Advancing the Energy and Transport Transitions with Railways, Public Transport and Active Mobility

A Land Transport Perspective

Overview

In 2020, the movements of goods and people were responsible for 30% of the global total final energy consumption. Fossil fuels provided 95.9% of energy consumed in the transport sector, while renewables only 4.1% (REN21, 2023). Due to this dependence on fossil fuels and growth in transport demand, transport was responsible for 22% of global fossil CO_2 emissions in 2019 (SLOCAT, 2023). From 2010 to 2019, the transport sector had the fastest growth in energy consumption and CO_2 emissions among combustion sectors globally, rising 18% overall. Road and rail transport consumed 81% of transport-related energy. In 2020, due mainly to the impacts of COVID-19, transport CO_2 emissions fell 13% but nearly completely recovered in 2021 and are projected to resume their upward trend (2022 publicly available data are forthcoming) (SLOCAT, 2023).

Investing in low carbon, sustainable land transport and mobility infrastructure will help national and local leaders curb greenhouse gas emissions, improve air quality and increase equitable access to jobs, healthcare, public services, etc., creating socio-economic opportunities for populations. One of the most affordable ways to address climate change, air pollution and congestion is to design cities that enable public transport, walking and cycling. This will yield a projected savings of more than $100 trillion in public and private capital and operating costs of urban transport by 2050 (ITDP/UC Davis, 2014). A parallel scaling up of energy efficiency and renewable energy for transport will maximise decarbonisation benefits.

There are significant opportunities for a mutually-reinforcing decarbonisation transition of the energy and transport sectors when a shift to low energy intensity land transport modes is planned in tandem with a shift to energy efficient engines and low carbon energy. Railway emissions per passenger kilometre are around one-sixth those of air travel. Urban public transport is up to four times more efficient than private cars (from point of fuel production to combustion). Emissions from electrified passenger rail and buses are even lower, particularly when powered by renewables. Transitions can be accelerated through integrated planning of transport energy demand, renewables supply, and transport and energy infrastructure.

Energy-Transport Transitions and the *Avoid-Shift-Improve* Framework

The *Avoid-Shift-Improve* (A-S-I) Framework has been central to strategies to scale up access to sustainable, low carbon transport and mobility for over a decade. While guaranteeing access to transport and mobility, the A-S-I Framework calls for the following (Figure 1):

- *Avoid* unnecessary motorised trips based on proximity and accessibility;
- *Shift* to less carbon-intensive modes – that is, from private vehicles to public transport, shared mobility, walking and cycling, water-based freight, electrified road-railway freight, and cargo bikes for last-mile deliveries, among others; and
- *Improve* vehicle design, energy efficiency and switch to low carbon and sustainable energy sources for different types of freight and passenger vehicles.

Applying A-S-I measures through integrated, inter-modal and balanced approaches is critical to unleashing the full benefits of sustainable, low carbon transport (SLOCAT, 2021). The A-S-I framework can be the reference for an integrated transport and energy decarbonisation transition. The framework's principles translate into the key pillars of the energy transition: *Avoid* unnecessary energy consumption, *Shift* to more sustainable energy modes and *Improve* energy efficiency and energy intensity of transport (REN21, 2019) .

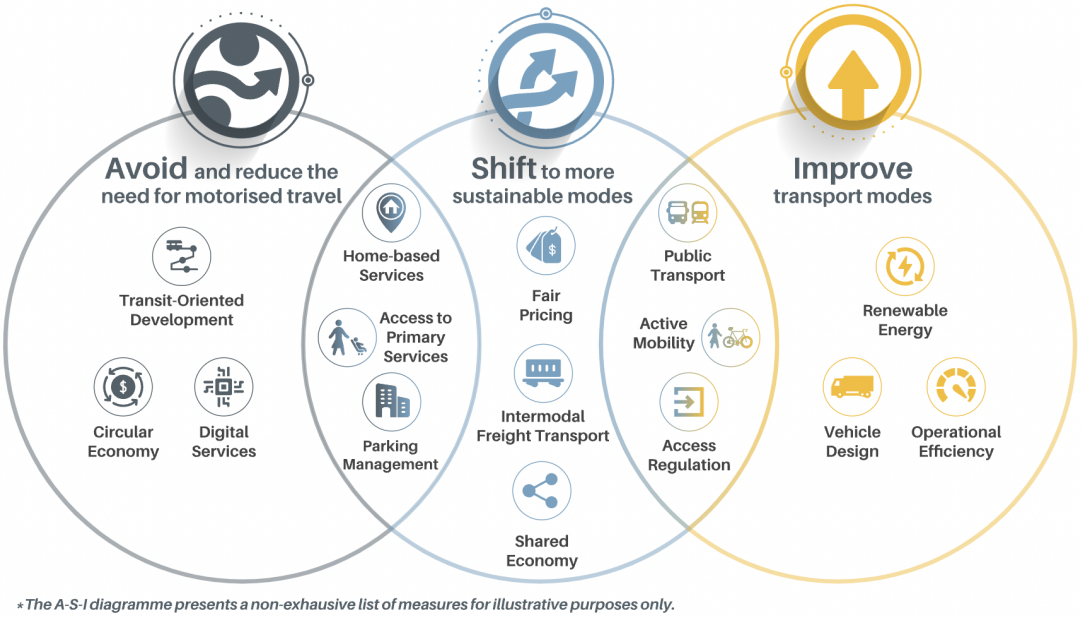

Figure 1: Avoid-Shift-Improve Framework

More robust measures on transport decarbonisation are needed by 2030 to limit global warming to 1.5 degrees Celsius, including reducing vehicle kilometres travelled and electrifying vehicles. Sustainable modes of travel, such as public transport, can and must play a crucial role in reducing the growth of private motor vehicle use, while at the same time bus fleets must be electrified (WRI, 2022). While widespread *Improve* measures (e.g. electrification and fuel switch) are vital to decarbonising the transport sector and supporting the energy transition, evidence shows that *Avoid* and *Shift* strategies can account for 40-60% of transport emission reductions, often at lower costs than *Improve* strategies (Umweltbundesamt, 2016) (Figure 2).

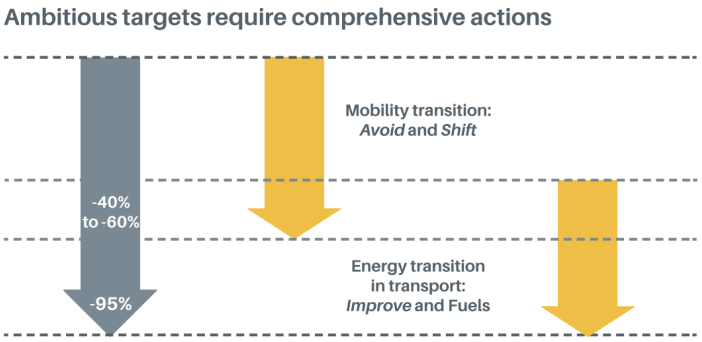

Figure 2: Potential emission reductions resulting from actions in the A-S-I Framework

Avoid and *Shift* measures (for example, allocating road space for dedicated BRT and bus lanes) may also be far less costly for enhancing transport access than many *Improve* measures, particularly in rapidly urbanising Low- and Middle-Income Countries (LMICs). For example, public transport reforms and bus sector modernisation in LMICs offer cost-effective strategies to *Shift* ridership to more efficient and environmentally-friendly fleets and services (ITDP, 2023).

Mutually-Reinforcing Energy and Transport Transitions are Needed and Feasible

- Active mobility, public transport and railway freight play a central role in the decarbonisation of the transport sector. They are more efficient in the use of energy resources than private vehicles and road freight transport. They also offer numerous societal benefits including air quality, social cohesion and democratic use of public space.
- *Avoid* and *Shift* measures are critical strategies for reducing land transport energy demand (e.g. proximity planning in cities to reduce long-distance trips and increase public transport usage, maintaining mode share of walking and cycling in LMICs).
- *Improve* measures complement *Avoid* and *Shift* measures in reducing energy demand (e.g. increasing electrification of 2- and 3-wheelers to reduce impacts of road transport).
- Electrified public transport services generate predictable demand for electricity (i.e. in many countries urban rail systems are the top electricity consumer). The joint development of renewable electricity and public transport infrastructure can optimise investments in both sectors, unlock economic justification for investment, and jointly accelerate the renewable energy and transport transitions.
- Increasing shares of variable renewable electricity (e.g. photovoltaics, wind) requires increasing grid flexibility. Electrified land transport can offer flexibility services to the grid, in the form of predictable load management, demand-side management and battery storage.
- Synergies between renewable energy and the public transport and railway sectors increase access to low-carbon mobility and drive sustainable economic growth.

Key Messages

Deep transformations are needed in both the energy and transport sectors towards a 1.5ºC scenario. Energy use in the transport sector is projected to grow in coming years, due to factors such as rising motorisation rates and growing demand for freight delivery. The increase in energy demand requires scaling up renewables while increasing focus on *Avoid* and *Shift* measures to transport people and goods more efficiently, through a widespread shift to walking, cycling, public transport and rail. Cities can reduce their transport-related fuel consumption by around 25% through combinations of more compact land use and the provision of less car-dependent transport infrastructure.

Electrification of trucks and cars is necessary to reduce dependence on fossil fuels, but will not be sufficient to meet Paris Agreement targets in transport. Transport electrification can increase energy security and resilience to energy price shocks. The global transition to zero emission vehicles is already avoiding nearly 1.5 million barrels of oil per day and increasing the share of renewable energy in transport. 30% of global power supply is now renewable, and 86% of new power generation capacities are renewable. However, this strategy does not solve the problem of congestion in cities or equitable

access to transport and mobility; thus, options such as a modal shift to low energy intensive and collective modes (e.g. public transport and active mobility) must be given equal priority.

A shift to public transport and railways is a critical element for mutually-reinforcing transport and energy transitions. Railways and public transport, coupled with walking and cycling, play a central part in the decarbonisation of the transport sector. Railways are already the most electrified transport mode, with almost half of the energy used supplied by electricity. The electrification of urban buses is projected to advance twice as fast as cars by 2030 (Bloomberg, 2018). In addition, almost all public transport vehicles on the roads are able to run on renewable energy (e.g. biofuels, biomethane, renewable electricity, renewables-based hydrogen).

Railway and public transport operators and authorities are key partners to accelerate the energy and transport transitions. As one of the largest single direct consumers of energy both nationally and in cities, they can be partners and financiers of renewable energy projects. They can be allies to act as target setters, planners and standard setters for renewables in transport. The purchasing power of public transport can also drive the demand for renewables to companies interested in generating renewable power for the sector. There are capital investment needs, but cost savings can be achieved in a reasonable payback period, while reducing the exposure to changes in the wholesale energy market as well as supporting their decarbonisation strategies.

Railway and public transport infrastructure can act as the backbone of energy grids, through their well-connected networks in cities, between cities, industries and ports. Railway and public transport operators are typically major land and building owners, so they can use their estate and infrastructure to co-locate renewable energy production and storage. This can lay the foundation for integrating renewable energy into other transport modes, such as private electric vehicles, taxis, car sharing/pooling or micro-mobility charging infrastructure at stations. In countries where access to clean and reliable energy is limited, these networks can provide corridors to distribute energy and connect people, supporting decentralised energy production and distribution. Where diesel-operated railway services struggle to make a business case to electrify, partnering with renewable energy suppliers can increase viability.

Railway and public transport vehicles, if connected as open grids, can provide a source of renewable power to residential and commercial buildings. The battery storage provided by electric buses could speed the transition to a renewable energy grid while ensuring urban resilience, as a critical source of stability, peak regulation and emergency power. This could also create new sources of revenue streams for the sector. Implementing such schemes requires the coordination of different sectors and new actors, as well as new sources of finance for more, clean sustainable transport options.

A rapid transition to efficient transport systems, built on a backbone of rail, public transport and active mobility, and powered by renewables can drive a just transition. Doubling public transport usage as part of a green, equitable and resilient recovery would create tens of millions of jobs in cities around the world (4.6 million new jobs in the nearly 100 cities of the C40 network alone); cut urban transport emissions by more than half, and reduce air pollution from transport by up to 45% by 2030. It would protect lower-income and service-sector workers and connect city residents to work, education and community (C40/ITF 2021). More than two-thirds of first- and second-round NDCs submitted as of December 2021 (based on SLOCAT analysis as of July 2022) mention public transport, but only 26 contain quantified targets. More ambitious NDC targets will be needed to drive public transport through national policies and sub-national mitigation actions (WRI, 2022).

The repurposing of international and national financing away from fossil fuels and towards sustainable, low carbon transport is a must. Achieving low carbon transport pathways will require substantial investments on the order of USD 2.7 trillion per year through 2030, with 60-70% of these investments in emerging economies (OECD, 2017). With more efficient fuel prices, the IMF estimates that 28% of global CO_2 emissions and 46% of air pollution deaths could be avoided annually, increasing tax revenues by 3.8% and adding economic benefits worth 1.7% of global GDP (Coady et al., 2019). Fossil fuels represent nearly 40% of global freight volumes, and the industry must be prepared for a projected reduction in demand with energy transition. *[See also World Bank, 2023]*

Coordinated, multi-stakeholder global initiatives can enable the acceleration of energy and transport transitions. The COP27 Presidency launched the Low Carbon Transport for Urban Sustainability (LOTUS) Initiative, which presents an opportunity to activate systemic change to improve and decarbonise transport in cities worldwide, particularly in LMICs. The Presidency subsequently decided to integrate LOTUS within the Sustainable Urban Resilience for the Next Generation (SURGe) Initiative (hosted by UN-Habitat) and the Sharm El-Sheikh Adaptation Agenda (also launched at COP27). The close coordination between these initiatives can leverage synergies between the energy and transport transitions.

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Useful Resources

- Strategies to phase-in renewable energy and phase-out fossil fuels in transport - SLOCAT Partnership, LEDS Global Partnership
- Energy and Transport Starter Data Kits by Climate Compatible Growth - SLOCAT Partnership, IRF, and UIC
- SLOCAT Transport, Climate and Sustainability Global Status Report - 3rd Edition
- REN21 Global Status Report: Energy Demand Module
- Climate Change Mitigation and Transport in Developing Nations - UNEP
- A Smooth Ride to Renewable Energy: 7 actions for public transport to address emissions and air pollution by advancing renewables - UITP, REN21
- National Policies for Walking and Cycling in ITF Countries - Partnership for Active Travel and Health (PATH), Walk21
- Protected Cycle Lane Networks Can Make a Big Impact on Climate Change - ITDP
- Intergovernmental Panel on Climate Change Sixth Assessment Report, Transport Chapter