



Truck Fleet Modernization in Indonesia

Mitigation Action Outline



Ministry of Transportation
Republic of Indonesia

giz Deutsche Gesellschaft
für Internationale
Zusammenarbeit (GIZ) GmbH

On behalf of:



Federal Ministry
for the Environment, Nature Cons
and Nuclear Safety

of the Federal Republic of Germany

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The TRANSfer project is implemented by GIZ and funded by the International Climate Initiative (IKI) of the German Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU) and operates on three levels.

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List of acronyms and abbreviations

| | |
|-------------------|--|
| APTRINDO | Indonesian Truck Businessmen Association |
| ASEAN | Association of South East Asian Nations |
| BAPPENAS | National Planning Agency |
| BAU | Business as usual |
| BC | Black carbon |
| BPJT | Task Toll Road Regulatory Agency |
| CH ₄ | Methane |
| CO | Carbon monoxide |
| CO ₂ | Carbon dioxide |
| DPF | Diesel particulate filter |
| EU | European Union |
| FOLU | Forest land and other land use |
| GAIKINDO | Indonesian Auto Industry Association |
| GDP | Gross domestic product |
| GHG | Greenhouse gas |
| GIZ | Deutsche Gesellschaft für Internationale Zusammenarbeit |
| GPS | Global Positioning System |
| GVW | Gross vehicle weight |
| HC | Hydrocarbon |
| HDV | Heavy-duty vehicles |
| I&M | Inspection and maintenance |
| ICCT | International Council on Clean Transportation |
| ICCTF | Indonesia's Climate Change Trust Fund |
| IDR | Indonesian Rupiah |
| INDC | Intended Nationally Determined Contribution |
| IPPU | Industrial process and product use |
| KLTSP | Kuala Lumpur Transport Strategic Plan |
| LCDI | Low Carbon Development Indonesia |
| LPI | Logistics performance index |
| MEMR | Ministry of Energy and Mineral Resources |
| MoEF | Ministry of Environment and Forestry |
| MOF | Ministry of Finance |
| MOI | Ministry of Industry |
| MOT | Ministry of Transportation |
| MRV | Monitoring, reporting and verification |
| MSRP | Manufacturer's suggested retail prices |
| N ₂ O | Nitrous oxide |
| NDC | Nationally determined contributions |
| NGO | Non-governmental organization |
| NO _x | Nitrogen oxide |
| OBD | On-board diagnostic |
| ODOL | Over dimension overload |
| ORGANDA | Association of Land Transport Businessmen |
| PJ | Petajoules |
| PM | Particulate matter |
| PM _{2.5} | Particulate matter 2.5 |
| ppm | Parts per million |
| PPP | Public-private partnership |
| PPTB | Center of Sustainable Transport Management |
| RAN-API | National Action Plan on Adaptation |
| RENSTRA | Strategic Planning |
| RPJMN | Rencana Pembangunan Jangka Menengah Nasional (National Medium-Term Development Plan) |
| RUEN | National Energy Plan |

| | |
|-----------------|---|
| SCC | Social cost of carbon |
| SO ₂ | Sulfur oxide |
| UNFCCC | United Nations Framework Convention on Climate Change |
| UPPKB | Motorized Vehicle Weighing Implementation Unit |
| US | United States |
| VAT | Value-added tax |
| VKT | Vehicle kilometer travelled |
| VOC | Volatile organic compounds |

Exchange rates

| Local Currency | EUR | USD | Date |
|----------------|--------------|--------------|------------|
| 1 IDR | 0.000064 EUR | 0.000071 USD | 15.06.2020 |

Executive Summary

Indonesia is a large trading partner in the ASEAN region and in world. **The high volume of imported and exported goods places high demand on logistics services, 90% of which is dominated by trucking.** Freight transportation in Indonesia faces various challenges, including poor energy and environmental performance, safety risk, and high cost. These factors are attributed to older trucks with poor technologies, truck oversizing and overloading, road congestion, high cost, and other factors. As a consequence, **freight transportation is a significant contributor to greenhouse gas (GHG) and criteria pollutant emissions** in Indonesia, magnifying the environmental and public health burden of the transportation sector.

In 2017, Indonesia emitted 1.2 billion tCO₂e (MoEF, 2017). As Figure ES-1 shows, the energy sector exceeds industrial process and product use (IPPU) as the biggest contributor to GHG emissions. The transportation sector accounts for 26.2% of energy sector GHG emissions, while land transport accounts for 90.8% of transport sector emissions. The GHG emission data for the truck sector is not available for Indonesia, but **according to global estimate, heavy-duty vehicles (which consists of mostly freight vehicles) on average account for 44% of the GHG of the land transportation sector** (Miller & Facanha, 2014). More information on the context in Indonesia in chapter 2.

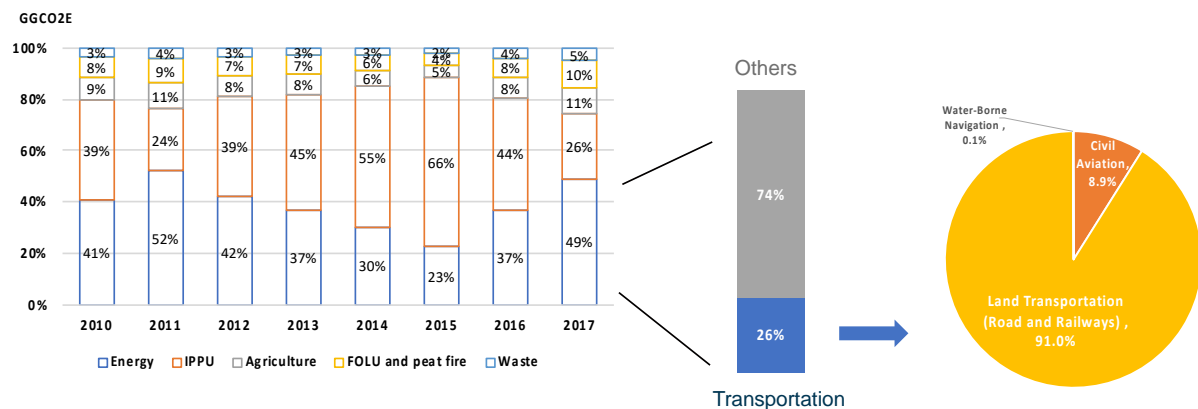


Figure ES-1: GHG emissions by sector from 2010 to 2017 (MoEF, 2017)¹

Four main barriers delay truck fleet modernization in Indonesia. These include **the absence of strategic policy guidelines; expensive and inefficient business practices; weak compliance and enforcement programs; and absence of cross sector coordination.** To support government and private sector stakeholders to overcome these barriers, this action plan provides best practices from vehicle replacement programs worldwide and adapts them to Indonesia.

This Mitigation Action Plan on truck modernization in Indonesia outlines a governmental program designed to mitigate GHG emissions in the freight sector through the deployment of an environmentally friendly fleet. **The objective** of the scheme is to **encourage truck owners to modernize their fleets**, replacing the dirtiest and least efficient vehicles with new trucks carrying the latest generation of engine efficiency and emission control technologies. (See Table ES-1 for an overview of the action plan.)

Several government agencies have participated in the development of this action plan and have agreed to carry it forward. **The Ministry of Transportation will lead** the implementation of this plan, with support from Ministry of Environment and Forestry, Ministry of Energy and Mineral Resources, and the National Planning Agency. Other governmental institutions will support implementation, including the Ministry of Industry, the Ministry of Finance, and the Traffic Corps.

¹ IPPU refers to industrial process and product use; FOLU refers to forest land and other land use.

Table ES-1: The mitigation action plan at a glance

| | | | |
|---|--|-----------------------------------|--|
| Contribution to NDC implementation | Reduce GHG emissions from transportation sector from 2020 to 2030 and beyond. | | |
| Type of action | Policy / regulation / fiscal instrument | Subsector | Truck |
| Geographical scope | Full country | Type of policy instruments | <u>Regulations</u> : yes <u>Economic instruments</u> : yes <u>Public spending/ investments</u> : no <u>Communication and information</u> : no |
| Organization | <u>Responsible organization</u> : Ministry of Transportation <u>Involved national partners</u> : Ministry of Environment and Forestry; Ministry of Energy and Mineral Resources; National Planning Agency <u>Involved international organizations</u> : GIZ | | |
| Main mitigation measures | (1) Scrappage of high-emitting trucks <ul style="list-style-type: none"> ➤ Set a scrappage schedule and corresponding management mechanism ➤ Provide fiscal support to incentivize early scrappage ➤ Establish scrappage implementation mechanism (2) Accelerate the transition to cleaner and efficient trucks <ul style="list-style-type: none"> ➤ Introduce fuel efficiency standards to accelerate the uptake of advanced technologies ➤ Accelerate adoption of Euro VI fuel and engine standards ➤ Provide incentives for clean truck purchase and operation (3) Track, monitor, and reduce emissions of in-use trucks <ul style="list-style-type: none"> ➤ Reduce fuel consumption and emissions from in-use fleet ➤ Build a system to identify noncompliant trucks ➤ Set pilot projects on low emission zone and local benefit to renewed trucks | | |
| GHG mitigation effect and other benefits | <u>GHG mitigation</u> : 1.6 to 23 MtCO _{2e} between 2020 and 2030; average annual mitigation 0.16 to 2.3 MtCO _{2e} <u>Other benefits</u> : 14 to 47 kilotons black carbon emission reduction between 2020 to 2030. | | |
| Feasibility | <u>Financial feasibility</u> : Section 5.2 provides information on micro-economic feasibility and details required incentives <u>Economic feasibility</u> : Section 5.3 estimates economic benefits, costs and benefits, etc. | | |
| Type of required support | <u>Technical support</u> : Analysis of the Indonesian truck fleet characteristics, establishment of the dedicated fund, cost analysis of trucks to design financial support mechanism; set up of the green freight program; social impact analysis of the truck modernization program. <u>Financial support</u> : Fiscal incentives to reduce the cost of replacing scrapped trucks with new, more advanced trucks. | | |

The Mitigation Action Plan comprises **three direct mitigation measures** and **four sets of supporting measures**. The Plan utilizes a combination of:

1. Mandatory policies,
2. Fleet management practices, and
3. Fiscal support.

Full implementation of the plan should lead the majority of the trucks consists of clean trucks. Figure ES-2 summarizes these measures.

| Barriers | | | | |
|-------------------------|---|--|---|---|
| | Absence of strategic policy guidelines | Expensive and inefficient business practices | Weak compliance and enforcement program | Absence of cross sector coordination |
| Direct measures | Scrappage of high-emitting trucks | Accelerate the transition to cleaner and efficient trucks | | Track, Monitor and Reduce Emissions of in-use trucks |
| | <ul style="list-style-type: none"> Set a scrappage schedule based on truck age or emission level Establish scrappage implementation mechanism Provide financial support to incentive early scrappage | <ul style="list-style-type: none"> Introduce fuel efficiency standards or green freight program to incentivize advanced technologies Accelerate adoption of Euro 6/VI emission/fuel standards Provide incentives to green truck purchase and operations | | <ul style="list-style-type: none"> Improve periodical vehicle inspection requirement and testing facilities Build a system to identify noncompliant trucks Set pilot projects on low emission zone and local benefit to renewed trucks |
| Supportive measures | Develop strategic document | <ul style="list-style-type: none"> Establish roadmap for renewing truck fleet Establish roadmap toward world-class emission and clean fuel standards Set guidelines for in-use vehicle management improvement | | |
| | Lower cost and improve efficiency | <ul style="list-style-type: none"> Invest in infrastructure to improve traffic and driving conditions Reduce interruption or waiting time on the road at the port Establish operators and drive education program on reducing fleet operation cost Strengthen ODOL regulation and implementation | | |
| | Enhance monitoring and enforcement | <ul style="list-style-type: none"> Enhance institutional testing capacity Build infrastructure to for on-road monitoring Create responsibility sharing mechanism and increase cost of noncompliance | | |
| | Strengthen cross sector coordination | <ul style="list-style-type: none"> Coordinate and support small truck operators Build certification and benefit for green freight operators Establish system to optimize flow | | |
| Organizational measures | Establish a National Steering Committee | <ul style="list-style-type: none"> Establish a national steering committee that comprise representatives from the MoT, MoEF and BAPPENAS | | |
| | Establish a Technical Steering Committee | <ul style="list-style-type: none"> Establish a technical steering committee that comprise representative from implementation directorates | | |

Figure ES-2: Overview of the Truck Modernization Mitigation Action Plan

One challenge in financing any truck modernization scheme is the higher upfront cost of cleaner and more efficient new trucks. Fleet operators today, especially smaller operators, may struggle to transition to new business or financing models necessary for the realization of vehicle modernization without the intervention of public policies. Public support to facilitate early-stage mitigation actions is needed.

One key to increasing the financial feasibility of a truck fleet modernization scheme is to reduce the total cost of ownership of new, cleaner trucks while increasing the total cost of ownership of older, dirtier trucks. Additional measures exist that do not require additional public funding support but can help to create the business case for truck modernization scheme. Public financing should be provided through a dedicate fund and can focus on providing financial incentives to the truck scrappage and clean and efficient truck

purchases. The sources of revenue to support the dedicate fund include taxation and fee collection related to vehicle, fuel, and truck business operation, vehicle manufacturer revenue donation, scrappage and recycling revenue, national climate fund, general government budget, and global organizations funding. Figure ES-3 illustrates a potential financing structure for a truck modernization scheme.

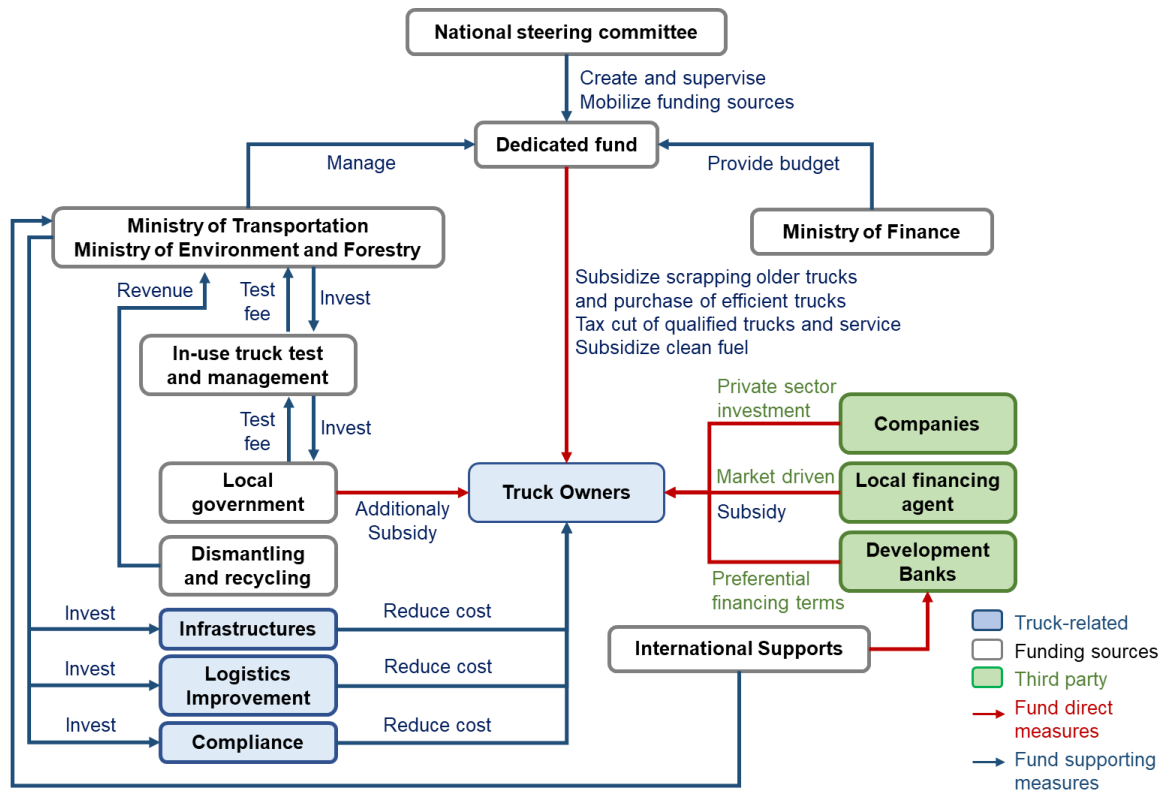


Figure ES-3: financing structure for the truck modernization scheme

To estimate the impact of this Mitigation Action Plan, a Business as Usual (BAU) scenario is used as a reference case to compare **mitigation scenarios**. A Moderate scenario represents the policy efforts which are believed very feasible for Indonesia to achieve based on its current pathway, while the World Class scenario aligns Indonesia with the leading countries in the world and leapfrogs to more aggressive policies along a shorter timeline. Table ES-2 lays out the key policies captured under each scenario. These scenarios offer a comprehensive overview of the potential impacts of the Mitigation Action Plan in Indonesia when compared with the BAU.

Table ES-2: Scenarios for truck modernization in Indonesia

| Scenario | Fleet renewal program | Fuel efficiency standards/green freight program | Vehicle emission standards | Ultralow-sulfur fuel |
|--------------------------------|---|---|--------------------------------|---|
| Baseline Scenario (BAU) | N/A | N/A | 2010: Euro II 2021: Euro IV | 2018: CN 53: 300 ppm CN 51: 1,200 ppm CN 48: 1,200-2,500 ppm 2021: 50 ppm |
| Moderate | Scrap 20+ pre-Euro trucks by 2025 Scrap 15+ Euro II trucks by 2030 | 1.5% annual improvement from 2025 | 2025: Euro V 2030: Euro VI | 2030: 10 ppm |
| World Class | Scrap 20+ trucks by 2023 Scrap pre-Euro trucks by 2025 Scrap 15+ Euro II trucks by 2027 | 3% annual improvement from 2023 | 2023: Euro VI | 2023: 10 ppm |

The mitigation action is expected to achieve accumulated CO₂ emission reductions in the range of 1.6 to 23 million tons (Mt) over 10 years between 2020 and 2030 (Table ES-3). This translates into an average annual GHG emission reduction of 7.1 Mt CO₂ in 2030 in the World Class scenario, which is about 10% of total trucks' emissions in the BAU scenario.

Table ES-3: Ex ante GHG impact assessment 2020 - 2030

| | Moderate Scenario (in MtCO ₂ accumulated from 2020) | World Class Scenario (in MtCO ₂ accumulated from 2020) |
|-------|---|--|
| @2025 | 0 | 5.5 |
| @2030 | 1.6 | 23 |

By replacing old, dirty trucks with cleaner and more efficient trucks, the Indonesian government can:

- reduce transportation energy demand: **A truck modernization program can save up to 312 petajoules (PJ) of energy cumulatively with the standards proposed under the World Class scenario, which are about 8,573 million liters of diesel fuel.**
- yield tremendous social and health benefits: reducing emissions of diesel black carbon (BC), a short-lived climate pollutant whose global warming potential equals 910–3,200 times that of CO₂ (Bond et al., 2013). Other local pollutants like fine particulate matter (PM_{2.5}) and nitrogen oxides (NO_x), will also decline. Chronic exposure to these pollutants is associated with lung cancer, heart disease, stroke, and adverse health outcomes.

The more stringent emission controls proposed under the World Class scenario outweighs the emission reductions achieved under the Moderate scenario by approximately three to eight times between 2020 and 2030. These numbers will be even larger when looking at impacts beyond 2030. Figure ES-4 presents the cumulative pollutants saving from 2020 to 2030 in the Moderate and World Class scenario.

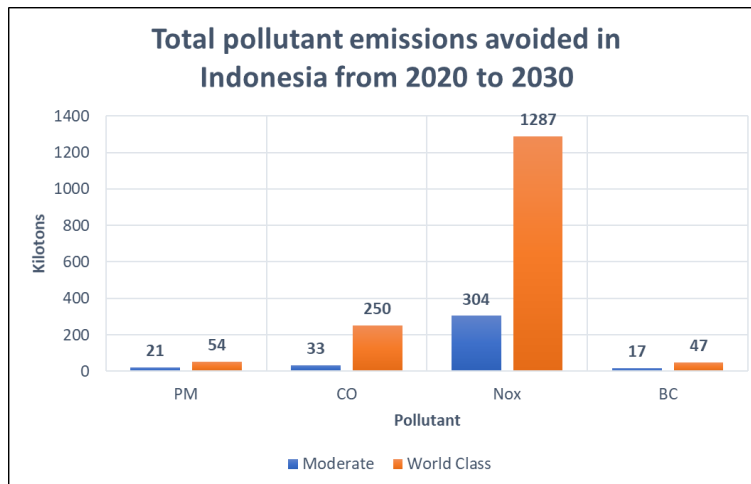


Figure ES-4: Total pollutant emissions avoided in Indonesia from 2020 to 2030 (kilotons)

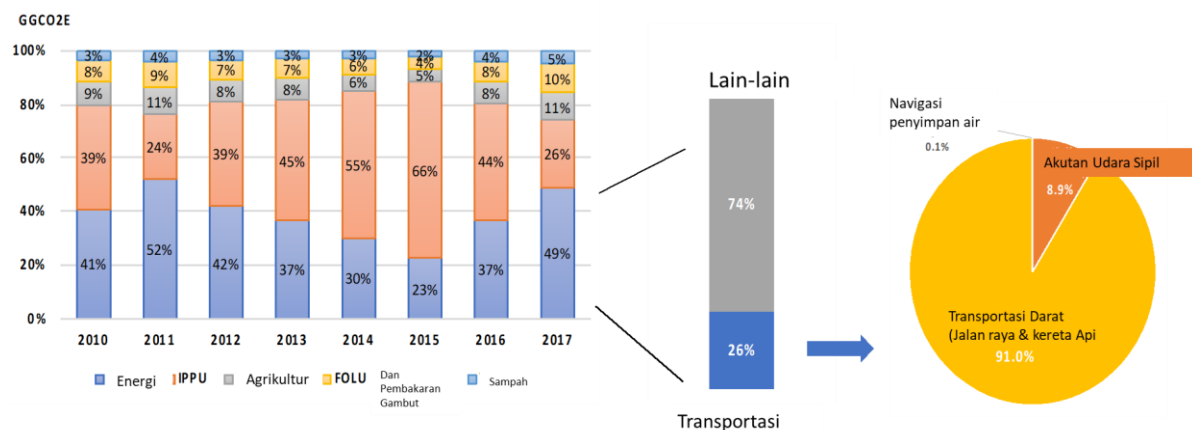
The full-scale implementation of the scheme—replacing trucks to be scrapped with trucks equipped with the cleanest technology and subsidizing the full price difference—will cost 50 trillion – 61 trillion IDR (USD 3.5 – USD 4.3 billion). The actual financial support to be delivered will depend on political leadership.

This **Mitigation Action Plan will generate significant benefits that outweigh their costs**. This paper estimates a benefit-to-cost ratio greater than 2.5:1 for implementation of actions described by the Moderate scenario and 4:1 for actions described by the World-Class scenario. The social costs cover the pollutant-specific and time-dependent damages associated with emissions, including direct climate and health impacts, climate-related health damages, and the effects of ozone on reduced agricultural productivity. Benefits equal the difference between damages under these scenarios when compared against the BAU.

Ringkasan Eksekutif

Indonesia merupakan mitra dagang besar di kawasan ASEAN dan dunia. **Tingginya volume barang impor dan ekspor menyebabkan tingginya permintaan akan jasa layanan logistik, 90% di antaranya didominasi oleh angkutan truk.** Transportasi barang di Indonesia menghadapi berbagai tantangan, antara lain energi dan kinerja lingkungan yang buruk, risiko keselamatan, dan biaya tinggi. Faktor-faktor ini disebabkan oleh truk yang lebih tua dengan teknologi yang buruk, truk yang kelebihan muatan dan muatan berlebih, kemacetan jalan, biaya tinggi, dan faktor lainnya. Akibatnya, **angkutan barang merupakan penyumbang gas rumah kaca (GRK) yang signifikan dan kriteria emisi pencemar di Indonesia**, sehingga memperbesar beban lingkungan dan kesehatan masyarakat di sektor transportasi.

Pada Tahun 2017, Indonesia mengeluarkan 1,2 miliar tCO₂e (KLHK, 2017). Seperti yang ditunjukkan Gambar ES-1, sektor energi melebihi proses industri dan penggunaan produk (IPPU) sebagai penyumbang emisi GRK terbesar. Sektor transportasi menyumbang 26,2% dari emisi GRK sektor energi, sedangkan transportasi darat menyumbang 90,8% dari emisi sektor transportasi. Data emisi GRK untuk Sektor Jasa Transportasi Truk tidak tersedia untuk Indonesia, tetapi **menurut perkiraan global, kendaraan berbobot berat (yang sebagian besar terdiri atas kendaraan angkutan) rata-rata menyumbang 44% dari GRK sektor transportasi darat** (Miller & Facanha, 2014). Informasi lebih lanjut tentang konteks di Indonesia terdapat di Bab 2.



Gambar ES-1: GHG Emisi berdasarkan sektor dari 2010-2017 (KLHK, 2017)²

Terdapat **Empat hambatan utama** yang menunda modernisasi armada truk di Indonesia. Hal ini termasuk **tidak adanya pedoman kebijakan strategis; praktik bisnis yang mahal dan tidak efisien; kepatuhan program penegakan hukum yang lemah; dan tidak adanya koordinasi lintas sektor.** Dalam rangka mendukung pemerintah dan pemangku kepentingan sektor swasta dalam mengatasi hambatan tersebut, rencana aksi ini memberikan praktik terbaik dari program penggantian kendaraan di seluruh dunia dan disesuaikan dengan konteks Indonesia.

Rencana Aksi Mitigasi tentang modernisasi truk di Indonesia ini menguraikan program pemerintah yang dirancang untuk mengurangi emisi GRK di sektor pengangkutan melalui penggunaan armada yang ramah lingkungan. **Tujuan dari skema ini adalah untuk mendorong pemilik truk untuk memodernisasi armada mereka**, mengganti kendaraan paling berpolusi dan paling tidak efisien dengan truk baru yang mengusung teknologi efisiensi mesin dan kontrol emisi generasi terbaru. (Lihat Tabel ES-1 untuk ikhtisar rencana aksi)

Beberapa instansi pemerintah telah berpartisipasi dalam pengembangan rencana aksi ini dan telah setuju untuk melanjutkannya. **Kementerian Perhubungan akan memimpin pelaksanaan rencana ini**, dengan

² IPPU singkatan dari *industrial process and product use*; FOLU singkatan dari *forest land and other land use*.

dukungan dari Kementerian Lingkungan Hidup dan Kehutanan, Kementerian Energi dan Sumber Daya Mineral, dan Badan Perencanaan Nasional. Kementerian/Lembaga (K/L) pemerintah lainnya akan mendukung implementasi, termasuk Kementerian Perindustrian, Kementerian Keuangan, dan Korps Lalu Lintas Kepolisian.

Tabel ES-1: Sekilas tentang Rencana Aksi Mitigasi

| | | | |
|--|---|----------------------------------|---|
| Kontribusi untuk implementasi NDC | Mengurangi emisi GRK yang dihasilkan dari sektor transportasi dari 2020 hingga 2030 dan seterusnya. | | |
| Jenis tindakan | Kebijakan/regulasi/instrumen fiskal | Subsektor | Truk |
| Cakupan geografis | Negara secara keseluruhan | Jenis instrumen kebijakan | <u>Regulasi</u> : ya <u>Instrumen ekonomi</u> : ya <u>Belanja / investasi publik</u> : tidak ada <u>Komunikasi dan informasi</u> : tidak |
| Organisasi | <u>Organisasi yang bertanggung jawab</u> : Kementerian Perhubungan <u>Mitra nasional yang terlibat</u> : Kementerian Lingkungan Hidup dan Kehutanan; Kementerian Energi dan Sumber Daya Mineral; Badan Perencanaan Nasional <u>Organisasi internasional yang terlibat</u> : GIZ | | |
| Langkah-langkah mitigasi utama | (1) Eliminasi/ <i>scrapping</i> truk beremisi tinggi <ul style="list-style-type: none"> ➤ Menetapkan jadwal eliminasi dan mekanisme pengelolaannya ➤ Memberikan dukungan fiskal untuk memberi insentif pada eliminasi yang dilakukan lebih awal ➤ Menetapkan mekanisme implementasi eliminasi (2) Mempercepat transisi ke truk yang lebih bersih dan efisien <ul style="list-style-type: none"> ➤ Memperkenalkan standar efisiensi bahan bakar untuk mempercepat penggunaan teknologi canggih ➤ Mempercepat adopsi bahan bakar Euro VI dan standarisasi mesin ➤ Memberikan insentif untuk pembelian dan pengoperasian truk yang bersih (3) Melacak, memantau, dan mengurangi emisi truk yang sedang beroperasi <ul style="list-style-type: none"> ➤ Mengurangi konsumsi bahan bakar dan emisi dari armada yang masih beroperasi ➤ Membangun sistem untuk mengidentifikasi truk yang tidak patuh ➤ Menetapkan proyek percontohan di zona emisi rendah dan manfaat untuk truk baru | | |
| Efek mitigasi GRK dan manfaat lainnya | <u>Mitigasi GRK</u> : 1,6 hingga 23 MtCO ₂ e antara tahun 2020 dan 2030; mitigasi tahunan rata-rata 0,16 hingga 2,3 MtCO ₂ e <u>Manfaat lainnya</u> : Pengurangan emisi karbon hitam 14 hingga 47 kiloton antara tahun 2020 hingga 2030. | | |
| Kelayakan | <u>Kelayakan Finansial</u> : Bagian 5.2 memberikan informasi tentang kelayakan mikro-ekonomi dan rincian insentif yang ditetapkan <u>Kelayakan ekonomi</u> : Bagian 5.3 memperkirakan manfaat ekonomi, biaya dan manfaat, dll. | | |

| | |
|---------------------------------------|---|
| Jenis dukungan yang dibutuhkan | <p><u>Dukungan Teknis:</u> Analisis karakteristik armada truk Indonesia, pemberian dana khusus, analisis biaya truk hingga merancang mekanisme dukungan pembiayaan; menyiapkan program angkutan hijau; analisis dampak sosial dari program modernisasi truk.</p> <p><u>Dukungan Finansial:</u> Insentif fiskal untuk mengurangi biaya penggantian truk bekas dengan truk baru yang lebih canggih.</p> |
|---------------------------------------|---|

Rencana Aksi Mitigasi terdiri atas **tiga aksi mitigasi langsung dan empat rangkaian aksi pendukung**. Rencana tersebut merupakan kombinasi dari:

1. Kebijakan wajib,
2. Praktik pengelolaan armada, dan
3. Dukungan fiskal.

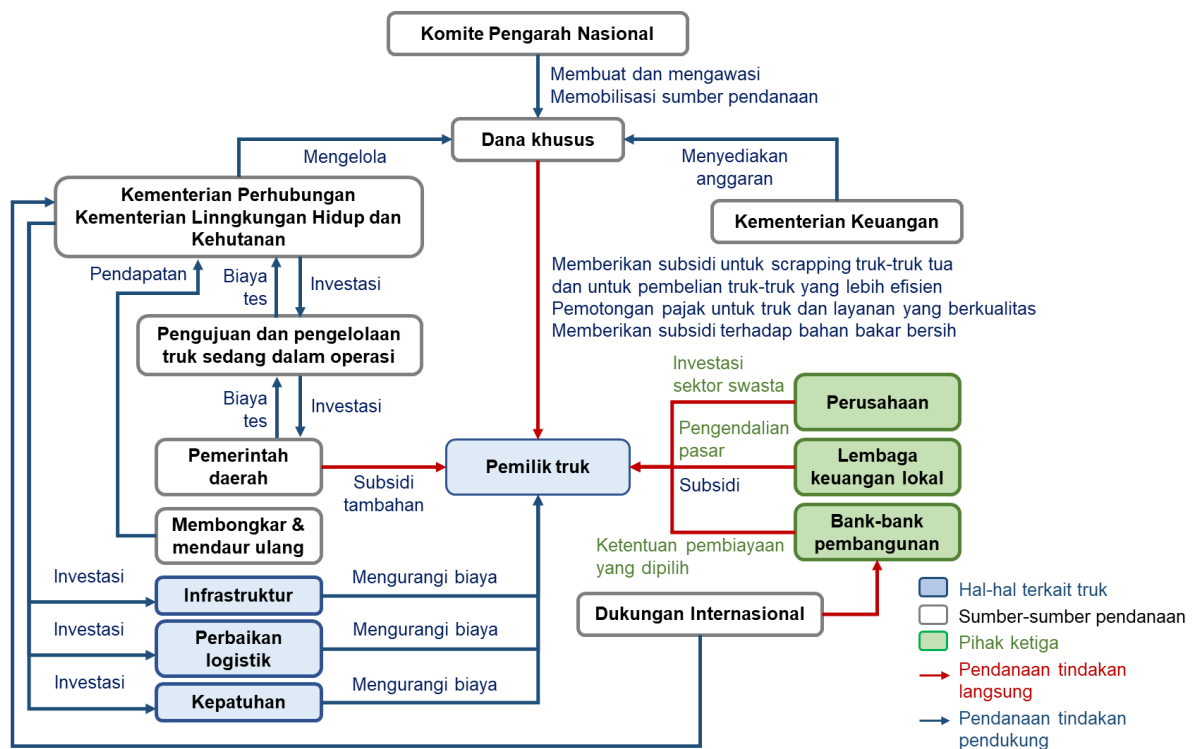
Implementasi dari rencana tersebut harus menggiring sebagian besar truk menuju kriteria truk bersih. Gambar ES-2 telah merangkum langkah-langkah tersebut.

| Hambatan | Tidak adanya pedoman kebijakan strategis | Praktik bisnis yang mahal dan tidak efisien | Program kepatuhan dan penegakan yang lemah | Tidak adanya koordinasi lintas sektor |
|---------------------|--|---|--|--|
| Tindakan langsung | <p>Scrapping truk-truk beremisi tinggi</p> <ul style="list-style-type: none"> Menetapkan jadwal scrapping truk dan mekanisme pengelolaannya Memberikan dukungan fiskal sebagai insentif awal untuk melakukan scrapping Menetapkan mekanisme penerapan scrapping | <p>Mempercepat transisi ke truk yang efisien dan ramah lingkungan</p> <ul style="list-style-type: none"> Memperkenalkan standar efisiensi bahan bakar guna mempercepat penyerapan teknologi yang lebih maju Mempercepat adopsi Euro VI untuk standar bahan bakar/emisi Memberikan insentif untuk pembelian dan pengoperasian truk ramah lingkungan | <p>Melacak, memantau dan mengurangi emisi dari truk yang sedang beroperasi</p> <ul style="list-style-type: none"> Memperbaharui persyaratan dan fasilitas pengujian untuk inspeksi kendaraan secara berkala Membangun sistem untuk mengidentifikasi truk yang tidak mematuhi aturan Menetapkan proyek pencontohan bagi zona rendah emisi (LEZ) dan manfaat yang dirasakan di tingkat lokal untuk truk-truk yang mengalami modernisasi tersebut | |
| Tindakan pendukung | <p>Membuat dokumen strategis</p> <ul style="list-style-type: none"> Menetapkan peta jalan untuk modernisasi armada truk Menetapkan peta jalan menuju kendaraan berstandar emisi kelas dunia dan berbahan bakar bersih Menetapkan pedoman untuk memperbaiki kualitas manajemen kendaraan yang sedang beroperasi | <p>Menurunkan biaya dan meningkatkan efisiensi</p> <ul style="list-style-type: none"> Berinvestasi dalam infrastruktur guna meningkatkan kondisi lalu lintas dan mengemudi Mengurangi gangguan atau waktu tunggu di jalan atau di pelabuhan Membangun program pendidikan untuk pengemudi dan para operator guna mengurangi biaya operasi armada Memperkuat regulasi dan penerapan ODOL | <p>Meningkatkan pengawasan dan penegakan hukum</p> <ul style="list-style-type: none"> Meningkatkan kapasitas pengujian secara institusi Membangun infrastruktur untuk membantu pemantauan di jalan Meningkatkan biaya ketidakpatuhan dan menciptakan mekanisme berbagi tanggung jawab | <p>Memperkuat koordinasi lintas sektor</p> <ul style="list-style-type: none"> Saling berkoordinasi dan mendukung para operator truk berskala kecil Membangun skema manfaat dan sertifikasi bagi para operator ramah lingkungan Membangun sistem untuk mengoptimalkan aliran logistik |
| Tindakan Organisasi | <p>Membentuk Komite Pengarah Nasional</p> <ul style="list-style-type: none"> Membentuk Komite Pengarah Nasional yang terdiri atas perwakilan dari Kemenhub, KLHK dan BAPPENAS | <p>Membentuk Komite Pengarah Teknis</p> <ul style="list-style-type: none"> Membentuk Komite Pengarah Teknis yang terdiri atas perwakilan dari direktorat pelaksana | | |

Gambar ES-2: Tinjauan Rencana Aksi Mitigasi Modernisasi Truk

Salah satu tantangan dalam **pembiayaan** skema modernisasi truk adalah biaya di muka yang lebih tinggi untuk truk baru yang lebih bersih dan efisien. Operator truk terutama operator yang lebih kecil akan sulit beralih ke bisnis baru atau model pembiayaan untuk realisasi modernisasi kendaraan tanpa intervensi kebijakan publik. Dukungan publik untuk memfasilitasi aksi mitigasi tahap awal sangat dibutuhkan.

Salah satu kunci utama untuk meningkatkan **kelayakan finansial dari skema modernisasi armada truk** adalah dengan mengurangi total biaya kepemilikan truk baru yang ramah lingkungan dan berangsur-angsur meningkatkan total biaya kepemilikan untuk truk yang telah tua dan berpolusi. Terdapat langkah-langkah tambahan lainnya yang tidak memerlukan tambahan pendanaan pemerintah tetapi mampu menciptakan kasus bisnis bagi terwujudnya skema modernisasi armada truk. Pendanaan pemerintah harus disediakan melalui dana khusus dan difokuskan untuk memberikan insentif pembiayaan bagi truk-truk yang mengalami eliminasi/*scrapping* dan bagi pembelian truk-truk baru yang efisien dan ramah lingkungan. Beberapa sumber pendanaan yang teridentifikasi dapat mendukung keberadaan pendanaan khusus tersebut meliputi pengumpulan pajak dan pendapatan yang terkait dengan kendaraan, bahan bakar, dan operasi bisnis truk, sumbangan pendapatan pabrik kendaraan, pendapatan dari eliminasi dan daur ulang, dana iklim nasional, anggaran pemerintah, dan pendanaan organisasi global. Gambar ES-3 menunjukkan struktur pembiayaan yang berpotensi untuk skema modernisasi armada truk.



Gambar ES-3: struktur pembiayaan untuk skema modernisasi truk

Untuk dapat memperkirakan dampak dari Rencana Aksi Mitigasi ini, skenario *Business as Usual* (BAU) digunakan sebagai studi kasus referensi untuk membandingkan **skenario mitigasi**. Skenario Moderat menggambarkan upaya kebijakan yang diyakini sangat layak untuk dicapai oleh Indonesia berdasarkan kondisi saat ini, sementara skenario Kelas Dunia berupaya menyelaraskan Indonesia dengan upaya negara-negara terkemuka di dunia dan merupakan sebuah lompatan besar menuju kebijakan yang lebih agresif dalam jangka waktu yang lebih singkat. Tabel ES-2 menjabarkan kebijakan-kebijakan utama yang diambil dalam tiap-tiap skenario. Skenario-skenario ini memberikan penjabaran secara komprehensif terkait dampak potensial dari Rencana Aksi Mitigasi di Indonesia jika dibandingkan dengan BAU.

Tabel ES-2: Skenario modernisasi truk di Indonesia

| Skenario | Program modernisasi armada truk | Standar efisiensi bahan bakar/program angkutan barang ramah lingkungan | Standard emisi bahan bakar | Bahan bakar berkadar sulfur rendah |
|-----------------------------|---|--|--------------------------------|---|
| Skenario dasar (BAU) | Tidak tersedia | Tidak tersedia | 2010: Euro II 2021: Euro IV | 2018: CN 53: 300 ppm CN 51: 1,200 ppm CN 48: 1,200-2,500 ppm 2021: 50 ppm |
| Moderat | <ul style="list-style-type: none"> • Eliminasi truk-truk di bawah standar Euro, umur >20 tahun sebelum 2025 • Eliminasi truk-truk Euro II, umur >15 pada 2030 | 1.5% perkembangan tahunan dari 2025 | 2025: Euro V 2030: Euro VI | 2030: 10 ppm |
| Kelas Dunia | <ul style="list-style-type: none"> • Eliminasi truk-truk umur >20 sebelum 2023 • Eliminasi truk-truk di bawah standar Euro pada 2025 • Eliminasi truk-truk Euro II, umur >15 pada 2027 | 3% perkembangan tahunan dari 2023 | 2023: Euro VI | 2023: 10 ppm |

Aksi mitigasi diharapkan dapat mencapai pengurangan akumulasi emisi CO₂ pada kisaran 1,6 hingga 23 juta ton (Mt) selama 10 tahun antara tahun 2020 dan 2030 (Tabel ES-3). Hal ini berarti pengurangan emisi GRK tahunan rata-rata sebesar 7,1 Mt CO₂ pada tahun 2030 dalam skenario Kelas Dunia, yaitu sekitar 10% dari total emisi truk dengan skenario BAU.

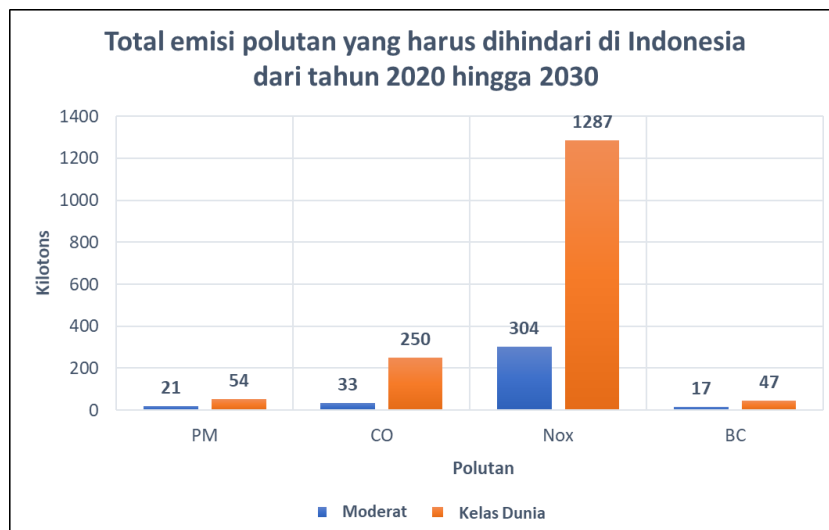
Tabel ES-3: Penilaian Dampak GRK Tahap Perencanaan (*ex-ante*) 2020 - 2030

| | Skenario Moderat (dalam MtCO ₂ yang terakumulasi dari 2020) | Skenario Kelas Dunia (dalam MtCO ₂ yang terakumulasi dari 2020) |
|-------|---|---|
| @2025 | 0 | 5.5 |
| @2030 | 1.6 | 23 |

Melalui peremajaan truk tua dan berpolusi dengan truk yang lebih bersih dan efisien, pemerintah Indonesia dapat:

- mengurangi permintaan energi transportasi: **Program modernisasi truk dapat menghemat energi secara kumulatif hingga 312 petajoule (PJ) dengan standar yang diusulkan di bawah skenario Kelas Dunia, yaitu sekitar 8.573 juta liter bahan bakar diesel**
- memberikan manfaat sosial dan kesehatan yang sangat besar: pengurangan emisi karbon hitam diesel (BC), polutan iklim berumur pendek yang berpotensi berdampak pada pemanasan global setara dengan 910–3.200 kali lipat CO₂ (Bond et al., 2013). Polutan lokal lainnya seperti partikel halus (PM_{2.5}) dan nitrogen oksida (NO_x), juga akan menurun. Paparan kronis terhadap polutan ini dapat menyebabkan kanker paru-paru, penyakit jantung, stroke, dan gangguan kesehatan yang merugikan.

Agar dapat mengurangi emisi melalui Skenario Kelas Dunia agar melebihi pengurangan emisi di bawah Skenario Moderat, diusulkan untuk dilakukannya pengendalian emisi yang lebih ketat agar mencapai tiga sampai delapan kali antara tahun 2020 dan 2030. Angka-angka ini akan lebih besar lagi bila melihat dampak setelah tahun 2030. Gambar ES-4 menyajikan penghematan polutan kumulatif dari tahun 2020 hingga 2030 dalam Skenario Moderat dan Kelas Dunia.



Gambar ES-4: Total emisi polutan yang harus dihindari di Indonesia tahun 2020 -2030 (kilotons)

Penerapan skema aksi secara menyeluruh – **mengganti truk-truk yang akan diremajakan dengan truk-truk yang dilengkapi teknologi ramah lingkungan serta memberikan subsidi untuk selisih harga yang timbul akibat pembelian truk-truk baru** – Hal ini akan membutuhkan biaya sekitar **Rp 50 triliun sampai dengan Rp 61 triliun (USD3.5 – USD4.3 milyar)**. Jumlah dana tersebut tergantung pada kepemimpinan dan keberpihakan secara politik.

Rencana Aksi Mitigasi ini akan menghasilkan manfaat yang lebih besar dibandingkan biaya yang dikeluarkan. Kajian ini memberikan estimasi rasio manfaat-terhadap-pertambahan biaya yaitu sebesar 2.5:1 dengan menerapkan aksi yang dijabarkan pada skenario Moderat dan rasio 4:1 melalui penerapan aksi yang dijelaskan dalam skenario Kelas Dunia. Biaya social yang timbul mencakup kerusakan yang diakibatkan oleh polutan dan emisi tertentu, termasuk dampak langsung terhadap iklim dan kesehatan, dampak kesehatan akibat iklim, dan dampak dari kerusakan ozon terhadap melemahnya produktivitas pertanian. Manfaat yang dihasilkan setara dengan selisih yang dihasilkan dari kerugian-kerugian yang disebutkan dalam skenario diatas melalui skenario BAU.

1. Introduction

Indonesia is the 25th largest exporter and 29th largest importer in the world in 2017 (OEC, 2019). The logistics performance index (LPI) of Indonesia evaluated by the World Bank has reached in 2018 its highest performance since 2007, but still ranks the fifth among Association of South East Asian Nations (ASEAN) countries, behind Singapore, Thailand, Vietnam, and Malaysia (WB, 2019). The high volume of imported and exported goods creates great needs of logistics, which is 90% dominated by trucking as a transport model (Figure 1).³

Indonesia is the world's 12th biggest market of commercial vehicle sales, with 250.000 vehicles sold on average between 2015 to 2019. Trucks make up 5% of the annually registered vehicles, yet account for 20-25% of the domestic transport energy demand according to the Ministry of Energy and Mineral Resources. The island of Java, Indonesia's economic activity center, accounts for 46% of the more than 8 million trucks that have been registered by 2019 in Indonesia. As GDP as well as logistics business continues growing in Indonesia, the government recognizes that **the development of national connectivity and the improvement of transport infrastructure are among the priorities to achieve sustainable development goals**. This recognition is reflected in the National Medium-Term Development Plan (RPJMN) 2015–2019 issued by the National Planning Agency (BAPPENAS) that identifies long-term national development targets.



Figure 1: Traffic in Jakarta

Freight transportation in Indonesia faces various challenges, including poor energy and environmental performance, safety risk, and high cost. These factors are attributed to older trucks with poor technologies, truck oversizing and overloading, road congestion, high cost, and other factors. As a consequence, freight transportation is a significant contributor to greenhouse gas (GHG) and criteria pollutant emissions in Indonesia, magnifying the environmental and public health burden of the transportation sector.

Indonesia's 2015 NDC doesn't include specific targets or activities for mitigation in the transport sector and therefore green freight actions are not yet an explicit part of the government's climate action

³ Information collected through interview with the Task Toll Road Regulatory Agency (BPJT).

framework. However, **fleet modernization (in general, not specific to a vehicle type) has been highlighted as an action in the RAN GRK (government's 2011 action plan to reduce GHG emissions) as well as in the government's draft NDC Roadmap which elaborate mitigation potentials and actions for the transport and other sectors.** The 2020 NDC update has been work-in-progress at the time of writing, yet it is expected to be more elaborate but possibly not more ambitious in terms of sector action.

This mitigation action plan is to outline a governmental program on environment-friendly truck fleet modernization in Indonesia. It provides a thorough review of the sector situation, a barrier and challenges analysis regarding to truck fleet modernization, and measures to address the barriers, including direct measures and supportive measures.

The overall objectives of the fleet modernization scheme would be **to get the owners of trucks to modernize their fleets**— replacing the dirtiest and least efficient vehicles with trucks equipped with most advanced technologies. This objective is mainly the “improve” approach under the “Avoid–Shift–Improve” scheme. **Ministry of Transportation (MOT) will lead the implementation** of this plan, with support from Ministry of Environment and Forestry (MoEF), Ministry of Energy and Mineral Resources (MEMR), and BAPPENAS. Other governmental institutions must be engaged to support to the scheme implementation, such as Ministry of Industry (MOI), Ministry of Finance (MOF), and Traffic Corps.

2. Overview of truck sector in Indonesia

2.1 Relevance of the sector

2.1.1 National economics and logistic industry

The gross domestic product (GDP) growth in Indonesia relies more on domestic demand, while can also be affected by changes in global trade environment (Breuer et al., 2018; Reuters, 2019; Blankenship, 2012). From 2008 to 2018, Indonesia's GDP growth ranged from 4.6% to 6.1% annually and stabilized around 5% since 2014 (Figure 2). The GDP growth is expected to increase as the Indonesia's President Joko Widodo set a 5.6%-6.2% annual GDP growth target from 2020 to 2024 (Reuters, 2020). To fulfill the constant growth of domestic consumption power, **the logistic business in Indonesia** has also been **increasing over years**. Figure 3 summarizes the trend of the logistic business⁴ from 2010 to 2018, indicating a stable growth of the business.

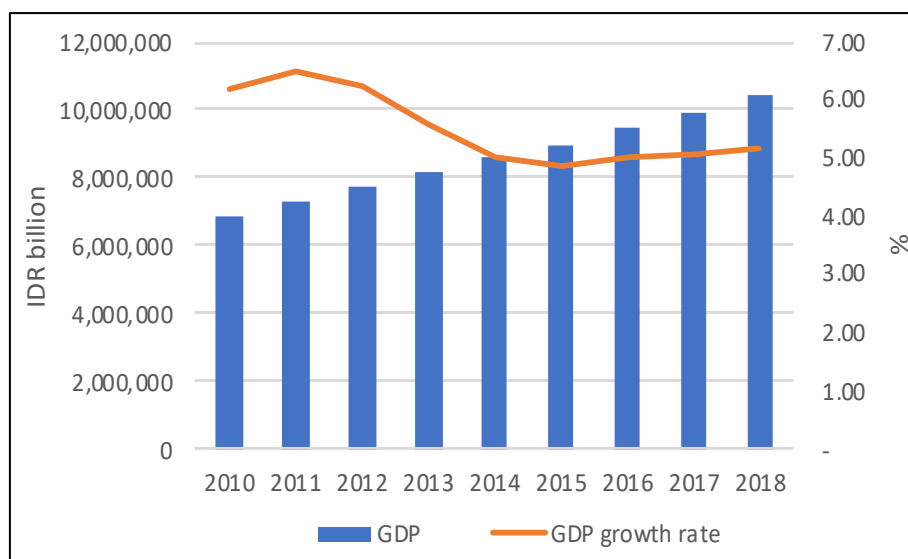


Figure 2: Indonesia GDP and GDP growth rate from 2010 to 2018

Source: Statistical Agency of Indonesia (2020); Statistical Agency of Indonesia (2016); Central Bank of Indonesia (2020); Central Bank of Indonesia (2016)

⁴ Logistic business is defined as business that covers modern postal and courier services.

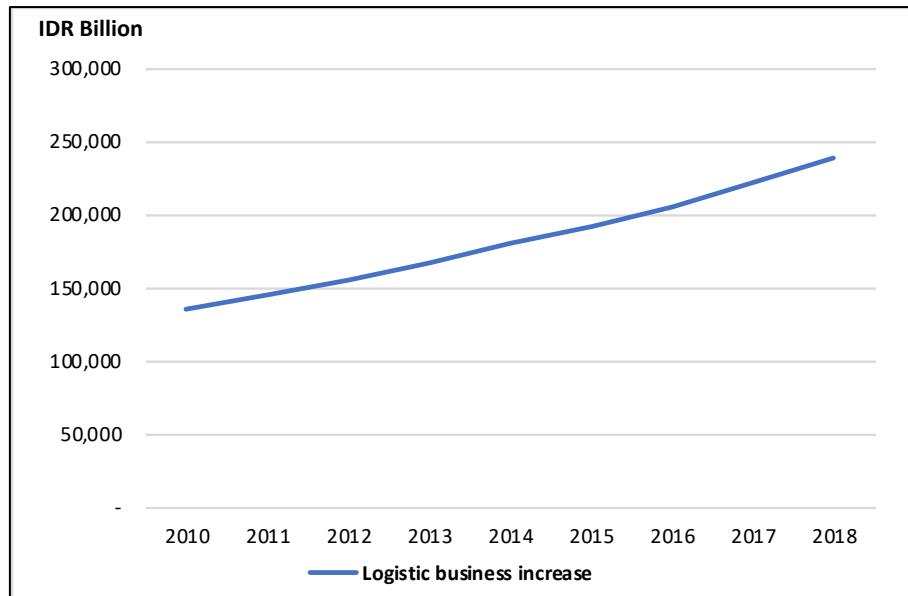


Figure 3: Logistic business in Indonesia from 2010 to 2018

Source: Statistical Agency of Indonesia (2020); Statistical Agency of Indonesia (2016)

2.1.2 Vehicle and freight transport fleet

The number of vehicles⁵ sold closely related to the economy trend, as the number of total four-wheeled vehicles sold decrease in 2009 and picked up since 2014. In 2018, the annual sale of vehicle sales reached 9.65 million units. Compared with some of other ASEAN economies, the motorization rate of Indonesia is relatively low (Figure 4). From 2005 to 2017, Indonesia grew from 61 to 84 vehicles per 1000 inhabitants (excluding motorcycles), far behind Malaysia, Singapore, and Thailand. Due to the low motorization rate and the expected growth of GDP, **the number of vehicles is expected to continue grow in Indonesia.**

⁵ For “vehicles” mentioned in this report, motorcycles and three-wheelers are excluded from all discussion.

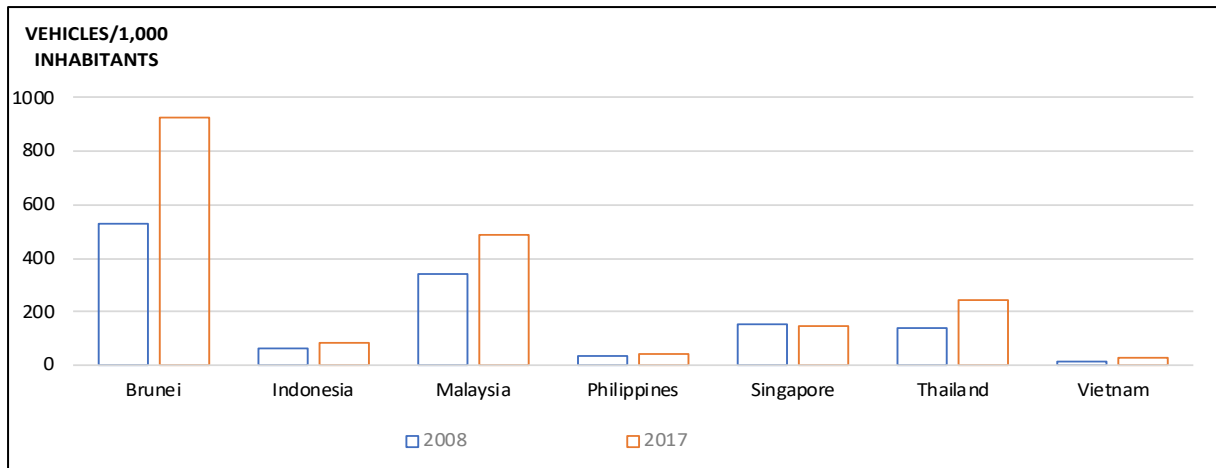


Figure 4: Motorization rate of Indonesia and other ASEAN economies

Source: ASEANStats (2020); Plecher (2019)

The growth of logistic business has also led to increasing demand of trucks and truck drivers for road transport. The sales of brand-new trucks have been picking up since 2019 after three years of significant decline (Figure 5). Historically, majority of trucks sold in Indonesia have a gross vehicle weight (GVW) lower than 10 tons. **As the truck fleet grows, Indonesia has a growing problem with truck driver shortage** (Rinaldi, 2019a; Rinaldi, 2019b). Due to the shortage of professional truck drivers, truck fleet cannot be operated in full capacity and in its full efficiency.

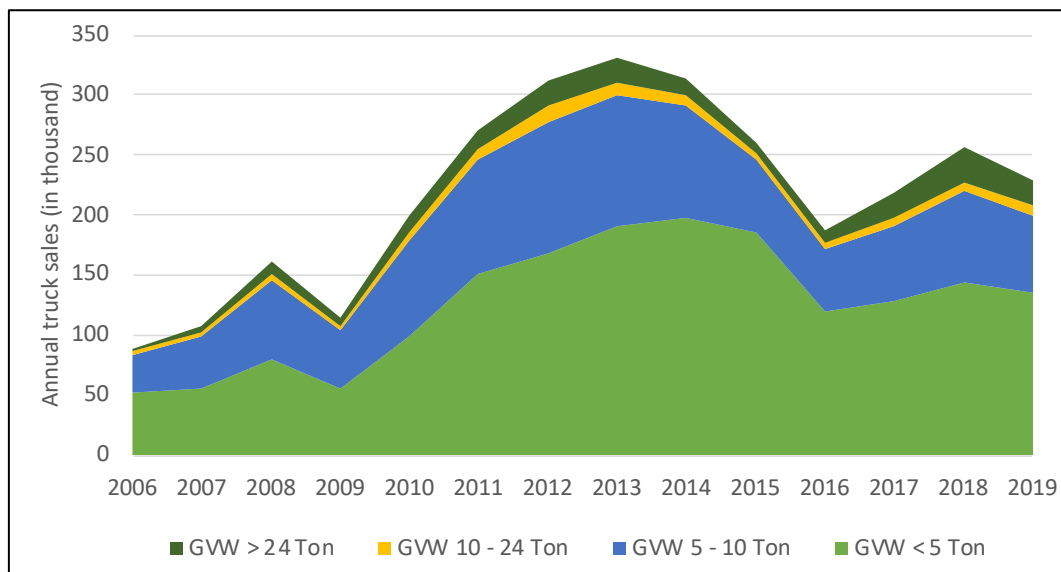


Figure 5: Annual sales of trucks by gross vehicle weight (GVW) from 2006 to 2018

Source: GIZ (2019)

The truck fleet in Indonesia is relatively old, with an average age of more than 10 years (GIZ, 2019). According to the Indonesian Truck Businessmen Association (APTRINDO), around 63% of the truck fleet in Indonesia are older than 10 years (Kumparan, 2019) and 35% of the truck fleet are older than 20 years (Purba, 2020). Data provided by the Association of Land Transport Businessmen (ORGANDA) even indicated that 70% of the 7 million trucks circulating in Indonesia are more than 20 years old, yet is unknown how many of them are still active or have been retired (GIZ, 2019).

The trucking business efficiency is low compared with other key economies. In Indonesia, the average annual mileage that trucks travel is 50,000 km (Motoris, 2019). It lags far from other countries. In European Union (EU) countries, depending on the truck types, trucks on average travel around 60,000km to 116,000km annually (EU 2019/1242, 2019). In the United States (US), the Class 8 trucks on average travel 107,000km annually (Federal Highway Administration, 2016).

Part of the inefficiencies are caused by the long time spend with loading and unloading and traffic jams (Rinaldi, 2019b). The average running speed is less of 40 km/h on Indonesia's roads, which significantly slow down transport speed if the trucks are not taking the highways (GIZ, 2019). Whereas the average running speeds of trucks in the United States are greater than 88 km/h on most interstate highways (Bureau of Transportation Statistics, 2017).

2.1.3 Contribution to GHG emissions

In 2017, Indonesia emitted 1.2 billion tons of carbon dioxide (CO₂) equivalent (MoEF, 2017), which means Indonesia is the 5th biggest emitter of GHG emission worldwide (WRI, 2017). As Figure 6 shows, the energy sector exceeds industrial process and product use (IPPU) as the biggest contributor to GHG emissions. **The transportation sector accounts for 26.2% of energy sector GHG emissions, while land transport accounts for 91.0% of transport sector emissions.** The GHG emission data for the truck sector is not available for Indonesia, but according to global estimate, heavy-duty vehicles (which consists of mostly freight vehicles) on average account for 44% of the GHG of the land transportation sector (Miller & Facanha, 2014).

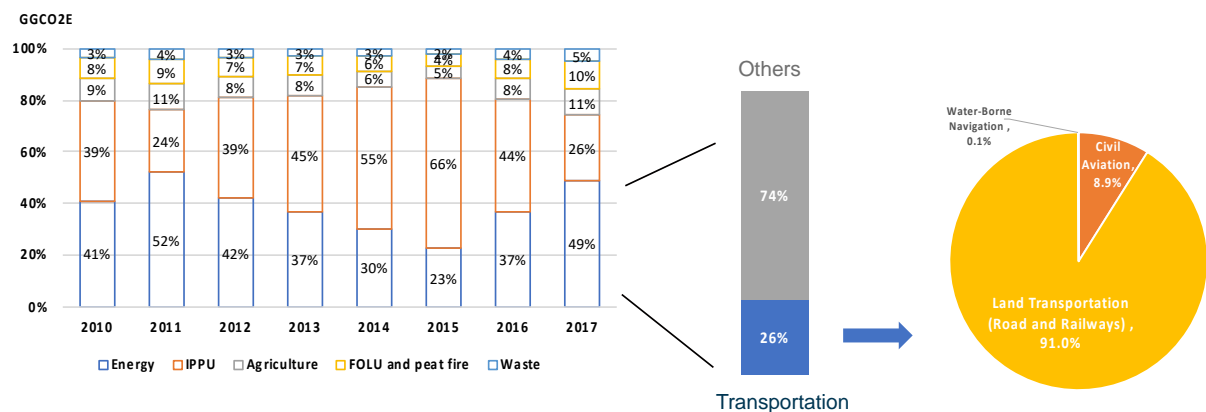


Figure 6: GHG emissions by sector from 2010 to 2017

Source: MoEF (2017)⁶

2.2 Transport and climate policy context

Accelerating truck modernization will require support from a variety of policies, including vehicle efficiency and emission standards, fuel standards, in-use vehicle certification and inspection, driver qualification, infrastructure construction, financial mechanism, and logistic optimization (Figure 7). However, few of those fields have been properly planned by existing policies or strategies.

⁶ IPPU refers to industrial process and product use; FOLU refers to forest land and other land use.

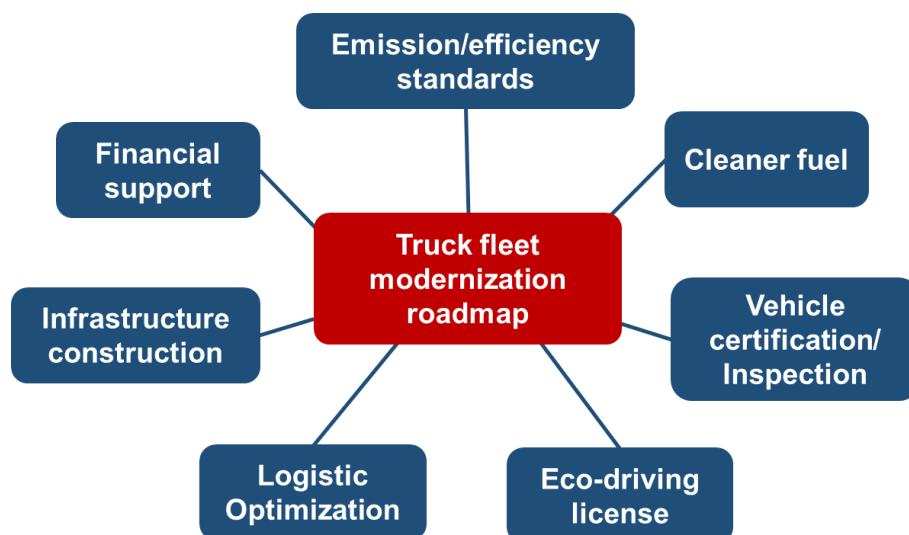


Figure 7: The policies required to support acceleration of truck modernization

There has been policy action related to some aspects presented in Figure 10. However, those efforts are carried out to meet individual policy or administrative targets of the responsible agencies, rather than being part of a coherent programmatic approach towards a collective goal.

In 2015, the President Joko Widodo stated in the COP21 meeting in Paris that **Indonesia commits to reduce its GHG emissions by 29% compared to the projected business as usual (BAU) by 2030 and by 41% with international support**, which later on converted into registered nationally determined contributions (NDC) (Indonesia Government, 2016).

The NDC serves as the main reference point in formulating the country's approach towards GHG emission reduction. **Pre-NDC frameworks to achieve GHG mitigation targets by the government of Indonesia** include Indonesia Climate Change Sectoral Roadmap (Indonesia Government, 2009), National Action Plan on Greenhouse Gas Emission Reduction "RAN-GRK" (Indonesia Government, 2011) and, Regional Action Plan on Greenhouse Gas Emission Reduction "RAD-GRK" (Indonesia Government, 2016).

In early 2020 the Indonesian government adopted a new five-year plan, the **National Mid Term Planning (RPJMN 2020 – 2024) adopted via Presidential Decree No. 18/2020**. The RPJMN 2020 – 2024 is the first mid-term plan that entails a dedicated chapter on Environment, Improving Disaster Resistance and Climate Change.

To ensure the appropriate **implementation of the plan**, particularly the environment chapter, BAPPENAS formed the **Low Carbon Development Indonesia (LCDI)**, which is a merged body of three predecessor bodies formed under the RAN-GRK set-up, namely the Secretariat for RAN-GRK, the National Action Plan on Adaptation (RAN-API), and the Indonesia's Climate Change Trust Fund (ICCTF).

As for the strategy to achieve GHG mitigation target, there is a **lack of implementation strategy by sector**, including freight sub-sector. The existing mitigation actions for transport sector are not sufficient as most of the actions relating to land transport focus on urban areas and include projects such as parking management, development of public transport and plans for non-motorized transport infrastructures, all these were reflected under the MoT's strategic plans (RENSTRA) throughout the period of 2010 until 2019.

The upcoming MoT's RENSTRA 2020 – 2024 may include more relevant activities for freight sub-sector. Based on Ministry of Environment and Forestry (MoEF) data (2017), the mitigation actions only reduced 1.5% and 1.4% of land transport GHG emissions in 2015 and 2016, respectively. **Most of the reduction contributions came from improvement of railways rather than road transport**. These together indicated greater efforts needed to reduce GHG emissions from the road transport sector.

Although there have been some updates within the RPJMN and strategic plans of line ministries, the **NDC remains as the main guideline for emission reduction targets**. In the ongoing development of the NDC roadmap, transport renewal has been mentioned as one of the GHG emission reduction measures⁷. MoEF, through DG Climate Change is still continuously streamlining the targets with other line ministries. In coming years, Indonesia's NDC might be reviewed and updated if it is deemed necessary, however this will likely happen only in 2023 or after the global stock take.

In addition, there are **policy documents** which have been set previously to monitor the achievement of the emission reduction, such as Presidential Regulation No. 71/2011 concerning implementation of national GHG emissions inventory, Presidential Regulation No. 16/2015 and the MOEF decree NO. 18/2015 concerning organization and work procedure in implementing the activities of GHG emissions inventory and Monitoring, Reporting and Verification (MRV) (MoEF, 2018).

These documents assign responsibilities to several ministries for MRV related issues. For the transport sector, **the Center of Sustainable Transportation Management (PPTB or Pusat Pengelola Transportasi Berkelanjutan) of Ministry of Transportation is responsible for GHG emission inventory and MRV of activities related to transport**. Table 1 lists the core policy documents related to climate and transport policies in Indonesia.

Table 1: Summary of main policies related to climate and transport policies in Indonesia

| Year | Policies, programs and projects | Relevance |
|---------------------------------------|---|--|
| Environment and Climate Change | | |
| 2011 | Presidential Decree No. 61/ 2011 concerning National Action Plan to Reduce GHG Emissions (RAN-GRK) | Pledged to reduce its GHG emissions by 41% with respect to the projected BAU by 2020 compared with 2000 level (15% with international support). It provides guidelines to national action plan to achieve 2020 GHG reduction targets. The RAN-GRK is implemented by various line ministries. In relation to road transport, the plan has a strong passenger transport focus but proposes two as yet unimplemented freight-specific activities – creating a modern logistic system in 12 cities and a replacement program for heavy trucks. Measures relevant to road transport are being coordinated by MoT. |
| 2011 | Presidential Decree No. 71 / 2011 concerning GHG emission inventory | Define GHG inventory and the implementation of GHG inventory, including the process and calculation procedure of GHG inventory. |
| 2015 | First Nationally Determined Contribution (NDC) | In September 2015, Indonesia officially submitted its INDC – it Intended Nationally Determined Contribution – to the United Nations Framework Convention on Climate Change (UNFCCC). This included a GHG emission reduction target of 29% below BAU by 2030. The INDC was converted into an NDC and registered with the UNFCCC in November 2016. |
| 2015 | MoEF Decree No. 18/2015 concerning Organizations and Procedure for the Ministry of Environment and Forestry | Clarify MoEF's function on climate change control and relevant technical guidance implementation and supervision. Specify MoEF's responsibilities in formulating and implementing GHG policies, conducting GHG emissions mitigation, adaptation, and reduction, implementing GHG inventory and MRV; drafting relevant norms, standard, procedure and criteria. |
| 2015 | Presidential Decree 16/2015 concerning Ministry of Environment and Forestry | Carrying out function of climate change impact control (Art. 3a), Implementing policies on climate change control (Art. 3b), Coordination and synchronization of climate change control (Art 3c) |

⁷ Based on interview with regulators, the draft NDC roadmap is not yet released to the public as of May 25, 2020

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| 2016 | Regional Action Plan to Reduce GHG emissions (RAD-GRK, 2016) | Provide guidelines to regional action plan to achieve 2030 GHG reduction target of 29% and 41% (with international support) with respect to the projected BAU by 2030. |
| 2016 | Act 16/2016 concerning Ratification of Paris Agreement to the UNFCCC | Ratify the Paris Agreement to support Indonesia's mitigation and adaptation to climate change, and support Indonesia to obtain access to funding sources, technology transfer, capacity building for implementing mitigation and adaptation actions. |
| 2017 | MoEF decree No. 73/2017 management and reporting guidelines on national GHG emissions inventory | Provide guidelines for managing and reporting GHG inventories from transportation sector by Center for Sustainable Transportation Management (MOT) and Data Center and Information Technology (MEMR). |
| 2017 | GHG Inventory Report: Monitoring, Reporting, and Verification | Indonesia has stated its commitment on Nationally Determined Contribution to reduce GHG emissions by 29% (unconditional) and 41% (conditional) by 2030 from BAU. A concrete form of Indonesia's commitment is the issuance of the Law No. 16/2016. |
| 2017 | Government Regulation No. 46/ 2017 | An implementing regulation to Act No. 32/ 2009, this legislation refers to environmental economic instruments: a. To integrate environment into the development and economic activities planning; b. Environmental funds available/ under development; Guarantee fund, Rehabilitation Fund and conservation fund; c. Incentives and/or disincentives (incl. ecolabel, sustainable procurement, tax, etc.). The instruments used for guaranteeing accountability and legal compliance in the implementation of environmental protection and management, changing stakeholders' mind-sets, managing Environment Funds, and public trust building on the fund management. |
| 2020 | National Medium-term Development Planning (RPJMN) 2020-2024 | Developing the Environment, Enhancing Disaster Resilience and Climate Change are one of the seven agenda of RPJMN IV 2020 – 2024. |
| Transport | | |
| 2009 | Act No. 22/ 2009 on Traffic and Road Transport | The act manages road transport & traffic activities to make them more transparent, accountable & sustainable. It defines vehicle classification and technical requirements and eligibility for motorized vehicles, including exhaust gas emissions and minimum performance. Define vehicle type approval and inspection requirement for vehicle technology, roadworthiness, and operation. It also regulates driving license. |
| 2012 | Presidential Decree No. 26 / 2012 on Blueprint for Development of National Logistic System (SISLOGNAS) 2012. | Target at increasing the effectiveness and efficiency of national logistics flows in order to ensure that the public's basic needs are fulfilled and to increase the competitiveness of national products within the domestic, regional and global markets. The vision of SISLOGNAS for 2025 is for a national logistics system that is 'locally integrated, globally connected for national competitiveness and social welfare'. The locally integrated concept aims to have all logistics activities in Indonesia effectively and efficiently integrated by 2025, at the rural, urban, inter-regional and inter-island levels. |
| 2012 | Government Regulation No. 55/2012 concerning Vehicles | Regulate the compliance, supervision, and enforcement of vehicles classification and function related provisions, including technical requirements and road worthiness of motor vehicles, trailer and railroad trains, motorized vehicle testing related to the technical requirements and motor vehicle roadworthiness threshold and motor vehicle repair shops. |

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| 2014 | Government Regulation No. 74/2014 concerning road transport | Regulate the compliance, supervision, and enforcement of cargo freight transport related provisions, including loading procedure and loading capacity and dimension requirement. Regulate the utilization, recording, and reporting procedure of Motorized Vehicle Weighing Implementation Unit (UPPKB). |
| 2015 | MOT Decree No. PM. 133/2015 concerning the Periodical Testing of Motor Vehicles | Specify the scope and procedures of periodic testing of motor vehicles, periodical testing unit (UPUBKB) which is implemented at the Province DKI Jakarta/District/City level related to the facility and inspection tools, and inspector of periodic testing of motor vehicles including the authorities and responsibilities in carrying out and deciding the results of periodic tests. |
| 2015 | MOT Decree No. 134/2015 concerning the implementation of weighing motorized vehicles on the road | Specify that the installation of UPPKB and the supervision of cargo is under the responsibility of MOT. Further define the detailed function of UPPKB for supervision, enforcement and recording. |
| 2015 | Ministry of Transport Decree No. 189/ 2015 | Strategic planning document endorsed in September 2015. Maps out how to establish better national connectivity and improved access to transport, incl. distribution of goods. <i>RENSTRA</i> (Strategic Planning) identifies a need to accelerate multimodal transport & enhance transport services to foster development of Indonesia's industry & logistics sector. |
| 2015 | Presidential Decree No. 2/ 2015 | To develop national connectivity, the National Mid Term Plan or <i>RPJMN</i> 2015-2019 aims to improve transport infrastructure & the integration of multimodal-intermodal transport, including increasing the rail freight volumes. |
| 2017 | Director General of land transport Decree 736/AJ.108/DRJD/2017 | Define enforcement of violations of the excess capacity of trucks or heavy loads exceeding 5% (five percent) of the carrying capacity of the vehicle, including fine and forbidding the driver to continue their trip with over-weighted cargo. |
| 2017 | MoEF Decree No. 20 / 2017 on Emission Standard Limits for New Type of Motor Vehicles & Motor Vehicles in Current Production | Issued in response to air pollution problems related to vehicle emissions. Calls on the oil industry to produce fuel of a quality that is compliant with the Euro IV emission standard. Constitutes the basis for the MoEF to carry out its function to manage and protect the environment & ecosystem. |
| 2018 | MOT Decree No. PM. 33/2018 concerning the Approval Type Testing of Motor Vehicles | Specify the scope and procedures of type approval testing of motor vehicles, the authorities and responsibilities of inspectors in carrying out and deciding the results of type approval tests, and the facility and inspection tools requirement for the type approval testing unit (BPLJSKB). |
| 2019 | Ministry of Transport Circular letter No 21/2019 | An instruction issued by the Minister of Transport to do supervision over all cargo vehicles and trucks with over loading and over dimension (ODOL). The main task will still be under the DG Land Transport of MOT (monitoring and putting sanction to those who violate), however relevant agencies in both national and sub-national governments are also urged to monitor freight carriers and report potential case. |
| 2019 | MOT Decree No 60 / 2019 concerning management of on-road freight activities | A new guideline regarding road-based freight and logistics, which supersedes MOT Decree No 29 / 1993. It defines the specification and limits of freight carrier and classify type of goods allowed to be carried. The decree also sets minimum competence of freight drivers as well as other crews (such as stevedoring) that should be proven through relevant certificate of competence (refers to MOT Decree No. 171/2019). |

| | | |
|--------------------------|--|---|
| 2019 | MOT Decree No. 171 / 2019 concerning Enactment of National Working Competence Standard for the Category of Transport and Warehousing Specifically on Land-based Freight Transport Main Group | Provide an operational support to the preceding Decree issued by the Ministry of Manpower No. 269 / 2014 on National Working Competence Standard for the Category of Transport and Warehousing Specifically on Land-based Freight Transport Main Group. Although it has been enacted by MOT in 2019, as of now the implementation guideline is still being developed. It is also not clear at this moment if the responsible ministry to implement the certification for truck drivers will be MOT or Ministry of Manpower. |
| Energy | | |
| 2001 | Act No. 22/ 2001 | This is the legal basis for the implementation of cleaner fuel specifications set by the Directorate General of Oil and Gas. It covers the operational requirement for the opening of the downstream market. |
| 2017 | Presidential Decree No. 22/ 2017 | <p>The National Energy Plan (RUEN) includes a projection of GHG emissions up to 2050 for all sectors, with a BAU and a highly efficient scenario that aims for a 58% reduction in GHG emissions.</p> <p>The RUEN does not include a breakdown of projected GHG emissions reduction by sector. However, there is detailed information for the set of policy measures that have the potential to reduce GHG from the freight sector, including fuel support, technology development, fiscal policies, fuel economy standards, infrastructure development.</p> |
| Local Regulations | | |
| 2000 | Gubernatorial Decree No. 95/2000 | Stipulate compulsory emission check of vehicles in Jakarta. Currently only public transportation vehicles have to undergo regular emission tests. |
| 2005 | Local Government Regulation (<i>Perda</i>) No. 2/ 2005 | Prevent, control, monitor & mitigate air pollution in DKI Jakarta. This <i>Perda</i> provides the legal basis for Jakarta to set up its local thresholds for air pollution, with reference to the Government Regulation No. 41 / 1999; it also regulates emissions from motorized vehicles. |
| 2014 | Local act No. 5/2014 concerning transportation | Set an age limit of 10 years for freight vehicle in Jakarta effective from 2025. |

2.3 Governance, market organization and relevant stakeholders

Truck modernization is a collaborative effort that needs support from various government agencies and participation from a range of stakeholders. Figure 8 presents a map showing the stakeholders that are relevant to the truck modernization scheme.

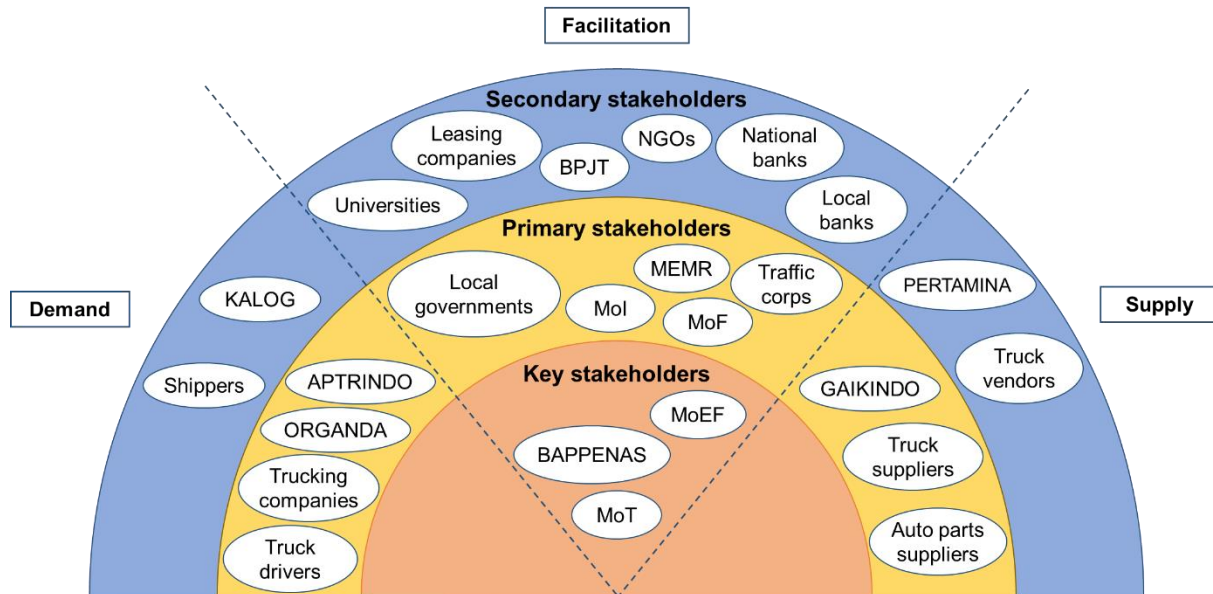


Figure 8: Stakeholder map of truck fleet modernization scheme

The Ministry of Transportation is responsible for governance and regulation of transport, including both new vehicles and vehicles on the road, therefore is one of the core ministries that lead the truck modernization activities. **BAPPENAS and MoEF** are critical ministries for action planning and impact tracking. **MEMR and MOI** are responsible for setting policies that relevant to technical specification, production line and requirement for more advanced fuels for trucks while **MoF** is the key ministry to coordinate the financial support to the actions by focusing on setting up regulations related to import duties of automotive parts & crude oil.

MoF is also responsible for designing fiscal policies (in terms of incentives, tax and subsidies) for Indonesian vehicle market. **Local governments and traffic corps** are the main players to ensure effective implementation of policy actions. Additionally, institutes that related to truck purchase and operation, such as the Task Toll Road Regulatory Agency (**BPJT**), leasing companies and banks are part of the support chain to facilitate the actions. **Universities** and non-governmental organizations (**NGOs**) will complement the government agencies in designing effective policies.

The private stakeholders of the truck modernization scheme can be divided into supply side and demand side. The supply side consists of manufacturers and vendors of trucks, parts of trucks, and fuels. Besides key truck manufacturers, the Indonesian Auto Industry Association (**GAIKINDO**) represents firms that produce and import automotive vehicles and can be a bridge between policy makers and their members. The demand side mainly includes carriers, trucking companies, truck owners, and truck drivers who rely on trucks for their business as well as shippers who needs the service to transport the commodities.

Because the trucking business is highly fragmented in Indonesia, industry organization like **APTRINDO** and **ORGANDA** can facilitate the communication between the industry and policy makers. Table 2 below list the key stakeholders and specify their roles and responsibilities to facilitate truck modernization actions.

Table 2: Roles and responsibilities with regards to truck modernization scheme

| | Roles and responsibilities with regard to the truck modernization |
|----------------------------|---|
| Key actors | |
| Ministry of Transportation | Formulate and implement national policies in the transport sector and enforce and monitor compliance of regulations in the transport sector, including: |

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|--|---|
| | <ul style="list-style-type: none"> - Vehicle technical requirement, type approval, KEUR test, periodic testing - Vehicle age limits, scrappage procedure - Vehicle over-dimensioning and over-loading (ODOL), weight bridge and investigator management - Freight transport-related infrastructure, toll road rate design mechanism, |
| Ministry of Environment and Forestry | Coordinate activities related to climate change including establishing emission inventory and MRV; the national focal point for the UNFCCC. Formulate vehicle emission and CO ₂ emission policies. |
| National Planning Agency | Responsible for national mid-term and long-term development planning and coordination among line ministries on sectoral issues, including the transport sector. Responsible for the newly established Low Carbon Development Indonesia (LCDI) and to provide guidance and assistance for local governments in setting up low carbon policies within their respective regions. |
| Primary stakeholders | |
| Ministry of Industry | Formulate and implement policies related to vehicle fuel economy, industry standardization, industry technology, and transport, maritime, vehicles and equipment. Formulate and implement policies to improve competitiveness, business environment, industry and the service industry, industry standardization, industry technology. Issue policies related to the car industry, including carbon taxes. |
| Ministry of Energy and Mineral Resources | Formulate and implement policies related to in fuel quality, new and renewable energy, and energy conservation. Set fuel price taking into consideration factors such as macroeconomic developments, purchasing power, and social and political conditions and coordinate fuel tax and subsidy regulation setting. |
| Ministry of Finance | Distribute, allocate, and manage yearly budget and expenditure for the state and by ministry. Develop fiscal policies on vehicle and parts import, manufacture, sales, vehicle and fleet operation. The Fiscal Policy Board (BKF) under the MoF works directly to formulate macro-economic analysis and to harmonize fiscal policies (incentives, disincentives and subsidies) including for fuel efficient and clean vehicles. |
| Ministry of Home Affairs | Facilitate and coordinate the design and implementation of in-use vehicle tax and fee at local level. This includes motorized vehicle tax, transfer tax, fuel tax, and parking tax. |
| Traffic corps | Law enforcement related to road traffic, including vehicle registration and operation. |
| Local department of transportation | Distribute, allocate, and manage yearly local budget and expenditure in the transport sector in the region. Manage vehicle periodical inspection, issue vehicle safety inspection certificate, formulate local policies related to transportation in the jurisdiction. |
| APTRINDO (Association of truck businessmen) | Key group that represents truck owners, operators, and drivers. |
| ORGANDA (Association of Land Transport Businessmen) | Key group that represents businessmen and companies in transportation and logistics sector. |

| | |
|--|--|
| GAIKINDO (Indonesian Auto Industry Association) | Key group that represents firms that produce and import automotive vehicles |
| Trucking companies | Truck owners and operators that are subjected to national and local freight related regulations |
| Truck drivers | Own a truck or hire by trucking companies to deliver goods/logistics from point to points. |
| Truck suppliers | Truck manufacturers and importers that are subject to new truck related regulations. |
| Secondary stakeholders | |
| BPJT (Toll Road Regulatory Agency) | Implement part of the Government's authority in the operation of toll roads which includes regulating, operating and supervising Toll Road Business Entities |
| Banks | Provide financial and leasing service to truck companies that need a loan to purchase truck fleets |
| Leasing companies | Provide financial and leasing service to truck companies that need a loan from the banks to purchase truck fleets |
| Universities | Provide academic support to policy making related to vehicles. |
| Pertamina | Main supplier of clean fuel to cleaner and efficient trucks. |
| Kalog | State-own intermodal logistic transportation company. |

2.4 Business and financing model of trucks in Indonesia

The Indonesian trucking sector is fragmented with over 1 million trucking companies (World Bank, 2016). There are a large number of ‘small players’ within the market. The two biggest truck companies in terms of the number of truck ownership are PT. Dunia Express Transindo and PT. Siba Surya, both own around 2,600 trucks. Smaller operators that own 1 to 5 trucks account for the majority of the companies, but only handle a small portion of trucks (World Bank, 2016). For smaller operators that are typically poorly capitalized, it is more challenging for them to invest significantly in new truck technologies beyond essential maintenance.

Fleet owners are required by law to obtain general business permits. There are no restrictions in regard to the type of companies that are eligible to apply for business permit. The permit must be reviewed and renewed every 5 years. From 2019, MOT requires operators of passenger vehicles to own or manage a motorized vehicle of at least five units in order to get business license, but it does not apply to freight transport companies yet. There are route permits that are only issued by some local governments. Truck operators need to apply and pay for the permits or license in order to drive into and through the jurisdiction.

2.4.1 Investment costs

The investment costs of truck owners are cost purchasing the trucks. The upfront purchase cost includes truck price, taxes and fees, and cost of finance. Truck companies usually reach an agreement with the leasing companies on installment (“tenor”), the tenor include a down payment and a monthly installment schedule. The total value of the tenor is evaluated by the leasing companies to take account of

truck model, the cash price of truck without the installment, the value-added tax (VAT), length of tenor, down payment, interest, and administration fee (Figure 9).

The VAT on the import of trucks is 10%. The down payment to the truck is usually 20% to 30% of the price of new truck (Purba, 2020). The recorded annual interest rates range from 7% to 19% and usually around 13% (Meeuws, 2014; Purba, 2020). The administration fee of the leasing company is Indonesian Rupiah (IDR) 350,000 to IDR 550,000 (USD 24.8 to USD 38.9) depending on the length of the installment terms.

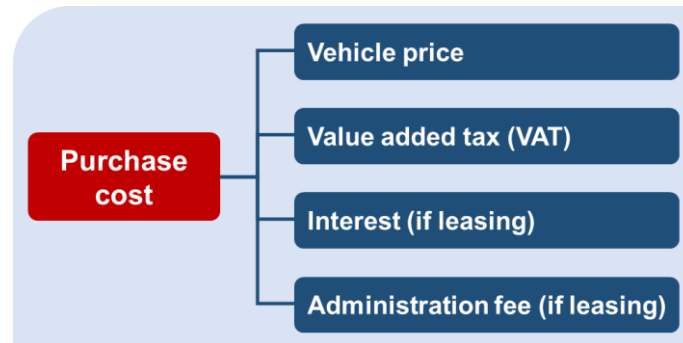


Figure 9: Composition of investment costs of truck owners

The prices of trucks usually have a wide range **depending on the types of trucks**. (Figure 10) presents the manufacturer's suggested retail prices (MSRP) of some Mitsubishi models in Indonesia market. Because each model usually has some variants, the price in the figure shows the average price of the model.

Mitsubishi is the top seller of trucks in Indonesia, with a 35% share of the new truck sales in 2017. For Mitsubishi pick-up trucks with GVW below 5 tons, the prices range from 186 to 232 million IDR (USD 13.2 to USD 16.4 thousand); for trucks between 5 to 10 tons, the prices range from 218 to 423 million IDR (USD 15.4 to USD 30 thousand); for trucks with GVW between 10 to 24 tons, the prices range from 610 to 1190 million IDR (USD 43.2 to USD 84.3 thousand); for trucks with GVW above 24 tons, the price range from 850 to 1080 million IDR (USD 60.2 to USD 76.5 thousand). The overall market of all truck brands has a wider price range for each type of trucks, but the price of Mitsubishi trucks to some extent reflect the truck price trend and spread in Indonesia.

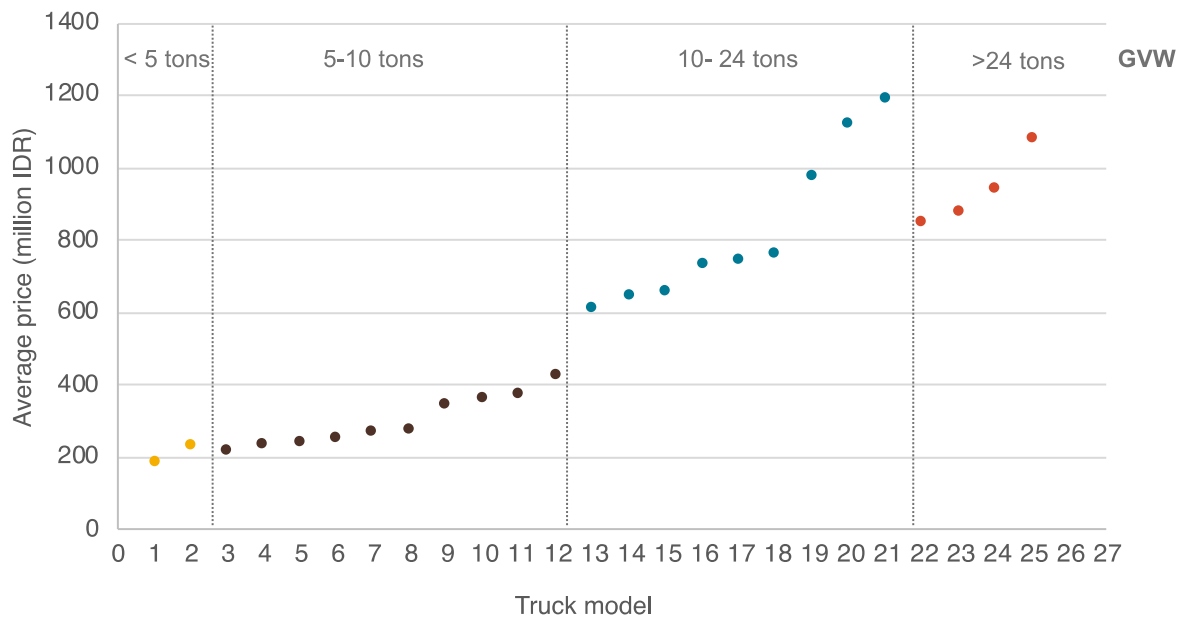


Figure 10: Average manufacturer's suggested retail prices of some Mitsubishi models in Indonesia

The truck companies finance the purchase of trucks through either bank loan or leasing companies. The interest rates of leasing companies are usually higher than banks but using leasing companies is usually a preferable choice because of the simpler lending requirement and process and longer installment period⁸. There are eight top leasing companies in Indonesia for trucks: Dipo Star Finance; BFI Finance; Mitsui Finance; Tifa Finance; BCA Finance; Maybank Finance; CIMB Finance; and Mandiri Tunas Finance. Some vehicle manufacturers also provide financing service to their customers. Truck companies usually pay off the cost of their truck in 3-5 years, the truck companies will own the trucks after paying off the tenor.

2.4.2 Operational costs

The operational costs of trucks include annual tax, fuel cost, maintenance and tire cost, insurance, legal and liaisons cost (such as vehicle registration, KEUR test, business license, hazardous and toxic waste, terra and calibration fee, retribution fee, and dispensations etc.) (Figure 11). For operators of the truck fleet, additional cost includes driver lump sum payment, over-head cost, and other miscellaneous cost to improve business.

The truck drivers are usually contracted by the truck companies rather than a fix employment because the high turnover rate of truck driver. This is also reflected in the employment status in the transport industry in 2019 that 51% employment in the transport sector are own account workers (e.g. individual workers that are not employed by the companies) (Indonesia statistics agency, 2020). For each trip, the drivers are usually paid in lump sum based on the tasks, the lump sum is expected to cover driver wage, toll, parking, loading and unloading, food allowance, honor, unpredicted fee on the road to police, etc.

⁸ Information collected through talking with stakeholders.

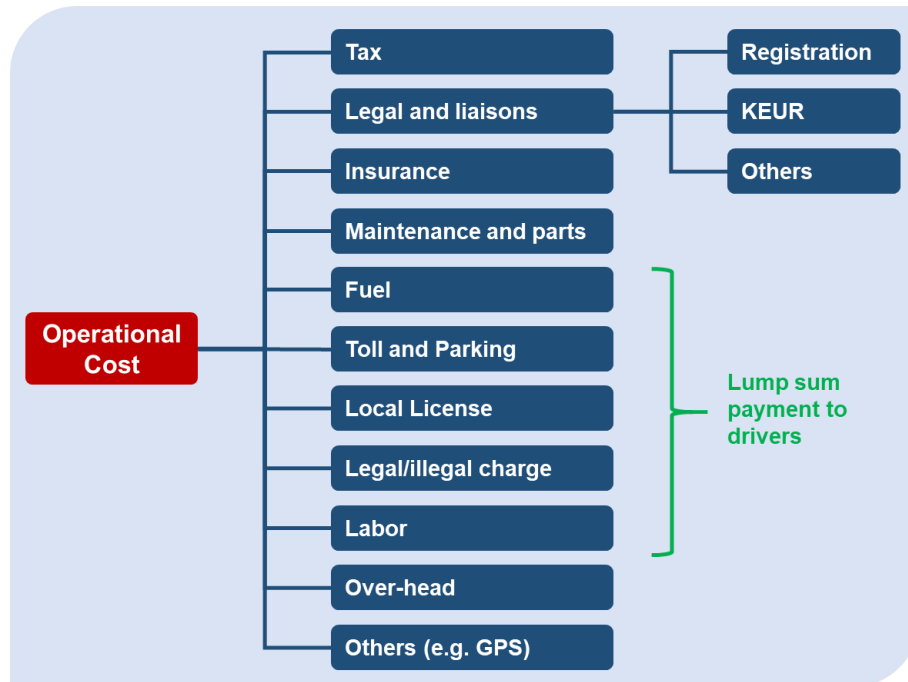


Figure 11: Composition of operation costs of truck owners

Vehicle operational costs vary around the country and vary by route (Sudjana, 2011). One study that survey several trucking routes concluded that the average vehicle operating cost is IDR3093 (\$0.34)/km, higher than Asian average of \$0.22/km (Sudjana, 2011). There are many factors that will impact operation cost. For example, topography will influence maintenance costs and fuel costs and reducing the roughness index for the route can reduces operating costs. The maintenance cost can be tripled as the truck gets older and older. The level of on-road charges to truck drivers - both legal and illegal (e.g. bribes) - also influence the operation cost (Figure 12).

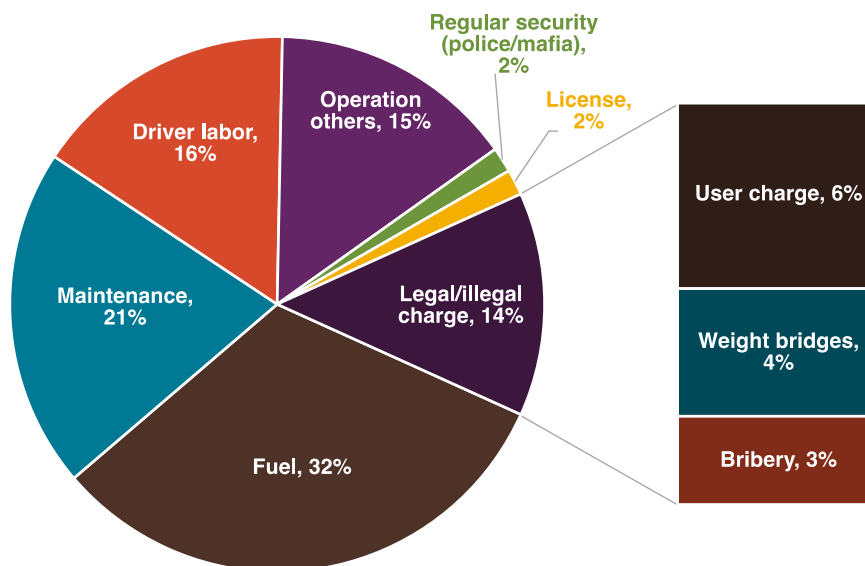


Figure 12: Estimation of composition of truck operation cost

Source: Sudjana (2011), ICCT modification

Depreciation is not included in the operational cost because it is embedded in the upfront purchase cost. When the trucks are getting old, the old trucks have their remaining values. After a comparison of

new truck prices and used truck prices of a number of models in the second-hand vehicle website, the value of second-hand trucks can vary a lot, with a general market research, the value of trucks that are more than 20 years can be 10% to 23% of the new trucks in the market. For old trucks to be scrapped, the parts can be resale and recycle to replace parts on other trucks.

2.4.3 Operating revenues

Revenues for truck operators are generated by payment of freight transport by owners of goods and shippers. There is no tariff setting for good transport services, it is to be agreed between the shippers and the operators transporting the goods. The tariff of trucking service usually depends on the length of trip⁹, the weight or volume of the goods (Abdurrahman & Febrianty, 2016), and the type of the goods (Zuhriyah, 2018).

According to a survey conducted by the World Bank on the logistic industry (World Bank, 2016), in Indonesia, owners of goods tend to hire trucking companies directly for their services. The negotiation power on customer side highly depends on the volume of the cargo, but generally **customers hold a high bargaining power due to the fragmentation of the trucking market**. The power of negotiation of truck operators is evaluated as medium, as it depends on the type of trucks, such as whether trucking companies require less or more than 8 years-old trucks.

The truck operators usually have a thin profit margin, as reflected in the spreading of over dimension overload (ODOL) issues. A lot of trucks are restructured or have an open-box body to be able to carry payload beyond the maximum capacity in order to make a profit. The World Bank survey revealed that reliability of logistics services is a top priority for these companies, followed by timeliness, then cost. However, in practice, shippers still request the lowest price, as confirmed by interview with APTRINDO.

Considering the overall business situation, the weaker negotiation power of truck operators, the price-driven bidding, and high competitiveness of the service providers lead to a thin profit margin for truck operators. Based on the evaluation of **the negotiation power on service supplier and customer side**, fleet operators with older trucks— more likely to be smaller fleet operators —have even lower negotiation power than operators with newer trucks, thus has a thinner profit margin.

2.5 Initiatives related truck modernization

There are few projects and collaborations that are directly related to truck modernization (Table 3), but some of those indirectly support the development and implementation of the actions, including sustainable transportation planning, logistic business reform, infrastructure construction, over-dimension-over-loading (ODOL) management.

In 2015, the ASEAN Secretariat issued a Kuala Lumpur Transport Strategic Plan (KLTSP) (**ASEAN Transport Strategic Plan**) that identified strategic actions to be implemented in the period 2016 to 2025 (ASEAN 2015). The plan set specific goals, actions, and milestones for land transport, sustainable transport, and transport facilitation among other transport sectors. It set milestones for developing a regional framework towards green and efficient freight and logistics in order to support ASEAN Member States in implementing respective policies.

In 2019, the ASEAN Secretariat, with support of Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ), issued **ASEAN regional strategy on sustainable land transport** (ASEAN, 2019). The strategy aims to support implementations of the elements in KLTSP regarding to sustainable transport regional strategy, green freight and logistics strategy, fuel economy, and sustainable transport indicator. This Strategy detailed a vision for a sustainable land transport system in ASEAN.

In 2016, based on the studies (World Bank, 2013; World Bank, 2015a), the International Bank for Reconstruction and World Bank provided **a loan for Indonesia to reform logistic development policy**.

⁹ Information collected through interview with APTRINDO.

The main target of the project is to reduce the costs and improve the reliability of the logistic chain in Indonesia. One of the reform areas is improving logistics services, which is enabling a competitive business environment for logistics service providers by increasing competition in: (i) freight forwarding services, storage and distribution services; (ii) auxiliary shipping services; and (iii) reducing inventory costs of imported materials for producers.

In 2018, the World Bank launched a **second logistics reform development policy loan** project. This second phase targets at (i) enhancing ports' performance; (ii) improving logistics services; and (iii) strengthening trade processing.

The Trans-Java Toll Road initiative from 2011 to 2019 proposed a modern, efficient and economically sustainable highway running from East to West Java and connecting major cities. These roads were to be funded by build-operate-transfer schemes and public-private partnerships (PPPs), with investment coming from both domestically and internationally (Sullings, 2019). In early 2019, the Road was officially declared open. For trucking sectors, the construction of toll road will directly save truck travel time, promote mobility, improve operation efficiency, and reduce truck operation cost.

In addition, there are a **series of analyses by different international agencies** to facilitate the development of logistics services in Indonesia, including the status update of logistics performance in Indonesia (World Bank, 2013; World Bank, 2015b), an analysis on trade in logistics services (Bennis & Tuijll, 2016), and international trade fairs like Intertraffic Indonesia to exchange experience on smart mobility (Allen, 2018).

Table 3: Initiatives related to truck modernization in Indonesia

| Programme / Project | Objective | Supporting international agencies | Relevance for truck modernization | Budget |
|--|---|---|---|---------------|
| Kuala Lumpur Transport Strategic Plan (KLITSP) | Guide ASEAN transport cooperation and integration 2016 to 2025 | ASEAN | <ul style="list-style-type: none"> Set specific goals, actions, and milestones for land transport, sustainable transport, and transport facilitation Set milestones for developing a regional framework towards green and efficient freight and logistics in order to support ASEAN Member States in implementing respective policies | NA |
| ASEAN regional strategy on sustainable land transport | Put the region on the path of sustainable transport development | ASEAN | <ul style="list-style-type: none"> Recommend regional actions on green freight and logistics, including setting national action plans, logistics optimization, greening of trucks (including development of standards and policies to promote fuel efficiency measures for trucks) | NA |
| First Indonesia logistics reform development policy loan | Reduce logistic costs | International Bank for Reconstruction/ World Bank | <ul style="list-style-type: none"> Logistic reforms help reduce operation cost of truck operators Facilitate coordination of several ministries and agencies to address powerful domestic vested interests | \$400 million |
| Second logistics reform | Reduce logistic costs; improve | World Bank | <ul style="list-style-type: none"> Enhance ports' performance Improve logistics services | \$300 million |

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|----------------------------|--------------------------------|---|--|---|
| development policy loan | logistics chain reliability | | <ul style="list-style-type: none"> Strengthen trade processing | |
| ‘Trans-Java Toll Road’ | Toll road construction | Japan International Cooperation Agency | <ul style="list-style-type: none"> Provide infrastructure support by establishing modern, efficient, and economically sustainable highway running from east to west Java and connecting major cities. With toll road constructed, it will save truck travel time, promote mobility, improve operation efficiency, and reduce truck operation cost. | Funded by build-operate-transfer schemes and PPPs, with other investment. |

3. Barriers to decarbonizing truck fleet in Indonesia

Currently, several barriers inhibit decarbonizing truck fleet in Indonesia. Four main barriers will delay a truck modernization transition in Indonesia (Figure 13). These include the absence of strategic policy guidelines; expensive and inefficient business practices; weak compliance and enforcement programs; and absence of cross sector coordination.



Figure 13: Four major barriers

3.1 Absence of strategic policy guidelines

Indonesia currently does not have an integrated policy target and roadmap that drive nation-wide truck modernization efforts. Without such policy roadmap, there is a lack of guidance to the public and private sectors to support transition to cleaner and efficiency truck technologies, including policy making of various government departments, industry investment, public infrastructure planning, and governance capacity building.

For vehicle (especially heavy-duty vehicle, including trucks) and fuel standards that are important to ensure that the scrapped vehicles are replaced by the trucks with most advanced technologies, **there is no clear roadmap to direct Indonesia toward a world-class standards for both vehicle and fuel.** Indonesia has set emission standards of trucks, but the standards is weak compared with world-leading markets. The implementation of Euro IV emission standards by 2021 is more than 16 years lag behind of European countries, 15 years lag behind Singapore, 11 years lag behind China, and 3 years lag of Vietnam. There is no plan for fuel efficiency standards for this sector. Therefore, there is a lack of incentive to the technology innovation. Meanwhile, poor fuel quality in Indonesia could also prevent advancement of technologies. There is no clear plan to widely introduce ultra-low-sulfur fuel to support vehicles that Euro IV or future stricter emission standards.

The implementation of truck modernization scheme needs **strong collaboration** between agencies. Efficient implementation can be challenging without top-down guideline. For example, although MOT will be the leading agency that drive this transition, MOT needs to collaborate with the traffic corps on in-use fleet management, with MOF on vehicle purchase and operation subsidy, with BPJT on toll design and management. With so many stakeholders that will be involved in this transition, a centralized guidance will clarify the responsibilities of different agencies and smooth collaboration across agencies.

3.2 Expensive and inefficient business practices

The upfront cost of purchasing clean and efficient new trucks can be high. The purchase cost consists of truck price, VAT and import tax. For small operators that cannot afford paying full price of the trucks because of the thin profit margin of existing business, they usually lease the trucks from the leasing companies with a considerable interest rate range from 7% to 19% a year (Meeuws, 2014; Purba, 2020).

The operational cost of trucks in Indonesia is relatively high for a variety of reasons. Based on estimation from different literatures (Figure 12), fuel cost account for one third of total cost of operation. High fuel consumption can be the result of outdated technology of the old trucks and poor maintenance,

it is also caused by fuel siphoning and theft, poor driving behavior, and long idling time during break and at night.

Maintenance cost will significantly increase as vehicle ages. On average, maintenance cost account for 21% of total truck operation cost. For a heavy-duty truck with a relative high level of durability, the annual maintenance cost will be 3.3 times for 10-year old truck compared with a 1-year old truck¹⁰. This assumes that main components (engine, gearbox etc.) are overhauled when the truck reaches 7 year. For around 65% of trucks that are older than 10 years in Indonesia, the maintenance cost will keep increasing after the truck gets over 10 years.

The ODOL issue and poor road quality will further add the maintenance cost to the truck owners and operators. Legal and illegal charge also contribute to an unneglectable portion of the operation cost, which include user charge required by local government, penalty and bribery paid for overweight, and payment to local police as well as to mafias.

There is a **lack of professional truck drivers** in Indonesia. The difference in good and bad driving behavior can contribute to 5-20% of fuel consumption of trucks (Gonder et al., 2012). In 2019, MOT issued certification standards for land transportation drivers, but the enforcement of the standards is not strict enough to ensure consistent eco-driving behaviors. For small truck operators that don't install the Global Positioning System (GPS) for tracking truck activities, the drivers may detour from the main street to get side job along the route. This usually cause higher fuel consumption and low efficiency of the trip. Because the fuel cost is included in the lumpsum paid to the truck drivers, the increased fuel cost will either increase the lump sum that need to be paid to the drivers or reduce the profit margin of truck drivers.

The truck productivity in Indonesia is low compared with other key economies. As stated in Section 2.1.2, the annual mileage of trucks in Indonesia is lower than those in the US and EU. There are several reasons for the inefficient operation. Most trucks are still going through local road rather than the toll road; thus, the average truck speed is 40 km/h in Indonesia (GIZ, 2019). By choosing local road, the travelling time of one trip can increase by 50% to 200% (Meeuws, 2014).

The poor road condition of local road also increases fuel consumption and adds maintenance cost to the trucks. The limitation of port design lead to traffic jam at port and significantly extend trucks' waiting time for loading and unloading at the port. The lack of systematic logistic arrangement and low usage of information platform cause high percentage of trip travelling without cargo, which significantly reduce the efficiency of trucking therefore reduce the revenue from providing the transporting service.

3.3 Weak compliance and enforcement program

Compliance and enforcement are key for effective implementation of regulations. Otherwise, any policy will be just "paperwork". A variety of regulations are in place to manage in-use trucks in Indonesia, but the existing verification programs are not sufficiently restrictive and there are significant difficulties for monitoring. For example, the KEUR testing has been required for commercial vehicles for two times a year for 300,000 IDR (USD 21.3) of testing each time. In fact, to save the time for testing and save the trouble to fix the vehicle in case there is problem, it is well-known that the vehicle owner can pay a higher amount money to pass the KEUR without bringing the truck to the testing centers.

In 2019, MOT started to **strengthen the inspection of testing facilities, taking over the authority from local government, and has shut down a number of unqualified inspection centers.** MOT has also set on-road checking and testing, but the testing capacity is limited.

The truck population from statistical agencies and MOT show truck population of 7.3 million and 6.5 million, respectively, whereas the Traffic Corp shows registered trucks as 4.6 million. **The difference in statistics** implies that some trucks are not regularly inspected and registered as required. There is great amount of trucks that are not registered for their utilization on the road. It is also an indication that the retirement of trucks is not properly tracked. Same weak compliance issue is also reflected in the

¹⁰ Estimation based on conversation with industry stakeholder.

management of ODOL. Although there are regulations to restrict ODOL, ODOL issues still widely exist on road in recent years.

These compliance issue partly due to the weak monitoring system and the lack of top-down management mechanism that oversees the implementation at local level. It also partly due the low noncompliance cost to vehicle owners or operators who violate these regulations. The penalty of getting caught for noncompliance or cheat is very low compared with the revenue made from commercial activities. **The inability to penalize noncompliance creates an unfair competitive disadvantage for truck operators who comply with the regulations.**

A weak compliance and enforcement system not only influences the effectiveness of existing programs, but also influence additional actions to support truck modernization, including establishing a solid truck registration and monitoring system to identify old and high-emitting trucks, monitoring scrappage of old trucks, establishing low emission zones, and certifying professional drivers.

3.4 Absence of cross sector coordination

Logistic business runs across multiple sectors. As Figure 14 shows, trucking closely connects with port of entrance and exit, the manufacturer factories where is the origin of the products, and the warehouse, and customers. Also **trucking account for more than 70-90% of the logistic transportation volume in Indonesia** (Sudjana, 2011; Parikesit, 2020), **there is a lack of coordination between trucking and logistic business.**

First, **the trucking market is fragmented.** There are many small trucking companies that contain less than 5 trucks., yet specific data is not available. The smaller truck companies are challenging to unified and manage. There is no existing policy that enables the unification of small truck companies.

Second, **the trucking business interacts with road infrastructures, port, and railway transportation, however, there is little policy initiative towards multimodal integration.** The toll road is expanding rapidly in Indonesia. Even though, according to evaluation of BPJT¹¹, the toll road will only support 20% of trucking transportation. There is no additional plan to improve the road condition for the rest 80% of the trucking activities. In addition, the toll road charging formula is based on vehicle axle number and doesn't factor in environmental criteria.

A lot of congestion is at the port due to long load and unloading time. Current practices require cargo to be loaded and uploaded twice in the transition, which double the time and lower efficiency. There is no action that intends to improve the efficiency at the port. Same issue will apply to the transloading at railway station between trucks and trains.

¹¹ Information collected through interview.

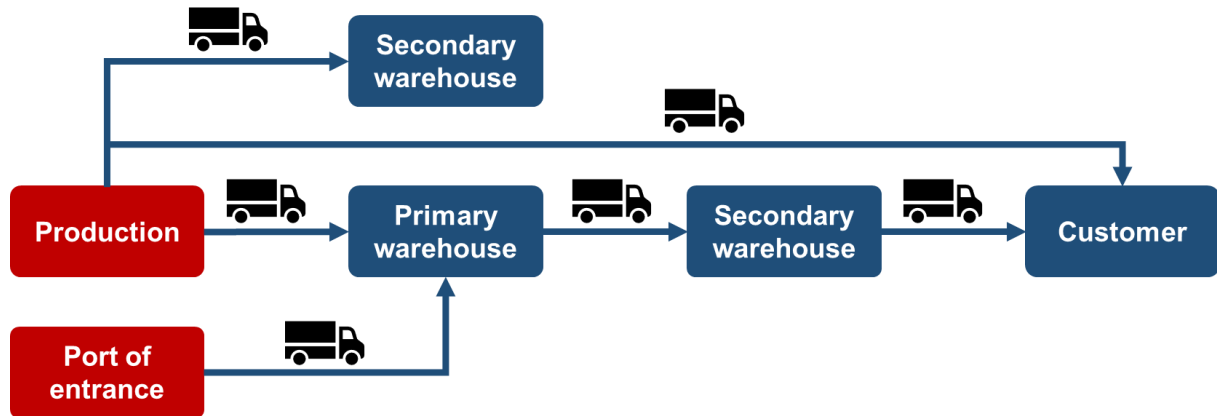


Figure 14: Illustration of logistic flow related to trucking companies

Third, there is a **lack of usage of information platform to optimize logistic flow for trucking**. Nearly half of trucking activities are back to the origins without any cargo. This issue to some extent reduces business efficiency and increases operation cost. There is existing business like Ritase that provides a free platform for logistic shippers and transporters (Ritase, 2020). Moreover, there are more start-ups in the field of logistics to that invest in infrastructure, reliable IT, and communication networks (Mulia, 2019). Nevertheless, there are challenges like increasing users and educating the individual truck drivers for using the digital app on smartphones.

4. The Mitigation Action

4.1 Objective and concept

This Mitigation Action Plan on truck modernization in Indonesia outlines a governmental program designed to mitigate GHG emissions in the freight sector through the deployment of an environmentally friendly truck fleet. **The objective of the scheme is to get truck owners to modernize their fleets, replacing the dirtiest and least efficient vehicles** with new trucks carrying the latest generation of engine efficiency and emission control technologies. The main indicator of achieving this goal is the replacement rate of older and gross emitting trucks with newer, more efficient, and environmentally friendly trucks.

This action plan adopts the best practices of vehicle replacement programs worldwide as guidelines and adapts to the local context in Indonesia. **The mitigation strategy is based on a combination of mandatory policies, management improvement, and financial support.** Ultimately, the mitigation action programme aims to achieve that the majority of the aged and dirtiest trucks across Indonesia are scrapped and replaced with clean trucks that are operated in the most efficient way. The truck modernization action plan comprises three direct mitigation measures and four sets of supporting measures.

Table 4 provides an overview of the mitigation action and Figure 15 maps out all action plans for truck modernization scheme, including direct measure and supportive measures.

Table 4: The Mitigation Action Plan at a glance

| | | | |
|---|---|-----------------------------------|--|
| Contribution to NDC implementation | Reduce GHG emissions from transportation sector from 2020 to 2030 and beyond. | | |
| Type of action | Policy / regulation / fiscal instrument | Subsector | Truck |
| Geographical scope | Full country | Type of policy instruments | <u>Regulations</u> : yes <u>Economic instruments</u> : yes <u>Public spending/ investments</u> : no <u>Communication and information</u> : no |
| Organization | <u>Responsible organization</u> : Ministry of Transport <u>Involved national partners</u> : Ministry of Environment and Forestry; Ministry of Energy and Mineral Resources; National Planning Agency <u>Involved international organizations</u> : GIZ | | |
| Main mitigation measures | (1) Scrappage of high-emitting trucks <ul style="list-style-type: none"> ➤ Set a scrappage schedule and corresponding management mechanism ➤ Provide fiscal support to incentivize early scrappage ➤ Establish scrappage implementation mechanism (2) Accelerate the transition to cleaner and efficient trucks <ul style="list-style-type: none"> ➤ Introduce fuel efficiency standards to accelerate the uptake of advanced technologies ➤ Accelerate adoption of Euro VI fuel and engine standards ➤ Provide incentives for clean truck purchase and operation (3) Track, monitor, and reduce emissions of in-use trucks <ul style="list-style-type: none"> ➤ Reduce fuel consumption and emissions from in-use fleet | | |

| | |
|---|---|
| | <ul style="list-style-type: none"> ➤ Build a system to identify noncompliant trucks ➤ Set pilot projects on low emission zone and local benefit to renewed trucks |
| GHG mitigation effect and other benefits | <p><u>GHG mitigation:</u> 1.6 to 2.3 MtCO_{2e} between 2020 and 2030; average annual mitigation 0.16 to 2.3 MtCO_{2e}</p> <p><u>Other benefits:</u> 14 to 47 kilotons black carbon emission reduction between 2020 to 2030.</p> |
| Feasibility | <p><u>Financial feasibility:</u> Section 5.2 provides information on micro-economic feasibility and details required incentives</p> <p><u>Economic feasibility:</u> Section 5.3 estimates economic benefits, costs and benefits, etc.</p> |
| Type of required support | <p><u>Technical support:</u> Analysis of the Indonesian truck fleet characteristics, establishment of the dedicated fund, cost analysis of trucks to design financial support mechanism; set up of the green freight program; social impact analysis of the truck modernization program.</p> <p><u>Financial support:</u> Fiscal incentives to reduce the cost of replacing scrapped trucks with new, more advanced trucks.</p> |

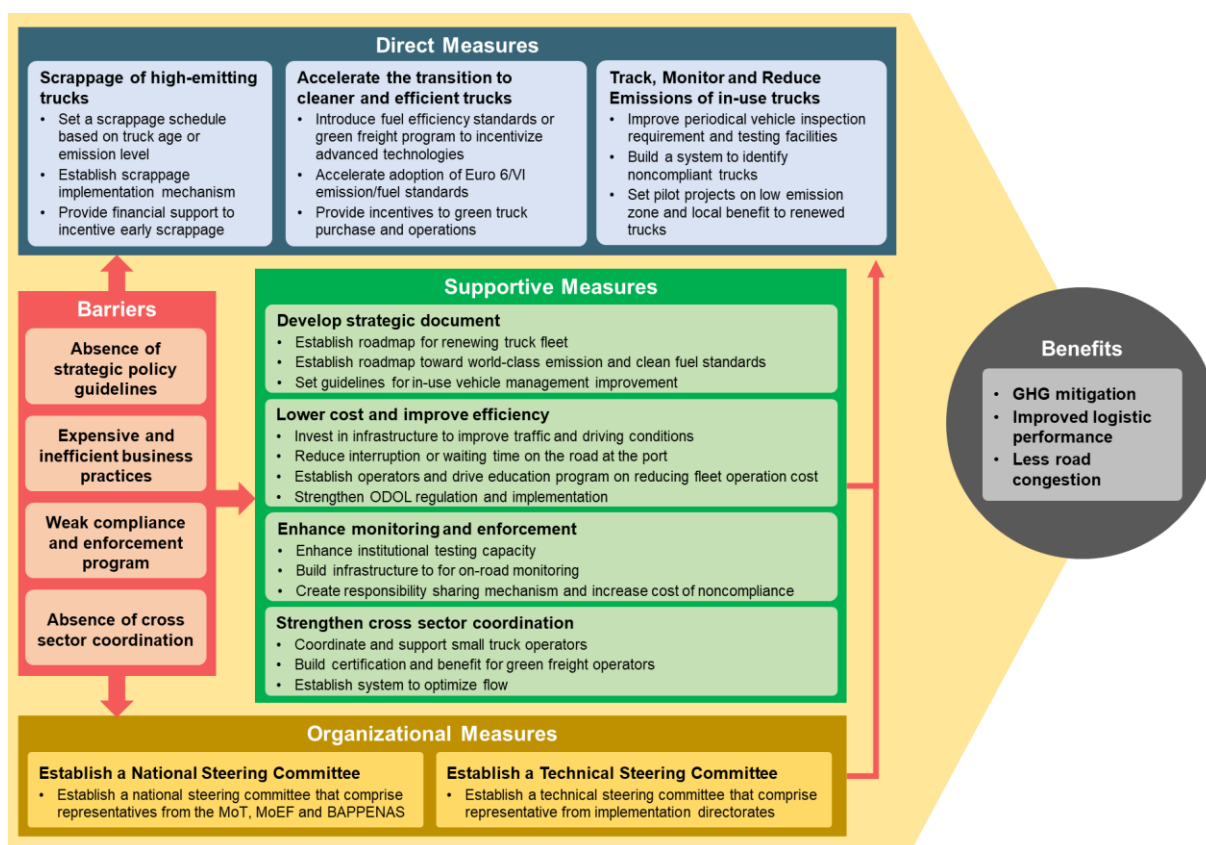


Figure 15: Overview of truck modernization mitigation action plan

4.2 Scope

This action plan covers all trucks with gross vehicle weight higher than 3.5 tons. The trucks fleet include trucks that use both petroleum fuel and alternative fuel, including gasoline, diesel, natural gas, biodiesel, electricity, and other alternative fuels.

The action plan aims **to reduce climate impact of truck fleet, including reducing GHG and black carbon emissions**. It also has significant side benefit on reducing criteria pollutant emissions, such as nitrogen oxide (NO_x), particulate matter (PM), carbon monoxide (CO), and hydrocarbon (HC). The plan in general will advance technologies that can improve vehicle fuel efficiency and reduce black carbon emission of trucks.

The timeframe of this action plan is **from 2020 to 2030**. Noted that the impact of the action plan will be larger in the long term. The action plan applies to nation-level deployment, but there are possibilities to have pilot projects of some actions at local level.

To maximize the effectiveness of this action plan, **the listed actions**, especially supporting actions, **go beyond truck management**. The plan includes actions related to road transport and traffic management, infrastructure construction, and logistics management.

4.3 GHG mitigation actions (direct mitigation measures)

This action plan proposes **three direct mitigation** measures that focus on:

- scrapping high-emitting and less efficient trucks,
- accelerating the transition to cleaner and efficient trucks, and
- enhancing in-use truck management respectively.

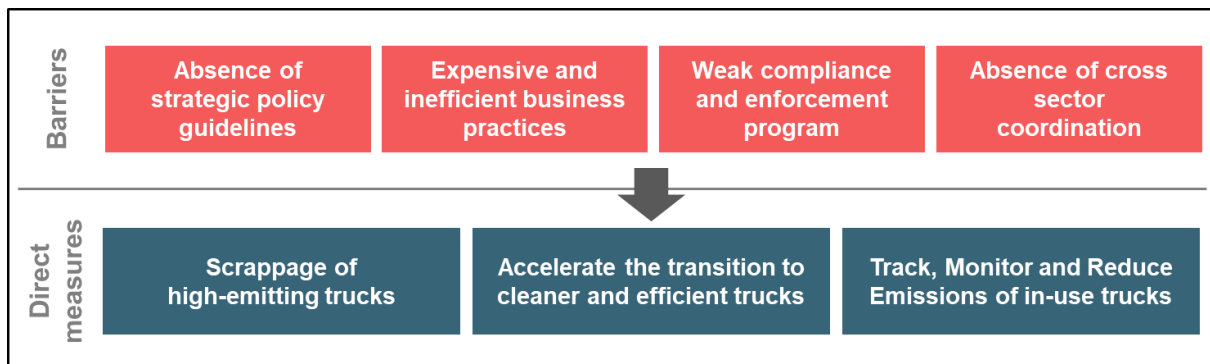


Figure 16: Overview of direct mitigation measures

All three measures should proceed in parallel (Figure 16). Each measure category includes a series of sub-actions with recommendations of steps to carry out the action and suggests one or more responsible agencies that will lead the activities.

4.3.1 Scrap high-emitting trucks

There are some set of recommendation actions that can be taken to support the truck scrapping:

Set a scrappage schedule and corresponding management mechanism.

This should be done in coordination between Ministry of Transportation; Ministry of Environment and Forestry, Ministry of Energy and Mineral Resources; National Planning Agency; Ministry of Industry. For doing so, there are some sub-actions need to be done as follow:

- Conduct comprehensive overview of **existing truck fleet characteristics** and define criteria of old and high-emitting trucks according to their age (e.g. trucks that are older than 20 years) and/or certified emission standard (e.g. trucks that are certified under pre-Euro and Euro I emission standards). Improve the existing in-use vehicle registration and recording system in collaboration with Traffic corps at national and local level to track implementation of the scrappage schedule.

- b. Establish a **voluntary scrappage schedule** of high-emitting trucks with regulatory backstops. Regulatory backstops are mandatory scrappage requirements which take effect after a set time period of voluntary program.
- c. Define **criteria of operators** that are subjective to the scrappage program, with special consideration of the compliance capacity of large group of small operators and individual truck owners. Set adjusted scrappage schedule, waivers, and exceptions of scrappage objectives based on Indonesia context.
- d. Conduct **social-economic analysis** of the scrappage program, identify additional support needed to facilitate the program, and secure buy-in from related government agencies and key stakeholders.

Provide fiscal support to incentivize early scrappage.

Coordination among Ministry of Transportation; Ministry of Finance; Ministry of Home Affairs is needed for this measure. Some sub-actions:

- a. Create a **dedicated fund to facilitate the early scrappage** of old trucks and financing of the clean truck purchases. The fund will enable fiscal support, together with other non-fiscal complementary policies, to complement the current market value of the vehicles to be scrapped and higher cost of clean trucks.
- b. Conduct in-depth analysis the **total cost of truck** scrappages and replacement by truck type to determine the level of financial support needed. Design fiscal incentives to compensate the cost, especially take account of the more challenging financial situation of small operators and individual truck owners.
- c. Define **eligibility criteria for trucks to receive fiscal incentive**. Ensure the fiscal incentives to go to trucks that are still in regular operation and are not already abandoned. Verify usage profiles of the truck before providing subsidies, for example, by checking insurance, registration, KEUR and odometer records.
- d. **Reform in-use vehicle tax system** to increase the tax rate of in-use vehicles proportionally as vehicle age increase, especially after 15 years. This will incentivize scrappage of old truck without influencing the tax revenue stream.

Establish scrappage implementation mechanism.

This shall be coordinate between Ministry of Transportation and Traffic Corps. Sub-actions are:

- a. Establish a **mechanism or procedure to identify high-emitting trucks** based on the set criteria. Such mechanism can be built upon on existing KEUR testing and registration process.
- b. Set requirement and procedure to **certify scrappage facilities** to dismantle increasing number of scrapped vehicles. Set the third party to verify that the destruction facilities are scrapping these vehicles according to government-specified standards. Assign legal responsibility to dismantling facilities to ensure that the engines and parts are destroyed properly, with all hazardous materials removed and disposed in an environmentally friendly manner.
- c. **Increase vehicle scrappage capacity** to support increasing demand of scrappage service as results of truck modernization program.

Table 10 shows the assumed numbers of scrapped trucks that will receive public financial support under moderate and world-class scenarios. The actual financial support to be delivered will depend on political leadership. More information is within Chapter 5.

4.3.2 Accelerate the transition to cleaner and efficient trucks

For accelerating the transition to cleaner and efficient trucks, there are some recommended actions that can be done:

Introduce fuel efficiency standards to accelerate the uptake of advanced technologies.

This shall be done in coordination between Ministry of Energy and Mineral Resources and Ministry of Environment and Forestry, with sub-action below:

- a. Establish a **technical committee for developing fuel efficiency standards for new trucks** sold in Indonesia. The technical committee will coordinate technical assessment, standard making, and stakeholder consultation regarding to fuel efficiency standards.
- b. Conduct **comprehensive analyses to support fuel efficiency standard making**, including evaluating the fleet characteristics and fuel efficiency level of new trucks sold to the market, analyzing efficiency technology baseline of the existing fleet, estimating technology improvement feasibility and cost, and analyzing payback and social impact of technology improvement.
- c. Build up on the technical analyses, **develop fuel efficiency standards** for trucks incorporating experience learnt from global best practices, estimate regulatory impact, and finalize the standards after consultation with key stakeholders.
- d. **Ban the import of second-hand** trucks, trailers, and other key truck parts older than five years
 - Establish compliance and enforcement mechanism for the implementation of the fuel efficiency standards and clearly appoint a responsible agency to track the compliance of fuel efficiency standard.

Accelerate adoption of Euro VI emission and clean fuel standards

Ministry of Environment and Forestry, and Ministry of Energy and Mineral Resources shall take the lead on this, with below recommended activities:

- a. **Determine the roadmap to adopt Euro VI emission standards**, which will significantly reduce particulate matters (including black carbon) and NO_x emission of truck by 90% and 88%, respectively, compared with Euro IV trucks.
- b. **Develop Euro VI emission standards** based on global best practices to ensure on-road emission reduction and evaluate the cost and benefit of the standard in the Indonesia context.
- c. Allow **local government to early adopt Euro VI standards** for trucks registered locally.
- d. **Ensure supply of ultra-low-sulfur fuel** (e.g. gasoline and diesel with sulfur content lower than 10 parts per million “ppm”) and alternative fuel (e.g. natural gas) to ensure clean fuel are supplied to cleaner trucks with advanced technologies.

Provide incentives to clean truck purchase and operation.

Collaboration among Ministry of Transport, Ministry of Finance, Local department of transportation, and BPJT shall be taken. Some recommendation actions are:

- a. **Reform toll road charge** design to require lower charge for cleaner and efficient trucks and higher charge to older and dirtier trucks.
- b. Encourage other **non-fiscal incentives to cleaner and efficient trucks**, for example: reduce KEUR test frequency, simplify loan application requirement and process from banks, encourage local government to provide local permit and license benefit.
- c. **Reform taxation of fuel** to subsidize fuels that support operation of cleaner trucks, such as ultra-low-sulfur fuels and natural gas.
- d. Provide clear **cost and benefit analysis to inform operators and business owners** and prove financial feasibility of truck modernization, taking consider of all fiscal and non-fiscal incentives for truck renewal.

4.3.3 Track, monitor, and reduce emissions from in-use trucks

To monitor and enforce the programme, the Ministry of Transportation and Local department of Transportation shall coordinate to implement this action. There is some recommended action below:

Improve periodical vehicle inspection requirement and testing facilities

- a. **Strengthen KEUR testing standards** and upgrade in-use vehicle emission testing facilities to accommodate the increasing share of trucks with advanced technologies.

- b. **Strengthen certification and inspection of KEUR testing institutes**, require testing institutes to submit testing data to regulatory agency, and establish online monitoring system for constant testing data reporting.
- c. Enhance the **monitoring and enforcement of KEUR testing** to ensure capture of noncompliant in-use trucks and enforce repairment.

Build a system to identify noncompliant trucks

- a. **Establish high emitter screening program** with a combination of regular KEUR testing and selective road test. Require trucks that are older than 20 to conduct more frequent KEUR tests. Any vehicle that fail three consecutive KEUR tests after repairs have been performed should be scrapped, and the vehicle owners should be compensated.
- b. Provide a **5-year waiver on KEUR test** for trucks that meet the world-class Euro VI emission standards, therefore reduce the test and cost burden for cleaner trucks.
- c. Establish **vehicle labeling system** to link to the vehicle registration information and distinguish cleaner and newer vehicles from dirtier and older ones. The label will **link to the vehicle information**, including certified emission level, efficiency, and/or age. Color coded labels will be considered to provide a simple signal to vehicle owners, inspectors, and traffic officials how high a vehicle's emissions are, and whether the vehicle is eligible for scrappage subsidies and/or liable for any local charge. The labels can also be used to enforce driving restrictions at the city or regional levels, and to check compliance with the KEUR requirements.

Set pilot projects for local in-use vehicle management

- a. Encourage **local government to set low emission zones** that restrict or forbid the old and dirty trucks from driving through the local jurisdiction. Provide guidance to set the criteria of old and dirty trucks based on local context and policy targets and the implementation of such projects based on global best practices.
- b. Guide **local government** to build facilities and mechanism **to monitor and enforce regulations on truck fleet**, for example, installing cameras to capture, read, and analysis vehicle plate and related registration and KEUR testing information and training officers to monitor the data, identify noncompliant vehicles, and impose penalty.

4.4 Supportive actions (framework conditions, capacity development)

To ensure that the implementation of the direct GHG mitigation measures works and to overcome the barriers outlined in chapter 3 that have not been addressed by the direct measures, several adjustments to the political, legal and regulatory framework are needed to strengthen following areas: regulatory framework, fiscal policy, compliance and enforcement capacity, and business integration. Figure 17 gives an overview of the planned **supportive actions** and the following text outlines the measures in more detail. Each measure suggests one or more responsible agencies that will lead the activities.

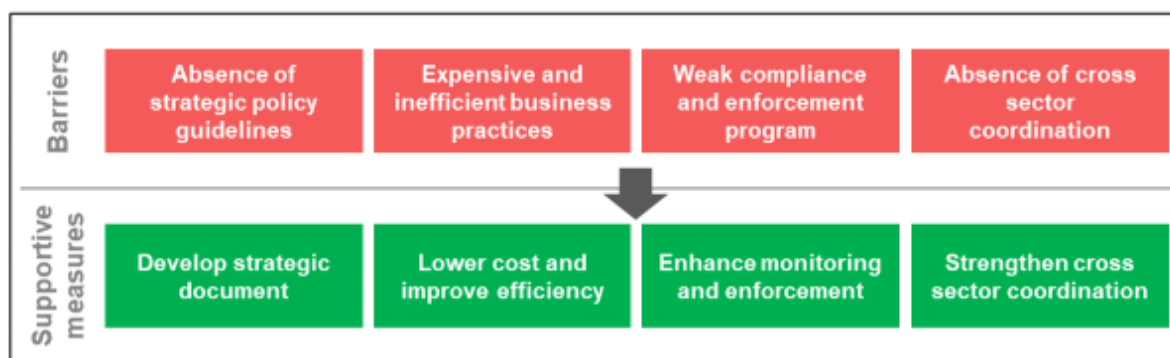


Figure 17: Overview of supportive mitigation measures

4.4.1 Develop strategic document

Establish roadmap for truck fleet modernization

(National Planning Agency; Ministry of Transportation; Ministry of Environment and Forestry, Ministry of Energy and Mineral Resources; Ministry of Industry)

The roadmap aims **to set targets and timeline of truck fleet modernization program**, including the targeted **trucks to be scrapped**, the **estimated percentage of targeted trucks that the program aims to scrap**, and the **key agencies that are responsible** for policy design and implementation. The roadmap should layout the supporting policies to maximize the effect of truck modernization and identify the responsible agencies to lead each of the actions, such as financial support, standard setting, in-use vehicle management, improvement of truck driver license requirement, infrastructure construction, logistic integration and optimization. Furthermore, the roadmap must be closely aligned with the fight against ODOL trucks and it must be sensitive to the socio-economic situation of the many small-scale road transport operators.

Establish roadmap toward world-class vehicle and clean fuel standards

(Ministry of Environment and Forestry, Ministry of Energy and Mineral Resources; National Planning Agency)

Set a **pragmatic policy roadmap with a clear timeline for tightening fuel efficiency and emissions standards for trucks or heavy-duty vehicles in general and fuels in Indonesia**. Currently there is no fuel efficiency standards for heavy-duty vehicles, including trucks. The existing emission policies will require heavy-duty diesel vehicles to meet Euro IV emission standards from 2021 and require supply of 50ppm. The roadmap should indicate the timing to adopt Euro V and Euro VI, or leapfrog to Euro VI emission standards and suggest timing for advanced local government to early adopt the stricter emission standards. The fuel standards should align with the progress of vehicle emission standards.

Set guidelines for in-use vehicle management improvement

(Ministry of Transportation)

Provide **strategic guidelines to improve in-use vehicle management mechanism nationwide**. Identify the responsible agencies and the timeline to strengthen KEUR standards and enhance testing capacity. Set targets and guidelines for expanding vehicle scrappage capacity. Clarify the responsibility of local government in managing in-use vehicle fleet, especially in-use commercial vehicle fleet.

4.4.2 Lower the cost and improve efficiency of trucking business

Invest in infrastructure to improve traffic and driving conditions

(Ministry of Transportation; BPJT)

Complete promised \$70 billion investment in 5,400 km toll road construction by 2024. Meanwhile, identify and pave heavily worn non-toll roads that cause low speed of traffic and vehicle deterioration. This may reduce fuel consumption while reduce overall vehicle repair and maintenance costs of trucks.

Reduce interruption or waiting time on the road or at the port

(Ministry of Transportation)

Reduce stops and stopping time at toll and inspection stations. Strengthen national regulations and management to guide the work of traffic police and prevent interruption from mafia. Mandate installation of GPS to track truck operation and monitor driver behaviors.

Reduce truck dwelling time at the port for loading and unloading. Prevalent approaches include increasing port capacity through port construction at new berths, improving loading and unloading process, and improving navigability and handling equipment quality of the ports to reduce loading and unloading time at the port.

Establish operators and driver education program on reducing fleet operation cost

(Ministry of Transportation)

Design **driving training courses to teach truck drivers to drive efficiently and safely** in collaboration with training service providers and integrate this as a mandatory element into the truck driver certification training system. Require certified drivers to take driving class periodically and review drivers' qualification through periodical drive license renewal. Drivers should also be restricted to idle climate-controlled trucks overnight to sleep. Telematic equipment can be used to track driver performance over time. Anti-idling devices as well as related campaigns by local authorities can help in promoting behavior change.

Provide **education to truck operators**, especially small truck operators, on the management of truck fleet operation and the cost and benefit of renewing old and inefficient trucks. The trained skills will include, but not limited to, accounting, which is to understand the allocation of fleet costs, including both expenses and capital expenditures; finance, including the basics behind the lease and purchase decision, the money flows in a corporate environment, interest rates, and taxes; law and government, which is to understand the impact of local, state, and federal legislation on a truck fleet operation and how government works. The education will help truck operators to better understand their business and the benefit of modernizing their trucks or truck fleets and make rational decisions in response to government regulations and incentives.

Strengthen ODOL regulation and implementation

(Ministry of Transportation)

Ensure to completely address ODOL issues by the end of 2023 as planned and **create sharing penalty system between shippers and truck operators in case of noncompliance**. Truck specification requirement in the truck type approval regulation should be reevaluated and strengthened to close potential policy loopholes in truck designing and production. The existing of ODOL causes an unlevelled field for trucking companies and increase maintenance cost to truck operators and roads. **By addressing ODOL issue, trucks will operate at their optimal designed condition, therefore have better efficiency, higher speed, and slower deterioration. In addition, stricter enforcement of ODOL can accelerate the replacement rate of truck fleets.**

4.4.3 Enhance monitoring and enforcement

Enhance institutional testing and repairment capacity

(Ministry of Transportation; Local department of transportation)

Conduct a **survey on capacities of in-use vehicle testing institutions and identify the need for improvement**. Establish robust in-use vehicle testing system is critical to a comprehensive in-use compliance program to ensure that vehicles continue to meet the emission limits to which they are certified throughout their useful lives. The adoption of new measurement techniques and testing methods are needed to accommodate the cleanest fleets and as well as additional pollutants and more accurately capture the high emitters.

Improve the capacity of the service sector to provide adequate maintenance and repairs for vehicles that fail KEUR tests should be another focus of capacity building. The vehicle service enterprises that would most likely attend to the older, more problematic vehicles are usually small or family-owned repair shops. These small shops may lack the requisite training for diagnosis and repair of specific emission control

technologies. Thus, KEUR programs should encompass measures that offer assistance to the service sector for the proper electronic and mechanical evaluation of vehicles, including access to training, tools, and repair manuals.

Introduce complementary testing methods to assist monitoring

(Ministry of Transportation; Local department of transportation)

KEUR test should be ideally combined with complementary measures, such as **spot-checking, remote sensing, and public spotter program**, to help governments concentrate resources on monitoring and improving the vehicle types with highest noncompliance ratios and prescreen for vehicles that may subject to be scrapped. Remote sensing program tests on-road vehicle emission levels during normal street operations. Spot-checking programs create checkpoints for conducting emission tests along the roadside or in parking lots. Public spotter programs encourage and empowers citizens to voluntarily report the license plate numbers of smoky vehicles and aim to eliminate vehicles emitting visible smoke from their tailpipes.

Increase cost of noncompliance and create responsibility sharing mechanism

(Ministry of Transportation; Traffic Corps)

Compliance program can only be effective with strong penalties for non-compliance. Especially for commercial vehicles, the existing noncompliance penalty for ODOL and KEUR test is significantly lower than the profits from transporting, thus the penalty is considered as a cost of business. **Setting serious noncompliance penalty for violating regulations related to truck modernization program**, such as high amount of fine, retain truck or commercial license, deny of re-registration, will empower the regulators to effectively implement the regulations.

Considering that the smaller truck operators are often under higher pressure to compete for the business, therefore as forced to violate the regulation to be in the business, legal sanctions should be created for both shipper and truck operators in case of noncompliance. **Shippers shall be partially responsible to ensure the truck operators they contract with to comply with regulation**, including meeting loading requirement and owning business and driver certifications. Therefore, in case of noncompliance, both shippers and truck operators are sanctioned with heavy penalties or even criminal charge.

4.4.4 Strengthen cross sector coordination

Coordinate and support small truck operators

(Ministry of Transportation)

Incentivize unification of small trucking operators. Indonesia has many small operators in trucking business, the smaller operators are typically poorly capitalized and will have difficulties in investing in new trucks after paying off the cost of their unit beyond essential maintenance. The policies can incentivize grouping of small trucking business, for example, set procedures to facilitate forming of trucking company groups, provide significant loan benefits to the eligible groups in leasing and purchasing new trucks after scrapping older trucks, set additional funding to subsidize truck scrapping of eligible trucking groups, and provide education program to improve the competitiveness of small operators in the road transportation business.

Build green certification program

(Ministry of Transportation)

Develop a green freight program with key sector associations that provides **certification for operators who implement green practices such as efficient and cleaner vehicle technologies**. Provide guidance and incentives for shippers, carriers, and/or third-party logistics providers to participate to save costs and reform their operation and fleet management to increase demand for certified green truck operators.

Establish system to optimize logistic flow

(Ministry of Transportation)

Incentivize establishment of logistic information platform to integrate trucking and logistic business. Establish **training program to educate truck operators and drivers to use digital logistic platform**. Form a collaboration among government agencies to support efficiency improvement of logistic business. Encourage establishment of intelligent transportation system to improve the quality of transportation and better monitor, manage, and enhance transportation system.

4.5 Implementation arrangement (organizational measures)

To ensure efficient and effective implementation and management of the truck modernization scheme, the following steering structure is planned (Figure 18):

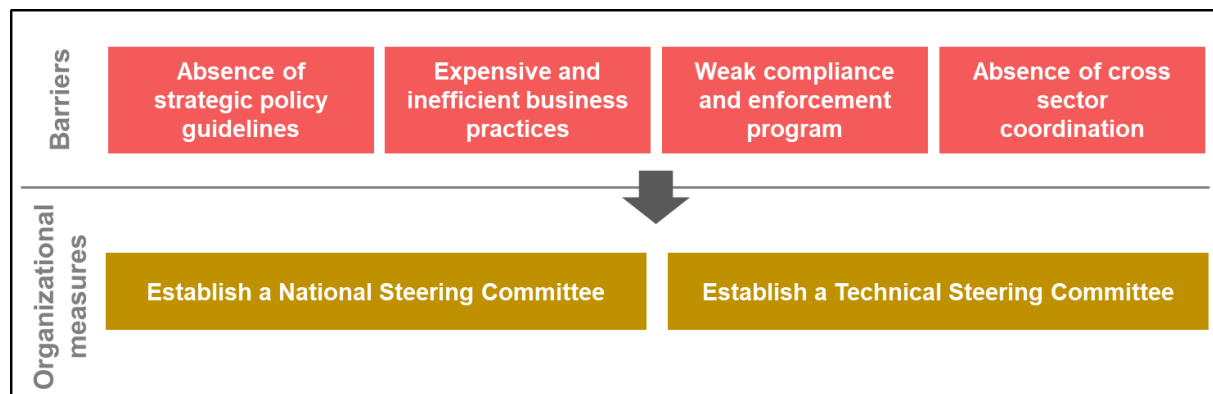


Figure 18: Overview of organization mitigation measures

Establish a **National Steering Committee** that comprise representatives from the MoT (Directorate General of Land Transportation), MoEF (Directorate General of Climate Change Control), and BAPPENAS (Deputy of Facility and infrastructure). The Steering Committee will give guidance to the project at political and strategic level. It will coordinate the collaboration across agencies.

Establish a **Technical Steering Committee** that comprise representatives from implementation directorate of MOT, MoEF, MEMR and BAPPENAS, and representatives of MOF, MOI, Traffic Corps, BPJT, and local governments in order to coordinate activities of different parties and give technical guidance. The Directorate of Road Transport and the Directorate of Road Transportation Facility of MOT will advise on onroad trucks and regulate new trucks respectively. The Directorate of Climate Change Management of MoEF will advise environmental related standards making and MRV. The Directorate of MEMR will advise on fuel quality improvement and fuel pricing. The Directorate of Transportation of BAPPENAS will advise on development planning and coordination. The MOF and MOI will advise on fiscal support and industry development respectively, while Traffic Corps and BPJT will advise on the onroad implementation and toll road development. The Technical Steering Committee will work closely with the Technical Support Unit to address concerns from the Technical Support Unit while get technical suggestions based on the assessment of the Technical Support Unit.

Establish a **Technical Support Unit** that comprise government staff and experts in the field to support the decision-making within the National Steering Committee and the Technical Steering Committee. The Technical Support Unit will mainly include staff from MOT Directorate of Road Transport and the Directorate of Road Transportation Facility and the Transportation Research and Development Agency. MOT will identify the experts, stakeholders, academics in other ministries, institutions, organizations,

private sector, and universities to support investigation and information integration on various action measures. The technical research will provide input to the decision-making process.

The overall steering structure is illustrated in Figure 19.

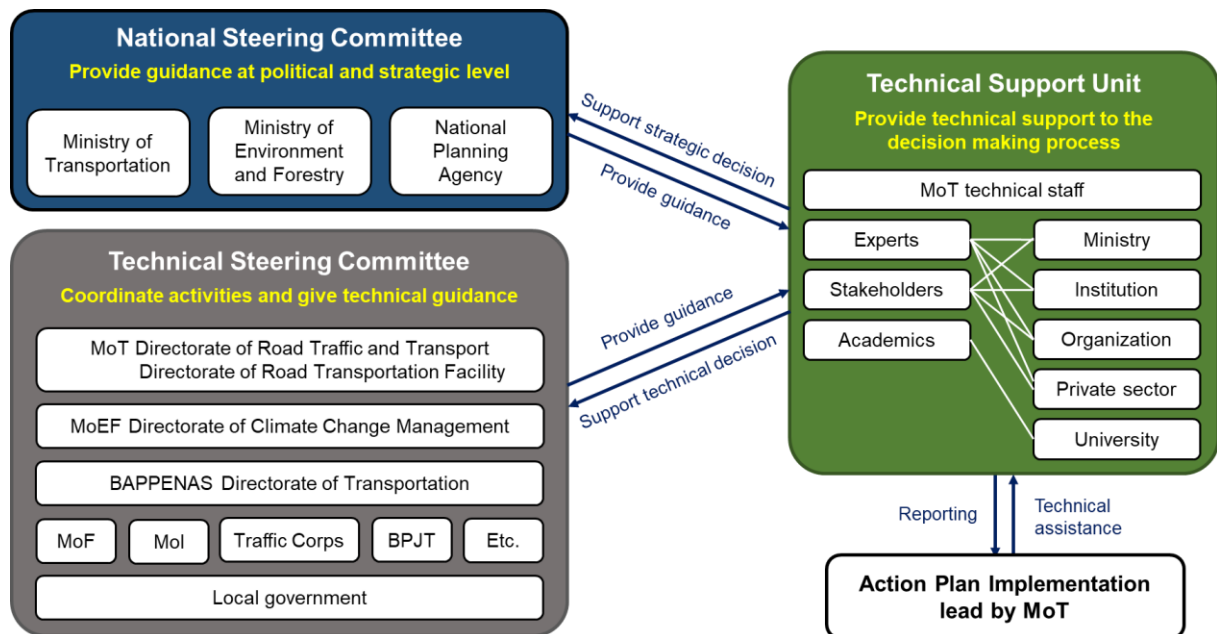


Figure 19: Organizational structure to facilitate the implementation and management of the truck modernization scheme

4.6 Transformational change

The mitigation actions of truck modernization that are outlined in this document have great potential for transformational change that will have permanent positive influence on the road transportation sector.

In general, the transformational changes that the truck modernization program can accelerate are threefold: reduce in-use emissions rapidly; accelerate the transition to world-class efficiency and emissions standards; and enhance in-use vehicle track and monitor mechanism (Table 5).

Table 5: Key transformational changes lead by the truck modernization program

| Transformational change | Detailed reflection |
|--|---|
| Reduce in-use emissions rapidly | Scrapping old trucks from the fleet will permanently prevent those trucks from emitting excessive GHGs. The old trucks not only inherently have higher emissions due to the outdated technologies, but also have higher possibilities to emit significantly higher than the regulatory standards due to low durability and poor maintenance. Additionally, a well-established scrappage program will address greater issues related to old trucks, such as building scrappage facilities, establishing enforceable scrappage procedure, enhancing parts recycling capacity. |
| Accelerate the transition to world-class efficiency and emissions standards | There is currently no published plan in place to advance vehicle emission and efficiency standards beyond 2021. This action plan aims to accelerate this agenda. The replacing new trucks that are required to be equipped with advance technologies to meet world-class standards will have both instant real-world emission reduction and long-term environmental benefit. Such benefit will not only apply to new trucks that are bought to |

| | |
|---|--|
| | replace old scrapped trucks, but also apply to all new trucks sold and operate in Indonesia in the long term. |
| Enhance in-use vehicle track and monitor mechanism | Build institutional capacities and strong compliance and enforcement in managing all in-use vehicles on the road. For example, the measures in the action plan will build digital database to track and monitor registration, emission, and testing information of onroad vehicles; establish mechanism to monitor KEUR test quality; and installing equipment to conduct random onroad testing of vehicles. All improvement in in-use vehicle management will have spillover impact on the entire in-use fleet. |

There are other **transformational changes** in other fields that are facilitated by the truck modernization program:

- The truck modernization program will **significantly contribute to air quality improvement** by reducing criteria pollutants emissions from the truck fleet.

Figure 20 illustrates how the required particulate matter 2.5 (PM_{2.5}) level reduce as the advancement of emission standards. By replacing an uncontrolled old truck with Euro IV trucks, the PM_{2.5} emission reduce by almost 90%. On the other hands, adopting more advance emission standards, e.g. Euro VI, will further reduce PM_{2.5} emission by 90% compared with Euro IV trucks. Similar significant reduction to other pollutants, including NO_x, CO, and HC, and to light-duty vehicles. Therefore, truck modernization program will accelerate adoption of not only most efficient technologies, but also cleanest technologies.

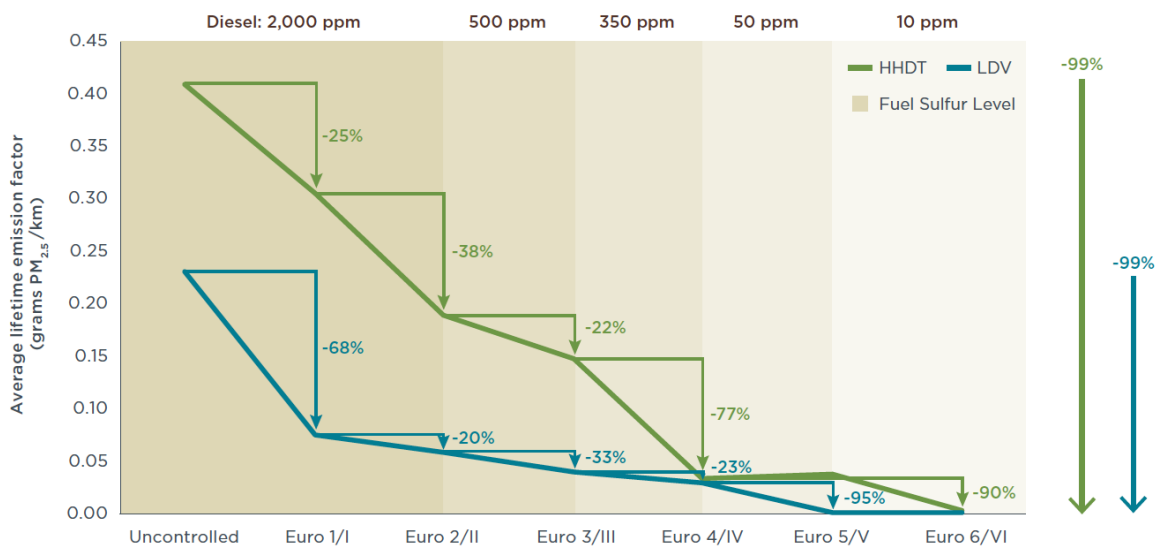


Figure 20: Tailpipe PM emission standards from uncontrolled to Euro 6/VI vehicles

- The action plan will **increase trucking industry competitiveness** over the long term.

By reducing operation cost and improving business efficiency, the action plan has the potential to increase profit margin for trucking industry. This will especially benefit smaller truck operators that may likely own older trucks while improving the quality of services, as newer and more efficient trucks will have lower operational costs from reduced fuel and maintenance expenditures, and increased safety records and driver retention. By establishing funding mechanisms to support the introduction and operation of new vehicles, the action plan helps to overcome the current financial constraints of truck operators and targets at the right technologies that are already matured and widely adopted by other leading vehicle markets. This will be a “win-win” situation for government to meet its NDC target while improve air quality, for truck operators to improve service competitiveness, and for local vehicle manufacturer to increase manufacturing competitiveness in the global market.

- The action plan for truck modernization can be **easily replicated for other vehicle modes**, especially passenger cars and light commercial vehicles.

In addition, any pilot in-use vehicle management activities at local level can be replicated by other states or cities or scaled up to national action. For example, successful experience in setting low emission zone to restrict old and dirty trucks from getting into the cities may accelerated the adoption of same programs in surrounding cities or other cities with a similar context.

- The action plan will have **spillover impact beyond the infrastructures**.

As an example, establishing eco-driving training and certification program will enhance the professional capacity of truck drivers and may likely increase the welfare of certified drivers. The increasing number of qualified truck drivers will also likely improve the on-road safety during and reduce traffic-related fatality rate.

4.7 Risk assessment

There are **several risks for implementation** of the truck modernization action plan. Table 6 lists some main risks, their potential seriousness, and possible risk mitigation measures.

Table 6: Potential risk of implementation of truck modernization action plan

| Risk | Seriousness | Possible risk mitigation actions |
|--|-------------|---|
| Discontinuity due to public leader change or other external factors | high | <ul style="list-style-type: none"> ▪ Ensure that the action plan is agreed by key stakeholders and institutionalize public policy. ▪ Set clear roadmap for key direct measures to indicate long-term policy direction. |
| Sustainability of public funding for fully finance the implementation | medium | <ul style="list-style-type: none"> ▪ Set funding priorities and fund higher-ranked activities. ▪ Clearly identify potential opportunity to raise sustainable funding sources. |
| Lack of supply of high-quality fuels that limits the potential to introduce world-class truck technologies | medium | <ul style="list-style-type: none"> ▪ Set the roadmap of high-quality fuel supply and ensure the implementation of the roadmap. ▪ Reform the existing fuel taxation structure to incentivize supply of high-quality fuel. |
| Corruption that influences the effectiveness of implementation | medium | <ul style="list-style-type: none"> ▪ Minimize impact of individual behaviors through a well-design compliance and enforcement program ▪ Increase the penalties for noncompliance. |
| Opposition and protest from the trucking industry | medium | <ul style="list-style-type: none"> ▪ Conduct cost and benefit analysis to support the implementation of the action plan and fully communicate with key stakeholders ▪ Design policy and financing system to minimize the negative impact on the industry and trucking industry ▪ Ensure thorough socialization of the measures throughout the industry |
| Delay in test facility upgrade and infrastructure construction | low | <ul style="list-style-type: none"> ▪ Early engagement and education of local government and implementation agencies for the improvement of in-use vehicle management |

Mitigation Action Outline on Truck Fleet Modernization Scheme in Indonesia

| | | |
|--|--|---|
| | | <ul style="list-style-type: none">▪ Assign responsible agencies to take charge and keep track of development progress |
|--|--|---|

5. Financing concept

Refer to the Chapter 3 on barriers to decarbonizing truck fleet, there are four main barriers mentioned: the absence of strategic policy guidelines; expensive and inefficient business practices; weak compliance and enforcement programs; and absence of cross sector coordination (Figure 21).

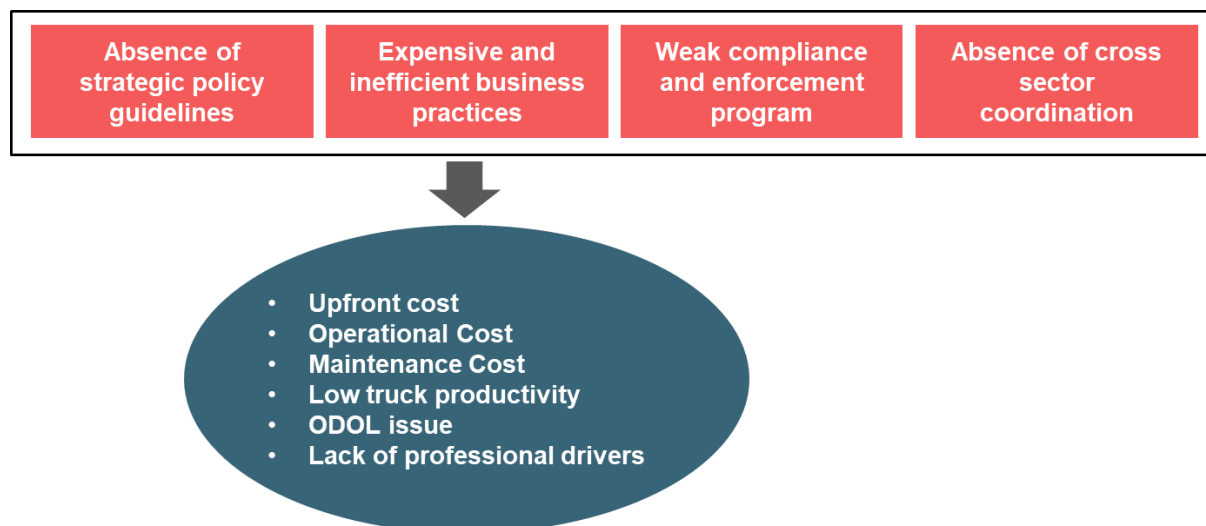


Figure 21: Variabel influencing the expensive and inefficient busienss practices

Under the expensive and inefficient business practices, upfront cost has been highlighted as the high cost. **It is the biggest (financial) challenge in financing the truck modernization scheme.** The higher cost of advanced trucks (mainly Euro VI) exceeds that of a Euro IV vehicle due to the use of a diesel particulate filter (DPF) to meet the emission standards. The new truck will also have a newer engine technology that have a more competitive fuel consumption performance.

Truck operators usually run the road transport with a thin profit margin, even after they pay off the loan of the trucks. For truck operators that owning old trucks, the operation cost of old trucks is even higher due to the high fuel consumption caused by outdated truck technologies, poor maintenance, and thus high maintenance cost. Therefore, **the old truck owners usually lack the financial capacity to pay for the upfront cost of new trucks.** It is especially challenging for smaller truck operators, because these operators confront difficulties to prove financial credibility therefore face higher cost to obtain loans and financial support from banks and financing institutes.

Therefore, **public financial support is necessary to facilitate the truck modernization program** and especially support the smaller operators that are financially incapable of making such transition. The financing mechanism would focus on providing government incentives ('subsidies') to all eligible parties, who scrapped trucks and replace with advanced trucks that meet world-class emission standards. The subsidies should ideally cover the financial burden of eligible truck owners from replacing scrapped vehicles with advanced trucks. The subsidies can come in various forms, including direct (e.g. cash grants, tax exemption, interest-free/low-interest loans) and indirect (e.g. KEUR test waivers, local permit benefit).

5.1 Overview of costs and revenues

The cost of the mitigation action mainly come from financial support to direct GHG mitigation measures. There are cost related supporting measures, but those are expected to be covered by revenue sources outside this action plan due to the spillover impact of the supportive measures. For example, the investment in infrastructure construction can improve the overall traffic and driving condition, rather than

only for the purpose of facilitating truck modernization; the establishment of mechanism to optimize logistic flow will not only influence the efficiency of truck operation but also improve efficiency of the entire logistic service chain and contribute to industry and economic development.

The overall cost of financial support to direct measures mainly comes from providing financial support to incentivize replacing targeted trucks with cleanest trucks. Figure 22 illustrates the impact on truck operator cost of truck modernization programs and the optional revenue sources to close the funding gap.

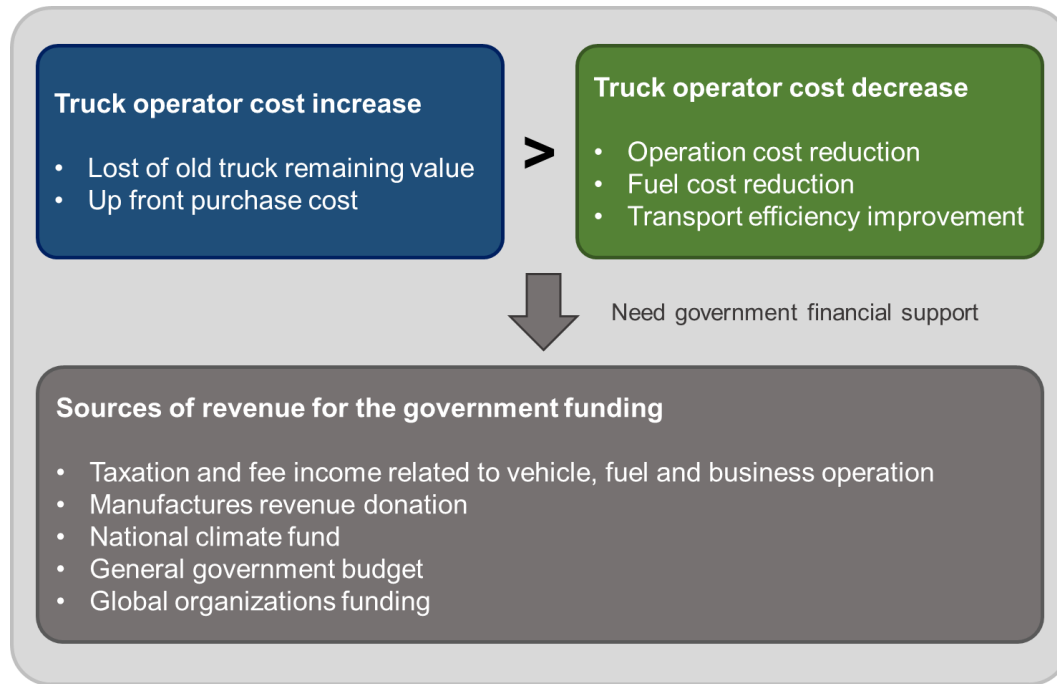


Figure 22: Sources of revenue to close the funding gap of the truck modernization program

5.1.1 Cost composition

It is impossible to establish a simple rule of thumb for the amount of subsidy that should be offered to truck owners. The level of fiscal support necessary will vary by the type of trucks and the financial capacity of truck owners. Generally speaking, **the fiscal incentive should cover the current market value of the truck to be replaced and the cost increase of technology upgrade**, in order to incentivize owners to a) scrap their trucks instead of continuing operating or selling it to another person; b) replace the scrapped trucks with new trucks equipped with advanced technologies. The MOT and MOF should work together to **conduct comprehensive analysis of the costs and seek to find the “tipping point”** at which owners of the targeted percentage of older vehicles actually participate in the vehicle replacement program, without offering subsidies that are too high and thus not cost-effective.

The Carl Moyer Program in California, which initially focused on reducing NO_x emissions from heavy-duty vehicles (HDVs) in order to help the state meet ambient air quality standards for ozone, **provides** replacement **subsidies between 4% and 18%** of the price of the new vehicle, depending on vehicle type (CARB, 2007; CARB, 2011). Table 7 provides a list of cases of vehicle modernization programs around the world and the relevant program target, the subsidy level, and supporting policies.

Table 7: Examples of vehicle modernization programs around the world

| Program | Vehicles targeted | Approximate average subsidy offered | Complimentary policies used |
|--|--|--|--|
| US: California: Carl Moyer Program | Multiple types, including on-road and off-road | ~\$28,000 per vehicle | Mandatory upgrades of high polluting vehicles (regulatory backstops) |
| US: Consumer Assistance to Recycle and Save (CARS) | Light-duty vehicles | \$3,500-\$4,500 | None |
| US: National Clean Diesel Campaign (NCDC) | Heavy-duty vehicles | ~\$9,400 per vehicle spent for the program | None |
| Germany: Scrappage Bonus | Light-duty vehicles | \$3,500 | Low emission zones |
| China: National Vehicle Scrappage Program | Light- and heavy-duty vehicles | Varies by vehicle type; between \$980 and \$2,940 | Mandatory vehicle age limits |
| China: Local Vehicle Scrappage Program | Light- and heavy-duty vehicles | Varies by vehicle type; LDVs: \$410-2410 HDVs: \$1,330-\$2,100 | Mandatory vehicle age limits and low emission zones |
| Mexico: Program to Modernize Federal Road Transportation | Heavy-duty vehicles on federal highways | Up to 15% of the cost of the replacement vehicle | None |
| Mexico: Mexico City: Program to Replace Microbuses with New Autobuses | City buses | Up to \$7,700 | None |
| Chile: Swap your Truck | Heavy-duty trucks | From \$8,000 to \$24,000 depending on vehicle category | Partial: there is a ministerial decree to implement a low emission zone, but it has not been executed. |

Source: Posada et al. (2015)

Besides the cost of providing direct subsidy to truck replacement, **indirect subsidies through tax incentives or financing benefits** (e.g. lower interest loans) can be provided to reduce the purchase and operation cost burden on truck owners. Whenever these incentives are provided, the amount of direct subsidy can be reduced accordingly. That means, with incorporation of other types of financing, the total cost to support the actions will not change.

5.1.2 Revenue sources

There are **multiple sources of revenues** identified to finance truck modernization effort in Indonesia:

- **Taxation and fee income related to vehicle, fuel, and business operation.** Based on existing vehicle taxation system, there are value-added-tax charged for the purchase of vehicle and annual tax for the operation of vehicles. Fuel tax also contributes to the government revenue. As for the fee collection, there are fees for vehicle registration and company operation license registration. These tax and fees, either collected by national or local government, can be mobilized to the dedicated truck modernization fund. A direct tax cut that will reduce the purchase and operation cost of cleaner trucks can also meet the similar goal as direct subsidy.
- **Manufacturer revenue donation.** As vehicle manufacturers will benefit from accelerated adoption of advanced technologies and accelerated selling of new trucks, it is reasonable to require manufacturers to contribute part of their revenues from selling new trucks to lower the cost of truck scrappage and replacement and support the continuity of the program.

- **Scrappage and recycling revenue.** Due the large amount of the trucks to be scrapped, the government will allocate part of the revenues from recycling the scrapped parts and materials to fund the scrappage program.
- **National climate fund.** As one of the important efforts to reduce carbon emission from the transportation sector, truck modernization program can be part of the actions to achieve carbon reduction targets in NDC, therefore apply for climate fund to finance the implementation of the program.
- **General government budget.** Given the great climate and environmental benefits of truck modernization and its transformational impact, both national and local governments can allocate their budget to finance the program in order to achieve its strategic targets, such as reducing national reliance on fossil fuel energy, accelerate road transportation sector development, improve logistic transport efficiency, etc.
- **Global organizations funding.** Truck modernization program can also apply for funding provided by global organization to support activities related to carbon-reduction and air pollution. For example, the Climate & Clean Air Coalition has set a rolling fund to support government projects in targeted countries (including Indonesia) that aims to improve air quality and protect the climate through actions to reduce short-lived climate pollutants.

5.1.3 Other considerations

Besides the funding of scrappage and vehicle technology upgrade, there are **cost of upgrading the inspection and testing facilities** to identify noncompliant trucks and enhance in-use vehicle management system. But this action can be mainly self-financed by private sector, namely the testing institutions that provide in-use vehicle testing services. The cost of this measure mainly comes from the investment in purchasing and installation of new facilities and monitoring equipment and investing staff time to establish and manage scrappage implementation mechanism. The inspection fee can be set at levels that will cover equipment and facility upgrades.

Currently, the inspection fee is very low— around 300,000 IDR (USD 21.3) per test. The cost to conduct two KEUR tests a year for commercial vehicles account for a neglectable portion of the annual operation cost of truck owners. With millions of in-use trucks that need to be tested twice a year, increasing inspection fee will generate sustainable revenue for both testing center and the government. In addition, **increasing penalties for noncompliant vehicles** will not only improve the effectiveness of compliance and enforcement efforts, but also increase revenue in the pool that can be used to fund either truck replacement program or inspection improvement.

5.2 Financial viability

As demonstrated by similar program around the world, although **the truck modernization program cannot be self-financed by truck owners**, the financial support from the government will make it financially feasible for truck owners to make the transition. For truck owners, especially for small truck fleet operators, purchasing new trucks will significantly increase their upfront investment while the old trucks have remaining value. They will face high interest when applying loan for the new trucks through the leasing companies whereas their cost of business of old trucks will mainly be operation cost after paying off the loan of the old trucks.

The design and financing mechanism of the truck modernization program will **solve** the financing issues for truck owners in mainly **two aspects**: reducing purchase and operation cost and providing public financial support to relieve remaining financial burden.

5.2.1 Reduce purchase and operational cost

The key measures and policies will reduce truck owner operation cost of new trucks, therefore increase the profit margin for truck owners after replacing old trucks with new ones. These measures do not require public funding support but can **help to create the business case for truck modernization scheme**:

- a. **Reforming in-use vehicle tax system** will increase the tax rate of in-use vehicles proportionally as vehicle age increase while reduce the tax rate for newer vehicle, therefore truck owners with newer trucks will benefit from lower tax rates.
- b. **Reforming fuel subsidy system** to switch existing fuel subsidies for CN48 diesel to subsidize supply of fuels that are used by cleaner trucks (e.g. ultra-low-sulfur fuel, CNG) will lower the operation cost of clean trucks and even reduce government expenditure on fuel subsidies when the usage of clean fuel is still low in Indonesia.
- c. **Facilitating and simplifying the leasing process** for truck operators that seek financing of clean and efficient trucks will enable cleaner truck owners to have access to banks that provide relatively lower interest of leasing, therefore reduce the purchase cost of trucks.
- d. **Increasing requirement of KEUR testing** frequency for old trucks and providing 5-year test waivers for that meet the world-class Euro VI emission standards will greatly relief the test burden of owners of new truck fleet, therefore reduce not only the cost to undertake the tests but also time spent for testing which would alternatively be used for conducting transporting business.
- e. **Lowering toll road fee for clean and efficient trucks** and providing beneficial local permit and license requirement will further reduce operation cost of newer trucks.
- f. Operating newer **trucks with advance technologies** will automatically reduce operation and fuel cost for truck owners. The truck fleet operator education program will help fleet owners to more accurately evaluate their operational cost, adjust payment to drivers based on the fuel cost reduction, and make rationale decision on optimizing their fleet operation.
- g. **Establishing low emission zones** at city level that forbid or limit entry of old and dirty trucks can indirectly increase the operation cost and burden of old trucks, therefore provide additional operation advantage for newer trucks.
- h. Establishing **green certification program** that provides green procurement requirement to promote efficient and cleaner vehicle technologies will increase competitiveness of clean and efficient truck fleet.

In general, the increased profit margin as results of the measures above will to some extend compensate the upfront cost of purchasing new trucks in the long term.

5.2.2 Provide public financial support

The public financing that provides direct subsidies to purchase of trucks equipped with the cleanest technologies are supposed to fully cover the remaining financial burden of replacing scrapped old trucks with new trucks for truck owners that do not have the capacity to do so.

Among vehicle replacement programs around the world, the reference subsidy amount in this action plan refers to **the vehicle replacement subsidy scheme in Guangdong**, a province in China that **is quite advanced in reducing emissions from old in-use vehicles**. To achieve the scrappage and replacement target of the scheme, cities of Guangdong province provided subsidies to vehicle replacement coupled with a variety of supporting measures.

Table 8 summarizes the subsidy scheme provided by the Guangzhou city, the capital of province. Other cities in Guangdong provided subsidies as well, but the amount varied slightly. Compared with other countries and regions, **the subsidy amount provided by Guangzhou is relatively low per vehicle for the same vehicle type**. This program, which initiated in 2009 and updated in 2014 successfully scrapped more than 90% of the old vehicles in Guangdong Province (Yang et al. 2015).

Table 8: Summary of vehicle replacement subsidies in Guangzhou, Guangdong Province, China

| | Subsidy (RMB) | Subsidy (million IDR) | Subsidy (thousand USD) |
|--------------|---------------|-----------------------|------------------------|
| Micro truck | 8,000 | 15.9 | 1.1 |
| Light truck | 15,000 | 29.8 | 2.1 |
| Medium truck | 22,000 | 43.7 | 3.1 |

| | | | |
|-------------|--------|------|-----|
| Heavy truck | 30,000 | 59.6 | 4.2 |
|-------------|--------|------|-----|

Such **subsidy level** accounts for 4 to 14% of the truck price in Indonesia which is in line with the range of subsidy amount provided by Carl Moyer Program in California, another success vehicle scrappage and replacement program. Such financial subsidy levels have proved to be sufficient and effective in providing financial support to truck owners for truck scrappage and replacement in both developed and developing countries.

Another angle to evaluate the sufficiency of subsidy is **to compare with the incremental cost of technology improvement**. According to an International Council on Clean Transportation (ICCT) study (Shao, 2020), the technology improvement from Euro IV to Euro VI truck leads to an approximate cost increase of \$1,396-\$2,100 (19.4 million- 29.2 million IDR) in Indonesia's market. Table 9 lists the incremental cost of technology improvement of different types of heavy-duty trucks in Indonesia context. The reference subsidy amount from the Chinese case has well covered the incremental technology cost.

Table 9: Incremental cost of technology improvement of heavy-duty vehicles in Indonesia per vehicle (2019 USD/IDR)

| | Light HDV (<5 tons) | Medium HDV (5- 24 tons) | Heavy HDV (>24 tons) |
|---------------------------|------------------------|----------------------------|-------------------------|
| Euro IV to Euro V | 220 (3.1 million) | 278 (3.9 million) | 350 (4.8 million) |
| Euro IV to Euro VI | 1396 (19.4 million) | 1903 (26.5 million) | 2100 (29.2 million) |

The specific financial support level of each truck under the Indonesia truck modernization program will be determined after a thorough study on the financial need based on local context and may vary by truck type and eligibility of financial support receiver. Based on the reference subsidy level, the public financing will make the business case that enables targeted fleet, including those owned by smaller fleet operators, to be scrapped and replaced.

5.3 Economic viability

Social cost benefits of reducing air pollution

The fleet modernization scheme focuses on replacing old trucks by new trucks equipped with advanced technologies, which will significantly reduce not only CO₂ emission but also criteria pollutant emissions. Indonesia is facing severe air quality issues and transportation tailpipe emissions have significant air quality and health impacts. In 2015, **the transportation-attributable PM_{2.5} and ozone death was 7,100, which accounts for 13% of all emission sources and the highest among ASEAN countries** (Anenberg et al., 2019). The transportation-related health damages was 3.9 billion EUR¹² (Anenberg et al., 2019). A 2012 Indonesian Ministry of Environment cost-benefit analysis study reported the average cost of air pollution illnesses in Jakarta alone in 2010 was US \$535 million (Safrudin, 2013).

The truck modernization scheme would be an efficient step in improving the air quality and public health in Indonesia. Older and poorly maintained trucks have a higher likelihood of emitting disproportionately high levels of pollutants. Therefore, replacement of old and dirty heavy-duty vehicles,

¹² 2015 USD adjusted to 2019 USD (1.08 inflation).

including trucks, has been one of the priorities to reduce emissions from the transportation sector in many other countries (Posada et al., 2015).

This truck modernization scheme is estimated to accumulatively reduce 21 to 54 kilotons of PM_{2.5} and 304 to 1287 kilotons of NO_x, 33 to 250 kilotons of CO, and 17 to 47 kilotons of black carbon from 2020 to 2030 under scenarios specified in Section 6.

The benefits of vehicle emission reductions can be estimated in the form of avoided social costs. The social costs cover the pollutant-specific and time-dependent damages associated with emissions, including direct climate and health impacts, climate-related health damages, and the effects of ozone on reduced agricultural productivity. A study (Shao et al. 2020) has estimated that the accumulative societal benefit of a moderate and world-class emission and fuel standards improvement strategies are 81 trillion IDR (USD 5.7 billion) and 247 trillion IDR (USD 17.5 billion) respectively from 2020 to 2030. The study covers all types of vehicles (excluding motorcycles and three-wheelers), with the assumed policy scenarios for emission and fuel standards adoption for trucks same as the assumptions in Section 6.3.1.

In a world class scenario, the social benefit outweighed the cost with a benefit-to-cost ratio of 2.5:1 under moderate scenario and 4:1 under world-class scenario when compared with the baseline scenario. Although this estimation is for the entire vehicle fleet, the cost and benefit analysis studies from China shows that the benefit-to-cost ratio in similar emission technology improvement situation is much higher for heavy-duty vehicles (mainly trucks) compared with light-duty vehicles (Shao et al. 2017, Cui et al., 2018).

The above **estimation only reflects the societal benefit from adoption of emission and fuel standards** applying the natural vehicle survival curves. **Since the truck modernization scheme accelerates the retirement of trucks, the social benefits will only be higher than this estimation.**

Greenhouse gas emissions benefits

It is widely recognized by government and academic that there is social cost of carbon (SCC). Thus, **reducing greenhouse gas emission as results of the truck modernization efforts will reduce social cost accordingly.** Although countries usually utilize existing government-recognized estimates, recent academic estimates of the global SCC are substantially higher than the estimates commonly used by national governments. An example of the 2019 survey of experts shows that a median SCC of \$200 per tCO₂ (Pindyck, R., 2019). If taking this SCC for a rough estimation, the truck modernization program can save SCC of accumulatively \$320 millions (IDR 4,5 trillion) to \$4.6 billions (IDR 64,7 trillion) by 2030 based on the estimation in Section 6 under two scenarios.

Energy saving benefits

As fuel cost represents about a third of operating cost for commercial trucking fleets, there is clear benefit of using fuel as efficiently as possible. In general, the savings from fuel cost can pay back the increased additional cost of technologies that improve efficiency of trucks. As for the proposed US standards to reduce the fuel consumption and greenhouse gas emissions of new heavy-duty vehicles, tractors, trailers, and engines, the estimation of the payback periods for truck owners would be within two years for tractor-trailers, within three years for pickups and vans (ICCT, 2015). the payback periods associated with different tractor-trailer technology packages in 2030 range from 0.5 to 2.7 years (Delgado & Rodriguez, 2018).

Transport, infrastructure, and industry benefits

To general public, **the truck technology upgrade will reduce congestion on the road and improve road safety.** The benefits will make impact on the entire society. The enhancement of the trucking-related regulations and their implementations is expected to improve trucking business efficiency and create a levelled field of competition among truck operators. Both will improve Indonesia's freight logistics system and therefore improve well-being of both truck owners and truck drivers.

5.4 Financing mechanism and structure

The financing mechanism of the truck modernization scheme is established to mainly support the implementation of direct measures, including:

- a. incentivizing early scrappage of old trucks
- b. accelerate adoption of cleanest trucks, and
- c. improve in-use vehicle management capacity.

The financial support will mainly **come from the dedicated fund** created to facilitate this truck modernization program. The fund aims to ensure sustainability of the program implementation and prevent exhaust of public funding. The national steering committee will be responsible for the creation and supervision of the dedicated fund.

The fund amount should be pre-estimated based on the scrappage target of each year and adjusted based on implementation status on yearly basis. The national steering committee will coordinate the estimation efforts. MOT and MoEF are the key agencies that will secure funding through budget discussion with the MOF and estimate the annual budget that need to be allocated to the dedicated fund. MOT and MoEF will also be responsible for managing the fund under the supervision of the national steering committee.

The national steering committee will work with technical committee to identify a group of revenue sources that will be allocated to the dedicated fund. As identified in Section 5.1.2, the optional revenue sources include taxation and fee collection related to vehicle, fuel, and truck business operation, vehicle manufacturer revenue donation, scrappage and recycling revenue, national climate fund, general government budget, and global organizations funding. A thorough review of the revenue stream of each revenue source will be carefully studied by the technical committee. The identified group of revenue sources should be able to cover the estimated amount of the funding on annual basis. Then the national steering committee will facilitate to mobilize the identified revenue sources to the dedicated fund.

For in-use vehicle testing equipment upgrade, including equipment for KEUR testing and on-road testing, **the funding can come from increased testing fee and the penalty** collected from noncompliant vehicles. The investment in the equipment will benefit the all vehicle types rather than trucks only.

Figure 23 below illustrates the potential financing structure for the truck modernization scheme:

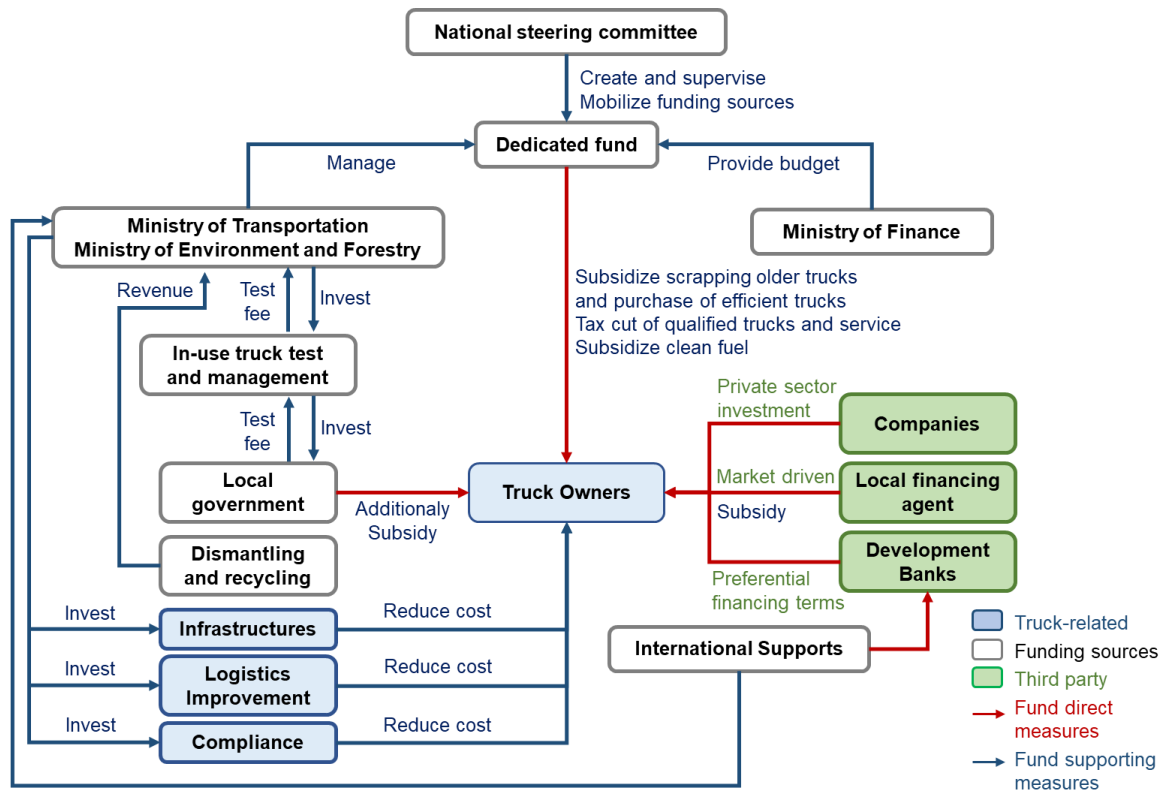


Figure 23: Proposed financing structure for the truck modernization scheme

5.5 Scale of investment and support needs for different ambition levels

The estimation of investment scale assumes that the support from public funding will take account of the implementation of complementary incentives and fully relieve the remaining cost burden on truck owners of scrappage trucks and the replacement with trucks that meet world-class standards. The estimation does not separate national level financial support from local level financial support. This will be determined by the regulatory design and the budget.

The subsidy amount for trucks refer to the level proposed in Table 8 in Section 5.2.2. To evaluate the number of trucks that will be scrapped, the trucks population from Traffic Corps is used to reflect the number of active trucks on the road, which is 4.6 million in 2019. The trucks that need to be scrapped are defined based on the scenarios in Section 6.3.1. Note that **the estimation of the fleet distribution by certified emission standard and vehicle age is based on the vehicle kilometer traveled of each type of vehicle**. The analysis assumed that the older trucks travel the same distance annually compared with newer trucks. This will overestimate the annual mileage of older trucks, therefore slightly inflate the number of trucks that need to be scrapped and subsidized.

Because not all scrapped vehicles will end applying for subsidies, some of the trucks will be naturally scrapped or scrapped automatically when the mandate scrappage take effect. **This estimation assumes that 70% of overall truck scrappage and replacement will benefit from government financial incentives.** Table 10 shows the assumed numbers of scrapped trucks that will receive public financial support under moderate and world-class scenarios.

Table 10: Number of scrapped trucks that will receive public financial support)

| | Trucks | Pre-Euro trucks | 15+ Euro II trucks |
|--|--------|-----------------|--------------------|
|--|--------|-----------------|--------------------|

| | | | |
|--------------------|------------|---------|---------|
| Moderate | Light HDV | 619,302 | 402,360 |
| | Medium HDV | 392,354 | 372,456 |
| | Heavy HDV | 36,917 | 57,545 |
| World class | Light HDV | 619,302 | 718,639 |
| | Medium HDV | 392,354 | 513,387 |
| | Heavy HDV | 36,917 | 78,213 |

The overall estimation of financial support to facilitate full-scale implementation of the program—replacing trucks to be scrapped with trucks equipped with the cleanest technology will cost 50 trillion – 61 trillion IDR (USD 3.5 billion – 4.3 billion). The actual financial support to be delivered will depend on political leadership. Table 11 lists the detailed estimations under two scenarios.

Table 11: Scale of investment needed

| | | Moderate Scenario | World-class Scenario |
|---|---|--------------------------|-----------------------------|
| Impact | CO₂e reduction 2020-2030 (Mt) | 1.6 | 23 |
| | Black carbon emission reduction 2020-2030 (kilotons) | 17 | 47 |
| Needed investment (trillion IDR) | | 49.9 | 61.4 |

6. Expected benefits and MRV approach

Based on the strategy proposed for the truck fleet modernization program, this section estimates the **expected benefits in GHG and non-GHG emissions and defines the approach of monitoring, reporting and verification (MRV)**. The MRV approach will support evaluating the impacts of the modernization program, while the modeling process offers a guidance on the data collection and management, databased development, and maintenance and capacity development in evaluating the real-world impacts from the program.

6.1 Cause-impact chain

The **direct GHG impact** of the truck fleet modernization program is defined as the GHG emissions **resulting from intended effects on the targeted emission sources**, while an **indirect GHG impact** is defined as **unintended effect on emission resulting from the actions that are implemented**.

The **proposed mitigation strategy focuses on three elements**, which are a fleet renewal program, a transition to cleaner and efficient trucks, and an in-use truck emission control element. The three programs work dynamically to accelerate the reduction of GHG emissions of those old, dirty trucks.

In order to reach the best results of truck modernization program, stringent tailpipe emission standards and fuel efficiency standards are required along with the fleet renewal program. **Indonesia** lags behind in terms of emission standards when compared with other ASEAN countries (Figure 24) and **does not have any requirements on the fuel efficiency improvement**. Thus, it's urgent to initiate the process of introducing state-of-the-art requirements.

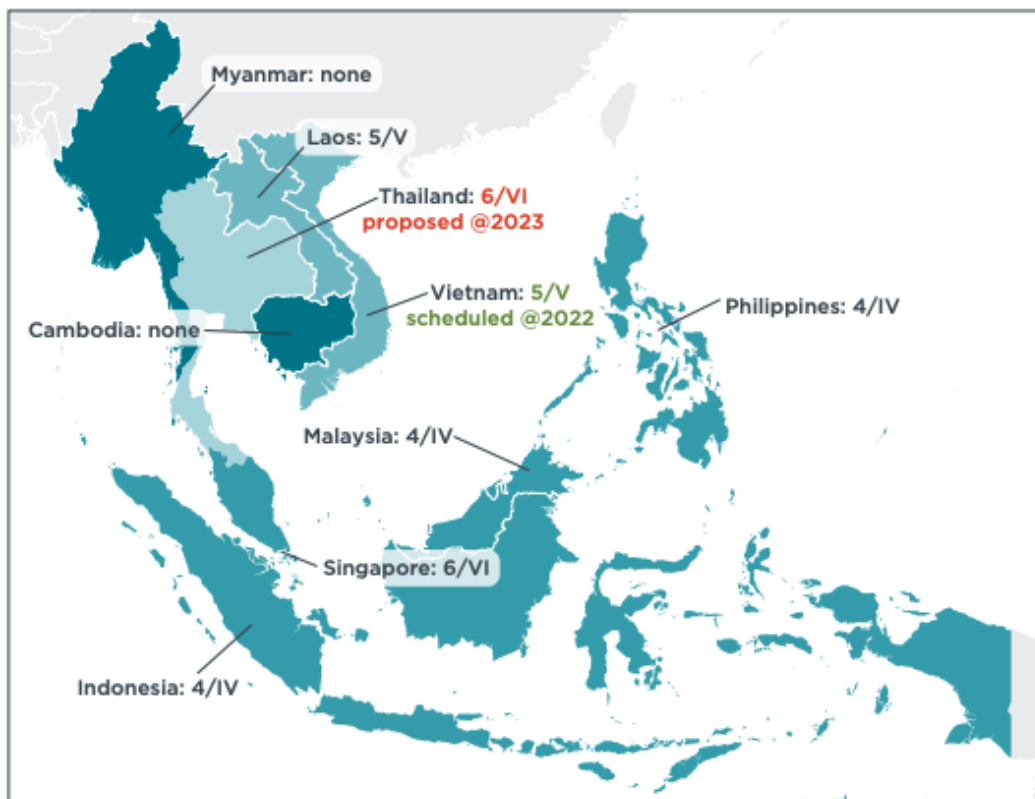


Figure 24: Light-duty and heavy-duty vehicle standards adopted by ASEAN countries

The in-use vehicle emission control, such as establishing low emission zone, set requirements as certain vehicles are prohibited from traveling or may only enter during designated times. Older vehicles with little or no emission control technology or vehicles not meeting certain emission standards are often the targets

of restricted vehicles. Many low-emission zones do not ban these vehicles outright but collect fees or taxes when restricted vehicles enter these areas.

Cities in China and Europe have actively adopted this strategy to deter high-emitting vehicles from driving in core urban areas, where population density and traffic flow are high (Shao et al., 2016). **Low-emission zones offer non-fiscal incentives for truck drivers and/or owners to upgrade vehicles to qualified ones so that they can continue use the truck.** The adoption of low-emission zones can potentially reduce the activity of these old vehicles as well. Although low-emission zones normally are set for vehicles being high emitters with air pollutant, those vehicles usually perform poorly on fuel consumption as well.

Figure 25 illustrates the **cause-effect chain** of the truck modernization program proposed, showing three elements discussed and their expected impacts. Obviously, the three elements—fleet renewal program, transition to cleaner and efficient trucks and low-emission zone policy—will support reduce energy demand, air pollutants, and GHG emissions, which will be quantified in the later section.

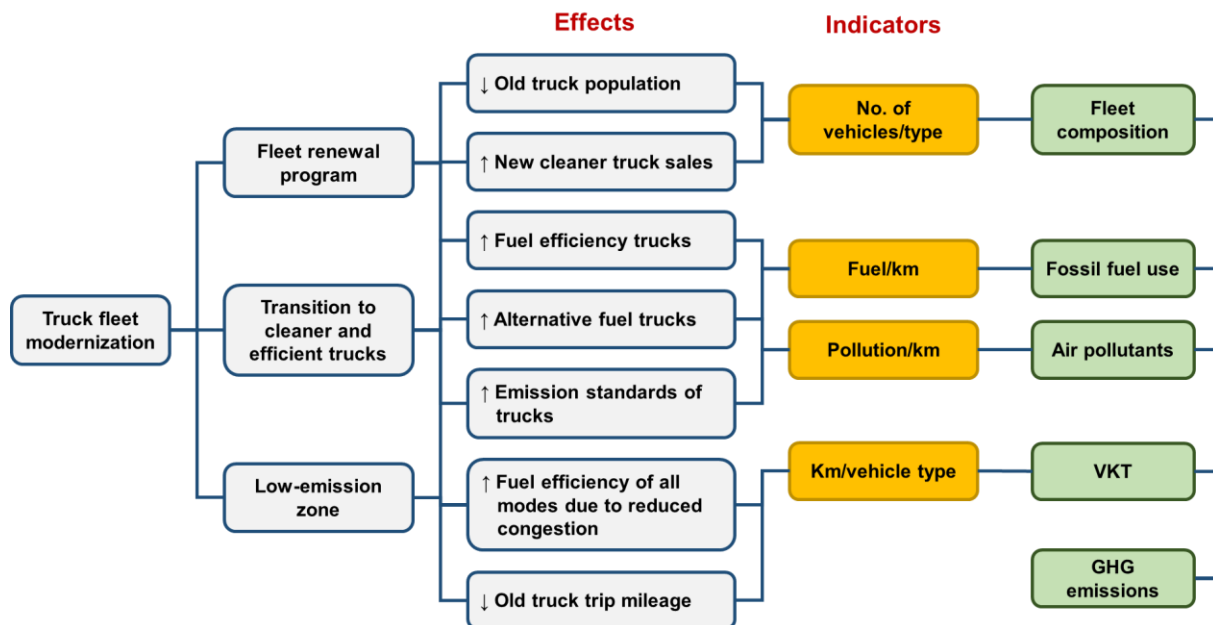


Figure 25: Cause-effect chain of the truck modernization program proposed (direct impacts)

In addition to the direct GHG impacts described above, **the truck fleet modernization program will potentially reduce congestion, improve traffic speed and therefore further reducing fuel consumption, emissions and air pollutants from all vehicles operated in Indonesia.** The program, targeting at trucks, can be a pilot project for other transportation modes, which will potentially lead to similar program launched for buses, taxis and even two-wheelers in addressing their large contribution to the GHG emissions in Indonesia (Shao et al, 2020).

With all the positive impacts from the program, it worth mentioning the such program could increase the average kilometer vehicles traveled due to lower cost and better performance of the replaced, clean and efficient trucks (*rebound effect*), which is not considered in this calculation here.

6.2 Assessment boundaries

The quantitative assessment (Table 12) of the truck modernization program focuses on on-road heavy-duty trucks performed in Indonesia. The analysis categorizes the trucks by weight, which are defined as light-commercial vehicles (3.5-5 tonnes), medium heavy-duty trucks (5-24 tonnes) and heavy heavy-duty truck (over 24 tonnes). This categorization is consistent with Indonesia's registration system.

The study estimates both **GHG emissions and local pollutants**, with selected ones reported. The reported emissions, including CO₂, CO, volatile organic compounds (VOCs), PM, NO_x and black carbon (BC), are selected for their representative roles in indicating the policy impacts on climate change and public health and thus, which can offer insights for policy makers.

The following analysis reports only tank-to-wheel emissions with a focus on the impacts from heavy-duty trucks. Upstream emissions, though important, are not included here.

Considering that the fleet renewal program normally yields direct and immediate impacts on regions' emissions and air pollutions reduction, **this study limits the horizon of the impact assessment to 2030**, but the impacts of fleet renewal program will extend beyond this time.

Table 12: Assessment boundaries

| Boundary elements | Description |
|--|---|
| Temporal boundary | 2020-2030 |
| Sectoral boundary | The assessment covers road transport truck activities. |
| Territorial boundary | Due to the nature of truck transport, the territorial boundary is all trucks used in Indonesia for road transport |
| GHG included | The focus is on direct, activity based GHG emissions. The monitoring covers tank-to-wheel CO ₂ , methane (CH ₄) and nitrous oxide (N ₂ O). Indirect upstream emissions for fuel production or vehicle manufacturing are not covered. |
| Sustainability effects included | Estimates of pollutant emissions cover PM, NO _x , SO ₂ , CO emissions, and VOC from road-based truck transport activities within the territorial boundaries. |

6.3 Ex ante impact assessment

6.3.1 Baseline and mitigation scenarios

The analysis below **focuses on the impacts on vehicle scrappage and replacement program along with fuel efficiency standards, tailpipe emissions standards, and ultralow-sulfur fuel quality standards**. Although many other supplementary policies, including compliance requirements, fiscal subsidies, non-fiscal incentives, low-emission zones and etc., are important in the truck modernization program, the study does not take into quantification here, to more **clearly isolate the effects of strategies on energy, emissions and local pollutants**. The stringent standards will reduce the fuel consumption and tailpipe emissions from heavy-duty vehicles fleet, and more importantly, incorporate comprehensive in-use requirements, including inspection and maintenance protocols, to ensure those replaced vehicles performing by the limits through lifetime.

The timeline of the vehicle emission standards and ultralow-sulfur fuel standards proposed in the BAU and mitigation scenarios **are consistent with the ones suggested for Indonesia's soot-free transport (2020)**. The fuel efficiency standards and scrappage progress proposed here are based on the conversations with key stakeholders and experts in the area. Table 13 and Figure 26, below, lays out the key policies captured under each scenario. These **scenarios offer a comprehensive overview of the potential impacts of the Mitigation Action Plan in Indonesia when compared with the BAU** (see also Table 14 for values):

- **BAU:** Assumes Indonesia successfully implements Euro IV heavy-duty emission standards and requires the matching fuel (50 ppm) for diesel grades by 2021, but no effort to promote trucks' fuel efficiency.
- **Moderate:** Assumes that Indonesia implements the moderate scenarios requires Euro VI emission and ultralow-sulfur fuel (10 ppm) by 2030 and implements fuel efficiency standards and truck fleet modernization program starting from 2025.
- **World Class:** Assumes that Indonesia leapfrogs to the Euro VI emission and ultra-sulfur fuel (10 ppm) directly by 2023, phases in stringent fuel efficiency standards and implements aggressive truck fleet modernization together from 2023 as well.

Table 13: BAU and mitigation scenarios

| Scenario | Fleet renewal program | Fuel efficiency standards/green freight program | Vehicle emission standards | Ultralow-sulfur fuel |
|--------------------------------|---|---|--------------------------------|---|
| Baseline Scenario (BAU) | N/A | N/A | 2010: Euro II 2021: Euro IV | 2018: CN 53: 300 ppm CN 51: 1,200 ppm CN 48: 1,200-2,500 ppm 2021: 50 ppm |
| Moderate | Scrap 20+ pre-Euro trucks by 2025 Scrap 15+ Euro II trucks by 2030 | 1.5% annual improvement from 2025 | 2025: Euro V 2030: Euro VI | 2030: 10 ppm |
| World Class | Scrap 20+ trucks by 2023 Scrap pre-Euro trucks by 2025 Scrap 15+ Euro II trucks by 2027 | 3% annual improvement from 2023 | 2023: Euro VI | 2023: 10 ppm |

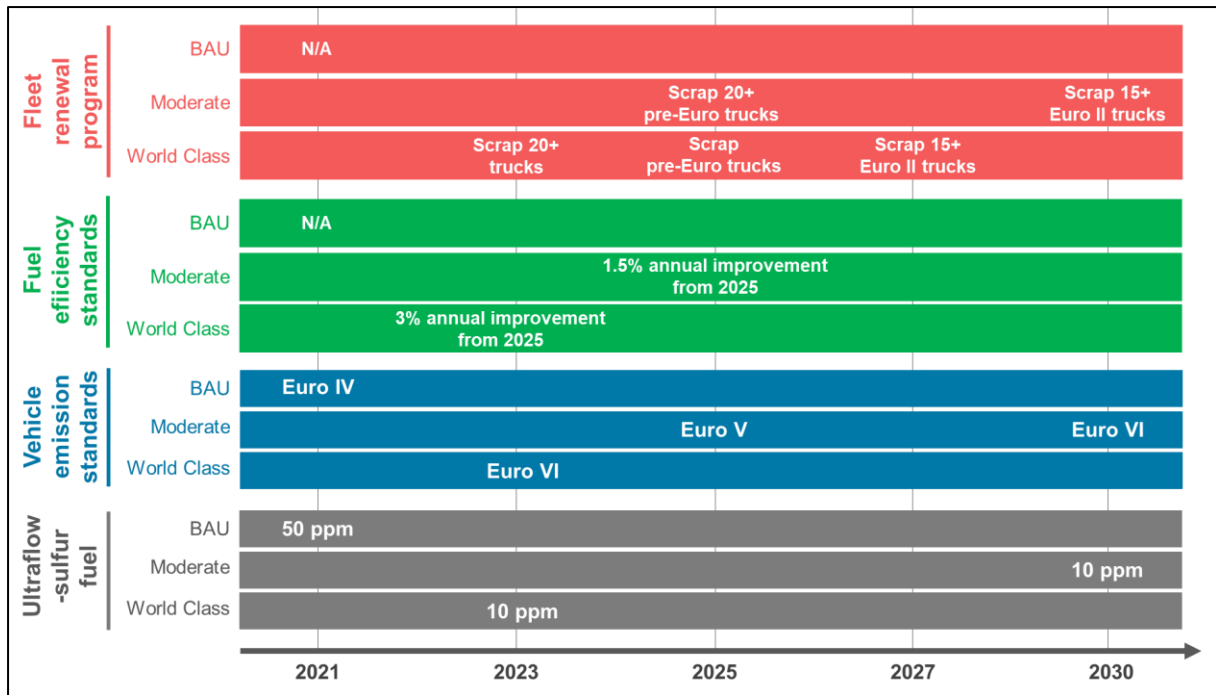


Figure 26: BAU and mitigation scenarios

The scenarios and **assumptions** defined provide a good indication of the possible mitigation strategies adopted in the truck fleet modernization program. Nonetheless, the ex-ante calculations necessarily require a set of assumptions and simplifications to be feasible. Uncertainties include:

- The study assumes that **all trucks scrapped in the fleet renewal program will be replaced by the new ones complying the emission standards and fuel efficiency standards in time**. The users' choice of buying second-hand vehicles are not included.
- **The change of activity due to the fleet renewal program and fuel efficiency standards have not yet been taken into account** due to a lack of good enough data for decent estimation. Replaced trucks, with better fuel economy, can lead to more frequent use and/or longer driving distance that might increase the average vehicle kilometer traveled.
- The study assumes that **all trucks used in Indonesia comply with the fuel efficiency and tailpipe emission standards through the entire lifetime**. The stringent standards on fuel consumption and tailpipe air pollutions comes with comprehensive requirements on in-use performance which includes but not limiting to inspection and maintenance (I&M) program, on-board diagnostic (OBD) system and anti-tampering provisions. Those elements are considered in our modeling process based on the real-world information collected in the regions where equivalent standards are implemented.

6.3.2 Methodology for calculation

GHG emissions and local pollutants were derived using **bottom-up fleet modeling**, based on the forecast of Indonesia's vehicle market growth. The sales projection used in the model is consistent with the studies from the IEA (Abergel et al., 2017; IEA, 2017). Energy consumption and emissions come from the product of travel distance, fuel efficiency/emission factors and fuel sulfur effects.

The estimation approach of the fleet renewal program that old, dirty vehicles will leave the fleet earlier than their natural retirement pattern. The model scraps the vehicles that meet the scrappage requirements out of the fleet and replaces them with the ones complying with the latest emissions standards available on the market.

The **total driving distance (in vehicle kilometer travelled (VKT))** of trucks in Indonesia is calculated as the product between vehicle stock and average annual travel distance, where vehicle stock comes from the registration information and average annual travel distance can be collected from odometer reading and/or surveys¹³.

$$VKT_{\text{vehicle, year, fuel, age}} = \text{Annual travel distance}_{\text{vehicle, year, fuel, age}} * \text{Stock}_{\text{vehicle, year, fuel, age}}$$

Where:

VKT = total vehicle kilometers travelled for modeled vehicle, fuel type, age and calendar year

The model calculates the **energy usage, emissions and local pollutants** by using the VKT and emission factors/fuel efficiency associated with the standards implemented for the year.

$$\text{Energy}_{\text{vehicle, year, fuel, age}} = VKT_{\text{vehicle, year, fuel, age}} * \text{fuel efficiency}_{\text{vehicle, year, fuel, age}}$$

$$\text{Emissions/local pollutants}_{\text{vehicle, year, fuel, age}} = \text{energy}_{\text{vehicle, year, fuel, age}} * \text{emission rates}_{\text{vehicle, year, fuel, age}}$$

Where:

Energy = total energy estimated for modeled vehicle, fuel type, age and calendar year

Emissions/local pollutants = total emissions or local pollutants estimated for modeled vehicle, fuel type, age and calendar year

In the analysis of BAU and mitigation scenarios, fuel efficiency and emission rates used in the calculation reflect the policy efforts proposed.

6.3.3 Data

Data on vehicle sales, stock, fuel blends and fuel quality were obtained from regional sources, including Badan Pusat Statistik—the Statistical Agency of Indonesia (2019), GAIKINDO—the Association of the Indonesian Motor Vehicle Industry (2019), and interviews with key experts. The emission rates used in the analysis are consistent with the ones adopted in ICCT's global estimation (Miller & Jin, 2018; Miller & Jin, 2019). **Other data**, including vehicle mileage and energy consumption, were calibrated to match the data **from the International Energy Agency** (Abergel et al., 2017; IEA, 2017).

Vehicle sales in Indonesia have grown exponentially since the early 1990s, and as illustrated in Figure 27. From 2000 to 2017, **Indonesia's truck sales grew at an annualized rate of 10%**. The ICCT expects that the truck sales will continue to grow in the coming decade, reaching the sales over 400,000 in 2030.

¹³ Collecting the information from odometer during annual registration process is an efficient way of understanding the vehicle usage. This is a widely adopted approach for collecting and validating the usage of on-road vehicles. The other effective approach used often by research agencies is to have in-person survey with the drivers and fleet owners to collect the average annual driving distance.

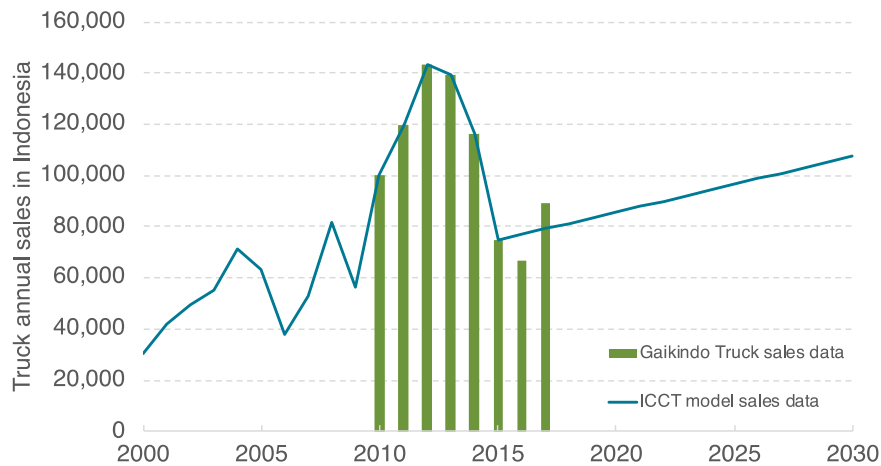


Figure 27: Indonesia truck sales statistic data and model sales data used in the analysis

6.3.4 Expected benefits

GHG mitigation impact

The mitigation action is expected to achieve accumulated CO₂ emission reductions in the range of 1.6 to 23 million tons (Mt) over 10 years between 2020 and 2030. This translates into an annual GHG emission reduction of 7.1 Mt CO₂ in 2030 in the World Class scenario, which is a 10% cut from the BAU scenario.

The benefits come mostly from the implementation of the fuel efficiency standards starting from 2025 in Moderate scenario and from 2023 in World Class scenario. The following table summarizes the cumulative CO₂ reduction in 2025 and 2030 when compared with the BAU scenario.

Table 14: Ex ante GHG Impact Assessment 2020 - 2030

| | Moderate Scenario (in MtCO ₂ accumulated from 2020) | World Class Scenario (in MtCO ₂ accumulated from 2020) |
|-------|---|--|
| @2025 | 0 | 5.5 |
| @2030 | 1.6 | 23 |

Here, the analysis reports the benefits between 2020 and 2030 only. However, many of the measures proposed in the program start right on 2030 or just couple years ahead of 2030 as defined in the scenario above. The impacts of such policies are not fully captured in the assessment. Based on the estimation in 2050, the World Class scenario could save over one-fifth of the CO₂ emissions from the BAU scenario. The estimated annual saving in 2050 is about 25 Mt CO₂, which is larger than the cumulative savings between 2020 and 2030.

Black Carbon

Black carbon (BC), a short-lived climate pollutant, has a global warming potential that is 910–3,200 times that of CO₂ (Bond et al., 2013). Furthermore, when black carbon lands on ice or snow, it reduces reflectivity and favors more sunlight absorption, thus increasing heat and accelerating the melting of glaciers

and ice caps. **The truck modernization program avoids the emission increase shown in the BAU scenario** (Figure 28).

The fleet renewal program, the key element in the truck fleet modernization program, removes old, dirty trucks out of the fleet earlier than their natural retirement, achieve immediate emission reduction along with the replacement of Euro V or Euro VI compliant vehicles. With aggressive truck modernization proposed in the World Class scenario, **over 60% of the BC emissions can be removed in 2030**. Considering BC's strong impacts on climate as well as a fraction of PM_{2.5}, removing BC can significantly improve Indonesia's climate mitigation, air pollution and public health.

Again, Figure 28 highlights that the benefits of the truck fleet modernization program last and further expand beyond the reported timeline (2030).

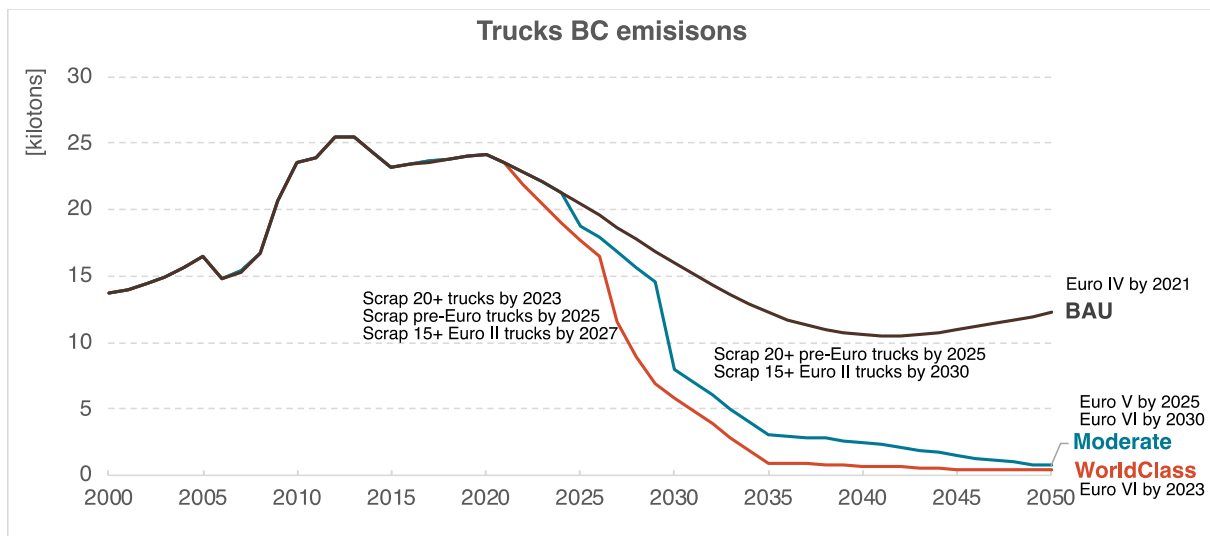


Figure 28: Truck BC emissions in Indonesia, 2000-2050

6.3.4.1 Sustainable development benefits

Operation cost saving

The truck modernization program is expected to generate various sustainability benefits besides GHG emission reductions. **Trucks that comply with Euro V and Euro VI standards tend to have better in-use performance and durability, ensuring lower emissions emitted through the entire lifetime.** The reduction on the local pollutants due to the stringent requirements in the advanced emission control standards will improve Indonesia's air quality and public health. The improved in-use performance of these new Euro V and Euro VI trucks will reduce the needs of repairments, saving operation costs for drivers and truck owners. Further, retiring these old, dirty trucks out of the fleet in advance can potentially increase the road safety and reduce the congestions caused by traffic accidents and incidents. The needs of replacing trucks will support the development and upgrade of truck and engine industry in Indonesia.

Reduced energy demand

Truck modernization can further reduce the energy demand in Indonesia. It can save up to 312 petajoules (PJ) of energy cumulatively with the standards proposed under the World Class scenario, which are about **8,573 million liters of diesel fuels**. Considering that Indonesia largely rely on imports for meeting its domestic fuel demand, the truck modernization program can reduce the reliance of fuel imports and save economically on oil imports.

Social and health benefits

The truck modernization program **yields to tremendous social and health benefits by reducing the local pollutant like PM and NO_x**, both of which are linked to a range of adverse health outcomes. These include systemic heart disease, chronic obstructive pulmonary disease, lung cancer, and ultimately years of life lost to disease and premature death (Chambliss, et al., 2013). Table 15 presents the cumulative pollutants saving in both scenarios. The more stringent requirements proposed in the World Class scenario outweighs the Moderate scenario by approximately three to eight times in emission reduction in between 2020 and 2030. These numbers will be even larger when looking at impacts beyond 2030.

Table 15: Total pollutant emissions avoided in Indonesia from 2020 to 2030 (kilotons)

| | | PM | CO | NO _x | BC |
|---------------------|-------------|----|-----|-----------------|----|
| Truck modernization | Moderate | 21 | 33 | 304 | 17 |
| | World Class | 54 | 250 | 1287 | 47 |

As discussed earlier, the quantitative **analysis focuses on four types of policies**, which are **vehicle emission standards, ultralow-sulfur fuel standards, fuel efficiency standards and scrappage program**. However, many other complementary measures, including but not limiting to in-use compliance, low-emission zones and fiscal incentives, will have positive impacts on implementing the truck modernization program and leads to additional reduction on GHG and local pollutants.

The following table shows a qualitative assessment of the major expected benefits associated with the truck modernization program.

Table 16: Qualitative assessment of co-benefits (sustainable development benefits)

| Main co-benefits | Relative importance | Justification |
|---|---------------------|--|
| Socio-economic | | |
| Decreased travel times and associated economic benefits | High | Traffic congestion can be decreased due to the reduction of traffic incidents and accidents. |
| Reduced stress levels and diseases (and consequent reduced societal health costs) associated with traffic noise/air pollution | High | Long-term impact due to the reduced traffic noise and air pollution |
| Reduced casualties and injuries by accidents | High | Reduced traffic and modernised truck fleet |
| Increased income for logistic industry | High | Rationalised and modernised logistic system will lead to higher revenues and income situations |
| Lower road repairing cost | High | Improved in-use vehicle management program reduce ODOL noncompliant |
| Lower vehicle maintenance and repair fee with newer fleet | High | Modernized truck fleet leads to lower repair needs |
| Improved Indonesia vehicle and engine manufacturers capacity to supply global market | Low | The capacity to supply vehicles that meet Euro VI equivalent standards and stricter efficiency standards |

| | | |
|--|------|--|
| Reduced reliance on fuel imports, and increase energy security | High | Reduce the diesel consumption from trucks. |
| Environmental | | |
| Reduced traffic related air pollution (NO _x , SO _x and PM) | High | Stringent vehicle standards, reduced fuel consumption and emissions due to optimized truck fleet |
| Improved city air quality | High | The establishment of low emission zone will reduce truck impact on air pollution in the city |
| Rational use of scarce resources, e.g. fossil fuels | High | Stringent vehicle standards, reduced fuel consumption and emissions |

6.4 Monitoring and reporting plan

To ensure the success of the proposed program, groups including Indonesia domestic audience, international donor need to work together and report the key information in the program to NDC. Table 17 highlights the **key information that three main target groups might be interested in**. Each of the group has its unique interests in the program but some of which can be overlapped.

Table 17: Targeted groups for reporting

| Target group | Objective | Required information |
|----------------------------|---|---|
| Domestic | Inform domestic planning and decision-making process; respond to stakeholder demand | Indonesia needs to make sure targeted old, dirty vehicles to be removed from the in-use fleet completely and ensure the implementation of stringent emission standards. The country also needs to report the change of the air quality. |
| International donor | Attract climate finance Account for successful implementation | Estimated emission reduction of mitigation actions as well as costs and support needs are key elements in any proposal for international support. |
| NDC | International reporting on efforts to address climate change | Information on mitigation actions in design and implementation phases both have to be reported. |

As part of the truck modernization program, a detailed monitoring plan, including responsibilities and processes will be developed. The monitoring plan will build on the truck modernization structure, with focus on the removal of old, dirty vehicles and replacement of cleaner and efficient ones. The monitoring of implementation progress aims at not only estimating real-world impact on GHG emission reduction, but also impact on criteria pollutant emission reduction.

There are several monitoring tools for regularly collecting data from truck fleet, which are:

- Vehicle registration system and scrappage record to track truck fleet change
- Self-monitoring reports for the truck operators
- Survey of truck operators
- Random and scheduled in-use compliance testing
- Roadside check
- Sample surveys for determining potential adjustments for the program

The ex-post monitoring framework is summarized in the Table 18. The collecting agencies are proposed in the table, but some of the information can be cross verified with information from difference sources. Reporting will take place annually and progress reports will serve as input to the planning meetings.

Table 18: Parameters for GHG impact monitoring

| Data | Indicator | Unit | Source / Data Collection Method | Collection Frequency | Collecting Agency |
|---------------------------------|---|--|--|----------------------------|---|
| Vehicle population | The number of in-use trucks and new registered trucks | No. of vehicles | Through vehicle registration | Annually | Vehicle registration agency |
| Technology Split | The share of trucks certified with each level of emission standards | % Technology type | Vehicle registration forms | Annually | Vehicle registration agency/Environmental protection agency |
| Vehicle age | The vehicle age of in-use trucks | Years | Vehicle registration forms/sample surveys | Annually | Vehicle registration agency/research organization |
| Average retiring age | The age of the trucks when retires | Years | Vehicle scrappage form | Annually | Vehicle registration agency/Environmental protection agency |
| Vehicle trips of trucks | The trips made per vehicle in a specified route/corridor | No. of trips/ Vehicle/yr. | Toll road record/ Sample surveys | Daily/Annually | Highway patrol/research organization |
| Average driving distance | The distance travelled of in-use trucks | km/trip | Odometer measurements/ GPS installations per unit / Sample surveys | Daily/monthly/ annually | Driver/fleet owner/ Vehicle registration agency/Environmental protection agency |
| Fuel consumption | The total fuel consumed per vehicle | Liters | Registration record/Self-monitoring reports from operators | Annually | Vehicle registration agency/research organization |
| Emission factors | The amount of CO ₂ per liter | gCO ₂ /liter; gCO ₂ /MJ | Lab measurement/in-use vehicle testing | Annually/daily | Vehicle registration agency/research organization |

| | | | | | |
|--------------------|--|--|--|------------------------------|--|
| Air quality | Estimated amount (tons) PM, NO _x , SO _x , CO | Mg/m ³ levels for selected pollutants | AQ monitoring stations | Aggregated annually/daily | Vehicle registration agency/research organization |
| Speed | The average speed per vehicle | km/h | Odometer measurements/t oll road monitoring | Daily | Driver/fleet owner/monitori ng system |
| Road safety | Road accidents | # | Based on national statistics | Annually | Highway patrol |

Among all these parameters included in the monitoring system, the data availability and quality vary when used for GHG impacts monitoring. The truck fleet modernization program focuses on the renewal of the fleet by using clean and efficient vehicles, so **it is important to track the new and in-use trucks used in Indonesia**. Vehicle registration agency can easily track the number of in-use fleet, the average age of retired vehicles, the average age of in-use fleet, and the annual driving distance through annual registration. Some other information, such as speed, and fuel consumption requires the support of truck drivers to record the information accordingly on their daily performance.

Research agencies or environmental protection agencies can **run sample surveys and tests to verify the information**. Such sample surveys and tests can be designed to collect emission factors as well, including the CO₂ performance of vehicles. But due to the size of surveys and tests can be limited, the quality of such data might not be representative enough for the program.

Other parameters listed in the table associates with the indirect impacts. The monitoring and reporting system of the air quality is an essential approach to evaluate sustainable development benefits from the program. **Transport agencies, including highway patrol, will support the data collection of speed and accidents, as the information can reveal the impacts on congestion and road safety.**

Even with this detailed monitoring plan designed with agencies and information assigned, **improvements on registration mechanism and in-use vehicle management are expected**. With much of the information can be included in the annual registration process, it is also urgent to develop a platform that could consolidate and publish data on annual base. Similarly, transport data (speed and accidents) collection and monitoring are required in transport agencies and its affiliate agencies, and it requires a solid approach of sharing such data to support direct and indirect monitoring.

Such database can further encourage domestic and international stakeholders to verify the emission reduction and other effects of the truck fleet modernization program. The information published in the database will feed the emissions calculations and other assumptions for Indonesia's future measures.

Bibliography

- Abdurrahman & Febiranty, R. (2016). Analisa tarif ideal angkutan barang lintas Banjarmasin – Palangka Raya. Available at <https://transukma.uniba-bpn.ac.id/index.php/transukma/article/view/50/31> (April 10, 2020)
- Abergel, T., Brown, A., Cazzola, P., Dockweiler, S., Dulac, J., Fernandez Pales, A., . . . West, K. (2017). Energy technology perspectives 2017: Catalysing energy technology transformations. Retrieved from <https://www.iea.org/etp/>
- Allen, H. (2018). Indonesia's traffic and mobility industry prepares for its Intertraffic 2018 showpiece. Retrieved from <https://www.traffictechnologytoday.com/news/smart-cities/indonesias-traffic-and-mobility-industry-prepares-for-its-intertraffic-2018-showpiece.html> February 18, 2020.
- Anenberg, S. Miller, J., Henze, D., Minjares, R. (2019). A global snapshot of the air pollution-relevant health impacts of transportation sector emissions in 2010 and 2015. Retrieved from https://theicct.org/sites/default/files/publications/Global_health_impacts_transport_emissions_2010-2015_20190226.pdf
- ASEAN. (2015). Kuala Lumpur Transport Strategic Plan. Retrieved from https://espas.secure.europarl.europa.eu/orbis/sites/default/files/generated/document/en/KUALA_LUMPUR_TRANSPORT_STRATEGIC_PLAN.pdf
- ASEAN. (2019), ASEAN regional strategy on sustainable land transport. Retrieved from <https://asean.org/storage/2019/03/ASEAN-Regional-Strategy-for-Sustainable-Land-Transport-Final.pdf>
- ASEANStats. (2020). ASEANStatsDataPortal: Transports Statistics. Retrieved from <https://data.aseanstats.org/>. February 20, 2020
- Badan Pembangunan dan Perencanaan Nasional (BAPPENAS) 2014, Laporan Dua Tahun Pelaksanaan Rencana Aksi Nasional dan Rencana Aksi Daerah Gas Rumah Kaca, viewed 18 December 2019, http://ranradgrk.bappenas.go.id/rangrk/admincms/downloads/publications/Laporan_Dua_Tahun_Pelaksanaan_RAN-GRK_RAD-GRK.pdf
- Bennis, L. & Tuijll, V. D. (2016). The Republic of Indonesia study on trade in logistics services analysis. Retrieved from <http://documents.worldbank.org/curated/en/232691540822189989/Analysis>
- Blankenship, L 2012, 'Indonesia's Economy Booms in 2011', globalEDGE, 2 August, p.1, viewed 2 January 2020, <https://globaledge.msu.edu/blog/post/1233/indonesias-economy-booms-in-2011>
- Bond (2013). Bond, T. C., Doherty, S. J., Fahey, D. W., Forster, P. M., Berntsen, T., DeAngelo, B. J., ... Kinne, S. (2013). Bounding the role of black carbon in the climate system: A scientific assessment. *Journal of Geophysical Research: Atmospheres*, 118(11), 5380-5552. doi: 10.1002/jgrd.50171
- Breuer, L, Guajardo, J, Kinda, T, 2018, Realizing Indonesia's Economic Potential, Retrieved from <https://www.elibrary.imf.org/view/IMF071/24870-9781484337141/24870-9781484337141/ch2.xml?redirect=true> (2 January 2020)
- Bureau of Transportation Statistics. (2017). Average truck speeds on select interstate highways: 2017. Available at <https://www.bts.gov/average-truck-speeds-select-interstate-highways-2017> (April 10, 2020)
- California Air Resources Board, 2007. The Carl Moyer Program 2006 Status Report. January, 2007. Retrieved from http://www.arb.ca.gov/msprog/moyer/status/2006status_report.pdf

- California Air Resources Board, 2011. The Carl Moyer Program Guidelines. April 28, 2011. Retrieved from http://www.arb.ca.gov/msprog/moyer/guidelines/2011gl/2011cmpgl_10_30_13.pdf
- Central Bank of Indonesia (Bank Indonesia). (2016). Laporan Perekonomian Indonesia 2019 (Indonesian Economic Report 2019 2015). Retrieved from https://www.bi.go.id/id/publikasi/laporan-tahunan/perekonomian/Pages/LPI_2015.aspx
- Central Bank of Indonesia (Bank Indonesia). (2020). Laporan Perekonomian Indonesia 2019 (Indonesian Economic Report 2019). Retrieved from https://www.bi.go.id/id/publikasi/laporan-tahunan/perekonomian/Pages/LPI_2019.aspx
- Chambliss, S., Miller, J., Façanha, C., Minjares, R., & Blumberg, K. (2013). The impact of stringent fuel and vehicle standards on premature mortality and emissions. Retrieved from the International Council on Clean Transportation, https://www.theicct.org/sites/default/files/publications/ICCT_HealthClimateRoadmap_2013_revised.pdf
- Cui, H., Posada, F., Lv, Z., Shao, Z., Yang, L., Liu, H. (2018). Cost-benefit assessment of the China VI emission standard for new heavy-duty vehicles. Retrieved from https://theicct.org/sites/default/files/publications/China_VI_cost_benefit_assessment_20180910.pdf
- Delgado, O. & Rodriguez, F. (2018). CO₂ emissions and fuel consumption standards for heavy-duty vehicles in the European Union. Available at https://theicct.org/sites/default/files/publications/Efficiency_standards_HDVs_EU_Briefing_051618.pdf (April 10, 2020)
- EU 2019/1242. (2019). Setting CO₂ emission performance standards for new heavy-duty vehicles and amending Regulations (EC) No 595/2009 and (EU) 2018/956 of the European Parliament and of the Council and Council Directive 96/53/EC.
- GAIKINDO (Association of the Indonesian Motor Vehicle Industry) and AISI (the Indonesian Motorcycle Industry Association). (2019). Produksi kendaraan bermotor dalam negeri (unit), 2000-2016 (Production of domestic motor vehicles [units], 2000-2016). Retrieved from <https://www.bps.go.id/statictable/2017/11/23/1981/produksi-kendaraan-bermotor-dalam-negeriunit-2000-2016.html>
- GIZ. (2019). Moving towards green logistics in Indonesia- A status analysis. Sector baseline analysis and identification of main challenges and action levers for green freight transport in Indonesia. April 2019.
- Gonder, J., Earleywind, M., & Sparks, W. (2012). Analyzing vehicle fuel saving opportunities through intelligent driver feedback. National Renewable Energy Laboratory.
- ICCT. (2015). United States efficiency and greenhouse gas emission regulations for model year 2018-2027 heavy-duty vehicles, engines, and trailers. Available at https://theicct.org/sites/default/files/publications/ICCT-update_US-HDV-Ph2-NPRM_jun2015_v2.pdf (April 10, 2020)
- Indonesia government. (2009). Indonesia Climate Change Sectoral Roadmap. Retrieved from https://www.adaptation-undp.org/sites/default/files/downloads/indonesia_climate_change_sectoral_roadmap_iccsr.pdf February, 27, 2020
- Indonesia government. (2011). Pedoman Pelaksanaan Rencana Aksi Penurunan Emisi Gas Rumah Kaca (RAN-GRK).
- Indonesia government. (2016). Pedoman Kaji Ulang Rencana Aksi Daerah Penurunan Emisi Gas Rumah Kaca (RAD-GRK).
- Indonesia statistics agency. (2020). 2020 statistical yearbook of Indonesia.

- International Energy Agency. (2017). World energy balances 2017. Retrieved from <https://www.iea.org/statistics/balances/>
- Kumparan 2019, 'Ada 7,4 juta truk di RI, 63 persen berusia diatas 10 tahun', 17 April, p.1, viewed 13 January 2020, <https://kumparan.com/kumparanbisnis/ada-7-4-juta-truk-di-ri-63-persen-berusia-di-atas-10-tahun-1qqFtp011uU>
- Meeuws, R. (2014). How the road freight transport sector can contribute to the reduction of logistics costs in Indonesia.
- Miller, J. & Facanha, C. (2014). The state of clean transport policy: A 2014 synthesis of vehicle and fuel policy developments. Available at <https://theicct.org/publications/state-clean-transport-policy-2014-synthesis-vehicle-and-fuel-policy-developments> (April 10, 2020)
- Miller, J., & Jin, L. (2018). Global progress toward soot-free diesel vehicles in 2018. Retrieved from the International Council on Clean Transportation <https://www.theicct.org/publications/globalprogress-toward-soot-free-diesel-vehicles-2018>
- Miller, J., & Jin, L. (2019). Global progress toward soot-free diesel vehicles in 2019. Retrieved from the International Council on Clean Transportation <https://theicct.org/publications/globalprogress-toward-soot-free-diesel-vehicles-2019>
- Ministry of Environment and Forestry (MoEF) 2018, Statistics 2018 Directorate General of Climate Change Control, viewed 11 December 2019, http://ditjenppi.menlhk.go.id/reddplus/images/adminppi/dokumen/statistik_PPI_2018_opt.pdf
- Ministry of Environment and Forestry (MoEF), (2017), Report of greenhouse gas inventory, monitoring, and reporting 2017, Retrieved from http://ditjenppi.menlhk.go.id/reddplus/images/adminppi/dokumen/lap_igrk_2018.pdf December 11, 2019.
- Motoris 2019, 'Indonesia kekurangan supir truk, ini penyebabnya', 5 October, p.1, viewed 13 January 2020, <https://www.motoris.id/industri/28458/indonesia-kekurangan-supir-truk-ini-penyebabnya/>
- Mulia, K. (2019). Smart logistics is the Indonesian digital economy's up-and-coming sector. Available at <https://kr-asia.com/smart-logistics-is-the-indonesian-digital-economy-s-up-and-coming-sector> (April 8, 2020)
- OEC. (2019). OEC-Indonesia. <https://oec.world/en/profile/country/idn/#Origins>
- OICA. (2019). Motorization rate 2015-worldwide. Retrieved from <http://www.oica.net/category/vehicles-in-use/> (October 10, 2019)
- Parikesit, D. (2020). Interview with Pak Danang Parikesit, the head of BPJT. February 4, 2020.
- Pindyck, R. (2019). The social cost of carbon revisited. Journal of Environmental Economics and Management, Volume 94, March 2019, Pages 140-160.
- Plecher, H. (2019). Total population of the ASEAN countries from 2008 to 2018. Retrieved from <https://www.statista.com/statistics/796222/total-population-of-the-asean-countries/> February 20, 2020.
- Posada, F., Chambliss, S., & Blumberg, K. (2016). Costs of emission reduction technologies for heavy-duty diesel vehicles. Retrieved from <http://www.theicct.org/costs-emission-reduction-tech-hdvs>
- Posada, F., Wagner, V. D., Bansal, G., & Fernandez, R. (2015). Survey of best practices in reducing emission through vehicle replacement programs. ICCT. Retrieved from <https://theicct.org/publications/survey-best-practices-reducing-emissions-through-vehicle-replacement-programs>
- Purba, S. J. (2020). Interview with Jahannes Samsi Purba, the Executive Director of APRTINDO. February 5, 2020.

- Rinaldi, M (2019a). ‘There are 15 million drivers of goods transport that must be certified!’, *Ekonomi*, 16 September, p. 1, viewed 13 January 2019, <https://ekonomi.bisnis.com/read/20190916/98/1148659/ada-15-juta-sopir-angkutan-barang-yang-wajib-bersertifikat>
- Rinaldi, M. (2019b). Aprindo Complains about Lack of Truck Drivers. 11 August 2019, Retrieved from <https://ekonomi.bisnis.com/read/20190811/98/1135070/aptrindo-keluhkan-minimnya-pengemudi-truk>
- Ritase. (2020). Our history. Available at <https://ritase.com/about-ritase/> (April 8, 2020)
- Reuters. (2019). Indonesia GDP shows weakest growth in over two years. *Nikkei Asian Review* November 5, 2019. Retrieved from <https://asia.nikkei.com/Economy/Indonesia-GDP-shows-weakest-growth-in-over-two-years>
- Safrudin, A., Palguna, A., Adrison, V., Khoirunurrofik, Haryanto, B., Krisnawati, L., Zakaria, M., Hamonangan, E., Nurafiatin, L., Suhud, M., Reksowardojo, A., and Huda, A. (2013). Cost-Benefit Analysis for Fuel Quality and Fuel Economy Initiative in Indonesia. Jakarta, Indonesia: Ministry of Environment, Assistant Deputy for Mobile Source Emission.
- Sari, S. et al. (2018). Infrastructure improvement: Logistics performance starting to get competitive. Translated by PWC.
- Shao, Z., Chambliss, S., & Bandivadekar, A. (2016). India heavy-duty fleet modernization program—a scrappage program combined with accelerated adoption of Bharat Stage VI emission standards. Retrieved from the International Council on Clean Transportation, https://theicct.org/sites/default/files/publications/ICCT_HDV-fleet-renewal-India_20160610_vF.pdf
- Shao, Z., Miller, J. & Jin, L. (2020). Soot-free road transport in Indonesia: A cost-benefit analysis and implications for fuel policy. Retrieved from <https://theicct.org/sites/default/files/publications/Indonesia-sootfree-CBA-02182020.pdf>
- Shao, Z., Yang, Z., Cui, H. (2017). Cost-benefit analysis of early implementation of the China 6 light-duty vehicle emission standard in Guangdong Province. Retrieved from https://theicct.org/sites/default/files/publications/CBA-LDV-China-6-GP_ICCT-Working-Paper_09082017_vF_updated.pdf
- Statistical Agency of Indonesia (Badan Pusat Statistik). (2016). Indonesia Statistics 2016 (Statistik Indonesia 2016). Retrieved from <https://www.bps.go.id/publication/2016/06/29/7aa1e8f93b4148234a9b4bc3/statistik-indonesia-2016.html>
- Statistical Agency of Indonesia (Badan Pusat Statistik). (2020). Quarterly GDP at 2010 Constant Prices by Business Field (Billion Rupiahs), 2014–2019 (PDB Triwulanan Atas Dasar Harga Konstan 2010 Menurut Lapangan Usaha (Miliar Rupiah, 2014–2019). Retrieved from <https://www.bps.go.id/linkTableDinamis/view/id/827>
- Sudjana, G. B. (2011). Road transport of goods in Indonesia: infrastructure, regulatory and bribery costs. *Business and Entrepreneurial Review*.
- Sullings, G. (2019). Indonesia’s ‘Trans-Java Toll Road’ Infrastructural Development Project (2011–2019). Retrieved from <https://www.centreforpublicimpact.org/case-study/indonesias-trans-java-toll-road-infrastructural-development-project-2011-2019/>
- USDOE. (2018). Average Annual Vehicle Miles Traveled by Major Vehicle Categories. Alternative Fuels Data Center. Retrieved from <https://afdc.energy.gov/data/> February 27, 2020
- World Bank (2013). State of logistics Indonesia 2013. Washington DC; World Bank. Retrieved from <http://documents.worldbank.org/curated/en/208191468254039925/pdf/808710WP0logis0Box0379822B00PUBLIC0.pdf>

- World Bank (2015a). “Improving Indonesia’s Freight logistics a plan for action.” Jakarta: The World Bank.
- World Bank (2015b). State of logistics Indonesia 2015. Washington DC; World Bank. Retrieved from <http://indodutchmaritimesecretariat.com/download/9/>
- World Bank. (2016). The Republic of Indonesia study on trade in logistics services analysis. 7 December 2016.
- World Bank. (2019). Global rankings 2018. Retrieved from <https://lpi.worldbank.org/international/global/2018>
- World Resource Institute (2017). Evaluating Indonesia’s Progress on its Climate Commitments. Retrieved from <https://www.wri.org/blog/2017/10/evaluating-indonesias-progress-its-climate-commitments>
- Zuhriyah, D. A. (2018), Aturan tarif angkutan barang: Kemenhub Bahas Usulan Pengusaha Truk. Available at <https://kalimantan.bisnis.com/read/20180118/450/727630/aturan-tarif-angkutan-barang-kemenhub-bahas-usulan-pengusaha-truk> (April 10, 2020)

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