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Cross-cutting issues in transport

Environmentally sustainable transport systems and services

Note by the secretariat

Summary

The present document serves to outline the challenges and opportunities related to addressing environmental externalities generated by the transport sector in the Asia-Pacific region. It also contains some policy options to enhance the environmental sustainability of transport systems and services in the region.

The Committee on Transport may wish to review the challenges and opportunities presented and policy options offered in the document and take the following actions: (a) encourage members and associate members to strengthen regional cooperation on the environmental sustainability of transport systems and services, including by refining nationally determined contributions and adopting and using smart transport systems; and (b) provide guidance to the secretariat on priority areas related to environmentally sustainable transport systems and services for inclusion in the next phase of the Regional Action Programme for Sustainable Transport Connectivity in Asia and the Pacific, to be developed in 2021.

I. Introduction

1. Globally, energy demand has been rising faster in the transport sector than in any other sector. In the Asia-Pacific region, the transport sector accounts for 19 per cent (852 million tons of oil equivalent) of total final energy consumption[1] and 52 per cent of total oil consumption.[2] Energy consumption in the transport

* ESCAP/CTR/2020/L.1.

1 *Energy Transition Pathways for the 2030 Agenda in Asia and the Pacific: Regional Trends Report on Energy for Sustainable Development 2018* (United Nations publication, Sales No. E.18.II.F.14).

2 ESCAP calculations based on data from the International Energy Agency. Available at www.iea.org/data-and-statistics?country=WORLD&fuel=Oil&indicator=Crude%20oil%20imports%20vs.%20exports (accessed on 14 July 2020).

sector is set to continue to grow, with Asia projected to experience the greatest growth owing in part to its rapid urbanization. In 2019, more than 2.3 billion people were living in urban areas of Asia and the Pacific, accounting for more than 50 per cent of the region's population.[3] By 2050, the population of Asia-Pacific cities will reach 3.5 billion.

2. The transport sector is responsible for 24 per cent of direct carbon dioxide emissions from fuel combustion,[4] and it is the third-largest contributor to carbon dioxide emissions from fuel consumption in the region. Road transport, which is still a popular mode of transport for passengers and freight, accounts for more than 75 per cent of carbon dioxide emissions from the transport sector.

3. Transport emissions from fuel combustion are also primary sources of commonly recognized air pollutants such as carbon monoxide, fine and coarse particulate matter (PM2.5 and PM10), nitrogen oxides, sulphur oxides, volatile organic compounds and ground-level ozone.

4. Innovations and technologies are evolving in the transport sector. There is potential in the region for the adoption and use of smart transport technologies, including smart and intelligent transport systems and smart mobility, to improve the environmental performance of transport systems and to decarbonize the transport sector.

5. As a result of the growing energy demand and emissions in the transport sector, together with public awareness regarding externalities and the rapid emergence of new technologies, the concept of environmentally sustainable transport systems is gaining recognition. According to the Organization for Economic Cooperation and Development (OECD),[5] an environmentally sustainable transport system is defined as one in which transportation does not endanger public health or ecosystems and meets needs for access consistent with (a) the use of renewable resources below their rates of regeneration and (b) the use of non-renewable resources below the rates of development of renewable substitutes.

6. In the planning and development of transport systems, it is now common practice to consider significant transboundary and global risks and impacts, such as climate change mitigation, associated with any given project. Therefore, it is important that the region's transport systems and services follow an environmentally sustainable and low-carbon development path, increase their renewable energy share and adopt innovations and emerging technologies that will improve their environmental sustainability.

7. The present document serves to outline the challenges and opportunities related to addressing environmental externalities generated by the transport sector in the region. It also contains some policy options to enhance the environmental sustainability of transport systems and services in the region.

[3] *World Urbanization Prospects 2018: Highlights* (United Nations publication, Sales No. E.19.XIII.6).

[4] International Energy Agency, *Tracking Transport 2020* (Paris, 2020).

[5] OECD, *OECD Guidelines towards Environmentally Sustainable Transport* (Paris, 2002).

II. Environmental sustainability of the transport sector: challenges and opportunities

8. The transport sector is a driver of economic growth and social development. Transport demand continues to rise with the growth in trade and the increase in the movement of people. However, in Asia and the Pacific, the sector faces major challenges, including rising fuel consumption, emissions and air pollution. The scale of the impact that these challenges have on the environment depends on local topography and how transport systems are developed, operated and maintained.

9. The region's transport sector has a major role to play in supporting the implementation of the Paris Agreement and associated nationally determined contributions. However, a transport-focused review of the nationally determined contributions indicates that some of the sector's emissions mitigation strategies lack ambition[6] and specific targets.

10. The Asia-Pacific region is also striving to achieve the Sustainable Development Goals but, despite some good progress on education and economic growth, is not on track to achieve any of them by 2030.[7] Measures to enhance the environmental sustainability of transport systems also complement the achievement of targets 7.3, 9.1, 9.4, 9.a, 11.2 and 13.1 of the Goals. Accelerated actions and immediate efforts to address the challenges and seize the opportunities outlined in the present document are required to achieve the transport-related targets of the Goals.

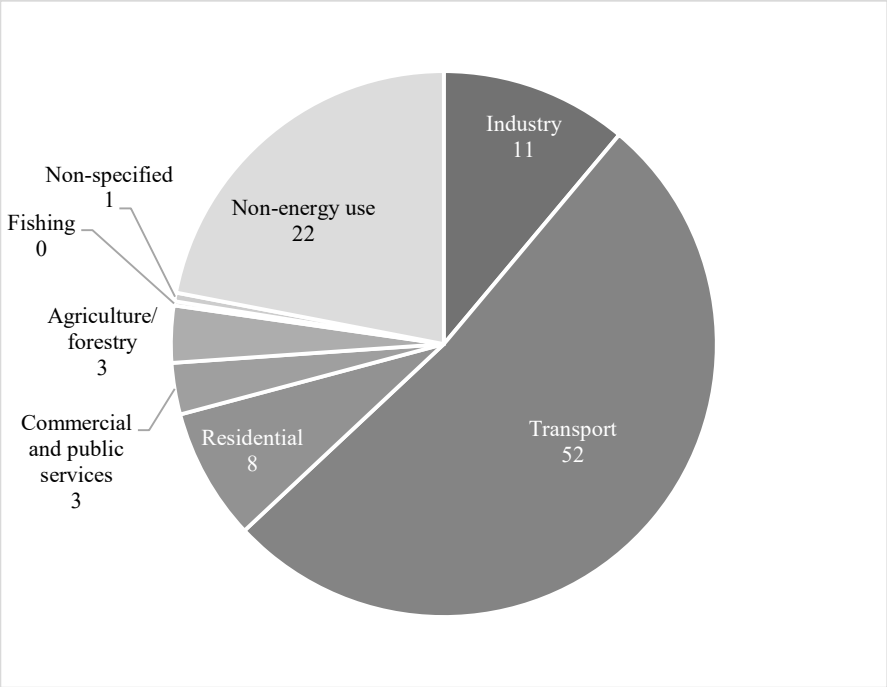
A. Energy consumption, emissions and air pollution

11. Energy consumption in the transport sector is set to continue to grow, predominantly in non-OECD countries, with the greatest growth projected for Asia. In the Asia-Pacific region, the transport sector accounts for 52 per cent of total oil consumption (see figure I). The sector's total final energy consumption and carbon dioxide emissions have doubled since 2000 owing to the rapid population growth and economic development and are projected to continue to increase in the absence of targeted policies.

[6] International Transport Forum, "Transport CO2 and the Paris Climate Agreement: reviewing the impact of nationally determined contributions" (Paris, 2018).

[7] *Asia and the Pacific SDG Progress Report 2020* (United Nations publication, Sales No. E.20.II.F.10).

Figure I
Final consumption of oil products in the Asia-Pacific region by sector, 2017
(Percentage)



Source: Economic and Social Commission for Asia and the Pacific (ESCAP) calculations based on OECD/International Energy Agency, CO2 Emissions from Fuel Combustion database. Available at www.iea.org/subscribe-to-data-services/co2-emissions-statistics (accessed on 14 July 2020).

12. Globally, energy demand has been rising faster in the transport sector than in any other sector. In the Asia-Pacific region, the sector's share of oil consumption grew from 40 per cent in 1990 to 52 per cent in 2017.

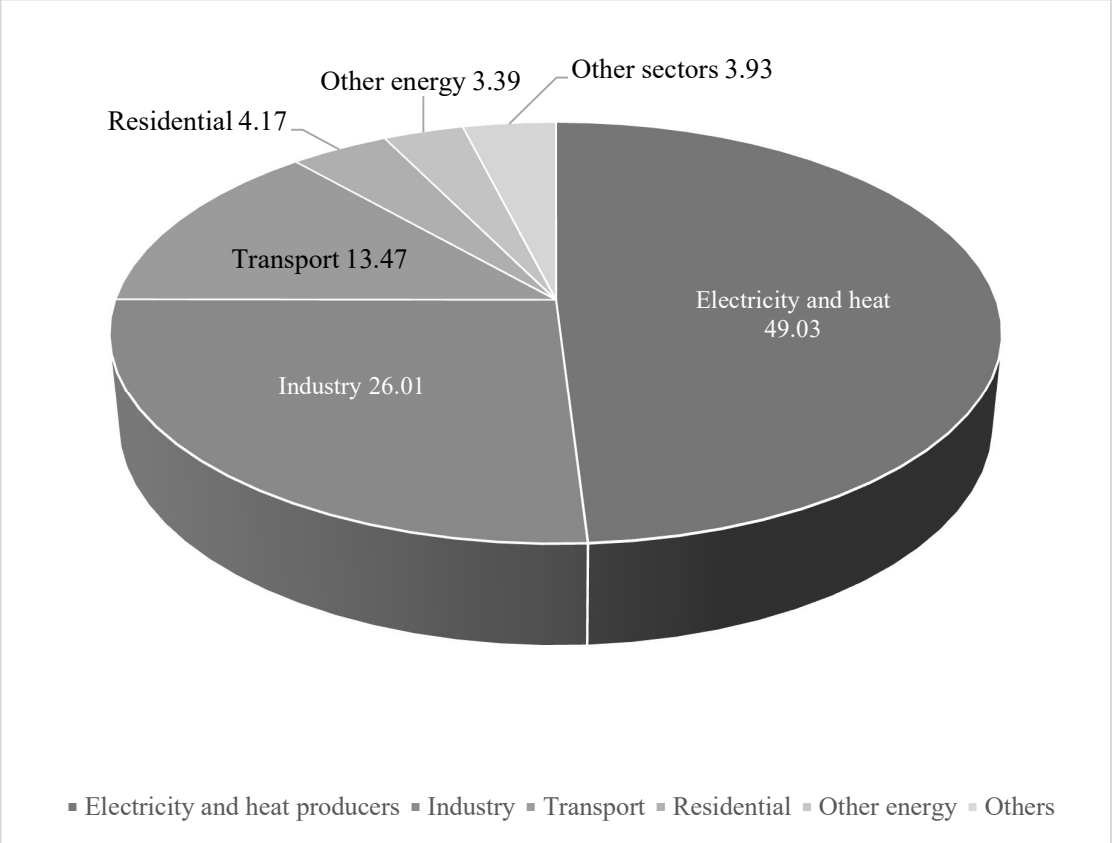
13. In order to reduce dependency on fossil fuels, many policy efforts are being made in the transport sector to use renewables, such as biofuels, or to pair renewables with other technologies, such as electric vehicles. Despite gains in energy efficiency and the continued growth in the use of biofuels and electric vehicles, renewable energy use is growing slower in the transport sector than in the heating and power sector. The renewable share of total final energy consumed by the transport sector in 2017 was approximately10 per cent.[8]

14. The sector's carbon dioxide emissions have been rising in Asia in line with the global trend, increasing from 625 million tons in 1990 to 2105 gigatons in 2017.[9] Road vehicles account for the majority of the sector's emissions. Figure II shows that in 2017, the transport sector accounted for 13.47 per cent of carbon dioxide emissions from fuel combustion in the region.

[8] Renewable Energy Policy Network for the 21st Century, "Key findings of the *Renewables 2020 Global Status Report*" (Paris, 2020).

[9] OECD/International Energy Agency, CO2 Emissions from Fuel Combustion database. Available at www.iea.org/subscribe-to-data-services/co2-emissions-statistics (accessed on 14 July 2020).

Figure II
Carbon dioxide emissions from fuel combustion in the Asia-Pacific region by sector, 2017
(Percentage)



Source: OECD/International Energy Agency, CO2 Emissions from Fuel Combustion database (see figure I).

15. Emissions from freight transport are growing more rapidly than emissions from other types of transport, while total energy demand in freight transport is expected to triple between 2015 and 2050.[10] Between 2000 and 2016, absolute transport emissions in Asia grew by 92 per cent as a result of economic prosperity and growth in passenger and freight transport. The motorization rate almost doubled, from 51 cars per 1,000 people in 2005 to 96 cars per 1,000 people in 2015. Furthermore, between 2000 and 2016, per capita transport emissions grew by 312 per cent in Viet Nam, 193 per cent in China and 184 per cent in India.[11]

16. The region's surface freight transport accounts for nearly 60 per cent of global surface freight. One estimate suggests that in the Asia-Pacific region, ton-kilometres from surface freight alone will increase by 261 per cent between 2015 and 2050 to account for more than two thirds of global surface freight.[12]

[10] United Nations, "Interlinkages between energy and transport", Accelerating SDG 7 Achievement Policy Briefs, No. 16 (New York, 2018).

[11] Partnership on Sustainable, Low Carbon Transport, *Transport and Climate Change Global Status Report 2018* (Brussels, 2018).

[12] International Transport Forum, *ITF Transport Outlook 2017* (Paris, 2017).

Consequently, freight transport energy consumption and emissions are rising, and the region has a critical role to play in decarbonizing surface freight.

17. Energy efficiency measures need to be put in place in the sector to reduce the growth of carbon dioxide emissions from freight transport. Energy efficiency is recognized as the most cost-effective means of reducing emissions, and there is an opportunity to ramp up the use of energy-efficient technologies and decarbonize the transport sector. The strategies for reducing emissions are mainly focused on avoiding unnecessary trips, measures to manage transport demand, shifting trips to more sustainable modes for passenger and freight, improving the efficiency of transport operations, market penetration of electric vehicles and access to renewable energy.[13] Examples can be found in the Transport Climate Action Directory, a database of potential emissions mitigation measures for the transport sector compiled by the International Transport Forum.[14]

18. Rapid deployment of electric vehicles could deliver emissions reductions at scale while also reducing dependence on fossil fuels. Moreover, pairing electric vehicles with energy derived from renewable sources would further amplify emissions reductions. Current regional efforts aimed at decarbonizing electricity grids together with policies that promote setting up infrastructure for charging electric vehicles could facilitate the adoption of electric vehicles, which represented 2.6 per cent of global vehicle sales in 2019.[15] Electric mobility was one of the emissions mitigation strategies highlighted in member States' nationally determined contributions.

19. Some member States have taken action to improve the environmental sustainability of the transport sector. For example, since 2009, the Government of China has been implementing an electric vehicles promotion scheme to promote the transition towards electric mobility. China ranks first in the world in terms of the number of electric buses in use and passenger traffic volume. Three of its cities, namely Guangzhou, Shenzhen and Xi'an, have public transport systems that are 100 per cent electric (comprising battery electric vehicles, plug-in hybrid electric vehicles and fuel cell electric vehicles).

20. Most cities in Asia have a high level of air pollution. An assessment of the sustainability of urban transport in 16 cities[16] was conducted using the sustainable urban transport index. In that assessment, the annual mean PM10 value was found to exceed the 20 microgram/m3 value fixed by the World Health Organization (WHO) in its guidelines,[17] ranging from 35 micrograms/m3 (Thimphu) to 193 micrograms/m3 (Jaipur, India). Other cities including Dhaka; Khulna, Bangladesh; Ho Chi Minh City, Viet Nam; and Surat, India, also had very high PM10 values. Therefore, local and national governments need to initiate strategies to improve air quality, including by reducing particulate matter from transport. However, it is important to note that sectors other than the

[13] European Academies Science Advisory Council, *Decarbonisation of Transport: Options and Challenges* (Halle, Germany, 2019).

[14] See www.itf-oecd.org/tcad-measures.

[15] International Energy Agency, "Electric vehicles" (Paris, 2020). Available at www.iea.org/reports/electric-vehicles.

[16] Bandung, Indonesia; Bhopal, India; Colombo; Dhaka; Greater Jakarta; Hanoi; Ho Chi Minh City; Jaipur; Kathmandu; Khulna; Surabaya, Indonesia; Surat; Suva; Tehran; Thimphu; and Ulaanbaatar.

[17] WHO, "WHO air quality guidelines for particulate matter, ozone, nitrogen dioxide and sulfur dioxide: global update 2005 – summary of risk assessment", WHO/SDE/PHE/OEH/06.02 (Geneva, 2006).

transport sector, such as manufacturing and power, also contribute to deteriorating air quality.

21. Switching to cleaner fuels and adopting higher standards for fuel economy and stringent standards for vehicle emissions can contribute to the improvement of air quality. Many initiatives and efforts are under way, for example the Global Fuel Economy Initiative, which is aimed at doubling the fuel economy of new light-duty passenger vehicles globally by 2030 and reducing global carbon dioxide emissions by 90 per cent by 2050.[18] Table 1 shows the planned progression of fuel economy and emissions standards for light-duty vehicles in selected countries.

Table 1
Fuel economy and emissions standards for light-duty vehicles

Countries/standards	2020		2025	
	Carbon dioxide emissions (g/km)	*Fuel economy* (km/l)	*Carbon dioxide emissions* (g/km)	*Fuel economy* (km/l)
China	116.8	20.0	95.0	25.0
India	128.6	18.2	111.2	21.0
Japan	115.0	20.3	-	-
Republic of Korea	97.0	24.2	-	-
United States of America	140.0	16.7	113.4	20.8
European Union	95.0	24.6	75.0	31.3

Source: ESCAP estimates based on data from Ministry of Industry and Information Technology, China; www.transportpolicy.net (accessed on 24 July 2020); International Council on Clean Transportation; Regulation (EC) No 443/2009 of the European Parliament and of the Council of 23 April 2009; and Bureau of Energy Efficiency, Ministry of Power, India.

B. Urban transport

22. The growth in the region's urban population demands better urban mobility. National and municipal governments are working to improve public transport systems in cities. Bus rapid transit systems are operating in 44 cities in Asia, with 9.5 million passengers transported per day along 1,625 km of routes.[19] Mass transit systems are being expanded in Jakarta, Dhaka, Bangkok, Hanoi and Ho Chi Minh City, as well as in many cities in China, India and the Islamic Republic of Iran. However, the mode share of public transport is still low in many cities, and the use of personal vehicles is dominant. The resulting negative externalities are increases in traffic congestion, consumption of fossil fuels, road accidents, emissions and air pollution. Various policies can be implemented to enhance the environmental sustainability of urban transport by improving the accessibility, quality and reliability of public transport systems, encouraging their use, and restricting and discouraging the use of personal vehicles.

[18] Global Fuel Economy Initiative, "Global Fuel Economy Initiative: for zero carbon vehicles by 2050" (London, 2019). Available at www.globalfueleconomy.org/media/708303/gfei-20-brochure-print.pdf.

[19] Global BRT Data. Available at www.brtdata.org/ (accessed on 27 July 2020).

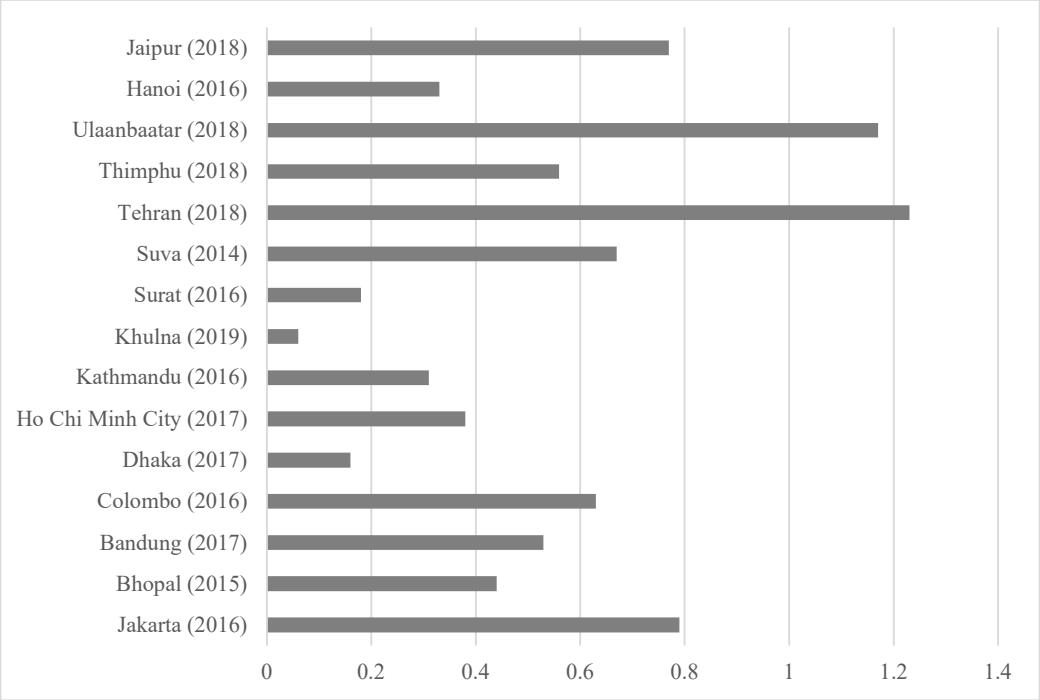
23. In Asia, there is a general aspiration to establish metro systems in cities, and some governments are planning to develop at least one metro line. Such high-capacity transit could be a viable option along high-density settlement corridors in which the concept of transit-oriented development can be applied. If land value capture is incorporated into the planning stages of metro projects, it can help to offset costs. However, to ensure efficiency, public transport networks must provide accessibility to the maximum number of urban residents. Networks could include a combination of forms and modes of transport, for example bus, subway, metro, light rail transit, bus rapid transit, urban railway, river ferry and routes for bicycles and pedestrians, allowing users to seamlessly transfer between modes.

24. One important aspect of seamless intermodal transfer is service and fare integration with combined ticketing. Often, a single trip requires the use of a combination of transport modes. In addition, providing integrated real-time information and digital payment for all modes of public transport makes it more efficient, attractive and convenient, enabling users to effect smooth transfers.

25. While capital and major cities have attracted more attention from Governments and development partners, there is great scope for city planning, including integrated public transport and land use, in secondary and medium-sized cities in their early stages of development.

26. There is a considerable opportunity to improve urban transport planning in the region by integrating various public transport modes, incorporating infrastructure for non-motorized mobility and intermodal transfer points, and increasing the accessibility and mode share of public transport. The above-mentioned assessment of the sustainability of urban mobility revealed that in most of the 16 cities, public transport fares were affordable and an urban transport master plan was in place. The percentage of the population with access to public transport ranged from 38 to 98 per cent. The mode share of public transport and active mobility (walking and cycling) ranged from 13.5 to 87 per cent. Fatalities from road crashes ranged from 2 to 15 per 100,000 people. The percentage of users satisfied with the quality and reliability of public transport services ranged from 30 to 89 per cent. With the exception of a few cities, investment in public transport as a share of total transport investment was low. The farebox recovery ratio was also low, indicating that the operation of public transport was heavily subsidized by city, state or national governments, except in Kathmandu and Suva. Cities such as Dhaka, Jaipur, Khulna and Ho Chi Minh City were found to have very high levels of particulate matter concentration. Figure III shows average annual per capita carbon dioxide emissions from transport in selected cities. The low values shown for many cities could be due to low population concentration and low levels of motorization.

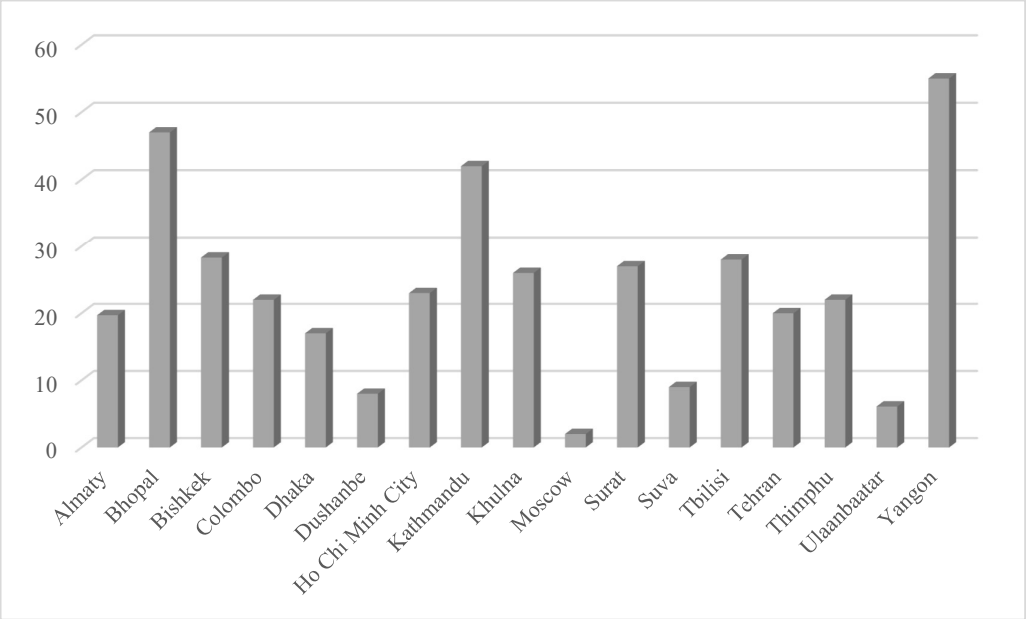
Figure III
Carbon dioxide emissions from transport in selected cities in Asia
(Tons per capita)



Source: ESCAP calculations based on data from city mobility assessment reports.

27. Non-motorized transport or active mobility (cycling and walking) is another viable option in cities and settlements. A shift to active mobility would contribute to decarbonization efforts, given that it is the cleanest form of mobility. Figure IV shows the mode share of active mobility in commuting trips in selected cities in the region. It indicates that the share is higher than 20 per cent in many cities and more than 40 per cent in three, thus highlighting the importance of active mobility in meeting the needs of urban residents. It also indicates that there is scope to improve the mode share of active mobility in some cities such as Dushanbe, Moscow, Suva and Ulaanbaatar.

Figure IV
Mode share of active mobility in selected Asia-Pacific cities
(Percentage)



Source: ESCAP calculations based on data from sustainable urban transport index mobility assessment reports, available at www.unescap.org/announcement/sustainable-urban-transport-index-suti; and United Nations Development Programme/Global Environment Facility (GEF), *City of Almaty Sustainable Transport: UNDP/GEF Project – Final Report 2011–2017* (Almaty, Kazakhstan, 2017).

28. In the context of the coronavirus disease (COVID-19), active mobility can allow people to maintain physical distance. In the medium and long term, a new paradigm is desirable for mobility and public transport in Asia-Pacific cities. This will require city and mobility planning concepts that are based on public transport and places and include improved infrastructure for active mobility, with exclusive pedestrian zones, bicycle lanes and walkways. Improving the surrounding environment, creating interconnected parks, providing bicycle sharing schemes and bicycle parking facilities and designating car-free zones and days would induce greater use of active mobility. The supply of infrastructure, active mobility and the health and well-being of commuters are directly interrelated. Providing good infrastructure can increase active mobility, which in turn leads to health benefits associated with increased physical activity. According to WHO, the recommended amount of physical activity is at least 150 minutes per week,[20] which can include transport. Non-motorized transport runs on zero energy and produces no emissions. It is the cleanest form of transport. Thus, increasing the mode share of active mobility can reduce transport sector emissions while also promoting the health and well-being of commuters.

29. The restriction of mobility due to COVID-19 has provided new business opportunities in online shopping, lean delivery and logistics. The use of telecommuting, online meetings and teleconferences has also increased. As a result, cities have experienced reductions in traffic congestion and improvements in air quality. If the use of digital technology to meet some mobility needs

[20] WHO, *Global Recommendations on Physical Activity for Health* (Geneva, 2010).

continued, it could reduce non-essential trips and contribute to environmental sustainability.

C. Freight modal shift

30. Total freight transport demand is expected to triple between 2015 and 2050.[21] In most countries in Asia, road transport plays a dominant role in terms of freight volume and mode share. For example, the share of freight volume carried by road transport is 94 per cent in the Islamic Republic of Iran, 89 per cent in Myanmar, 78 per cent in the Russian Federation, 83 per cent in Thailand, 85 per cent in Turkey and 76 per cent in Viet Nam.[22] There is huge potential for a modal shift of freight transport from road to rail, inland waterways and coastal shipping.

31. The region is home to the largest railway networks, accounting for up to 40 per cent of the world's railway lines, including extensive rail networks in China, India and the Russian Federation. Asia is also generously endowed with navigable inland waterways, such as the Padma, Ganges, Mekong, Volga and Yangtze rivers, which are used for passenger and freight transport. The total navigable length of rivers, lakes and canals in the region is estimated to exceed 290,000 km. Lastly, archipelagic and coastal countries are well suited to the use of coastal shipping for their freight operations.

32. International rail transport in the region continues to face obstacles due to infrastructure bottlenecks, break of gauge at borders, procedures for cross-border movement, and the insufficient integration of railways into transport and logistics chains. However, during the COVID-19 pandemic, railways have demonstrated higher resilience than other modes, because they require less labour over long distances and fewer quarantine checks and human interactions.

33. Practical obstacles to a greater use of inland navigation include insufficient inland ports and navigation facilities, the lack of intermodal integration, the road-oriented focus of transport investments, and restrictions on vessel traffic due to seasonal fluctuations. The lack of dedicated long-term public policies, regulatory frameworks and institutions to support the promotion of inland navigation constitutes additional challenge.

34. Likewise, while coastal shipping is recognized as an eco-friendly and inexpensive transport mode, it is still considered an auxiliary to land transport, specialized in long-distance bulk cargo transport. Similar to inland navigation, coastal shipping suffers from the lack of infrastructure, integrated transport policies and incentives, and logistics services and business models, as well as imbalances in cargo flows.

35. The above challenges need to be addressed in order to influence a modal shift. Improving railways, reviving and improving canals and river routes through dredging and widening, and adding river ports would help to improve services and increase capacities. New policy and regulatory measures would help to enhance short-sea and coastal shipping in the region. The combined use of coastal shipping and trucks rather than the use of trucks alone could lead to a 60 per cent reduction in emissions owing to the fuel efficiency of coastal

[21] United Nations, "Interlinkages between energy and transport".

[22] *Review of Sustainable Transport Connectivity in Asia and the Pacific 2019: Addressing the Challenges for Freight Transport* (United Nations publication, Sales No. E.20.II.F.2).

shipping.[23] In addition, the use of technology and consolidation centres can help road freight service providers and operators to reduce the number of empty backloads and/or increase the load factor of their trucks. Optimizing the modal split of freight transport requires a wide range of national measures, including the following: investment; fiscal and regulatory policies; new approaches to operations, pricing and marketing; use of technology; regulations on land use; and support for adequate coordination among sectors and institutional networks at the national level.

D. Innovations and smart transport systems

36. Smart transport systems embrace a range of information and communications technologies and applications and integrate drivers, vehicles and transport infrastructure to improve overall transport efficiency. Intelligent transport systems, which are considered a subset of smart transport systems, are agglomerations of diverse technologies that enhance the sustainability of transport in a smarter and greener way.[24]

37. Smart transport systems consist mainly of vehicle systems, road infrastructure, and management and operational strategies. The most common applications of smart transport systems include traffic operations and management; electronic toll collection; congestion charging; providing real-time travel information; and assisting route planning. These applications can directly and indirectly contribute to environmental sustainability. For example, drivers can reduce fuel consumptions and associated costs by using eco-driving systems in vehicles. Car navigation systems optimize travel routes and avoid potential crashes by using real-time traffic information. Smart transport technologies can automatically track the movements of vehicles in predefined areas and times for congestion charging. They can also include mobile phone applications to support the use of shared mobility (electric vehicles, e-scooters and bicycles) and influence a shift to greener transport modes.

38. Despite the fact that smart transport systems are one of the most cost-effective solutions,[25] there is a misconception among policymakers that these systems are costly and that only developed countries can afford their adoption and use. This misconception is hindering the wider adoption and utilization of smart transport systems in the region.

39. Another challenge is the lack of necessary expertise and the varying levels of technological readiness among member States to embrace smart transport systems. A recent study conducted in South-East Asia revealed that among 10 Association of Southeast Asian Nations countries, only Singapore, and to a lesser extent Malaysia, have levels of readiness similar to developed

[23] Chun-Hsiung Liao, Po-Hsing Tseng and Chin-Shan Lu, "Comparing carbon dioxide emissions of trucking and intermodal container transport in Taiwan", *Transportation Research Part D: Transport and Environment*, vol. 14, No. 7 (October 2009), pp. 493–496.

[24] ESCAP, *Guidelines for the Regulatory Frameworks of Intelligent Transport Systems in Asia and the Pacific* (Bangkok, 2019).

[25] Western Michigan University, *Costs and Benefits of MDOT Intelligent Transportation System Deployments* (Kalamazoo, Michigan, 2015).

countries with regard to connectivity and the extent and quality of communications infrastructure.[26]

40. Only a limited number of countries in the region have national plans, guidelines and regulations for smart transport systems. Member States that have not yet done so are encouraged to develop comprehensive plans and policies including an overarching vision, specific goals, standards and requirements for the development of smart transport systems. These plans, guidelines and regulations would provide an overall direction for technology development and facilitate efficient interactions among various ministries and agencies and among current and future technologies for enhanced interoperability and compatibility between various systems.

41. Many activities related to smart transport systems are being designed and pursued locally without consideration for regional consistency, owing to passive international collaboration and cooperation and a lack of direction for the future, with multifarious discussions being held at the regional level. This approach eventually creates services that are fragmented and geographically limited among countries. Without consensus on the direction smart transport should take at the regional level, the advantages of smart transport systems will be underutilized in addressing environmental issues in the transport sector. Strong regional collaboration and cooperation are necessary to advance the adoption and utilization of smart transport systems in Asia and the Pacific.

42. Emerging technologies, such as cooperative intelligent transport systems, connected and autonomous vehicles and smart mobility, could have unprecedented effects on environmental issues. These technologies utilize vehicular wireless communications, satellite positioning systems and diverse sensors to collect and share information. Smart mobility includes accessible transport, by any mode, to create seamless, efficient and flexible services in response to the user's demands. Travel routes optimized and trips made seamless by such technologies will significantly cut down traffic congestion and fuel consumption. Electrification or the use of renewable energy combined with such technologies will further slash dependence on conventional fuels.

43. In countries such as Australia, China, Japan, the Republic of Korea and Singapore, various forms of smart transport technologies have been used to improve the efficiency and safety of traffic operations and management. Table 2 shows the environmental benefits of selected smart transport technologies.

[26] PricewaterhouseCoopers, "Smart cities in Southeast Asia" (Kuala Lumpur, 2015). Available at www.pwc.com/my/en/assets/publications/smart-cities-in-southeast-asia.pdf.

Table 2
Examples of smart transport technologies and environmental benefits

Technology	*Country*	*Benefits*
Electronic toll collection	Republic of Korea	The Hi-pass system showed a reduction of carbon dioxide emissions ranging from 38 to 99 grams, corresponding to the range of reductions in wait times for one-ton cargo trucks, which could lower carbon dioxide emissions by 15,300 tons and fuel costs by 12.3 billion won annually.[a]
	Singapore	Under electronic road pricing scheme, a fee is charged to road users during periods of high congestion,[b] which has reduced carbon dioxide emissions by 103 kilotons.[c]
Advanced traffic signal control	Australia	In Sydney, 21 intersections controlled by a coordinated adaptive traffic system showed a 15 per cent reduction in carbon dioxide and coarse particulate matter (PM10) emissions and a 13 per cent reduction in nitrogen oxide emissions from vehicles.[d]
Advanced traveller information	Japan	The vehicle information and communication system contributed to a decrease in annual carbon dioxide emissions by 2.4 million tons in 2009.[e]
Cooperative intelligent transport systems/connected vehicles	Australia	In New South Wales, early results of the implementation of cooperative intelligent transport systems used to warn drivers indicated that using smart traffic signals with cooperative vehicles could potentially save up to 15 per cent in fuel consumption and corresponding emissions.[f]
	Republic of Korea	By 2020, 30 per cent of roads are expected to be vehicle-to-everything-based, which will lead to an estimated reduction of 2.2 million tons of carbon dioxide per year.[g]
Autonomous vehicles	Australia	In Victoria, the trial run of autonomous vehicles showed an approximate reduction of 27 million tons of greenhouse gas emissions and 706 million Australian dollars in health benefits.[h]
	Japan	A truck automated driving system was tested by a platoon of four vehicles on the Shin-Tomei route. The introduction of the system could reduce the carbon dioxide emissions of the 1,000 platooning vehicles on the route at midnight by 0.3 per cent and the emissions of the 3,000 platooning vehicles on the route during any given 24-hour period by 0.8 per cent when the vehicles are travelling at a speed of 80 km/h on less congested weekdays.[i]

Technology	*Country*	*Benefits*
Smart mobility	China	In Hangzhou, a bicycle sharing scheme with smart card technology, automated check-in and check-out and a smartphone application enabled users to cover a total of 1,032,000 km per day as at October 2009, reducing emissions by 190,920 kg.[j] In Shanghai, a bike sharing scheme with a smartphone application and electronic payment reduced carbon dioxide and nitrogen oxide emissions in 2016 by 25,240 and 64 tons, respectively.[k]

[a] Republic of Korea, Ministry of Land, Infrastructure and Transportation, *2013 Modularization of Korea's Development Experience: Establishment of Intelligent Transport Systems (ITS)* (Seoul, 2014).

[b] Gopinath Menon and Sarath Guttikunda, "Electronic road pricing: experience & lessons from Singapore", SIM-air Working Paper Series, No. 33-2010 (Urbanemissions.info, 2010).

[c] Development Asia, "The case for electronic road pricing", May 2016.

[d] Christian Chong-White and others, "The SCATS and the environment study: introduction and preliminary results" (Adelaide, Australasian Transport Research Forum Incorporated, 2011).

[e] Japan, Ministry of Land, Infrastructure, Transport and Tourism, *ITS Initiatives in Japan* (Tokyo, n.d.). Available at www.mlit.go.jp/road/ITS/pdf/ITSinitiativesinJapan.pdf.

[f] "Cooperative vehicles receiving and transmitting information to smart traffic signals could potentially save up to 15 per cent in fuel consumption", see John Wall, "Self-driving cars: fiction or reality?", statement to the IEEE Conference, Sydney, 30 October 2014. See also Dave Maunsell, Praveen Tanguturi and James Hogarth, "The new road to the future: realising the benefits of autonomous vehicles in Australia" (Sydney, Accenture, 2014).

[g] Ajou University, University of Seoul and Myongji University, *Study on ITS Evaluations and Business Development Plans – Final Report* (Seoul, 2017) (in Korean only). Available at www.prism.go.kr/homepage/researchCommon/downloadResearchAttachFile.do;jsessionid=3ED7CA847ADF54E649EFB2157250FD94.node02?work_key=001&file_type=CPR&seq_no=001&pdf_conv_yn=N&research_id=1613000-201700068.

[h] KPMG Australia, "Australia's future transport and mobility: progress, policies and people" (Sydney, 2019).

[i] Daisuke Oshima and Takashi Kurisu, "Development of tool for assessing impact of automated driving systems on traffic flow and CO2 emissions", in *SIP-adus: Project Reports, 2014–2018* (Tokyo, Cabinet Office, Japan, 2019).

[j] Susan A. Shaheen, Stacey Guzman and Hua Zhang, "Bikesharing in Europe, the Americas, and Asia: past, present, and future", *Transportation Research Record: Journal of the Transportation Research Board*, No. 2143 (March 2010).

[k] Yongping Zhang and Zhifu Mi, "Environmental benefits of bike sharing: a big data-based analysis", *Applied Energy*, vol. 220 (June 2018), pp. 296-301.

44. Smart transport systems are still evolving, and levels of understanding and stages of utilization vary by country. It is essential to raise awareness about the misconceptions and benefits [27,28] associated with smart transport systems so that Governments can make informed decisions. More studies on needs, local capacities and pilot applications can help to accelerate the diffusion of technologies and maximize their potential to reduce environmental externalities.

45. The secretariat is developing the first regional road map for smart transport systems including strategies and policies, and subregional guidelines for smart mobility. Timely policy support for streamlined operations and services at the subregional and regional levels would maximize the considerable and proven advantages of smart transport systems in tackling environmental issues. The road map and guidelines can serve to harmonize policy directions among member States on how to use smart transport systems to decrease traffic congestion and associated fuel consumption and vehicle emissions. Furthermore, they can include overarching policy goals that member States could consider adopting to address their environmental issues using smart transport systems.

E. Transport and the nationally determined contributions

46. Nationally determined contributions are one of the main elements of the Paris Agreement. Through them, Governments communicate the national climate actions and emissions reduction efforts that they intend to carry out to contribute to keeping the increase in global average temperatures to less than 2°C and closer to 1.5°C above pre-industrial levels.

47. In a study on transport and nationally determined contributions, it was found that measures contained in them were often desired outcomes, remained vague at best and, in some cases, had contestable mitigation potential.[29] In another study on transport decarbonization and the Paris Agreement, which included nationally determined contributions submitted as of 2016, it was found that only approximately 9 per cent of them contained a specific transport emissions reduction target and only approximately 12 per cent contained assessments of country-level transport mitigation potential, which suggested that transport measures were generally not prioritized among mitigation strategies.[30]

48. The transport sector is highlighted in several of the current nationally determined contributions that have been submitted by member States. However, the transport emissions mitigation measures in many of the contributions lack details on the following: (a) specific transport emissions reduction targets; (b) contribution of the mitigation actions to overall emissions reduction targets; and (c) how the transport sector will be decarbonized.

[27] Economic Commission for Europe, *Intelligent Transport Systems (ITS) for Sustainable Mobility* (Geneva, 2012).

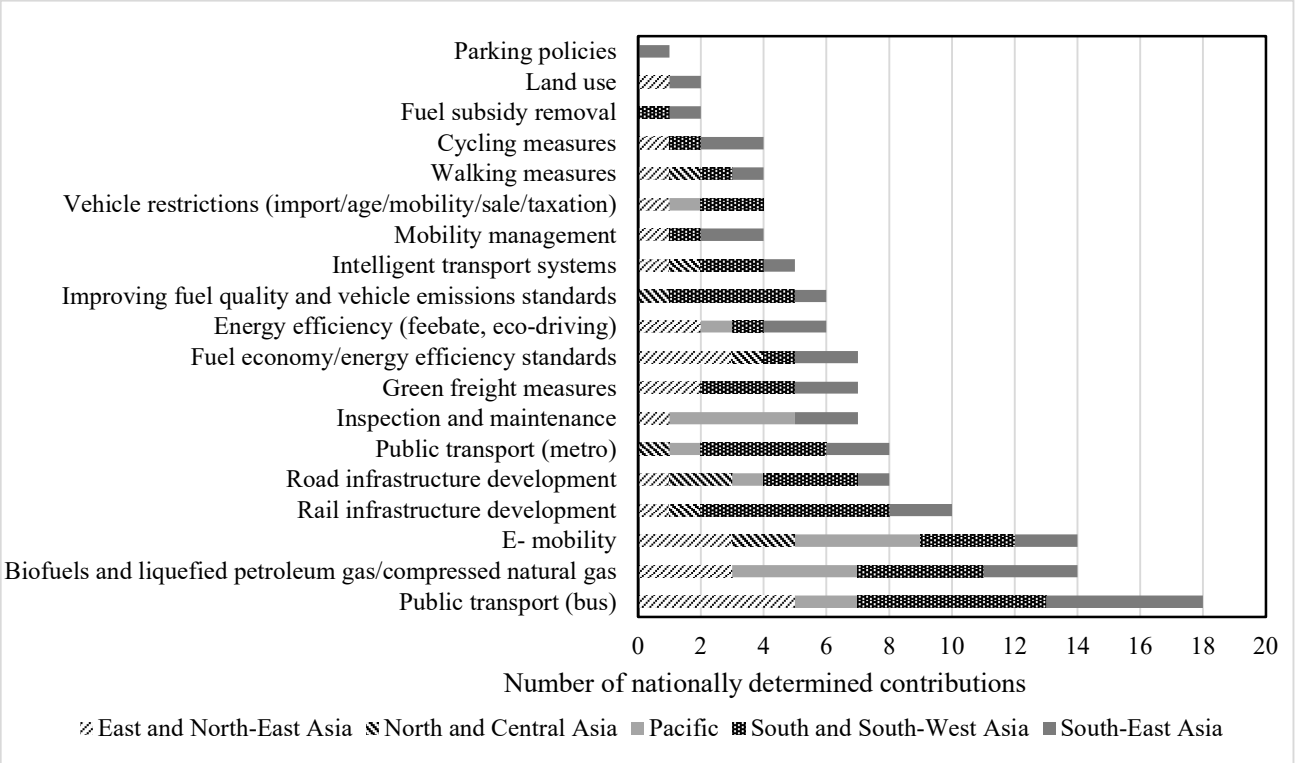
[28] IBM Institute for Business Value, *Transportation and Economic Development: Why Smarter Transport is Good for Jobs and Growth* (New York, IBM Corporation, 2011).

[29] International Transport Forum, “Transport CO2 and the Paris Climate Agreement”.

[30] Sudhir Gota and others, “Decarbonising transport to achieve Paris Agreement targets”, *Energy Efficiency*, vol. 12, pp. 363–386 (February 2019).

49. The transport emissions mitigation measures in some of the Asia-Pacific nationally determined contributions are primarily aimed at passenger transport, with fewer measures aimed at freight transport. The promotion of public bus transport, alternative energy sources and electric mobility were the top three emissions mitigation strategies (figure V) highlighted in the region.[31]

Figure V
Transport sector emissions mitigation strategies in nationally determined contributions in Asia and the Pacific as of 2018



Source: ESCAP calculations based on data from Partnership on Sustainable, Low Carbon Transport, Transport Knowledge Base database.

50. Under the provisions of the Paris Agreement, each party is expected to submit nationally determined contributions every five years, showing a progression beyond its current submission to reflect its highest possible ambition.[32] With new or updated contributions due in 2020 and 2025, there exists an opportunity to enhance transport sector measures such as freight transport emissions mitigation strategies, the application of smart transport technologies, and the inclusion of mitigation targets in the updated versions to better align with the objectives of the Paris Agreement. In a study on nationally determined contributions in seven countries, it was found that, in many cases, transport ministries had limited involvement in the process of developing nationally determined contributions, which was attributed to a lack of institutional mechanisms to involve transport stakeholders and policymakers in the process

[31] Based on data from Partnership on Sustainable, Low Carbon Transport ,Transport Knowledge Base database, version 0.2. Available at https://slocat.net/our-work/knowledge-and-research/trakb/ (accessed on 21 August 2020).

[32] International Transport Forum, “Transport CO2 and the Paris Climate Agreement”.

and, in some cases, a lack of climate change expertise in transport ministries.[33] Efforts to enhance nationally determined contributions would stand to benefit from buy-in at the highest levels of Government, together with clear and coordinated institutional arrangements.[34]

51. The need for improved institutional mechanisms can be addressed by putting in place institutional arrangements that include cooperation across sectors/ministries at the national and subnational levels in the development of nationally determined contributions. For instance, in the transport sector, efforts should be made to engage relevant stakeholders at the national, subnational and city levels to align transport priorities across all levels.

52. In order to minimize environmental impacts during the construction, operation and maintenance of transport systems and services, it is essential to conduct environmental impact assessments, following a standard process. It is worth noting that development partners involved in financing transport projects prescribe their own guidelines[35] and frameworks.[36,37]

53. In addition to addressing emissions mitigation, parties to the Paris Agreement called for national efforts on enhancing adaptive capacity, strengthening resilience and reducing vulnerabilities to climate change. The International Organization for Standardization guidelines[38] and other resources[39] contain guidance on planning adaptation and resilience measures.

III. Policy options to enhance the environmental sustainability of transport systems and services

54. A comprehensive, integrated and coordinated set of policies is needed in the region to address the issues and challenges faced by the transport sector and to enhance the environmental sustainability of transport systems and services. In this regard, rather than taking a piecemeal approach, a combination of policies and strategies is essential.

55. Bold strategies, political commitments, policy measures, frameworks and action plans, and their implementation at the regional, national and local levels, can contribute to the environmental sustainability of transport systems and services. It is often observed in the region that there is a high level of enthusiasm in developing transport policies and plans, but that a gap exists between development and effective implementation. Therefore, a long-term commitment from policymakers and implementing agencies is required at the national level.

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[33] Edina Löhr and others, “Transport in nationally determined contributions: lessons learnt from case studies of rapidly motorising countries – synthesis report” (Bonn, German Agency for International Cooperation, 2017).

[34] World Resources Institute and United Nations Development Programme, *Enhancing NDCs: A Guide to Strengthening National Climate Plans by 2020* (Washington, D.C., 2019).

[35] Asian Development Bank, *Environmental Assessment Guidelines* (Manila, 2003).

[36] World Bank, *The World* Bank *Environmental and Social Framework* (Washington, D.C., 2017).

[37] Asian Infrastructure Investment Bank, *Environmental and Social Framework* (Beijing, 2019).

[38] International Organization for Standardization (ISO), “ISO 14090:2019: adaptation to climate change – principles, requirements and guidelines” (Geneva, 2019).

[39] Global Facility for Disaster Reduction and Recovery, “Transport sector recovery: opportunities to build resilience” (Washington, D.C., 2018).

56. Because the issues related to the environmental sustainability of transport systems are transboundary in nature, regional cooperation is necessary to streamline the process of formulating regional policies, frameworks and guidelines aimed at addressing the environmental externalities of transport systems, and to facilitate the sharing of best practices and examples from the region and beyond. The region needs to expand partnerships and mobilize support from development partners.

57. The following policy options would be beneficial in enhancing the environmental sustainability of transport systems and services. These policies and related initiatives could be clustered to develop a regional framework and later developed into a blueprint for environmentally sustainable transport in the Asia-Pacific region.

58. **Energy efficiency and renewable energy**. There are opportunities to support the development of alternative fuels, such as biofuels, ethanol and biodiesel, and renewable energy, such as hydropower and wind, solar and biomass energy. One viable option is to consider initiating policies for the wider use of electric vehicles, electric public transport and the development of charging infrastructure. Policies and regulatory measures such as the adoption of progressive fuel economy standards for vehicles can help to improve energy efficiency. Member States could consider developing a regional fuel economy and emissions standard for vehicles and a regional framework to enhance the energy efficiency of freight transport. Phasing out the operation of aged vehicles and restricting the importation of old used vehicles can also help to reduce fuel consumption.

59. **Vehicle emissions and air pollution.** Comprehensive and integrated policies are required in order to reduce emissions and improve air quality in the region. Emissions reduction strategies could include the following: deployment of electric mobility; freight modal shift; progressive vehicle emissions standards; restriction of use of private vehicles; optimization of public transport; application of smart transport technologies; promotion of shared mobility and active mobility; and introduction of cleaner vehicles for public transport and intermediate public transport systems. These efforts to reduce emissions would help to improve air quality.

60. **Urban public transport systems.** Municipal governments of the region need to develop and implement integrated urban transport plans that incorporate various public transport modes, infrastructure for non-motorized transport and intermodal transfer stations, and to increase the use of public transport. Increased investment in public transport can help to improve accessibility and provide service to the maximum number of city residents. In order to increase public transport ridership, governments can employ pull policies, such as increasing the quality and reliability of public transport services, and push policies, such as restricting the use of private vehicles. Service and fare integration among various public transport modes with smart payment systems would allow users to effect smooth transfers between modes. A refined sustainable urban transport index could be used to assess urban transport systems, and assessment results could be used to make evidence-based decisions and enhance the overall sustainability of urban mobility.

61. **Active mobility.** The COVID-19 pandemic has prompted a rethinking of city and public transport planning that takes into account the health and well-being of urban residents. It is essential to prioritize active mobility and create more liveable and walkable cities. Supply-led interventions such as the improvement of walking and cycling infrastructure and of the surrounding environment by creating interconnected parks would encourage more urban residents to active mobility.

62. **Freight modal shift.** The formulation of a regional initiative including a plan of action could inspire freight modal shift from road to railway, inland water transport or coastal shipping. Policies such as investing in railway infrastructure, improving operational efficiency, reviving inland waterways and coastal shipping, and introducing fiscal and regulatory measures on transport pricing and incentives can influence a modal shift. These policy elements need to be employed in a manner that increases the attractiveness and competitiveness of the desired modes such as railways, inland waterways or coastal shipping. The modal shift will only be possible if the desired modes fulfil shippers' logistics requirements and fit into their logistics chains. In addition to modal shift, improving the efficiency of road freight transport operations is an equally important area of focus.

63. **Innovation and smart transport systems.** The development of smart transport systems requires comprehensive plans and policies with an overarching vision, specific goals, standards and requirements. As levels of adoption and application of smart transport systems vary among countries, policy and technical support would be needed at the national level to develop the plans, guidelines and regulations necessary to ensuring interoperability and compatibility among existing systems as well as between current and emerging technologies. In this context, guidelines and a regional road map for smart mobility could support the transformation of intermittent national or subregional activities into the wider deployment of smart transport systems. In particular, the regional road map would be useful to narrow the development gap of technologies and enhance the consistency of operations and developments among member States. It is essential to make a plan for new technologies that is inclusive from the regional and subregional perspectives and integrate the technologies with various forms of existing smart transport systems so that they can yield unprecedented benefits to society and the environment.

64. **Environmentally sustainable construction practices.** Following a standard environmental and social impact assessment process during the planning, construction, maintenance and operation of transport systems and services constitutes a systematic approach to identifying potential adverse impacts as well as measures to safeguard the environment. Implementation and monitoring of the recommended measures arising from environmental and social impact assessments would lead to a reduction in the potential adverse environmental impacts of transport development and operations. There are plenty of environmental and social impact assessment guidelines and frameworks available for reference.

65. **Transport and the nationally determined contributions.** Firstly, the role and capacity of transport ministries need to be strengthened in providing input during the preparation or updating of forthcoming nationally determined contributions due in 2020 and beyond. Ideally, ministries should ensure that transport sector emissions reduction targets and adaptation strategies are specified. Some examples of potential transport sector emissions reduction strategies are outlined in table 3. Secondly, additional efforts are required for the successful implementation of the pledged transport sector emissions reduction strategies.

66. **Regional collaboration.** The next phase of the Regional Action Programme for Sustainable Transport Connectivity in Asia and the Pacific, to be developed in 2021, will provide an opportunity to enhance regional collaboration on environmentally sustainable transport, including through the policy options outlined above. Table 3 contains a summary of some of the priority areas for the mitigation of emissions from the transport sector, based on the avoid-shift-improve approach.

Table 3
Priority areas for mitigation of emissions from the transport sector in the Asia-Pacific region

Strategies	*Avoid*	*Shift*	*Improve*
Policy and management	• Avoidance of unnecessary trips • Travel demand reduction measures • Encouragement of telework, online shopping, virtual meetings	• Modal shifts of passengers from private cars to public transport • Modal shift of freight from roads to railways, inland waterways and coastal shipping • Shift to non-motorized transport • Shift to shared mobility • Integrated logistics policy • Initiation of long-haul railway freight	• Increased number of electric vehicles and public transport • Adoption of smart transport systems • Exploration of alternative fuels • Increased share of renewable energy
Regulatory	• Restriction of private car use • Parking restriction • Car-free days • Car-free streets	• Safety and operational standards for river and coastal ports • Service and fare integration in public transport • Standards for quality and reliability of public transport	• Fuel economy standards for vehicles • Emissions standards for vehicles • Carbon standards for fuels • Limits on use of large personal vehicles • Limits on imports of used vehicles • Pricing for charging electric vehicles • Guidelines on the use of biofuels, biogas, natural gas and methane • Definition of standards and regulations for intelligent transport systems • Support for the transition from internal combustion engines to electric vehicles • Guidelines on vehicle inspection and enforcement

Strategies	*Avoid*	*Shift*	*Improve*
Financial	• Congestion charges • Parking charges	• Investment in urban public transport • Investment in railways, inland waterways and coastal shipping • Incentives to increase occupancy level in public transport • Incentives to use railways, inland waterways and coastal shipping • Investment in infrastructure for active mobility	• Tax incentives for electric vehicles • Incentives to use renewable energy • Investment in intelligent transport systems and smart transport technologies • Investment in vehicle charging infrastructure • Invest in research and innovations, electric vehicles, battery electric vehicles, plug-in hybrid electric vehicles, fuel cell electric vehicles and autonomous vehicles

Source: ESCAP calculations based on data from European Academies Science Advisory Council, *Decarbonisation of Transport*; Partnership on Sustainable, Low Carbon Transport, *Transport and Climate Change Global Status Report 2018*; and Transport Climate Action Directory, available at www.itf-oecd.org/tcad (accessed on 28 July 2020).

IV. Issues for consideration by the Committee

67. The secretariat's activities relating to freight transport, urban mobility and the use of smart transport systems, including intelligent transport systems, are outlined in document ESCAP/CTR/2020/1 and information note ESCAP/CTR/2020/INF/1.

68. The secretariat will continue to support member States in three work streams, namely intergovernmental collaboration, normative analysis and capacity-building to enhance the environmental sustainability of transport systems and services and achieve the transport-related targets of the 2030 Agenda for Sustainable Development.

69. In order to address the energy efficiency of freight transport, the secretariat is planning to support policymakers to formulate and implement sustainable and energy-efficient freight transport policies in the region.

70. The secretariat is developing a regional road map for smart transport systems for Asia and the Pacific and guidelines for smart mobility for South-East Asia, to harness the potential benefits of new technologies that can enhance the environmental sustainability of transport systems and services in the region.

71. In light of the considerations outlined in the present document, the Committee on Transport may wish to review the challenges and opportunities presented and policy options to enhance the environmental sustainability of transport systems and services in the Asia-Pacific region. The Committee may also wish to consider taking the following actions:

(a) Encourage members and associate members to strengthen regional cooperation on environmental sustainability of transport systems and services, including by developing evidence-based policies, considering the inclusion of specific emissions reduction targets and strategies for the transport sector in their nationally determined contributions and adopting and using smart transport systems;

(b) Consider the dimensions of environmentally sustainable transport systems and services for inclusion in the next phase of the Regional Action Programme, to be developed in 2021.