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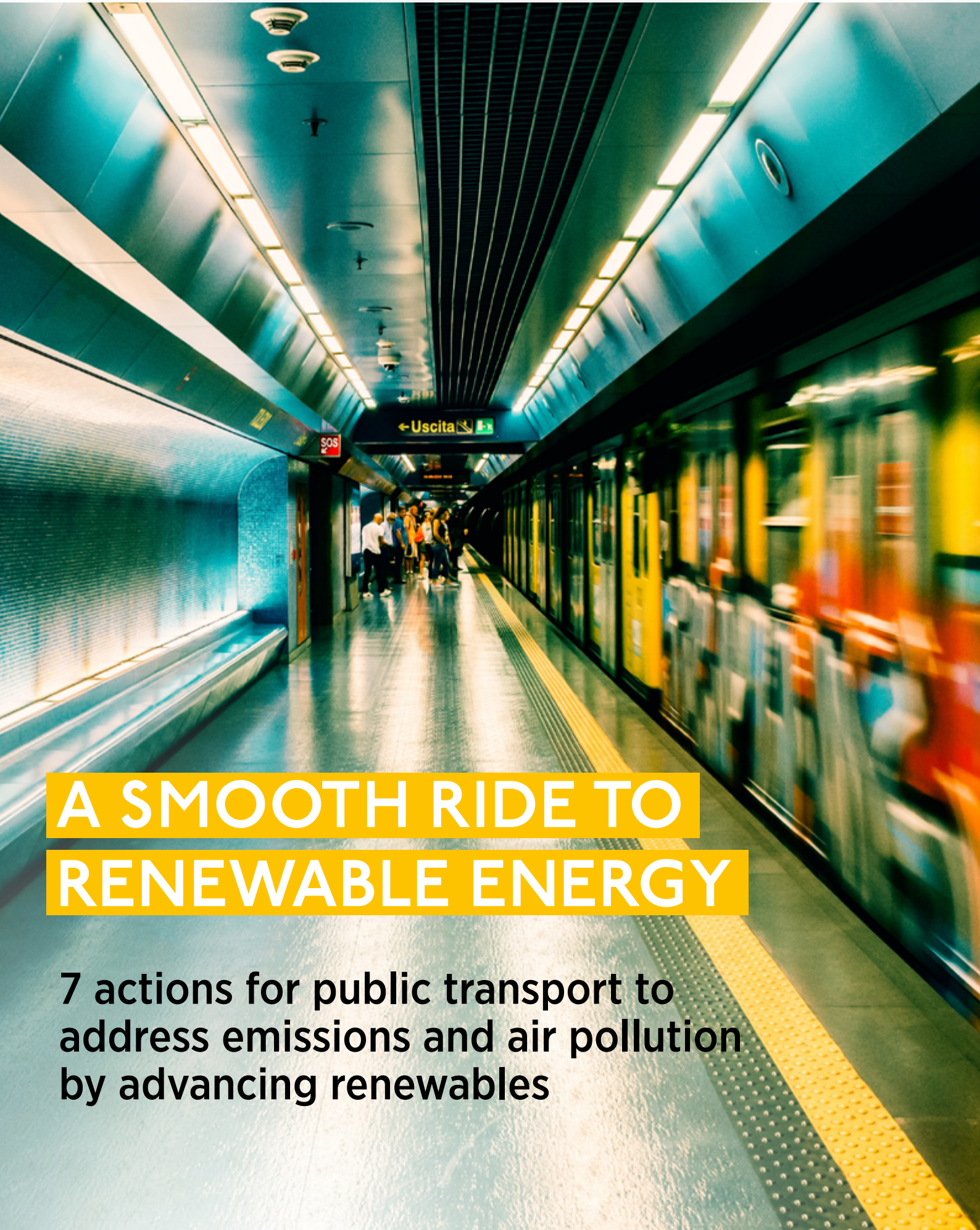

A SMOOTH RIDE TO RENEWABLE ENERGY

7 actions for public transport to address emissions and air pollution by advancing renewables

POLICY BRIEF
November 2021

A SMOOTH RIDE TO RENEWABLE ENERGY

Market-ready solutions for a renewable energy transition in public transport

Affordable, accessible and safe public transport is a fundamental solution to dramatically reduce emissions. However, the crucial link between renewables and public transport has been largely ignored. By powering public transport with renewable energy, countries and municipalities can make serious contributions to address climate change, while improving local air quality and public health. Many solutions exist to shift public transport to rely on renewable energy and are in many cases ready to be implemented. Each city must create a plan that is adapted to the local resources, governance and market conditions.

This brief proposes actions and solutions that can accelerate the path to achieve net zero and carbon neutral goals through the connection between renewable energy and public transport.

THIS BRIEF WAS PRODUCED COLLABORATIVELY BY REN21 AND UITP, WITH THE SUPPORT OF THE UITP SUSTAINABLE DEVELOPMENT COMMITTEE

REN21 is the only global renewable energy community of actors from science, governments, NGOs and industry. We provide up-to-date and peer-reviewed facts, figures and analysis of global developments in technology, policies and markets. Our goal: enable decision-makers to make the shift to renewable energy happen – now.
www.ren21.net

UITP (Union Internationale des Transports Publics) is the International Association of Public Transport and a passionate champion of sustainable urban mobility. Established in 1885, with more than 135 years of history, it is the only worldwide network to bring together all public transport stakeholders and all sustainable transport modes.
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BACKGROUND

PUBLIC TRANSPORT IS A SOLUTION TO ACHIEVE CARBON NEUTRAL AND NET ZERO GOALS

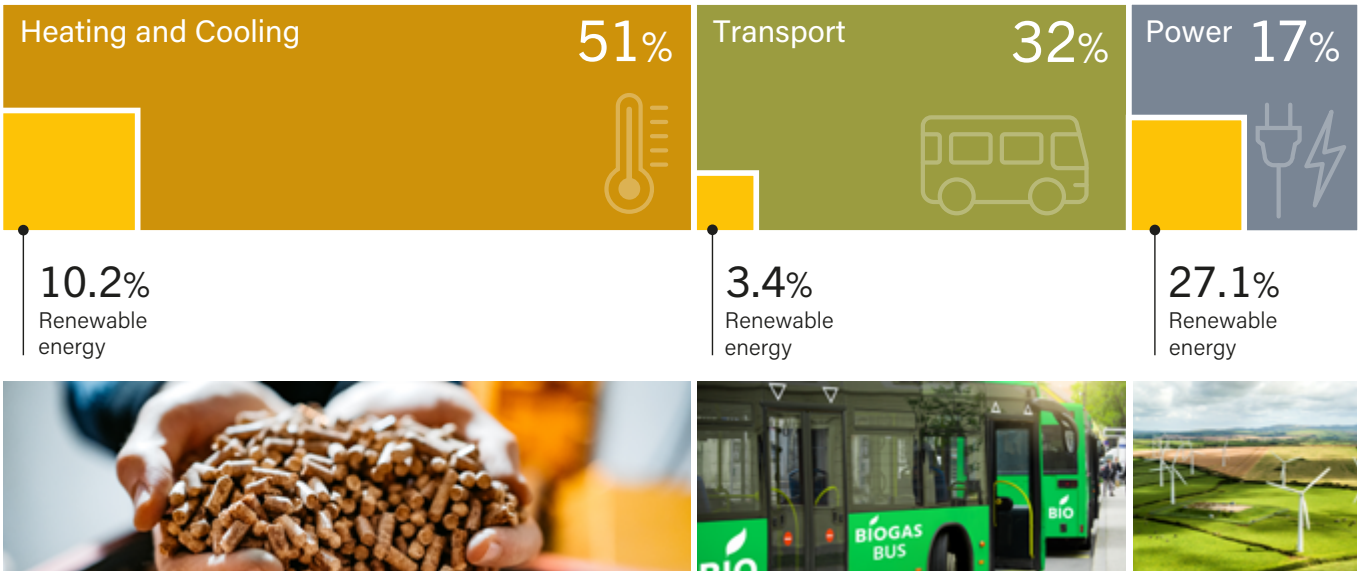
Economy-wide system changes are required to address the urgent need to drastically cut emissions, and the transport sector is key to these changes. The latest IPPC report issues a stark warning that drastic reductions in emissions are urgent and necessary.[1] Transition plans currently in place are not sufficient to meet the Paris Agreement, meaning we will surpass the global warming tipping points and overshoot the 1.5°C warming target. There is a pressing need to raise the level of ambition towards climate neutrality.[2]

Decarbonising the transport sector with renewable energy is essential to meeting these goals.[3] This entails not only actions to reduce energy demand, but also the further development of renewables-based public transport. The technology for renewable energy in public transport is available, so some of the main barriers are more political, financial, and institutional. Capacity building and knowledge also play a critical role in ensuring that the right policy and regulatory frameworks are in place, alongside the skills and knowhow for operational delivery.

THE TRANSPORT SECTOR IS THE SOURCE OF ONE-QUARTER OF GLOBAL ENERGY-RELATED CO_2 EMISSIONS

The global transport sector accounted for around one-third of final energy consumption and one-quarter of energy-related CO_2 emissions (→ *see figure 1*).[4]

Figure 1. **Renewable Energy in Total Final Energy Consumption, by Final Energy Use, 2018**



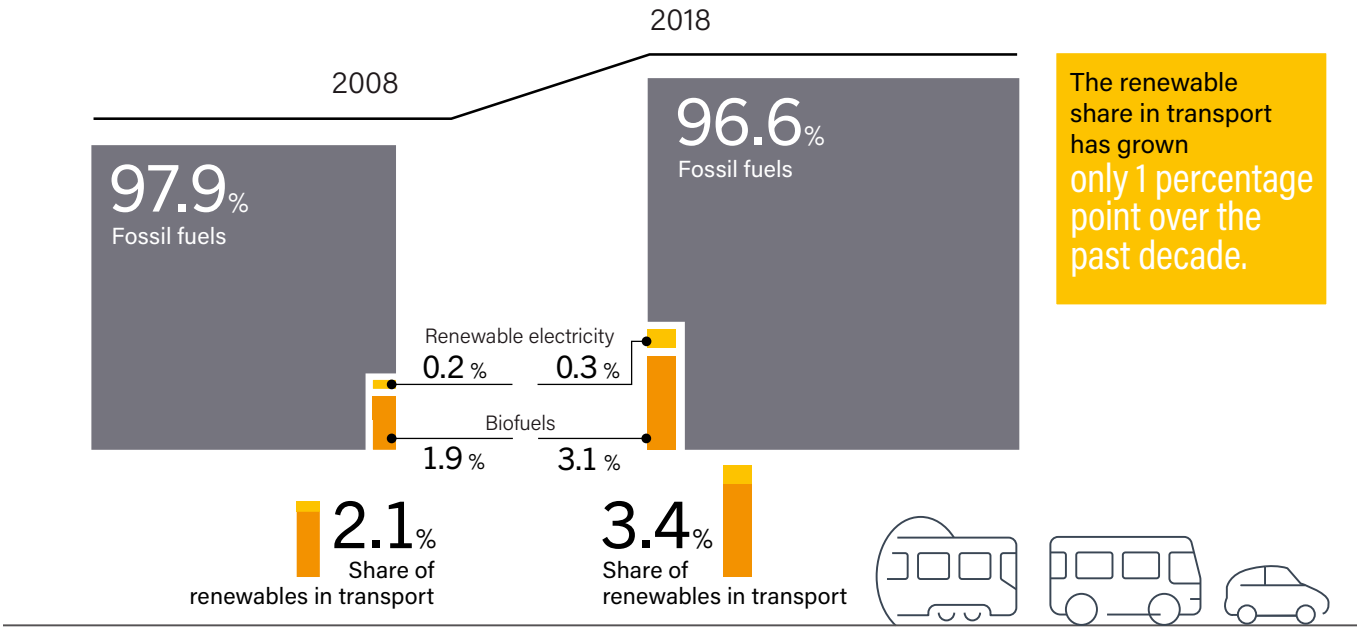
Source: REN21. Based on IEA data. See endnote 4.

Current emissions reduction efforts cannot keep up with ever-increasing car usage and ownership and the slow development of alternatives.[5] As renewable energy only accounts for 3.4% of the energy used for transport, the sector still relies *heavily* on fossil fuels. Change has been very slow: the share of renewable energy in the sector has increased by only around 1% over the past decade, while transport energy demand has grown more than 22% (→ *figure 2*).[6] At the same time, transport-related emissions keep increasing.

CITIES ARE KEY TO DECARBONISING TRANSPORT

Motivated to improve urban air pollution, protect public health and well-being, as well as mitigate congestion and noise, public transport authorities[i] have made strides to reduce energy demand and decarbonise transport fleets and mobility infrastructure. The sheer size and scale of cities can result in great impacts on CO_2 emissions and public health as they are responsible for 75% of global CO_2 emissions, with transport and buildings being among the largest contributors.

Figure 2. **Share of Renewable Energy in Transport, 2008 and 2018**



Note: Box sizes differ due to increased energy demand for transport from 9.9 Exajoules in 2008 to 12.1 Exajoules in 2018 (a 22% increase). Totals may not add up due to rounding.

Source: REN21. Based on IEA data. See endnote 6.

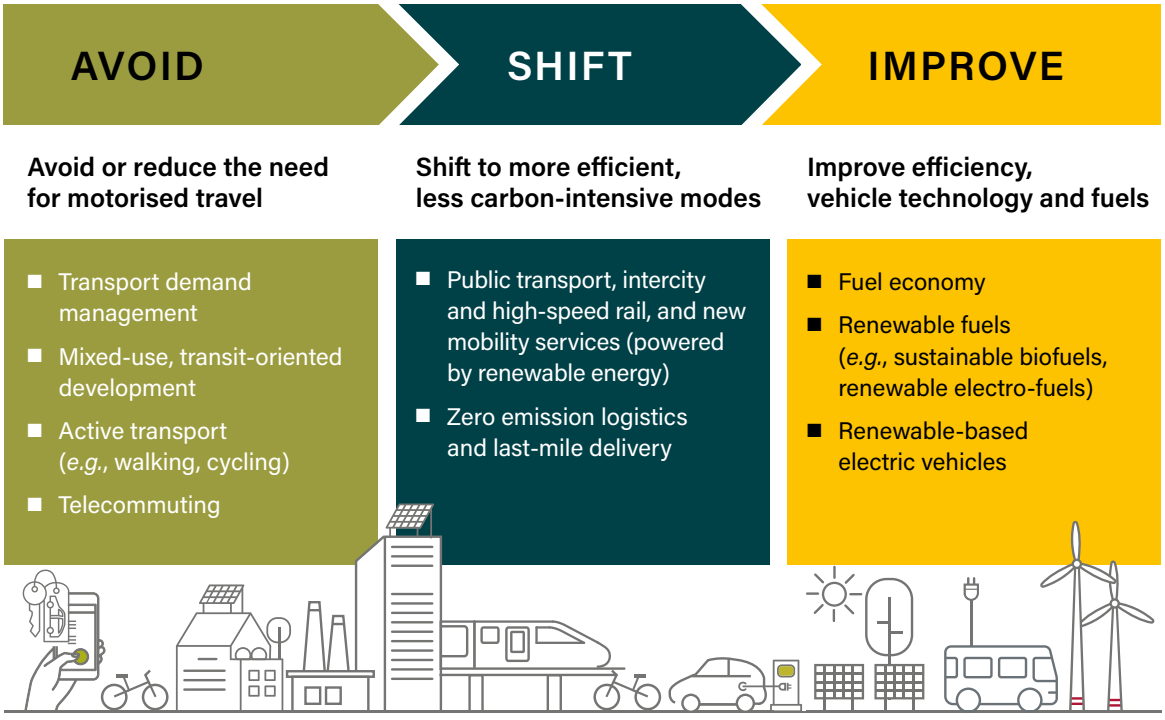
i Transport authorities include any public body that can (a) help deliver politically desirable high-level transport and mobility strategies, and (b) implement integrated urban policies and define service requirements.

AVOID-SHIFT-IMPROVE: UNLOCKING EMISSIONS REDUCTIONS IN URBAN TRANSPORT

Renewable energy solutions in the transport sector need to be embedded in a wider framework of action on transport, which will bring integrated benefits in line with the Sustainable Development Goals (SDG).[8]

Public transport is well-placed to embed renewable energy solutions in wider action frameworks to support urban decarbonisation efforts (→ *see figure 3*).[9] To **avoid** and reduce the need for motorised transport, city governments have improved walking and cycling infrastructures alongside public transport and supported efforts to manage transport demand. They have also encouraged the **shift** to more efficient and less carbon-intense modes of transport, such as public transit, including metros, buses and trams. Public authorities have also complimented city efforts to **improve** transport system efficiency, vehicle technology and fuels by procuring renewable fuels and renewables-based electric vehicles.

Figure 3. **Avoid-Shift-Improve Framework for Transport**



Note: Transport demand management refers to encouraging travelers to avoid trips or shift to more resource-efficient options to limit vehicle traffic. Mixed-use development refers to having more than one use or purpose within a building of development area, ranging from housing on upper floors of a building and office or commercial space on the ground floor, to comprehensive developments with multiple buildings having separate but compatible uses. Transit-oriented development refers to mixed urban development around or near a transit station to reduce the need for motorised trips.

Source: REN21. See endnote 9.

PUBLIC TRANSPORT THAT RUNS ON RENEWABLES HOLDS A HUGE POTENTIAL FOR IMPACT

Shifting people to public transport can be one of the strongest assets for combating climate change in any given city or region and one of the fastest and most cost-effective ways to reduce emissions and decarbonise people's daily mobility.[10]

As almost all public transport vehicles on the roads and rails today are already able to run on renewable fuels, it is possible to achieve cost-effective emission reductions (→ *see box 1*). Increasing the share of renewable energy and basing urban transport networks on public transport would show a significant increase in climate action compared to current pledges across the world.

DECARBONISED PUBLIC TRANSPORT IS NOT NEW

Electric mobility options in public transport have been around for over a century, as have biofuels.[12] The public transport sector is already procuring renewables for their own traction needs in daily mobility operations, alongside scaling up local renewable power generation for office buildings, stations and depots.

Multiple renewable energy sources can be used by both road- and rail-based public transport and should be chosen according to the local context, resources and operating conditions. There are a variety of tools and technologies available, offering complementarity, and each has an important part to play in the transition to truly zero-emission public transport.[13] The four main types of renewable energy for public transport are: (1) gaseous or liquid biofuels, (2) the direct use of renewable electricity, (3) renewable electricity-based hydrogen and (4) renewable electricity-based synthetic fuels.[14]

Box 1. **Leading the way: renewables in rail**

The rail sector is the most highly electrified sector and has the highest share of renewable energy among transport modes. Many operators have directly linked projects to renewable energy sources. For example, in the Netherlands, 100% of the electric trains have been powered by wind energy since 2017. Tokyo's Setagaya light rail line has been using 100% renewable power (from geothermal and hydropower) since early 2019. In 2020, FNM Group, the Italian transport and mobility group, launched the H2Iseo project that aims to create by 2023 the first Italian Hydrogen Valley in Lombardy through the purchase of 30 new-hydrogen Alstom trains and the construction of green hydrogen production plants. The German railway company Deutsche Bahn signed the country's first offshore wind power purchase agreement to source 100% of its electricity from clean sources. In 2019, the first 100% solar-powered railway line opened in Hampshire, UK and a portion of France's SNCF train operations will be sustained by utility-scale solar PV by 2022-2023. Chile's Santiago metro system sources as much as 60% of its energy requirement from renewable energy sources: around 40% of its energy needs come from solar power while an additional 20% comes from a wind energy project.[11]

Biofuels currently make the largest renewable contribution to the transport sector. Renewable fuels such as biogas and biodiesel (provided they are transformed and processed before use), either in combination with energy efficient combustion engines or used alongside electricity in hybrid engines, can help to reduce the total well-to-wheel carbon emissions of a public transport vehicle by up to 90% compared with fossil fuels.[15] As these renewable fuels can be derived from organic material such as agricultural waste, they can also play a wider role in supporting circular economy models of energy sourcing across the entire fuel value chain, from production to tailpipe (→ see case study ***Abidjan***). It is important that biofuels are produced sustainably (→ see box 2).

Case Study: A complete renewable urban transport solution for **Abidjan, Côte d'Ivoire**

Abidjan is one of West Africa's fastest growing urban centres. To ensure the city is prepared for the future, it is going through a major rethink of its public transport system, which will involve the delivery of renewably powered buses (400 compatible with biodiesel and 50 with biogas), alongside the development of a multi-modal sustainable transport system. The aim is to have all the buses running on local biodiesel and biogas when the BRT "Latrille" starts operations. The fuels will be produced from agricultural waste in partnership with the national rural agency and a local start-up which will help to create a market for agricultural waste, improving living standards for farmers in the region. The first biodiesel production will come from rubber seeds while the first biogas production will use sources such as banana and cassava waste as well as chicken and pork manures.[17]

Box 2. **Sustainability of biofuels**

It is critical that biofuels are produced in a sustainable manner to avoid the risk of direct and indirect land-use change, which can increase life cycle emissions. As potential demands are sure to far exceed a sustainable supply, left unchecked, this could heighten the risks of the unsustainable management of natural resources.[18] Regulatory policies and standards therefore require various sustainability criteria for biofuels to help mitigate this risk. It is important that the sector ensures that specified sustainability criteria is met for their biofuels so that tangible emission reductions are achieved.

The use of **renewable electricity** in transport is increasing as the number of EVs increases. However, the overall share of EVs on the market remains low, and ultimately electricity makes up only 1.1% of final energy consumption for transport. Only about one-quarter of that electricity comes from renewable sources, and electric vehicle policies do not necessarily result in increased renewable energy use by themselves. However, EVs offer the potential for greater penetration of renewables when the source of the electricity is renewable, and they also offer increased efficiency and lower emissions. When governments talk about 'emission-free', 'zero-/low-emission' or 'carbon-neutral' transport, they typically are referring to vehicle tailpipe emissions only. However, such transport options must source their energy from renewables to be truly emission-free and carbon-neutral, and could go even further by considering 'Scope 3' emissions (indirect emissions that occur in a company's value chain).[19] Public transport has started to couple their transport electrification efforts with renewables (→ see case study ***Fujian Province***).

Hydrogen demand in the transport sector is still in its infancy, and about 99% of all hydrogen production globally remains fossil-fuel based; however, some examples of green (renewables-based) hydrogen in public transport are emerging. The production of **synthetic fuels or e-fuels** is also in its infancy and remains relatively elaborate and costly.[21]

LONG-STANDING BUSINESS CASE FOR RENEWABLES IN PUBLIC TRANSPORT

Business demand for renewables has been increasing in recent years, and both public and private transport providers are investing in renewable power and fuels for their operations.[22] Some public authorities are also scaling up local renewable power generation for office buildings, stations and depots. As energy represents one of the largest operating costs for any public transport undertaking, there is an increasing business case for sourcing cheaper and cleaner energy options. In addition, renewables are offering new business opportunities for the sector, which is also helping to boost the wider market confidence in renewable energy.[23]

The rapid decline in renewable power generation costs has further built the business case for greater uptake in the transport sector and beyond. For instance, in 2020, the cost of electricity from utility-scale solar PV had fallen 85% since 2010, while onshore wind power costs fell 56% during the same period.[24] These declines mean that for most of the world's population, electricity production from renewables is the most cost-effective option.

Case Study: Electric bus charging with solar power in **Fujian Province, China**

The Jinjian Chenye Binjiang Business District bus charging station was Fujian Province's first integrated solar-storage-charging station and has been charging electric buses using solar power since 2019. Approximately RMB 8 million (USD 1.25 million) was invested to construct the station, and the investment recovery period is anticipated to be six years. The project will save 50,000 to 100,000 kWh of electricity each year by relying on its on-site solar power generation. Many other charging stations that use solar PV and energy storage have been developed in China since 2017.[20]

In a growing number of regions, it has already become cheaper to build new wind or solar PV plants than to operate existing coal-fired power plants. Renewables also are outcompeting new natural gas-fired power plants on cost in many locations and are the cheapest sources of new electricity generation in countries across all major continents.

CITY GOVERNMENTS SUPPORT TRANSPORT DECARBONISATION

City governments often have a high level of control over their ability to drive the uptake of renewables in their public transport. They have used different types of targets, policies and actions to show their renewable energy ambition: more than 1 billion people – around 25% of the urban population – lived in a city with either a renewable energy target and/or policy in 2020.[25]

City governments have made strides to decarbonise their public transport fleets and mobility infrastructure, in addition to promoting active modes of transport, and expanding public transport fleets and services. To support decarbonisation, more than 330 city governments have used their policy-setting abilities, in particular to advance EVs city-wide. This includes mandates to install EV charging points in new buildings, as well as fiscal and financial incentives – including grants, tax rebates and tax exemptions. In addition, cities have undertaken efforts to establish low-emission zones and bans and/or restrictions on the circulation of certain types of vehicles in their jurisdictions.

Although some cities have continued to support the use of biofuels in fleets, urban policies and procurement have increasingly focused on the electrification of transport. However, only a few cities have taken e-mobility as an opportunity to specifically increase the share of renewables in the sector. Opportunities to do this include direct investment in new renewable electricity capacity via power purchase agreements and/or by setting obligations or requirements for procurement. For example, a few cities require the use of renewables to charge electric buses: in 2019, São Paulo (Brazil) integrated 15 electric buses into its fleet that must be charged using solar power, while new electric buses in Portland (Oregon, US) will be 100% wind-powered as part of the city's aim for a non-diesel fleet by 2040.[26]

KEY ACTIONS

SEVEN ACTIONS TO ADVANCE RENEWABLES IN PUBLIC TRANSPORT

The following seven actions by local and national governments can help to advance and scale up efforts of renewable energy in public transport. While not all the policy levers are held by local governments and public transport authorities, especially in smaller cities, several solutions to decarbonise transport, address emissions and improve air pollution exist.

There is no single solution that will work in every locality. Adapting to the physical environment, local policy and governance capacity, citizen needs, and financing/funding sources are all fundamental to the success of any public transport plan.

1 SET AMBITIOUS TARGETS FOR PUBLIC TRANSPORT AND BACK THEM UP WITH SUPPORT POLICIES

Targets provide some certainty for decision makers and the private sector. At the same time long-term regulatory, governance and financial frameworks should be put in place for further certainty as well as practical delivery (→ see Case Study ***Madrid)***. Both net zero emissions and renewable energy targets should be made, and actions should be taken to directly support achieving them. Shifting to renewable energy sources needs to be underpinned by additional emission-reduction strategies and targets embedded in a wider Avoid-Shift-Improve policy framework. When deciding on technological options, a wide range of factors should be taken into consideration – from market availability and infrastructure needs, to 'cradle to grave' and wider sustainability considerations.

Case Study: EMT **Madrid**'s commitment towards sustainable public transport

The multi-modal public transport operator, EMT in Madrid, is making a major contribution to the city's 360 Environmental Strategy by integrating renewable energy and zero emission technologies as part of a growing and enhanced sustainable transport system needed for a green, smart and carbon neutral city.

By the end of 2021, 15 bus lines are set to be fully electrified and as of 2023, EMT will no longer provide a service with diesel buses. To support the ever-growing electric bus fleet, more than 130 charging points have been installed, alongside solar PV on roofs, which are providing up to 1 MW of renewable energy. A green hydrogen fuelling station is also being designed which will come into operation in 2023 to serve 10 hydrogen buses, also powered by solar PV. These actions complement efforts at the national level to increase the share of renewable energy in the power sector from 40% in 2020 to 100% by 2050.[27]

2 BUILD THE BUSINESS CASE WITH PILOT AND DEMONSTRATION PROJECTS

The business case for renewables has been demonstrated, and an increasing number of public transport projects that use renewable energy continue to demonstrate the growing business case of integrating the two. However, in order to build local capacity and showcase the business case to investors and decision makers, pilot or demonstration projects have a role to play. These types of projects help to raise awareness of and confidence in technologies and solutions. Demonstration projects have been shown to promote institutional learning at all levels of government – from the national to local level. This learning can help establish the right regulatory and operational environment needed to scale up local solutions and integrate them with other city transport services, modes or sectors successfully, thereby also increasing chances of citizen support for such projects. It is therefore vital that public transport authorities and operators prioritise securing funding for pilot projects for vehicles and infrastructure (e.g. electrical charging, renewable electricity production, hydrogen).

3 CREATE AN ENABLING TAX AND REGULATORY ENVIRONMENT AT ALL LEVELS

Local and national governments can use policies to support decarbonisation of transport and encourage a greater uptake of renewables across all sectors. This includes providing financial support and low interest loans, mandating the use of renewables or creating tax incentives. Local level actors should also come together to engage national governments on key regulatory issues – at both the political and technical levels – so that the right enabling frameworks and incentives can be further established and so that inconsistent policies (e.g., inefficient fossil fuel subsidies) are removed. Also important are digital policy frameworks that clarify issues such as data ownership and data security, as Information Communication Technologies (ICT) will play an increasingly important role when it comes to the wider integration of transport and energy solutions. The regulatory framework should also ensure that measures and commitments entrenched in transport policy (supply side, demand management, etc.) meet the overarching goal of climate protection.

4 LEVERAGE PUBLIC TRANSPORT'S PURCHASING POWER AND DEVELOP NEW BUSINESS MODELS

While the public transport sector cannot alone influence the national energy mix, its large purchasing power does mean that it can leverage this influence to increase the level of local renewable power generation. This can help to lock in prices and achieve emissions reductions at lower costs. Developing smart charging systems could also bring added financial value to the public transport sector. The sector is also typically a major land and building owner, so it can use its infrastructure and purchasing power to drive the demand for renewables in a city (→ see Case Study ***Delhi***). Agreements such as renewable power purchase agreements (PPAs) have proven to be successful, as well as the leasing of assets (e.g., station and depot roof space) to companies interested in generating renewable power for the sector. These arrangements are increasingly common and can reduce exposure to changes in the wholesale energy market. This adds cost certainty and long-term cost savings can be achieved, while also helping meet climate change targets through developing new renewable power generation projects.[29]

New sources of revenue and financing should be explored to support a broad range of integrated public transport and renewable energy projects. Given the significant size of new public transport infrastructure projects, they lay the foundation for integrating renewable energy into other modes of transport, such as private EVs, taxis, car sharing/pooling or electric micro-mobility options. Their immense scale even offers the opportunity to provide a source of renewable power to residential and commercial buildings. This can also create new sources of revenue streams for the sector, but implementing such schemes requires the coordination of different sectors and new actors as well as possibly new sources of finance. National coordination bodies should therefore be established to make this possible. Finally, new innovative financing mechanisms such as Green Bonds should be explored as they are a powerful but underutilised tool at the local level.[30]

Case Study: Using solar power in rail operations in **Delhi, India**

Delhi Metro Rail Corporation (DMRC) has become both a solar power consumer as well as a producer by installing solar rooftops on all station buildings and depots. They have been installed under the RESCO (Renewable Energy Service Company) model, wherein the capital cost has been invested by the solar developer and DMRC has signed the PPA for 25 years. DMRC shall only pay energy charges for the actual energy generated, thereby helping to save costs as well as emissions. As the return on investment is clear, the corporation now aims to run all its operations on solar power, and the government is working on replicating the success of the initiative in other cities.[28]

5 BUILD BACK BETTER THROUGH A GREEN COVID-19 RECOVERY

Recovery from the Covid-19 crisis offers a unique chance to combine economic development with shifting mobility behaviour and scaling up low-carbon technologies. Governments can reinforce their decarbonisation targets and policies by leveraging Covid-19 recovery funds. However, in Covid-19 recovery packages as of mid-2021, investment in fossil fuels was far greater than for renewable energy or for sustainable mobility. Fossil fuels received at least 42% of recovery funds, compared to 22% for sustainable mobility and only 7% for renewables. By simply redirecting these investments to renewable energy alongside sustainable public transport, it will be possible to achieve a steep decline in emissions.[31]

6 INTEGRATE RENEWABLES IN URBAN CARBON NEUTRAL PLANNING

Carbon neutrality and net zero targets in cities are gaining traction, but the path to achieve this objective may appear unclear.[32] Policy makers should consider these factors when developing their own plans that are adapted to the local resources and context:

- Clarify who is responsible for emissions, set priorities for reducing these emissions, and identify the stakeholders responsible for them.
- Outline the role that renewable energy and public transport will play.
- Establish the governance structure or model for holding stakeholders accountable for reducing emissions and develop a clear accountability framework.
- Clarify the monitoring, reporting and verification requirements that should be in place to track (and possibly offset) emissions and priority areas.
- Identify how performance and meeting emissions reductions objectives early will be rewarded.
- Clarify how decision makers at all levels will ensure a consistent and supportive policy framework for delivery.
- Enable participatory models of governance with commitments and actions from different sectors of society, including the public transport and renewable energy sector. Only through this multi-level and co-creative process can net zero cities be achieved.

7 BUILD CAPACITY AND SKILLS FOR CHANGE

Greater collaboration, experience, exchange and partnerships with the renewable energy and public transport sector are needed, but also with a wide group of urban transport stakeholders, including the private sector and citizens. Renewable energy solutions in public transport may require a new set of employee skills and technology knowhow. This is especially true as new solutions enter the market. Organisations such as REN21 and UITP should be leveraged to help both sectors understand the impact of new technologies and provide critical platforms to enlarge opportunities for information and best practice exchange. UITP can also help to enhance the formal training of public transport employees in those areas where skills will be increasingly needed.

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