WORLD RESOURCES INSTITUTE

WORKING PAPER

ENHANCING NDCs: OPPORTUNITIES IN TRANSPORT

TARYN FRANSEN, BENJAMIN WELLE, CAMRON GORGUINPOUR, MARGARET MCCALL, RANPING SONG, ALEXANDER TANKOU

EXECUTIVE SUMMARY

Highlights

- Limiting warming in line with the Paris Agreement goals requires deep cuts in transport emissions, even as demand for transport continues to grow. Yet under business as usual, emissions are projected to double.
- Nationally determined contributions (NDCs)—countries' plans to address climate change under the Paris Agreement—can help correct course. Yet while most countries mention transport in their NDCs, few draw on the full range of available solutions, and less than a fifth specify quantitative targets for transport.
- Reviewing the current NDCs—as well as recent technological advances—through the lens of the "Avoid-Shift-Improve" framework for sustainable transport, we identify meaningful, novel opportunities for countries to enhance their NDCs by better integrating transport solutions.
- We highlight three opportunities to enhance NDCs via transport: accelerating electrification while addressing fuel economy; strengthening "avoid and shift" measures that support travel by low-carbon modes; and seizing new opportunities to address freight emissions via electrification and use of information technology.

CONTENTS

Working Papers contain preliminary research, analysis, findings, and recommendations. They are circulated to stimulate timely discussion and critical feedback, and to influence ongoing debate on emerging issues. Working papers may eventually be published in another form and their content may be revised. All views expressed in this publication are those of the authors and do not represent those of the United Nations, including those of UNDP, or the UN Member States.

Suggested Citation: Fransen, T., et. al. 2019. "Enhancing NDCs: Opportunities for Transport." Working Paper. Washington, DC: World Resources Institute. Available online at www.wri.org/publication/enhancing-ndcs-transport.

Context

Demand for transportation of people and goods is surging. Driven by gross domestic product (GDP) growth, population growth, and urbanization, demand for passenger transport (in passenger-kilometers) has risen by 74 percent since 2000. Likewise, freight demand (in ton-kilometers) has increased by 68 percent. Under business as usual, these trends are expected to continue, with passenger and freight transport projected to grow by 90 to 160 percent and 100 to 230 percent, respectively, by 2030 (ITF 2017).

Current transportation approaches are unsustainable. They are currently on track to generate greenhouse gas (GHG) emissions by 2050 that are approximately three to six times higher than in scenarios consistent with the Paris Agreement. These approaches harm far more than the climate. Every year, road fatalities take roughly 1.35 million lives (WHO 2018a), outdoor air pollution causes nearly 4.2 million premature deaths (WHO 2018b)—with transport contributing an estimated tenth of these (Anenberg et al. 2019)—and a lack of physical activity accounts for 5.3 million more (Lee et al. 2012). Furthermore, in many cities, most residents have limited access to jobs and services because of congestion and lack of public and active transport options. Transforming the transport sector is vital to achieving more than half of the Sustainable Development Goals, including targets on fossil fuel subsidies, road fatalities, access to public transport, access to quality rural roads, and freight movement.

Sustainable, low-carbon transport demands a comprehensive approach that avoids unnecessary travel, shifts travel to more sustainable modes, and improves transportation technology. Known as the "Avoid-Shift-Improve" framework, this approach emphasizes avoiding the need for travel through regional and urban development policies, integrating transport and spatial planning, and optimizing the management of logistics and travel demand. This entails shifting passenger travel to public transport, cycling, and walking; relying more on railways and inland waterways to move freight; and reducing the carbon intensity of transport through a range of technologies and practices.

NDCs are an important lever for advancing sustainable transport, and, likewise, transport solutions can help deliver more ambitious NDCs in 2020. Because NDCs encompass countries' broad plans for addressing climate change through approximately 2030, ensuring that transport is well addressed in the NDCs can help align transport plans and investments with the broader low-carbon transformation. This can prevent transport from locking in carbon-intensive infrastructure and facilitate coordination between an increasingly electrified transport sector and the power sector. Additionally, since NDCs serve as a basis for identifying and prioritizing international climate finance, including transport within NDCs can help direct climate finance to the sector. Finally, the NDCs can foster buy-in and accountability—both domestically and internationally—for action. The year 2020 is key for enhancing NDCs, as the 2015 Paris conference explicitly invited countries to communicate NDCs—including new and updated NDCs—in 2020.

The initial NDCs address transport in a limited manner and do not fully leverage the opportunities available. In the first round of NDCs, over 150 countries highlighted transport-related mitigation, but only 35 NDCs included quantified targets for the transport sector (ClimateWatch 2019). Most NDCs do not specify measures to avoid unnecessary travel in carbon-intensive modes; shift to low-carbon modes of transport such as public transport, intercity bus and rail, cycling, and walking; and improve vehicle technology, particularly through electrification as well as fuel efficiency. NDCs prioritize "Improve" over "Avoid-Shift" solutions, and within the "Improve" category, a small share (under 15 percent) address electrification. Freight is rarely mentioned. Furthermore, NDCs miss opportunities to link transport to national policies and strategies, align with national transport plans or strategies, create national finance programs for sustainable transport, enable sound city- and state-level policies, and work with other sectors such as health and urban development.

About This Guidance

This guidance aims to help countries incorporate ambitious, relevant, and tangible transportation solutions into enhanced NDCs for communication to the UN Framework Convention of Climate Change (UNFCCC) by 2020. It reviews the treatment of transport in the initial NDCs through the lens of the Avoid-Shift-Improve framework, taking into account recent technological developments to identify key opportunities for NDC enhancement. It is part of a series of guides on NDC enhancement developed by World Resources Institute (WRI), United Nations Development Programme, and other partners. The series includes an overarching guide to NDC enhancement, as well as

detailed guidance on additional sectors and themes. Its use is voluntary and is intended to complement, but not substitute for, NDC provisions in the Paris Agreement and the Katowice Rulebook.

Opportunities for NDC Enhancement in the Transport Sector

We identify three key opportunities to enhance NDCs via the transport sector. These areas represent the biggest opportunities to fill previous gaps and harness new technologies. They are summarized below and depicted in Figure ES-1.

Accelerate electrification while continuing to advance fuel economy. Most current NDCs do not adequately address transport electrification, yet it is key for long-term decarbonization goals. At the same time, improving fuel efficiency offers near-term gains. Regarding electrification, renewable energy is getting cheaper and the grid is getting cleaner (IRENA 2019a). The decline in lithium-ion battery cost has far outpaced projections, dropping by more than 80 percent since 2010. These trends facilitate electrification of the transport sector and ensure it will increasingly result in lower carbon emissions. Meanwhile, advances in technology and policy enable electric vehicles to improve the efficiency and reduce emissions from the grid through targeted vehicle–grid integration.

Countries should adopt policies and programs that include zero-emission vehicle mandates and incentives, support the transition of all transportation modes to zero-emission vehicles, invest in smart charging infrastructure, and ensure policy and regulatory development to maximize the environmental, economic, social, and operational benefits of electric mobility for the transport and energy sectors. Indeed, a growing number of countries have shown interest in these emerging technologies, including through the Polish Declaration on Electromobility, signed by more than 40 countries in 2018. Countries can build upon this momentum in their NDCs.

Amplify Avoid and Shift solutions, such as land use and mobility planning, public transport, cycling, and walking. Only one-third of the NDCs that do address transport acknowledge policies to avoid unnecessary travel and shift to or retain low-carbon modes such as public transport, cycling, and walking. This requires immediate, medium-term, and long-term solutions in land use and planning to induce shorter trips or foster more compact development while increasing the quantity and quality of public transport, walking, and cycling. We suggest action areas that include measures such as eliminating fuel subsidies, adopting national urban growth and transport master planning, investing in infrastructure prioritizing sustainable mobility such as high-quality public transport, and encouraging the retention or growth of safe cycling and walking in cities.

Figure ES-1 | **Key Opportunities to Enhance NDCs through Transport**

Electrification: The cost of lithium-ion batteries has fallen 80% over the past decade, transforming the potential to power transport through an increasingly clean grid.

Avoid-Shift: Support for "avoid-shift" solutions like land use planning, public transport, walking, and cycling is vital to a sustainable transportation sector.

Freight: While freight accounts for 40% of transport emissions, only a small fraction of NDCs mention it, even as clean fuels and improved logistics are increasingly viable.

Source: Authors.

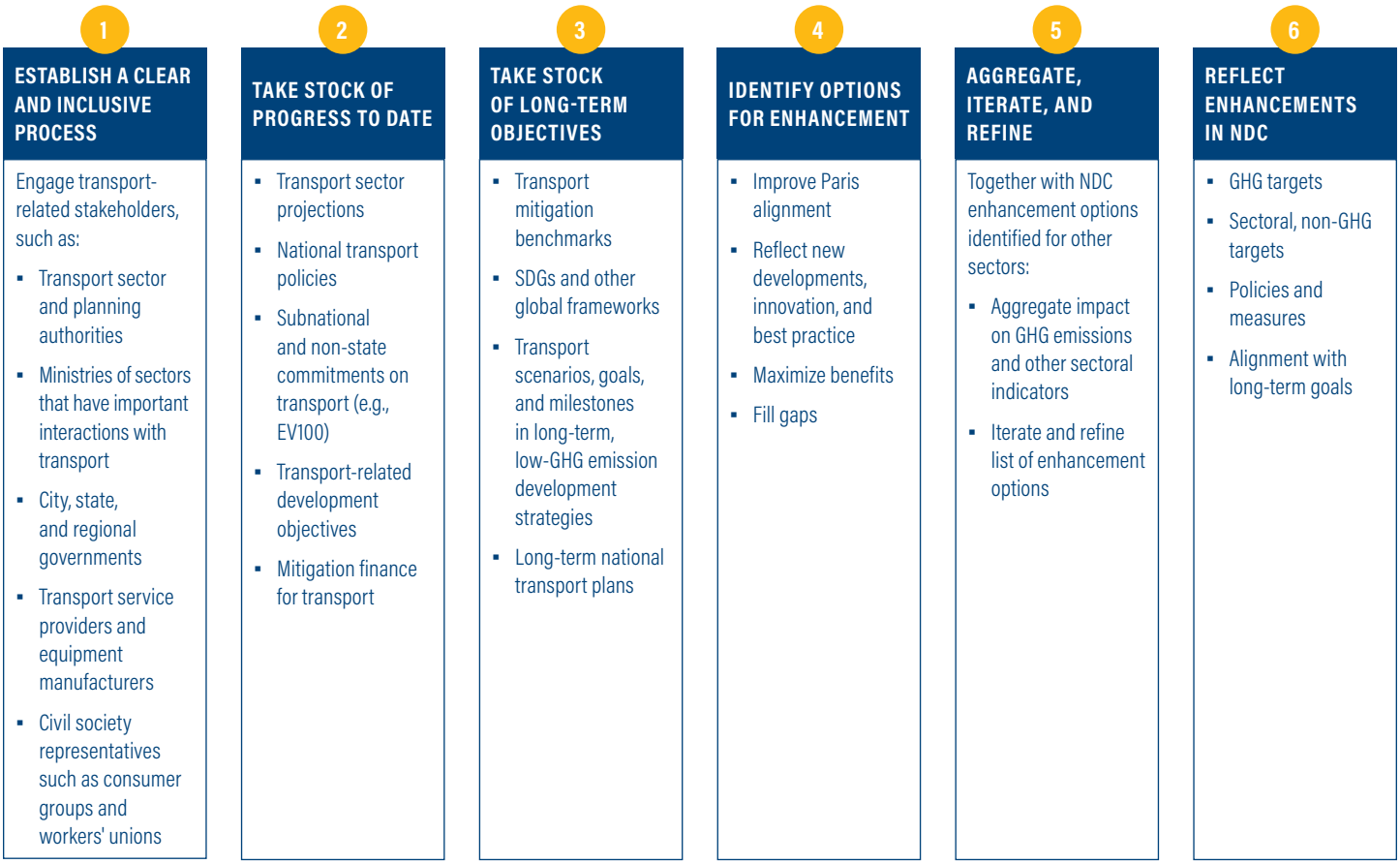
Address freight emissions by leveraging new clean fuels and information technology. Freight is only lightly addressed in the current NDCs; although it accounts for around 40 percent of transport emissions, only 13 NDCs have communicated targets, policies or measures that directly address freight (ClimateWatch 2019). However, a variety of emerging options addresses this subsector. For example, electric freight vehicles are becoming a feasible option—in 2019, Amazon ordered over 100,000 electric trucks—whereas in the last round of NDCs the technology was much less advanced. Countries should include freight in their move toward electrification and should also take advantage of Avoid and Shift policies; for example, by using information technology to improve logistics and operational efficiency and by shifting road freight to rail where possible.

Applying the Guidance

This guidance outlines six steps for countries to identify transport-related opportunities to enhance their NDCs. The steps, visualized in Figure ES-2, are as follow:

- Establish a clear and inclusive process for NDC enhancement that engages key transport-relevant stakeholders
- Take stock of progress to date in the transport sector
- Take stock of long-term objectives and their link to transport
- Identify transport-related options for enhancement
- Aggregate the options together with other sector-specific and economywide options, iterate them, and refine the list of options
- Decide how to reflect the enhancements in the NDC

Figure ES-2 | Six Steps to Applying the Transport NDC Enhancement Guidance



Source: Authors

1. INTRODUCTION

Confronting climate change demands a paradigm shift toward sustainable, low-carbon transport. In 2016, the transport sector accounted for one-quarter of total energy-related CO_2 emissions, and that share is climbing. It has risen 71 percent since 1990, with the largest increase coming from road transport (OECD/IEA 2018). Global emissions from land transport—road and rail—could nearly double from 6.3 gigatons (Gt) annually in 2013 to 13 Gt by 2050 and grow from 12 percent to 16 percent of total emissions by 2050 (Gota et al. 2016).

Transport is a major element of the global economy. International trade depends on transporting goods across borders by road, rail, air, or sea. Transportation costs account for 37 percent of global trade expenditures on the flow of goods, and 17 percent of the flow of services (WTO 2018). In addition, in many developed countries, transport accounts for 6–12 percent of gross domestic product (GDP) and consumes 10–15 percent of household expenditures (Rodrigue et al. 2017).

Sustainable, low-carbon transport is vital to achieving more than half of the Sustainable Development Goals (SDGs), including targets on fossil fuel subsidies, road fatalities, access to public transport, access to quality rural roads, and freight movements (SLoCaT 2019). Every year, 1.35 million people die in traffic accidents, and ambient air pollution causes nearly 4.2 million premature deaths (WHO 2018a; WHO 2018b).

The transport sector is currently in rapid transition, driven by the "three revolutions" of electrification, automation, and sharing (Sperling n.d.). These revolutions have created changes and considerable discourse within the sector, even in the five years since the first NDCs were developed. Trends such as dockless bicycles, e-bikes, and e-scooters have descended upon cities in just a few years. Still, many cities lack adequate public transport options and offer difficult environments for cycling and walking, though many are reshaping streets for sustainable travel. This has led several cities, companies, and organizations to release a set of Shared Mobility Principles for Livable Cities that prioritize people over cars, promoting equity and efficient use of space, among other things (Shared Mobility Principles n.d.).

Currently, the global stock of electric vehicles is surging—particularly in developed countries and in China—and is expected to exceed 100 million by 2030. At the same time, continued increases in private vehicle use and the emergence of ride-hailing apps are sapping demand for public transport. These transitions present risks as well as new opportunities.

Including transit commitments in NDCs can capitalize on the three revolutions, hasten the adoption of existing solutions, incentivize low-carbon modes of mass travel, and make the transport sector more sustainable. They can also develop and implement policies that prevent the three revolutions from exacerbating or perpetuating dependence on automobiles and other carbon-intensive modes of transport.

The core principles of sustainable mobility remain to move people and goods as efficiently as possible by planning ways to reduce the number and lengths of trips; prioritizing public transport, cycling, and walking; and switching to more efficient vehicles. This is known as the Avoid-Shift-Improve framework (see Box 1).

Although most NDCs mention transport in some way (such as an economywide target or as specific policies and actions), few treat the sector in detail, and even fewer take a comprehensive approach to identifying and advancing the necessary changes.

The coming round of NDC updates in 2020 presents an opportunity to more fully seize the opportunities available in the transport sector; that is, to articulate an ambitious vision of the transition each country intends to achieve, what it will do to get there, and, for developing countries, what support is needed.

In enhancing their NDCs, countries also have a chance to integrate transport policy with other vital sectors—health, energy, land use, and urban development—in a holistic way. To catalyze action, it will be important to engage key stakeholders: certainly national government ministries, but also states and cities, the private sector, nongovernmental organizations (NGOs), and citizens.

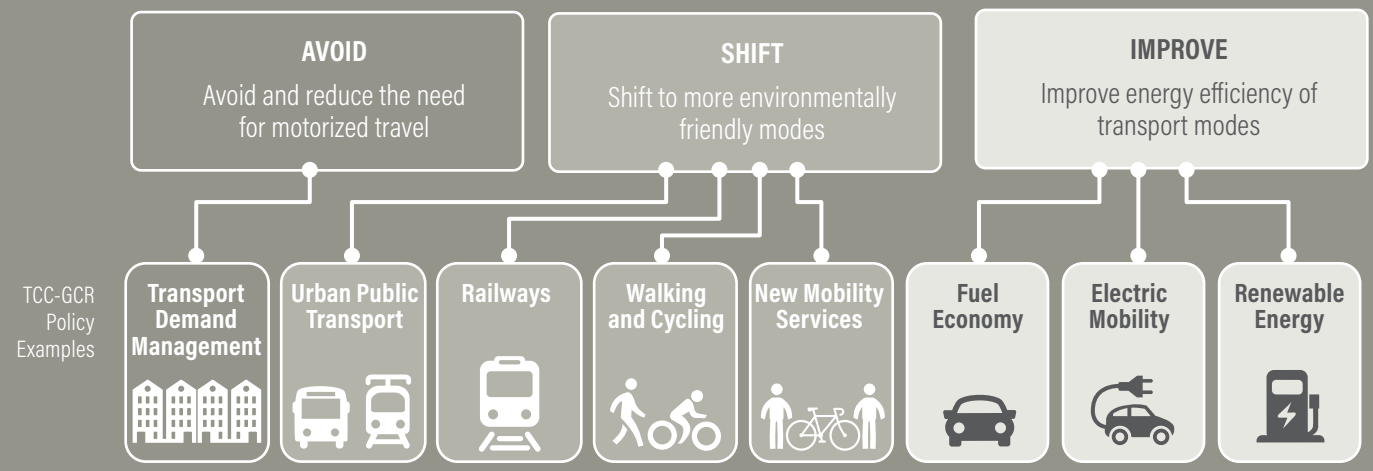
Box 1 | The Avoid-Shift-Improve Framework for Sustainable Transport

The Avoid-Shift-Improve framework provides a way for governments and other actors to consider policies and actions to reduce emissions in transport in three key areas. These areas are visualized in Figure B1.A and described below (SLoCaT 2018).

- **Avoid** passenger trips and freight movement or reduce travel distance by motorized modes of transport through regional and urban development policies such as integrated transport, spatial planning, logistics optimization, and travel demand management.
- **Shift** passenger and freight travel to more environmentally and socially sustainable modes, such as public transport, cycling, and walking (for passenger transport), and railways or inland waterways (for freight transport). Low-carbon modes of transport should be retained. Encourage new mobility services such as bicycle and electric scooter sharing.
- **Improve** the energy efficiency of transport modes through fuel economy, low-carbon fuel, electric mobility and vehicle technologies, increased vehicle load factors, and better-managed transport networks, with nonpetroleum, low-carbon fuels playing a more significant role, particularly before 2030.

The **Avoid-Shift-Improve** framework provides a strategy to decarbonize the transport sector through a comprehensive approach that draws on the full range of solutions.

Figure B1.A | The Avoid-Shift Improve Framework



Note: TCC-GSR = Transport and Climate Change—Global Status Report (see SLoTCaT 2018)
Source: Dalkmann and Brannigan 2007.

About NDC Enhancement

The term "NDC enhancement" captures the idea of NDC progression embedded in the Paris Agreement, starting with the request to Parties in the Paris Conference of Parties (COP) decision to communicate new or updated NDCs in 2020 (Fransen et al. 2017). NDCs can be enhanced along various dimensions, including mitigation ambition, implementation, adaptation, and transparent communication—recognizing that the objectives and requirements under the Paris Agreement vary across these dimensions (Figure 1).

Ideally, the NDC enhancement process will bring NDCs more closely into alignment with the goals of the Paris Agreement to mitigate greenhouse gases, maximize resilience to adapt to climate change, incorporate relevant opportunities to strengthen implementation, and improve transparency. These elements of NDC enhancement are neither mutually exclusive nor interchangeable, and it may be appropriate for a country to enhance its NDC across more than one of these dimensions.

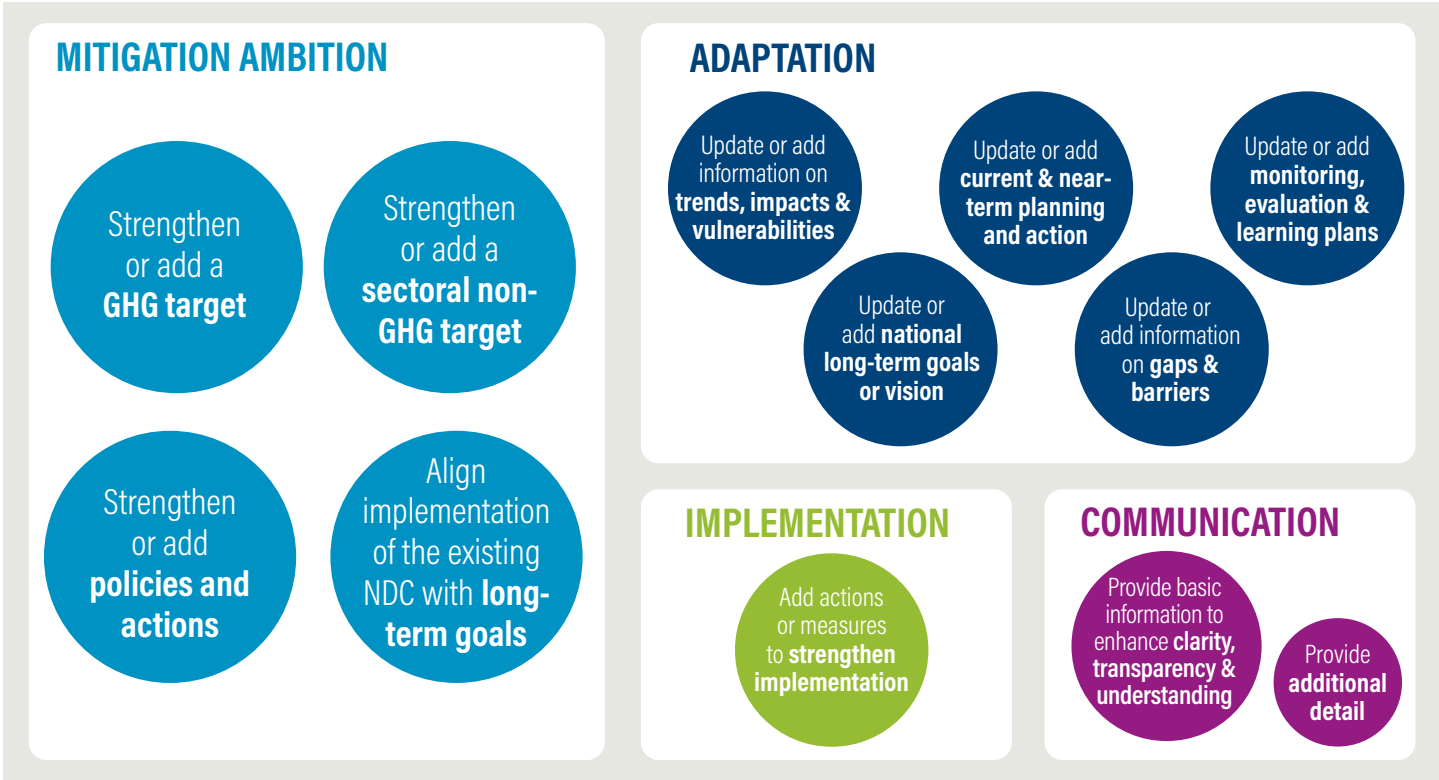
About This Guidance

As the following sections will demonstrate, transport, climate, and sustainable development are closely intertwined. Enhancing NDCs through transport provides important opportunities to address these complementary objectives. The purpose of this guidance is to help countries identify ways to enhance their NDCs by incorporating solutions in the transport sector. It is aimed at policymakers focusing on climate change, who are tasked with updating their NDC, as well as at transport policymakers and other stakeholders looking to leverage their NDC to achieve sustainable transport outcomes.

It emphasizes land transport, which accounts for over three-quarters of total transport emissions (OECD/IEA 2018). The guidance reviews the treatment of transport in the initial NDCs through the lens of the Avoid-Shift-Improve framework, taking into account recent technological developments, to identify key opportunities for NDC enhancement.

This transport guidance is one module in a series of guid-

Figure 1 | **Types of NDC Enhancements**



Source: Fransen et al. 2017.

Box 2 | **Terms Related to NDC Enhancement**

New or Updated NDC: From the COP decision adopted together with the Paris Agreement (1/CP.21), these terms refer to the request in the COP decision to Parties concerning NDCs in 2020. A new NDC is one subsequent to the initial NDC, when a Party's initial NDC contains a time frame up to 2025. An updated NDC is one communicated by a Party whose initial NDC contains a time frame up to 2030.
Enhanced NDC: In this guidance, this refers to a new or updated NDC that improves upon the initial NDC with respect to mitigation (ambition and/or implementation), adaptation, and/or communication.
NDC with enhanced mitigation ambition: In this guidance, this refers to an NDC that, if fully implemented, would result in lower cumulative emissions than the fully implemented existing NDC. It is important to note that a new, updated, or enhanced NDC may not necessarily lead to enhanced mitigation ambition. The baseline for determining this is the complete set of mitigation targets and/or actions articulated in the original NDC. In determining the effect on mitigation ambition, it is important to consider the cumulative impact of all changes to the NDC, including the extent to which they overlap with each other, as well as the targets, policies, and measures in the existing NDC.*
Notes: *Determining whether a new option will enhance a Party's level of ambition can be technically complex. Consider, for example, an NDC that contains both a GHG intensity target and a renewable energy target. Say the GHG intensity target is close to current projections of GHG intensity, but the renewable energy target vastly exceeds current projections of renewable energy capacity. In this case, the renewable energy target is the key driver of ambition, and raising it will likely enhance overall ambition. Conversely, if the GHG intensity target is more aggressive and the renewable energy target less aggressive relative to current projections, raising the renewable energy target may not raise the overall level of ambition. The "GHG Protocol: Mitigation Goal Standard" (WRI 2014a) and "GHG Protocol: Policy and Action Standard" (WRI 2014b) provide guidance on GHG accounting that can inform analysis of ambition.

Source: Fransen et al. 2019.

ance documents on NDC enhancement developed by the World Resources Institute (WRI) and the United Nations Development Programme (UNDP). The series (Figure 2) includes an overarching guide, *Enhancing NDCs: A Guide to Strengthening National Climate Plans by 2020* (Fransen et al. 2019), as well as detailed guidance on power, agriculture, forests and land use, oceans, short-lived climate pollutants, and other themes. We recommend that countries consult *Enhancing NDCs* as well as other modules relevant to their national context. Countries seeking guidance on how to implement existing NDCs should consult the forthcoming guide, *Implementing NDCs*.

Enhancing NDCs outlines four broad elements of the NDC enhancement process (Figure 3):

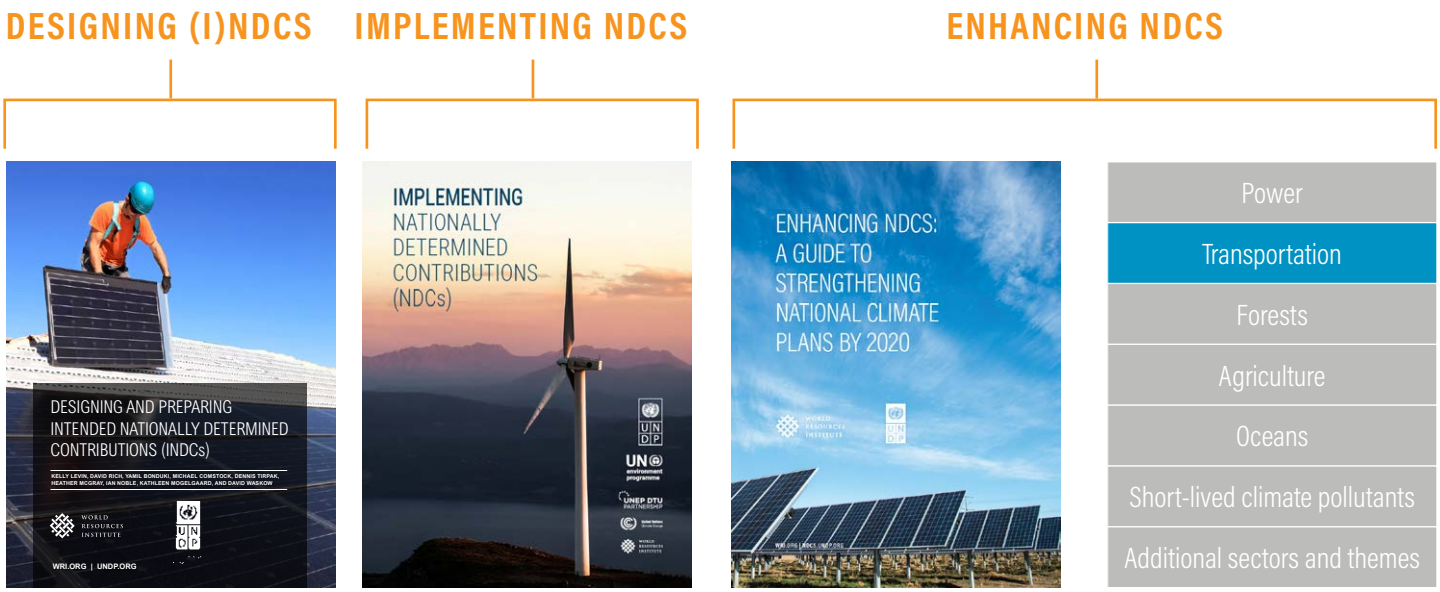
- Establishing a process for NDC enhancement
- Designing an enhanced mitigation component of an NDC
- Designing an enhanced adaptation component of an NDC
- Communicating an enhanced NDC transparently

This transport-specific guidance is intended to help users identify mitigation enhancements in the transport sector, though it also speaks to establishing a process for enhancing NDCs. Additionally, some key mitigation options for transport also improve resilience to climate impacts, and these are identified in the "synergies with sustainable development" subsections in Section 4. Such benefits may also be relevant to enhancing the adaptation component of NDCs.

This guidance is organized as follows: Section 2 lays out the context for taking climate action in the transport sector, first outlining the contribution of transport to climate change, then presenting the potential of different solutions to mitigate emissions, and finally discussing how these solutions can also contribute to resolving other development challenges. The guidance next turns to the NDCs. Section 3 reviews the current NDCs and how they address transport, identifying gaps in how transport is currently treated. Section 4 presents key opportunities to fill these gaps, taking into account the Avoid-Shift-Improve framework as well as notable technological progress over the past several years. Section 5 outlines steps to guide countries through the application of this guidance, and Section 6 offers conclusions.

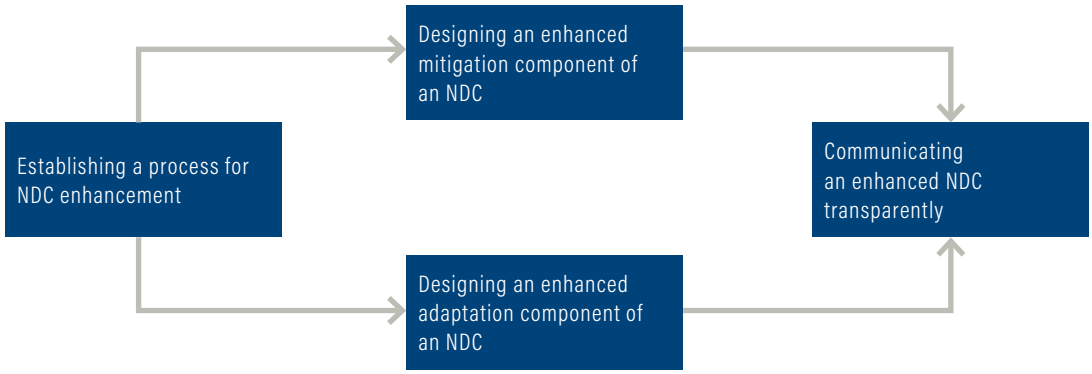
The use of this guidance is entirely voluntary; countries are free to use it in whole or in part, and to adapt it to their national circumstances as relevant. The guidance is intended to complement, but not substitute for, NDC provisions in the Paris Agreement and the Katowice Rulebook (UNFCCC 2018).

Figure 2 | **Overview of NDC-Related Guides by WRI and UNDP**



Source: Fransen et al. 2019

Figure 3 | **Overarching Process for NDC Enhancement**



Source: Fransen et al. 2019

2. TRANSPORT, CLIMATE CHANGE, AND DEVELOPMENT

Transport and Climate Change

Transport represents a large and growing share of global, energy-related CO_2 emissions. It makes up approximately one-quarter of such emissions, and that share is expanding faster than any other sector, climbing by 2.5 percent per year from 2010 to 2015 (IEA 2017). As shown in Figure 4, these emissions stem first from light-duty vehicles (45 percent) followed by trucks (21 percent), followed by aviation and shipping (11 percent each). The split between modes varies widely by region; for example, two- and three-wheelers and buses make up a greater share of passenger trips in non-OECD countries than in OECD countries (Fulton and Eads n.d.; IEA n.d.). Freight accounts for a large (40 percent) and growing share of total transport emissions (SLoCaT 2018).

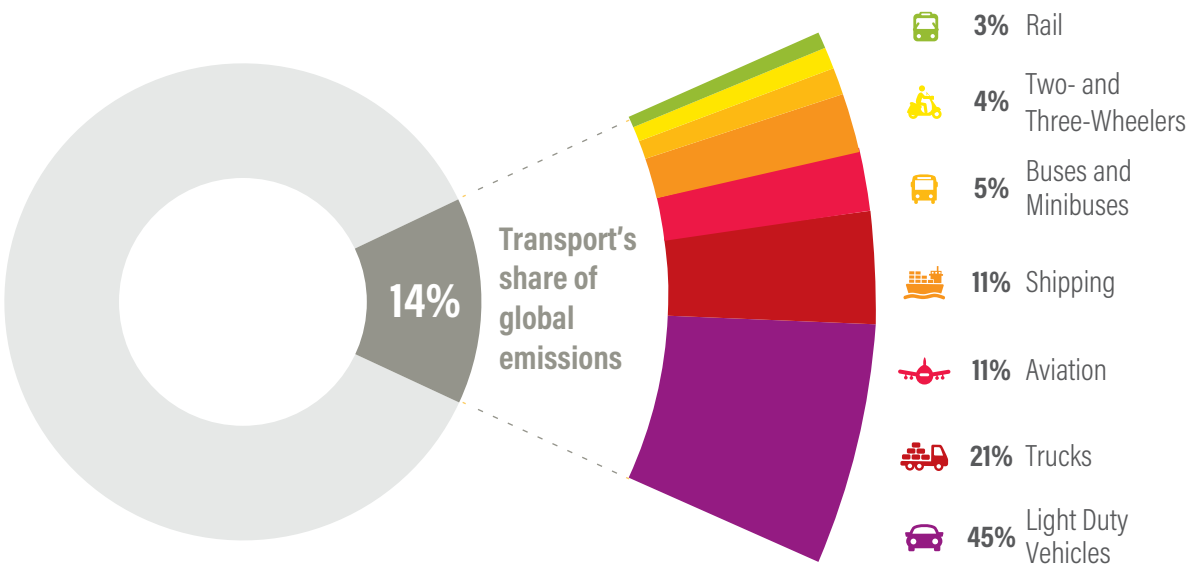
Modeling studies analyzing scenarios compatible with global temperature increases of 1.5°C and 2°C show a range of pathways for transport (Figure 5). But all such scenarios require a large reduction in transport emissions relative to current levels, and especially relative to business-as-usual (BAU) projections, by 2050.

These scenarios from the Intergovernmental Panel on Climate Change (IPCC) also show a growing share of electrification, and a greater reliance on biofuels, especially for heavy-duty transport, aviation, and shipping (IPCC 2018).

While these studies can help benchmark targeted emissions reductions in the transport sector, several factors should be borne in mind. IPCC (2018) notes that sector-specific studies identify more ambitious reductions in transport sector emissions than integrated assessment model (IAM) studies. That is because many IAM studies assume that countries will be able to remove significant levels of carbon dioxide from the atmosphere to help achieve temperature benchmarks. Finally, newer studies reflect a greater share of electrification in road transport relative to older studies, targeting biofuels toward modes that are harder to decarbonize, such as aviation.

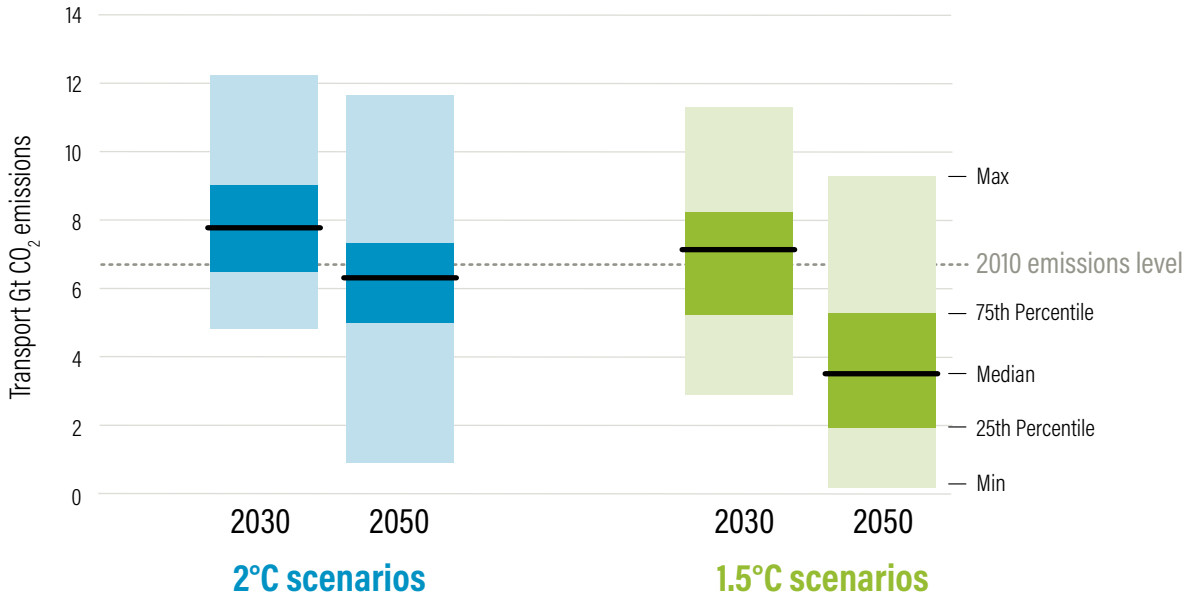
A land transport sector meta-analysis by Partnership for Sustainable Low Carbon Transport (SLoCaT) identified several trends and necessary benchmarks (Figure 6; Gota et al. 2016):

Figure 4 | **Global Transport Sector GHG Emissions by Mode, 2015**



Source: SLoCaT 2018 based on IEA 2016.

Figure 5 | **Transport Sector CO_2 Emissions in 2030 and 2050 Associated with 1.5°C and 2°C Scenarios**



Source: Adapted from IPCC 2018.

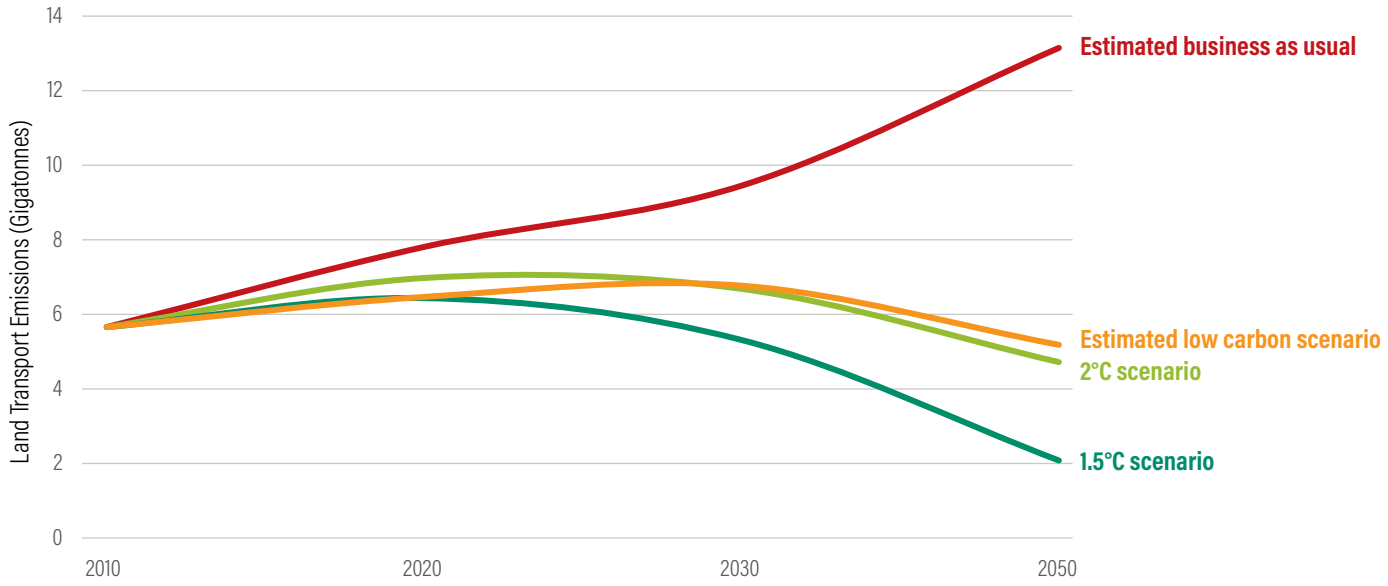
- Under a business-as-usual scenario, global land transport sector emissions could grow from 6.3 gigatons (Gt) annually in 2013 to 13 Gt by 2050, moving from 12 percent to 16 percent of total emissions by 2050.
- From 2010 to 2050, under a business-as-usual scenario, land transport sector emissions in non-OECD countries are projected to increase nearly threefold (295 percent) while land transport emissions from OECD countries are projected to increase only slightly (17 percent), with potentially more rapid increases in transport emissions in the period 2030–50 based on country estimates.
- Applying 2-degree scenario (DS) and 1.5-DS targets for the land transport sector could result in emissions of 4.7 Gt and 2 Gt by 2050, respectively, compared with a 13 Gt projection under BAU.
- Land transport sector emissions need to peak in the first half of the 2020s (or require even more intense reductions later) to stay on track to achieve these targets.

These emission reduction pathways translate into concrete changes for the transport sector. Kuramochi et al. (2018) determined the changes needed in each transit mode to hold temperatures to 1.5°C. (This study focused on technological changes, while acknowledging the potential contribution from behavioral changes described in the Avoid-Shift-Improve framework.) The changes include the following:

- Rapid penetration of zero-emission passenger vehicles, with the last internal combustion engine car to be sold by 2035–50
- Similar technology shifts for heavy-duty road transport, though the technology is not yet as advanced
- Rail electrification
- A long-term vision for aviation and shipping that is compatible with 1.5°C

Taking a comprehensive Avoid-Shift-Improve approach to decarbonization will result in greater abatement. Actions will be needed in all three areas, from long-term land use planning (avoid), to inducing and implementing public transport and cycling (shift), to fueling vehicles cleanly and efficiently (improve), to decarbonize the sector (Figure 7).

Figure 6 | **Projected and Targeted Land Transport Emissions Curves**



Source: Gota et al. 2016.

Transport and Sustainable Development

Addressing transport in the NDCs can bring about several broad cobenefits in the sustainable development agenda by addressing air quality, road safety, physical activity, access to opportunities, and economic development.

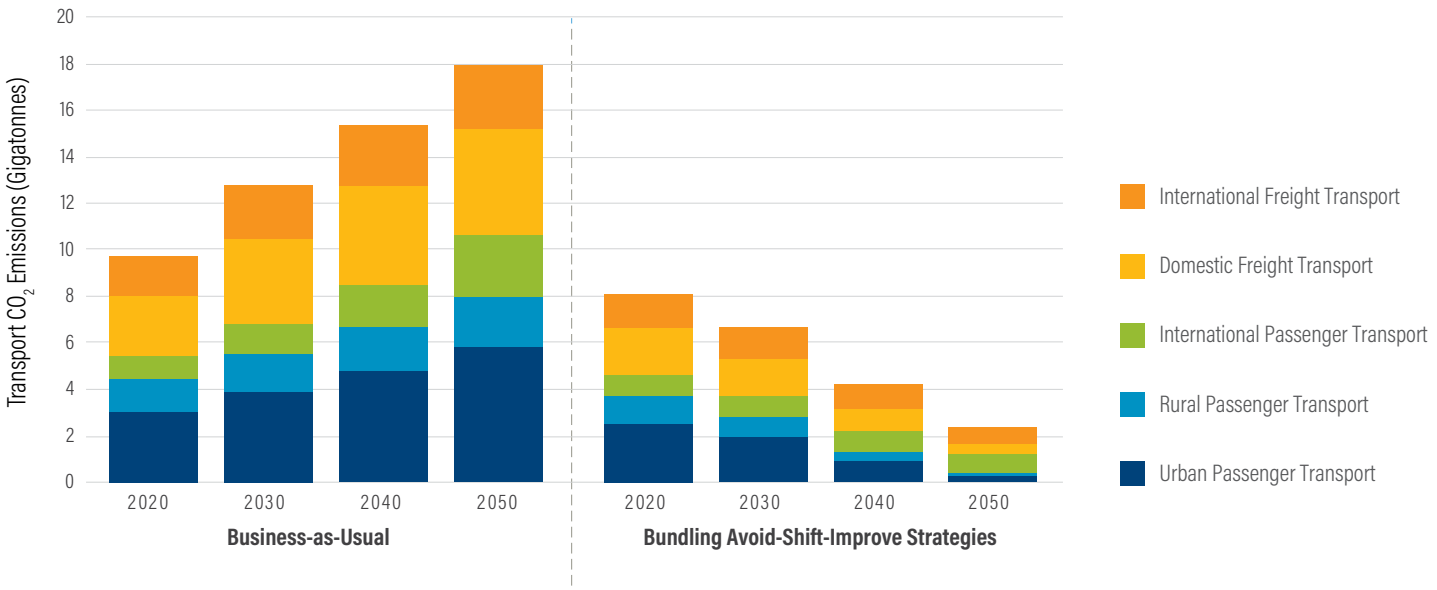
Air pollution and black carbon

Ambient air pollution kills 4.2 million people around the world every year (WHO 2018b). A report by the International Council on Clean Transportation (ICCT) and Climate and Clean Air Coalition (CCAC) estimates that in 2015 transportation emissions contributed to about 1 in 10 of these premature deaths (Anenberg et al. 2019). In addition, air pollutants other than CO_2 can contribute to climate change. Black carbon, a component of a class of air pollutants called particulate matter, has recently been identified as a significant contributor to global climate change (Bond et al. 2013). After CO_2 emissions, black carbon emissions are the second strongest warming influence in the atmosphere (Ramanathan and Carmichael 2008; Bond et al. 2013), and studies show that curbing these emissions may slow down the atmospheric warming expected by 2050 (Ramanathan and Carmichael 2008; Bond et al. 2013). Black carbon is also a major threat to human health because this type of particulate matter is associated with a range of respiratory and cardiovascular diseases and with premature death (Health Effects Institute 2010). Reducing emissions of black carbon presents an opportunity to slow the rate of near-term climate change and to achieve substantial public health benefits.

Road safety

Road fatalities, which take 1.35 million lives every year, are one of the world's top 10 causes of death (WHO 2018a). Climate and safer roads may seem like separate items, but the link between them is real and important. Making roads safe for cycling and walking is essential to enable the use of low-carbon modes of transport. In addition, public transport, a form of low-carbon mobility, is also the safest mode of transport (Hidalgo and Dudata 2014). Countries that prioritize the safe movement of all road users, particularly through public transport, cycling, and walking, may achieve lower carbon emissions from transport as well (Lefevre et al. 2016). The "Safe System" approach adopted by Denmark and the Netherlands, which focuses systematically on the safety of vulnerable road users such as bicyclists and pedestrians, has helped these countries achieve some of the world's lowest fatality rates for all modes (Welle et al. 2018). The International Energy Agency calls for reducing the vehicle-kilometers of travel as part of a move from a 4°C global climate change scenario to a 2°C scenario. Following this recommendation would also reduce traffic deaths by an estimated 200,000 a year (Hidalgo and Dudata 2014).

Figure 7 | **Transport Mitigation Potential across Subsectors**



Source: SLoCaT 2018.

Physical inactivity

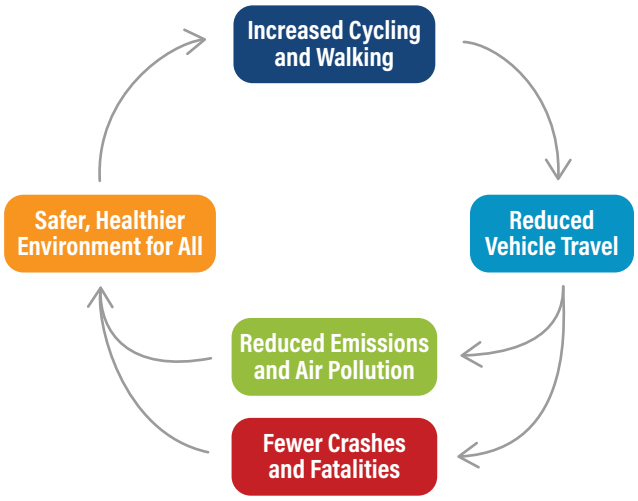
Globally, 5.3 million deaths a year are attributed to inactivity (Lee et al. 2012). Countries such as the United States have seen steep declines in physical activity since 1965; many rapidly motorizing countries are now experiencing similar trends. China, for example, had a 45 percent drop in physical activity between 1991 and 2009, and Brazil is slated to see a 34 percent decline between 2002 and 2030 (Ng and Popkin 2012). Cycling and walking and are the lowest-emitting modes of transport, and they also bring impressive health benefits. Making active transport such as public transport, cycling, and walking safe, convenient, and accessible—and thus more appealing—can encourage people to exercise. A growing body of research shows that aggressively expanding active transport is an effective, but underutilized, policy option with significant health cobenefits for mitigating greenhouse gases (Maizlish et al. 2017). See Figure 8.

Equitable access and travel time savings

Equitable access to opportunities is an emerging goal within transport sectors, seeking to provide residents, not just with nearby transportation options, but with access to jobs and services across income levels. Focusing on access to opportunities means looking at how many opportunities can be reached within a set amount of time for all residents across different modes of transport.

Better access to opportunities from compact development to public transport to cycling and walking can mean shorter trips, and thus lower emissions, as well as less time spent on congested city streets or along rural road networks. Transport improvements often disproportionately benefit wealthier residents while leaving poorer residents disproportionately impacted by the negative externalities, including poor air quality, unaffordable transport options, dangerous walking infrastructure, and exclusion from opportunities. Addressing transport poverty means taking a nuanced look at the mobility options, accessibility, transport's affordability, and negative externalities faced by a city's most vulnerable residents (Lucas et al. 2016). Currently many cities fail to offer all residents access to transit without major time delays, poor quality, or unaffordable service (Venter et al. n.d.).

Figure 8 | **Environmental and Health Benefits Cycle**



Source: Welle et al. 2018.

3. TRANSPORT IN THE NDCS

The Case for Addressing Transport in the NDCs

Even as countries move increasingly toward economywide emission targets in their NDCs, addressing the transport sector explicitly can confer multiple potential benefits. These include aligning transport-sector development with a low-carbon transformation, attracting investments and support, and increasing buy-in and accountability to achieve relevant targets.

Aligning transport sector development with decarbonization

Addressing the transport sector in NDCs provides opportunities for nations to align climate objectives and transport sector development objectives. By taking a hard look at how transport sector could contribute to low-carbon transformation, countries can avoid locking in high-emission pathways and seize economic and development opportunities. Likewise, they can identify ways in which NDCs can help advance transport-related goals. They can recognize the risks and costs of building transport infrastructure that are carbon intensive or that are not resilient to climate change, and use sustainable transit options to improve road safety, energy security, and air quality, as well as cutting GHG emissions. By so doing, countries can use NDCs as a tool to advance their climate-relevant transport goals.

Attracting investment and support

Many countries have noted the need for international support to implement their NDCs. Although the overall climate-related support in the transport sector is limited, it is likely to grow. For example, eight multilateral development banks provided about US$23 billion of new funding for sustainable transport projects in 2015 and are committed to increase support for climate-resilient and low-carbon transport (AfDB et al. 2017). Including specific actions and targets for the transport sector in NDCs will send a clear signal to investors and international institutions, making it easier to attract private investment or international support.

Increasing buy-in and accountability to achieve relevant targets

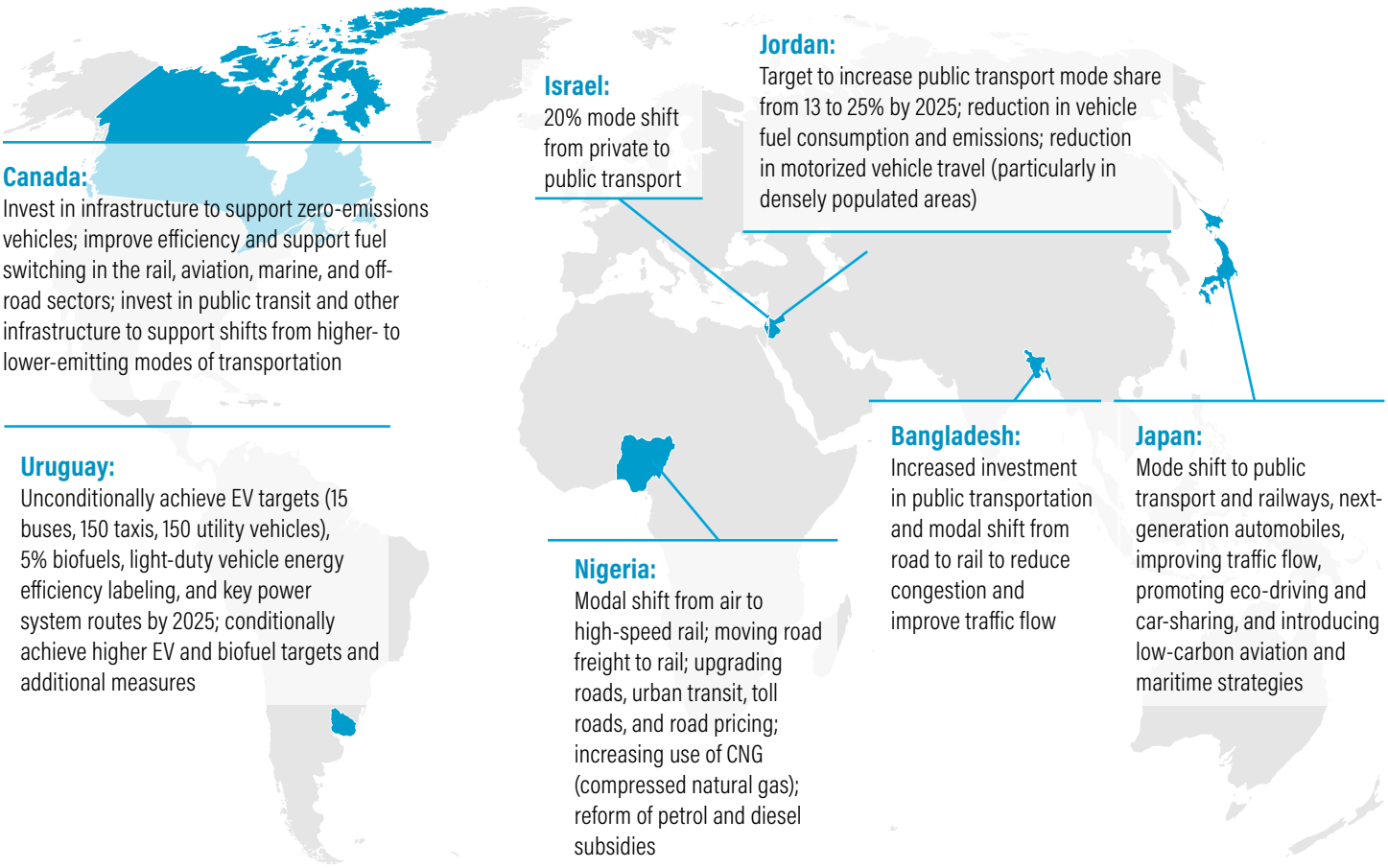
Countries can use the NDC process to articulate the economic, social, and environmental benefits of a decarbonized transport sector and concretize a strategic vision with relevant stakeholders. In doing so, countries can create broader ownership for the shared vision, which is conducive for its realization. Additionally, under the Paris Agreement, nations agreed to review their progress against NDC targets and actions every five years and enhance them if possible. At the international level, this mechanism creates expectations that countries will transition to low-carbon transportation. At the national level, having transport targets and actions in NDCs can make relevant authorities accountable for the sector's contribution toward NDCs, facilitating implementation.

Transport in the Current NDCs

In their first NDCs, over 150 countries defined mitigation actions in the transport sector, and approximately 20 countries recognized the sector's role in adaptation (ClimateWatch 2019). The proposed actions take on a range of forms: some are mentioned as approaches to support achieving national targets, while others refer to planned or ongoing measures. The NDCs include a variety of targets and measures (Figures 9 and 10).

Thirty-five NDCs include quantitative targets for transport. The most common target types are GHG emissions targets, public transit targets, and electric vehicle targets. A greater number of NDCs include transport-related policies and actions, addressing infrastructure, public transit, electric vehicles, and other interventions. Overall, the incidence of any single policy type is low; none appears in more than one-fifth of the NDCs (ClimateWatch 2019).

Figure 9 | **Examples of Transport Sector Measures in NDCs**



Source: Huizenga and Peet 2017; GIZ 2017; ClimateWatch 2019.

Freight draws much less attention than passenger transport (Huizenga and Peet 2017). Most of the transport measures in NDCs embrace the "Improve" approach while "Shift" and "Avoid" approaches receive less attention (see Figure 11; Huizenga and Peet 2017).

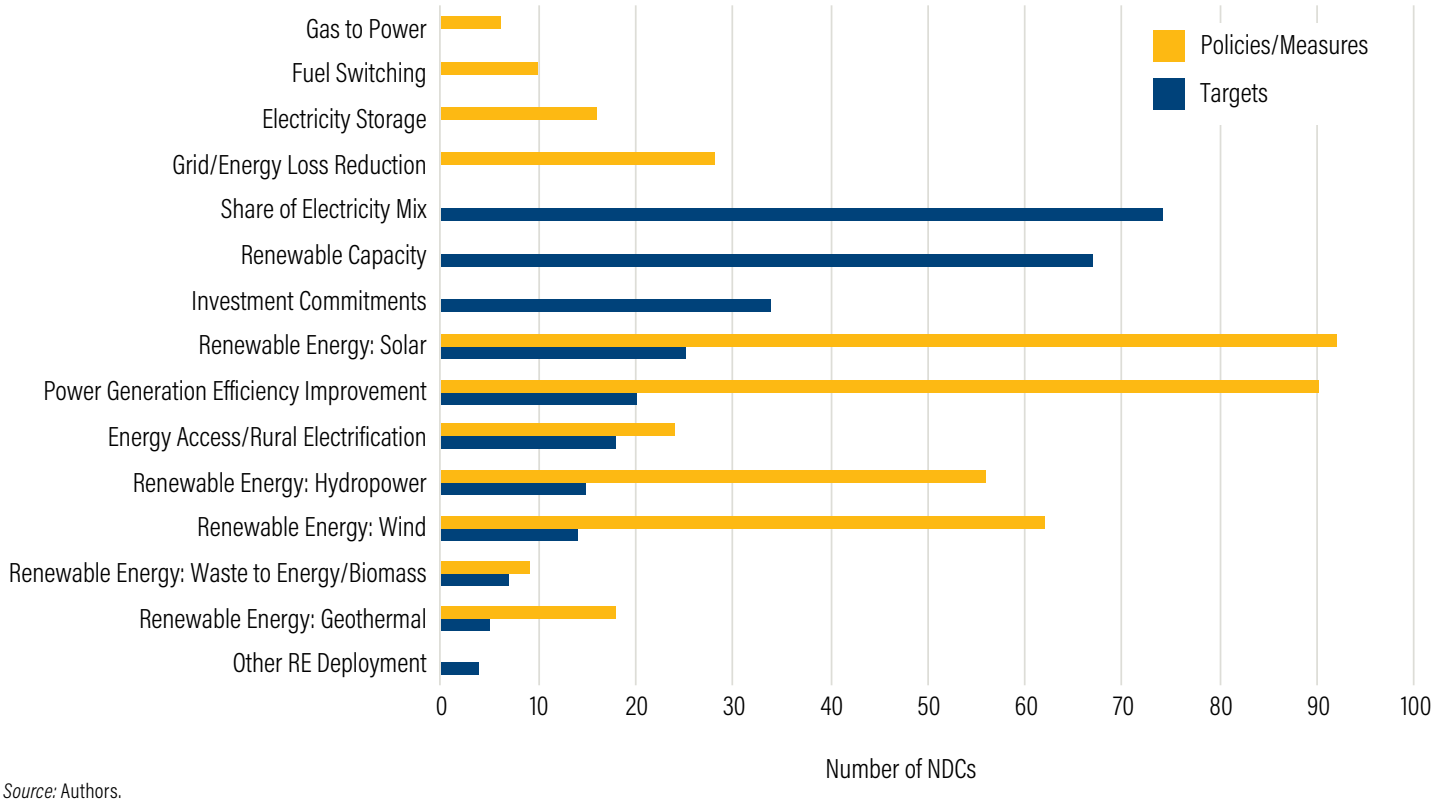
Key gaps in the current NDCs

Although a vast majority of countries noted the importance of the transport sector in their NDCs, gaps remain, and opportunities have been overlooked.

Few NDCs address transport electrification. A review of transport mitigation measures in NDCs found that just 23 mentioned electric mobility, and even fewer cited other forms of clean technologies, such as compressed natural gas or biofuels. These figures include policies and actions, in addition to quantitative targets (ClimateWatch 2019).

Countries tend to overlook Avoid and Shift mitigation approaches in their NDCs. While it is important to pay attention to the Improve approach, an integrated and balanced set of Avoid and Shift approaches could potentially reduce GHG intensity in the transport sector far more—by 20 to 50 percent by 2050, below a 2010 baseline (IPCC 2009). However, Huizenga and Peet (2017) note that the majority of NDC transport mitigation measures represent the Improve approach (Figure 11) and therefore fail to optimize the full mitigation potential of transport. This can also be connected to a lack of requisite knowledge and skills to advance such measures.

Figure 10 | **Types of Transport Targets in NDCs**



Source: Authors.

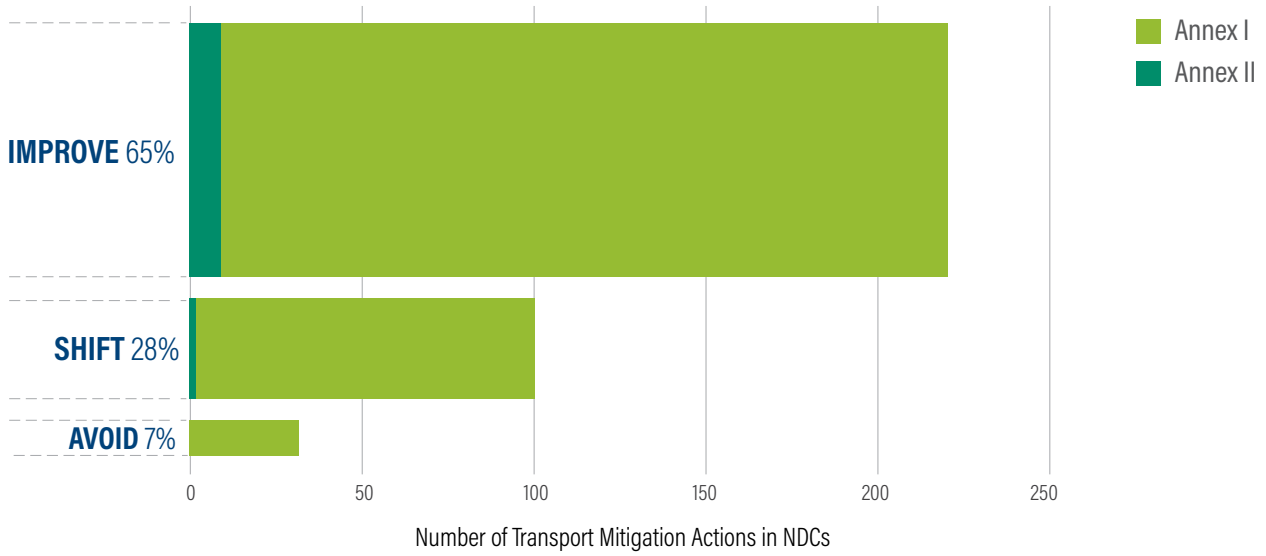
NDCs do not sufficiently address freight transport. Between 2000 and 2015, freight transport emissions increased more than twice as much as emissions for passenger travel (75 percent compared with 36 percent). As a result, freight's share of total transport CO_2 emissions rose from 35 percent in 2000 to 41 percent in 2015 (IEA 2016). However, as Figure 12 shows, most transport actions in non-Annex I countries' NDCs are directed toward passenger transport, and freight transport is largely neglected.

Transport sector targets and action in NDCs are not fully aligned with national transport plans or strategies. Based on case studies in seven countries, the Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ; GIZ 2017) concludes that some countries have yet to fully align their transport sector NDCs with national transport plans or strategies. Many transport plans have a timeline for 2020 while their NDCs have a 2030 horizon. Because of lack of clarity on how the two plans fit together, transport plans end up with limited influence on NDCs, and vice versa (GIZ 2017).

As a result, mitigation potential is not fully captured in NDCs. Studies estimate that while countries' transport sector actions would reduce CO_2 emissions below the baseline scenario, they are insufficient to meet the emissions trajectory of the 2°C scenario. The actions would also fail to achieve the emissions reductions that are feasible (ITF 2018; Gota et al. 2018).

Likewise, most NDCs do not recognize the transport sector's potential in climate adaptation. Only 21 countries mention the transport sector in their efforts to adapt to climate change (ClimateWatch 2019). Much transport infrastructure is vulnerable to extreme climate events and rising sea levels. Disruptions in transport services would impose high economic costs and may disproportionately burden disadvantaged social groups or regions. Therefore, transport sector adaptation deserves more attention than it has received. While this guidance focuses primarily on mitigation, it notes synergies with adaptation that can be amplified via the NDCs.

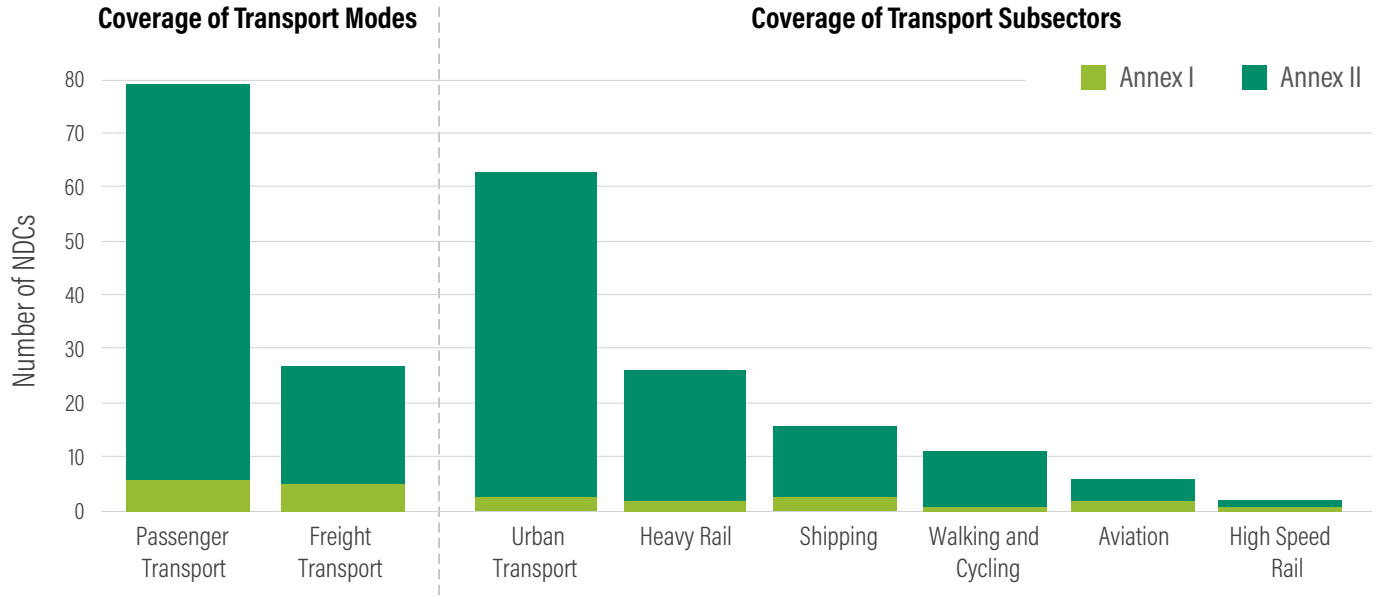
Figure 11 | **Most NDC Transport Mitigation Interventions Are in the Improve Category**



Note: See list of Annex I and non-Annex I countries at https://unfccc.int/process/parties-non-party-stakeholders/parties-convention-and-observer-states.

Source: SLoCaT 2018.

Figure 12 | **Number of NDC Mitigation Interventions in Transport Modes and Subsectors**



Note: See list of Annex I and non-Annex I countries at https://unfccc.int/process/parties-non-party-stakeholders/parties-convention-and-observer-states.
Source: SLoCaT 2018.

These gaps may have emerged in part because some transport planning authorities are not closely involved in the NDC planning process. GIZ (2017) notes that authorities responsible for transport planning do not participate adequately in the development of NDCs. At the same time, planning officials may lack the expertise they need to integrate climate and mobility goals. The roles of different levels of governments in the transport sector make it even harder for relevant agencies to participate in the NDC process. GIZ (2017) finds a need for climate change capacity development in transport authorities. If they had their own climate change teams, equipped with both technical and strategic policy knowledge, transport planning authorities could provide valuable input and work closely with teams developing NDCs, leading to better alignment in planning and implementation. For example, Peru's Ministry of Transport has formed an internal working group to focus on climate change policies (Córdova and Lefevre 2016). Similar arrangements will likely strengthen transport actions in the NDCs. Section 5 suggests ways to engage key stakeholders in transport-related NDC enhancement.

4. OPPORTUNITIES FOR NDC ENHANCEMENT

This paper identifies three key areas for enhancing NDCs in the transport sector. In identifying these priorities, we considered the full range of solutions available under the Avoid-Shift-Improve framework, the gaps identified in the current NDCs, and the evolution of critical technology since the initial NDCs were developed. The three key areas are as follows:

- Accelerate electrification in the sector to ensure new technologies are meeting their full potential while continuing to advance fuel economy
- Amplify Avoid-Shift solutions, including land use and mobility planning, public transport, walking, and cycling, so that countries are taking comprehensive measures to implement sustainable transport
- Seize new opportunities in sustainable freight and logistics

These three priorities draw on all elements of the Avoid-Shift-Improve framework, but they do not mirror these elements exactly, nor are they meant to be applied sequentially or in order of priority. Different elements will prove more relevant for different countries.

In keeping with the general guidance on NDC enhancement (Fransen et al. 2019), which prompts countries that are enhancing mitigation ambition to maximize synergies with development goals and address implementation challenges, each section first lays out the general mitigation opportunity and then discusses links to development issues, including resilience and implementation.

Accelerate Electrification while Continuing to Strengthen Fuel Efficiency

Within the universe of priorities for sustainable mobility, two policy tools for improving efficiency are paramount: robust national fuel efficiency standards and comprehensive electric mobility policies. Fuel efficiency standards form the baseline policy by which automakers are compelled to reduce harmful emissions from the products they sell. When properly developed and enforced, these standards can provide a significant short-term benefit to cities by reducing air pollution and contribute to overall reductions in greenhouse gas emissions from the transportation sector. In developing robust standards, governments are often faced with intense political pressure from the automotive sector to allow for more environmentally harmful vehicles to remain on the road. A common claim is that more stringent fuel economy standards will raise prices and limit vehicle choices. In fact, there is frequently a direct, positive correlation between improved fuel efficiency and economic growth because both public health expenditures and individual fuel expenditures decline dramatically with increasing vehicle efficiency. For example, the Consumer Federation of America estimates that fuel efficiency standards adopted since 2008 have resulted in a benefit-cost ratio of 8:1, without considering public health, environmental, or other ancillary benefits (Cooper 2017).

While zero-emission transportation is ultimately necessary to achieve transportation emissions reduction targets, fuel efficiency standards are imperative for reducing GHG emissions as zero-emission vehicle markets mature and proliferate. Although few NDCs currently address such standards, the Global Fuel Economy Initiative (GFEI) calls for an aggressive increase in fuel economy standards, including a 90 percent reduction in CO_2 per kilometer emissions by 2050 (relative to a 2005 baseline) for passenger light-duty vehicles, 70 percent for heavy-duty trucks, 95 percent for two- and three-wheel vehicles, and 95 percent for transit buses. Achieving these targets will require dramatic increases in overall fuel economy, such as doubling the fuel economy for passenger light-duty vehicles by 2030. A focus on heavy-duty vehicle efficiency

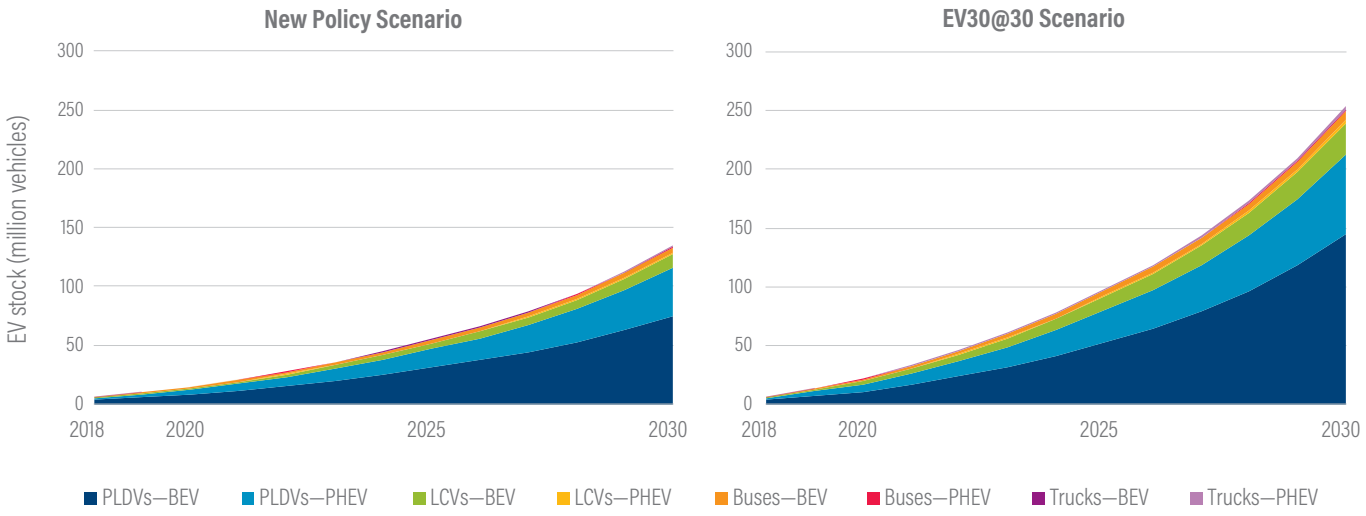
is also critical; only Japan, the United States, Canada, China, and India currently have fuel economy programs addressing this sector, with Mexican, Korean, and European programs in development (GFEI n.d.). These targets are achievable only through the mass introduction of zero-emission vehicles and decisive steps to curb the global trend toward private vehicle ownership.

While fuel efficiency standards are necessary for reducing greenhouse gas emissions from the transportation sector, they are insufficient to achieve the degree of decarbonization necessary to avoid the most severe effects of climate change. Electrification–in conjunction with decarbonization of the power sector—is needed. Yet most current NDCs do not directly address electrification of the transport sector.

Zero-emission vehicle programs, such as those implemented in California and China, provide examples of the regulatory and policy levers needed to compel automakers to transition away from fossil fuels. When zero-emission vehicle mandates are applied to the automotive sector and combined with carefully managed incentive programs for automakers and consumers, governments can truly manage transport-related emissions to acceptable levels over time. Much of the success in accelerating electric vehicle adoption in China and California is due to the artful application of both incentive and mandate policies directed toward industry and consumers.

Of the zero-emission technologies currently available, electric vehicles offer the most immediate and profound benefits. While fuel-cell vehicles may grow in feasibility over time, electric powertrains are much more evolved and economical today across most vehicle categories—particularly for passenger transport. Battery prices have fallen more than 80 percent since 2010, to a global average of US$176 per kilowatt hour (kWh) in 2018.

Figure 13 | **Electric Vehicle Adoption Forecast for Existing and Aggressive Policy Scenarios**



New Policy = Existing policy. EV30@30 Scenario = Aggressive policy.
BEV: Battery Electric Vehicle; LCV: Light Commercial Vehicle; PLDV: Passenger Light-Duty Vehicle; PHEV: Plug-in Hybrid Electric Vehicle
Source: IEA 2018.

Bloomberg expects average battery pack prices to reach US$94 per kWh by 2024—before the end date of most NDCs—and US$62 per kWh by 2030. Tesla expects to break the US$100 per kWh barrier even sooner, by 2020 (Bloomberg New Energy Finance n.d.). Bloomberg also notes that battery manufacturers are becoming increasingly adept at finding ways to reduce their exposure to higher costs for expensive metals, such as lithium and cobalt, in their manufacturing process. Continuing cost reductions and innovation in batteries are key elements of the opportunity for transport electrification.

In fact, research institutes, policymakers, automakers, and advocacy groups all generally agree that mass adoption of plug-in EVs is inevitable and, in some places, such as China and Norway, already under way. The future is never certain, but the preponderance of evidence is that the global stock of personal EVs will minimally exceed 100 million by 2030 (not including two- and three-wheel vehicles) and some project 250 million new electric vehicle (EV) sales by 2040. This growth in EV adoption is also expected to occur with buses, trucks, and other commercial vehicles (see Figure 13).

Despite the anticipated global growth in EV adoption, much of the world is currently moving glacially toward adopting clean vehicles. Most of the electric vehicles on the road in 2030 and beyond are projected to reside in China, Europe, and the United States. While it is important for these regions to continue accelerating electrification, all countries need to begin enacting proactive policies that will ensure an equitable transition away from the polluting vehicle technologies of the last century. Just as energy sector NDCs include specific renewable energy targets, NDCs for transport should include specific targets for zero-emission kilometers traveled (as a percentage of total kilometers) in addition to overarching targets for transport sector emissions reductions.

Synergies with sustainable development

An often overlooked aspect of electric vehicles is their integral relationship with the electric grid. Being able to store renewable energy is vital to mitigating climate change. By 2030, the amount of battery storage within electric vehicles will cumulatively reach more than 10 times the anticipated global market for all energy storage services. Harnessing this capacity is essential to minimizing waste of financial and natural resources. The inherent (and literal) connectedness between electric vehicles and the electrical grid creates new opportunities to not only improve the energy efficiency of the transport sector but also to improve the overall efficiency and cleanliness of the energy sector, advancing the Sustainable Development Goals. Integrating vehicles into the grid also has the potential to improve the grid's resilience to shocks—for example, from extreme weather events. Grid-integrated electric vehicles can provide back-up power and facilitate demand-response measures, among other services (EAC 2018). Figure 14 depicts the anticipated benefits from the use of electric vehicles as energy storage devices for enhancing renewable energy resources.

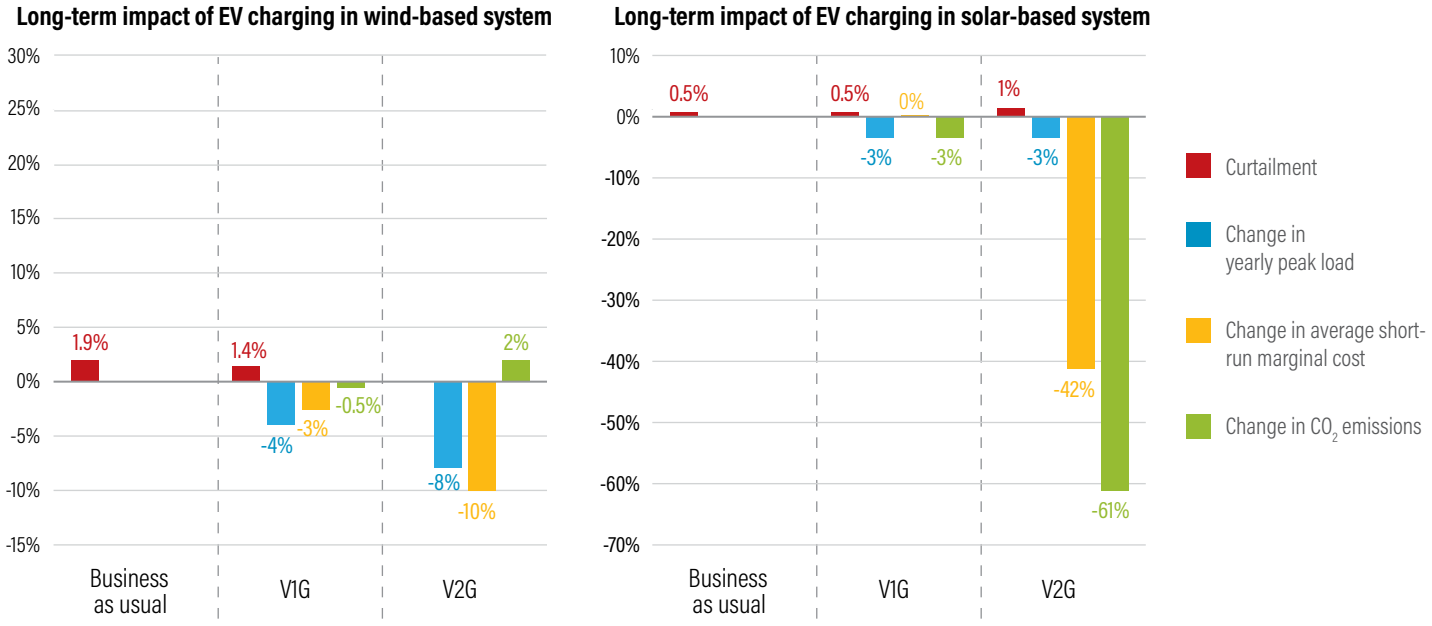
Using EV batteries to support renewable energy is just one application of a range of services that can improve overall grid efficiency and create new economic opportunities. But these transformations will not take place automatically. Leveraging electric mobility to improve the energy and mobility sectors will require a framework and operating guidelines to develop opportunities that would otherwise be overlooked. Figure 15 presents an overarching framework for optimizing electric mobility systems to maximize benefits to both the power and transport sectors based on the following common sustainability goals:

- Reducing GHG emissions in the energy and mobility sectors
- Improving local air quality by reducing small particulate emissions in the energy and mobility sectors
- Providing for equitable access to safe, reliable, and sustainable electricity and transportation
- Improving overall quality of life for communities that incorporate electric mobility

Addressing barriers to implementation

The framework in Figure 15 links three technical elements (vehicles, batteries, and charging infrastructure) with objectives such as fostering renewable energy and mobility to best achieve sustainability goals. It can leverage the dual nature of electric mobility systems to make sweeping improvements not attainable through traditional siloed approaches to energy and mobility. Using electric vehicles to store power is just one step planners can take to achieve more sustainable living. For example, the siting and pricing of public charging stations can be a tool to promote densification or lure drivers away from congested corridors. Planners may need to weigh competing goals. The ideal locations for public charging from a mobility

Figure 14 | **Relative Benefits of Managed Charging and Battery Sharing for Renewable Energy Adoption**



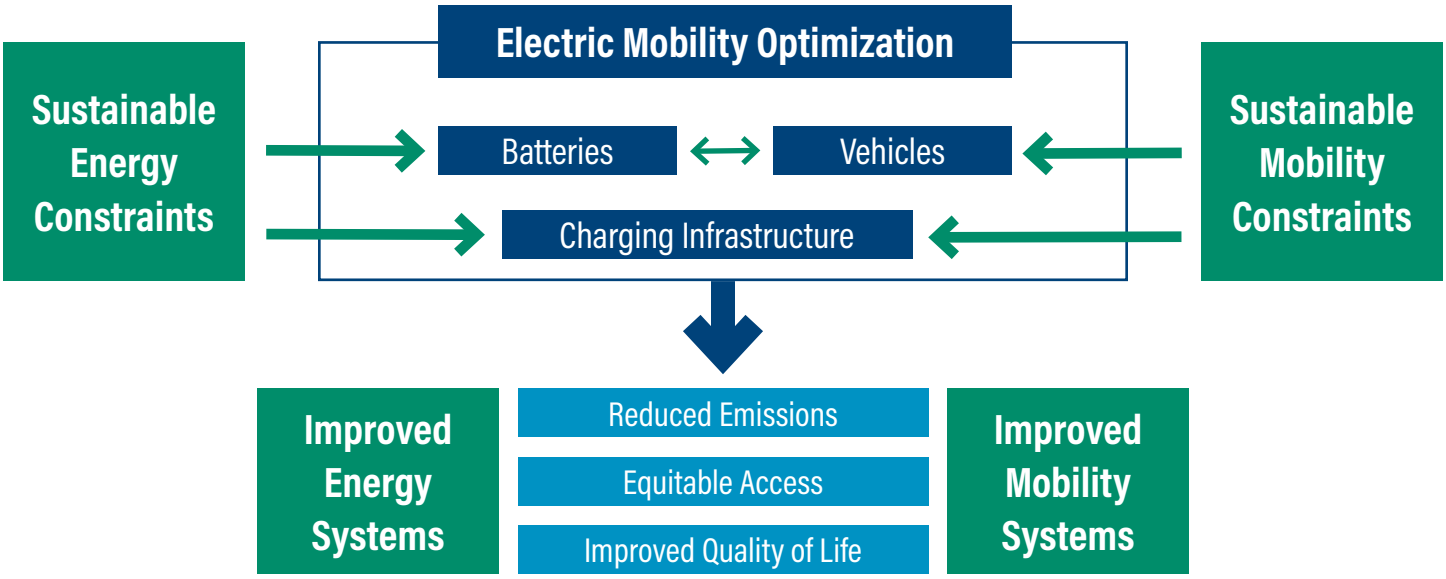
V1G = advanced charging systems that control the rate of EV charging to optimize for financial and environmental outcomes. V2G = "vehicle-to-grid" systems where electric-vehicle batteries can modulate their charging from the grid but also provide energy to the grid as a true distributed energy storage resource. Curtailment = curtailing energy delivery from the wind or solar generator to the grid.
Source: IRENA 2019b.

perspective may conflict with the ideal locations from an energy management perspective, so a multivariate analysis is required to optimize for multiple constraints. More importantly, the failure to optimize in this manner will lead to suboptimal systems that reinforce negative externalities associated with the energy and transportation sectors.

Through the lens of dual optimization of sustainable mobility and energy, every charging point is an opportunity to shape the future characteristics of transportation and energy management. Optimization of the entire electric mobility system requires new areas of research and standards of practice to adapt traditional principles to a modern context and gauge impacts across sectors. From this perspective, the improvement of transportation through electrification should be measured by both tailpipe emissions and net benefit to upstream emissions from the grid, rather than simply treating the energy sector as an unrelated entity with its own objectives and measures of performance.

The emission reduction potential for the energy sector derived from the mobility sector (through grid-integrated EVs) should be addressed NDC content pertaining to both sectors. Integrating national policy between these sectors can be a powerful tool to force collaboration and planning that would otherwise be difficult to achieve. Moreover, calling out the ability of EVs to support energy sector emissions objectives within NDCs reaffirms the perspective that electric vehicles are both energy and mobility assets and will spur new thinking that will lead to technological advancement and economic growth.

Figure 15 | **WRI Electric Mobility Framework**



Source: WRI

Reflecting the opportunities in the NDCs

Governments can reflect these opportunities in their NDCs by committing to NDC targets and measures such as the following:

- New or strengthened fuel efficiency standards
- Vehicle electrification targets
- Zero-emissions vehicle mandates and incentives
- Internal combustion engine phase-out goals
- Investments in charging infrastructure
- Vehicle-to-grid integration measures

Amplify Avoid and Shift Solutions, Including Land Use and Mobility Planning, Public Transport, Walking, and Cycling

As described earlier, Avoid and Shift policies are narrowly covered in the current NDCs. Meeting carbon reduction targets means going beyond efforts to improve efficiency of growing fleets, particularly for motor vehicles. NDCs will be comprehensive only when they consider efforts to reduce unnecessary travel and shift to low-carbon transport modes.

In this section we cover the opportunities for enhancing transport in the NDCs from the perspective of Avoid and Shift strategies.

Avoid

Avoid strategies seek to reduce motorized trips and trip lengths, as well as encourage trips in low-carbon transport. These strategies can play a significant role in achieving sectoral benchmarks. They can help plan cities where people take fewer or shorter vehicle trips and travel more by public transport, cycling, or walking. They can also provide rural areas with better access to services and opportunities. Among the many ways NDCs may be enhanced under Avoid measures, the following are especially promising and ripe for inclusion in NDCs.

Removing fuel subsidies. Fuel subsidies make vehicle travel less expensive, thus inducing people to travel more and consume more fuel, regardless of fuel economy standards. NDCs should seek to eliminate fuel subsidies. Removing all fossil fuel subsidies would cut global carbon emissions by 6.4–8.2 percent by 2050. It would also save money. Fossil fuel subsidies cost US$5.2 trillion per year according to a recent study that accounts for other costs, such as air pollution and climate abatement, as well as the subsidy (Coady et al. 2019). Although subsidies making it

cheaper to buy fuel are politically popular, they are not the most effective ways to help the poor, who depend more on public transit, cycling, and walking (Arze del Granado et al. 2012).

Some countries have begun to remove fossil fuel subsidies and replace them with increased support for renewables and energy efficiency. The Philippines, Peru, and Morocco are reported to be making progress in this direction (Merrill et al. 2017). Ensuring a just transition is important in this context.

Managing transport demand. One policy innovation that is increasingly being discussed and implemented is managing demand for transport through measures such as congestion pricing. Congestion pricing restricts driving by charging vehicles to enter cordoned areas in the core of the city. It has been implemented successfully to reduce vehicle emissions and induce sustainable transport in Singapore, Stockholm, and London. Most recently, congestion pricing was approved for New York City. NDCs, where possible, should seek to enable or incentivize such policies in cities. Countries can create laws to promote congestion pricing in cities or establish programs to support the creation of congestion charges and pricing in cities and states. With the emergence of ride-hailing applications that may steer people away from public transit and toward private vehicles, restricting or imposing a cost on private vehicle use in congested cities has become more urgent. Other forms of transport demand management—including low-emission or car-free zones, parking policies, and employer-commuter policies—may also be supported by national governments.

Enacting sustainable land use planning and regulations. There is a well-known saying that a good land use plan is a good transport plan. This applies to transport emissions as well. Land use plans and zoning regulations that promote connected streets, mixed uses, and compact development centered around public transport discourage vehicle travel and cut emissions (Newman and Kenworthy 1989; Ewing et al. 2008). NDC commitments on transport should be linked to national urban development policies to promote compact growth with connected street networks focused on urban roads rather than expressways. The NDCs can include commitments to national policies that encourage land use plans to favor movement of people over the movement of motor vehicles. Examples of such measures are national urban growth, economic development, and housing construction programs favoring compact urban development connected to public transport and street-based and mixed land use planning that encourages cycling, walking, and other forms of sustainable transport.

Examples of actions in this area include Ethiopia's first NDC that includes a commitment to complement transport investments with urban planning for mixed use, compact, and polycentric cities that result in "shorter distances travelled to reduce transport/traffic related GHG emissions." In addition, the Colombian Nationally Appropriate Mitigation Action (NAMA) on transit-oriented development integrates sustainable mobility with land use development; it focuses public and private development around transit stations and provides a strategy for implementing this approach on a larger scale (Kooshian and Winkelman 2018). To support public transport demand, U.S. cities like Minneapolis and states like Oregon have recently abolished single-family zoning and the requirement that builders provide a certain amount of parking.

Sustainable mobility plans. Land use planning should be complemented by national sustainable transport plans and city-level sustainable urban mobility plans (SUMPs). Enhanced NDCs can include commitments to prepare such plans and require or help city governments to prepare them along certain guidelines, potentially in connection with federal transport funding programs. Globally, more than 800 SUMPs have been identified, with over 60 percent being implemented in European cities (SLoCaT 2018). The process of preparing SUMPs specifically prioritizes more sustainable modes of transport: public transport, cycling, and walking. Some progress has been made by countries outside of Europe. For example, in Brazil, all cities with more than 20,000 residents are required to prepare an urban mobility plan.

Shift

NDC transit commitments oriented toward Shift strategies should focus on switching to or retraining travel through low-carbon transport, such as public transport, cycling, and walking, and away from private motor vehicles. This means creating policies and financial environments for countries and cities to plan and implement high-quality public transport and citywide connected and well-planned bicycle and pedestrian infrastructure.

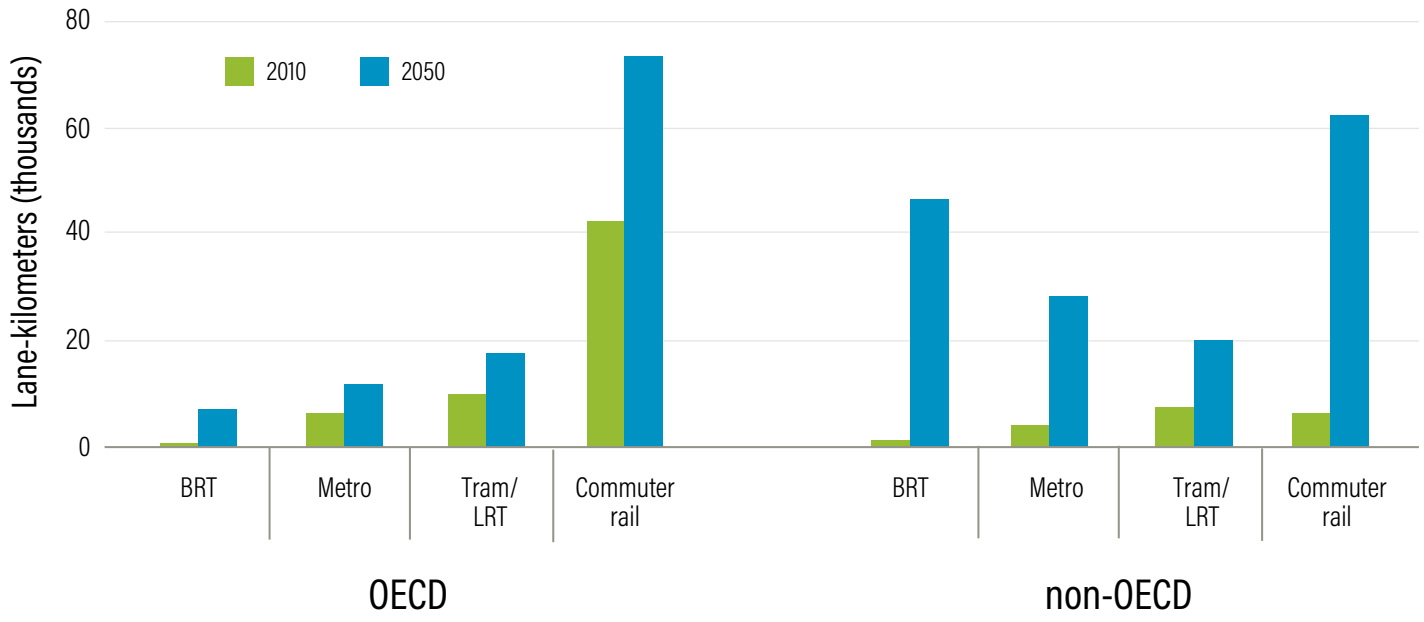
Providing high-quality public transport. By investing in high-quality public transport (i.e., reliable, safe, frequent, direct, connected, and accessible) with commuter catchments that prioritize safe cycling and walking,

governments can shift passenger travel toward travel modes with less emissions. NDCs can include programs to finance bus rapid transit (BRT), metro systems, trams, light rail transit (LRT), and commuter rail that offer people access to opportunities within cities and reduce emissions. In countries with large shares of informal transit or paratransit (i.e., minibus taxi networks), programs to improve the quality of such services should also take priority. One analysis found that, taken together, a "fuel economy goal with better public transport, walking, and cycling could cut annual urban passenger transport CO_2 emissions in 2050 by 55 percent below what they might have been otherwise, and to 10 percent below 2010 levels" (Repogle and Fulton 2014).

Public transport plays a key role in achieving this goal. Large benefits would come from investments adding BRT, metro, LRT, and commuter rail, especially in the United States and developing countries (See Figure 16). These estimates do not consider further gains that could be achieved through bus fleet electrification or upgrading informal (paratransit) networks.

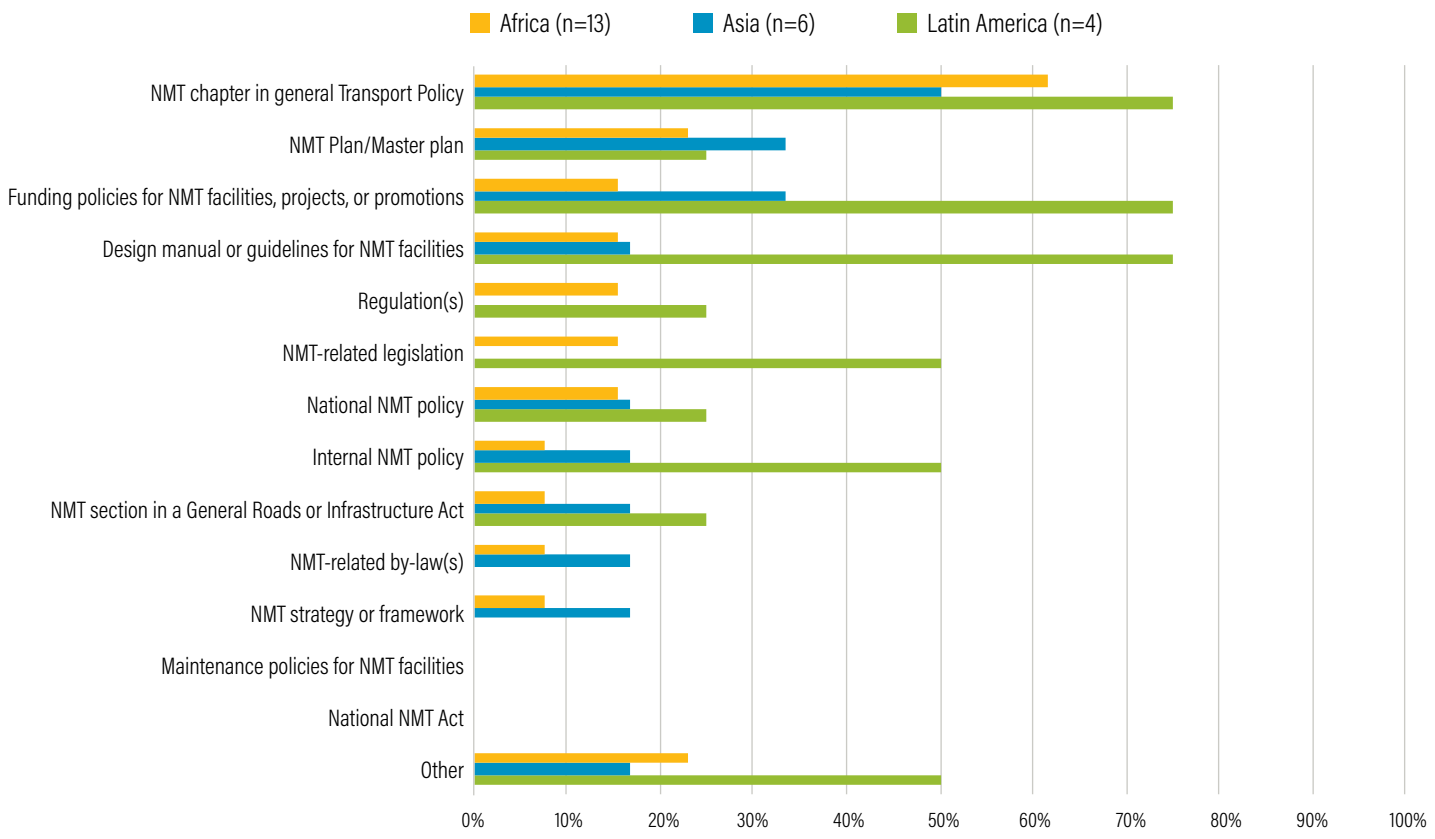
Ambitiously expanding and retaining cycling and walking. There is a clear opportunity to integrate robust cycling and walking plans and policies into the NDCs. Given the nearly zero-carbon emissions of walking and cycling (including scooters), shifting toward these modes provides large potential benefits in mitigating emissions from transport. One in-depth analysis of global cycling potential found that a dramatic increase in cycling could save society US$24 trillion in energy, vehicle, and infrastructure costs cumulatively between 2015 and 2050 and cut CO_2 emissions from urban passenger transport by nearly 11 percent in 2050 compared with a Shift scenario without a strong emphasis on cycling (Mason et al. 2015). NDCs can include commitments to create or strengthen policies and programs to provide for and promote cycling and walking. Many countries can build on existing policies. A 2016 UN Environment Programme report that surveyed cycling and walking issues and policies in 25 low- to middle-income countries across Africa, Asia, and Latin America found that most had a policy at some level intended to give cycling and walking more attention (UN Environment 2016). But it also found that commitments

Figure 16 | **High Shift Assumptions for Rapid Transport System Length by Transport Mode and Region, 2010 and 2050**



BRT = bus rapid transit. LRT = light rail transit. OECD = Organisation of Economic Co-operation and Development.
Source: Repogle and Fulton 2014.

Figure 17 | **Cycling and Walking (Nonmotorized Transit) Commitments by Region, 2016**



NMT = nonmotorized transit, meaning cycling and walking.
Source: UN Environment 2016.

varied widely from "relatively insubstantial" sections in a general transport or mobility policy to "standalone national walking and cycling policies." Figure 17 shows that Latin American countries in the survey had more plans and policies for nonmotorized transit (NMT) than African and Asian countries.

Countries can give these modes priority within the transport network. Options for NDC enhancement include commitments to develop and implement cycling and walking policies, to designate dedicated funding to such programs, and to dedicate a certain amount (e.g., at least 20 percent) of transport budgets to cycling and walking infrastructure. Commitments to gather better data and to address concerns of key users such as women, children, and the elderly can also provide valuable benefits.

Synergies with sustainable development

Countries can also connect nonmotorized transit to resilience planning and the SDGs, mainly through land use and mobility planning. The impacts of extreme weather events, natural disasters, and other events caused by climate change can be avoided or reduced by enhancing the resilience of infrastructure, including considerations for climate change in planning transport systems, building capacity, and incorporating transport asset management lifecycles. Integrating resilience into transport planning is relatively new. For example, in the United States, the U.S. Department of Transportation as well as metropolitan and statewide transportation planning regulations require or suggest planning for natural disasters, climate, and weather extremes.

Addressing barriers to implementation

Enhanced NDCs in these areas can help overcome barriers in the following two key ways:

- By identifying finance needs for sustainable transport solutions, the NDC can help channel finance, particularly climate finance that may not be prioritizing transport, to support them.
- The NDC could commit to conducting capacity-building initiatives among local officials who need them.

Implementing large-scale measures to maintain and increase sustainable transport modes such as public transport, cycling, and walking can be a challenge. Governments need to wrench themselves free from assumptions, habits, and interests hardened by years of catering to private vehicles. This dependence on private vehicles has concentrated investments and planning that promote high-carbon modes of heavy vehicle travel. Government institutions, laws, regulations, and finance often perpetuate a legacy of directing investments and policies toward the use of private automobiles, as is evident by urban expressways, wide roads, a lack of investment in BRT or metro, and nonexistent or poor cycling and walking facilities. Countries will need policy innovations to override this tendency and will need to navigate an array of issues from establishing new finance programs to addressing the concerns of policymakers who may not be users of public transport, to establishing capacity and knowledge of sustainable transport planning as opposed to highway planning and engineering.

Implementing these actions is less about the resources available than the way existing resources are allocated. Shifting trips to sustainable transport means channeling investments toward more public transport, cycling, and walking. A report on NDCs that investigated opportunities for policy shifts ranging from fuel subsidies that foster carbon emissions to low-carbon transport notes that "by actively investing in public transportation infrastructure at the same time as reducing fossil-fuel subsidies and increasing conventional taxation on transport fuels, governments could reduce demand (energy saving) and encourage switching, and therefore could potentially influence and increase emission reductions from subsidy reform" (Merrill et al. 2015).

Reflecting the opportunities in the NDCs

Governments can reflect these opportunities in their NDCs by including the following:

- Modal shift targets (e.g., a certain percentage of trips within cities to be done by public transit, cycling, or walking)
- Kilometers of high-quality public transit (e.g. BRT, LRT, metro)
- Infrastructure for cycling and walking (e.g., kilometers of protected cycling infrastructure, bicycle share systems, standards for inclusion of pedestrian infrastructure)
- Elimination of fuel subsidies and reinvestment into sustainable mobility
- National policies requiring creation of sustainable urban mobility plans in cities
- Land use policies preferring transit-oriented development (rather than urban expressways) and compact development of towns and villages in rural areas
- Transport demand management programs that support local implementation of congestion or road pricing, a reduction in the supply of parking, and commute trip reduction programs
- National public transport policies and finance programs
- National cycling and walking (nonmotorized transport) policies and finance, as well as national road safety strategies embracing a "safe system" approach
- Linking with the health sector on plans to support nonmotorized transport to foster physical activity and road safety

Seize New Opportunities in Freight and Logistics

Freight (mostly road freight) was responsible for 41 percent of total transport CO_2 emissions in 2015. In non-OECD countries, this share is even higher; for example, 53 percent in India (SLoCaT 2018). Under business as usual, freight demand (in metric tons per kilometer) is expected to grow by 100 to 230 percent by 2050, raising emissions along with it. Road freight emissions alone are projected to grow significantly, nearly doubling from 2.5 $GtCO_2$ in 2014 to 4.6 $GtCO_2$ in 2050 under business as usual (ETC 2018).

Table 1 | **Road Freight Efficiency Strategies**

STRATEGY	ESTIMATED POTENTIAL ENERGY BENEFIT	ENABLING POLICIES AND HOW REFLECTED IN NDCS
High-capacity vehicles (larger trucks that improve efficiency)	20% or more, depending on rebound effect	Performance-based standards
Optimized routing	5–10% intracity, 1% long haul	Real-time routing data based on geographic information systems (GIS). Easing of delivery time constraints
Platooning (driving heavy-duty trucks [primarily tractor-trailers or rigid trucks] in a single line with small gaps between them to reduce drag to save fuel during highway operations)	5–15%, depending on assumptions	Vehicle communication and automation technologies
Improved vehicle utilization	Substantial but difficult to quantify	Better data collection (enabled by ICT) Collaboration and alliances among carriers and logistics companies
Backhauling (using return trips formerly run without cargo to transport goods, thereby reducing trips)	Substantial but difficult to quantify	Collaboration and alliances among carriers and logistics companies (through freight exchanges)
"Last-mile" efficiency measures	1–5%	Allocation and prediction of dynamic demand to prepare for demand peaks. Increased competition, including market entry of freight service providers
Re-timing urban deliveries	Difficult to estimate and generalize	Incentives to shipment receivers to accept the insurance and logistical impacts of shifting to early-morning and off-hour deliveries
Urban consolidation centers (grouping shipments from multiple shippers and consolidating them onto a single truck for delivery to a given geographic region)	Vehicle activity, fuel use, and CO_2 emissions within urban centers can be reduced by 20 to 50%	City regulatory policies to reduce congestion and promote air quality
Co-loading (using supply chain collaboration within a company or across firms to increase vehicle load on outbound operations)	5–10%	Legal and regulatory frameworks to promote energy savings while protecting companies' intellectual property rights
Physical internet (open, global logistics system enabling efficient delivery based on sophisticated real-time data)	Work to date suggests 20% systemwide efficiency improvement	Legal and regulatory frameworks; ICT to collect, process and protect proprietary data

Source: Adapted from IEA 2017.

Despite freight's significant share in transport emissions, it is mentioned in only about a third as many NDCs as is passenger transport (SLoCaT 2018). This gap in the current NDCs—combined with significant technological advances over the past several years—sets the stage for countries to strengthen their NDCs by addressing freight emissions. Although emissions from freight can be reduced via Avoid, Shift, and Improve strategies, the largest abatement potential lies in accelerating the transition to zero-carbon fuels (Energy Transitions Commission 2018).

Avoid and Shift strategies to promote freight efficiency

Improving logistics and operational efficiency—for example, by using information technology to optimize freight routes, improve load factors, and eliminate backhauls—has the potential to abate an estimated 0.8 gigatonnes of carbon dioxide equivalent ($GtCO_2e$) in 2050 (ETC 2018). For urban freight, "last-mile" solutions, such as consolidating delivery at the city, neighborhood, or building level, can not only cut emissions but also improve safety and air quality in densely populated urban areas. Shifting strategies—for example, toward nonmotorized modes like e-trikes—could be deployed for urban freight.

Shifting diesel road freight to less carbon-intensive rail and shipping is also possible in some countries, offering an estimated 0.6 $GtCO_2e$ in abatement potential in 2050 (ETC 2018). Policymakers have explored options such as disincentivizing road freight through heavy-duty vehicle road tolls, investing in infrastructure to reduce rail bottlenecks, and mandating longer trains on major rail corridors (Frey et al. 2014). The Energy Transitions Commission (2018) notes that "in some countries, such as India, where rail freight subsidizes passenger rail, there is a clear political incentive to shift more transport to rail because the increase in revenues could be used to improve passenger services."

Table 1 summarizes strategies to improve road freight efficiency, potential energy savings, and enabling policies and how they could be reflected in NDCs.

Accelerating freight electrification

By far the greatest opportunity to reduce freight emissions lies in switching road freight –especially heavy-duty trucks—to lower- or zero-carbon fuels. The Energy Transitions Commission (2018) reviewed decarbonization pathways for heavy-duty transit—including liquefied natural gas (LNG) and biofuels as transition fuels, hydrogen fuel-cell vehicles, and battery-electric vehicles (with and without catenary wiring)—and concluded that electric drivetrains were most likely to dominate in the long term due to cost advantages. They see a very limited role for LNG and biofuels and some potential for hydrogen fuel-cell vehicles for long-haul freight, and catenary wiring on major freight routes, depending on developments in battery density and charging speed.

The feasibility of electrifying road freight represents a marked shift from even a few years ago, when heavy-duty trucking was seen as difficult to decarbonize and electrification was not viewed as an option. Declining battery costs have made commercial electric trucks increasingly available, while falling renewable energy costs help ensure that electrification results in decarbonization.

As discussed in the electrification section on page 18 ("Accelerate Electrification while Continuing to Strengthen Fuel Efficiency"), cheaper batteries are a major driver underpinning new, advanced transportation opportunities in heavy-duty transit. Battery costs are a key determinant of the feasibility of heavy-duty truck electrification because the battery pack accounts for the upfront cost increase of electric trucks over diesel (Sripad and Viswanathan 2019).

Manufacturers are coming out with a variety of new models of electric heavy-duty trucks. At least 13 major original equipment manufacturers, such as Daimler Chrysler, Cummins, Kenworth, and Mercedes Benz, are developing electric models. At least 17 models of heavy-duty trucks have been introduced since 2017, including long haul (4 models), regional-haul (6), refuse trucks (1), yard trucks (2), and urban delivery models (Global Automotive & Transportation Research Team at Frost & Sullivan 2017). In September 2019, Amazon announced it would order 100,000 electric delivery trucks from Rivian as part of an effort to go carbon-neutral by 2040 (Etherington 2019). The continued investment in electric vehicles on the part of major manufacturers is important to advance electric trucking.

The potential benefits of heavy-duty truck electrification are substantial. Road freight accounted for 7.3 percent of global greenhouse gas emissions in 2015 (OECD/IEA 2017; Global Carbon Atlas n.d.). Electrifying trucking—in tandem with decarbonizing the power sector—has the potential to eliminate those emissions. In addition, new analyses suggest that electric trucks can be owned and operated at a lower cost than diesel trucks. Assuming

electricity rates that reflect the actual power system costs of serving off-peak trucking loads, it is estimated that net savings (including amortized charging infrastructure cost) of electrifying a single truck in California or Texas may be up to $148,000 over the truck's lifetime, which is only 44 percent of its lifetime diesel fuel cost (Phadke et al. 2019). The California Air Resources Board preliminarily estimated that the total cost of owning an electric truck (a regional day tractor with a 510 kWh battery), including EV infrastructure, will be lower than that of a diesel truck by 2024 (and will remain lower than that of a hydrogen truck for the lifetime of the study). They estimate that the upfront vehicle cost will remain one-third higher for electric than for diesel trucks through 2030, with lifetime savings coming from fuel and maintenance costs (California Air Resources Board 2019). Supportive electricity pricing policies will be key for realizing fuel cost savings from electrification.

Synergies with sustainable development

Freight electrification and efficiency offer synergies with other sustainable development goals. Reducing urban air pollution, which is addressed by SDG 11, is a major cobenefit of truck electrification. Heavy-duty trucking is substantially and disproportionately responsible for nitrogen oxide (NO_x) emissions in particular. NO_x gases are central to the development of ground-level ozone and small particulate matter (PM2.5) (ICCT 2017). Road transport as a whole was responsible for 40 percent of NO_x emissions in the European Union in 2011, more than any other sector (Icopal n.d.); heavy-duty trucks contribute 55 percent of NO_x emissions in India's transport sector (Guttikunda and Mohan 2014) and are expected to contribute a third of NO_x from the U.S. transport sector (US EPA 2018). Ports are already using electrification to improve air quality (Port of Los Angeles n.d.). For example, the ports of Los Angeles and Long Beach are conducting a demonstration project that will deploy over 23 battery-electric Class 8 trucks by 2020 to travel between the ports and local and regional distribution centers, and provide the direct current (DC) fast-charging and regular charging infrastructure needed to support them (Descant n.d.).

Addressing barriers to implementation

NDCs can help address barriers to freight efficiency and electrification. On the efficiency side, legal frameworks restricting anticompetitive behavior pose barriers to backhauling, improved vehicle utilization, and the physical internet (digital transportation networks). Growing demand for just-in-time delivery affects optimized routing, "last-mile" efficiency measures, re-timing of urban deliveries, and co-loading (IEA 2017). As companies and governments experiment with the enabling policies outlined in Table 1, solutions are developing.

Regarding electrification, one major area that merits attention is integration of charging stations with the electricity grid, in terms of both generation and transmission and distribution capacity. If trucks can charge off-peak, the added electricity generation capacity required to power them may be minimal, as electricity grids are built to support system peak and thus have slack capacity during most hours of the year. New analysis demonstrates this in Texas and California (Phadke et al. 2019). In the high renewable energy penetration scenarios of the future, opportunities may exist for trucks to charge when there is excess renewable energy production. Accordingly, designing electricity tariffs to encourage off-peak charging is important to minimize overall cost to the electricity system: designing demand charges to be peak-coincident and structuring energy charges to reflect real-time prices will incentivize trucking loads to respond to real-time grid constraints. NDCs could commit to measures to help integrate charging with the grid.

Transmission and distribution (T&D) grid integration concerns are another important implementation issue. Large-truck charging stations may be connected at the transmission level rather than the distribution level. The impact of charging stations can be minimized by strategically siting them where excess T&D capacity exists; however, potential grid upgrade costs to accommodate charging loads merit further study. Charger siting and station rollout to support increasing numbers of electric trucks are related issues to address. Infrastructure siting challenges will differ for local, regional, and long-haul trucking.

Highlighting these implementation issues in the NDC and committing to measures to address them can help channel attention and resources to ensure that they are overcome.

Reflecting the opportunities in the NDCs

Governments can promote these measures via enhanced NDCs by committing in their NDCs to do the following:

- Adopt performance standards for high-capacity vehicles
- Invest in information technology and incentivize the adoption of such technology for efficiency-saving purposes

- Create incentives for companies engaging in efficiency-saving practices such as backhauling and re-timing urban delivery
- Create incentives for cities that adopt policies to reduce congestion
- Develop green freight zones/corridors
- Reform legal and regulatory frameworks that currently act as barriers to co-loading and the physical internet
- Adopt vehicle electrification targets (passenger and freight, light-duty and heavy-duty vehicles)
- Adopt phase-out targets for internal combustion engines
- Adopt charging infrastructure targets and policies (e.g., providing funding for charging infrastructure in different geographic areas and locations to support EV deployment targets, with requirements for the type of charging equipment and minimum technical specifications)
- Revise electricity policy to reward off-peak charging (e.g., implementing a tariff structure that reflects wholesale prices, like having lower electricity prices midday and overnight and higher prices in the evening)

5. STEPS FOR DEVELOPING TRANSPORT NDC ENHANCEMENTS

Sections 1–4 have reviewed the transitions necessary in the global transport sector to achieve climate and sustainable development objectives, the treatment of the sector in the current NDCs, and key opportunities to enhance transport action. Users of this guidance are now ready to undertake a step-by-step approach to identify ways to enhance their own countries' NDCs via the transport sector, as shown in Figure 18. Users should also consult the overarching guidance in *Enhancing NDCs* on considering adaptation-related NDC enhancement and on communicating NDCs in a clear and transparent manner consistent with the Paris Agreement.

Establish a Clear and Inclusive Process

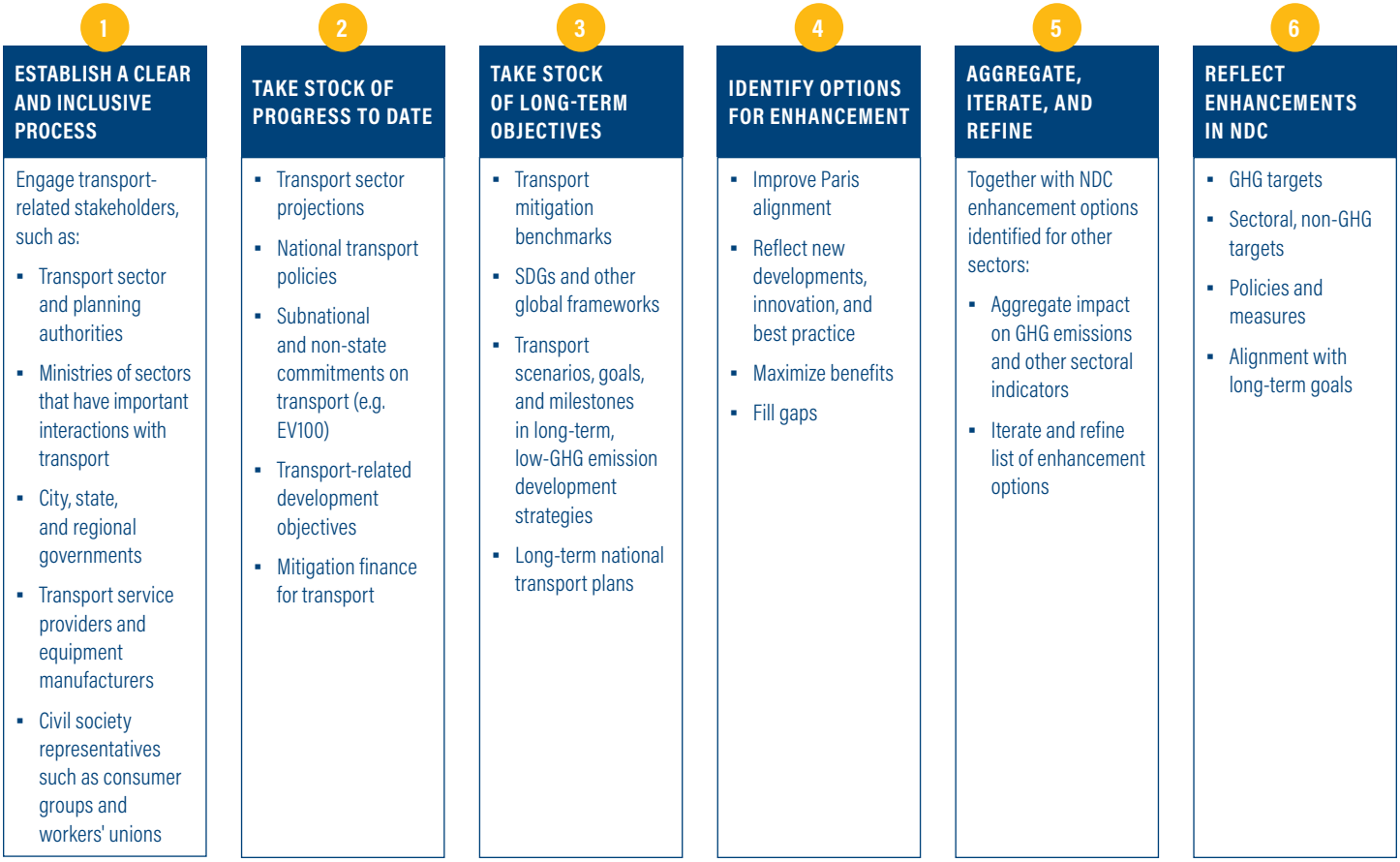
As outlined in *Enhancing NDCs*, the critical first step is to establish a clear and inclusive process for NDC enhancement. This exercise is, of course, broader than the transport sector, but in the context of this guidance, it is important to ensure institutional arrangements and stakeholder processes that engage perspectives critical to the transport sector. For example, countries should consider ways to integrate climate and transport sector planning processes. To better align NDCs with national transport plans, the consultation process should involve stakeholders such as transport sector planning authorities, energy planning authorities, and finance authorities, as well as authorities representing other sectors with which transport interacts in critical ways, such as land use, forests, and agriculture. Likewise, the NDC consultation process will benefit from involving nonstate and subnational actors. Transport service providers, equipment manufacturers, and subnational governments like cities are usually responsible for implementing many transport policies and actions. Civil society representatives such as consumer groups, resident welfare associations, and workers' unions, also have a direct interest in transport services, and their support is critical to the success of a shared strategic vision for the transport sector.

The NDC stakeholder process should build in opportunities for feedback and learning from affected stakeholders and those responsible for implementing transport policies on the ground. Such a setup helps to monitor progress, make corrections as needed, and raise ambition when opportunities arise. Finally, while noting that NDC development is an exercise of sovereign rights, donors and international communities can support countries with financial and technical assistance across all steps, including capacity building, to help countries collect data, develop scenarios, and generate policy ideas in time to inform the NDC process (GIZ 2017).

Take Stock of Progress to Date

In taking stock of progress to date, countries may wish to consider transport-related projections (for example, of demand, energy, fuel source, and emissions), as well as existing transport policies and their implementation status. Likewise, subnational and nonstate actors' commitments and policies on transport—whether individual or as part of transnational initiatives such as EV100 (a global initiative led by The Climate Group to bring together companies to accelerate the transition to electric vehicles)—will be important factors. Countries may also wish to take stock of progress on their transport-related development objectives, as well as the availability and flow of finance for transport.

Figure 18 | **Six Steps to Applying the Transport NDC Enhancement Guidance**



Source: Authors

Take Stock of Long-Term Objectives

Section 2 reviewed key long-term considerations for the transport sector, including the transitions needed to achieve the goals of the Paris Agreement and the relationship between transport and the SDGs. At the national level, this is also the appropriate stage for countries to review the treatment of transport in their long-term strategies and national long-term development plans, if applicable.

Identify Options for Enhancement

In this step, users will apply the set of diagnostic questions outlined in *Enhancing NDCs* to the transport sector. The questions are as follows:

Improving Paris alignment

- Does the treatment of the transport sector in the existing NDC align with the transitions needed in the transport sector to achieve the Paris Agreement temperature goals?

Reflecting new developments, innovation, and best practices

- Does the initial NDC reflect up-to-date assumptions regarding available transport-related technologies and their costs? (Technologies and costs related to electrification and charging infrastructure, as outlined in Section 4, may be particularly relevant.)

- Does the initial NDC reflect the relevant plans, policies, and measures that are being implemented and considered at the national level (as identified in the stock-taking exercise above) or that ought to be considered based on available best practices, such as those outlined in Section 4?
- Does the initial NDC reflect the relevant plans, policies, and measures that are being implemented and considered by nonstate and subnational actors (as identified in the stock-taking exercise above)?

Maximizing the benefits

- Does the initial NDC maximize synergies and reduce potential conflicts between the transport sector and development objectives, including climate resilience?

Filling the gaps

- Does the NDC address all the relevant transport modes and subsectors?

Box 3 | Ideas for Reflecting Transport Enhancements in an NDC

GHG targets

- Strengthen an existing economywide target to take into account abatement opportunities in transport
- Create a new economywide target that considers ambitious transport abatement options
- Strengthen or create an ambitious, transport-specific GHG target (e.g., reduce GHG emissions from the transport sector by X% by 2030)

Non-GHG targets for transport

- Modal shift targets (e.g., a certain percentage of trips within cities to be done by public transit, cycling, or walking)
- Targets for kilometers of high-quality public transit (e.g., bus rapid transit, light rail transit, or metro)
- Targets for cycling and walking infrastructure (e.g., kilometers of protected cycling infrastructure, bicycle share systems, standards for inclusion of pedestrian infrastructure)
- Vehicle electrification targets (passenger and freight, light-duty and heavy-duty vehicles)
- Phase-out targets for internal combustion engines
- Charging infrastructure targets

Policies and measures

- Charging infrastructure policies (e.g., providing funding for charging infrastructure in different geographic areas and locations to support electric vehicle deployment targets, with requirements for the type of charging equipment and minimum technical specifications)
- Electricity policy that rewards off-peak charging (e.g., implementing a tariff structure that reflects wholesale prices, like having lower electricity prices in the midday and overnight and higher prices in the evening)
- Elimination of fuel subsidies and reinvestment in sustainable mobility
- National policies requiring creation of sustainable urban mobility plans in cities
- Land use policies preferring compact development of towns and villages in rural areas and transit-oriented development rather than urban expressways
- Transport demand management programs that support local implementation of congestion/road pricing, reduced supply of parking, and commuter programs
- National public transport policies and finance programs
- National cycling and walking (nonmotorized transport) policies and finance, as well as national road safety strategies embracing "safe system" approach
- Linking with health sector on plans to support nonmotorized transport as measures to foster physical activity and road safety
- Performance standards for high-capacity vehicles
- Investment in information technology and incentivizing the adoption of such technology for efficiency-saving purposes
- Policies that incentivize companies to engage in energy-saving practices such as backhauling and re-timing urban delivery
- Policies that incentivize cities to adopt policies to reduce congestion
- Policies for green freight zones and corridors
- Reform of legal and regulatory frameworks to support co-loading and the physical internet

Alignment with long-term decarbonization

- Complement near-term solutions (internal combustion engine efficiency improvements, compressed natural gas, biofuels) with long-term measures promoting electrification alongside Avoid and Shift policies

Addressing finance and implementation issues

- Could the NDC better reflect finance needs for implementing transport-related finance action? Could it better align finance flows with climate goals in the transport sector; for example, by addressing fuel subsidies?
- Does the NDC address important cross-sectoral interactions; for example, the link between the transport and power sector outlined in Section 4?
- Could the NDC otherwise facilitate strengthened implementation; for example, by including commitments to address implementation barriers outlined in Section 4?

Working through this list of questions will help users to create a list of enhancement options for the transport sector.

Aggregate, Iterate, and Refine

Along with enhancement options for other sectors, and for the economy as a whole, the transport enhancement options can be analyzed and prioritized on the basis of selected criteria, such as GHG reduction potential, feasibility, benefits, and costs. This step should be undertaken as part of the broader NDC enhancement process, as outlined in *Enhancing NDCs*, rather than at the sector level.

Reflect Enhancements in the NDC

Once countries have identified a set of options that are applicable to their circumstances, they can consider various approaches to reflecting these options in an enhanced NDC. These include incorporating additional transport sector action into an economywide GHG target, setting one or more specific targets for the transport sector, committing to specific policies and actions, and committing to implement the NDC in alignment with long-term decarbonization. See Box 3 for examples of each category.

These options are not mutually exclusive; countries can employ any number of them. Transport sector GHG mitigation information can be integrated into the economywide targets or presented as separate sector targets or policies. If the transport sector is not covered in the economywide target, or the country chooses not to present an economywide target, a country can set sector-specific GHG mitigation targets and policies to make use of transport's mitigation potential to raise mitigation ambi-

Box 4 | Tools and Resources for Addressing Transport in NDCs

Below are some key resources, including sectoral outlooks across regions, and policy guidance that may further inform policymakers wishing to enhance the role of transport in their NDCs.

Transport and Climate Change 2018: Global Status Report: The Partnership on Sustainable, Low Carbon Transport (SLoCaT) is leading the production of regular Transport and Climate Change Global Status Reports (TCC-GSR) to bring together information streams on transport and climate change and to offer policymakers and practitioners three key elements (SLoCaT 2018):

- A big-picture analysis of transport activities at global, regional, and national levels;
- Monitoring of transport contributions to global agendas through a central data repository on transport and climate change
- Highlighted linkages between transport and climate action and development cobenefits, such as energy efficiency, air quality, and road safety

Transport in Nationally Determined Contributions (NDCs): *Lessons Learnt from Case Studies of Rapidly Motorising Countries*. The Advancing Transport Climate Strategies (TraCS) project, implemented by the Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) and funded through the International Climate Initiative of the German Ministry for the Environment, Nature Conservation, Building and Nuclear Safety (BMUB), enables policymakers in partner countries to specify the contribution of the transport sector to their NDCs.

Transport CO_2 and the Paris Climate Agreement: Reviewing the Impact of Nationally Determined Contributions. This report introduces NDCs and provides an overview of economywide CO_2 reduction targets. It assesses the impact of transport commitments provided in NDCs on national transport CO_2 emissions. Countries are clustered into four groups based on transport-related information provided in their NDCs, with estimates on the impact of transport CO_2 mitigation actions and ambitions.

NDC Partnership's Knowledge Portal: This portal helps countries accelerate climate action by providing quick and easy access to data, tools, guidance, good practice, and funding opportunities. The Knowledge Portal draws together the most relevant resources from partners and other leading institutions on both reducing emissions and adapting to the impacts of climate change.

tion. Conversely, if a country has accounted for transport emissions in the economywide target, it can still consider setting sector-specific targets or policies to bolster action and drive abatement in the sector, or presenting an indicative sectoral breakdown of the economywide target to enhance clarity and specificity of the NDC.

The overarching NDC enhancement guidance contains a discussion of advantages and disadvantages of each of these categories. It is important to note that the Paris Agreement states that emissions reduction can be counted toward only one country's NDC, meaning the transfer of mitigation outcomes between countries must result in a corresponding adjustment to the mitigation accounting of both countries to ensure the emissions reduction is not double-counted.

Some tools and resources useful to countries integrating transportation into their NDCs can be found in Box 4.

6. CONCLUSIONS

Because transport is a major contributor to GHG emissions, a robust approach to addressing it in NDCs is vital if we want to reach targets identified in the Paris Agreement, let alone push beyond them. Transport is also key to people's daily lives—how they travel affects their access to jobs and services, their health and safety, and the costs borne by households, communities, and whole economies.

This guidance has shown key opportunities to enhance NDCs through a more robust approach using an Avoid-Shift-Improve framework. NDCs can include measurable targets in this next round, particularly by ramping up actions to reduce demand for carbon-intensive travel and to promote public transport, cycling, and walking. NDCs can harness new technologies to accelerate electrification, move freight more sustainably, and take other cost-effective and potent measures that have so far been missing. Even countries with limited abilities to identify targets can still make NDC enhancements in transport based on the guidance provided here.

Although these opportunities are all within reach, they will require serious policy commitments. They will need to overcome a legacy of dependence on and planning around carbon-intensive travel. Countries must dramatically shift policies away from private motor vehicles with internal combustion engines and unsound, unsustainable land use planning. They will need to include freight in the sweeping and wide-ranging changes needed to promote low-carbon transport. NDC policymakers will need to align goals and forge partnerships with ministries responsible for transport, development, health, and urban development. They must build both the capacity and knowledge needed to transform the transport sector to meet the goals of the Paris Agreement.

REFERENCES

AfDB (African Development Bank), Asian Development Bank (AsDB), CAF—Development Bank of Latin America (CAF), European Bank for Reconstruction and Development (EBRD), European Investment Bank (EIB), Inter-American Development Bank (IADB), Islamic Development Bank (IsDB), and World Bank (WB). 2017. "Progress Report (2015–2016) of the MDB Working Group on Sustainable Transport," January. https://www.adb.org/sites/default/files/institutional-document/211966/mdb-progress-report-2015-2016.pdf.

Anenberg, Susan, Joshua Miller, Daven Henze, and Ray Minjares. 2019. "A Global Snapshot of the Air Pollution-Related Health Impacts of Transportation Sector Emissions in 2010 and 2015." International Council on Clean Transportation (ICCT), Climate and Clean Air Coalition (CCAC). https://www.ccacoalition.org/en/resources/global-snapshot-air-pollution-related-health-impacts-transportation-sector-emissions-2010.

Arze del Granado, Francisco Javier, David Coady, and Robert Gillingham. 2012. "The Unequal Benefits of Fuel Subsidies: A Review of Evidence for Developing Countries." *World Development* 40 (11): 2234–48. https://doi.org/10/gf737c.

Bloomberg New Energy Finance. 2018. "BNEF Brief: Lithium Battery Prices Fall 18 Percent." https://www.bloomberg.com/news/videos/2018-12-21/bnef-brief-lithium-battery-prices-fall-18-percent-video.

Bond, T.C., S.J Doherty, D.W. Fahey, P.M. Forster, T. Bernsten, B.J. DeAngelo, M.G. Flanner, et al. 2013. "Bounding the Role of Black Carbon in the Climate System: A Scientific Assessment." *Journal of Geophysical Research* 18 (11): 5380–5552.

California Air Resources Board. 2019. "Advanced Clean Trucks Total Cost of Ownership Discussion Document." February. https://ww2.arb.ca.gov/sites/default/files/2019-02/190225actpres.pdf.

Climate Watch. 2019. Washington, D.C.: World Resources Institute. Available online at: www.climatewatchdata.org.

Coady, David, Ian Parry, Nghia-Piotr Le, and Baoping Shang. 2019. "Global Fossil Fuel Subsidies Remain Large: An Update Based on Country-Level Estimates." IMF Working Paper. Washington DC: International Monetary Fund. https://www.imf.org/en/Publications/WP/Issues/2019/05/02/Global-Fossil-Fuel-Subsidies-Remain-Large-An-Update-Based-on-Country-Level-Estimates-46509.

Cooper, Mark. 2017. "Pocketbook Savings, Macroeconomic Growth and Other Public Benefits of Fuel Economy Standards: Benefit-Cost Analysis of Four Decades of Rules Shows They Have Delivered Trillions of Dollars of Economic Value to Consumer and the Nation." Washington DC: Consumer Federation of America. https://consumerfed.org/wp-content/uploads/2017/07/benefits-of-fuel-economy-standards.pdf.

Córdova, Alfonso, and Benoit Lefevre. 2016. "Peru's National Climate Law: A Critical Step towards Reducing Global Emissions." LEDS Global Partnership. http://ledsgp.org/wp-content/uploads/2015/10/CDKN_LEDS_PB_INFOCARBONO_REV_APR16_WEB.pdf.

Dalkmann, H., and C. Brannigan. 2007. "Transport and Climate Change. Module 5e: Sustainable Transport: A Sourcebook for Policy-Makers in Developing Cities." Eschborn: Deutsche Gesellschaft Fuer Technische Zusammenarbeit (GTZ).

Descant, Skip. n.d. "Los Angeles Area to Host Government-Funded Electric Semi Demo." https://www.govtech.com/fs/Los-Angeles-Area-to-Host-Government-Funded-Electric-Semi-Demo.html. Accessed August 9, 2019.

EAC (Electricity Advisory Committee). 2018. "Enhancing Grid Resilience with Integrated Storage from Electric Vehicles: Recommendations for the U.S. Department of Energy." https://www.energy.gov/sites/prod/files/2018/06/f53/EAC_Enhancing%20Grid%20Resilience%20with%20Integrated%20Storage%20from%20EVs%20%28June%202018%29.pdf.

ETC (Energy Transitions Commission). 2018. "Mission Possible: Reaching Net Zero Carbon Emissions from Harder-to-Abate Sectors by Mid-Century." Report Summary. http://www.energy-transitions.org/sites/default/files/ETC_MissionPossible_ReportSummary_English.pdf.

Etherington, Darrell. 2019. "Amazon Orders 100K Electric Delivery Trucks from Rivian as Part of Going Carbon-Neutral by 2040." *TechCrunch*. Blog. September 19. http://social.techcrunch.com/2019/09/19/amazon-orders-100k-electric-delivery-trucks-from-rivian-as-part-of-going-carbon-neutral-by-2040/.

Ewing, Reid, Keith Bartholomew, Steve Winkelman, Jerry Walters, and Don Chen. 2008. *Growing Cooler: The Evidence on Urban Development and Climate Change*. Washington, DC: Urban Land Institute.

Fransen, Taryn, Eliza Northrop, Kathleen Mogelgaard, and Kelly Levin. 2017. "Enhancing NDCs by 2020: Achieving the Goals of the Paris Agreement." Washington, DC: WRI, November. https://doi.org/10.1163/9789004322714_cclc_2017-0020-024.

Fransen, Taryn, Ichiro Sato, Kelly Levin, David Waskow, David Rich, Sadya Ndoko, and Julie Teng. "Enhancing NDCs: A Guide to Strengthening National Climate Plans by 2020." 2019. Washington, DC and New York: WRI, United Nations Development Programme (UNDP), September. https://wriorg.s3.amazonaws.com/s3fs-public/enhancing-ndcs_0.pdf.

Fulton, L., and G. Eads. 2004. "IEA/SMP Model Documentation and Reference Case Projection." IEA, CRA, July. http://www.libralato.co.uk/docs/SMP%20model%20guidance%202004.pdf.

GIZ (Deutsche Gesellschaft Fuer Internationale Zusammenarbeit). Nipunika Perera, Nikolas Hill, Daniel Bongardt, and Urda Eichhorst. 2017. "Transport in Nationally Determined Contributions (NDCs): Lessons Learnt from Case Studies of Rapidly Motorising Countries." Synthesis Report. Bonn: GIZ.

Global Automotive & Transportation Research Team at Frost & Sullivan. 2017. "Executive Analysis of Electric Truck Market, Forecast to 2025." Frost & Sullivan, December.

Global Carbon Atlas. 2018. "CO_2 Emissions." Global Carbon Atlas Project. http://www.globalcarbonatlas.org/en/CO2-emissions.

Global Carbon Atlas. n.d. "Global Carbon Atlas." http://www.globalcarbonatlas.org/en/content/welcome-carbon-atlas. Accessed November 8, 2019.

Gota, Sudhir, Cornie Huizenga, and Karl Peet. 2016. "Implications of 2DS and 1.5DS for Land Transport Carbon Emissions in 2050." Partnership on Sustainable Low-Carbon Transport (SLoCaT).

Gota, Sudhir, Cornie Huizenga, Karl Peet, Nikola Medimorec, and Stefan Bakker. 2018. "Decarbonising Transport to Achieve Paris Agreement Targets." *Energy Efficiency*, May 8. https://doi.org/10/gfpm72.

Guttikunda, Sarath, and Dinesh Mohan. 2014 Re-fueling Road Transport for Better Air Quality in India. *Energy Policy*, May: 556–61. http://www.urbanemissions.info/wp-content/uploads/docs/2014-05-EP-Re-fueling-Transport-for-BAQ-India.pdf

Health Effects Institute. 2010. *Traffic Related Air Pollution: A Critical Review of the Literature on Emissions, Exposure, and Health Effects*. Boston: Health Effects Institute.

Hidalgo, Dario, and Nicolae Dudata. 2014. "Exploring the Connection between Climate Change and Traffic Safety: An Initial Aggregate Assessment." Paper presented at the 93rd Annual Meeting of the Transportation Research Board, Washington, DC.

Huizenga, Cornie, and Karl Peet. 2017. "Expert Perspective for the NDC Partnership: Transport and Climate Change: How Nationally Determined Contributions Can Accelerate Transport Decarbonization." NDCP, SLoCaT. http://www.ndcpartnership.org/sites/default/files/NDCP_Expert_Perspectives_SLoCaT_Transport_v4.pdf.

Icopal. n.d. "Nitrogen Oxide (NO_x) Pollution–Health Issues." Blog. http://www.icopal-noxite.co.uk/nox-problem/nox-pollution.aspx. Accessed September 13, 2019.

IPCC (Intergovernmental Panel on Climate Change). 2014. *Fifth Assessment Report*. Geneva: IPPC.

IPCC. 2018. *Global Warming of 1.5°C. An IPCC Special Report on the Impacts of Global Warming of 1.5°C above Pre-industrial Levels and Related Global Greenhouse Gas Emission Pathways, in the Context of Strengthening the Global Response to the Threat of Climate Change, Sustainable Development, and Efforts to Eradicate Poverty*. Edited by V. Masson-Delmotte, P. Zhai, H.O.D. Pörtner, J. Roberts, P.R. Skea, A. Shukla, W. Pirani, C. Moufouma-Okia, Péan, R. Pidcock, S. Connors, J.B.R. Matthews, Y. Chen, X. Zhou, M.I. Gomis, E. Lonnoy, T. Maycock, M. Tignor, and T. Waterfield.

ICCT (International Council on Clean Transportation). 2017. "Vehicle NO_x Emissions: The Basics." ICCT, October 10. https://theicct.org/cards/stack/vehicle-nox-emissions-basics.

IEA (International Energy Agency). n.d. "CO_2 Emissions Statistics: An Essential Tool for Analysts and Policy Makers." IEA. https://www.iea.org/statistics/co2emissions/.

IEA. 2016. "Energy Technology Perspectives 2016. Towards Sustainable Urban Energy Systems." https://www.iea.org/etp/etp2016/. Accessed November 24, 2019.

IEA. 2017. "Energy Technology Perspectives (ETP) 2017." https://webstore.iea.org/energy-technology-perspectives-2017.

IEA. 2018. "Global EV Outlook 2018: Towards Cross-Modal Electrification." Organisation for Economic Co-operation and Development (OECD)/IEA.

IEA. 2019. "Global EV Outlook 2019." IEA. https://www.iea.org/publications/reports/globalevoutlook2019/.

IRENA (International Renewable Energy Agency). 2019a. "Renewable Power Generation Costs in 2018." Abu Dhabi. IRENA.org/publications/2019/May/Renewable-power-generation-costs-in-2018.

IRENA. 2019b. "Innovation Outlook: Smart Charging for Electric Vehicles." Abu Dhabi: IRENA.

ITF (International Transport Forum). 2017. *ITF Transport Outlook 2017*. Paris: OECD Publishing. https://www.oecd-ilibrary.org/content/publication/9789282108000-en.

ITF. 2018. *Transport CO_2 and the Paris Climate Agreemen*t. Paris: OECD/ITF. https://www.oecd-ilibrary.org/content/paper/23513b77-en.

Jennings, Gail. 2016. "Global Outlook on Walking and Cycling 2016." Nairobi: UN Environment. https://www.fiafoundation.org/media/404898/globaloutlookonwalkingandcycling.pdf.

Kooshian, Chuck, and Steve Winkelman. 2018. "White Paper: A Matrix of Potential Policy Tools for Transit Oriented Development in Colombia." Washington, DC: Center for Clean Air Policy. http://ccap.org/assets/CCAP-TOD-Policy-Tools-Matrix-for-Colombia-Sept-2018-CR.pdf.

Kuramochi, Takeshi, Niklas Höhne, Michiel Schaeffer, Jasmin Cantzler, Bill Hare, Yvonne Deng, Sebastian Sterl, et al. 2018. "Ten Key Short-Term Sectoral Benchmarks to Limit Warming to 1.5°C." *Climate Policy* 18 (3): 287–305. https://doi.org/10/ggcptj.

Lee, I. Min, Eric J. Shiroma, Felipe Lobelo, Pekka Puska, Steven N. Blair, and Peter T. Katzmarzyk. 2012. "Effect of Physical Inactivity on Major Non-communicable Diseases Worldwide: An Analysis of Burden of Disease and Life Expectancy." *The Lancet* 380 (9838): 219–29. https://doi.org/10/f2fthh.

Lefevre, B., K. Eisenbeiss, N. Yadav, and A. Enriquez. 2016. "Make Roads Safe by Reducing Greenhouse Gas Emissions from Urban Transport." Low Emission Development Strategies Global Partnership. http://ledsgp.org/wp-content/uploads/2016/05/LEDS-GP_Safer-Roads_final_web_May15.pdf.

Levin, Kelly, Jared Finnegan, David Rich, Pankaj Bhatia, and Samuel Tumiwa. 2014. "Greenhouse Gas Protocol: Mitigation Goal Standard." Washington, DC: World Resources Institute.

Maizlish, Neil, Nicholas J. Linesch, and James Woodcock. 2017. "Health and Greenhouse Gas Mitigation Benefits of Ambitious Expansion of Cycling, Walking, and Transit in California." *Journal of Transport & Health* 6 (September): 490–500. https://doi.org/10/gcgs93.

Mason, Jacob, Lew Fulton, and Zane McDonald. 2015. "A Global High Shift Cycling Scenario: The Potential for Dramatically Increasing Bicycle and e-Bike Use in Cities around the World, with Estimated Energy, CO_2, and Cost Impacts." Institute for Transportation & Development Policy and University of California Davis. https://itdpdotorg.wpengine.com/wp-content/uploads/2015/11/A-Global-High-Shift-Cycling-Scenario_Nov-2015.pdf.

Merrill, Laura, Richard Bridle, Markus Klimscheffskij, Paula Tommila, Lucky Lontoh, Shruti Sharma, Yanick Touchette, et al. 2017. "Making the Switch: From Fossil Fuel Subsidies to Sustainable Energy." Denmark: Nordic Council of Ministers.

Merrill, Laura, Melissa Harris, Liesbeth Cassier, and Andrea Bassi. 2015. "Fossil-Fuel Subsidies and Climate Change Options for Policy-Makers within their Intended Nationally Determined Contributions." *Nordiske Arbejdspapirer* 2015: 905. Nordic Council of Ministers Secretariat. http://norden.diva-portal.org/smash/record.jsf?pid=diva2%3A786861&dswid=5929.

Newman, Peter W.G., and Jeffrey R. Kenworthy. 1989. "Gasoline Consumption and Cities." *Journal of the American Planning Association* 55 (1): 24–37. https://doi.org/10/dpkdss.

Ng, S.W., and B.M. Popkin. 2012. "Time Use and Physical Activity: A Shift Away from Movement across the Globe." *Obesity Reviews: An Official Journal of the International Association for the Study of Obesity* 13 (8): 659–80. https://doi.org/10/f34r26.

OECD/IEA (Organisation for Economic Co-operation and Development/International Energy Agency). 2017. "The Future of Trucks—Implications for Energy and the Environment." France: OECD/ IEA. https://www.iea.org/publications/freepublications/publication/TheFutureofTrucksImplicationsforEnergyandtheEnvironment.pdf.

Phadke, Amol, Margaret McCall, and Deepak Rajagopal. 2019. "Reforming Electricity Rates to Enable Economically Competitive Electric Trucking." Lawrence Berkeley National Laboratory.

Port of Los Angeles. n.d. "Zero Emissions Technologies." https://www.portoflosangeles.org/environment/air-quality/zero-emissions-technologies. Accessed August 9, 2019.

Ramanathan, V., and G. Carmichael. 2008. "Global and Regional Climate Change Due to Black Carbon." *Nature Geoscience*: 221–27. https://doi.org/10.1038/ngeo156.

Repogle, Michael, and Lew Fulton. 2014. "A Global High Shift Scenario: Impacts and Potential for More Public Transport, Walking, and Cycling with Lower Car Use." Institute for Transportation & Development Policy and University of California Davis. https://itdpdotorg.wpengine.com/wp-content/uploads/2014/09/A-Global-High-Shift-Scenario_WEB.pdf.

Rich, David, Pankaj Bhatia, Jared Finnegan, Kelly Levin, Apurba Mitra, and Samuel Tumiwa. 2014. "Greenhouse Gas Protocol: Policy and Action Standard." Washington, DC: WRI.

Rodrigue, Jean-Paul, Claude Comtois, and Brian Slack. 2017. *The Geography of Transport Systems*. 4th ed. London and New York: Routledge.

Schipper, L., and C. Marie-Lilliu. 1999. "Transport and CO_2 Emissions: Flexing the Link – a Path for the World Bank." France: IEA. http://www-wds.worldbank.org/servlet/WDSContentServer/WDSP/IB/2000/02/09/000094946_00012505400755/Rendered/PDF/multi_page.pdf.

SLoCaT (Partnership for Sustainable Low Carbon Transport). 2018. "Transport and Climate Change 2018: Global Status Report." http://slocat.net/tcc-gsr.

SLoCaT. 2019. "Sustainable Transport: Critical Driver to Achieve the SDGs." http://slocat.net/sites/default/files/u13/vnr_2019_infographic.pdf.

Sperling, Daniel. 2018. *Three Revolutions: Steering Automated, Shared, and Electric Vehicles to a Better Future*. Washington DC: Island Press.

Sripad, Shashank, and Venkatasubramanian Viswanathan. 2019. "Quantifying the Economic Case for Electric Semi-Trucks." *American Chemical Society (ACS) Energy Letters* 4 (1): 149–55. https://doi.org/10/ggcptm.

Tu, Qiang, Regina Betz, Jianlei Mo, Ying Fan, and Yu Liu. 2019. "Achieving Grid Parity of Wind Power in China—Present Levelized Cost of Electricity and Future Evolution." *Applied Energy* 250 (September 15): 1053–64. https://doi.org/10.1016/j.apenergy.2019.05.039.

UN Environment. 2016. *Global Outlook on Walking and Cycling 2016*. Nairobi: UN Environment.

UNFCCC (UN Framework Convention on Climate Change). 2018. "COP Decision 1/CP.24," https://unfccc.int/event/cop-24.

US EPA (U.S. Environmental Protection Agency). 2018. "Cleaner Trucks Initiative." Policies and Guidance. November 7. https://www.epa.gov/regulations-emissions-vehicles-and-engines/cleaner-trucks-initiative.

Venter, C., A. Mahendra, and D. Hidalgo. 2019. "From Mobility to Access for All: Expanding Urban Transportation Choices in the Global South." World Resources Report. Washington, DC: WRI. https://wriorg.s3.amazonaws.com/s3fs-public/from-mobility-to-access-for-all.pdf.

Welle, Benjamin, Anna BraySharpin, Claudia Adriazola-Steil, Amit Bhatt, Saul Alveano, Marta Obelheiro, Tolga Imamoglu, Soames Job, Marc Shotten, and Dipan Bose. 2018. "Sustainable and Safe: A Vision for Zero Road Deaths." Washington, DC: WRI.

WHO (World Health Organization). 2018a. "Global Road Safety Status Report." Geneva, Switzerland: World Health Organization. https://apps.who.int/iris/bitstream/handle/10665/277370/WHO-NMH-NVI-18.20-eng.pdf?ua=1.

WHO. "Ambient (Outdoor) Air Quality and Health. 2018b. Fact Sheet. Last modified May 2. Accessed September 17, 2019. https://www.who.int/en/news-room/fact-sheets/detail/ambient-(outdoor)-air-quality-and-health.

WTO (World Trade Organization). 2018. "World Trade Report 2018." Geneva, Switzerland: WTO. https://www.wto.org/english/res_e/publications_e/world_trade_report18_e.pdf.

ACKNOWLEDGMENTS

We are grateful to the many people and institutions who supported and shaped this paper. Claudia Adriazola-Steil, Marcel Alers, Pankaj Bhatia, Daniel Bongardt, Angela Enriquez, Arya Harsono, Nikola Medimorec, Winnie Mitullah, Alicia Olago, Bronwen Thornton, Miriam Vieweg, David Waskow, Sheila Watson, and Lulu Xue provided detailed and constructive feedback on earlier drafts. Michael Comstock managed UNDP's role as a partner in this paper and in the series of guidance documents of which it forms a part. Carlos Muñoz Piña and Emilia Suarez provided valuable advice from WRI's Science and Research team, while Carni Klirs, Mary Paden, and Romain Warnault undertook editing, production, and design. Aishwarya Ramani and Nikita Luke provided research and project coordination support.

This report was generously supported by the Federal Ministry for Economic Cooperation and Development of Germany (BMZ), which provided funding for the project as a contribution to the NDC Partnership. Likewise, we are grateful to the IKEA Foundation for funding support and to the Lawrence Berkeley National Laboratory for in-kind support. Finally, we are also pleased to acknowledge our institutional strategic partners, who provide core funding to WRI: Netherlands Ministry of Foreign Affairs, Royal Danish Ministry of Foreign Affairs, and Swedish International Development Cooperation Agency.

UNDP is pleased to acknowledge support from BMU, BMZ, the European Union, and Spain (AECID), in contribution to the NDC Partnership.

Federal Ministry
for Economic Cooperation
and Development

ABOUT THE AUTHORS

Taryn Fransen is a Senior Fellow in the Global Climate Program at the World Resources Institute.

Contact: taryn.fransen@wri.org

Benjamin Welle is Director of Integrated Transport and Innovation at the WRI Ross Center for Sustainable Cities.

Contact: benjamin.welle@wri.org

Camron Gorguinpour is the Senior Global Manager for Electric Mobility at the World Resources Institute.

Contact: camron.gorguinpour@wri.org

Margaret McCall is a Research Affiliate with the Lawrence Berkeley National Laboratory.

Contact: margaret_mccall@berkeley.edu

Ranping Song is the Developing Country Climate Action Manager in the Global Climate Program at the World Resources Institute.

Contact: ranping.song@wri.org

Alexander Tankou is a Research Analyst in the Global Climate Program at the World Resources Institute.

Contact: alexander.tankou@wri.org

ABOUT UNDP

UNDP partners with people at all levels of society to help build nations that can withstand crisis, and drive and sustain the kind of growth that improves the quality of life for everyone. On the ground in nearly 170 countries and territories, we offer global perspective and local insight to help empower lives and build resilient nations.

The views expressed in this publication are those of the author(s) and do not necessarily represent those of the United Nations, including UNDP, or the UN Member States.

ABOUT WRI

World Resources Institute is a global research organization that turns big ideas into action at the nexus of environment, economic opportunity, and human well-being.

Our Challenge
Natural resources are at the foundation of economic opportunity and human well-being. But today, we are depleting Earth's resources at rates that are not sustainable, endangering economies and people's lives. People depend on clean water, fertile land, healthy forests, and a stable climate. Livable cities and clean energy are essential for a sustainable planet. We must address these urgent, global challenges this decade.

Our Vision
We envision an equitable and prosperous planet driven by the wise management of natural resources. We aspire to create a world where the actions of governments, businesses, and communities combine to eliminate poverty and sustain the natural environment for all people.

ABOUT THE NDC ENHANCEMENT SERIES

This working paper is part of a series of guidance documents developed by the World Resources Institute and the United Nations Development Programme to help government officials identify options for enhancing Nationally Determined Contributions (NDCs) in line with the Paris Agreement. Further information is available at www.wri.org/our-work/project/stepping-2020-ndcs.