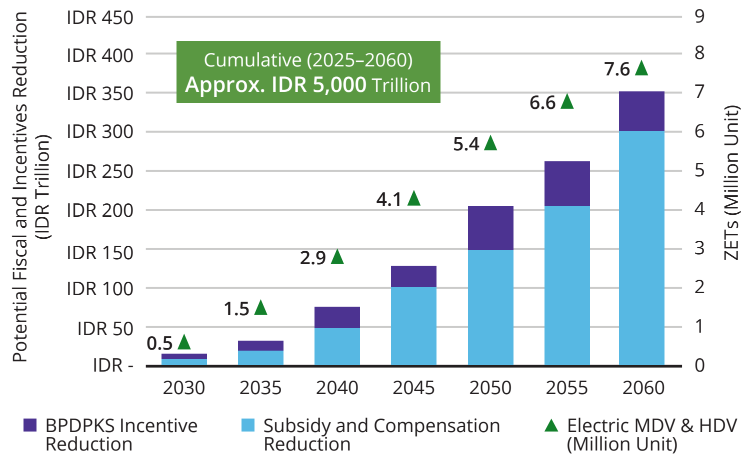
- Diesel subsidy and compensation exposure in the truck sector are highly sensitive to global crude oil prices. Under the Business-as-Usual (BAU) scenario, the cumulative MDV and HDV subsidy, compensation, and BPDPKS incentives total IDR 313 trillion over 2026–2030. A disruption scenario (e.g., the closure of the Strait of Hormuz) pushing crude to $114/bbl would spike the per internal combustion engine (ICE) truck subsidy by 63% in 2026 alone (from IDR 21 million to IDR 35 million), expanding cumulative costs by IDR 500 trillion over 2026-2030. This price sensitivity compounds annually, where each 1 USD/bbl increase above the baseline crude oil price adds roughly 2% or around IDR 400 thousand to per-truck subsidy costs annually.
- Based on our scenario modeling, the continued penetration of ZETs through 2060 yields massive fiscal benefits by progressively reducing annual fuel consumption. By 2030, each deployed ZET avoids approximately IDR 21 million per ICE truck per year in diesel subsidies, compensation, and *Badan Pengelola Dana Perkebunan Kelapa Sawit* (BPDPKS) incentives. Driven by fuel price increases and inflation, this avoided cost is projected to rise to around IDR 50 million per unit per year by 2060. Scaled up to a fleet of 7.6 million zero-emission trucks (ZETs) on the road by 2060, this transition translates into IDR 650 trillion in total annual savings from policy incentives by 2060 and gives a cumulative saving of IDR 5,000 trillion between 2025 and 2060. Every year of delayed adoption means continued diesel subsidies for trucks, funding that could otherwise be reallocated to more important sectors, such as freight-sector investments like electric truck charging infrastructure, logistics corridor improvements, port and industrial estate connectivity upgrades, and targeted incentives to accelerate fleet electrification.
- Beyond direct fiscal savings from subsidies and compensation, the transition unlocks a second dividend. BPDPKS has historically allocated around 92% to the biodiesel incentive (BPDPKS, 2025). As ZETs reduce the need for biodiesel incentives, these freed-up funds can be redirected toward *Peremajaan Sawit Rakyat* (PSR), oleochemical downstream development, or a just transition fund for displaced workers. Prioritizing the PSR program will boost yields on existing plantations, which directly reduces the need for oil palm land expansion.

Subsidy per truck sensitivity analysis



Source: IESR Analysis, 2026; low and high cases of Strait of Hormuz closure used 89 and 114 USD/bbl, respectively (TradingEconomics); 1 USD = IDR 16.400–18.100 (Kurs projection assumption for 2026–2030); BAU used 80 USD/bbl by 2026 and followed IEA's CPS scenario (IEA, 2026)

Potential subsidy saving and incentives reduction from zero-emission trucks

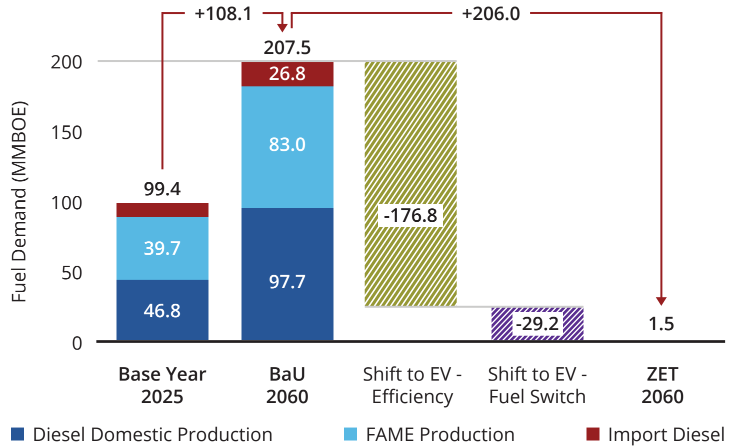


Source: IESR Model, 2026; Subsidy Calculation by Kepmen No.62. K/12/MEM/2020 (MEMR, 2020); Biodiesel HIP (MEMR, 2026); Crude Oil Price Projection (IEA, 2025).

Truck electrification is a strategic path to fuel self-sufficiency, reducing final energy consumption by 78% in 2060

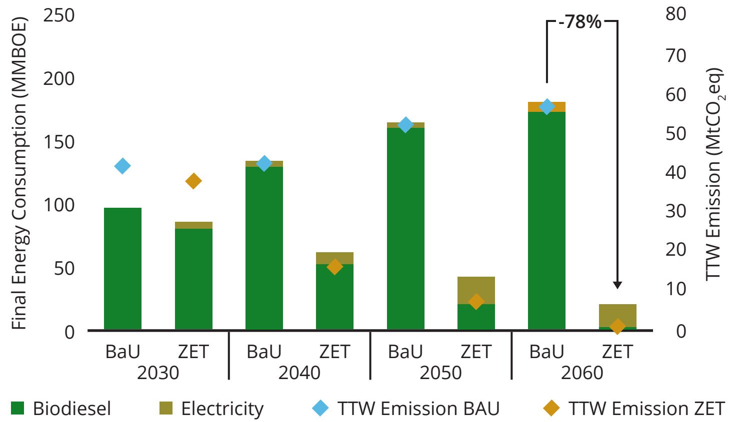
- Current diesel-based truck activities place a heavy burden both domestic production and import of diesel fuel. Under the BAU trajectory, diesel demand is projected to increase from 99.4 to 207.5 MMBOE by 2060. Consequently, the reliance on imported both crude oil for domestic refining and imported diesel fuel would also increase. For context, Indonesia already imported USD 10.4 billion in crude oil and USD 25.9 billion in refined petroleum in 2024 (BPS, 2025), making refined petroleum the country's single highest imported product. Therefore, simply increasing local refinery capacity to meet this demand will only worsen our reliance on imports.
- The ZET scenario addresses this challenge through electrification of the truck fleet, delivering two key benefits. First, ZETs substantially reduce overall energy requirements, lowering total final energy demand by 177 MMBOE relative to BAU by 2060. Approximately 85% of this reduction is attributable to the higher efficiency of electric drivetrains, consistent with estimates that electric trucks are 62–87% more efficient than conventional diesel trucks (DEA & MEMR, 2024). Second, electrification completely removes the sector's reliance on biodiesel, replacing 207.5 MMBOE of liquid fuel demand with only 29.2 MMBOE of electricity by 2060.
- This transition substantially strengthens energy security. By eliminating diesel dependence, per-truck energy costs become entirely decoupled from global oil market movements and disruption scenarios. Furthermore, as the fleet shifts from diesel to electricity, energy demand becomes increasingly supplied by Indonesia's evolving power system, which is expected to become progressively less carbon-intensive over time under national power sector planning.
- The result is a fundamentally more secure and efficient freight energy system. By shifting away from liquid fuels and dramatically improving vehicle efficiency, the ZET pathway reduces dependence on imported petroleum products while strengthening long-term energy resilience. By 2060, total final energy demand falls by 78% relative to BAU, alongside a near-total (99%) reduction in (Tank-to-Wheel) (TTW) or tailpipe emissions driven by the electrification of the national truck fleet.

Diesel and biodiesel consumption reduction of ZET scenario



Source: IESR Model, 2026; Assumed B50 was implemented by 2026; EV adoption in BAU follow the most ambitious electric trucks projection in RUKN (MEMR, 2025)

Final energy consumption and tailpipe emissions (BAU vs. ZET)



Source: IESR Model, 2026; ZETs were assumed to account for 99.5% of total MDV and HDV fleet by 2060 under the ZET scenario

Electrification improves air quality and human health across freight corridors

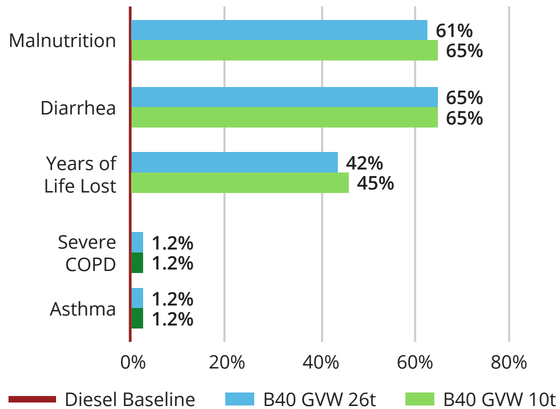
- Air quality in the corridor traversed by trucks is affected by tailpipe emissions from MDVs and HDVs, with key pollutants including CO_2, NO_x, and particulate matter (PM). Among these, CO_2 constitutes the largest share of tailpipe emissions, representing more than 90% of the total emission mass relative to NO_x and PM for both MDVs and HDVs.
- Using Life Cycle Assessment and the environmental priority strategies (EPS) 2015 method, the health impacts of truck route emissions on local communities were quantified. The assessment focused on five primary health outcomes: asthma, chronic obstructive pulmonary disease (COPD), diarrhea, malnutrition, and years of life lost (YOLL), which were evaluated based on population exposure to air pollution consisting of NO_x, CO_2, and $PM_{2.5.}$
- With 50 annual asthma cases emerging per 10 million vehicle kilometers traveled (VKM) across a baseline density of 243 people/km², and assuming an average operational distance of 32,000 VKM per vehicle, the diesel truck burden equates to roughly 160 chronic respiratory cases generated annually by a standard fleet of 100 trucks, highlighting a highly concentrated public health impact. Additionally, an impact of 1520 YOLL means that for every 10 million kilometers driven, truck emissions effectively steal 10 years of life away from 150 different individuals in the community, or completely erase the equivalent of twenty full human lifetimes. These results align with scientific evidence from Ducruet et al., (2024) which shows that freight routes passing through dense communities create respiratory hotspots. Because MDVs and HDVs are operated at low speeds through populated zones, they maximize street-level exposure to hazardous NO_x, CO_2, and $PM_{2.5}$ emissions. Furthermore, the data indicates that MDVs exert a higher overall health impact because their longer transit routes extend the duration and geographic scope of public exposure.
- The health benefits of 40% biodiesel blend (B40) are highly specific: while lower tailpipe CO_2 emissions correlates with a roughly 60% drop in diarrhea and malnutrition cases, it leaves asthma and COPD rates unchanged. In fact, B40 produces higher levels of NOx emissions (Reksowardojo et al., 2023). This specific pollutant acts as a severe respiratory irritant, which likely offsets other benefits by driving up the severity of asthma attacks and COPD complications.
- The transition from diesel and B40-fueled trucks to ZETs can achieve zero tailpipe emissions, eliminating on-road pollutant such as NO_x, CO_2, and $PM_{2.5}$ and significantly improving local air quality and climate-impact outcomes. The deployment of ZETs thus help address respiratory health issues in nearby communities.

Annual human health impacts of diesel trucks (total cases/10 million km)

Disease	GVW 10 (MDV)	GVW 26t (HDV)
Asthma	50	80
Severe COPD	5	10
Diarrhea	20	20
Malnutrition	3180	2860
Year of Life Lost (YOLL)	1520	1340

Source: IESR Model, 2026

Human health impact reduction: shifting from diesel to B40



Source: IESR Model, 2026

Government commits to trucks decarbonization through biofuel and BEV simultaneously, but stronger signal on biofuel

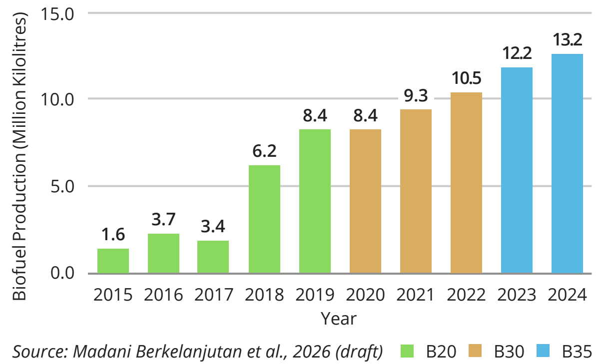
- The Presidential Regulation 55/2019 opened the floodgates of battery electric vehicle (BEV) incentives in Indonesia. It covers all BEV vehicle categories, including ZETs, particularly through industrial policy, local content requirements (LCR), and infrastructure provisions. These incentives apply to BEVs broadly, so ZETs could benefit from import-duty fee and VAT discounts if imported or manufactured under this scheme. However, this benefit recently ended at the end of 2025, and no ZET manufacturers took advantage of this incentive. This might be due to limited government signal for ZET but rather a stronger signal on biodiesel and the significant obligation to commit to local manufacturing.
- There are also active policies such as tax exemptions for Vehicle Tax (PKB) and Title Transfer Fee (BBNKB) regardless of the LCR regulation. In practice, these are the only two incentives available to ZET. These incentives can directly impact the running costs of ZET.
- Indonesia's net-zero emissions (NZE) 2060 commitment, along with its Nationally Determined Contribution (NDC) and Long-Term Strategy (LTS-LCCR), embeds transport decarbonization, with *Rencana Umum Ketenagalistrikan Nasional* (RUKN) and *Kebijakan Energi Nasional* (KEN) supporting BEV adoption across vehicle classes. Based on RUKN, ZET deployment is projected to scale rapidly from around 107,000 units in 2030 to nearly 4.9 million by 2060, although these projections are not yet differentiated by truck weight class.
- Despite the electrification target, biofuel remains a decarbonization option for the government, as indicated by the highly ambitious biodiesel blending in the past 5 years. The Enhanced NDC 2021 (ENDC) estimates that biodiesel—particularly FAME—could contribute 47 $MtCO_2$ in emission reductions by 2030, or around 26% of the total energy-sector target. However, it can also increase NO_x emissions due to higher combustion temperature (Reksowardojo et al., 2023).
- The use of biodiesel also does not fundamentally resolve the high operating costs of diesel engine trucks. Furthermore, there are growing concerns that biodiesel can dissolve protective coatings, expose metal components to moisture and corrosion in truck parts, and ultimately damage fuel-system parts while also reducing engine power and increasing fuel consumption to deliver the same power output (Nguyen et al., 2023; ICCT, 2020). Combined, these add to the operational costs of operators.
- Based on our 2026 system dynamics modeling, biofuel policy would only reduce 123 $MtCO_2e$ in 2060, equivalent to only 39% of truck emissions. Meanwhile, electrification and vehicle turnover would reduce 95% of baseline emissions, showcasing efficiency in absolute emission reduction in achieving NZE.
- Ultimately, the government needs to prioritize on the least emission-technology pathway, as splitting policy attention and incentives between biodiesel and ZET potentially undermines the effectiveness of both policies.

Active incentives for ZETs

Tax exemptions	
	Exempted Vehicle Transfer Fee (BBNKB) BEVs are exempted from vehicle ownership transfer fees (BBNKB), including ZETs
	Exempted Vehicle Tax (PKB) Subnational governments may provide PKB exemptions for BEVs, including ZETs

Source: IESR analysis, 2026

Biodiesel production and fuel blending throughout the years



Source: Madani Berkelanjutan et al., 2026 (draft)

CHAPTER 2

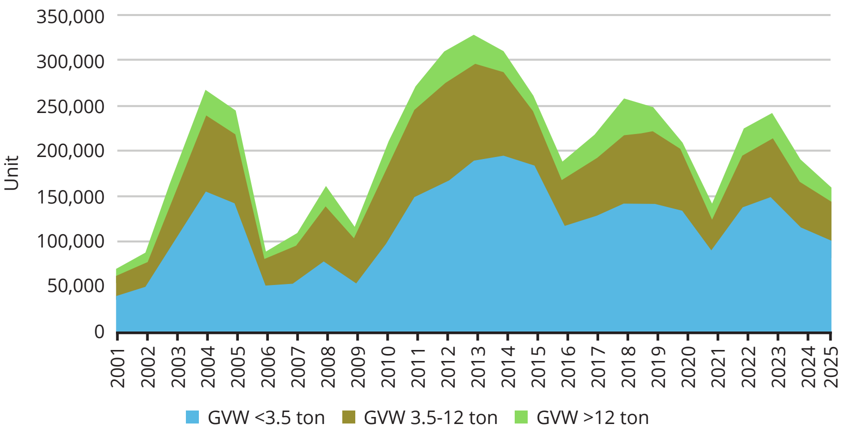
Landscape of Indonesia's road freight ecosystem and fleet composition

Contents

Aging truck fleet poses challenge, but the 20-year age limit could serve as an effective fleet turnover mechanism if enforced

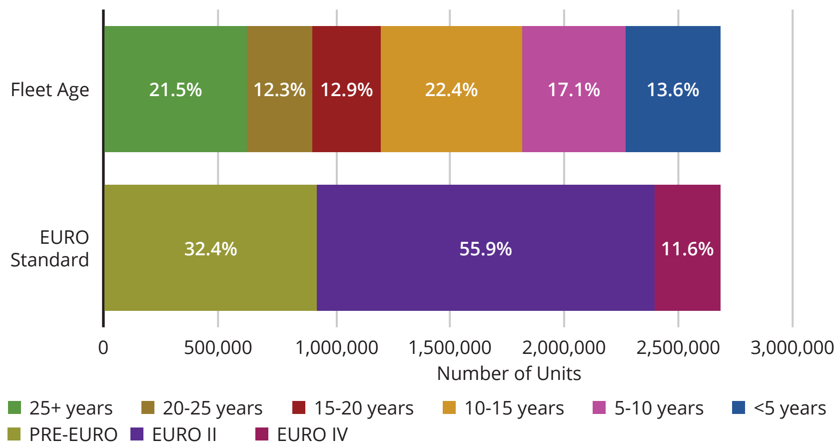
- According to GAIKINDO and BPS data, around 5 million trucks were sold in Indonesia between 2001 and 2025. These consisted of 2.9 million light-duty vehicles (LVDs), 1.5 million MDVs medium trucks, and 542,000 HDVs. As of November 2025, the Indonesian police registry recorded that 6.46 million freight vehicles were registered, implying that around 1.3 million trucks entered the fleet before 2001. Therefore, using early 2000s market shares to estimate the pre-2001 fleet composition, the total MDV and HDV population in 2025 is approximately 2.6 million units, whether or not they remain in operation.
- Indonesia's HDV fleets is large and mostly aging. Based on their registration year, around 33% of MDVs and HDVs are more than 20 years old, exceeding the typical minimum service standards (SPM) regulated under the Ministry of Transport Regulation 60/2019. The SPM function as mandatory operational requirements for freight companies. Violations are categorized as moderate offenses and may result in administrative penalties, including fines and the potential revocation of freight transport operating permits. Despite the regulation, old trucks continue to operate because of loose enforcement, while operators simply cannot afford to replace vehicles when margins are thin and demand for low-cost freight service still persists.
- Older HDVs are an emissions hotspot because they were built to weaker standards (i.e., pre-EURO standards or NOx limits), emission control technologies deteriorate over time, and a small fraction of pre-standard vehicles can produce a large fraction of total PM/NOx (European Commission, 2023; ICCT, 2022).
- Younger fleet, less than 5 years old, accounts for only 13.6% of the total fleet, indicating a slow vehicle stock turnover. Truck owners report that modernizing their fleets is difficult. The combination of slim profit margins and long break-even point—often stretching to nearly 10 years per vehicle—makes a rapid turnover rate financially unfeasible.
- Overall, the fleet composition is likely an indicator for the market structure: larger firms operate younger vehicles as part of a large fleet, while the oldest vehicles are used by owner-operators who do not replace their vehicles often or purchase them second-hand (Breemersch et al., 2021).

Truck wholesales by weight class



Source: Gaikindo, 2025; Breemersch et al., 2021

HDV and MDV classification based on age and EURO standards

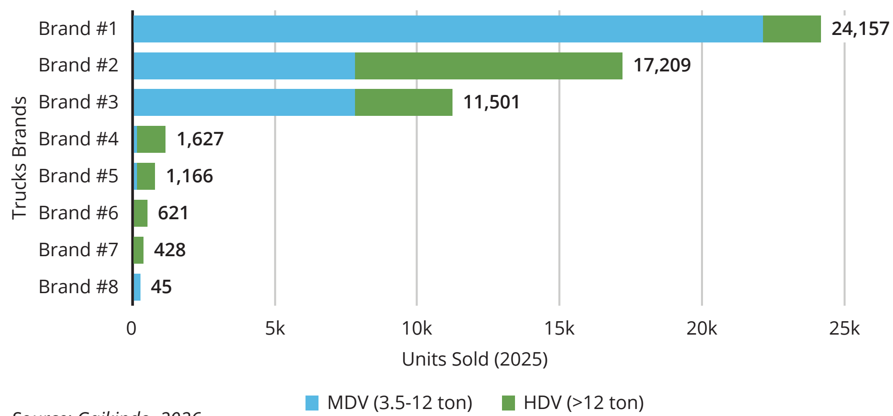


Source: IESR analysis, 2026

Indonesia's electric truck market requires greater commitment and offer from big OEMs

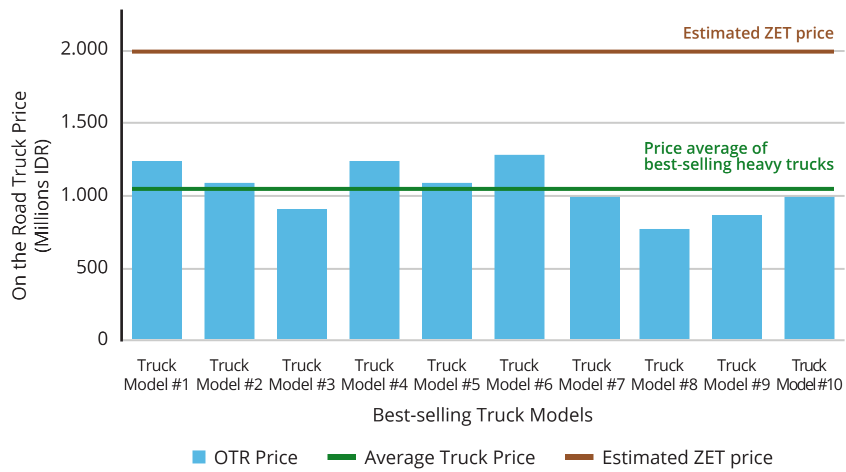
- The Indonesian truck market remains overwhelmingly ICE-dominated. Diesel still powers nearly all fleets, with only a very small compressed natural gas (CNG) presence. The market is also highly concentrated, with three major groups controlling more than 95% of truck sales (ICCT, 2025).
- Official Gaikindo data recorded only two ZET sales between 2024 and 2025, but this likely understates actual market activity because Gaikindo only reports sales from its original equipment manufacturer (OEM) members. In practice, some adoption is happening through emerging or start-up brands, including imported and made-to-order models. These adoption models face not only barriers for market visibility, but also incentive eligibility, as practically none of them meet the LCR threshold required for eligibility.
- The limited availability of ZETs is a significant barrier (ATA, 2022), particularly the lack of offerings from established OEMs. As trucks operate under harsh conditions, often on long and demanding routes, operators place importance on durability, after-sales support, and parts availability. Even non-OEM parts are widely available for established diesel brands, which reinforces operators' confidence.
- This means brand trust and service reliability remain decisive factors in truck purchasing decisions. At present, only one ZET model is available from a mainstream brand, and it is priced at roughly twice the price of its ICE equivalent. That price gap, combined with uncertainty around support and uptime, makes operators cautious.
- These trends are not due to brand loyalty but rather indicate that Indonesian consumers regard value, practicality, and operational confidence. The pattern resembles motorcycle electrification, where start-up brands emerged, although the difference is that government incentives and charging infrastructure helped build trust in the two-wheeler market. With government support, truck manufacturers need to provide the right product, the right network, and the right price, as there is currently a mismatch between available products and operator needs.

Truck sales by OEM in 2025



Source: Gaikindo, 2026

Best-selling HDV price and estimated ZET price (2025)

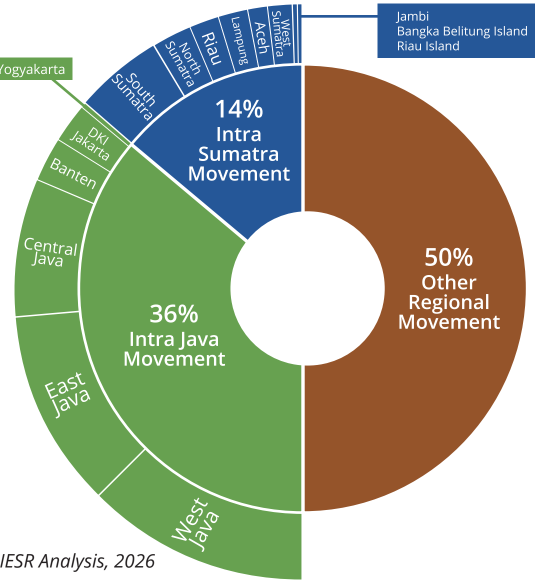


Source: IESR Analysis, 2026

Internal Java and Sumatra freight dominate Indonesia's logistic flows, accounting for half of national commodity trades

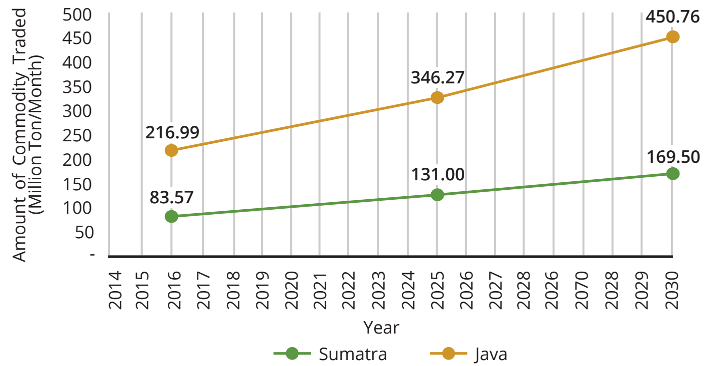
- The intra-island cargo trades in Java and Sumatra cumulatively reached 300 out of 598 million ton/month, equal to around 50% of national cargo activities, based on the national Origin-Destination (OD) survey conducted by the Ministry of Transportation (MoT) of Indonesia in 2016. These movements were classified into 33 commodity types according to MoT Decree No. KM 71 of 2005. These numbers are still on track with the data presented by Transportation Policy Agency (*Badan Kebijakan Transportasi*), MoT, in 2025, which implies both islands as centers of the national economy.
- Out of the total national freight movement in 2016, 36% of them (approximately 217 million ton/month) were registered as the internal cargo movement in Java Islands. Most of these movements were associated (depart from and/or address to) with the provinces of West Java, East Java, and Central Java, while DI Yogyakarta was the least associated province. Some of the leading commodity trades in Java indicate that general cargo for both consumption and industrial sectors dominates overall commodity flows.
- Meanwhile, internal cargo movement in Sumatra accounted for around 14% of the national cargo movements (approximately 83,6 million ton/month). South Sumatra was identified as the leading associated province, followed by North Sumatra, Riau, Lampung, and Nanggroe Aceh Darussalam, with each province indicates similar freight volumes. The main commodities traded in Sumatra include chemicals, fertilizers, crude oil, consumable cargo, and rubbers. Province-to-province freight flow diagrams for both islands are provided in Appendix 3.
- These numbers were predicted to rise 1.5 to 2 foldsa in average by 2025–2030, taking GRDP and population growth of each province into account according to the data by National and Regional Statistics (BPS). The growth projection incorporates elasticity effects, resulting in an exponential growth trajectory for developing countries with strong urban population growth (Tjandra et al., 2024).
- Based on these projections, commodity trades in Java and Sumatra are estimated to exceed 600 million ton/month cumulatively in 2030 (double than recorded in 2016), indicating substantial freight traffic to anticipate. Meanwhile, recent data from the Directorate General of Transportation and Multimodal Integration (DG-INTRAM), MoT, in 2025 indicates that 92% of national freight movements are carried by road-based transportation. These circumstances oversee both Java and Sumatra as the initial milestone of ZET adoption pilots and would play significant role in Indonesia's freight decarbonization priorities.

Inland cargo shares in Java and Sumatra by province-associated according to the 2016 Logistics National OD Survey



Source: IESR Analysis, 2026

Estimated growth in intra-island commodity trades in Sumatra and Java

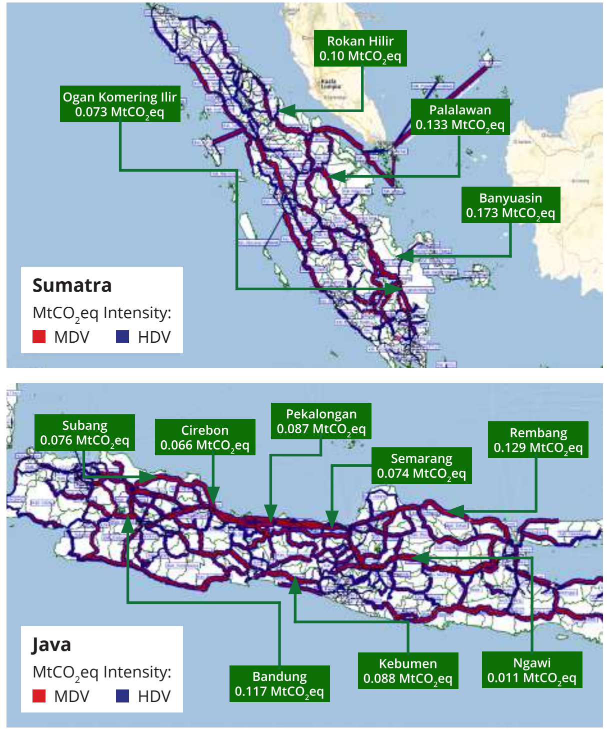


Source: IESR Analysis, 2026

East Sumatra Highway (*Jalintim*) and Java North Coastal Route (*Pantura*) are the busiest logistics corridors, causing significant emissions across both islands

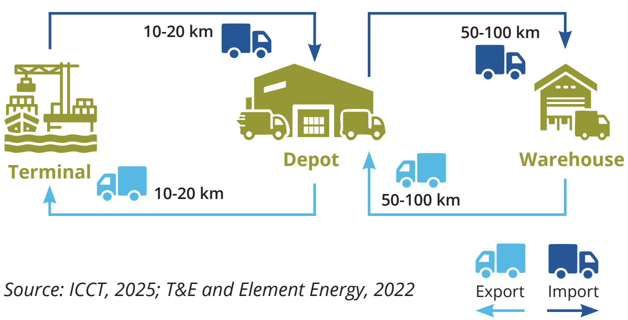
- The GRDP and population growth form a new 2025 OD Matrix, which serves as an approximation of existing traffic volumes across freight corridors in Java and Sumatra. The modeling framework focuses on the internal commodity flows, with the objective of analyzing inland logistics transport. This study assumes that inland commodity trades is highly dependent on the truck, given that most logistics flows in Indonesia are carried by road-based transportation (DG-INTRAM MoT, 2025). The vehicle kilometer traveled (VKT) results then construct emissions models, depicting the environmental impact of existing truck operations along the corridors.
- According to the model, freight transport emissions are concentrated heavily along Indonesia's main logistics corridors. In Sumatra, emission intensities are centered on the eastern section of the Trans-Sumatra (*Jalan Raya Lintas Timur*) corridor, which connects metropolitan areas, including Lampung, Palembang, Pekanbaru, and Medan. This corridor serves as a logistics backbone for plantations and industries accesses, including crude palm oil (CPO), coal, pulp and paper, and rubber. Meanwhile, in Java, the highest emissions are concentrated along the Northern Coastal Route (*Pantura*), reflecting the dominance of HDV link to densely-populated cities, manufacturing hubs, major ports, and industrial zones from west to east.
- MDVs dominate the generation of the CO_2 emissions at 13.05 $MtCO_2eq$, while HDVs contribute to 3.35 MtCO eq across Java and Sumatra. Looking at local air pollutants, the annual NO_x emissions from MDVs (136,600 ton NO_2-eq) are estimated to be three times higher than emissions from HDVs (44,800 ton NO_2-eq). At the same time, a similar pattern is observed for fine PM emissions, with MDVs contributing around 2,500 ton $PM_{2.5}$-eq annually, while HDVs' contribute approximately 900 ton $PM_{2.5}$-eq per year.
- From a spatial perspective, Banyuasin Regency's corridors hold the highest segment emission level at 0.173 $MtCO_2eq$, followed by corridors in Pelalawan Regency at 0.133 $MtCO_2eq$. Both are part of the existing eastern Trans-Sumatra corridors, reflecting their roles as the primary logistics access on the island. Meanwhile, the model identifies Rembang corridors as having the highest emissions, at 0.129 $MtCO_2eq$ in Java, followed by the Cianjur–Bandung and Ngawi Toll Road corridors with 0.117 and 0.110 $MtCO_2eq$, respectively. However, the North Coastal Route corridor in general demonstrates high levels of emissions across the island.
- Overall, this pattern suggests that higher freight activity and connectivity are linked to higher emission concentrations, such as in production hubs, industrial zones, and key logistics corridors.

Emission intensities across Java and Sumatra primary logistics corridors in 2025

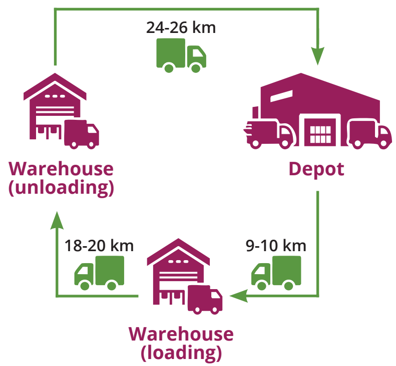


Source: IESR Model, 2026

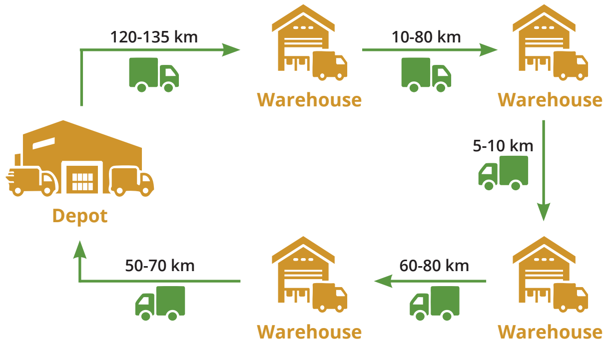
Different truck use cases present different opportunities for electrification



Source: ICCT, 2025; T&E and Element Energy, 2022



Source: Personal Communication, 2026



Source: ICCT, 2025; T&E and Element Energy, 2022

- Freight trucking operations generally fall into three broad use cases: port truck operation operations, quasi-shuttle factory–warehouse logistics, and regional multi-destination distribution (ICCT, 2023; T&E and Element Energy, 2022). These use cases differ in route predictability, daily driving distances, and operational patterns.
- In port operation, trucks function as first- and last-mile connectors in multimodal logistics, moving goods between rail terminals or ports and customer locations. Operations are relatively predictable with several trips per day and an average activity of ±200 km per day, with vehicles operating about 8–12 hours daily and carrying loads of over 50 tons.
- In quasi-shuttle logistics, trucks operate regular shuttle services between factories and warehouses, often combined with local distribution to avoid empty return trips. Operations typically involve 1–3 round trips per day, with ±70–100 km of daily travel, operating time of up to about 10.5 hours per day, and a 25-ton payload.
- In regional multi-destination distribution, trucks deliver goods from a depot to multiple customers across a wider area. Daily activity varies more significantly, ranging roughly between 350–510 km per day, and routes are less predictable due to changing delivery schedules.
- If electrified, each of these use cases poses different challenges and opportunities. For example, the highly predictable routes and frequent returns to depots or facilities in quasi-shuttle operations create regular opportunities for destination charging at the warehouse during loading or unloading, or overnight charging at the depot. On the contrary, the high-mile multi-destination regional operation might require public charging to top up during operations.

CHAPTER 3

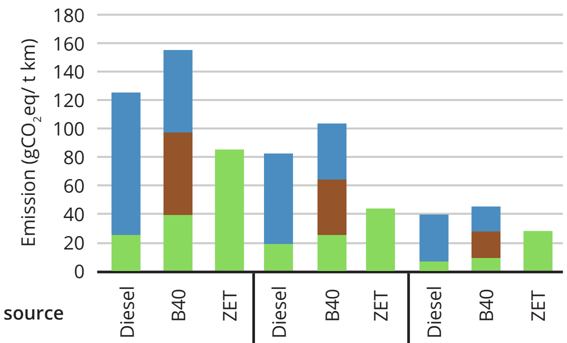
Techno-economy comparison of truck technologies

Contents

Heavier electric trucks achieve the lowest life cycle emissions, while biodiesel produces higher total emissions than conventional diesel

- Well-to-wheel life cycle assessment (LCA) is used to evaluate greenhouse gas (GHG) emissions from three truck gross vehicle weight (GVW) classes: 10.6 t (medium-duty), 26 t (heavy-duty), and 55 t (ultra-heavy). Unlike the tailpipe-only emission quantification, LCA approach gives a comprehensive figure of vehicle's energy chain impact, as its analysis scope covers all life cycle stages of fuel, including fuel production and combustion.
- Heavier trucks have significantly lower carbon emissions per ton-kilometer, as shown by a consistent and clear pattern regardless of fuel type. Shifting from a 10.6-ton to a 55-ton diesel truck can potentially cut emissions intensity by over half. It makes immediate load aggregation (only if trucks have similar routes and schedules) become a practical near-term solution. While B40 and ZETs follow the same trajectory, electrification multiplies the impact, delivering a fivefold emission reduction driven by superior freight efficiency per unit of energy.
- In case of diesel trucks, tailpipe emissions from fuel combustion are overwhelmingly the largest emission source, accounting for more than 70% of total lifecycle GHG emissions across all GVW classes. However, switching to B40 reduces these combustion emissions by approximately 41%.
- Despite reducing tailpipe emissions, B40's total life cycle emissions remain higher than diesel's because of large upstream emissions from direct land-use change (DLUC). DLUC occurs due to the emissions generated by feedstock plantation activities that convert land and decrease the land's capability to sequester CO_2 from the atmosphere. After accounting for DLUC, B40's total life cycle emissions are 27% higher than fossil diesel, and land-use emissions make up 37% of B40's total emissions.
- ZETs cut total life cycle emissions the most: electrifying MDVs reduces emissions by 29% relative to diesel and 43% compared to B40. For 26t trucks, electrification cuts 44% CO_2 compared to diesel and 55% compared to B40. With no tailpipe emissions, ZET entire footprint comes from upstream processes, especially Indonesia's coal-intensive electricity grid and power-plant construction. Thus, every improvement in the grid emission factor can immediately improve the life cycle emissions of every ZETs on the road, so decarbonization from electrifying today's fleet increases automatically as the grid becomes cleaner over time.

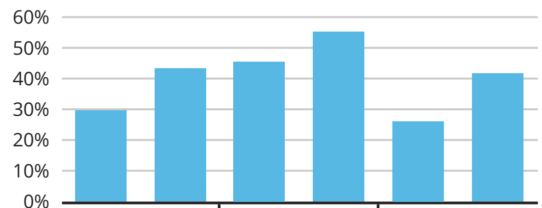
Truck life cycle emission



Energy source	Diesel	B40	ZET	Diesel	B40	ZET	Diesel	B40	ZET
Truck GVW	10.6 t			26 t			55 t		
Fuel Production	95	59	0	63	39	0	30	19	0
DLUC	0	55	0	0	37	0	0	18	0
Fuel Combustion	29	40	87	19	27	46	9	13	29

Source: IESR Model, 2026

Reduced emission by percentage through ZET implementation



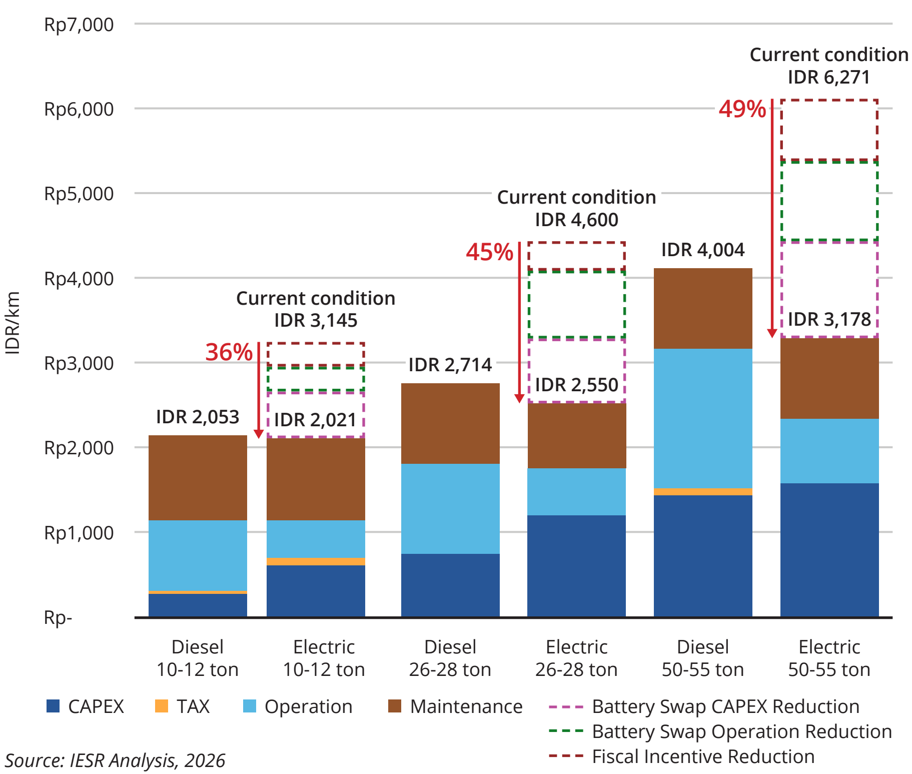
	Diesel Truck	B40 Truck	Diesel Truck	B40 Truck	Diesel Truck	B40 Truck
Truck GVW	10.6 t		26 t		55 t	
Total CO_2 Reduction (%)	29%	43%	44%	55%	27%	41%

Source: IESR Model, 2026

Tax exemptions alone are insufficient to make ZET competitive with diesel trucks running on subsidized fuel, but combining them with battery swap scheme makes it competitive

- The total cost to own and run (TCO) ZET for 100,000 km per year over 20 years remains higher than that of a diesel truck running on subsidized fuel across all weight segments: 10–12 ton, 26–28 ton, and 50–55 ton.
- Capital expenditure (CAPEX) is the main barrier for ZETs, contributing 42–56% of their TCO, compared to only 17–39% for diesel trucks. In contrast, operational costs are where ZETs have a clear advantage, accounting for about 25% of their TCO, compared with roughly 40% for diesel trucks.
- Mirroring the government's path to address the high CAPEX issues in the private vehicle segment, giving tax incentives is a feasible option to pursue. However, exempting the vehicle ownership tax (PKB) and title transfer fee (BBNKB) only reduces 300- 800 IDR/km, or around 8–13% of the ZETs total TCO. Therefore, another scheme is needed to make ZET more competitive.
- The battery swap scheme emerges as a promising solution. There are two ways to implement the battery swap scheme, whether or not it includes the battery in the vehicle. If it includes the vehicle battery, the swapping cost is lower than under the excluded scheme. However, the excluded scheme can reduce ZET CAPEX by approximately 60%, as shown in a case study in China (Lindholmen Science Park, 2025). Implementing the battery swapping scheme also reduces operational costs by up to 170 million rupiah per year (CATL, 2023). Another benefit of implementing battery swapping is increased consumer trust, as it provides battery health guarantees.

Subsidized diesel truck and ZET TCO comparison for 20-year period



Source: IESR Analysis, 2026

- Assuming a third-party battery-swap service costs around IDR 126 million per year. The scheme can lower ZET's TCO by 28–39% from its baseline, which comes from CAPEX reduction, a separation of battery and vehicle, and operational cost reduction, including battery replacement cost. However, to become fully competitive with diesel trucks running on subsidized fuel, battery swapping must be paired with additional fiscal incentives, such as exemptions from PKB and BBNKB, which can further reduce TCO by 8–10% after implementing the battery swap scheme. With that scenario, the 50–55 ton truck segment is the fastest to reach payback, as it only needs 3 years to reach positive cash flow, followed by the 26–28 ton segment with 9 years of operation to reach payback, and the 10–12 ton segment, which needs 20 years to reach payback. Consistent policy support and effective implementation of the battery swap ecosystem are needed for ZETs to achieve long-term feasibility.

CHAPTER 4

Policy pathways for zero-emission truck mainstreaming

Contents

Legacy OEMs offers their clean trucks to other regions, but they should start bringing their ZET offerings to Indonesia with the support of government incentives

- Many of the same truck brands operating in Indonesia already offer ZET models in China, Europe, North America and Australia (Nikkei Asia, 2023; Gasgoo, 2024; Toyota, 2025; Scania, 2025). FAW is rapidly expanding battery-swapping trucks in China, while Fuso, Hino, and other global OEMs are deploying BEV and fuel-cell technologies in more advanced freight markets. The technology already exists within these manufacturers' global portfolios, but its deployment follows market demand and regulatory requirements.
- ZET mandates and roadmaps create the commercial case for manufacturers to prioritize cleaner vehicles. Markets with clear emissions standards and ZET targets are more attractive for OEMs. In contrast, markets without comparable signals continue to receive conventional diesel offerings. As a result, Indonesia risks becoming a recipient of increasingly old diesel technologies while cleaner models are prioritized elsewhere.
- Indonesia still imports trucks of around 5% from total truck sales. Imports from China, Europe, India, and Japan remain dominated by diesel models, despite these same markets increasingly promoting cleaner models like ZET. The issue is accessing the ZET technologies within these global OEM portfolios.
- At the same time, Indonesia's truck market is overwhelmingly supplied by local production and assembly. More than 95% of MDV and HDV sales originate from domestically produced vehicles, while imports are largely limited to specialized ultra-heavy-duty trucks above 24 tonnes. This means imports can serve as a targeted pathway for introducing new technologies without significantly affecting the domestic manufacturing base.
- For that reason, improving access to ZET imports will be critical during the early stages of market development. As a market-shaping tool, Indonesia has already applied a 0% import duty/exemption for passenger cars in 2024-2025, as an incentive for completely built-up (CBU) cars. Hence, there is a clear policy precedent for using imports to create a new market—this time for ZET. Unlike the car scheme which tied import duty exemptions to local production commitments, Indonesia could reopen an import-fee tax exemption for ZET and, tie it to other obligations, such as minimum charging infrastructure investment and fleet operator training programs; basically, obligations that build an enabling ecosystem rather than a factory.

ZET offerings by major truck OEMs in overseas market

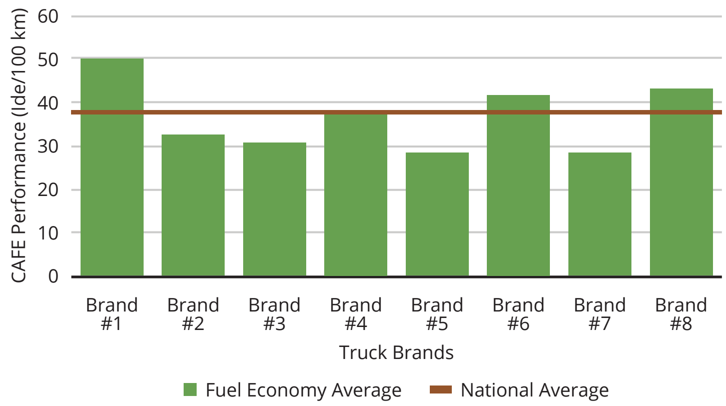
Brand	ZET offerings in other markets
Mitsubishi Fuso	**eCanter** is commercially deployed across Europe, Japan, North America, and Australia
Hino	In partnership with Daimler and Toyota, Hino supplies ZETs to the United States and Japan and has recently released a new **Le Series EV**, which will be sold mainly in the United States
Isuzu	The Isuzu **NRR EV** is sold and produced in North America, with manufacturing taking place in Michigan. The vehicle is available across the United States and Canada
FAW	Developing **battery-electric and battery-swapping heavy trucks** in China
Scania	Commercially available **battery-electric trucks** in Europe and ongoing development of hydrogen-based freight solutions

Source: Nikkei Asia, 2023; Gasgoo, 2024; Toyota, 2025

Fuel economy standard demands efficient fleets from OEMs, leading to the wider spread of ZET availability

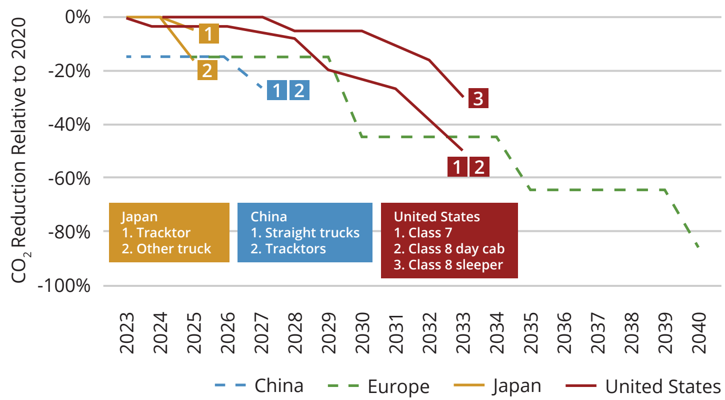
- As economies advance, consumers benefit from increasing access to product variety. Several strands of the economics literature have examined the value of new products and increases in variety either theoretically or empirically (Quan and Williams, 2018). The Indonesian electric car market illustrates this. Available models grew from 11 to over 50 between 2022 and 2024, with at least 8 new brands entering the market. This expansion in variety coincided with electric car sales reaching 6.5% of total car sales in 2024, with Jakarta recording as high as 25%. The same logic applies to electric trucks—without a meaningful range of ZET models available in the market, adoption will remain limited.
- At present, only one major OEM offers a ZET in Indonesia, leaving the ZET market largely to startup brands with limited track records. This is a problem because Indonesian truck buyers are strongly attached to established brands, due to their reliability, service network coverage, and parts availability. Getting established OEMs to bring ZET models to market is a prerequisite for adoption growth.
- One of the most direct policy tools available is fuel economy (FE) standards, which tracks the fuel economy of the fleet and set a limit on the average FE of all vehicles a manufacturer sells within a given period. In 2025, truck sales averaged 37 lde/100 km. However, this figure is pulled down by the dominance of MDV, which use less fuel per kilometer. As a result, the fleet average can appear efficient, while heavier trucks, particularly in the 40–50 ton segment, remain far less efficient but do not sell as much.
- Driving electrification requires a faster tightening of FE. Historically, FE standards have improved by around 3–6% per year, which can largely be achieved through incremental measures such as engine optimization and lightweighting. However, to meaningfully accelerate electrification, the annual rate of improvement needs to reach around 10% (ICCT, 2024). Below this number, manufacturers can continue complying without significant shifts toward zero-emission technologies.
- Tightening FE standards should ensure that established brands will offer ZETs. Without sustained regulatory pressure, major OEMs face little commercial incentive to prioritize ZETs in Indonesia, delaying scale, investment, and market readiness.

Fuel economy performance from truck OEMs based on 2025 sales



Source: IESR Analysis, 2026

FE improvements required for HDVs relative to 2020 baseline

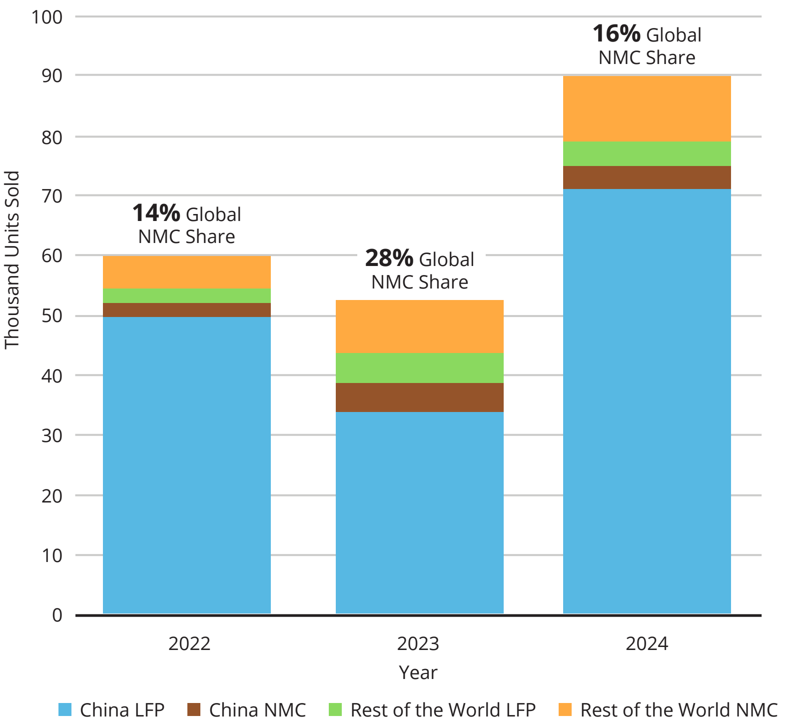


Source: ICCT, 2024

Gatekeeping incentives on nickel chemistry risks stalling the ZET transition altogether

- The Indonesian government is considering new targeted BEV incentives based on battery type, with nickel-based vehicles receiving a 100% VAT discount and other battery types receive a reduced 40% VAT support. This is a strategic decision for Indonesia's position as one of the world's largest nickel producers. Although this incentive is reserved for cars, it is possible that it will be applied to trucks in the future. Hence, it is important to analyzed in that context.
- To support Indonesia's ambitious plan to become the third largest producer of EV batteries by 2027 and produce approximately 140 GWh per year of EV battery capacity by 2030 (ASEAN Briefing, 2024), tiered incentives like this plan helps to sway private sector to build the required supply chain in Indonesia.
- The big problem is that the global trend is not moving in favour of nickel. Lithium iron phosphate (LFP) technology for trucks is still dominating globally, accounting for 72–86% of ZET sales. This assumes 90–95% of trucks sold in China use LFP, and the rest of the world is 30% LFP and 70% NMC based on 2022-2024.
- In emerging markets like India, 25 out of 29 ZET models are LFP. Every Indian OEM and every Chinese OEM uses LFP. The only non-LFP entry is Volvo, which uses NCA.
- Indonesia's nickel plan is at risk with this shift to LFP batteries, as LFP batteries do not use nickel due to cost, safety, and supply stability (IBC Institute, 2025). Further, LFP batteries are almost 30% cheaper per kWh than NMC batteries, but NMC batteries still provide an energy density advantage. However, the energy gap has narrowed in recent years (IEA, 2025). LFP packs offer about 20% lower energy density by mass (Wh/kg) and 33% lower by volume (Wh/L) than NMC. However, this is partly offset by LFP's ability to charge to 100% without significant degradation, while NMC is typically limited to 80% to preserve long-term performance.

Estimated worldwide truck sales by region and battery type



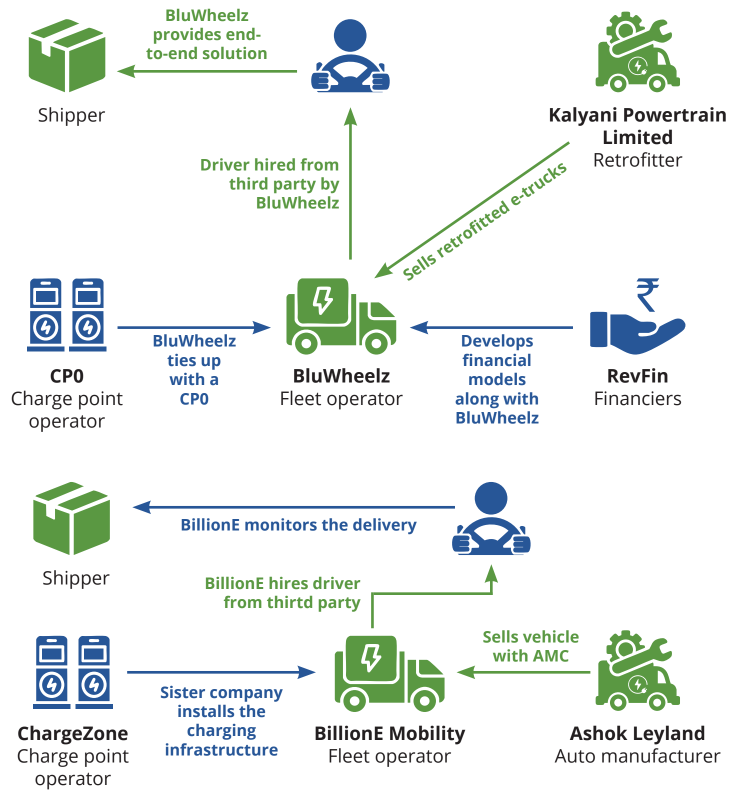
Source: IESR Analysis, 2026

- Indonesia needs to incentivize trucks altogether; the more accessible trucks are, the better. For nascent markets like ZETs, incentives should be technology-neutral to maximize adoption. Tiered or performance-linked incentives are better reserved for a stage when the market reaches a tipping point and multiple battery chemistries are genuinely competing—a stage where NMC's higher energy density may yet give it an edge. Disadvantaging the most affordable technology, i.e., LFP, at the early market phase risks slowing the transition altogether.

India's ZET ecosystem emphasizes use case importance and shipper-led demand aggregation

- India's truck electrification is growing, largely because major shippers (factories) are stepping up to aggregate freight volumes and demand for ZET. This gives fleet operators the confidence to invest, with logistics providers procuring ZET through competitive tenders. Platforms like e-FAST India are targeting 7,750 MDVs and HDVs by 2030, and major shippers are backing this up with public commitments like EV100+ to fully electrify their logistics fleets (CEEW, 2025).
- Factories like JSW Cement provides steady business guarantees to operators to help offset the high upfront cost of ZETs. IKEA took a similar approach, partnering with BLR Logistics with confirmed load commitments to ensure commercial viability for the operator. For ZET OEMs, these arrangements translate into a more predictable order book, which is crucial for scaling production, and backing trucks with strong warranties and after-sales support.
- Truck selection is tailored to specific duty cycles, with operators evaluating OEMs based on route efficiency, topography, and payload requirements before deployment. To manage the risks that come with new technology, contracts are structured around operational characteristics, price escalation clauses and defined risk-sharing between shippers, operators, and OEMs.
- Early pilots in cement, port operations, dairy, and e-commerce have already demonstrated that e-trucks are commercially and operationally viable in India. These sectors are well-suited for electrification due to their captive, closed-loop logistics, short and predictable routes (50–200 km) that align with current battery ranges, and assured two-way loads that keep utilization high and justify dedicated charging infrastructure.
- Financing structures need to evolve to keep pace with high upfront costs and perceived technology risks. Current options remain relatively expensive, as vehicle loans typically run at 8–12% interest over 4–7 years, while leasing models sit at an effective 9–13% over 3–6 years. Emerging models like Trucking as a Service (TaaS) and Battery as a Service (BaaS) can help by shifting asset ownership and battery risk away from operators, reducing CAPEX burden. The bottom line is lenders need to see stable and predictable cash flows before they commit, which comes down to long-term contracts and high route utilization.

Stakeholder relation models of the ZET ecosystem in India



Source: CEEW, 2025

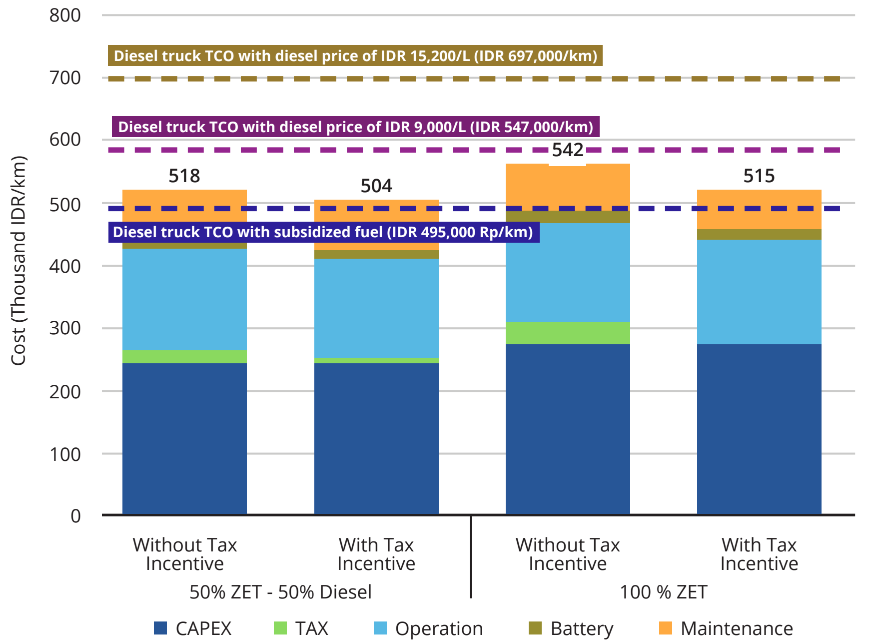
Potential pilot project A: Patimban Port corridor — heavy trucks for automotive cargo

This corridor is identified as a candidate for a ZET pilot based on route intensity, cargo type, and use case of port operations. No feasibility study has been conducted yet. TCO comparison uses IESR model assumptions.

- Electrifying port truck operations is an excellent choice for a ZET pilot project because the system offers a closed-loop setup with trucks running on a routine schedule, simplifying both trip planning and charging coordination.
- In this case, the route serves goods exported from two industrial areas to the harbor, located 50 km and 100 km away, respectively. Electrification is planned to begin in 2030. The required fleet consists of 39 HDVs making 6 trips per day on the 50 km route and 58 HDVs making 5 trips per day on the 100 km route.
- However, even when replacing half of or the entire fleet with ZETs, the total system cost using diesel trucks with subsidized fuel remains slightly lower, with the assumption of no diesel scarcity that would drive up prices.
- Tax incentives alone, such as exemptions from PKB and BBNKB, are insufficient to make ZET competitive against diesel. These incentives must be paired with the removal of diesel subsidies. Raising the subsidized diesel price from IDR 6,800/L to IDR 9,000/L makes electrification the more logical choice. If tax incentives are also provided, the required diesel price increase is lower—only IDR 8,000/L is needed to tip the balance in favor of ZET.
- Supporting this pilot project will require around 10 charging points along the 50 km route and 15 along the 100 km route. To maintain battery longevity, each truck must charge once daily during operation. This translates to a daily grid energy supply of 14 MWh for the shorter route and 21 MWh for the longer one.

Location: Karawang industrial area — Patimban Port.
Cargo type: Automotive parts and finished goods.
Truck type: HDV (55t GVW). Payload: 38.14 ton.
Route distance: 50 km/100 km (two segments).
Fleet size: 39 trucks (50 km), 58 trucks (100 km).
Trip frequency: 6 trips/day (50 km), 5 trips/day (100 km).
Port: Single port operation (Patimban).
Pilot start target: 2030.
Annual cargo volume: 1,330 tons/year.
Operating hours: 24 hours or 3 shifts per day.
Charging locations: Combination of depot/en-route/port charging.
Charging point: 25 points.
Charging frequency: Once per day.

Total system cost comparison of port electrification pilot project in Java for 10-year period



Source: IESR Model, 2026

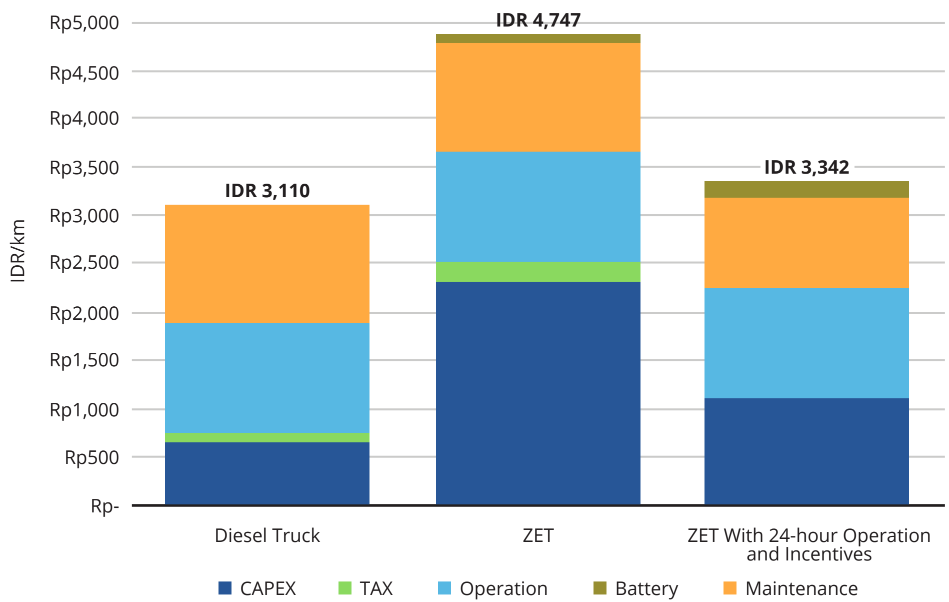
Potential pilot project B: Muara Enim Coal Mining corridor — medium trucks in quasi-shuttle operation

Quasi-shuttle operation identified as a ZET pilot candidate due to fixed route, depot-based charging, and high daily utilization. No feasibility study has been conducted yet. TCO comparison uses IESR model assumptions.

- Another operation well-suited for electrification is the quasi-shuttle truck model. In this setup, trucks depart from the depot with a fully charged battery, travel to a mining site to load coal, deliver it to the nearest train station, and repeat the cycle. Trucks operate for 12 hours per day, with each truck completing 5 round trips daily.
- Charging infrastructure is installed at the depot. When a truck's battery reaches around 20%, it returns to the depot for a 40-minute charge. Each truck requires two charging sessions per day to sustain 12 hours of operation.
- Under these conditions, the TCO for ZETs is still higher than for diesel trucks. However, ZETs TCO drops significantly when incentives are introduced. Allowing ZETs to operate 24 hours, combined with exemptions from vehicle ownership tax and title transfer fees, reduces their TCO by IDR 1,400 /km. To make e-trucks competitive, the government must raise the subsidized diesel price to at least IDR 8,000 /L.
- Electrification also offers benefits related to driver behavior. While there is not much difference in the case of a 12-hour operation between a ZET and a diesel truck, ZET drivers obtain 170 minutes of total rest time (including charging breaks), while diesel truck drivers only obtain 50 minutes of total rest time in a 24-hour shift. With adequate rest time, truck drivers' crash odds are reduced (Chen & Xie, 2014).

Location: Muara Enim mine site to Tanjung Enim Baru train station.
Cargo type: Coal.
Payload: 6.6 ton.
Route distance: 315 km.
Trip frequency: 5 round trips/truck/day.
Pilot start target: 2030.
Annual cargo volume: 1.3 Million Tonne.
Operating hours: 12 hr/day (baseline); 24 hrs (incentive scenario).
Charging locations: Depot only.
Charging frequency: 2 sessions/truck/day (~40 min each).
Charging power: 250 kW.

Total cost comparison of MDV quasi-shuttle operation in Sumatra for 10-year period



Source: IESR Model, 2026

CHAPTER 5

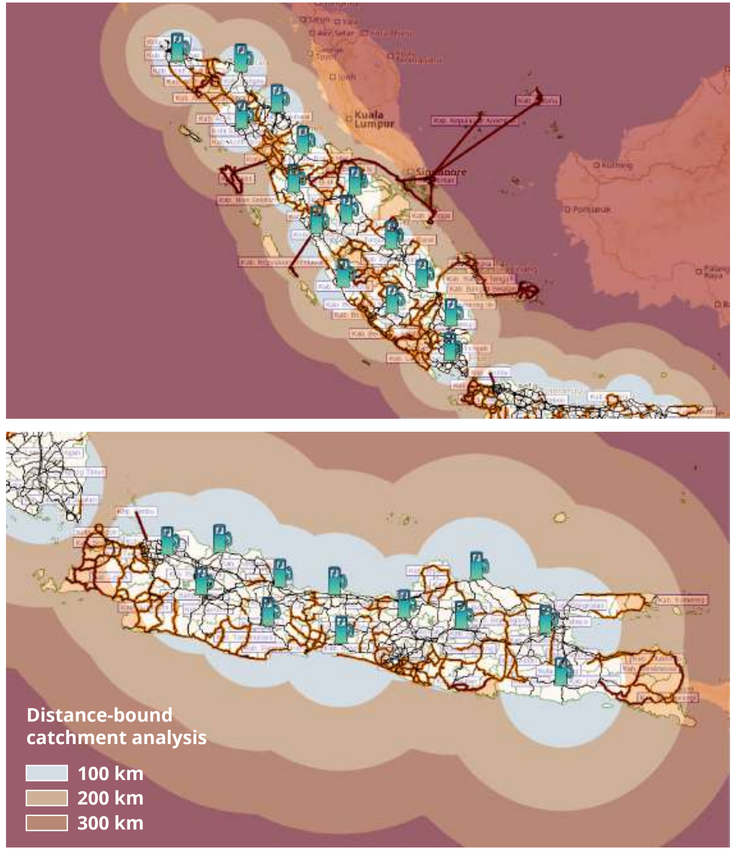
Building the enabling environments for zero emission trucks

Contents

ZET adoption relies on strategically mapped charging networks spanning 100-km intervals on primary freight corridors

- A recent stated-preference survey of truck operators by IESR indicates that more than 80% of respondents perceive charging logistics as a major operational bottleneck to ZET adoption. The lengthy charging time that causes significant downtime is a strict concern for the operators due to the potential for daily operational disruption. Therefore, a well-planned public charging (SPKLU) network establishment can be an alternative strategy to mainstreaming ZET adoption in Indonesia.
- ZET cannot rely solely on depot and destination charging at loading/unloading facilities. Hence topping up through public charging is necessary. Several pilots in India suggest that trucks cannot complete the trip due to lack of midway charging (CEEW, 2025). Meanwhile, the existing SPKLU points reserved for passenger cars cannot co-exist with trucks due to incompatible size and spacing. Hence, truck-specific charging points are highly recommended to enable the ZET operations.
- Based on our model, 15% of national truck fleets could be electrified in 2030, creating substantial demand across busy freight corridors. The points in the figures are indicative areas; thus, they are not exact points but a strategic guide to locate the optimum freight charging locations. The models are built on massive energy demand, which are formed by traffic volume forecast and distance-bound catchment analysis (isochrones) at 100 km intervals. In addition, the placement of charging points along the national artery roads is considered advisable to facilitate this initial phase of development, in consideration with operational cost-effectiveness, as informed through discussions with truck operators and associations. The details of these 27 indicative areas are provided in Appendix 4.
- With a capacity of 230 kW per station, the model spots 27 indicated areas in Java and Sumatra. Trucks are assumed to dispatch from their origin points with 100% state-of-charge (SoC) and arrive at the station with 30% SoC. It then allows them to top up midway until 80% SoC before completing their trip. This would take 100 kWh trucks around 20 minutes and 400 kWh trucks around 1 hour of charging time.
- Building this network will increase electricity demand along the routes by around 16.9 MW daily by 2030. These nodes also indicate where electrical grids must be reinforced to support simultaneous and multi-vehicle 230 kW charging demands without disrupting regional power distribution accordingly.

Strategic indicative truck charging placement across Java and Sumatra freight corridors to support ZET adoption in 2030

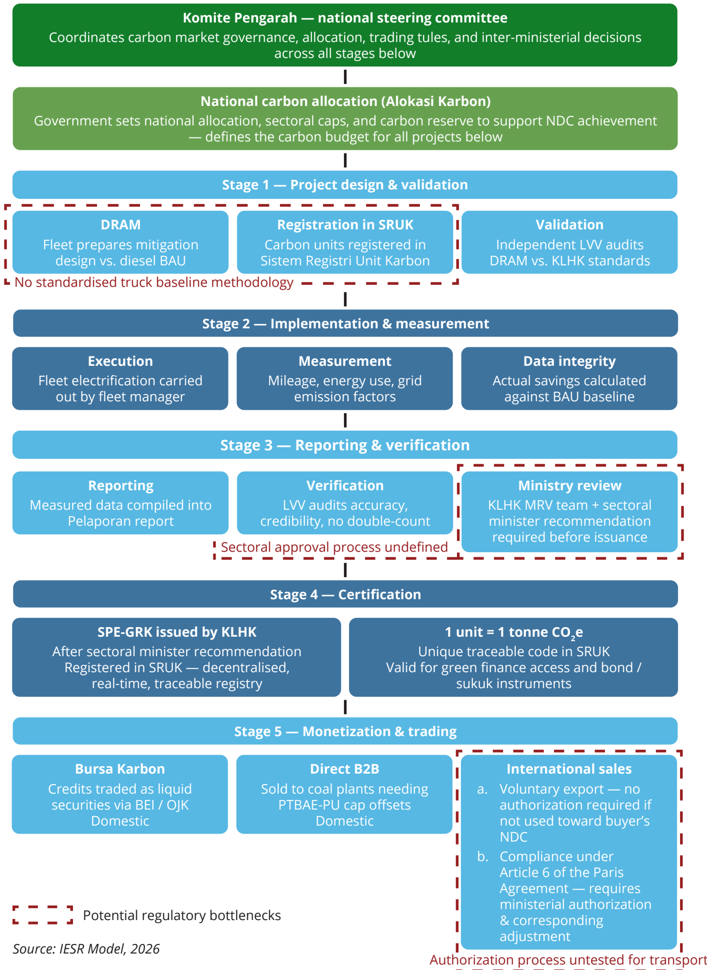


Source: IESR Analysis, 2026

Carbon market offers potential financing pathway for truck electrification, although implementation faces three potential bottlenecks

- Presidential Regulation (Perpres) No. 110/2025 now regulates the implementation of Carbon Economic Value (NEK), replacing Perpres No. 98/2021. This updated regulation introduces Carbon Allocations as a strategic planning tool and aligns with Article 6 of the Paris Agreement by establishing requirements for Ministerial Authorization and Corresponding Adjustments for international carbon trade. The specific procedures for registration, verification, and validation are detailed in Minister of Environment and Forestry Regulation No. 21/2022 (Christiawan et al., 2024). Additionally, Law No. 4/2023 officially recognizes carbon units as "securities" and mandates that any carbon exchange must be licensed by the Financial Services Authority (OJK).
- For truck fleet managers, electrification could create future carbon credit opportunities under Indonesia's evolving carbon market framework. Despite the regulation's implementation still pending, in theory, transport activities are categorized as a source of certified emission reductions that can be sold to those who exceed their limits (MEMR, n/d)
- The carbon monetization mechanism starts by obtaining a Greenhouse Gas Emission Reduction Certificate (SPE-GRK), recorded in the Carbon Unit Registry System (SRUK). This requires preparing a Mitigation Action Design Document (DRAM), which is then audited by an independent Validation and Verification Body (LVV) to verify the carbon savings.
- However, three regulatory gaps create uncertainty for private truck fleet operators. First, no standardized baseline methodology exists for truck electrification for DRAM. Second, the sectoral minister recommendation required before KLHK can issue SPE-GRK remains procedurally undefined. Third, international sales under Article 6 of the Paris Agreement require ministerial authorization and corresponding adjustment, a process that has not yet been tested.
- TransJakarta provides an example of carbon trading in the transportation sector, as it became the pioneer in obtaining the SPE-GRK for the Indonesian transport sector through its electric bus adoption (CNBC Indonesia, 2025). However, it remains to be seen whether this step has successfully generated financial returns, as carbon trading activity in Indonesia remains low. Regardless, truck fleet managers can follow TransJakarta's approach when planning to monetize fleet electrification. Truck electrification is particularly lucrative because the higher fuel consumption and utilization rates of HDVs result in a larger volume of carbon credits per unit compared to passenger vehicles.

Carbon market mechanisms as a financing pathway for truck electrification based on Perpres 110/2025 and its potential bottlenecks

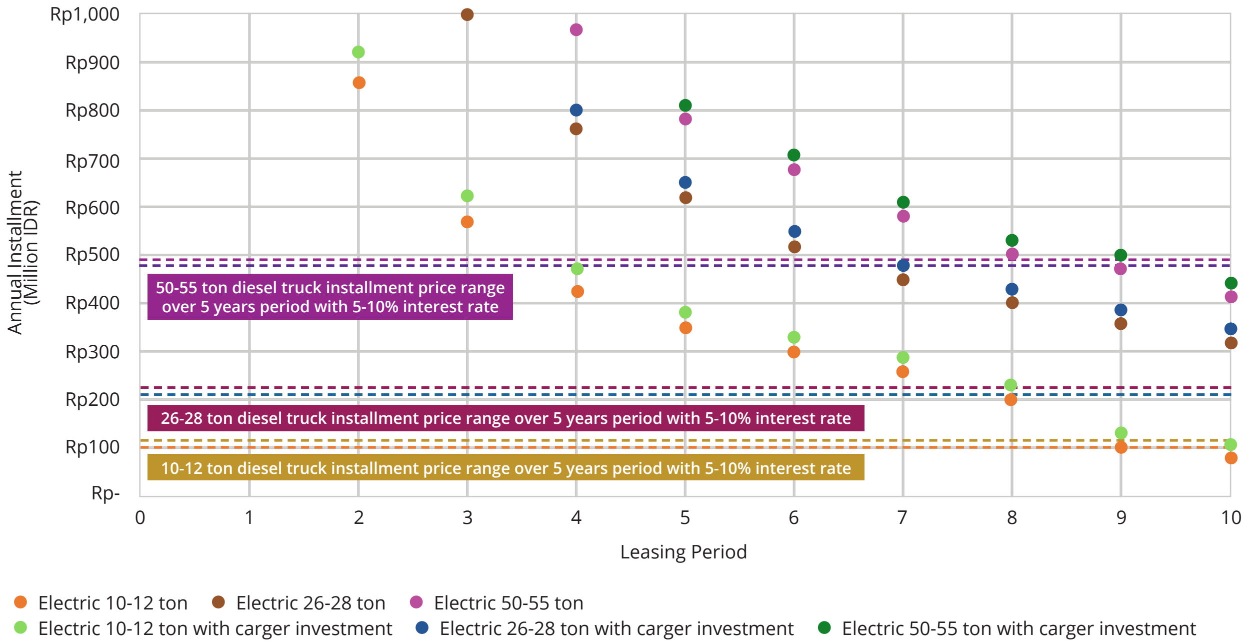


Source: IESR Model, 2026

Extravagant ZET prices hinder its adoption, creative fiscal incentives schemes are needed

- ZET upfront cost remains a major barrier, with prices reaching up to four times higher than those of its diesel truck counterpart. Leasing can reduce initial capital needs, but under standard terms of a 30% down payment, 5–10% interest, and a 5-year tenor, ZET installments remain 2–4 times higher (ranging from around IDR 380 million to 1 billion per year) than diesel trucks (ranging from around IDR 100 million to 500 million per year).
- To match diesel installment levels, ZETs would need much longer leasing periods: around 10 years for 50–55 ton trucks, 20 years for 26–28 ton trucks, and more than 30 years for 10–12 ton trucks, which is not a feasible option to pursue. Even with 2% interest, the required tenor remains around 10–20 years, suggesting that incentives, concessional financing, or residual value guarantees are still needed.

Annual installment price of ZET with 2% interest rate without incentives



Source: IESR Analysis, 2026

- Another important aspect to consider in business is whether ZET owners own charging infrastructure. When the ZET owners also invest in chargers, the initial cost will be increased, but it comes with the opportunity to recharge at a more affordable cost through a special charging tariff. Installing a charger will be beneficial if the charger cost is shared across at least 4 electric trucks, resulting in savings of IDR 10-15 million per month compared to owning a ZET without chargers. This can indirectly help the owner reduce the monthly leasing cost, even though the monthly installment also rises slightly.
- Despite that, the government needs to introduce policies to solve financing problems in procuring ZETs. The government can introduce a lower interest rate and a longer tenor period for leasing ZETs, separate the battery and truck cost through BAAS system, give incentives via a cross-financial scheme, or link incentives to service standards.

CHAPTER 6

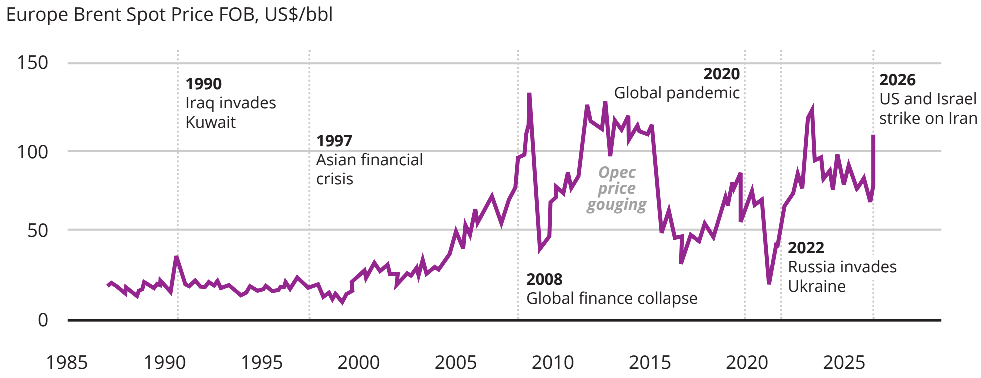
Outlook

Contents

Achieving logistics sector security and automotive industry competitiveness through electrification

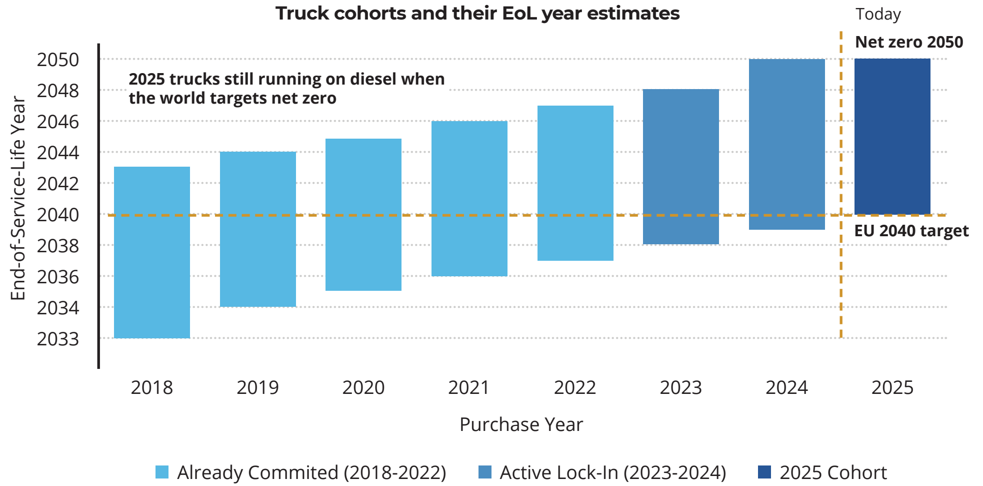
- Since 1990, oil prices have been very much dependent on geopolitical dynamics and crises. Early in 2026, the US–Israel–Iran conflict inflated oil prices, which reached USD 114/bbl (Trading Economics, 2026).
- When the domestic freight sector is locked into diesel, every global crisis translates directly into higher domestic logistics costs—either directly or through increased, state subsidies. As freight movement is the backbone of the national economy, making the freight sector dependent on volatile oil prices puts the macroeconomy at the mercy of global crises and uncertainty.
- Since Indonesian trucks are used for more than 15–20 years, every truck sold today means a commitment to imported fuel and subsidy through 2040–2045. This timeline is beyond what other markets like the EU are doing with their target of 90% ZET sales in 2040 (IESR, 2024).
- In the future, Indonesian logistics companies will still be paying a premium for the fuel consumption of older truck fleets with older technology, while other countries operate cheaper, electrified fleets. If fuel continues to be subsidized, this will further strain the national budget.
- Without a clear electrification roadmap, OEMs may continue investing in diesel production lines, locking domestic markets into aging technologies while global R&D and manufacturing increasingly shift toward electric powertrains.
- As advanced markets like EU and China phase out diesel, global OEMs are likely to redirect ICE production to countries with weaker electrification policies. Maintaining industrial competitiveness therefore requires aligning with global technology leaders and accelerating the transition to zero-emission vehicles.

Historical global oil shocks



Source: Trading Economics, 2026

Truck cohorts and their EoL year estimates

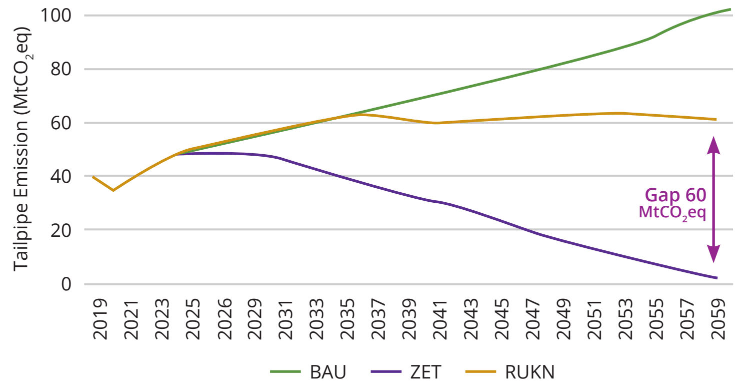


Source: IESR Analysis, 2026

Scaling truck electrification in the near-term to avoid delaying road freight NZE by 2060

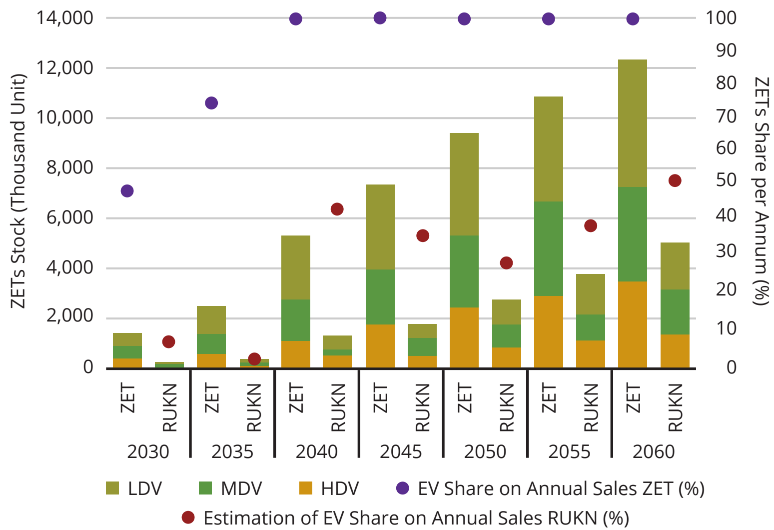
- Model results show that truck electrification can substantially reduce emissions, but the level of ambition matters. While the RUKN scenario slows emissions growth compared to BAU, it still leaves around 60 MtCO_2eq of tailpipe emissions in 2060, whereas the ZET pathway reduces emissions to near zero. This indicates that current electrification targets are insufficient to fully align the freight sector with a net-zero trajectory.
- The divergence between the RUKN and ZET pathways becomes increasingly visible after 2040. Delayed adoption allows more diesel trucks to remain in operation for decades, locking in future emissions and widening the decarbonization gap over time. The results suggest that accelerating measures, for instance, sales mandates, during the 2030s are critical, as actions taken before 2040 have a disproportionately large influence on long-term emissions outcomes.
- The emissions gap is primarily driven by differences in ZET adoption. The modeled RUKN pathway already reflects the upper-bound truck electrification assumptions contained in the current RUKN document, resulting in approximately 4.9 million ZETs and around 50% ZET sales penetration by 2060. In contrast, the ZET pathway requires 100% ZET sales by 2040 and deploys more than 12 million ZETs by 2060. These finding imply that achieving a 2060 net-zero pathway for road freight would require the transition to zero-emission truck sales within the next 15 years.
- The challenge is particularly significant for MDVs and HDVs, where vehicle turnover is slower, capital requirements are higher, charging infrastructure needs are more demanding, and technology adoption typically lags behind that of passenger vehicles and LDVs. As these segments account for the majority of freight activity and emissions, the extent and timing of MDV and HDV electrification will be key determinants of long-term emissions trajectories in the road freight sector. With Java and Sumatra accounting for approximately 50% of national road freight activity and having some of Indonesia's most emission-intensive freight corridors, these regions are well-positioned to serve as early adopters for both electric truck deployment and charging infrastructure expansion. Accelerating the transition in these freight-intensive corridors could play a critical role in achieving the 100% ZET sales required by 2040 and supporting a net-zero freight pathway by 2060.

Tailpipe emission reduction for several scenarios



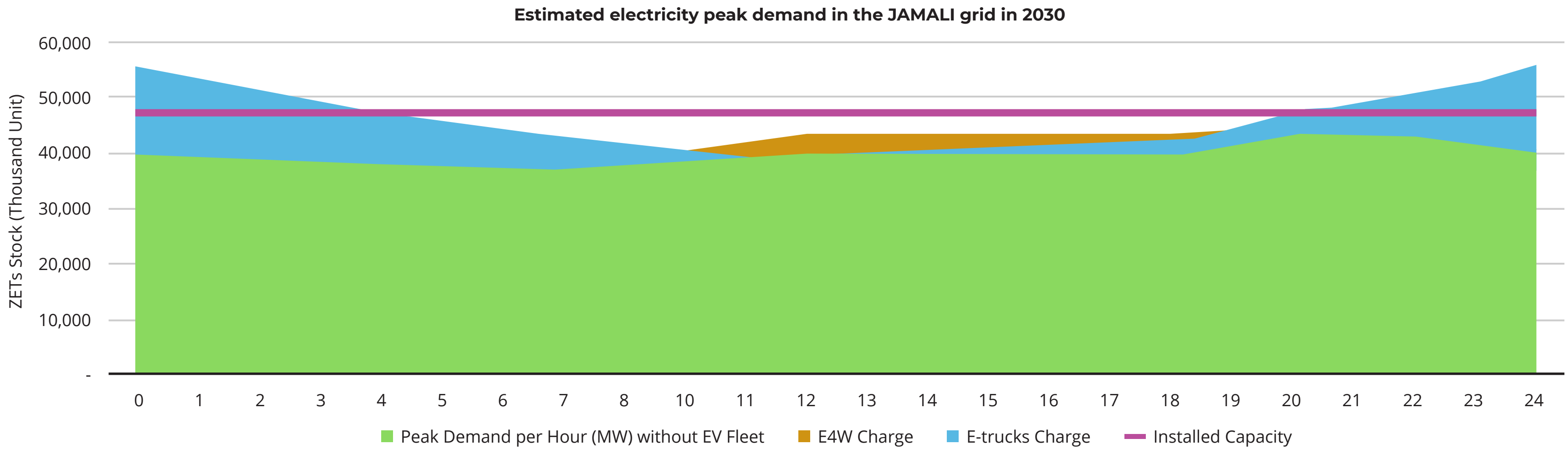
Source: IESR Model, 2026; RUKN, 2025

Amount of ZETs in ZET and RUKN scenarios



Source: IESR Model, 2026; Reverse calculation using stock-turnover model

Managing ZET charging time is the key to maintain grid reliability



Source: (IESR Analysis derived from Tampubolon & Dalimi, 2024, Wirajaja, 2025, Chen et al., 2018, Tampubolo et al., 2025, and Borlaug et al., 2021, 2026)

- The growing number of EVs has raised concerns about grid capacity. During the 2026 back-to-hometown (Eid mudik) holiday, estimated peak demand reached 47 GW, while supply stood at around 54 GW (Kumparan, 2026). Over the same period, SPKLU recorded 300,000 transactions, delivering a total of 7.16 GWh of energy (Kurniawan, 2026).
- Indonesia's EV fleet is concentrated in the Java-Bali region, which accounts for 85% of the nation's EVs. This area is served by the JAMALI grid, which has a supply capacity of 46 GW (Wiraraja, 2025). Peak demand in the region is projected to reach 35 GW in 2026. Hourly data show that demand rises from around 18:00 to 23:00, while off-peak periods occur from 01:00–04:00 and 07:00–09:00 (Tampubolon & Dalimi, 2024).
- Looking ahead to 2030, the projected number of EVs is 940,000 electric four-wheelers (E4Ws) (MEMR, 2025), and around 500,000 ZETs will significantly impact the electricity demand. ZETs typically require higher-power charging due to their larger batteries and the need to minimize dwell time during operations. Consequently, if there is no additional generation capacity on the JAMALI grid from 2026 to 2030, electricity demand is projected to exceed supply from 19:00 to 06:00.
- Several solutions can address this issue without adding new generation capacity. First, since trucks are banned from certain routes during traffic peak hours, they could use that time to charge, shifting charging demand from nighttime to daytime. Second, instead of charging to full each time, ZETs could charge during their rest breaks, distributing the charging load across multiple daytime sessions. While the first option is more straightforward, the second offers lower capital investment (as trucks may not need larger batteries) and longer battery life, but it will take a greater cost in charging infrastructure investment, which can be mitigated through shared use of charging infrastructure.

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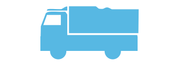
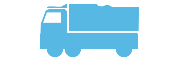
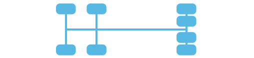
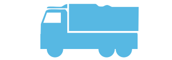
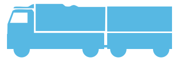
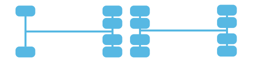
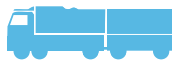
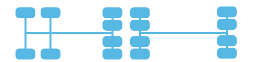
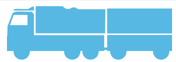
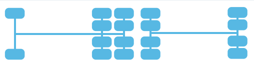
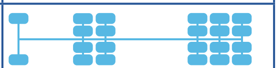
Appendices

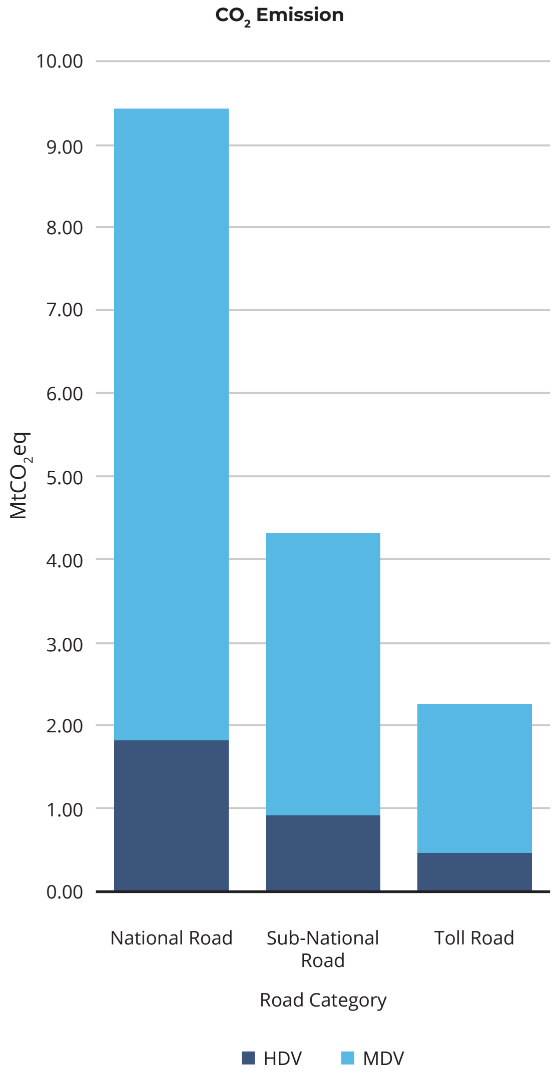
Appendix 1 — Truck size and weight classification

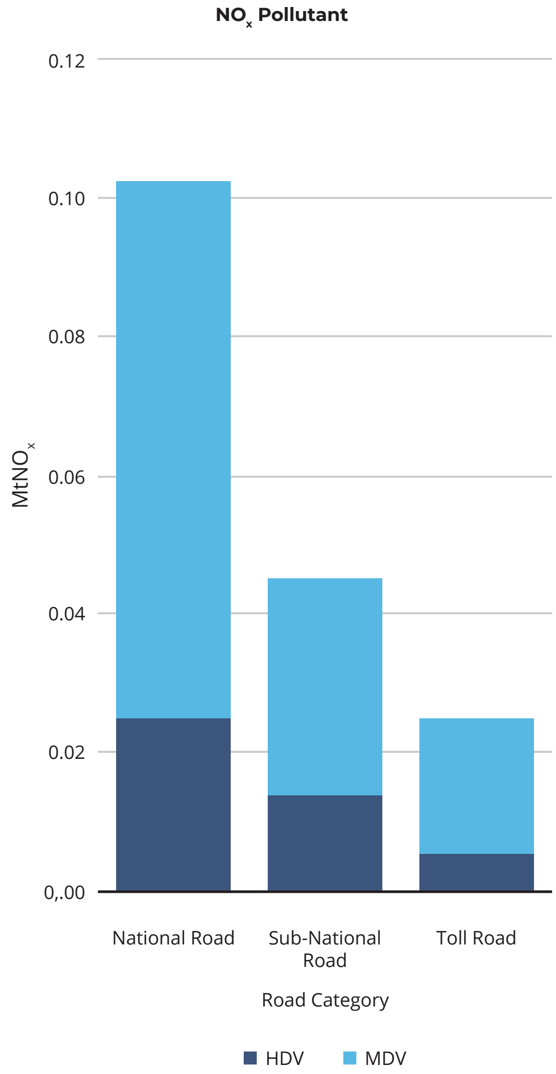
Commercial vehicle types (Permen PU No. 13/2024)

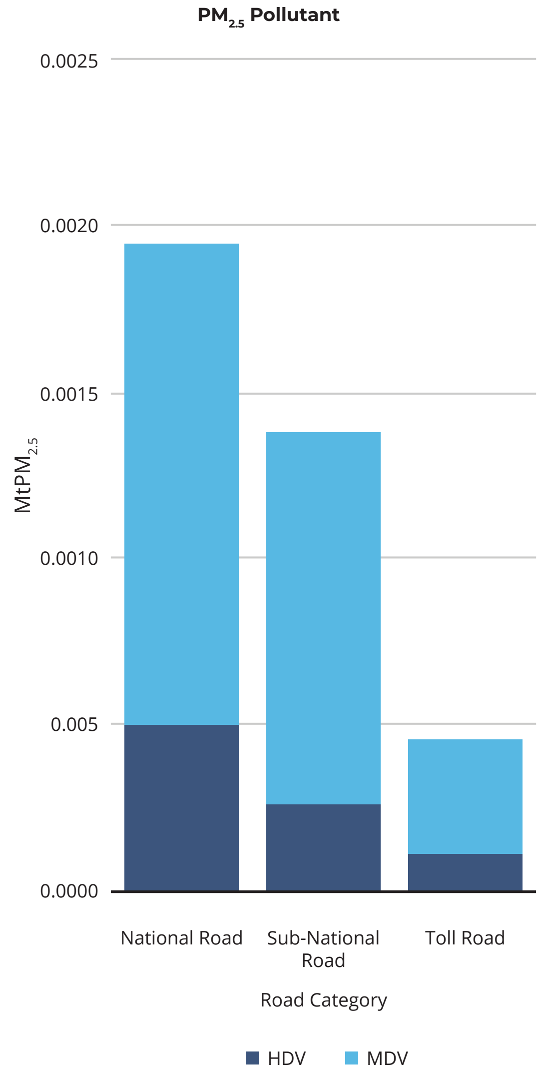
Vehicle type	Axle configuration	Axle group	Configuration scheme	
Large bus	1.2	2		
2 axle truck - light truck	1.1	2		
2 axle truck - medium truck	1.2	2		
3 axle truck - heavy	11.2	2		
3 axle truck - heavy	1.22	2		
4 axle truck - heavy	11.22	2		
4 axle truck - heavy	1.2 + 2.2	4		
5 axle truck - heavy	11.2 + 2.2	4		
5 axle truck - heavy	1.22 + 2.2	4		
4 axle truck - heavy	1.2 - 22	3		
5 axle truck - heavy	1.22 - 22	3		
5 axle truck - heavy	1.2 - 222	3		
6 axle truck - heavy	1.22 - 222	3		
6 axle truck - heavy	1.22 - 2222	3		

- Weight classification (Permen LHK No. 20/2017/ Ministry of Environment and Forestry No. 20/2017)
  - » **Medium truck**
    - Rigid truck N_2 (GVW 3.5t – 12t)
    - Trailer truck O_3 (GVW 3.5t – 10t)
  - » **Heavy truck**
    - Rigid truck N_3 (GVW > 12t)
    - Trailer truck O_4 (GVW > 10t)
- Vehicle type: **Type II, III, IV dan V**

Appendix 2 — HDV and MDV emission footprint across road categories

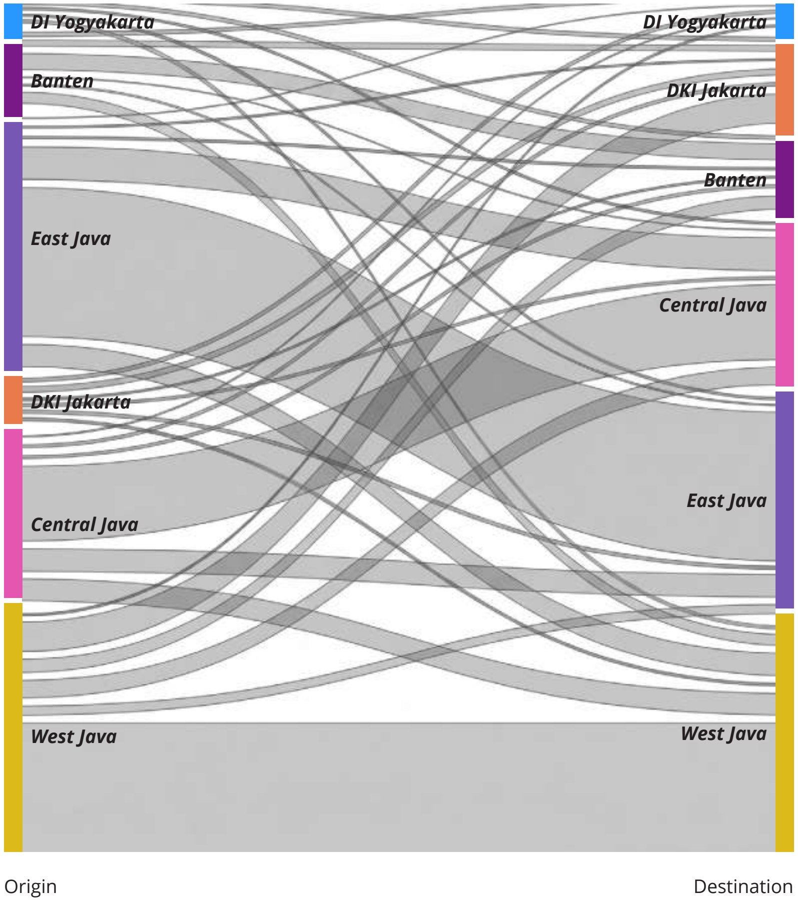




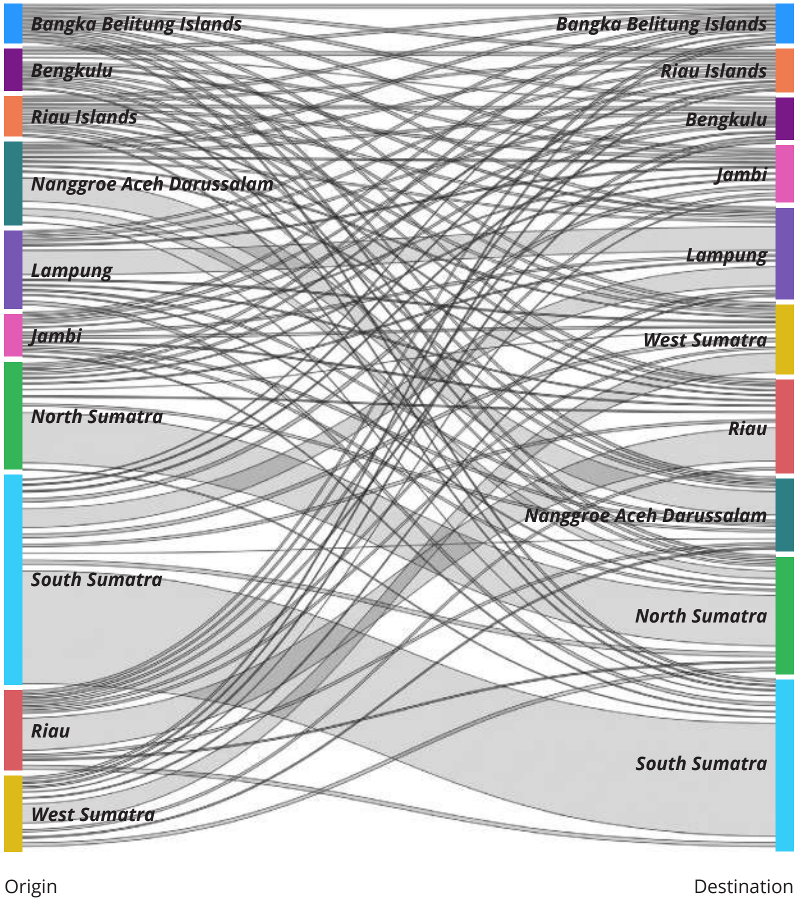


Appendix 3 — Inland logistics flows across Java and Sumatra according to National Logistics Origin-Destination Survey 2016

Java
Province-to-Province

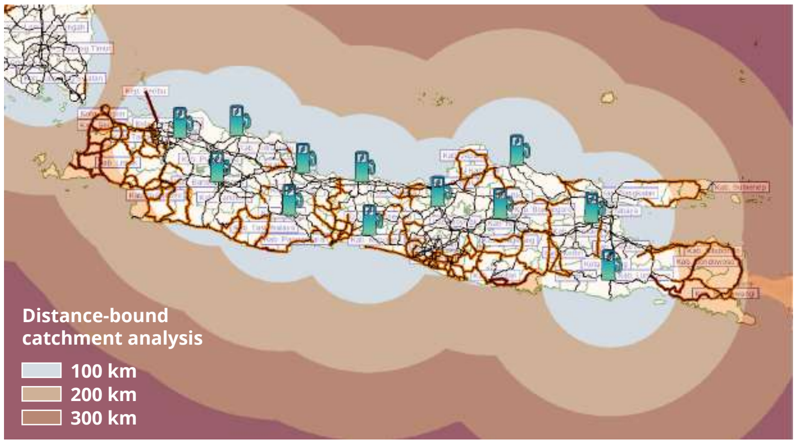


Sumatra
Province-to-Province



Appendix 4 — List of potential locations for charging infrastructure across Java and Sumatra

No	Regency/City	Corridor
	Java Island	
1	**Bandung Barat**	Cianjur - Bandung
2	**Ngawi**	Sragen - Ngawi
3	**Pekalongan**	Pantura
4	**Kebumen**	Pansela
5	**Malang**	Pansela
6	**Subang**	Pantura
7	**Semarang**	Joglosemar
8	**Bekasi**	Pantura
9	**Ciamis**	Ciamis - Banjar
10	**Cirebon**	Pantura
11	**Surabaya**	Pantura
12	**Rembong**	Pantura



No	Regency/City	Corridor
	Sumatra Island	
1	**Banyuasin**	Jalintim
2	**Pelalawan**	Jalintim
3	**Labuhan Batu Selatan**	Jalintim
4	**Padang**	Jalinbar
5	**Lampung - Palembang**	Jalintim
6	**Kuantan Singingi**	Pekanbaru - Kuantan Singingi
7	**Mandailing Natal**	Jalinbar
8	**Tanjung Jabung Barat**	Jalintim
9	**Empat Lawang**	Jalinbar
10	**Mukomuko**	Jalinbar
11	**Aceh Timur**	Jalintim
12	**Aceh Besar**	Jalintim
13	**Subulussalam**	Jalinbar
14	**Serdang Bedagai**	Jalintim
15	**Lampung Selatan**	Jalintim

Appendix 5 - TCO list of assumptions

Variable	Value	Unit
Travelled distance	100,000	km/year
TCO period	20	year
Fuel price (unsubsidized)	23,600	IDR/L
Fuel price (subsidized)	6,800	IDR/L
Charging price (public)	2,467	IDR/kWh
Idle and waiting time	6.72	hour/day
Conversion rate	16,790	IDR/USD
Transaction cost	57,000	IDR/charge
Discount rate	10%	
Battery price	81	USD/kWh
Battery lifetime	4,000	Cycle
Vehicle ownership tax	2%	Vehicle value per year
Title transfer fee	12.5%	Of vehicle value (One-time cost)
Purchase administration fee	968,000	IDR
Yearly administration fee	493,000	IDR/year
Down payment fee	30%	CAPEX
Tenor period	5	years
10–12 ton truck price	2,350,600,000	IDR/truck
26–28 ton truck price	4,113,550,000	IDR/truck
50-55 ton truck price	6,209,713,948	IDR/truck

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