International Transport Forum

The Carbon Footprint of Global Trade

Tackling Emissions from International Freight Transport

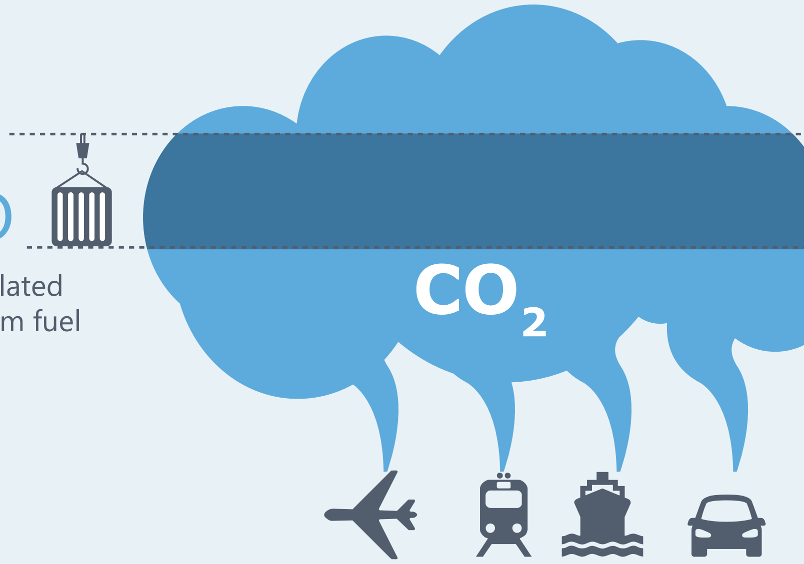
International Transport Forum: Global dialogue for better transport

Growing concern

Projected increase of CO_2 emissions from trade-related international freight

CO_2 emissions from freight = 30%

of all transport-related CO_2 emissions from fuel combustion

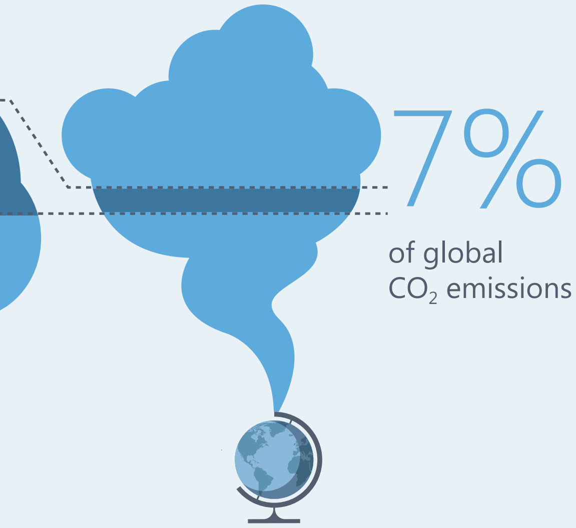


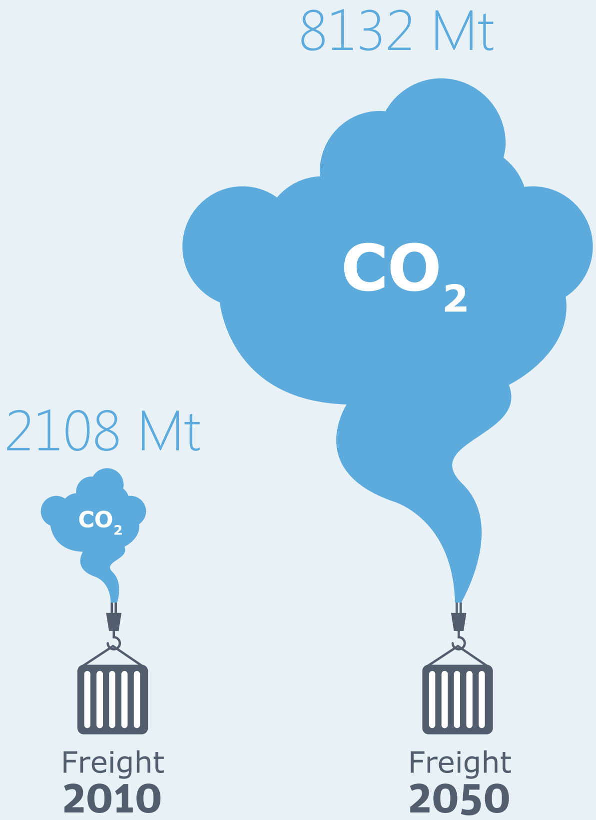
The issue

CO_2 emissions from global freight transport are set to increase fourfold

Growth in international trade has been characterised by globalisation and the associated geographical fragmentation of international production processes. Supply chains have become longer and more complex, as logistics networks link more and more economic centres across oceans and continents. Changing consumer preferences and new manufacturing requirements also affect international trade and thus shape freight patterns. This has led to more frequent and smaller freight shipments and, as a result, to less full containers, more empty runs and increased demand for rapid, energy-intensive transport such as air freight. As freight transport — whether by air, land or sea — relies heavily on fossil fuel for propulsion and is still a long way from being able to switch to cleaner energy sources, it is one of the hardest sectors to decarbonise.

The long-term impact of global trade on carbon dioxide (CO_2) emissions has been largely ignored. International trade contributes to global CO_2





emissions mainly through freight transport. The International Transport Forum (ITF) estimates that international trade-related freight transport currently accounts for around 30% of all transport-related CO_2 emissions from fuel combustion, and more than 7% of global emissions.

Projections based on the ITF's International Freight Model foresee an increase of trade-related freight transport emissions by a factor of 3.9 to 2050. In the base year 2010, global emissions from trade-related freight transport are estimated to be 2 108 million tonnes (Mt) and could rise to 8 131 million tonnes under the baseline scenario.

A nearly fourfold increase would seriously undermine climate goals. Assessing how changing trade patterns will affect future CO_2 emissions is important in establishing whether policies are aligned across the supply chain to achieve climate change mitigation objectives.

OECD
Trade Projections

Projections on future global trade in value terms

+

Production/ consumption centres

- 19 product groups
- 26 zones
- 294 centroids covering 2 539 cities

+

Freight mode choice

- Includes multimodal routes
- Includes economic profile
- Includes direct borders, trade agreements

+

The approach

From global trade value to international

Standard projections of future global trade are expressed in value terms and do not take account of the physical transport activity involved. The ITF International Freight Model projects international freight transport activity and related CO_2 emissions up to 2050 under alternative trade liberalisation scenarios. The model expresses future trade in value and volume (in USD, tonnes and tonne-kilometers) and assigns freight volumes to actual routes by transport mode - thus also enabling the calculation of related CO_2 emissions.

The starting point of the ITF model is OECD projections for international trade at the level of 26 regions and 19 product groups. To obtain a realistic picture of how these trade projections translate into freight movements, four additional layers are built into the model: First, trade flows are disaggregated into production and consumption centres around the world, representing pair-wise trade flows between nearly 300 such "centroids". Second, a mode choice model assigns the transport mode (sea, air, road, rail) used for trade between each origin-destination pair by product group. The model is calibrated using European and Latin American data on trade by mode for different products and also takes into account travel time and distance between trading partners as well as the existence of trade agreements and a land border between trading countries.

Third, a weight-to-value model, calibrated again with European and Latin American trade data on value/weight ratios for different commodities, is applied to obtain freight volumes from trade projections. Again, the model takes into account travel time and distance, trade agreements, land borders and common languages — among other things — as explanatory variables for trade between different countries for each commodity. Economic profile variables are also included to describe trade relations between countries with different production sophistication and intensity of trade.

+ **Value to weight conversion** + **Global transport network** = **ITF Freight Projections**

Value to weight conversion

- In tonne-kilometre
- By origin-destination pair

Global transport network

- All ports, train stations, routes,
- Links between modes
- Dwelling times

ITF Freight Projections

Assigment of freight volume to routes by transport modes

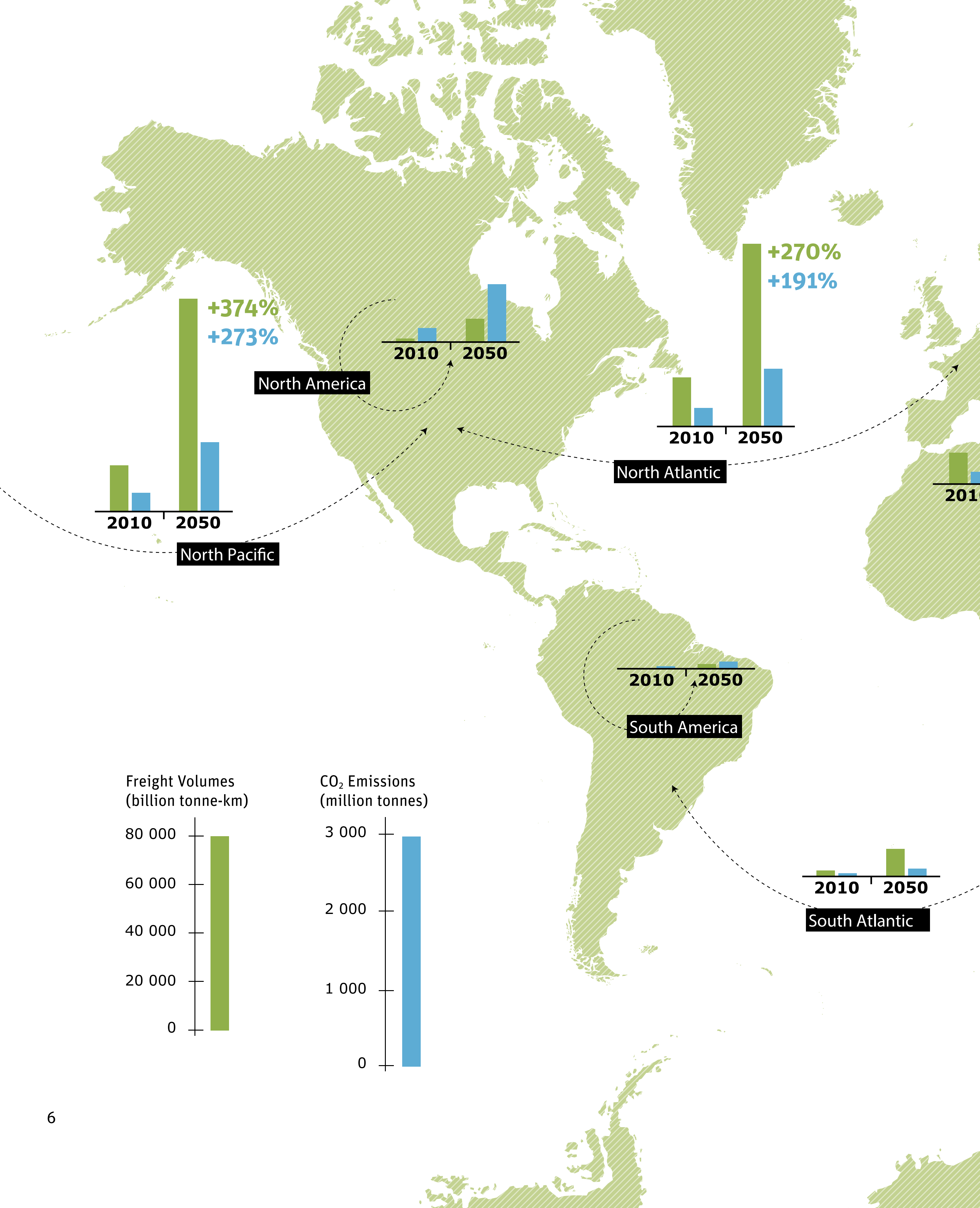
freight volumes

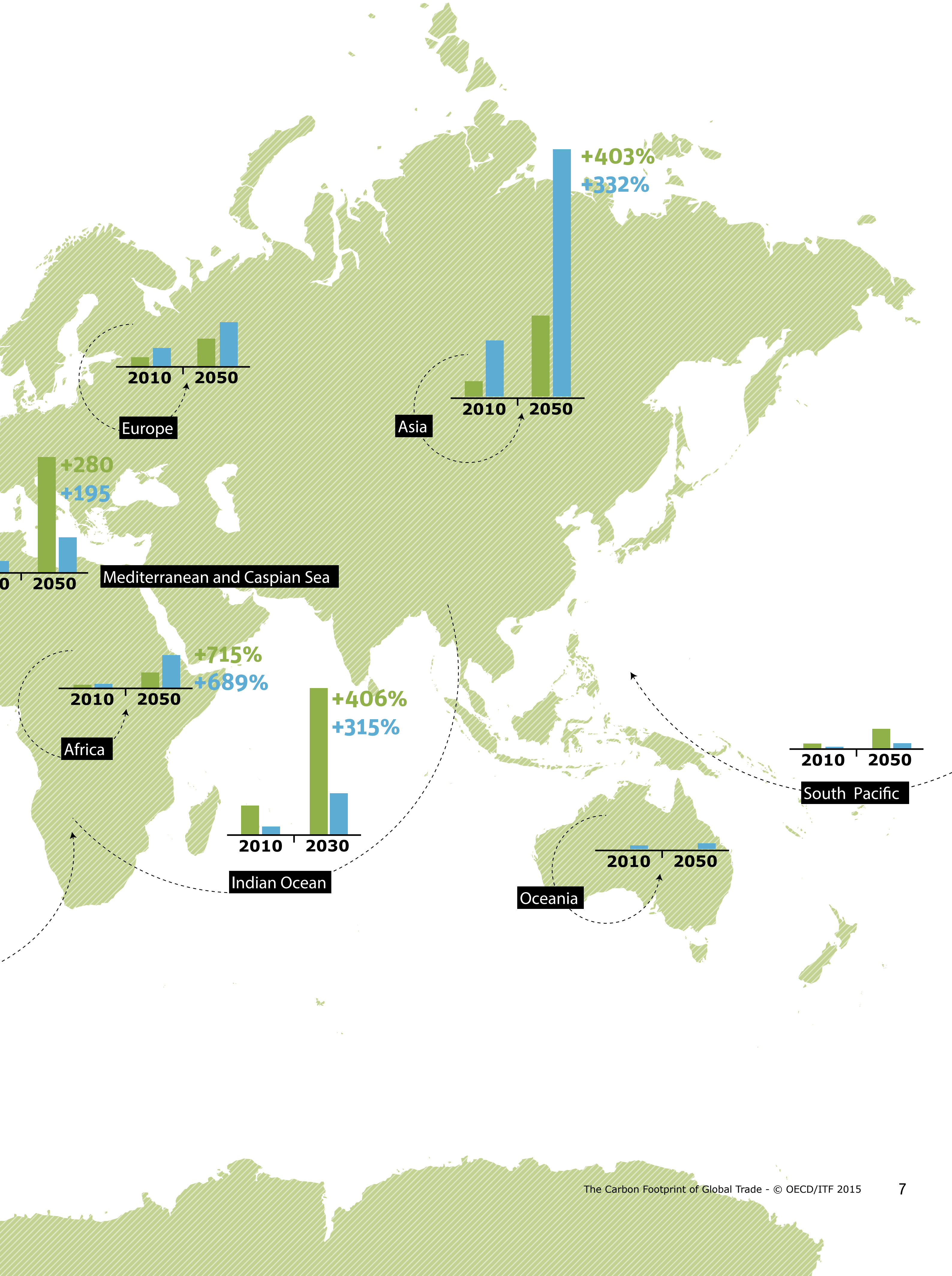
Finally, the resulting trade by mode in tonnes of goods moved by product group is assigned to a global freight transport network model. This consolidates all freight networks in the world based on open GIS data. It includes all world highways and main roads, rail stations and networks, sea ports and actual routes as well as airports and commercial flights in a routable intermodal network connecting all production and consumption centres around the world. Each seaport and airport is connected to road and rail networks with intermodal dwelling times, reflecting the multimodal nature of most freight journeys. The model also includes differentiated speed for each link and border crossing times.

For the first time, the ITF International Freight Model allows the calculation of the domestic share of international trade and the CO_2 emissions associated with it. Contrary to common modeling approaches, trade does not stop at ports. Goods transported by road or rail from (or to) centres of production or consumption to (or from) ports are a significant element of international freight. However, this domestic share of international trade-related freight is not accounted for in previous global freight models. Linking the information on global production and consumption centres with the global freight network model enables the ITF International Freight Model to estimate the domestic share of international freight for a country, providing insights into how an important segment of the freight journey can be shaped by domestic transport policies.

More freight, more CO_2

International trade-related freight and associated emissions by corridor





+403%
+332%
2010
2050
Asia
2010
2050
Europe
+280
+195
0
2050
Mediterranean and Caspian Sea
+715%
+689%
2010
2050
Africa
+406%
+315%
2010
2030
Indian Ocean
2010
2050
South Pacific
2010
2050
Oceania

The insights

How shifting trade patterns increase freight volumes and CO_2

The elasticity of world trade to world GDP has fallen since the start of the economic crisis in 2008 and world trade growth has been slower than before. The lower responsiveness of trade to GDP reflects partly the sluggishness of GDP but also structural shifts – especially a slowing down in the global value chains' fragmentation and increases in the domestic value-added component in the exports of low and middle-income economies. The underlying trade projections up to 2050 assume that GDP will grow on average around 3% per year with declining rates in many countries. Growth in trade is expected to continue to outpace GDP growth with world trade estimated to grow at around 3.5% annually, compared to 6.9% over the period 1990-2007.

Still, global trade is projected to grow by a factor of 4.1 from 2010 to 2050 (in constant value). The weight of trade (in tonnes of goods moved) will grow less, by a factor of 3.8, reflecting changes in the product composition of the world trade and more specifically the fact that countries are moving up in the value chain, producing more high value goods.

While freight weight will grow slower than the trade value, world freight volumes will increase more strongly over the same period, by a factor of 4.3 (measured in tonne-kilometres) in the baseline scenario. This illustrates the geographical shift of trade patterns as a result of the unequal distribution of income across world regions and changes in consumption structures and in relative produtivity. The baseline trade scenario projects that trade within the OECD economies will halve its share from 47% to 25% of global trade, while trade between non-OECD economies will more than double from 15% to 33%.

Longer supply chains

The above changes in the direction of trade will also result in shifts in the geographical composition of freight movement, notably from the North Atlantic freight corridor to the Indian Ocean and North Pacific corridors. This increases the distance between trading partners, resulting in longer supply chains than ever before: Average hauling distance will grow by 12% from 2010 to 2050 under the baseline scenario. Distances on the traditional routes between developed economies will grow relatively slowly, whereas the hauling distances in the trade corridors connecting emerging economies lengthen nearly 20% on average. In terms of freight volumes, the North Pacific route will surpass the North Atlantic as the main freight corridor by 2050, reflecting an increasing flow of goods between North America and Asia.

Growth in trade will result in significant emission growth unless action is taken. Even assuming technological development and efficiency improvements over the next three-and-a-half decades, CO_2 emissions from international trade-related freight transport will grow by 290% to 2050 in the baseline scenario, i.e. to nearly three times today's level. Although the vast majority (85% of tonne-kilometers when including the domestic link of international trade) of international merchandised trade is carried by sea, maritime transport generates relatively low CO_2 emissions per tonne-kilometre of goods transported compared with road and air.

Carbon-intensive trucking

Indeed, road transport is the main CO_2 emitter in international trade-related transport due to its high emission intensity per tonne-kilometer compared with other modes, producing over half of all trade-related freight emissions. Road freight share of total international trade-related emissions will grow from 53% in 2010 to 56% by 2050. Over the same period, air transport will see an increase of 2 percentage points from 7% to 9%, according to ITF projections. The CO_2 share of maritime freight, on the other hand, is estimated to fall from 37% to 32% over the same period, while that of rail freight should remain stable at about 3%.

There are three main contributors to the increased CO_2 emissions and shifting emissions shares. First, in addition to growth in the volume of trade, the growth in the average hauling distance will also mean that goods need to be moved over longer distances between main trading partners, resulting in more fuel burn. The largest increases in CO_2 emissions in absolute terms will be registered in Asia and on the North Pacific corridor, while relative growth is strongest in Africa (+689%).

Second, intra-Asian and intra-African freight flows will grow significantly. This will lead to increasing trade volumes being moved by more carbon-intensive road transport as alternative transport infrastructure is currently less well developed in these regions than elsewhere. Third, air freight has a competitive advantage for carrying high-value goods and as countries export increasingly sophisticated products, this will increase the share of air cargo and emissions from aviation.

Impact of trade liberalisation

What would be the impact of future trade liberalisation on freight volumes and CO_2 emissions? In a multilateral trade liberalisation scenario, trade growth is re-oriented towards the non-OECD area, reflecting comparatively larger reductions in tariffs than in OECD countries, as well as stronger underlying economic growth in this area.

The implementation of a multilateral trade liberalisation regime would push CO_2 emissions from trade-related freight transport to 15% above the business-as-usual baseline scenario by 2050. Under this scenario, the largest absolute increases in CO_2 emissions compared to the baseline would occur in Asia, Africa and the Indian Ocean corridor. In relative terms the greatest increase would take place in Africa (28%), South Atlantic (19%), South America (18%) and Indian Ocean (15%). Road freight also continues to represent the largest share of CO_2 emissions under the liberalisation scenario. However, the share of air transport increases more than in the other scenarios. This is likely an effect of trading more valuable goods with more distant partners and with land-locked countries.

These results illustrate how trade flows and the related transport choices can have a big impact on environmental outcomes. While encouraging trade liberalisation as an important element of future economic growth and enabler of sustainable development, it is also important to understand the possible trade-offs and how additional trade flows potentially affect CO_2 emissions under different liberalisation regimes.

Shipping and air freight

The shipping and aviation shares of emissions are lower than those of road transport, but they are not insignificant and are growing. Shipping emissions are projected to increase by 240% in the baseline scenario. International trade related aviation emissions are projected to grow even stronger over the same period, albeit their contribution to total emissions is small.
Because of the international nature of shipping and aviation, their emissions are not part of the current negotiations under the aegis of the United Nations Framework Climate Change Convention (UNFCCC). Instead, they are dealt with in the context of the International Maritime Organisation (IMO) and International Civil Aviation Organisation (ICAO), both specialised agencies of the United Nations. In the IMO, countries have reached agreements on improving fuel efficiency of ships, mainly through ship design and efficiency standards (known as Energy Efficiency Design Index, EEDI, and Ship Energy Efficiency Management Plan, SEEMP).

Together, these measures could reduce shipping greenhouse gas emissions by 180 Mt annually by 2020. No agreement has been reached to develop a market-based or pricing mechanism for shipping. For aviation, ICAO is currently exploring a multilateral market-based solution for aviation emissions, about which the next general assembly in 2016 is expected to take a decision and discuss implementation.

The domestic share of global trade

The domestic leg of global supply chains provides significant policy leverage for reducing emissions. Only around 10% of international trade (measured in tonne-kilometres) takes place within domestic borders. But this 10% share generates around 30% of the total trade-related CO_2 emissions. Again, this is because goods are moved from ports to consumption centres predominantly by road, a CO_2-intensive transport mode, due to lack of competitive alternatives. This significant share of emissions can be directly addressed through national regulations and policies, rather than complex multi-lateral agreements.

However, the domestic share of trade-related freight varies with the geographic location of the main producers and consumers in a given country. In China, where most of the economic activity is concentrated in coastal areas and hinterland supply chains are shorter, the domestic link represents 9% of the total international trade related freight volumes. In India, on the other hand, production and consumption centres are located inland, resulting in longer domestic links. The domestic share for trade-related freight is 14% in India.

How the domestic trade component will evolve for different economies depends on both geography and future trade patterns. For China, it is estimated to grow from 9% in 2010 to 11% in 2050, assuming that GDP remains concentrated in coastal areas. In the United States, the share is estimated at 15% for 2010 but could grow up to 40% by 2050, especially in the baseline scenario where agricultural exports from the United States to China grow significantly.

Continued efforts should be made to improve the efficiency of the transport system through optimising supply chain structures, increasing vehicle utilisation, reducing the emission intensity of existing vehicle fleets or developing alternative modes of transport especially for hinterland connectivity. Fuel-economy standards have been implemented in most OECD countries as well as in China and India, but gaps remain notably for heavy-duty road vehicles. An integrated approach to improving the efficiency of new trucks combines three policy elements: information measures (such as fuel economy or CO_2 emissions labelling); standard setting (for vehicle fuel economy and CO_2 emissions); and fiscal measures (such as vehicle taxes/tax incentives and fuel taxes).

Strategies to reduce CO_2 focus typically on vehicle technology, and technological improvements can do much to decarbonise transport. Yet there are many other contributing measures the sector can implement, including vehicle maintenance, driver training, vehicle loading, routing and scheduling. Improving the efficiency of operations can have a significant contribution to emission reduction while making business more profitable. Better route planning, for example, can deliver significant efficiency gains for companies through reduced fuel costs, while contributing at the same time to emission reduction. Making more use of shared transport options and opportunities can result in reductions of both costs and CO_2 by creating logistics synergies and limiting empty runs.

To meet climate mitigation goals, it is important to align policies across the supply chains to improve efficiency. International agreements at the multilateral level need to be in line with national policies for reducing CO_2 emissions. Economic measures, regulation, infrastructure and land-use policies at the national level need to be aligned with industry actions to improve vehicle design and utilisation, shared loading or use of alternative fuels. Improving logistics and optimising supply chains can have a significant impact on reducing CO_2 emissions from international trade-related freight transport.

Further reading

OECD/ITF, *ITF Transport Outlook 2015,*
Paris, 2015

OECD/IEA/NEA/ITF, *Aligning Policies for a Low-carbon Economy,*
Paris, 2015

"International Freight and Related Carbon Dioxide Emissions by 2050: New Modeling Tool",
ITF Discussion Paper, 2014

About the International Transport Forum

Who we are

The International Transport Forum at the OECD is an intergovernmental organisation with 57 member countries. It acts as a think tank for transport policy and organises the Annual Summit of transport ministers. ITF is the only global body that covers all transport modes. The ITF is administratively integrated with the OECD, yet politically autonomous.

What we do

The ITF works for transport policies that improve peoples' lives. Our mission is to foster a deeper understanding of the role of transport in economic growth, environmental sustainability and social inclusion and to raise the public profile of transport policy.

How we do it

The ITF organises global dialogue for better transport. We act as a platform for discussion and pre-negotiation of policy issues across all transport modes. We analyse trends, share knowledge and promote exchange among transport decision-makers and civil society. The ITF's Annual Summit is the world's largest gathering of transport ministers and the leading global platform for dialogue on transport policy.

International Transport Forum

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2016 Summit

Green and Inclusive Transport

18–20 May 2016

Leipzig, Germany

www.internationaltransportforum.org/2016
itf.contact@oecd.org

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