ESCAP
Economic and Social Commission for Asia and the Pacific

POLICY BRIEF

ENHANCING ENERGY EFFICIENCY OF THE FREIGHT TRANSPORT SECTOR IN ASIA AND THE PACIFIC

2024

The Economic and Social Commission for Asia and the Pacific (ESCAP) serves as the United Nations regional hub, promoting cooperation among countries to achieve inclusive and sustainable development. As the largest regional intergovernmental platform with 53 member States and 9 associate members, ESCAP has emerged as a strong regional think tank, offering countries sound analytical products that shed insight into the evolving economic, social and environmental dynamics of the region. The Commission's strategic focus is to deliver on the 2030 Agenda for Sustainable Development by reinforcing and deepening regional cooperation and integration to advance connectivity, financial cooperation and market integration. The research and analysis of ESCAP coupled with its policy advisory services, capacity-building and technical assistance to governments aims to support countries' sustainable and inclusive development ambitions.

This Policy Brief has been prepared based on the study report on "Enhancing energy efficiency of the freight transport sector in Asia and the Pacific".

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CONTENTS

EXECUTIVE SUMMARY

This policy brief is focused on strategies, technologies and policies crucial for enhancing energy efficiency of the freight transport sector in Asia and the Pacific. It serves as a guide, providing insights and understanding into the challenges and opportunities in the freight transport sector of the Economic and Social Commission for Asia and the Pacific (ESCAP) region, with a particular focus on the decarbonization of the freight transport.

A study report completed in July 2023 under the title "Enhancing energy efficiency of the freight transport sector in Asia and the Pacific" provided the basis for this policy brief.

The policy brief stresses the significance of modal shift and its relationship with decarbonizing freight transport, and presents the challenges and influencing factors for modal shift implementation, the role of synchromodal transport systems and the economic benefits tied to the reduction of logistics costs.

In addition, the technologies pivotal to greener transport and mobility: electric and alternative fuel vehicles; autonomous vehicles; intelligent transport systems (ITS); information and communications technology (ICT) infrastructure, the need for infrastructure modernization, with emphasis on railway electrification, and the potential applications of renewable energy in transport topics are covered in the mentioned study, "Enhancing energy efficiency of the freight transport sector in Asia and the Pacific". Many country examples are used to illustrate current trends in promoting energy efficiency and green mobility.

The policy brief further gives an outline of the vital role of policy and regulatory measures in driving sustainable and energy-efficient transport. Key policy tools examined are vehicle emission and fuel economy standards, greenhouse gas emissions pricing, policies promoting a shift to low-carbon transport modes, the role of sustainable transport in national development policies, and the use of financial incentives and subsidies. The policy brief also provides a review of relevant international climate initiatives that serve as important policy references.

As part of the policy brief, a regional road map was designed for attaining sustainable and energy-efficient freight transport. The concept of a regional road map for the Asia-Pacific region and insight into regional approaches for enhancing sustainable freight transport are discussed, and a regional road map for promoting energy-efficient freight transport is proposed.

This policy brief also includes a wide variety of recent sources and references with relevant information, which may help policymakers and institutions to further develop and implement measures to enhance energy efficiency and decarbonization of the transport sector in Asia and the Pacific.

BACKGROUND

The contribution of the transport sector to greenhouse gas emissions increased from 15 per cent in 1990 to 24 per cent in 2019; carbon dioxide (CO_2) made up the largest share in the emissions. The freight share of CO_2 emissions of the transport sector was estimated at 42 per cent, of which road transport comprised 65 per cent.

The International Transport Forum (IFT) has projected that the total freight-related CO_2 emissions would increase to 5.7 Gt in 2050, as compared to 3.2 Gt in 2015, and that the freight share of the total transport would increase from 40 per cent to 43 per cent over this period (ITF, 2017). This presents a serious need for the freight transport sector to reverse the growth of its greenhouse gas emissions, and in particular its CO_2 emissions. A broad range of measures is needed to bring these fundamental changes, namely reducing demand for transport, improving its energy efficiency,; switching to lower carbon energy sources and modal shifting from road to lower carbon modes.

The rationale for decarbonization of freight transport attained momentum at the twenty-first United Nations Conference of Parties (COP21) held in Paris from 30 November to 12 December 2015. During the Conference, participating countries discussed climate change and the global warming of the planet and concluded a climate change accord (the Paris Agreement). The Agreement includes a serious intention keep the temperature increase of the planet well below 2°C by 2100, with 1.5°C now widely being advocated as the new limit. The Intergovernmental Panel on Climate Change (IPCC) calculated that with a reduction in greenhouse gas emissions of 40-70 per cent, there is a 50 per cent chance that global warming would be less than 2°C in 2100.

The Paris Agreement has catalysed a global commitment to mitigate the impacts of climate change and global warming, and prompted countries to set clear and ambitious targets. To achieve these targets, substantial reductions in greenhouse emissions are needed, a task that calls for a strategic and holistic approach from all countries around the world. Several countries have embraced this challenge and are actively implementing strategies aimed at these established targets.

The most recent COP28, which was held in Dubai from 30 November to 12 December 2023, focused on the application of new technologies. New initiatives were taken in 2023 by various groups of countries to focus on increasing the use of renewable energy, enhancing energy efficiency and banning gradually the use of fossil fuels and coal. COP28 also reached an agreement on compensation for poor countries to take climate change policy measures through a loss and damage fund.

The overall policy measures to reduce energy related CO_2 emissions and decarbonize road freight may be directed on the following:

1. Reducing freight movement
2. Shifting to lower carbon transport modes
3. Optimizing utilization of logistics assets
4. Improving energy efficiency logistics operations
5. Cutting the carbon content of the energy used by logistics

In addition, the transport industry is involved in the development of measures to decarbonize transport. A good example is the IRU Green Compact, a collective global action to achieve carbon neutrality in commercial road transport by 2050. Use of alternative fuels may reduce CO_2 emissions 27 per cent, aided by reductions of 24 per cent, 22 per cent and 4 per cent in CO_2 emissions resulting from more efficient logistics operations, vehicles and drivers, respectively.

Three key pillars underpin the framework of this policy brief:

(a) The first pillar is the modal shift, which investigates how policy and regulatory changes and shifts in government structures can influence transport mode choices among road, rail and inland waterways. These shifts are significant as they have the potential to reduce energy intensity in freight transport systems, thereby making a substantial contribution towards the overall energy efficiency of the sector.

(b) The second pillar, technology, delves into the exploration of contemporary and prospective trends. This includes the exploration of vehicular efficiency standards, the fuel economy and emission standards, and emerging technological paradigms, such as hydro and battery electric vehicles, autonomous vehicle, and alternative fuels. The integration of these advanced technologies into freight transport operations is expected to yield notable enhancements in terms of energy efficiency.

(c) The third pillar, policy, explores the various policy options, incentives and other supportive measures that can expedite technology development and integration into the sector.

MODAL SHIFT

The concept of modal shift refers to the process of transferring the transportation of goods from one mode (typically road) to more environmentally friendly and energy-efficient alternatives, such as rail or inland waterways. The overall intent of a modal shift is to minimize the environmental footprint of the freight transport sector and optimize its energy efficiency.

Road transport dominates freight movement in the Asia and Pacific region. It is responsible for nearly 60 per cent of all freight tonnage in several countries. Road freight is preferred because of its flexibility, cost-effectiveness and ability to deliver door-to-door services. However, it also exhibits a higher energy intensity compared to rail and inland waterway transport, and. therefore, contributes more significantly to greenhouse gas emissions.

Transport modes significantly vary in terms of their CO_2 emissions per unit of freight movement. For instance, express air freight services can emit CO_2 at a rate 500 times higher than electric train bulk delivery (McKinnon, 2018). As such, an effective decarbonization strategy naturally includes a preference for transport modes with lower carbon intensity.

The concept of altering the "freight modal split," or modal shift, is a significant component in numerous decarbonization frameworks and government policy statements. As part of their commitment to the COP21 Paris Accord, countries have outlined intended nationally determined contributions aimed at reducing freight-related emissions. Approximately half (48 per cent) of these intended nationally determined contributions policy initiatives explicitly reference the strategy of a freight modal shift.

An important argument supporting a modal shift to transport modes with lower carbon intensity is to show that the other mode of transport has a lower carbon intensity. When doing this, it is essential to also incorporate the emission intensity of the primary energy source. This becomes particularly important for electrified freight services when the energy used for electricity production should be considered. To attain a more comprehensive understanding transport modes should be compared on a well-to-wheel basis rather than merely a tank-to-wheel approach.

Experience has shown that implementing a modal shift policy at a national level can be particularly beneficial for large countries, such as China, India, the Russian Federation and the United States of America among others. Furthermore, the exploration of a transcontinental modal shift policy holds considerable merit.

Implementation of a modal shift policy is very challenging and seldom very successful. Accordingly, it is important to identify the main challenges for the implementation of a modal shift from not only the perspective of the government, but also, and maybe even more important, from the perspective of the shipper. There are broadly five categories of influencers in the choice of the transport mode.

- **Shippers** generate demand for freight transportation and are the senders or recipients of the goods. They plan shipments to satisfy their customers and define how their freight should be moved, and can organize their freight transport themselves on own account or outsource this process to logistics service providers.
- **Logistics service providers** (including freight transport forwarders) may provide a range of value-added logistics services, such as warehousing, distribution, shipping, inventory management, co-packing, labelling, repacking, weighing and quality control.
- **Carriers** are the transport operators or transport companies that perform the transport for the shippers or logistics service providers.

There are also actors that influence the operational conditions for firms:

- **Infrastructure managers** may be public, private or hybrid entities. They deal with the management of the physical network and infrastructure, such as roads and highways, the rail infrastructure and intermodal port terminals. Accordingly, they play a central role by providing efficient physical networks and the necessary technology to control and optimize the use of infrastructure and facilities.
- **Policymakers** are governments and public administrations that levy taxes, provide incentives, develop policies and regulate transport activities. They also address externalities related to transport, such as the environmental impact and safety. Policymakers may also guide the transport and logistics system towards being more beneficial to society and sustainable ways of operation. For example, the usage of specific corridors or legal and regulatory requirements for vehicle and motorization types, and mode changes from road-based to water and rail-based transportation.

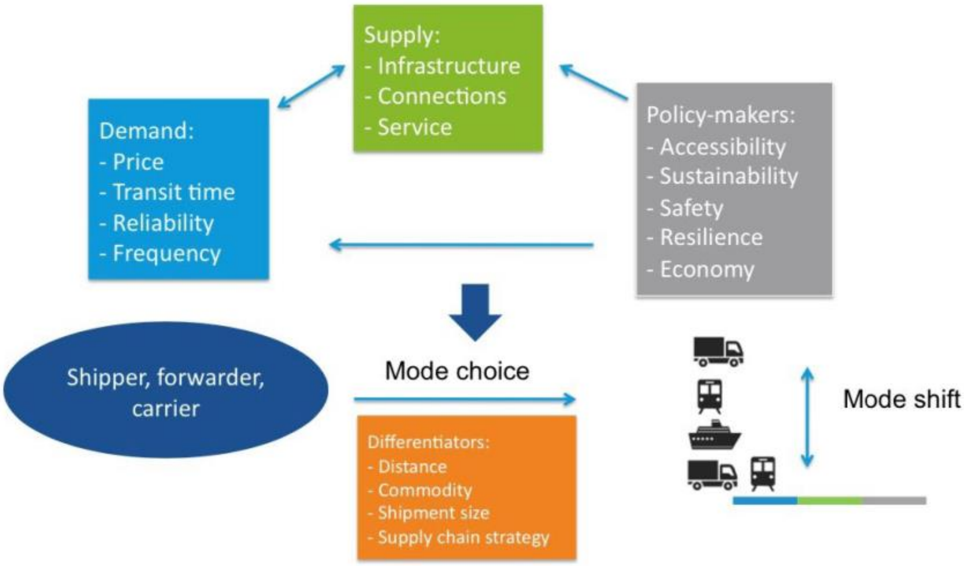

Figure 1 The main determinants for freight transport mode choice.
Source: ITF (2022).

The main determinants for the freight transport mode choice are cost, travel time, reliability, connections, frequency, flexibility, freight tracking and tracing, use of infrastructure, volume and freight characteristics, terminal services, legislation and regulations (including legal bottlenecks and advantages), safety, security, accessibility, sustainability and resilience.

Because many actors and stakeholders are involved in the decision process for modal choice, implementation of a modal shift policy from road freight to rail or other forms of intermodal transport is challenging.

One researcher distinguishes three sets of interrelated disadvantages of using these lower-carbon modes: geographical, temporal and operational (Mckinnon, 2018, p. 76−78).

- **Geographical:** Lower-carbon modes rail and waterways have much lower density and connectivity than road networks.
- **Temporal:** Rail and waterborne transport services tend to be slower than road transport. This may be a disadvantage for transport of more time-sensitive, higher-value cargo. Another disadvantage of railways is that it is bound to fixed and tight schedules as other (passenger) trains use the same rail tracks. In modern transport operations, flexibility is important, but so is reliability and sometimes also the just-in-time principle. In those cases, shippers often opt for road transport, which can be easier planned and controlled, and is more flexible.
- **Operation:** The consignment size across road, rail and waterborne transport vary significantly: road transport typically handles 20-40 tons, rail tends to deal with 1,000-2,000 tons, while maritime vessels, depending on their size, can carry significantly larger volumes. As such, vessels and rail systems must operate at maximum capacity to maintain cost-efficiency.

The rail sector faces a unique set of challenges. Historically, it had transported large quantities of coal and oil, but the global shift away from fossil fuels threatens to decrease its cargo volume significantly in the near future.

Government-led modal shift policies often encounter implementation challenges, largely because shippers and cargo owners are reluctant to transition from road transport to intermodal transport for various operational reasons, including the lack of flexibility inherent to rail and waterway transport. The comparatively recent concept of synchromodality addresses this hurdle, offering a framework that enables shippers and cargo owners to manage their supply chains more flexibly, thereby enhancing the potential for modal shift (Chuanwen and others, 2017).

The inherent inflexibility in delivery time, frequency and scheduling of lower-carbon modes, such as rail and inland water transport, hinders shippers, cargo owners and logistics managers from integrating these modes into their supply chains. This rigidity results in increased inventory costs due to the inability of these modes to adapt swiftly to fluctuating demand. Their efficiency also relies on large, consistent freight volumes. Furthermore, a conflict can arise between the interest of the shipper or cargo owner, who seeks prompt or just-in-time delivery, and the logistics service provider, who aims for optimal utilization of transport capacity, namely maximum loads for rail or water transport.

Synchromodality, the most recent concept tied to multimodal transportation, offers the capacity to interchange transport modes at specific times and locations while a shipment is in transit. This method necessitates a degree of flexibility, along with efficient, responsive synchronization of the schedules of available transportation modes. Synchromodality should enable modal switching at various nodes along the route in compliance with cost constraints and service level requirements (Chuanwen and others, 2017). A distinctive feature of synchromodality is horizontal integration of freight transportation planning, which allows for parallel usage of different transport modes during the entire supply chain from the origin to the destination.

The further development of a national transport and logistics infrastructure system should consider the application of the concept of synchromodality, such as a flexible multimodal transport system, which offers a variety of transport options and alternative transport modes with multiple nodes in the network in cases in which freight can be easily shifted from one mode of transport to another.

This national transport and logistics infrastructure system should be based on an analysis of the existing structure of national and international freight flows by commodity, volume, origin-destination, cost, duration and reliability. Based on this analysis, a freight model can be developed with different growth scenarios and assigned to the transport and logistics infrastructure network. The outcome of this exercise provides important indications of the need to restructure and further develop the present transport and logistics infrastructure network. It may also guide investment needed for developing transport and logistics infrastructure and optimizing the infrastructure network in such a way that logistics costs will be reduced in addition to greenhouse gas emissions.

In conclusion, it can be understood that modal shift may certainly contribute towards decarbonization of the transport sector, reducing logistics costs and also resulting in a more efficient transport and logistics infrastructure system, but to reap these benefits, tailor-made policies are needed.

TECHNOLOGIES FOR GREENER MOBILITY

The sustainable transformation of the freight transport sector hinges on the strategic integration and adoption of advanced technologies. The objective of this chapter is to delve into the landscape of these technologies, capturing their status, inherent potential, associated challenges and the strides made in implementing them around the world.

The discussion embraces several key areas, namely electric vehicles and alternative fuel vehicles, highly and fully autonomous vehicles, and the role of intelligent transportation systems and ICT infrastructure. Alternative fuel applications and the necessity for infrastructure modernization are scrutinized, bringing a spotlight on renewable and nuclear energy applications, and the entry points for various types of renewable energy into the transport sector. This exploration aims to foster a robust understanding of the technology landscape underpinning greener mobility.

ELECTRIC VEHICLES AND ALTERNATIVE FUEL VEHICLES

A battery electric vehicle (BEV) is basically an electric vehicle that consumes compound energy stored in rechargeable battery packs, with no other source (such as a hydrogen energy component or an internal combustion engine). They are otherwise called unadulterated electric vehicles or just electric vehicles or all-electric vehicle.

The use of BEVs along with the other types of hybrid vehicles may reduce substantially the greenhouse gas emissions over a life cycle. For example, a life-cycle comparison of the greenhouse gas emissions from combustion, electric, and hydrogen trucks and buses in Europe has revealed that battery electric trucks and buses outperform their diesel, hydrogen and natural gas counterparts in reducing greenhouse gas emissions over their lifetime (O'Connel, and others, 2023). The 2021 vehicle models produce at least 63 per cent lower lifetime emissions compared to diesel models. The high energy efficiency of electric powertrains shrinks their carbon footprint, making them a cleaner option even if the source of electricity is not fully clean.

Greenhouse gas emissions from fuel cell battery trucks and buses run on hydrogen produced from fossil fuels are 15 to 33 per cent less that those emitted by their diesel counterparts in the life-cycle analysis. The emissions reduction depends heavily on the source of hydrogen. With hydrogen solely produced with renewable electricity, emissions decline by up to 89 per cent. In contrast to battery electric trucks and buses, the emissions of hydrogen trucks and buses are not reduced significantly when using a non-renewable energy source—in this case, fossil hydrogen (figure 2).

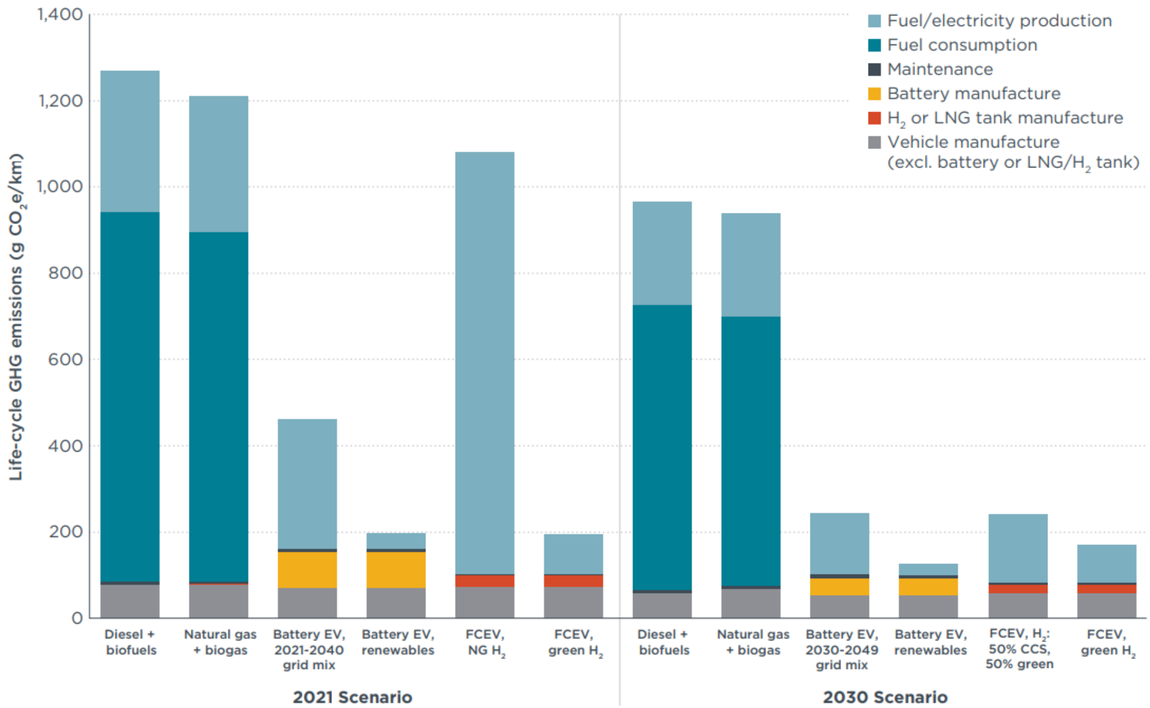

Figure 2 Life-cycle greenhouse gas emissions for 40-tonne tractor trailer in 2021 and 2030 scenarios
Source: O'Connell and others (2023).

Notably, use of natural gas trucks and buses result in marginal greenhouse gas reductions, at best, ranging from 4 per cent to 18 per cent, compared to their diesel counterparts.

The greatest portion of life-cycle greenhouse gas emissions produced by trucks and buses over their lifetime corresponds to the use (or fuel consumption) phase, not to the vehicle manufacturing. For diesel and natural gas trucks, the consumed fuel accounts for more than 90 per cent of their lifetime emissions. Accordingly, the higher vehicle and battery production emissions of battery electric trucks are offset by their high efficiency and low lifetime fuel cycle emissions.

Greenhouse gas emissions can be reduced through different powertrain options (electric batteries, fuel cell batteries, and combustion engines), and different fuel or energy choices (hydrogen, biofuels and natural gas). The climate impacts of these technologies and fuels vary over the lifetime of the vehicle model.

In ESCAP countries the production and utilization of electric vehicles are on the rise, aided by strong government support and increasing investment in research and development. As more countries in the region set ambitious climate goals and adopt policies to promote electric vehicles, the market for electric trucks is expected to expand significantly in the coming years.

DEPLOYMENT OF HIGHLY AND FULLY AUTONOMOUS VEHICLES

Highly and fully autonomous vehicles have the potential to improve energy efficiency in various ways, leading to lower energy consumption and reduced greenhouse gas emissions. Some of the energy efficiency advantages associated with highly and fully autonomous vehicles are the following:

- **Optimized driving behaviour:** Autonomous vehicles can employ advanced algorithms to optimize driving patterns, resulting in smoother acceleration, braking and cruising. Research suggests that eco-driving algorithms can reduce energy consumption by 5-20 per cent compared to human-driven vehicles, depending on traffic conditions and vehicle types.
- **Improved traffic flow:** Autonomous vehicles can communicate with each other and with traffic management systems, enabling better coordination and synchronization. This vehicle-to-vehicle and vehicle-to-infrastructure communications can reduce traffic congestion and minimize stop-and-go traffic patterns. Studies have shown that improved traffic flow can lead to a 15-20 per cent reduction in energy consumption.
- **Eco-routing and navigation:** Autonomous vehicles can use real-time traffic data and advanced algorithms to determine the most energy-efficient routes, considering factors, such as road grade, congestion and weather. By optimizing routes to minimize energy consumption, it is estimated that eco-routing can reduce energy use by up to 10 per cent.
- **Platoon driving:** Autonomous vehicles can drive in tightly coordinated groups or platoons, which allows them to maintain a consistent speed and follow each other at closer distances. This reduces air resistance and improves aerodynamics, resulting in energy savings of approximately 4-10 per cent for the lead vehicle and 10-20 per cent for following vehicles.
- **Lightweighting:** As autonomous vehicles eliminate the need for certain components, such as steering wheels, pedals and mirrors, they can be designed to be lighter, further improving energy efficiency. A 10 per cent reduction in vehicle weight can result in a 6-8 per cent improvement in fuel economy.
- **Electrification and renewable energy integration:** Autonomous vehicles can facilitate the adoption of electric vehicles, as they can autonomously recharge during periods of low electricity demand or when renewable energy sources are abundant. This can lead to a more significant penetration of renewable energy in the transport sector and further reduce greenhouse gas emissions.

In summary, fully and highly autonomous vehicles have significant potential to enhance the energy efficiency of road freight transport.

DEPLOYMENT OF INTELLIGENT TRANSPORT SYSTEMS AND INFORMATION COMMUNICATIONS INFRASTRUCTURE

Intelligent transport systems harness a multitude of technologies that aim to streamline traffic management and improve the safety, efficiency and convenience of transport systems. Simultaneously, ICT infrastructure provides the backbone that enables the data-driven decisions required in the increasingly interconnected world. The interplay of ITS and ICT can lead to remarkable advancements in, for example, freight transport, enabling real-time tracking, smart routing and fleet management. As a result, ITS can notably elevate energy efficiency and curtail emissions within freight transport, hinging on the prowess of advanced communication technologies, data analytics and automation. Some of the fundamental avenues through which ITS can lead to the achievement of these goals encompass the following:

- **Optimized route planning:** ITS can help freight vehicles save up to 10-15 per cent in fuel consumption by using real-time traffic data and advanced algorithms to identify the most energy-efficient routes, according to the European Commission. This can also lead to a reduction in CO_2 emissions by a similar percentage.
- **Eco-driving assistance:** Studies have shown that eco-driving techniques can result in fuel savings of 5-20 per cent, depending on the vehicle type and driving conditions. Real-time feedback provided by ITS can help drivers maintain optimal speeds, gear shifting and acceleration patterns, which can significantly reduce fuel consumption and CO_2 emissions.
- **Vehicle-to-vehicle and vehicle-to-infrastructure communication:** By improving traffic flow and reducing congestion, vehicle-to-vehicle and vehicle-to-infrastructure communication can decrease fuel consumption by up to 10 per cent and reduce CO_2 emissions by up to 8 per cent, according to the United States Department of Transportation.
- **Load optimization:** Proper load optimization can result in a 5-10 per cent reduction in fuel consumption and CO_2 emissions, as reported by ITF. Efficiently distributing cargo within freight vehicles ensures they operate at their most energy-efficient capacity, leading to fewer trips and lower fuel consumption.
- **Fleet management:** A study by the National Renewable Energy Laboratory indicates that fleet management systems can lead to a reduction of up to 15 per cent in fuel consumption and emissions by providing real-time monitoring of vehicle performance and driver behaviour.
- **Autonomous vehicles:** Autonomous freight vehicles can improve energy efficiency by 10-15 per cent through optimized driving behaviours and platooning, according to a study by the National Renewable Energy Laboratory. Additionally, better integration with electric vehicle charging infrastructure could further enhance the energy efficiency of these vehicles.
- **Intermodal transport:** The European Environment Agency has reported that shifting 20 per cent of freight from road to rail and inland waterways could result in a 7 per cent reduction in CO_2 emissions from the transport sector. By optimizing the use of different transport modes, ITS can facilitate more energy-efficient and environmentally friendly freight transport systems.

Within the landscape of the ESCAP countries, ITS already commands a vital role in the quest for enhanced energy efficiency and the reduction of emissions. Not merely an abstract concept, its applications are available in tangible forms in the region, manifesting in numerous implementations that have begun to influence the way freight transport operates.

Deployment of ITS can significantly bolster the energy efficiency of freight transport. By facilitating real-time information sharing, enhancing traffic management, and enabling more streamlined logistics processes, ITS can contribute towards reducing fuel consumption, decreasing idling times and promoting overall operational efficiency. Moreover, the potential for ITS to be integrated into other innovative technologies, such as autonomous vehicles, offers a promising avenue for further advancements.

APPLICATION OF ALTERNATIVE FUELS

The growing need for environmental sustainability has significantly increased the demand for alternative fuels in transportation. These alternative fuels, such as electricity, biofuels, hydrogen and natural gas, offer a wide range of benefits, including a reduction in carbon and other pollutant emissions, improved fuel economy and the potential for domestic production, which can enhance energy security. Recent trends suggest a growing global commitment to incorporate alternative fuels into the mainstream transport sector, supported by the considerable advancements in research, policy formulation and infrastructure development.

One of the most well-known and extensively used alternative gas fuels is natural gas. Composed primarily of methane, natural gas can be used in vehicles as compressed natural gas (CNG) or liquefied natural gas (LNG). CNG is commonly used in passenger vehicles and light-duty trucks, while LNG, due to its higher energy density, is typically used for heavy-duty and long-haul trucking applications. Natural gas vehicles produce significantly less tailpipe emissions than their gasoline or diesel counterparts, making them a popular choice in urban areas with stringent air quality standards.

Another increasingly important alternative gas fuel is hydrogen. When used in a fuel cell, hydrogen can generate electricity with water being the only by-product, making it a zero-emission fuel source. Fuel cell electric vehicles powered by hydrogen are becoming more common, particularly in the passenger vehicle sector, but they are also being explored for use in heavy-duty freight applications.

Biogas, another alternative gas fuel, is produced through the anaerobic digestion or fermentation of organic matter, including manure, sewage, municipal waste or plant material. Biogas, which primarily consists of methane, can be upgraded to a quality similar to natural gas and used as a vehicle fuel.

The application of these alternative gas fuels in transportation has the potential to drastically reduce greenhouse gas emissions, improve energy security by diversifying fuel sources and reduce reliance on fossil fuels. Despite the challenges related to infrastructure, fuel storage and vehicle availability, growing interest in and implementation of these alternative fuels present a promising future for their use in the transport sector.

Concerted endeavours conducted by many countries underscore the tangible possibilities and efficiency of incorporating biofuels into the transport landscape, with a particular emphasis on the freight sector. These initiatives, bolstered by dedicated governmental funding and clear temporal benchmarks, manifest a robust commitment towards the progression of a more sustainable and environmentally friendly freight transport framework. They serve as encouraging precedents for other countries embarking on similar sustainable journeys, thus promoting the global adoption of cleaner fuel alternatives in the freight industry.

RENEWABLE AND NUCLEAR ENERGY APPLICATIONS

Renewable energy, also known as clean energy, is derived from natural sources or processes that are continuously replenished. It offers a more sustainable alternative to conventional fossil fuels, resulting in reduced greenhouse gas emissions and less environmental degradation. The utilization of renewable energy is crucial for achieving long-term sustainable development by providing power for various sectors, including transportation.

There are several types of renewable energy sources, each with its own technicalities and applications. Among them are solar energy, wind energy, water energy, geothermal energy, biomass and biofuels.

Solar energy is one of the most rapidly growing renewable energy sources worldwide. Solar power is harnessed using photovoltaic cells that convert sunlight directly into electricity.

Wind power is harnessed by wind turbines that convert the kinetic energy from the wind into mechanical power. This mechanical power can be used for specific tasks, such as grinding grain or pumping water, or be converted into electricity by a generator.

Hydroelectric power, the most mature and widely used renewable energy source, involves harnessing the kinetic energy of moving water.

Geothermal energy exploits the Earth's natural heat in the form of steam and hot water to drive turbines and produce electricity. Countries located along the Pacific Rim's "Ring of Fire," such as Indonesia and the Philippines, have significant geothermal potential.

Nuclear energy is generated using heat produced during nuclear fission, when atoms split apart. The challenge for nuclear energy remains in managing the radioactive waste it produces and addressing safety concerns.

In the realm of freight transport, hydropower, solar, and wind power surface as the most promising renewable energy sources.

Transport remains the sector of energy use with the lowest share of renewables; more than 95 per cent of energy needs coming from oil and petroleum products and less than 4 per cent from biofuels and renewable electricity in 2018 (SLOCAT, n.d.).

Policies to promote renewable energy in the transport sector continue to focus mainly on road transport, giving less emphasis on rail, aviation and shipping even though those industries are large energy consumers. As of the end of 2019, only 46 countries had some form of renewable energy target for transport, and just 11 per cent of the countries included measures for renewables-based transport in their nationally determined contributions towards reducing emissions under the Paris Agreement.

Renewable energy sources hold significant potential for transforming the transport sector, especially freight transport, into a more sustainable and energy-efficient system.

The primary point of integration is the application of "green" electricity, generated from renewable energy technologies to power electric vehicles.

A secondary entry point is the deployment of renewable energy in the production of "green" hydrogen, which can be used in fuel cell electric vehicles.

A third integration pathway is through the production of advanced biofuels using sustainable biomass feedstocks.

Finally, renewable energy technologies can be integrated into the transport infrastructure itself providing a source of locally generated "green" electricity to power infrastructure facilities or to supply charging points for electric vehicles. Similarly, wind turbines can be used in areas with favourable wind conditions.

Each of these entry points represents an opportunity to harness the power of renewable energies to propel the transport sector towards a more sustainable future. However, the successful implementation of these strategies requires comprehensive policy support, significant investment and strong stakeholder collaboration, as well as continued research and development to overcome existing technical and economic barriers. By considering these factors, a smoother transition towards sustainable energy use in freight transport can be ensured.

Although fiscal measures, such as public subsidies, can help mitigate the costs associated with the adoption of sustainable transport strategies, the reality is that government support has remained somewhat restrained. Paradoxically, in many jurisdictions, substantial subsidies are still being allocated towards fossil fuels, or these energy sources are inadequately taxed. This practice results in artificially suppressed retail prices of petrol, making them lower than the global market prices for crude oil, and, in turn, hampers proactive climate actions.

It has become apparent that ongoing efforts and collaboration among governments, policymakers and diverse stakeholders are paramount to advance the development of renewable energy in the Asia-Pacific region.

INFRASTRUCTURE MODERNIZATION

Infrastructure modernization plays a crucial role in the sustainable transition of the freight transport sector. It involves upgrading or replacing existing transportation infrastructure with advanced, environmentally friendly infrastructure that can support new technologies and practices.

Intermodal transportation facilities enable the smooth transition of goods from one mode of transportation to another. They help in achieving a modal shift by allowing more efficient utilization of different modes of transportation based on their comparative advantages, thus reducing fuel consumption and emissions.

Widespread adoption of electric or alternative fuel vehicles depends on the availability of charging stations or refuelling infrastructure. Modern infrastructure should, therefore, include a network of these stations that are strategically located across cities and highways.

Modernization of infrastructure also involves integrating information technology with transportation infrastructure to manage and control traffic, optimize routing, improve safety and reduce environmental impacts. This could include technologies, such as real-time traffic management systems, connected and autonomous vehicles, and truck platooning technologies.

Being eco-friendly versions of traditional logistics centres and ports, green logistics hubs and ports are equipped with renewable energy sources, advanced energy management systems and low-emission handling equipment. They help in reducing the energy consumption and emissions associated with goods handling and storage.

Railway electrification is another key aspect of infrastructure modernization in the context of sustainable freight transport. It enhances the efficiency of train traction, bolstering the appeal of rail over road transportation. This not only stimulates a modal, shift but it also plays a pivotal role in slashing greenhouse gas emissions.

In 2021, the level of railway electrification worldwide was close to 30 per cent, or approximately 375,000 km of electrified rails out of 1.3 million in total.[1]

Overall, railways are up to nine times more energy efficient compared to roads for long distance freight, four times more economical in terms of land use, and six times more cost effective vs. roads in terms of construction costs for comparable levels of traffic.

In summary, the modernization of transport infrastructure is a strategic endeavour that spans the long term, necessitating substantial financial resources, comprehensive planning and coordination among a multitude of stakeholders. Public-private partnerships (PPPs) often emerge as a viable model for funding such extensive infrastructure initiatives. Simultaneously, it is imperative to design and execute infrastructure modernization initiatives with an eye toward future resilience. This includes considerations for rapid technological advancements, the effects of climate change and adaptability to potential challenges, such as shifts in logistics flows, even those induced by geopolitical variations.

However, infrastructure modernization alone is not enough. It needs to be complemented with other policy measures, such as emission standards, fiscal incentives and regulations, to achieve significant reductions in the freight sector's environmental footprint.

[1] See https://www.railwaypro.com.

REGULATORY MEASURES IN DRIVING SUSTAINABLE AND ENERGY-EFFICIENT TRANSPORT IN ASIA AND THE PACIFIC

Policies affecting the freight transport sector within the ESCAP region are notably diverse, reflecting the distinct social, economic and environmental factors that characterize different countries. These policies encompass a broad spectrum, including international conventions, intergovernmental initiatives, vehicle emission standard and incentives encouraging the adoption of energy-efficient technologies and transport modes, such as the modal shift.

Recognizing policy as a pivotal instrument for enhancing energy efficiency in the freight transport sector has become increasingly common. This growing awareness is leading countries across the region to integrate transport energy efficiency into their national energy and climate strategies more intentionally. Ambitious goals are being set for the deployment of zero-emission vehicles, alternative fuel promotion is on the rise and significant investments are being directed into infrastructure that support more efficient modes of transport, such as rail and inland waterways.

VEHICLE EMISSION AND FUEL ECONOMY STANDARDS

Greenhouse gas emission and fuel economy standards represent one of the principal regulatory strategies adopted by governments globally to encourage the shift towards sustainable road freight transport. These standards set specific limits on the emissions and fuel consumption of vehicles, pushing manufacturers to design and produce cleaner, more efficient vehicles.

In terms of emissions, standards are often aimed at controlling the output of CO_2, nitrogen oxides (NOx), particulate matter (PM), and other harmful pollutants. By setting limits on these emissions, governments can mitigate the environmental and public health impacts of road transport.

Fuel economy standards, on the other hand, directly influence the energy efficiency of vehicles. By requiring vehicles to travel a certain distance on a given volume of fuel, these standards can significantly reduce fuel consumption, leading to lower greenhouse gas emissions and energy use.

The implementation of these standards has proven to have a significant impact on reducing emissions.

In the ESCAP region, countries, such as China, Japan and the Republic of Korea, have taken the lead in implementing stringent greenhouse gas emission standards for heavy-duty vehicles. For instance, China has introduced China VI standards and Japan has enforced the Post New Long-Term Emission Standards, both of which are equivalent to the Euro VI standards. The Republic of Korea has also implemented the Korea Stage 7 (KNR 07) standards, targeting reduced emissions of pollutants, such as CO_2, hydrocarbons (HC), NOx and PM.

Other countries, namely India, Indonesia and Thailand, have been following suit in recent years. India has adopted the Bharat Stage (BS) VI emission standards, which are on par with Euro VI standards, and implemented them in April 2020. Thailand has implemented the Euro IV emission standards and plans to move towards the Euro V standards. Indonesia has enforced Euro IV-equivalent standards and is in the process of developing a road map for implementing Euro V and Euro VI standards. Some countries in the region, such as Myanmar, the Philippines and Viet Nam, have yet to implement comprehensive and stringent greenhouse gas emission standards for heavy-duty vehicles. This lag in policy adoption poses a significant challenge to achieving regional climate goals and mitigating the environmental impact of the transportation sector.

Implementation of emission and fuel economy standards across the ESCAP region is varied. This underscores the necessity for heightened collaboration, capacity enhancement and knowledge exchange. Bodies, such as ESCAP, can play pivotal roles in aiding these countries in the development and execution of sustainable transport policies. By encouraging regional cooperation and disseminating successful strategies, the ESCAP member countries can collectively address disparities in emission standards. This collaborative effort can create a more eco-friendly and sustainable freight transport sector throughout the region, thereby making substantial strides towards a greener future.

GREENHOUSE GAS EMISSIONS PRICING

Greenhouse gas emissions pricing is an effective regulatory measure that governments can implement to reduce emissions, including those from the transport sector. Greenhouse gas emissions pricing is based on the "polluter pays" principle, which places a financial cost on the emission of greenhouse gases. This can be done through mechanisms, such as carbon taxes or emissions trading systems.

A carbon tax is a fee imposed on the carbon content of fuels. This means that the more a person or business pollutes, the more they must pay. The objective of this fee is to incentivize individuals and businesses to reduce their carbon emissions by adopting cleaner technologies and practices.

An emissions trading system, also known as cap-and-trade, sets a cap on the total amount of greenhouse gas that can be emitted by certain sectors. Companies or other groups can buy or sell emission allowances, which gives them the right to emit a specified amount. The cap is reduced over time, so that total emissions declined.

The application of greenhouse gas emissions pricing in the freight transport sector would encourage operators to switch to more fuel-efficient vehicles or alternative fuels, reduce the number of vehicle miles travelled or improve logistics and operational efficiency. It can also stimulate innovation and the development of new technologies and practices in the sector.

There are challenges associated with implementing greenhouse gas emissions pricing, such as setting the right price, dealing with potential competitiveness impacts, and ensuring fairness and equity, particularly for low-income households or small businesses. Moreover, the effectiveness of greenhouse gas pricing also depends on the broader policy context, including existing energy and transport policies.

As of 2022, some countries have already implemented or are considering implementing greenhouse gas emissions pricing, including in the transport sector. These include countries in the European Union, which has a comprehensive emissions trading system, and Canada, which has a federal carbon pricing system.

POLICIES TO PROMOTE MODAL SHIFT TO LOW-CARBON MODES

The promotion of modal shift to low-carbon modes has already been discussed. The rationale for future policies in promoting a modal shift may continue based on the view that such a shift from road transport to other modes of transport, such as railways and waterway transport, contributes to less carbon emissions in the transport sector even though the potential carbon benefits of a freight modal split are possibly overestimated and the practical problems of getting large numbers of companies to switch mode are underestimated (McKinnon, 2018). The main challenge is how to implement such a modal shift policy.

Historically, numerous countries, particularly those with a regulated market and limited free competition, have imposed quantitative restrictions on access to the road transport market. Some have even tried to mandate a shift in transport modes without properly assessing their impact or considering the economic costs this could impose on society.

One way of implementing a modal shift policy is to introduce fairer pricing mechanisms and internalize environmental costs of freight transport in all modes of transport on an equal basis.

The internalization includes noise, local pollution and congestion on top of the mandatory recovery of wear and tear costs for road and rail transport. In addition, the costs associated with local pollution and noise in ports and airports, as well as with air pollution at sea, should be internalized and a mandatory application of internalization charges on all inland waterways should be examined. Market-based measures to further reduce greenhouse gas emissions should, therefore, be developed (European Commission, 2011). Although this policy has not resulted in much success, useful preparatory research has been conducted to calculate and estimate the monetary values of transport externalities to be considered for the environmental tax calculation.

Despite all the challenges involved in conducting a modal shift from road to low-carbon transport modalities, this policy will remain on the agenda of most countries in the world. Many governments, in cooperation with international organizations and institutions, will continue to facilitate and promote the use of intermodal transport services. They are often doing this using a corridor framework: the European Union with its nine intermodal transport corridors linking most of its member States and their neighbouring countries; the Indian subcontinent with its dedicated rail freight corridors; the Eurasian railway network linking China with Europe; and the ESCAP Asian Highway, Trans-Asian Railway and Dry Ports.

Governments have recognized the need to establish an intermodal transport network for synchromodality, facilitating seamless mode-switching for consignments in transit. Accordingly, investments should be channelled into developing synchromodal transport networks with various modal options. McKinnon (2018), in his research, has identified additional facilitators for shifting towards lower-carbon modes:, freeing up freight capacity through high-speed passenger rail lines; enhancing rail and waterborne services via upgrades to infrastructure, signalling systems, information technology and intermodal terminals; mitigating road network congestion; regulating truck driver times and rest periods; and reducing speed limits on highways.

Empirical evidence has shown that the results of the implementation of modal shift policies have not fully responded to the expectations that the policymakers had when designing them. Some recent developments, such as the growing need for integrated synchromodal systems, collaboration among stakeholders in the supply chain and improved interoperability may contribute towards making the modal shift policy more successful. However, it must be considered that road transport has also undergone rapid development towards cleaner motor engines and less emissions increasing its carbon efficiency.

SUSTAINABLE TRANSPORT IN NATIONAL DEVELOPMENT POLICIES AND STRENGTHENING SOUTH-SOUTH COOPERATION

Across the ESCAP region, numerous countries have implemented initiatives to enhance energy efficiency in freight transport. These initiatives form an integral part of their national development policies, strategies and programmes.

There is a need to strengthen South-South cooperation in advancing energy efficiency and sustainable freight transport across developing countries. By fostering an environment of knowledge exchange, technology transfer and shared resources, countries can collaboratively forge more sustainable and efficient transport systems. This collective action is key to reducing greenhouse gas emissions and enhancing environmental health.

FINANCIAL INCENTIVES AND SUBSIDIES

Governments around the world are effectively implementing incentive schemes aimed at fostering environmentally friendly practices and bolstering energy efficiency within the road freight transport sector. They are leveraging a range of fiscal and taxation incentives to catalyse this much-needed transformation. Financial incentives play a crucial role in fostering sustainable freight road transport by stimulating businesses to adopt more environmentally friendly practices.

One common type of incentive is to set fuel taxes or levies. Higher fuel taxes can encourage freight carriers to adopt more fuel-efficient vehicles and practices. For example, in countries with large distances between cities or limited alternatives to road freight transportation, lower fuel taxes may be in place. Conversely, some countries have eliminated diesel fuel subsidies to discourage the use of it.

Another type of incentive is to offer tax credits or rebates for the adoption of cleaner technologies. Governments may provide tax incentives for the purchase of low-emission vehicles or for the installation of energy-efficient equipment in freight vehicles. For instance, in the United States, the Government offers tax credits for the purchase of electric and hybrid vehicles.

Fiscal policies targeting infrastructure investments and internalizing external costs of road freight can promote a modal shift and decarbonization of the freight transportation sector. These policies can include incentives for rail and water transport and taxes or charges on road freight to internalize the environmental costs.

Another emerging trend leaning towards energy-efficient vehicles involves offering fleet renewal subsidy schemes, typically introduced as facets of comprehensive environmental and economic strategies. The primary objectives of these initiatives are to bolster the automobile industry, reduce economic and environmental costs of transport, decrease CO_2 emissions and enhance air quality, lessen reliance on imported oil, and boost road safety. By replacing older, less efficient vehicles with new, environmentally friendly alternatives, these programmes are intended to stimulate economic growth and promote sustainable practices in the automotive sector.

INTERNATIONAL CLIMATE INITIATIVES

Over the past decades, a myriad of international climate initiatives were launched with the purpose of mitigating climate change and driving sustainability across all sectors of the global economy, including freight transport. These initiatives, ranging from policy directives to comprehensive conventions, provide a structure for collective action and establish tangible goals that guide countries on their path towards a more sustainable future. They represent the international community's commitment to a shared vision of reduced greenhouse gas emissions, energy efficiency, and a sustainable and resilient global economy. Understanding these conventions and their implications for the freight transport sector is critical for aligning the sector's practices with global climate goals.

Some of the most important international climate initiatives are as follows:

- The **United Nations Framework Convention on Climate Change** (UNFCCC) is an international treaty that aims to address climate change by stabilizing greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic (human-induced) interference with the climate system. It was adopted in 1992 during the Earth Summit, held in Rio de Janeiro, Brazil, and entered into force in 1994. As of September 2021, it has been ratified by 197 parties, including 196 countries and the European Union.

  The United Nations Framework Convention on Climate Change provides a framework for the negotiation of specific protocols and agreements to reduce greenhouse gas emissions and adapt to the impacts of climate change. The primary goal of the Convention is to achieve stabilization of greenhouse gas concentrations at a level that allows ecosystems to adapt naturally, ensures that food production is not threatened, and promotes sustainable economic development.

- **The United Nations Climate Change Conference**, also known as the **Conference of the Parties (COP),** is an annual international event that brings together representatives from countries around the world to address the pressing issue of climate change. The Conference is the primary forum for countries to discuss, negotiate and implement global climate policies under UNFCCC.

  The Conference of the Parties is the supreme decision-making body of UNFCCC. It meets to assess progress and negotiate additional measures to address climate change. UNFCCC plays a central role in shaping global climate policy and fostering international cooperation to address the challenges posed by climate change.

- **The Kyoto Protocol** is an international treaty that commits its parties to reduce greenhouse gas emissions. Adopted in 1997 in Kyoto, Japan, and entered into force in 2005, the protocol is linked to UNFCCC. The Kyoto Protocol establishes legally binding emissions reduction targets for developed countries, also known as Annex I Parties, based on their 1990 levels of emissions.

  The Kyoto Protocol has been followed by the **Paris Agreement,** an international treaty under UNFCCC, aimed at addressing climate change by limiting global warming. Adopted on 12 December 2015, and entered into force on 4 November 2016, the Paris Agreement sets the goal of limiting global warming to well below 2°C, preferably to 1.5°C, compared to pre-industrial levels.

The key objectives of the Paris Agreement include the following:

- Strengthening the global response to climate change by limiting the global temperature increase and promoting climate resilience and low greenhouse gas emissions development.
- Enhancing financial, technological and capacity-building support to help countries, particularly developing countries, achieve their climate goals.
- Encouraging transparency and accountability in reporting and assessing countries' progress toward their climate goals.

Under the Paris Agreement, countries are required to submit nationally determined contributions outlining their plans to reduce greenhouse gas emissions and adapt to climate change impacts. Nationally determined contributions are intended to be updated every five years to reflect each country's evolving circumstances and ambition.

The Paris Agreement established a global stocktake process, which is a periodic assessment of collective progress toward achieving the agreement's long-term goals.

These initiatives, agreements and programmes play an essential role in promoting energy efficiency and sustainable freight transport by providing policy guidance, technical support and sharing best practices among countries and stakeholders.

ROAD MAP FOR ENHANCING ENERGY EFFICIENCY OF THE FREIGHT TRANSPORT SECTOR IN ASIA AND THE PACIFIC

Over the years, the pressing need to transition to sustainable and energy-efficient freight transport has been recognized globally. As countries grapple with the intertwined challenges of rising freight demand, climate change and the urgency to reduce environmental footprints, the development of a cohesive and strategic regional road map has become paramount. Such a road map would not only serve as a guiding blueprint for individual countries, but it would also foster collaboration, shared learnings and mutual progress across the region. It ultimately would aim to transform the freight transport sector of the Asia-Pacific region, ensuring that it is sustainable and energy-efficient and is aligned with global ambitions and regional nuances. The key components, strategic approaches and potential pathways that can shape a comprehensive road map are explored in this chapter.

The development of a regional road map towards a sustainable and energy efficient freight transport requires a comprehensive approach that considers a range of factors, including among them, infrastructure, policy, technology and stakeholder engagement. Such a regional road map towards sustainable and energy efficient freight transport in Asia and the Pacific may consist of five steps:

1. Conducting a baseline assessment, which includes a comprehensive assessment of the current state of the region’s freight transport system, including its energy use, emissions and efficiency to have a sound base for identification of the areas of improvement and the setting of the goals for the future.
2. Development of a stakeholder engagement plan, engaging the key stakeholders such as policymakers, shippers, carriers, logistics service providers and community groups, to understand their needs and priorities. This makes the development of a regional road map a realistic endeavour and relevant to the region’s context in addition to building support for it. Engagement of stakeholders in an early stage also enables implementation and enforcement of the regional road map.
3. Setting targets and developing strategies: Set targets for reducing energy use and emissions and develop strategies to achieve them. This may include investments in alternative fuels and vehicle technologies, improvements to infrastructure and logistics, and policies that incentivize sustainable practices.
4. Identification of funding sources: Identify potential funding sources, such as PPPs, grants and loans, to support the implementation of the road map.
5. Monitoring and evaluating progress of implementation: Develop a monitoring and evaluation plan to track progress towards attaining the road map's goals and make adjustments as needed. This enables the road map to remain relevant and effective.

In general, a successful regional road map towards a sustainable and energy efficient freight transport system requires a collaborative and iterative approach that involves multiple stakeholders and considers a range of factors. By taking these steps, regions can make meaningful progress towards a more sustainable and efficient future for the freight sector.

The Economic and Social Commission for Asia and the Pacific is developing a regional strategy to deepen sustainability and energy efficiency in freight transport and give further momentum and coherence to initiatives being carried out at the regional level. The regional strategy encompasses the following:

- Definition of common challenges;
- Presentation of a guiding vision;
- Formulation of objectives;
- Linkages to the Social Development Goals;
- Promotion of decarbonization of transport in the Asia and Pacific region;
- Improvement of energy efficiency;
- Definition of enablers;
- Identification of priority areas;
- Settings for implementation of arrangements.

The policy document brings a range of stakeholders onto a common platform to plan and implement sustainable and energy-efficient freight transport policies that contribute towards achieving the Sustainable Development Goals, decarbonization of transport and resilient energy efficient transport systems.

The key elements of a regional approach to enhancing the sustainability and energy efficiency of freight transport in Asia and the Pacific is presented in box 1.

Box 1: Regional approach for enhancing sustainable and energy efficient freight transport in Asia and the Pacific[2]

Guiding vision

Efficient, connected, safe, clean, energy efficient and resilient regional freight transport system to support the achievement of the Sustainable Development Goals, decarbonization of transport in the Asia and Pacific region and resilient transport systems.

Objectives

1. Providing coherence to sustainable and energy efficient freight initiatives.

[2] See ESCAP/TARN/WG/2021/4), p 16.

2. Creating synergies through partnerships.
3. Ensuring high-level political support.

Sustainable Development Goals supported directly

1. Target 9.1: develop quality, reliable, sustainable and resilient infrastructure, including regional and transborder infrastructure, to support economic development and human well-being, with a focus on affordable and equitable access for all.
2. Indicator 9.a: facilitate sustainable and resilient infrastructure development in developing countries through enhanced financial, technological and technical support to African countries, least developed countries, landlocked developing countries and small island developing States.
3. Target 3.6: by 2020, halve the number of global deaths and injuries from road traffic accidents.
4. Target 12.3: by 2030, halve per capita global food waste at the retail and consumer levels and reduce food losses along production and supply chains, including - losses.
5. Target 9.4: by 2030, upgrade infrastructure and retrofit industries to make them sustainable, with increased resource-use efficiency and greater adoption of clean and environmentally sound technologies and industrial processes, with all countries taking action in accordance with their respective capabilities.
6. Target 7.3: double the global rate of improvement in energy efficiency by 2030.
7. Target 13.1: strengthen resilience and adaptive capacity to climate-related hazards and natural disasters in all countries.

Cross-cutting enabling conditions

1. Strengthening governance for sustainable and energy efficient freight transport at the national level.
2. Enhancing coordination for sustainable and energy efficient freight transport at the regional level through appropriate modalities or instruments.
3. Building the capacity of transport officials to mainstream sustainability considerations into freight transport including in gathering and analysing related statistics.
4. Promoting the use of transformative transport technologies, in particular digitalization.
5. Encouraging private sector engagement to plan and implement sustainable and energy efficient freight transport policies.
6. Diversifying sources of financing to meet funding requirements for sustainable and energy efficient freight transport.

Priority areas

1. Decarbonize freight transport.
2. Improve energy efficiency of freight transport.
3. Build the resilience of freight transport to effectively deal with climate challenges and pandemics.
4. Strengthen cross-border and transit transport connectivity.
5. Enhance rural freight transport linkages.
6. Improve urban freight logistics.
7. Reduce accidents related to freight transport.
8. Support sustainable and energy efficient freight transport in countries with special needs.
9. Increase the share of rail freight and other sustainable transport modes.

Implementing, monitoring and evaluating

1. Converting strategy into action plans.
2. Implementing mechanism/arrangements/partnerships.
3. Monitoring and evaluating through a results framework.

Building on the discussions surrounding policy scenarios and tools a proposal for a regional road map is presented in annex 1. This proposed road map should be designed as a flexible blueprint, adaptable to the specific needs, priorities and resources of individual countries. It provides a general strategic direction, while considering that each country stands at a different juncture in the journey towards sustainable and energy-efficient freight transport. Accordingly, the road map is built on a principle of customization, advocating countries to align its recommendations with their unique contexts, paving the way for tailored solutions that address country-specific challenges and leverage available resources most effectively.

ANNEX : FRAMEWORK FOR A REGIONAL ROAD MAP FOR PROMOTING ENERGY-EFFICIENT FREIGHT TRANSPORT

Directions and activities	Target indicators	Implementation timing	Responsible entities	Form of deliverables	Data sources for monitoring
1. Develop and implement fuel economy standards for vehicles					
• Develop fuel economy standards for passenger cars, light-duty vehicles and heavy-duty vehicles in line with international best practices • Conduct a study to assess the potential impact of the standards on fuel consumption and greenhouse gas emissions • Implement the fuel economy standards through regulation and enforcement	• Reduction in fuel consumption and greenhouse gas emissions from vehicles • Increase in the adoption of fuel-efficient vehicles	• Year 1: develop fuel economy standards • Year 2-3: conduct study and finalize standards • Year 4-10: implement fuel economy standards through regulations and enforcement	• Ministry of Transportation and Communications • Environmental Protection Agency • Customs and Border Protection	• Fuel economy standards document • Study report on the potential impact of fuel economy standards • Regulation on fuel economy standards	• Vehicle registration data • Fuel consumption data • Greenhouse gas emissions data
2. Promote the use of alternative fuels and renewables					
• Develop comprehensive policies, incentives and support mechanisms to encourage the integration of alternative fuels and renewable energy sources in the freight transport sector • Develop financial incentives • Develop infrastructure to support alternative fuels, such as charging stations for electric vehicles and CNG filling stations • Conduct public awareness campaigns to promote the benefits of alternative fuels	• Increase in the adoption of alternative fuels, such as CNG, LNG and electric vehicles • Increase in the availability of infrastructure to support alternative fuels • Reduction in greenhouse gas emissions from the transport sector	• Year 1-2: develop policies, financial incentives and infrastructure to support alternative fuels • Year 3-4: conduct public awareness campaigns • Year 5-10: monitor and adjust policies and initiatives as needed	• Ministry of Transportation and Communications • Environmental Protection Agency • Local governments	• Financial incentive programmes • Infrastructure development plans • Public awareness campaign materials	• Adoption rate of alternative fuels • Availability of infrastructure to support alternative fuels • Greenhouse gas emissions data

Directions and activities	Target indicators	Implementation timing	Responsible entities	Form of deliverables	Data sources for monitoring
3. Encourage the use of intermodal transport					
• Develop and implement policies and regulations to promote intermodal transport, such as reducing road freight congestion and improving railway and waterway infrastructure • Establish logistics centres and freight villages to improve the efficiency of the logistics system and reduce unnecessary trips made by freight vehicles	• Increase in the use of intermodal transport modes, such as rail and waterway transport • Reduction in the number of unnecessary trips made by freight vehicles	• Year 1-2: develop policies and regulations to promote intermodal transport • Year 3-5: establish logistics centres and freight villages • Year 6-10: develop transportation systems to support logistics centres and freight villages	• Ministry of Transportation and Communications • Environmental Protection Agency • Local governments	• Policy and regulation documents • Logistics centres and freight village plans • Transportation data	• Use of intermodal transport modes • Number of unnecessary trips made by freight vehicles
4. Develop and implement policies and regulations to reduce environmental impact					
• Develop and implement policies and regulations to reduce air pollution and noise pollution from freight transport, such as emissions standards for vehicles and noise limits for freight operations • Implement energy-efficient technologies in the transport sector, such as the use of fuel-efficient engines and energy-efficient driving practices	• Reduction in air pollution and noise pollution from freight transport • Increase in the adoption of energy-efficient technologies in the transport sector	• Year 1-2: develop policies and regulations to reduce environmental impact • Year 3-4: implement policies and regulations • Year 5-10: monitor and adjust policies and initiatives as needed	• Ministry of Transportation and Communications • Environmental Protection Agency • Local governments	• Policy and regulation documents • Technology adoption reports • Environmental impact assessments	• Air pollution data • Noise pollution data • Adoption rate of energy-efficient technologies

Directions and activities	Target indicators	Implementation timing	Responsible entities	Form of deliverables	Data sources for monitoring
5. Establish logistics centres and freight villages					
• Identify key transport hubs for logistics centres and freight villages • Develop and implement plans for logistics centres and freight villages, including consolidation and distribution of goods, customs clearance and warehousing services • Develop and implement transportation systems to support logistics centres and freight villages, such as rail and waterway transport	• Improvement in the efficiency of the logistics system • Reduction in the number of unnecessary trips made by freight vehicles	• Year 1-2: identify key transport hubs and develop plans • Year 3-5: establish logistics centres and freight villages • Year 6-10: develop transportation systems to support logistics centres and freight villages	• Ministry of Transportation and Communications • Environmental Protection Agency • Local governments	• Logistics centre and freight village plans • Transportation system development plans • Freight vehicle trip reduction reports	• Logistics efficiency data • Number of unnecessary trips made by freight vehicles
6. Encourage the use of low-carbon transport modes					
• Develop and implement policies and regulations to encourage the use of low-carbon transport modes • Develop infrastructure to support low-carbon transport modes • Conduct public awareness campaigns to promote the benefits of low-carbon transport modes	• Increase in the use of low-carbon transport modes • Reduction in greenhouse gas emissions from the transport sector	• Year 1-2: develop policies and regulations to encourage the use of low-carbon transport modes • Year 3-4: develop infrastructure to support low-carbon transport modes • Year 5-10: conduct public awareness campaigns	• Ministry of Transportation and Communications • Environmental Protection Agency • Local governments	• Policy and regulation documents • Infrastructure development plans • Public awareness campaign materials	• Use of low-carbon transport modes • Greenhouse gas emissions data

Directions and activities	Target indicators	Implementation timing	Responsible entities	Form of deliverables	Data sources for monitoring
7. Develop and implement freight route optimization strategies					
• Develop and implement technologies and policies to optimize freight routes, such as route planning software and road pricing schemes • Encourage the use of off-peak delivery times to reduce road congestion • Implement measures to reduce empty vehicle miles, such as promoting backhauling and load consolidation	• Improvement in the efficiency of freight transport • Reduction in road congestion and traffic-related emissions	• Year 1-2: develop and test freight route optimization technologies and policies • Year 3-4: implement freight route optimization measures • Year 5-10: monitor and adjust policies and initiatives as needed	• Ministry of Transportation and Communications • Environmental Protection Agency • Local governments	• Route optimization technologies and policies • Off-peak delivery policies and guidelines • Measures to reduce empty vehicle miles	• Freight transport efficiency data • Road congestion data
8. Provide heavy-duty vehicle scrappage subsidies					
• Develop and implement a programme to provide subsidies for scrapping old and high-emission heavy-duty vehicles and replacing them with new, low-emission heavy-duty vehicles • Establish eligibility criteria, such as age and emission standards, for heavy-duty vehicles to qualify for the subsidy • Conduct public awareness campaigns to promote the benefits of heavy-duty vehicles scrappage and replacement	• Reduction in emissions from heavy-duty vehicles • Increase in the adoption of low-emission heavy-duty vehicles	• Year 1-2: develop and implement heavy-duty vehicle scrappage subsidy programme • Year 3-5: monitor and adjust the programme as needed • Year 6-10: increase the subsidy amount and expand the program if necessary	• Ministry of Transportation and Communications • Environmental Protection Agency • Local governments	• Heavy-duty vehicle scrappage subsidy program guidelines • Eligibility criteria and application process • Public awareness campaign materials	• Heavy-duty vehicle scrappage and replacement data • Emissions reduction data

Directions and activities	Target indicators	Implementation timing	Responsible entities	Form of deliverables	Data sources for monitoring
9. Stimulate modal shift to less emitting modes from road freight					
• Develop and implement policies and initiatives to promote the shift from road freight to less-emitting modes, such as rail, waterway, and pipeline transport • Establish incentive schemes to encourage shippers and logistics companies to use less-emitting modes • Develop infrastructure to support less-emitting modes, such as rail terminals and waterway ports	• Increase in the use of less-emitting modes for freight transport • Reduction in emissions from the transport sector	• Year 1-2: develop policies and initiatives to promote modal shift to less-emitting modes • Year 3-4: establish incentive schemes • Year 5-10: develop infrastructure to support less-emitting modes	• Ministry of Transportation and Communications • Environmental Protection Agency • Local governments	• Policy and initiative documents • Incentive scheme guidelines • Infrastructure development plans	• Modal shift data • Emissions reduction data
10. Join international conventions and treaties promoting energy-efficient freight transport					
• Join international conventions and treaties promoting energy-efficient freight transport, such as the Kyoto Protocol, the Paris Agreement and the Fuel Economy Campaign of IEA • Align national development policies with the goals and principles of these conventions and treaties • Establish monitoring and evaluation systems to track progress towards meeting the goals of these conventions and treaties	• Alignment of national development policies with international conventions and treaties promoting energy-efficient freight transport • Progress towards meeting the goals of international conventions and treaties	• Year 1-2: join relevant international conventions and treaties • Year 3-4: align national development policies with the goals and principles of these conventions and treaties • Year 5-10: establish monitoring and evaluation systems	• Ministry of Transportation and Communications • Environmental Protection Agency • Ministry of Foreign Affairs	• International convention and treaty membership documents • National development policy alignment documents • Monitoring and evaluation system guidelines	• Progress towards meeting the goals of international conventions and treaties • Alignment of national development policies

Directions and activities	Target indicators	Implementation timing	Responsible entities	Form of deliverables	Data sources for monitoring
11. Integrate target indicators for freight transport efficiency in national development policies					
• Develop and implement policies and initiatives to integrate target indicators for freight transport efficiency into national development policies • Establish a monitoring and evaluation system to track progress towards the target indicators • Provide regular reports and updates on progress towards the target indicators to stakeholders	• Improvement in freight transport efficiency • Reduction in emissions from the transport sector	• Year 1-2: develop policies and initiatives to integrate target indicators for freight transport efficiency • Year 3-4: establish a monitoring and evaluation system • Year 5-10: provide regular reports and updates on progress towards the target indicators	• Ministry of Transportation and Communications • Environmental Protection Agency • National Development Planning Agency	• Policy and initiative documents • Monitoring and evaluation system guidelines • Progress reports	• Freight transport efficiency data • Emissions reduction data

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