HIGH-LEVEL POLITICAL FORUM
ON SUSTAINABLE DEVELOPMENT

POLICY BRIEF #16

INTERLINKAGES BETWEEN ENERGY AND TRANSPORT

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This document is a part of a series of Policy Briefs being developed to support SDG7 review at the UN High-Level Political Forum to be held in July 2018. The objective is to inform intergovernmental discussions by providing substantive inputs on SDG7 and its interlinkages with other SDGs prepared through inclusive multi-stakeholder consultation processes. The development of these Policy Briefs is coordinated under the auspices of the Ad Hoc Informal Multi-stakeholder Technical Group of Advisors on SDG7.

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KEY MESSAGES

At the global level, the transport sector is annually (2010-2015 average) responsible for twenty-eight per cent of total final energy consumption (TFC). The transport sector has consumed around 60 per cent of global oil products on average over the past few years[1]. In many developed countries, transport is the single biggest energy user. Globally, transport energy demand has been rising faster than any other sector. Energy consumption in the transport sector is set to continue to grow, predominantly in non-OECD countries, with the greatest growth in Asia.

Transport, represented by its three pillars, aviation, inland transport[2] and maritime transport, is a key driver of economic and social development, connecting people and places, transporting goods and enabling access to services. Ensuring that the energy that powers transport is sustainable; clean, renewable and low carbon, is vital. However, overall transport is not on track to achieve sustainable mobility.

Road vehicles are responsible for most transport energy use. Improving the efficiency of vehicles will play a key role in managing energy demand, saving money and minimising climate and air quality impacts from emissions. Policies to improve the fuel economy of vehicles, such as improved aerodynamics and more efficient engines and powertrains, must be undertaken alongside policies to avoid unnecessary travel and support a shift to alternative, more sustainable, modes and fuels – including public transport and walking and cycling.

As the road transport increasingly looks to shift towards vehicles powered by electricity, it is vital that it is low carbon, and local energy systems are able to manage and to respond to patterns of demand.

While energy demand from the shipping and aviation are a relatively low proportion of total transport demand, energy use in these sectors is increasing and further policies and technology measures that promote fuel efficiency are needed.

Priority Actions over the Next Four Years

- Implement fuel economy policies to improve the efficiency of vehicles, including measures to incentivise electric and zero emission vehicles. Policies can include new standards, fiscal incentives or improved information.
- Introduce measures to improve the efficiency of trucks, including fuel economy standards, and voluntary 'green freight' initiatives to improve vehicle efficiency and consolidate journeys through advanced logistics and hubs where possible.
- Phase out inefficient transport related fossil-fuel subsidies, direct and indirect (e.g. inefficient fiscal measures), that encourage wasteful consumption.
- Contiguous urban areas should introduce sustainable transport policies, irrespective of political frontiers, that invest in safe walking and cycling infrastructure, with ring-fenced funding, and strong linkages to efficient, connected, and affordable public transport systems.
- Continuous progress in setting international policies and standards under International Civil Aviation Organization (ICAO), and International Maritime Organization (IMO) to address emissions from international aviation and maritime transport, respectively, including energy efficiency improvements by aircraft and ship technology and operational measures.

Priority Actions to 2030

- Accelerate research in efficient batteries and energy storage systems, including hydrogen and fuel cell technologies, to reduce prices and increase range in electric powered vehicles, trains, ships and aeroplanes. Develop the charging/refuelling infrastructure to enable a transition to electric mobility, and to facilitate a transition to more efficient, zero emission transport.
- Continue to develop and adapt vehicle fuel economy policies, and seek continuous energy efficiency improvements in other sectors including aviation and shipping as well as research and development around increased use of sustainable aviation fuel, clean energy and renewable power.

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[1] Data on transport sector final energy consumption was obtained from the IEA Sankey diagrams of World Final Consumption for the years 2010-2015: https://www.iea.org/Sankey/#?c=World&s=Final%20consumption
The "transport sector" in this sense is composed of domestic aviation, road, rail, pipeline transport, domestic navigation, and non-specified transport. In IEA data *international marine bunkers* and *international aviation bunkers* are shown in *Supply* and are not reported as final consumption. For detailed IEA definitions of energy balance and transport activity specifications please see: https://www.iea.org/statistics/resources/balancedefinitions/#transport

[2] Inland Transport consists of international and domestic rail-, road transport and inland navigation.

Transport and the 2030 Agenda

The importance of transport for achieving the SDGs

Transport is a vital sector for the achievement of the Sustainable Development Goals. Transport supports the achievement of virtually all of the goals, including those associated with economic and social development; connecting goods with markets, supporting agricultural productivity and access to services. Safe, clean and sustainable transport that is affordable and accessible to all is critical for sustainable development.

Transport is fuelled by energy and is therefore directly linked to SDG 7 on affordable and clean energy. Sector stakeholders can contribute to target 7.2 by increasing the share of renewables in the transport energy mix and to target 7.3 through measures that improve passenger/freight distance travelled per unit of energy input. Targets 7.A and 7.B also have links to transport. The sector's capacity to innovate may prove increasingly relevant to these two targets to 2030 through investment in R&D and as nascent technologies mature (for example, solar highways and induction-based charging of electric vehicle (EV) batteries that use them).

Current energy use from transport

Energy use in transport has increased significantly in correlation with world population growth and economic development. At the end of the twentieth century there were 500 million private cars in use globally. By 2015, that number had doubled to 1 billion. Over 20 million cars are sold each year in China alone, and the number of vehicles will continue to grow. Energy use from inland freight, aviation and shipping continue to increase in responding to the growing demand for goods and domestic and international travel.

The transport sector's share of TFC in the world in 2015 was 28.8 per cent. In the same year, it consumed 65% of global oil supply[3]. In total, transport consumes over 100 quadrillion British thermal units (Btu). The majority (96%) of this energy is in the form of petroleum or other liquid fuels, with a very small proportion as electricity. The share of electricity used in the sector is expected to increase gradually along with natural gas.

Road transport accounts for around three-quarters of transport energy consumption, with light duty vehicles responsible for around half, a quarter used by trucks and buses. Air and maritime are each responsible for around 10%, while railways' share is the least of all modes at 3%.

Key challenges

Virtually all (96%) of future transport energy use is expected to be in non-OECD economies. Recent increases in OECD countries' demand have been predominantly in aviation and shipping. Currently 70% of global trade in value and 80 per cent by volume is carried on board ships. Estimates vary, but most reference scenarios suggest population growth and rising incomes could result in around a 50% increase in demand by 2040 compared with 2015 levels.

Total freight transport demand is expected to triple, growing from 112,000 billion ton-kilometres in 2015 to 329,000 billion ton-kilometres in 2050. Airfreight volumes are expected to grow faster than other modes, at about 5 per cent annually. Trucks are the fastest growing source of global oil demand, and could account for 40% of the oil demand growth to 2050. Without policy action, they are likely to overtake light duty vehicles in the coming decades as the largest energy user.

How to fill the gap

The transport industry is a major global energy consumer and the dominant consumer of oil and its products. Improving the energy efficiency of vehicles, aircraft and ships and increasing the share of renewables in the fuel mix will be crucial to achieving the targets set out in SDG 7. A series of measures must be defined and put in place in order for the transport sector to contribute to achieving SDG 7 worldwide by 2030. These measures will need to be tailored to achieve the global targets while recognizing sectorial specificities, local socioeconomic circumstances, environment and development needs.

Another point where measures to improve energy efficiency and integrate renewables into transport systems commonly diverge is on the boundary between the urban scale and the inter-urban and international transport scale, so as to take in to consideration and respond to the particularities of these transport subsectors environments economics and stakeholders. Developing rail infrastructure so that freight and passengers can be transported between cities by train rather than road would reduce the energy intensity and carbon footprint of transport. Developing intermodal freight infrastructure to support the shift of freight transport to more energy efficient modes, namely rail and inland waterways, and improving transport logistics to reduce the number of journeys required – 'green freight' initiatives - will increase the energy efficiency of international freight transport.

At the urban scale, the 'avoid', 'shift', 'improve' mitigation framework describes pathways to improving the sustainability of transport:

- reducing travel demand and minimising unnecessary travel;
- shifting to lower emission alternatives;
- improving the technological performance of vehicles.

One program promoting this framework is the UN Environment's and the FIA Foundation's 'Share the Road' that works to promote policies for cycling in developing country cities. Similarly, UNECE's and WHO Europe's 'Transport Health and Environment Pan-European Programme' (THEPEP) promotes and provides support for developing policies that will encourage walking, cycling and a shift to greater use of public transport in urban centres in the ECE region.

Beyond context-specific measures, incremental and continuous improvements in vehicle fuel efficiency will be key for ensuring transport's contribution to achieving SDG 7. Most internal combustion engines are inefficient at converting fuel into usable energy. Most gasoline combustion engines average around 20 percent efficiency. Diesels are typically higher, approaching 40 percent in some cases. In sum, only 20 to 40% of the energy in the fuel burned in engines of road vehicles is actually employed to move them, with the rest rejected as

[3] Source: https://www.iea.org/Sankey/#?c=World&s=Final%20consumption

heat. The same is also true for aircraft turbojet engines, while marine diesel engines on large ocean-going ships (the main maritime energy users) can have slightly higher efficiencies, of around 50% (shaft power output) and even 55% when waste heat recovery is employed.

In addition to improving the efficiency of petrol combustion engines, further measures are needed to support expansion of the fleet of road vehicles propelled by alternative and renewable fuels, such as LNG and biofuels, hydrogen and fuel cells, and expanding the fleet of hybrid-electric vehicles (HEV) and EVs. The extent of the contribution of EVs will depend both on improving battery vehicle range on a single charge without adding significant additional cost and on the construction of EV charging infrastructure networks. The use of sustainable aviation fuel and other clean energy in air transport is another challenging area. Some industry-wide progress has been realized already, including the approval of five production processes for sustainable aviation fuels, and a number of airports distributing such fuels, which has led to 100,000 commercial flights being powered with sustainable aviation fuels through 2017.

Interlinkages with other SDGs

Transport is linked with virtually all SDGs. Direct impacts of transport on progress in achieving SDGs and their targets include reducing road traffic deaths (target 3.6), which are a factor of safety features of vehicles, the design of infrastructure and traffic systems and the behaviour of participants in traffic. Further key links are with Goal 13 on climate change (target 13.2 – mitigation), and targets on air quality in cities (Goal 11, target 11.2 on urban emissions and also Health target 3.9 on health impacts of air pollution). Transport is responsible for around a quarter of CO_2 emissions, and diesel fuels are also associated with particulate matter including 'black carbon' that acts as a 'Short Lived Climate Pollutant', particularly in areas covered by ice and snow, by absorbing heat and contributing to warming. Over 3 million people die each year from the impacts of outdoor air pollution, and transport is associated with a large proportion of this, particularly in cities.

Notable links are also observed in relation to SDG 8 on decent work and economic growth. The transport industry plays an important role in today's economy. It has a substantial impact on economic growth and provides a significant proportion of employment in high-income countries around the world. In the EU, the industry directly employs 10 million people (while the indirect and induced employment figures it generates are several orders of magnitude higher), and is responsible for 5% of the economic area's GDP. Taking into account the projected long-term strong rate of increase of demand for transport related products and services in developing countries, the industry will be a very important element of the equation to achieve targets of SDG 8.

Transport systems consumption of energy extends beyond that of vehicles which carry persons and freight. The manufacturing of vehicles and the construction and maintenance of transport infrastructure are energy intensive industries that can seek opportunities to improve their resource intensity throughout their products lifecycles. In this broader perspective, transport systems and energy consumption very much impact SDG 9 on industry, innovation and infrastructure and SDG 12 on responsible consumption and production, and they will in turn be impacted by measures taken by governments and industry stakeholders to achieve these goals (such as target 12.C. to rationalize inefficient fossil fuel subsidies that encourage wasteful consumption). Finding sustainable solutions for end of life management of EV batteries (scarce resource recycling) is a prime example of this transport-energy-resource sustainability nexus challenge for society. Finally, the evolution of transport systems and related industries will also affect the achievement of targets of SDGs 14 on life below water and SDG 15 concerning live on land.

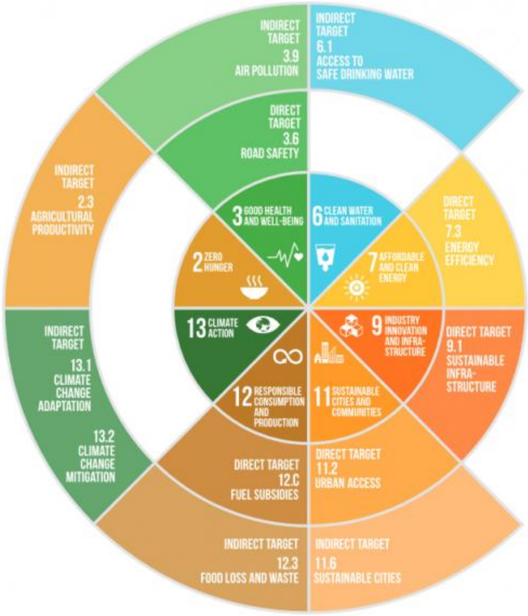

Figure 1 Transport and the SDGs (Source: SLOCAT)

Policy Implications

Due to increasing demand for mobility and freight transport, without a successful green technology and green behaviour transitions, the energy intensity and environmental impact of transport my increase substantially.

Improving vehicle efficiency

Agreeing approaches to managing growth in emissions from inland transport modes, aviation and shipping will restrain their respective passenger- and freight-transport energy intensities. The amount of CO_2 released into the atmosphere from fuel combustion is directly proportional to the amount of fuel burned. Therefore, improvements in petrol combustion engine efficiency reduce the per-unit of distance covered and per passenger/freight carried CO_2 emissions. These improvements thereby recuse harmful environmental and human health impacts (environmental and social sustainability) and reduce the amount of energy employed per unit of distance and passenger/freight carried, which will in turn save money and reduce energy intensity (immediate and upstream economic and environmental sustainability impacts).

The UN Vehicle Regulations, developed by United Nations Economic Commission for Europe (UNECE) World Forum for

Harmonization of Vehicle Regulations (WP.29)[4] and subsidiary working groups, prescribe CO_2 emission limits and thereby fuel economy standards for road vehicles, both light duty and heavy-duty, with internal combustion engines.

Similarly, standards for aircraft and ship engine CO_2 emission and fuel economy are developed respectively within the scope of activities of the International Civil Aviation Organization (ICAO)[5] and the International Maritime Organization (IMO)[6]. IMOs regulations for energy efficiency of ships apply to internationally trading ships of 400 gross tonnage and above, and make mandatory the Energy Efficiency Design Index (EEID) for new ships, and the Ship Energy Efficiency Management Plan (SEEMP) for all ships. ICAO adopted the first ever global certification CO_2 standard for aeroplanes, which will apply for new aeroplane type designs from 2020 and to aeroplane-type designs which are already in-production in 2023 (UNFCCC, 2017). ICAO also facilitates aviation's operational improvements, such as Air Traffic Management (ATM) for better use of airspace, more efficient air-routes and less congestion in the sky, as well as promoting green airports to reduce aviation –related fuels and CO_2 emissions at the ground level.

In addition to energy efficiency standards in the realm of construction of vehicles and their engines, there is a series of well-tested financial and non-financial instruments that have been used in the past decades to restrain the energy intensity of transport.

One obvious measure is increasing the price of energy through fuel taxes, thereby encouraging road users to adopt more energy efficient behaviour or to consider other transport modes. However, high fuel taxation can have important implications on mobility, if not compensated by measures promoting alternative transport options (public transport, ride sharing, bicycling, etc.).

Taxation of new cars based on CO_2 emissions levels or engine power can promote the use of energy efficient and low emission vehicles. A differentiated tax system on the purchase of new vehicles by taxing cars according to their CO_2 emissions levels has in the past been successful in European countries. Another example is bonus-penalty programs that promote replacing cars with newer more environmentally friendly versions, where owners receive bonuses if the new replacement car is more energy efficient than the old one, while are in contrast penalized for replacing their vehicles with vehicle that have more energy intensive engines.

Congestion charging programs have been a used financial instrument in urban environments (Stockholm, London, Rome, Milan, etc.), exempting frequently electric and HEVs, thereby providing an impetus for their purchase for city dwellers.

Examples of non-financial instruments include establishment of rules for public authorities that will serve as good examples for road users, such as the mandatory procurement of superiorly energy efficient vehicles for government institutions. Further measures worth considering are vehicle fuel efficiency educational campaigns that promote driver behaviour such as maintaining steady speeds, anticipating traffic, slow and smooth accelerations and maintaining tyre pressure at optimal levels.

ICAO's 192 Member States adopted in 2017 the Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA)[7], which will contribute to achieving the international aviation sector's goal of carbon neutral growth from 2020, together with other CO_2 mitigation measures. The CORSIA is strongly supported by the aviation as the only global market based instrument for international aviation, as opposed to a patchwork of different national and regional financial/economic instruments.

Modal shift and infrastructure development

Modal shifts are unlikely without substantial changes in costs/pricing, strong regulatory measures and changes in governance structures. Policy measures that may affect transport mode choices include economic instruments such as fuel taxes, congestion and emissions charges, and labour and safety regulations and investments in infrastructure and service improvements.

The construction of infrastructure to support a modal shift in passenger and, especially, freight transport is necessary in order to achieve a reduction in energy intensity of transport systems, especially in light of population growth projections and economic development targets. This means investments in the construction of rail networks to shift where possible freight transport from truck to rail, and intermodal terminals in key ports where freight can be transferred from ships to trains for transportation to the hinterland.

In the recent past, public sector investment in the rail industry has, in most of the world (with the exception of some European and Asian countries), been modest, with much of it focusing on upgrading. It may require a radical increase in rail investments to reduce prices and improve services, allowing rail to increase market share.

In passenger transport, the use of intermodal facilities can be encouraged by ensuring that there are proper alternatives to the car and by providing appropriate infrastructure to allow travellers to use different modes. National authorities can facilitate passenger use of intermodal transport by financing transport interchanges and generally improving public transport facilities and their accessibility at urban centres.

Increasing the share of renewables and sustainable alternative fuels in transport

Achieving a substantial increase of renewable energy in the transport energy mix will depend on setting ambitious targets for share of advanced biofuels and other alternative fuels with low carbon lifecycle emissions in the transport energy mix, the deployment of higher proportions of EVs in vehicle fleets and the expansion of renewable electricity generation capacities

[4] WP.29 is the leading international institution for harmonization of safety and environmental provisions for road vehicles. The three agreements that it administers cover 143 UN Regulations (1958 Agreement), 19 UN Global Technical Regulations (1998 Agreement) and 2 rules for Periodical Technical Inspections (1997 Agreement). All UN member States may accede to an apply regulations under the three UN vehicle agreements. https://www.unece.org/trans/main/welcwp29.html

[5] https://www.icao.int/environmental-protection/Pages/technology-standards.aspx

[6] http://www.imo.org/en/OurWork/environment/pollutionprevention/airpollution/pages/ghg-emissions.aspx

[7] https://www.icao.int/environmental-protection/Pages/market-based-measures.aspx

(on grid and decentralized). It is important to note that if the electricity powering EVs is not generated from renewable sources, the related emissions are simply displaced from the vehicle tailpipe to the fossil-fuel power plant.

Apart from using cleaner energy and in a more efficient way (electric motors are superior in efficiency compared to internal combustion engines), EVs are in future expected to be a key part of smart electricity grids. Their batteries will be used as grid storage devices, with the energy stored in them dispatched (if they are parked and plugged-in) when necessary to balance the electricity grid during daily peak loads.

Government, private sector and academia collaboration on R&D of EVs and their components (most importantly batteries), and investment in required infrastructure, i.e. charging stations in cities and along national roads and highways, are basic preconditions for the uptake of EVs. Challenges in this respect include the reinforcement of electricity distribution networks, their upgrading to allow a higher uptake of intermittent renewables into the grid, and the construction of the charging infrastructure itself. In addition, the end of life management (collection, depositing and/or recycling) of EV batteries is a process that is still maturing. The stock of natural resources that the batteries are constructed from is limited, extraction processes are energy intensive and used batteries can emit toxic gases if damaged. It is therefore key for the industry to develop environmentally sustainable and economically efficient technologies and processes for their recycling (or other solutions for reuse) before the market is overwhelmed with depleted EV batteries.

Hydrogen and full cells are another promising technology that can improve the energy efficiency of transport, beyond applications limited to road vehicles. A number of rail and shipping companies have announced the commercial rollout of trains and ships running on hydrogen fuel cells during the 2020-2025 period. Technological solutions for overcoming challenges in transport and storage of hydrogen are on the horizon, while the current state of the art already has solutions for its safe use. A number of challenges remain, though, in particular addressing the capital costs of establishing fuelling station networks and the corresponding required infrastructure for hydrogen fuelled road vehicles.

Because of deep technological gaps, renewable electricity will not substitute liquid fuels in air and seaborne transport in the near future. Consequently, aviation stakeholders endeavour towards a gradual increase in the share of drop-in biofuels that secure significant lifecycle emissions reductions for passenger and freight aviation in comparison with the industry dominant fossil fuels of today. EU countries have established, through the European Advanced Biofuels Flightpath [8], the goal of reaching a minimum of 40% low-carbon sustainable biofuels in national aviation by 2050. Within the UN system, ICAO's Global Framework for Aviation Alternative Fuels[9] provides a platform for coordination of national policy actions to accelerate the appropriate deployment of sustainable alternative jet fuels, a stage to exchange information and best practices and to draw attention to the need for increased harmonization for sustainability. In addition, the ICAO Conference in October 2017, agreed on the ICAO Vision as a pathway towards significant proportion of conventional aviation fuels to be substituted by sustainable aviation fuels by 2050. The ICAO Vision will be periodically reviewed, leading to the convening of the next ICAO Conference by 2025, with a view to updating the vision with a quantified 2050 goal. ICAO is also leading a number of studies and projects with the objective to increase the use of clean energy, including the installation of solar panels at airports in cooperation with EU, UNDP and GEF.

The UN's IMO adopted amendments to the MARPOL convention leading to a significant decrease of the sulphur content in fuels used by international shipping. This mandatory requirement will contribute to massively reshape international shipping's fuel mix. Further GHG emissions reduction opportunities in the current development of the IMO GHG Strategy include the uptake of low- and zero-carbon based fuels.

The wording of SDG 7's target 7.2 - "By 2030 ***substantially increase*** the share of renewable energy in the global energy mix" – is quite open. As such, it presents an opportunity for countries, which are able to dedicate sufficient resources, to define voluntary targets for share of renewables in their transport sectors by 2030, thereby taking the lead with proactive policy examples that may be replicated in elsewhere.

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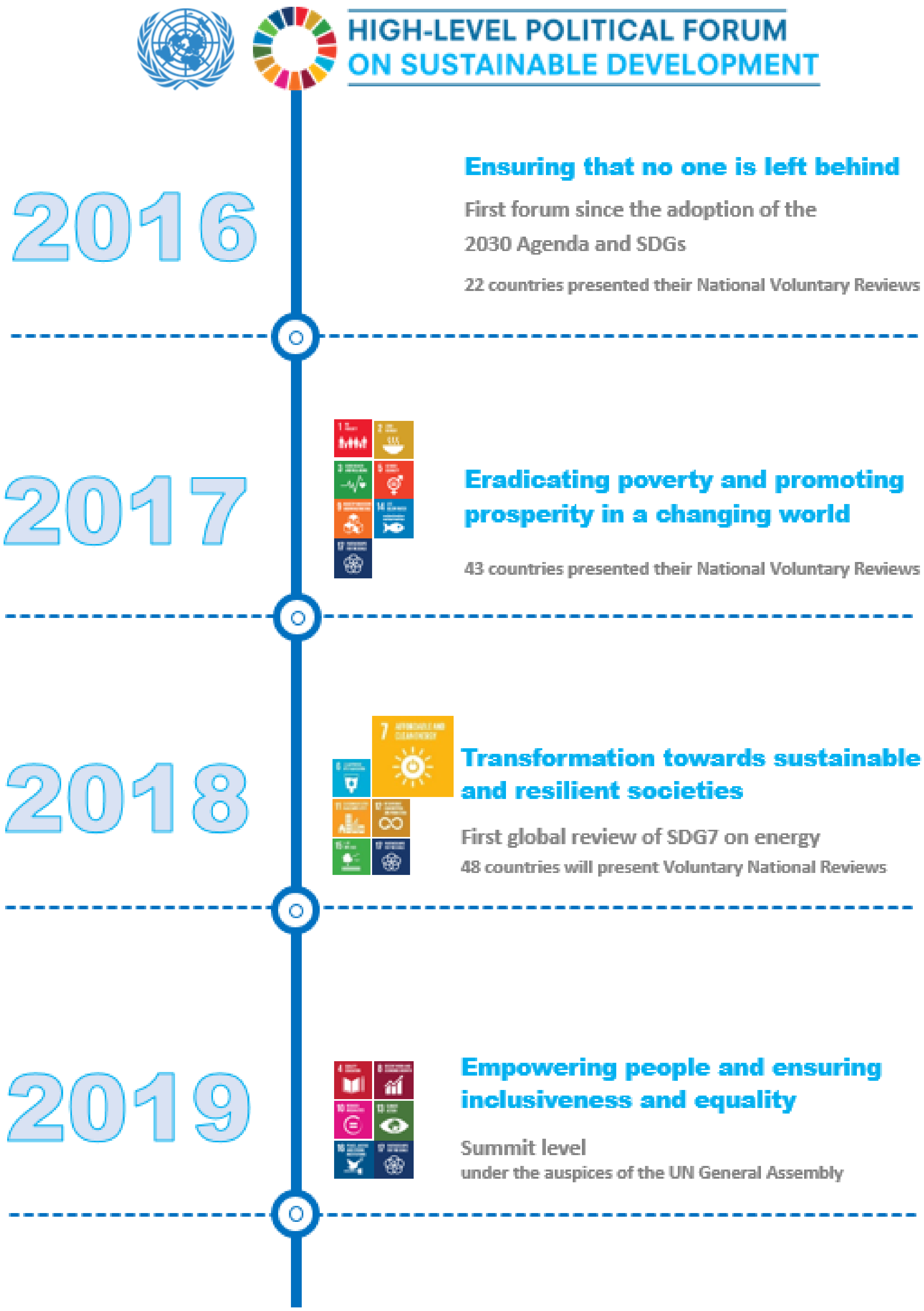

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