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Sustainable Infrastructure Programme in Asia

DECARBONISING PATHWAYS FOR FREIGHT TRANSPORT IN THE PHILIPPINES

Synthesis of project results

On behalf of:

Federal Ministry
for the Environment, Nature Conservation
and Nuclear Safety

of the Federal Republic of Germany

IKI INTERNATIONAL CLIMATE INITIATIVE

OECD

OUTLINE

- SIPA-TRANSPORT FOR THE PHILIPPINES
- TAILORED ITF GLOBAL FREIGHT MODEL FOR THE PHILIPPINES
- SCENARIO DESIGN
- SCENARIO RESULTS
- KEY TAKEAWAYS BY SCENARIO
- SCENARIO EXPLORATION TOOL

DECARBONISING PATHWAYS FOR FREIGHT TRANSPORT IN THE PHILIPPINES

This publication presents the results of the Philippines' national road map study under the Sustainable Infrastructure Programme in Asia (SIPA).

It features the three policy scenarios' impacts on the Philippines' freight transport emissions, demand, costs and travel times. In light of these results, the ITF developed a list of policy recommendations to promote and facilitate the implementation of more ambitious decarbonising policies in the Philippines' freight transport sector.

For more details, see:

https://www.itf-oecd.org/decarbonising-pathways-freight-transport-philippines

Policy recommendations for the Philippines

ROAD FREIGHT

- Follow international best practices in adopting fuel economy standards for trucks. Fuel economy standards can promote fuel-saving measures such as aerodynamic retrofits, vehicle weight reductions, engine efficiency improvements and hybridisation.
- Identify use cases for early adoption of zero-emission trucks in the Philippines and incentivise fleet conversions. Supporting pilot projects and offering purchase subsidies for electric trucks can promote low-carbon technologies in road transport.
- Promote private investments in charging infrastructure for depot-based vehicles with predictable, short-distance mission profiles, which are candidates for early electrification. Prepare the build-out of public chargers suitable for electric trucks along transport corridors.

SEA FREIGHT

- Promote efficient ships, for example, with differentiated port fees depending on the environmental performance of vessels and investment incentives. Explore use cases for ships with alternative powertrain technology, for example, in short-sea shipping.
- Invest in port capacity expansions and maximise utilising existing assets to enable maritime transport to capture a higher modal share. Ships are the most energy-efficient freight transport mode, and increasing their use can reduce overall transport energy use and emissions.

LOGISTICS AND DIGITALISATION

- Streamline and digitalise processes to reduce dwell times at cargo transfer points. This can smooth intermodal transport chains and reduce overall energy use and emissions if increasing the share of efficient modes.
- Incentivise and enable asset sharing, for example through promoting digital technologies and platforms to connect logistics operators. Asset sharing between operators can reduce empty running of trucks and increase load factors, lowering fuel use and emissions per cargo unit.

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SIPA-Transport for The Philippines

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SIPA – Transport

- The ITF leads the transport pillar of the **"Sustainable Infrastructure Programme in Asia" (SIPA)**, a four-year programme (2021-25) led by the OECD to encourage the transition towards cleaner energy, transport and industrial systems in **Central Asia** and **Southeast Asia**.
- SIPA-Transport focuses on sustainable transport infrastructure development in Central Asia and Southeast Asia, with studies covering regional and national levels.

Regional studies

Assess the potential of major transport infrastructure programs in **Southeast** and **Central Asia** to enhance connectivity and minimise environmental impact. This project will analyse existing and upcoming transport infrastructure projects in the region and evaluate their impacts using scenario analysis. The study will benchmark national freight transport policies to OECD standards, focusing on reducing CO_2 emissions from infrastructure construction and operation.

National studies

Develop sustainable transport roadmaps tailored to **Mongolia**, **the Philippines** and **Uzbekistan**. The focus of the roadmap will be developed in consultation with national stakeholders to identify relevant transport sub-sectors, transport modes, geographic scope, and suitable technologies and policies for implementation.

The Philippines' National Roadmap Study

The study is composed of three Parts:

1. **Understanding the freight transport context in the Philippines.** Make an inventory of current policy priorities and ongoing initiatives through data collection and information gathering.

2. **Quantitative assessment of decarbonisation pathways for the Philippines.** Define effective pathways for reducing CO_2 emissions in the freight transport sector using the ITF's existing modelling framework.

3. **Dissemination of best practices about low-carbon freight transport systems.** Share identified best practices, particularly among other interested stakeholders in the Philippines or the Southeast Asia region.

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Tailored ITF Global Freight Model for The Philippines

Introduction to the ITF PASTA Global Freight Model

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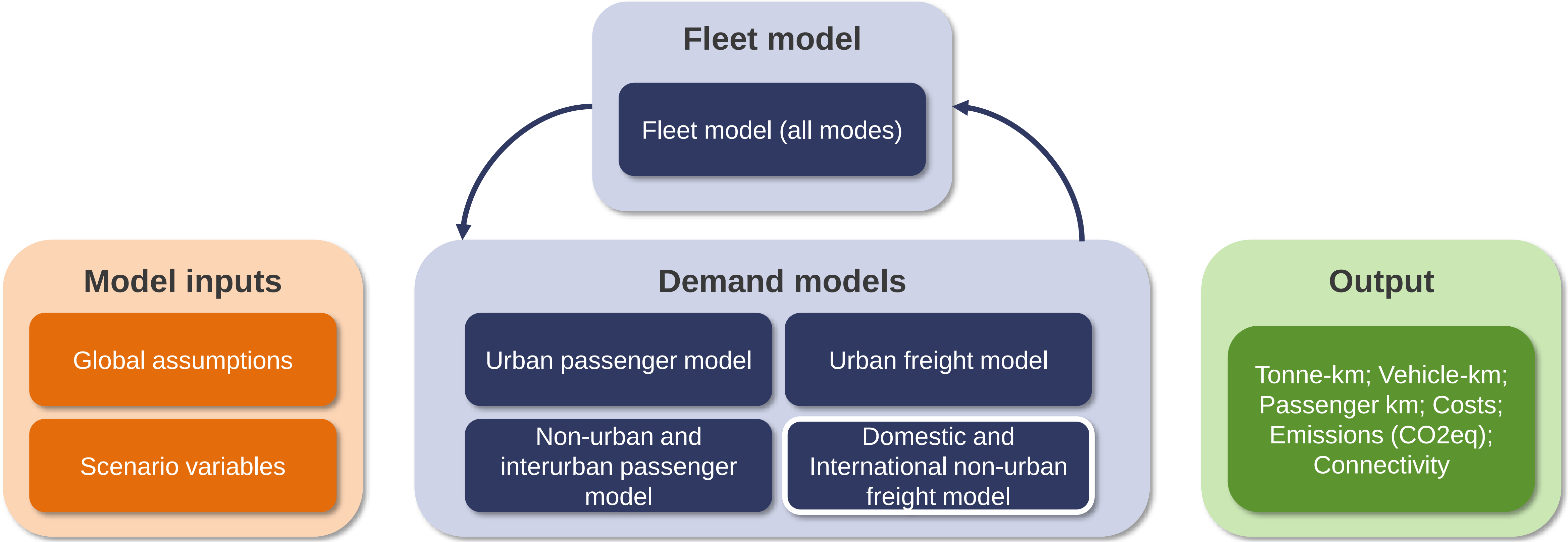
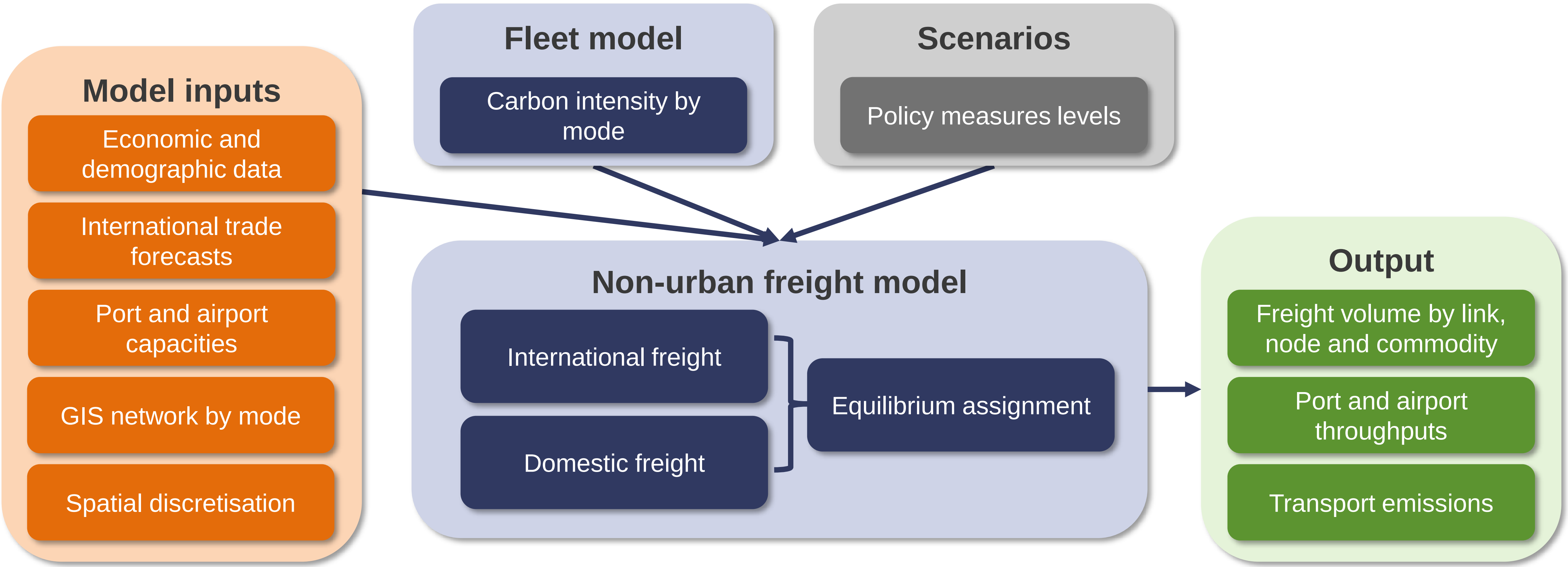
What is ITF PASTA?

- ITF's Global Freight Model is one of five models that make up the **ITF Policy Ambitions and Sustainable Transport Assessment (PASTA)** framework
- The tailored freight transport model for the Philippines is built on the **ITF's Global Freight Model**, allowing the assessment of the impact of various policies and measures on transport demand, mode shares and CO_2 emissions.



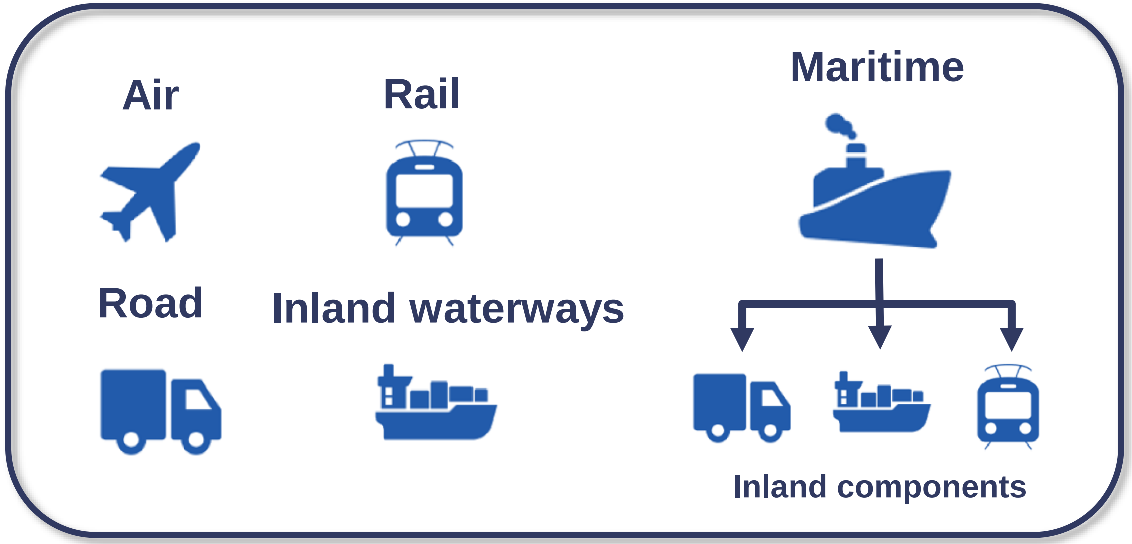
ITF non-urban freight model components

- It is a **fully integrated multi-modal network model** that assigns freight flows on all major transport modes to specific routes, modes, and network links.



International Freight Model

International centroids



- The model disaggregates the origin-destination (OD) trade flows into the set of production and consumption centroids defined in the spatial discretisation model. The discretisation allows for a proper breakdown of the travel path used for different types of products and leads to a better representation of actual freight flows.

- The underlying trade projections of the model are disaggregated in 26 world regions, assuming proportionality of trade to GDP. The commodity shares are also calculated according to the GDP created within the respective economic sector.

- The model computes the free flow shortest paths between all centroids for each transport mode, generating the cost, travel time, and distance by mode to link each pair of centroids.

Domestic Freight Model

Domestic centroids

- As no trade estimates between the different cities of any region are available, the model departs from the total freight activity estimation and follows a gravitational model to understand how the total trade splits into an OD matrix between the domestic freight centroids.
- Total surface freight activity is estimated by country, encompassing transport of international and domestic nature, plus urban freight transport.
- Domestic freight activity is estimated in alignment with international freight activity estimates and domestic freight weights. The shortest paths between all centroids within the same countries are computed for all existent surface modes (road, rail and waterways), considering their cost and travel time.

Equilibrium assignment

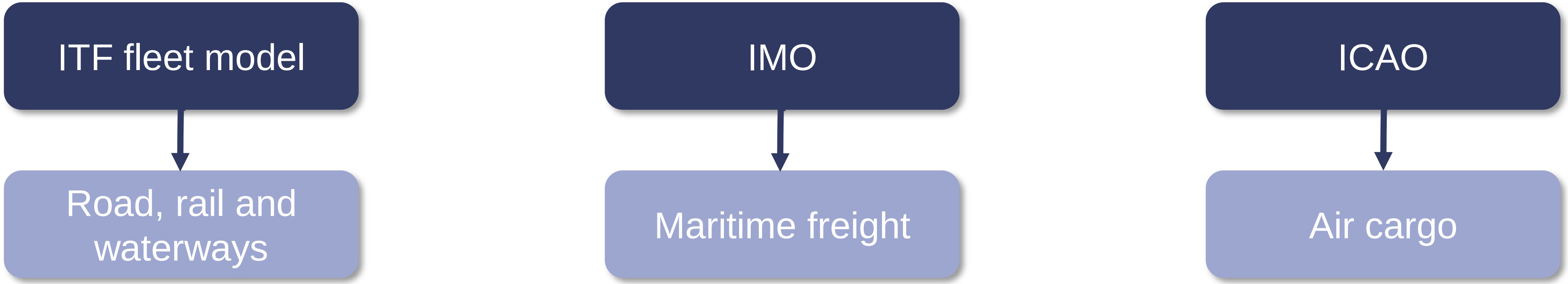
The model uses an iterative equilibrium assignment procedure with travel time and cost updates at every iteration, conducted every 5 years

- Every iteration incorporates updates in travel times, costs, transport infrastructure, port capacity and throughput in line with the development calendar. Freight transport activity by mode is assigned to the shortest/least costly path, based on minimising the generalised cost.
- In the case of maritime shipments, a route choice model considers the available alternatives for port selection and transhipment options for every OD pair. Introducing this procedure in the overall equilibrium assignment reduces the number of iterations required to converge. The shortest path algorithm is computed between ports to generate the port-to-port segments to create routing alternatives between each pair of centroids. This procedure considers both direct routing and indirect routing via a transhipment port.
- At every iteration, the equilibrium assignment produces an all-or-nothing assignment of all transport alternatives simultaneously. The model runs until there is a convergence of travel costs of all alternative paths for the same OD pair.

Output calculation

- The model provides tonne-kilometres (tkm) and vehicle-kilometres (vkm) for each link and centroid in the freight network, disaggregated by transport mode and commodity. This allows calculating the corresponding values for different origin-destination pairs and routes.
- CO_2 emissions are estimated for each commodity via transport activity in tkm or vkm, depending on the mode. For road transport, CO_2 is estimated via vkm, using specific load factors of trucks for the different types of commodities. Other modes of transport use tkm to determine CO_2 emissions.
- Load factors change over time as operational improvements in freight transport are assumed to happen. These will allow reducing empty vehicle kilometres and better using vehicle volumes.

Respective CO_2 intensities per tkm were obtained from:



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Outputs

Transport output

- Freight flows by origin-destination links, commodities and transport modes
- Throughputs by node
- Utilisation rate of infrastructure and potential bottlenecks
- Modal split by country, region or total

Connectivity output

- Connectivity index of a country
- Assessment of the access to world markets

Environmental output

- CO_2 well-to-wheel emissions
- Local pollutants
- Activity and emissions by vehicle type and distance

Policy output

- Evaluation of current policies
- Projection of the impact of alternative policy pathways
- Relevant and quantifiable policy recommendations

Tailored ITF Global Freight Model for The Philippines

Updates to the ITF Global Freight Model

Trade updates

- Trade data are a central pillar in the non-urban freight model that must be updated at each iteration to capture new trends. International trade data by country is used to calibrate the model and serve as a benchmark for its results.
- First, it is most important to identify data requirements for updating shapefiles and trade data used in the model. The ITF requests access to the required data and processes it, ensuring its quality and compatibility with the in-house models.
- Given the difference in commodity categorisation between the ITF model and the countries' national accounts, the second step is matching the trade data provided by stakeholders to ITF's commodity groups.
- Finally, international trade data by commodity type and transport mode is introduced in the model to calibrate it.

Step 1:
Data collection and validation

→

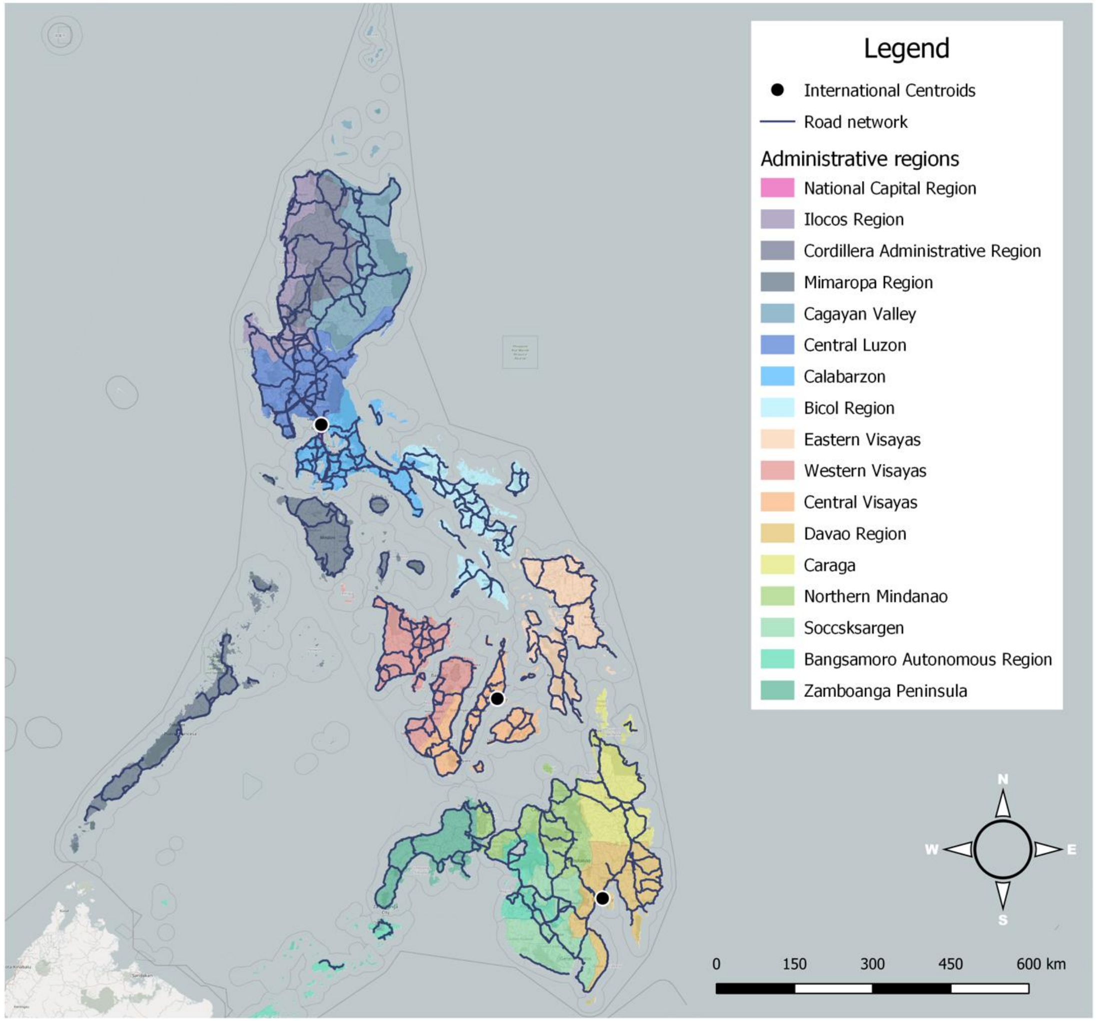
Step 2:
Match major types of goods in the model with those identified by national statistics authorities

→

Step 3:
Update international trade by commodity type and transport mode

Centroid updates

Map of the Philippines and administrative regions



Source: Department of Transportation, International Transport Forum, Open Street Map (2023)

- The number of centroids was re-evaluated to increase possible origin-destination links for international trade and maximise the use of data provided by local stakeholders.
- There are currently three international centroids in the archipelago, each representing one group of islands. Thus, there are three centroids: Manila (**Luzon**), Cebu City (**Visayas**) and Davao (**Mindanao**).
- Domestic centroids were equally updated. Using data from stakeholders, the ITF team updated the capacity of the existing domestic centroid in the model.

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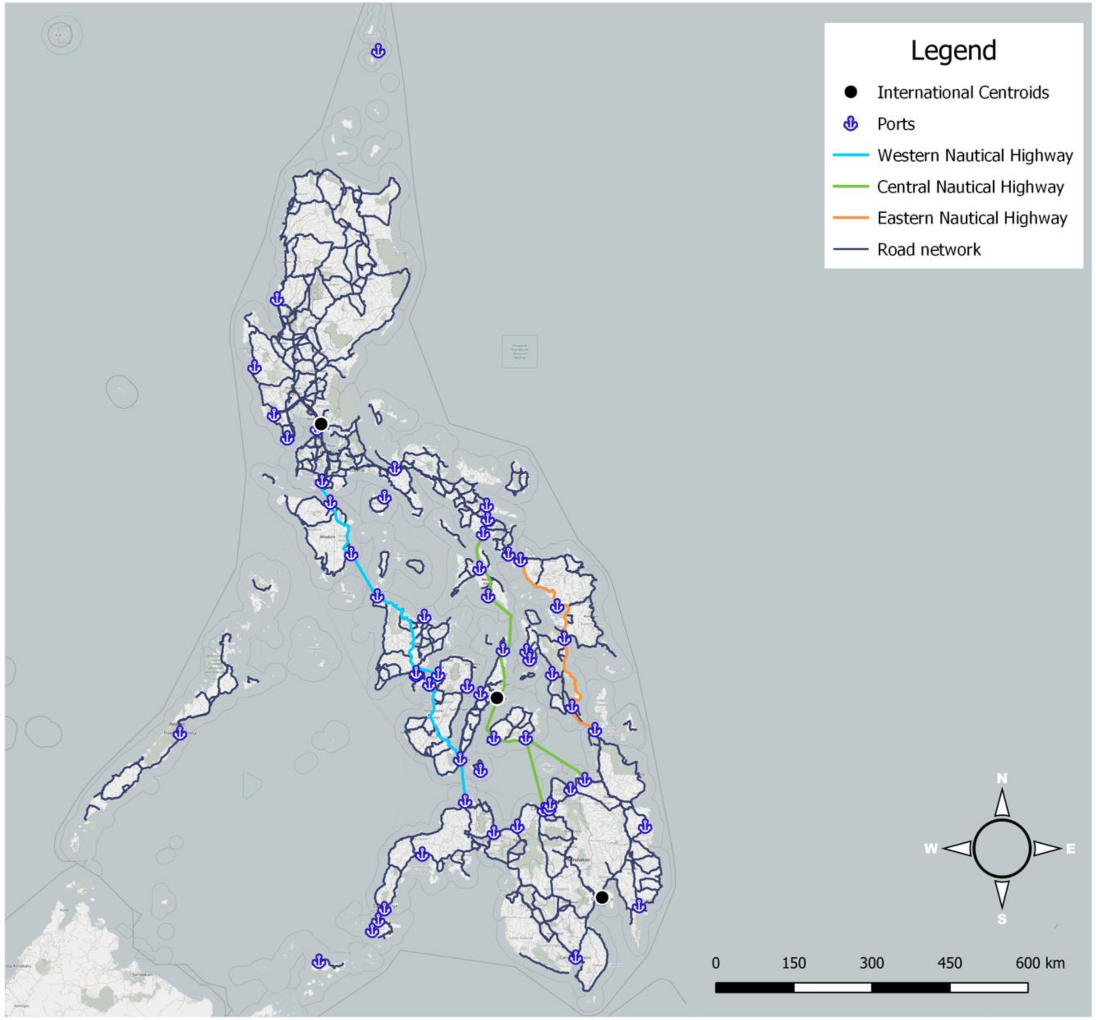
Nautical highways

Philippines nautical highways

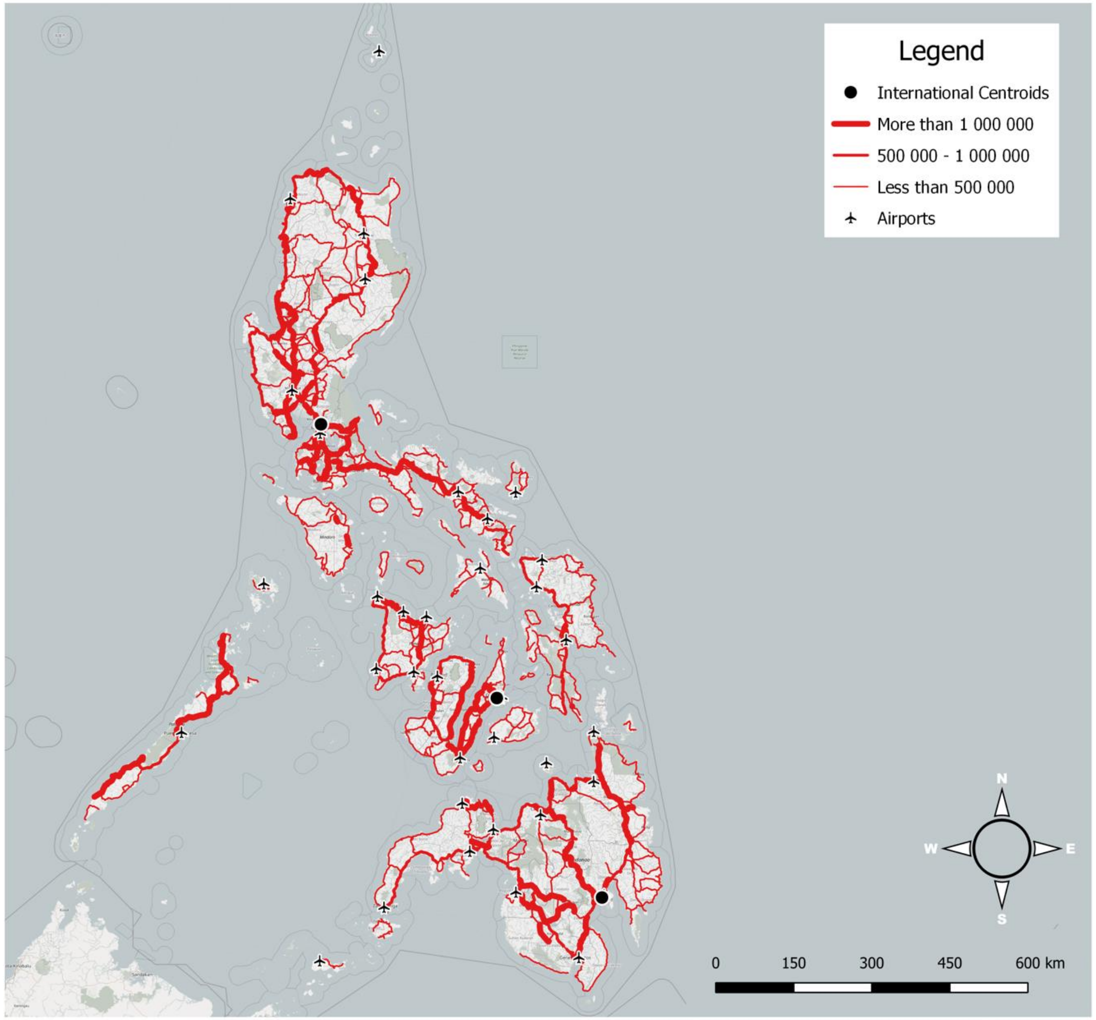


Source: Department of Transportation, International Transport Forum, Open Street Map (2023)

- One of the most important updates to the model consists of the inclusion of the three main nautical highways of the Philippines. These key roll-on-roll-off corridors are an essential component of the country's connectivity and are vital for domestic trade.
- The **western** nautical highway comprises approximately 130 nautical miles and 535 km of road and links 8 ports in the model. It connects the islands of Luzon, Mindoro, Panay, Negros and Mindanao.
- The **central** nautical highway extends approximately 190 nautical miles and 260 km of road. It connects a total of 11 ports in the model, distributed in Luzon, Masbate, Cebu, Bohol and Mindanao.
- The **eastern** nautical highway includes about 53 nautical miles and 415 road km. Being the shortest one, it links 4 ports in the model. This highway connects Luzon, Samar, Leyte and Mindanao.

Network updates – Part 1

Philippines road network by capacity and airports



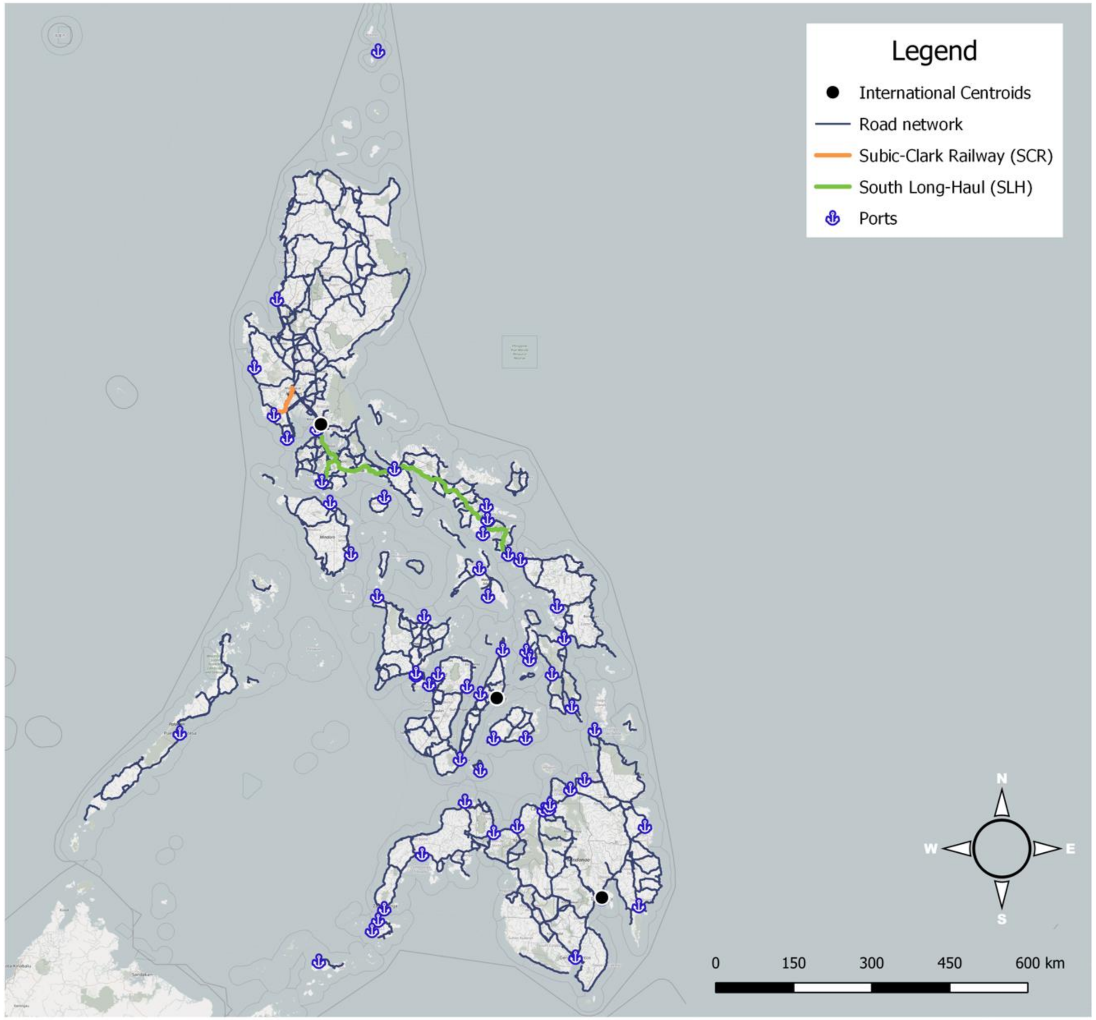
Source: Department of Transportation, International Transport Forum, Open Street Map (2023)

Transport infrastructure updates encompassed three main tasks: road capacity, the number of ports and airports, and rail infrastructure.

1. Road-specific characteristics, like the number of lanes and speed limit, were updated. These variables are crucial for the model to assign trade flows throughout the road network. Capacity is measured by the number of trucks circulating in a specific segment. The national model identifies 4 main road transport corridors distributed on the islands of Luzon, Panay, Cebu and Mindanao.

Network updates – Part 2

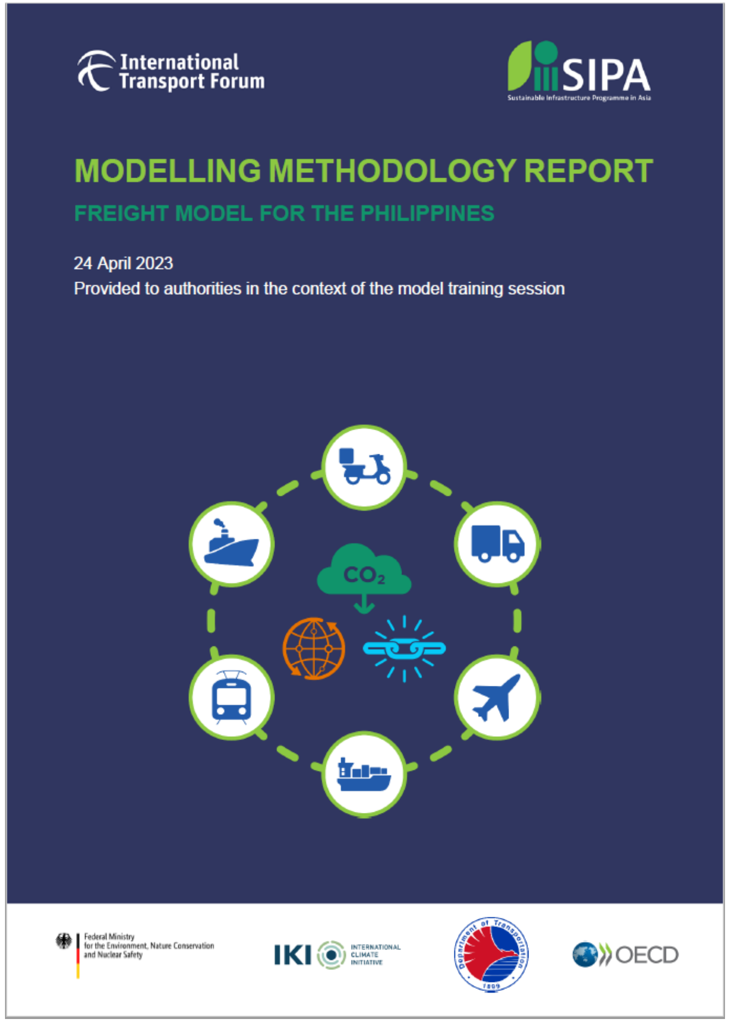
Philippines rail network



Source: Department of Transportation, International Transport Forum, Open Street Map (2023)

2. Additional entry/exit points to/from the Philippines for the international movement of goods were considered. In total, 12 new ports were included in the model. These new ports allow the model to capture better international trade and freight transport through nautical highways.
3. Rail infrastructure updates were made based on stakeholder consultations and desk research. Two rail corridor proposals, the SCR and SLH, were kept in the model with additional information on the estimated year to begin operations, capacity, speed and factors influencing costs.

Methodology Note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MODELLING METHODOLOGY REPORT

FREIGHT MODEL FOR THE PHILIPPINES

24 April 2023

Provided to authorities in the context of the model training session

For details related to the modelling steps, please consult/download the **Methodology Note**.

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Scenario Design

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Policy Scenarios for CO_2 Reduction

- A scenario is defined by a set of policy and technology measures and their level of implementation up to 2030 and 2050. The scenarios explore possible alternative futures, their impacts on the transport system and their externalities.
- The ITF designed **three scenarios to assess the CO_2 reduction potential** of different policy pathways.

Current ambition
Where we are heading

Climate ambition
How far we must go

Level of measure implementation

As expected / planned

Enhanced + New fleet measures considered

Enhanced + New intermodality measures considered

How did we build the Current Policy scenario?

In collaboration with Philippines stakeholders, the ITF team

1. Analysed **current transport policies** for the Philippines
2. Reviewed the planned evolution of the **transport network** in the coming years
3. Updated **international trade** data by commodity and mode
4. Inclusion of the three main **nautical highways** and other ferry connections

Combining the effects of each measure, we projected the CO_2 emissions of the transport sector in the Philippines between 2019 and 2050

Current transport policies

This scenario presents the **evolution of CO_2 emissions** if the **current measures** are implemented as planned, but further actions are not considered.

Technology stocks target for the LCV fleet	Rail freight expansions	Road upgrades	Eco-driving	Improving intermodal dwell time	Change in the energy mix
Target level: 10-30% zero-emission LCV sales/registrations between 2030 and 2050. (implementation starts in 2025).	Two new rail lines in Luzon (SCR and SLH); operational by 2026.	From provincial to tertiary road: 10-30% by 2030 and 2050. From tertiary to secondary road: 30-50% in 2030 and 2050. From secondary to primary road: 10-30% in 2030 and 30-50% in 2050.	This has already been implemented. This policy has the potential of reducing CO2 emissions by 1-2.5% in 2030 and by 5% in 2050.	Truck-to-port: reduced by 20% in 2030 and by 45% in 2050. Rail-to-port: reduced by 20% in 2030 and 2050. Shipping-to-port: reduced by 20% in 2030 and by 45% in 2050.	A decrease in oil and coal trade is expected to start by 2025.

Two Climate Ambition Scenarios

Green fleet:

Vehicle technology improvements through truck fleet renewal

Stricter fuel economy standards for diesel trucks

Fleet renewal/vessel refurbishment to reduce the share of fuel-oil-intensive ships

Green fleet: scenario measures

Truck fleet renewal

Truck fleet renewal schemes aim to increase demand for technologies that reduce the environmental impact of road transport and mobilise the required capital to ensure the supply of cleaner vehicles and the energy vectors they need. Renewal schemes reduce road freight's life-cycle greenhouse gas (GHG) emissions intensity by incentivising replacing the most polluting old trucks. Old vehicles tend to be heavier and more dependent on highly polluting fuels and technologies, like internal combustion engines (ICEV) for diesel and gasoline. These lead to high CO_2 and NOx tank-to-wheel (TTW) emissions. In contrast, newer trucks are lighter and implement cleaner technologies that significantly reduce TTW emissions. Plug-in hybrid electric vehicles (PHEV) and battery electric vehicles (BEV) have proved to reduce emissions during their use to offset any additional manufacturing GHG emissions. Economic incentives can be used to increase the competitiveness of clean vehicle technologies.

Fuel economy standards

Mandatory vehicle efficiency standards require newly registered vehicles to emit less tailpipe CO_2 emissions than a specified threshold value (usually specified in gCO2/km or similar) by a particular target date. Alternatively, such standards may be expressed as fuel economy standards that require vehicles to surpass a specific fuel-efficiency value (usually provided in miles/gallon fuel or similar). A vehicle's tailpipe CO_2 emissions and fuel consumption are typically assessed in standardised laboratory vehicle test procedures.

Fleet renewal and vessel refurbishment

This measure aims at incentivising the replacement of old operating vessels, or vessel parts, to incorporate new technologies that increase fuel efficiency. Some technological measures that reduce CO_2 emissions from maritime trade involve exhaust gas heat recovery as a source of energy, air lubrication, wind assistance for ships, and automated monitoring and control systems. Vessel design is equally important, with significant GHG emission reductions when implementing bulbous bows to reduce friction, slender structures, optimising hull length and fullness, lighter materials and larger vessels to maximise the efficiency per unit of work. Incentives for promoting the uptake of alternative fuels and renewable energy also help the decarbonisation of the sector. Advanced biofuels are already available and can be complemented with other natural or synthetic fuels to compensate for their scarcity.

Two Climate Ambition Scenarios

Seamless Intermodality:

Infrastructure improvement to increase port capacity

Infrastructure improvement to reduce dwell times

Asset sharing to increase load factors

Seamless intermodality: scenario measures (1)

Increasing port capacity

This measure consists of increasing port infrastructure investment to improve port capacity and competitiveness. Additional sub-measures are essential to complement capacity expansions, including reduction of frictions and delays in maritime and road transport (i.e. through dredging, signalling, new road-rail access, and dry ports, etc.), new or improved road and rail network (e.g. urban bypass or dedicated rail infrastructure), and regulatory or management measures (e.g. port management system, truck queuing/appointment, etc.). Increasing the port capacity allow terminals to increase international or domestic throughputs.

Decreasing dwell times

Dwell time refers to the time spent by shipped goods in a multi-modal freight interface to be transferred between different modes of transport. Reducing the transit time associated with intermodal transport lowers costs and the carbon footprint of freight transport while increasing capacity and reliability. Multi-modal transfers can be more efficient when improving one of their three components. First, investments in infrastructure facilitate access for different transport modes to the node and can expand its capacity. The construction of dry ports and inland terminals associated with ports is a clear example of how to better connect maritime with surface freight. Second, improving information exchange and synchro modality between operators, using advanced Information and Communication Technologies (ICT) and the Internet of Things (IoT) also contribute to more seamless interfaces. Finally, institutional alignment is also required, not only between operators but also at a higher intergovernmental level.

High capacity vehicles

Increasing the capacity of the vehicles can reduce the associated emissions by reducing the vehicle kilometres required to transport the same amount of tonnes. In a seamless intermodality scenario, a shift to high-capacity vehicles can increase efficiencies.

Seamless intermodality: scenario measures (2)

Asset sharing

Sharing assets (e.g. information flows, transport mechanisms or stocking spaces) can promote efficiency in resource management for logistic activities. One same enterprise, or several of them, can benefit from this sharing of assets. ICTs have only facilitated asset-sharing by decreasing information costs and providing platforms where various actors can share their assets. From an environmental point of view, sharing assets can increase logistic efficiencies by raising the occupancy rate of vehicles, for instance. Multimodality towards less carbon-intensive modes is also a possibility. Ultimately, improvements can reduce the number of trips required to deliver goods, thus reducing emissions linked to logistic activities. Asset sharing can also bring additional benefits. Costs for enterprises can be reduced by increasing efficiencies by decreasing fuel consumption. Improvements linked to asset-sharing measures will depend on the type of activities led by the enterprises that decide to share assets. For example, sharing transport assets between food and industrial goods transporters will be more challenging. Governments may need to consider appropriate competition regulations to facilitate such asset sharing and may need to consider how such actions could be enabled (e.g. through digital platforms).

Slow and smart steaming

Slow steaming is the practice of reducing maritime vehicle speeds. By operating ships at significantly slower speeds than their maximum speed, less fuel is consumed. This results in reduced CO2 emissions. Slow steaming has been widely adopted since 2007, mainly due to the increased fuel costs at the time. Different ship types benefit differently from slow steaming (ITF, 2023). Besides financial benefits, regulation of ship speeds could also be used to encourage slow steaming. There is also a possibility of using fuel levies to induce slow speeding through the increases in fuel prices (OECD/ITF, 2018).

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Scenario Results

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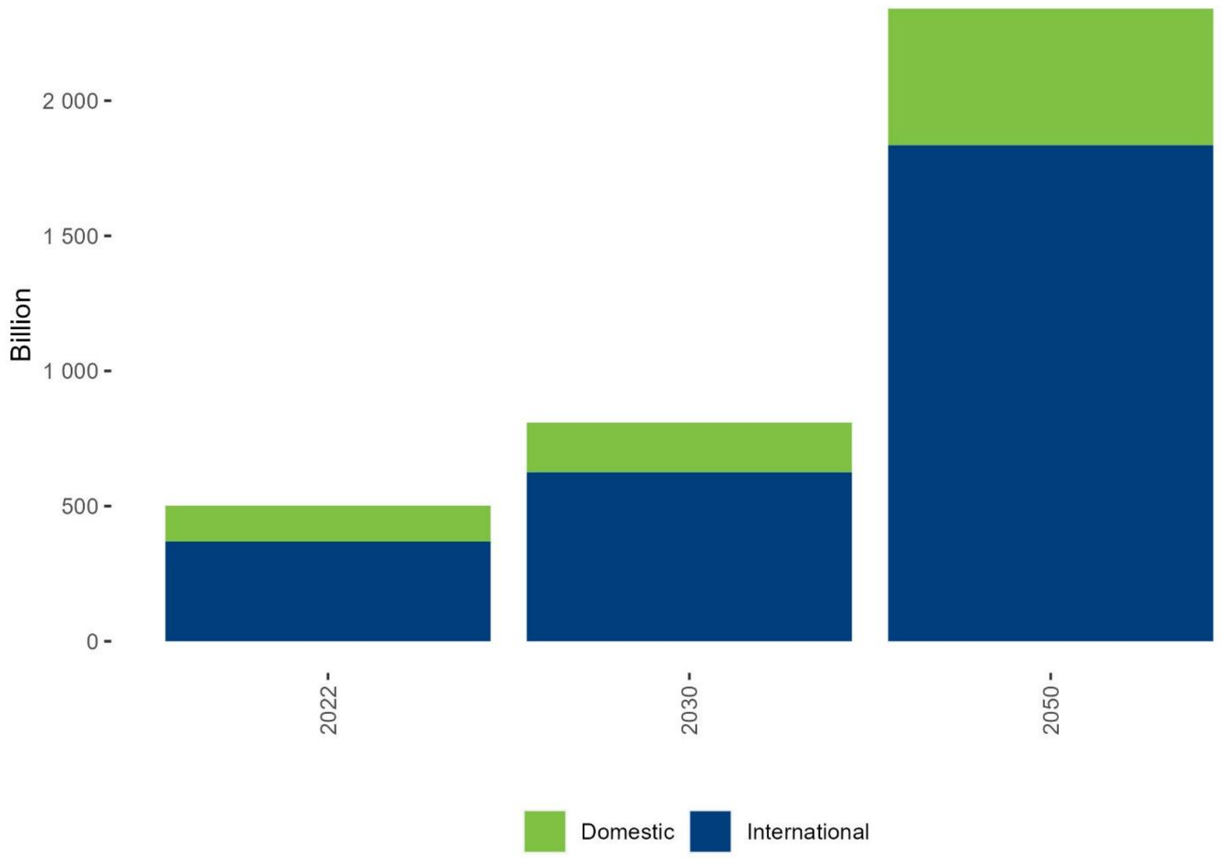
Freight transport is set to more than quadruple until 2050

- Transport activity in the Philippines is set to more than quadruple by 2050, accounting for more than 2 trillion tonne-kilometres under the current policy scenario.
- Economic growth in the region is the key driver, but it is also facilitated by infrastructure investment and regional connectivity.
- This growth splits mode or less evenly between domestic and international freight, yet international freight expects a higher absolute growth since it starts from a higher base.

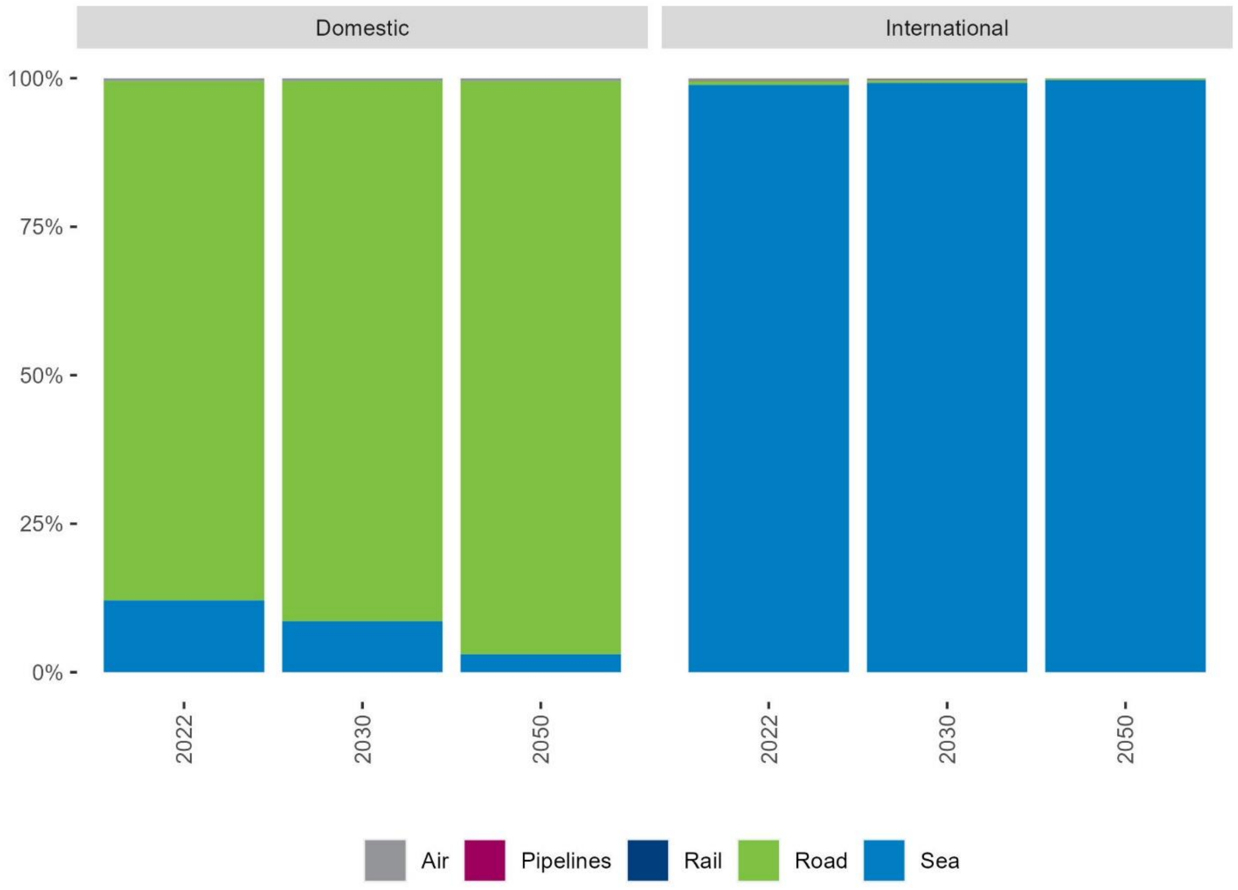
Total Freight Transport in Current Ambition Scenario (tkm)



Trucks and ships remain the main transport modes

- Most domestic transport is serviced by trucks, while ships dominate international transport to and from the country.
- Under current policies, trucks will take over 90% of domestic freight by 2050. Freight rail and air cargo will represent only marginal modal shares. The rail network will remain small despite investments. Air cargo tends to transport high-value light goods and, therefore, only has a marginal tkm share.
- Sea-born freight dominates international trade, as the Philippines has no terrestrial links to its neighbours.

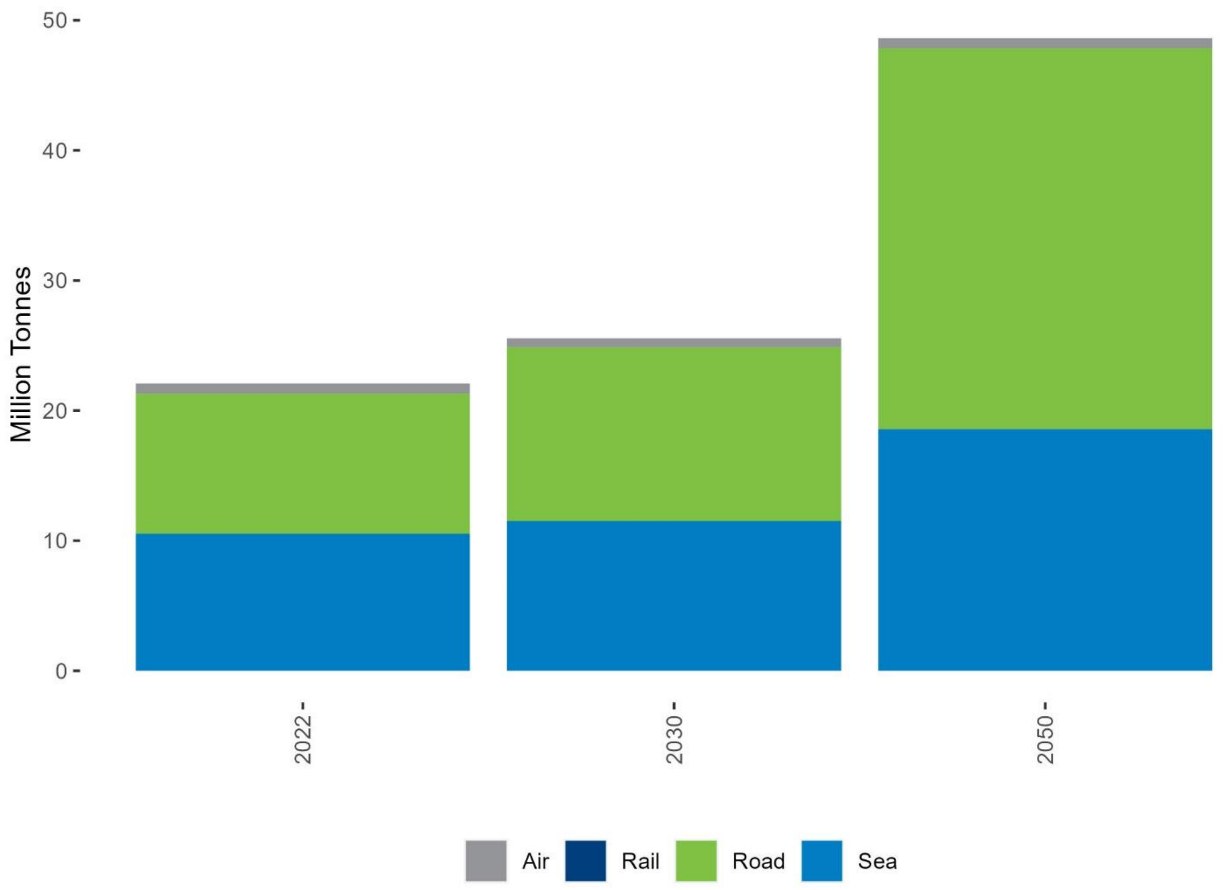
Freight transport modal share by year (based on tkm)



Tank-to-wheel emissions to reach 50 million tCO_2 by 2050

- Projections show that the transport sector in the Philippines will emit 50 million tonnes of CO_2 by 2050, doubling from current levels.
- Most of the emissions growth will come from the road sector, even though road represents a smaller share of total freight transport than maritime trade.
- This is because road transport is more carbon-intense than sea transport. The same activity increase in both modes will represent a proportionally higher increase in road emissions.
- Decarbonising road transport becomes a priority to slow down the projected emissions growth.

CO_2 emissions by transport mode and year (ttw)



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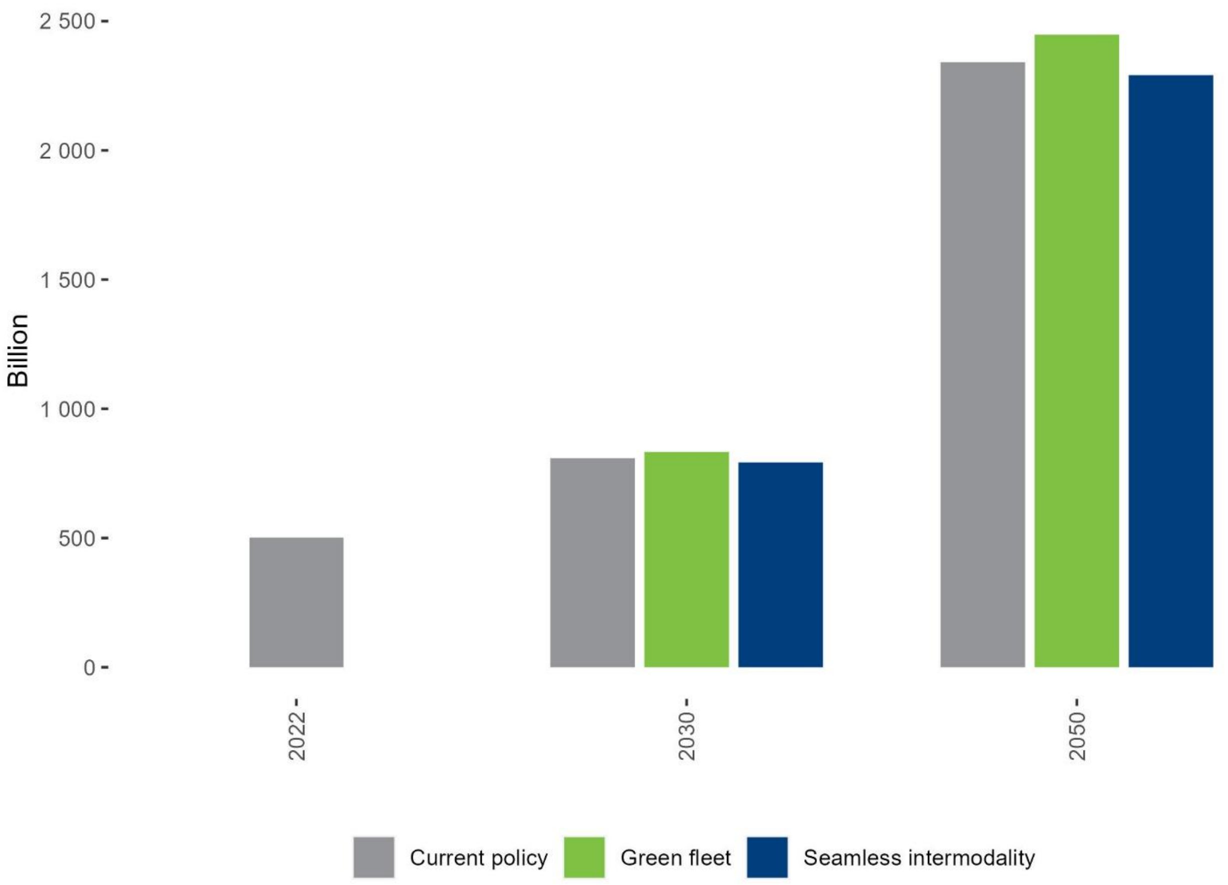
Transport decarbonising policies do not oppress growth

- Measures were grouped into two scenarios, Green Fleet and Seamless Intermodality, to assess how different measure packages could shape the trajectory of freight.
- Projections show that investing in more efficient trucks and vessels does have minor effects on transport activity; the same applies to promoting modal shifts towards more efficient modes.
- However, a slight reduction of tkm reflects more direct shipping routes thanks to port upgrades. The slight increase in green fleet is because the scenarios look at measures in isolation – the high ambition scenarios exclude some parameters considered in the current ambition scenarios.

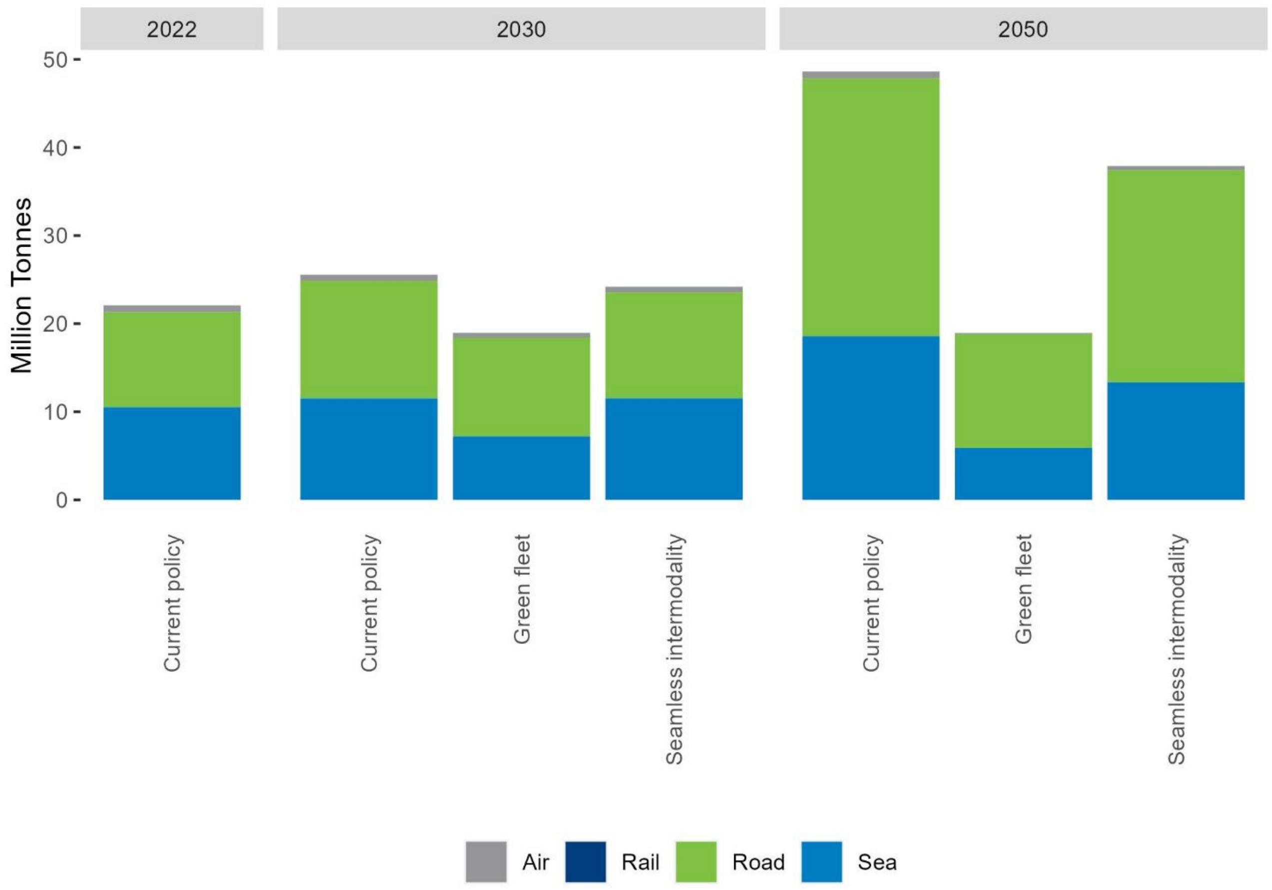
Freight transport by scenario and year (tkm)



Ambitious freight policies can halve sector emissions

- Scenario results show that road freight will become the most polluting transport mode by 2050. However, low-carbon measures can contain the mode's emission growth.
- Investing in more efficient trucks and ships can reduce emissions by 61% in 2050, below current levels, as shown by the results of the Green Fleet scenario. Savings from seamless intermodal transport, equal to 22%, are lower than in the Green Fleet scenario.
- Zero-emission trucks are the most effective measures to decarbonise freight transport, given the importance of this mode in the Philippines and the high carbon intensity of this sector.

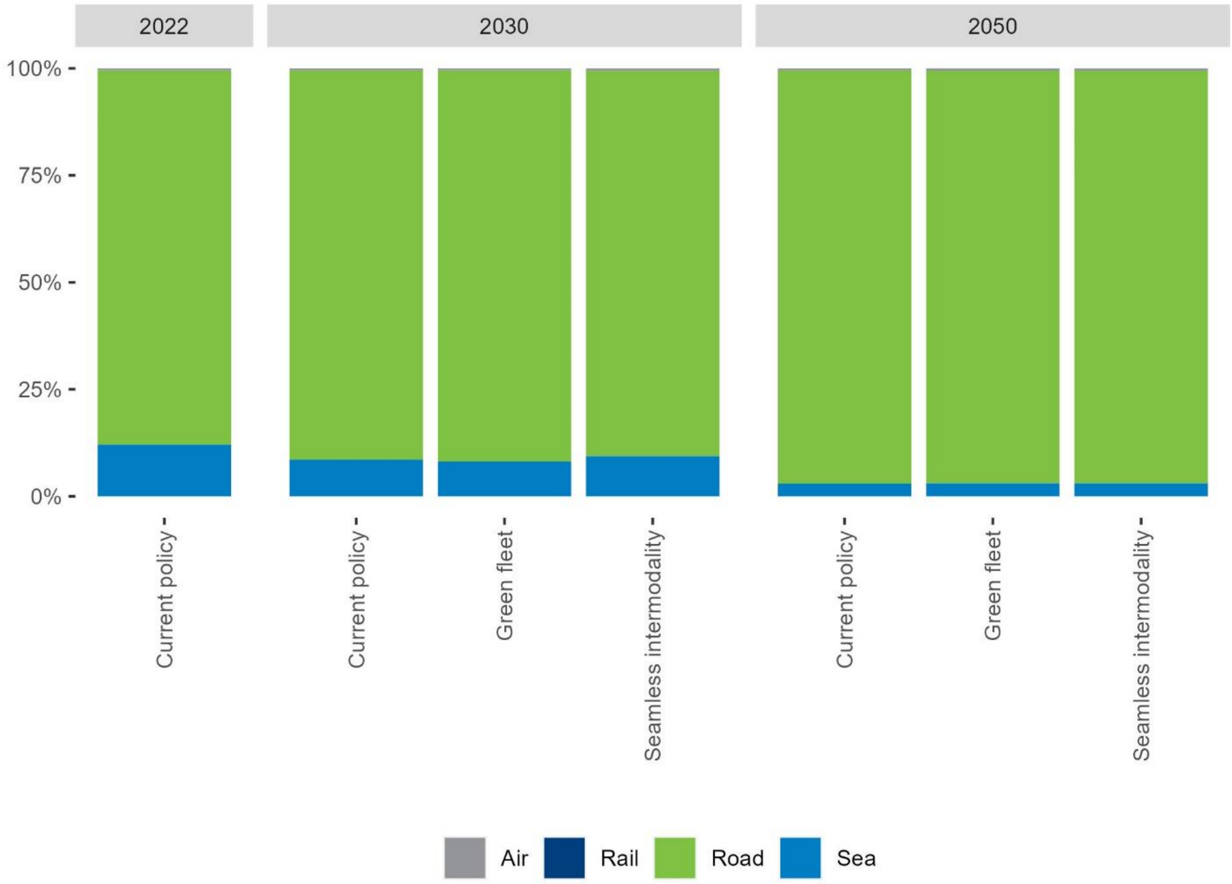
CO_2 emissions by year and scenario (ttw)



Modal shares do not vary significantly between scenarios

- Road freight will increase its modal share until 2050 in all scenarios, displacing more efficient modes.
- Ambitious low-carbon policies can reduce impacts from the sector. The measures included in the Green Fleet scenario tackle the problem directly, reducing the carbon intensity of trucks and vessels.
- The Seamless Intermodality scenario realises savings through more efficient transport flows, for example, increasing the load factors of trucks, reducing waiting times, and enabling more direct transport routes.

Modal share by year and scenario (based on tkm)



Key Takeaways by Scenario

Green Fleet Scenario: Calls-to-action

1. **Follow international best practices in adopting fuel economy or CO_2 emission standards for trucks.**
2. **Identify use cases for early adoption of zero-emission trucks in the Philippines and incentivise fleet conversions.**
3. **Promote efficient ships, for example, with differentiated port fees depending on the environmental performance of vessels and investment incentives.**

Seamless Intermodality Scenario : Calls-to-action

1. **Invest in port capacity expansions and maximise utilisation of existing assets to enable maritime transport to capture a higher modal share.**

2. **Streamline and digitalise processes to reduce dwell times at cargo transfer points.**

3. **Incentivise and enable asset sharing, for example through promoting digital technologies and platforms to connect logistics operators.**

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Scenario Exploration Tool

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Introduction to the dashboard

Components

Background datasheets

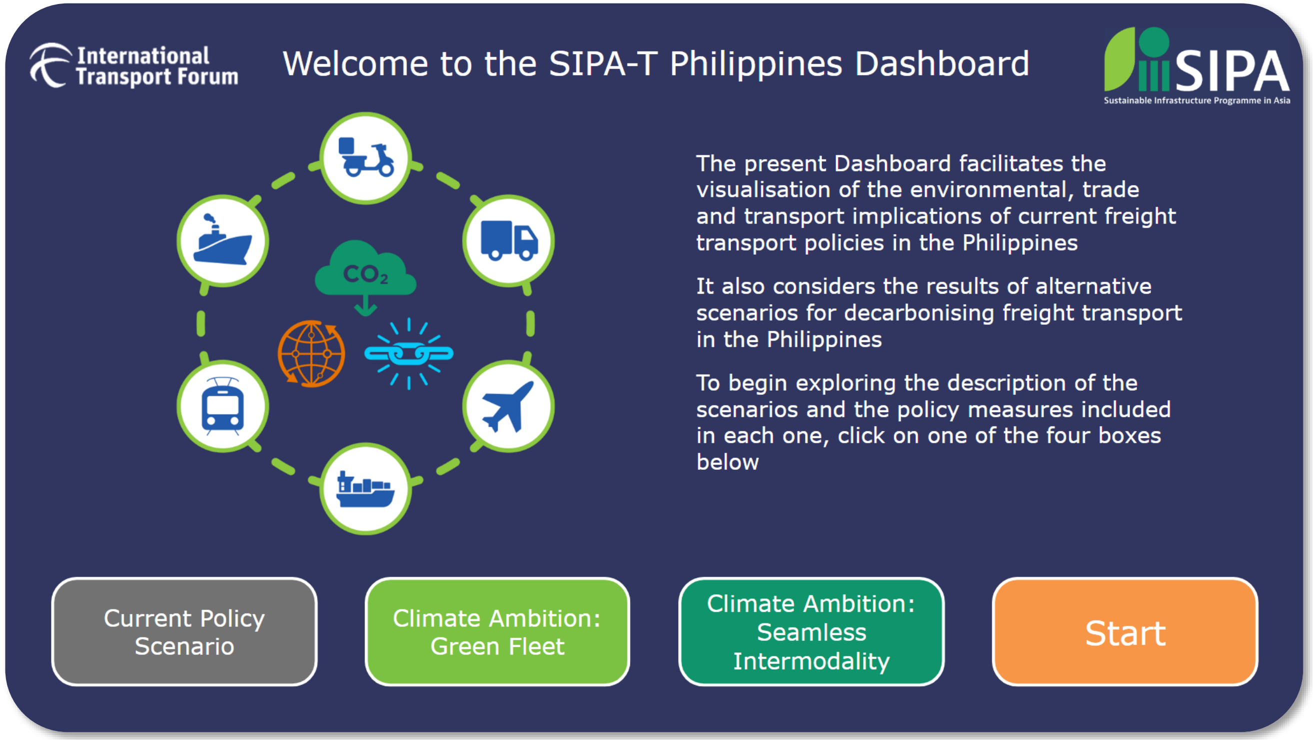
Composed of direct results from the model and divided into tables according to the needs

Metadata

Includes the scenario description and the overall framework

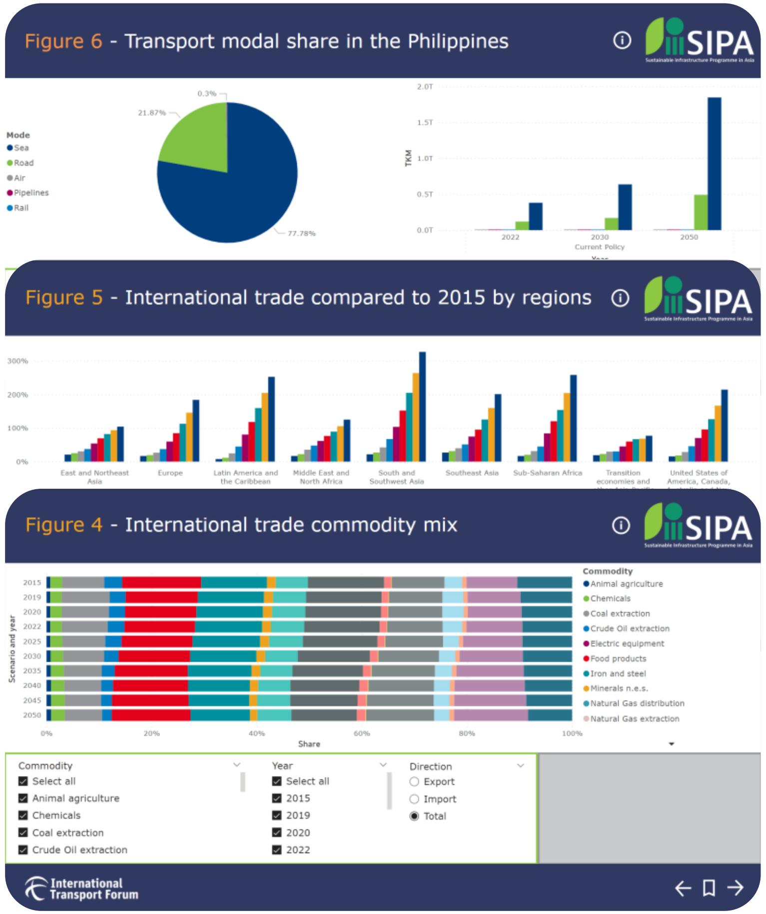
Dashboard

Showcases 8 interactive figures to explore additional results from the 3 freight transport decarbonisation scenarios

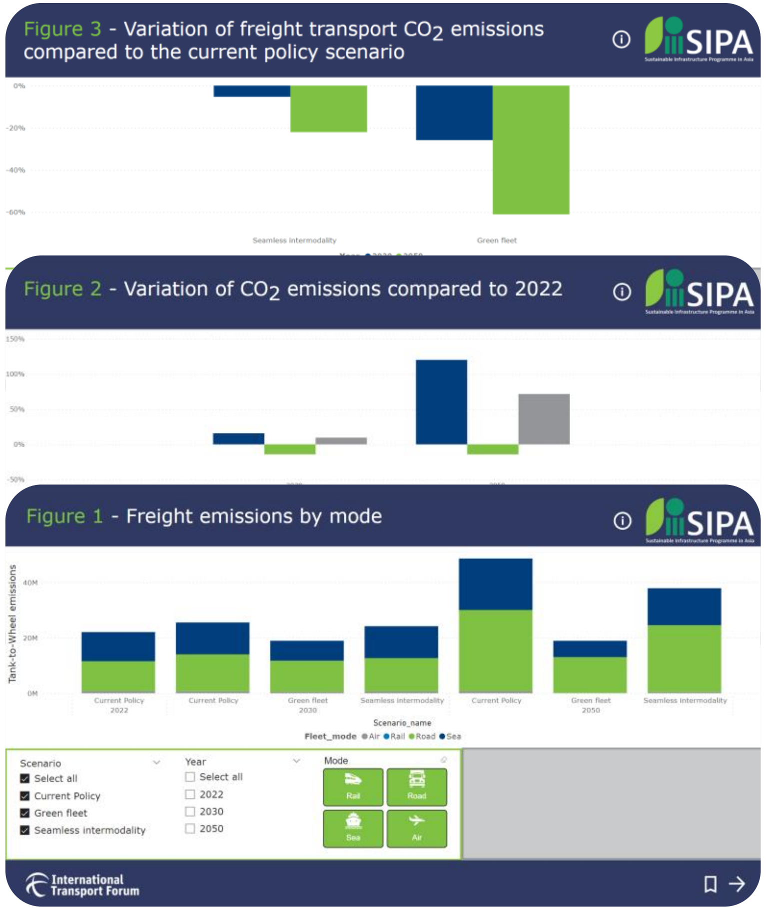


Visualisation tool zoom in

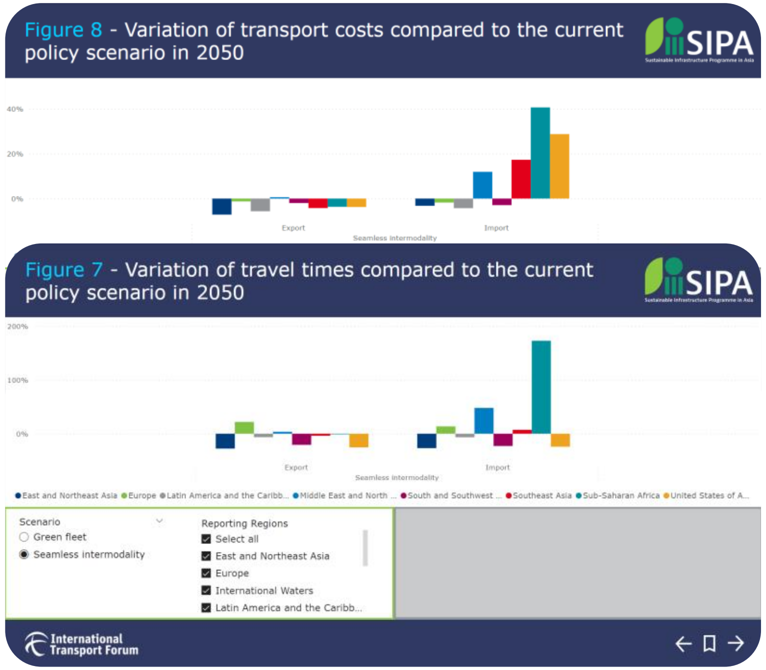
Trade



Environment



Travel time and costs



The Dashboard

Access the dashboard

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