Sectoral Guide Consultation Version 1

Low emission transport

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Green Climate Fund (GCF)
Songdo Business District
175 Art Center-daero
Yeonsu-gu, Incheon 22004
Republic of Korea

www.greenclimate.fund

+82 32 458 6059 (KST)

info@gcfund.org

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Contents

Abbreviations

ADB	Asian Development Bank
AE	Accredited Entity
AFD	Agence Française de Développement (French Development Agency)
BEB	Battery electric bus
BEV	Battery electric vehicle
BRT	Bus rapid transit
CCAC	Climate and clean air coalition
CO2	Carbon dioxide (a greenhouse gas)
EV	Electric vehicle
GCF	Green Climate Fund
GEF	Global Environment Facility
GHG	Greenhouse gases
Gt	Gigatonnes (of emissions)
HVT	High volume transport
ICE	Internal combustion engine
IEA	International Energy Agency
IFI	International financial institution
IPCC	Intergovernmental Panel on Climate Change
LDCs	Least developed countries
LEZ	Low emission zone
LICs	Low income countries
LRT	Light rail transit
LTS	Long term strategies
MDB	Multilateral development bank
MDCs	Most developed countries
MICs	Middle income countries
MRT	Mass rapid transit
Mt	Million tonnes (of emissions)
NDA	National designated authorities
NDB	National development bank
NDC	Nationally determined contributions
NMT	Non-motorised transport
PPP	Public private partnership
RE	Renewable energy
SDG	Sustainable development goals

SUMP	Sustainable urban mobility plans
SLCP	Short lived climate pollutant
TDM	Traffic demand management
TNA	Technology need assessments
TOD	Transit oriented development
ZEA	Zero emission area

Executive summary

The Green Climate Fund (GCF) is the world's largest dedicated fund helping developing countries respond to climate change. It was established by the United Nations Framework Convention on Climate Change (UNFCCC) in 2010 and has a crucial role in supporting the developing countries in achieving their commitments and ambitions towards meeting the goals of the Paris Agreement. The GCF is dedicated to boosting climate finance for developing countries and has set an ambitious agenda with its Strategic Plan for 2020-2023. In spite of the global pandemic, GCF is providing increased support, helping developing countries build a low emission, climate-resilient recovery. The GCF Sectoral Guide series supports the progressive work programme approved for 2020-2023 providing evidence-based information for impactful projects in priority investment areas and giving further momentum to making GCF operations more efficient and more effective.

There are eight result areas that GCF has targeted because of their potential to deliver a substantial impact on mitigation and adaptation in response to climate change. Result areas provide the reference points that guide GCF and its stakeholders to ensure a strategic approach when developing programmes and projects, while respecting the needs and priorities of individual countries. The transport result area has strong links to other sectors and these cross-sectoral issues are addressed through multiple result areas in a complementary manner, as shown in Table ES-1.

Table ES-1: Cross-sectoral issues addressed throughout the series

Sector	Cross-Sectoral issues addressed
Agriculture and food security	• Distribution of food locally and globally. • Competition of biofuels (particularly first generation) with food supply and decrease food security.
Cities, buildings, and urban systems	• Fostering integration and thus synergies between transport and energy efficient development. • Compact city and urban planning to reduce transport demand.
Ecosystems and ecosystem services	• Provision of transport, clean water and energy and flood and erosion control in marine ecosystems.
Forests and land use	• Sustainable forest and land use management including competing demand for biofuels (first generation) and land for transport.
Energy access and power generation	• Grid infrastructure issues related to electric vehicles (stable generation from renewable sources, storage, and distribution).
Climate information and early warning systems	• Geographic Information Systems, Global Positioning System. • CIEWS use for efficient transport and logistics planning.
Health and wellbeing	• Resilient transport in the face of climate hazards/emergencies. • Health issues related to localised pollution due to transport.
Water Security	• Greening of inland waterways transportation. • Biogas recovery from onsite sanitation at public transport stations.
Low emission transport	• Policies for accelerated shift to public transport. • Transit oriented and mobility-based transport policy and planning. • Electric vehicles and e-mobility. • Low carbon transport and non-motorised transport. • Charging Infrastructures and storage solutions for EV deployment. • New generation integrated RE-to-zero emission fuel for not-yet electrifiable uses.
Energy Efficiency	• Industrial energy efficiency, Appliance efficiency including engine efficiency.

GCF Low Emission Transport Sectoral Guide

The Transport sector has a significant and measurable impact on climate change accounting for nearly a quarter of all energy-related CO2 emissions (SuM4all, 2019; IEA, 2020b). Among the different modes of transport, road vehicles – freight, cars, trucks, buses, and two- and three-wheelers – account for nearly three-quarters of transport carbon dioxide emissions. At the same time hundreds of millions of people in developing countries lack convenient access to efficient and low emissions public transport. For instance, in sub-Saharan Africa, only two out of ten people have convenient access to public transport.

Radical paradigm shift or transformation is needed for the transport sector to stay within the 1.5-2°C goal by 2050 (SLOCAT, 2021). If current investments do not shift from low occupancy, fossil fuel-based systems to high occupancy, renewable powered systems, it will lock in a fossil-fuel, high emission future.

Paradigm shifting pathways

Research-based evidence, best practices, and lessons learned indicate that the highest impact for a paradigm shift in the low emissions transport result area can be achieved through three interlinked pathways. These pathways provide a holistic framework for meeting the demand for mobility in developing countries while decoupling it from carbon emissions growth. They reflect a comprehensive approach of transport systems and are mutually reinforcing. Moreover, they are based on the principles of sustainable urban transport of "Avoid-Shift-Improve". Pathway 1 focuses partially on "Avoid" and largely on "Shift" and Pathways 2 and 3 focus on "Improve" principles. The Cities, buildings, and urban systems Sectoral Guide also addresses aspects of "Avoid" through design and planning of high-density, compact cities that lead to avoidance and reduction of road trips.

The three pathways identified below provide a holistic framework for developing projects and programmes that enable developing countries to shift to low emission, climate resilient transport systems while meeting their sustainable development goals:

- Accelerating shift to low emission public transport: this pathway envisions an accelerated shift to highly efficient, low emission public transport networks that serve as the backbone to urban mobility with walking and micro mobility (bicycles, e-bikes, scooters, trikes) integrated with public transport.
- Rapidly electrifying transport systems: the focus of this pathway is the rapid electrification of the transport system throughout the entire value chain with integrated policy planning, innovation in technology and business models to catalyse rapid and systemic electrification (including charging infrastructure) enabled by renewable energy (RE) power generation.
- Supporting scale up of new generation zero emission fuels: this pathway proposes catalytic actions to scale innovative fuel technology (such as hydrogen and second generation zero emission biofuels) and their value chains.

To meet the capital needs of the three pathways, alignment between long term strategic transport planning as well as land, energy, and financial planning, which integrate climate and development goals, is essential. Public financing can lay the critical foundation for low emissions transport but will need to leverage and crowd in private investment at scale to meet the timeline and scale of transformation for the goals in the Paris Agreement. Therefore, GCF interventions that enable blended finance for developing countries is of paramount importance. Even though the long-term economic return of low emissions public transport and electrification of the transportation network is high, the immediate financial returns are low. Despite total cost of ownership (TCO) being comparably lower (e.g., for battery-electric vehicles) and despite prices likely continuing to fall, the risks remain at present comparably higher because of the high initial investment costs in fixed infrastructure and rolling stock that needs to be covered by uncertain and volatile revenue streams dependent on three or more decades of user behaviour. Hence, business model innovations, rapid scale up of advanced technology for electric traction and storage, and incentives for user behaviour change as well as de-risking private investments at scale will be critical.

Barriers to achieving paradigm shift

There are multiple barriers which prevent a low emission paradigm shift in the transportation sector. The greatest and most common are lack of sufficient funding and financing in the face of higher upfront costs as well as more significant technology risk (e.g., battery or fuel cell technical lifespan) and longer total cost of ownership lifespans, as well as lack of political support and continuity over time, and lack of governmental capacity. Other common barriers include the high risk associated with high costs of transportation infrastructure projects (including even higher costs with new technologies), volatile public transport user behaviour leading to fluctuating or insufficient revenue, negative externalities not being priced into legacy transport systems (e.g., the costs of air pollution), fossil fuel subsidies reducing the competitiveness of emission-free alternatives, fear of jobs losses or revenues losses from reforms to the transport sector. These perceived barriers deter private sector investments, which are often essential for financing transformative, low emissions, transportation projects.

In addition, each of the three paradigm shifting pathways face unique challenges. Accelerating a shift to low emissions public transport is challenged by a strong vehicle culture, and subsidisation of cars and roads; limited or poor-quality transportation infrastructure; and limited understanding of the need to prioritise public transport, non-motorised transport (NMT, i.e. walking and cycle). Barriers to the rapid electrification of the transport system include high upfront costs of electric vehicles and charging infrastructure; dependence on energy infrastructure and the energy sector; high and volatile electricity pricing; concerns with new electric technologies such as batteries which may not yet have reached full product lifecycle maturity; higher relative cost of synthetic fuels, and timely performance of new transport technologies and solutions. New generation zero emission fuels face barriers including uncertainty of environmental sustainability; concerns with biofuels competing with food supply and demand as well as posing significant risks to biodiversity where cultivated; lack of developed supply chains for alternative fuels; and infrastructure deficits for new fuels such as hydrogen distribution and storage or biofuel production facilities.

Role of GCF in financing paradigm shifting pathways

GCF offers a four-pronged approach to drive implementation of the paradigm shifting pathways at scale. While business models, project development systems, financing structures and ability to attract Private Institutional and Commercial finance (PIC) differ significantly across regions, these approaches can support developing countries' efforts in the transport result area. Possible actions for each of the paradigm shifting pathways, across the four drivers of the GCF Strategic Plan 2020-2023 follow and are summarised in Figure ES-1.

(1) Transformational planning and programming: integrated planning and programming that embeds climate change within national development and budget plans as well as a Covid-19 recovery plan can reduce capital requirements significantly in the long term. For the transport sector this would include transit-oriented development planning, programming and financing infrastructures for improved cycling and walking, travel demand management (such as parking pricing) and access incentives for increasing public transport ridership.

(2) Catalysing climate innovation: GCF funds can support innovations in technology, business models, or norms and specifications to encourage the emergence and diffusion of low emission and climate resilient innovations. Examples include business model innovations for rapid penetration of electric charging infrastructure or equity investments in value chain of energy storage technologies.

(3) Mobilization of funds at scale: investment needs for low emissions public transport infrastructure and new technology at scale, to achieve the depth and timeline required for meeting Paris Agreement goals require mobilising investments at scale. Strategic use of GCF funds can enable mobilisation of funds at scale through blended finance to improve risk-adjusted returns for private capital or increase access to sustainable sources of public investment.

(4) Coalitions and knowledge to scale up success: enabling countries to internalise learnings and knowledge generated from project implementation on policy, programmes, innovations, and fund mobilisation efforts at scale can enable the rapid diffusion of new technologies and norms for transition to low emission, climate resilient pathways.

To deliver a paradigm shift, GCF financial resources act as tools to address barriers in a systemic way and not just as a source of funding to deliver an investment for a specific project. The fund can deploy several financial instruments (grants, loans, equity and guarantees) that can be coordinated with co-financiers, blended, and sequenced in order to leverage other public and private capital.

When developing high impact low emissions transport GCF projects, AEs and other stakeholders are advised to take into consideration the GCF core principle of country ownership and align their intervention with existing national planning processes. This includes Nationally Determined Contributions (NDCs), Technology Need Assessments (TNAs) as well as country programmes developed by the National Designated Authorities (NDAs) and Focal Points of the GCF. The country programmes present the country's climate priorities to GCF, including a pipeline of projects that the country would like to develop with GCF. GCF strives to increase the focus on Direct Access Entities and acknowledges local financing's role in nurturing transformational business models.

Finally, partnership has formed the basis of the GCF business model since it was established. GCF is a fundamentally partnership-based institution, thus leveraging existing sectoral initiatives, coalitions, and platforms when planning interventions remains critical to creating multiplier effects at scale and promoting joint learning and knowledge transfer in the low emission transport sector.

Section 5 provides case studies that show how these criteria could pertain to the transport paradigm shifting pathways.

GCF investment criteria

Proposals to GCF are assessed based on six GCF Board approved investment criteria:

(1) Impact potential: to what extent does the project or programme contribute to the achievement of GCF objectives and result areas.

(2) Paradigm shift potential: degree to which the proposed activity can catalyse impact beyond a one-off project or programme investment.

(3) Sustainable development potential: how do the actions align with national SDG priorities? What are expected environmental, social, gender, and economic co-benefits and challenges? Consider wider benefits, priorities and problem shifting.

(4) Recipient needs: vulnerability and financing needs of the beneficiary country and population

(5) Country ownership: beneficiary country ownership of, and capacity to implement, a funded project or programme, policies, climate strategies and institutions.

(6) Efficiency and effectiveness: economic and, if appropriate, financial soundness of the programme/project.

Section 6 provides examples of how these criteria could pertain to the transport paradigm shifting pathways.

Figure ES-1: Possible actions for each pathway following the four pillars of the GCF Strategic Plan

Sector		Actions across the drivers of the GCF Strategic Plan			
Low emission transport		**Transformational planning & programming**	**Catalyzing climate Innovation**	**Mobilization of finance at scale**	**Coalitions & knowledge to scale up success**
Paradigm shifting pathway	**Accelerating shift to low emission public transport**	• Prioritise TOD planning with electrified public transport powered by RE • Integrate public transit with NMT (protected bike lane networks, bikeshare systems, charging infrastructure, complete streets) • Develop national decarbonisation roadmap and central paltform for public transport • Integrate multimodal pulibc transport (fare/payment-ticketing/smart card), IT integration, physical integration	• Introduce policy/strategies to shift drivers to walking, cycling, public transport • Develop big data transport solutions for end-to-end integration and real-time-performance services (smart fare/multimodal systems with easy transfer infrastructure/payment) • Develop TDM strategies (parking management, electronic road pricing, LEZ/ZEAs) • Repurpose motor vehicle space to NMT, public transport, housing or green space	• Support syndication for mobilising public/private finance for BRT, LRT, MRT with min revenue/risk guarantees • Enhance credit and guarantees for municipal bonds • Develop innovative public-private financing models with investment in non-revenue infrastructure (PPPs, pay-as-you-use/save, vehicle leasing, utility ownership) • Introduce equity/green financing to multiply options and understand local challenges/opportunities	• Introduce standards and specification for emissions that encourage high occupancy public transit, walking, and cycling over private vehicles • Develop institutional capacity (workshops, trainings, exchanges, community of practice groups)
	Rapidly electrifying transport systems	• Introduce transition strategies/policies (grid-to-transport and carbon pricing, preferential access, purchase incentives) • Pilot with plan for scale up elecric public transit (vehicles, depots, charging infrastructure) • Develop procurement policies for commercial electric vehicles • Greening of charging infrastructure with integrated RE • Develop national decarbonisation roadmap/platform for unified vision	• Innovate business models for charging and storage as services • Innovate energy storage and vehicle-go-grid-to-depot service models • Build utility-operator partnership models for end-to-end electriciation • Prioritise charging infrastructure for electric transit uptake (buses, paratransit vehicles, high travel modes) • Develop cost-effective charging • Explore secondar market for batteries	• Develop lease PPPs (batteries, buses, operations) for changeover to electric • Support syndication for vehicle-to-depot electrification • Anchor investment in supply chain for commercial Evs • Integrate new stakeholders into funding/financing (utilities, new investors for leasing) • Explore options to bring in OEMs into financing (deferred payments or vendor finance schemes)	• Develop institutional capacity (workshops, trainings, exchanges) • Establish facilities, community of practice groups, or platforms to share lessons learned and best practices • Electric grid analysis for electric public transit capacity (C40, 2020)
	Supporting scale up of new generation zero emission fuels	• Use a cradle-to-grave planning approach for alternative fuel adoption to avoid encouraging growth of fuels which have negative impacts on resource use and overall emissions • Address regulatory standards • Unify vision through national decarbonisation platform	• Integrate decentralised RE to hydrogen production and storage solutions • Pilot or implement small-scale adoption to trial new technologies and infrastructure deployment • Utilise local resources for biofuel generation, particularly those removed from food supply competition (in other words, cattle manure as a deriative versus corn as direct competition)	• Introduce aay-as-you-use/save models for hydrogen or next generatopm zero carbon fuels • Integrate new stakeholders into planning and funding/financing • Allow subsidies and no-to-low interest financing for initial adoptions as technology develops	• Support additional research for risk reduction • Develop institutional capacity (workshops, trainings, exchanges) • Establish facilities, community of practice groups, or platforms to share lessons learned and best practices

1 Introduction

1.1 GCF Sectoral Guides

The Green Climate Fund (GCF) is the world's largest dedicated fund helping developing countries reduce their greenhouse gas emissions and enhance their ability to respond to climate change in line with the Paris Agreement. The low emission transport result area emphasises reducing emissions from all kinds of transportation such as road, rail and maritime transport, and aviation through holistic, integrated mobility planning.

There are eight result areas that GCF has targeted because of their potential to deliver a substantial impact on mitigation and adaptation in response to climate change. Result areas provide the reference points that guide GCF and its stakeholders to ensure a strategic approach when developing programmes and projects, while respecting the needs and priorities of individual countries.

This Sectoral Guide focuses on how GCF can support developing countries transition to low emission transport systems.

Cross-sectoral issues are addressed through multiple result areas and presented in Table 1:

Table 1: Cross-sectoral issues addressed throughout the series

Sector	Cross-Sectoral issues addressed
Agriculture and food security	• Distribution of food locally and globally. • Competition of biofuels (particularly first generation) with food supply and decrease food security.
Cities, buildings, and urban systems	• Fostering integration and thus synergies between transport and energy efficient development. • Compact city and urban planning to reduce transport demand. • Transit oriented development embedded with urban planning • Improving EV charging points in car parks in residential and non-residential buildings.
Ecosystems and ecosystem services	• Provision of transport, clean water and energy and flood and erosion control in marine ecosystems. • Reduce the fragmentation of ecosystems due to transport infrastructure through better design and planning (e.g., wildlife crossings). • Synergies between mitigation and adaptation (e.g., cycling or pedestrian paths present an opportunity to join nature-based solutions).
Forests and land use	• Sustainable forest and land use management including competing demand for biofuels (first generation) and land for transport.
Energy access and power generation	• Grid infrastructure issues related to electric vehicles (stable generation from renewable sources, storage, and distribution).
Climate information and early warning systems	• Geographic Information Systems, Global Positioning System. • CIEWS use for efficient transport and logistics planning.
Health and wellbeing	• Resilient transport in the face of climate hazards/emergencies. • Health issues related to localised pollution due to transport. • Health benefits related to non-motorised transport and pedestrianisation (healthier personal routines, reduced urban congestion and stress, reduced traffic fatalities).
Water Security	• Greening of inland waterways transportation. • Biogas recovery from onsite sanitation at public transport stations.
Low emission transport	• Policies for accelerated shift to public transport. • Transit oriented and mobility-based transport policy and planning. • Electric vehicles and e-mobility. • Low carbon transport and non-motorised transport. • Charging Infrastructures and storage solutions for EV deployment. • New generation integrated RE-to-zero emission fuel for not-yet electrifiable uses.
Energy Efficiency	• Industrial energy efficiency, Appliance efficiency including engine efficiency.

1.2 Transport context

To this end, this document outlines three pathways for achieving a paradigm shift in the transport systems in developing countries: (1) accelerating shift to low emissions public transport, (2) rapidly electrifying transport systems, and (3) supporting scale up of new generation zero emission fuels for not-yet electrifiable uses. Radical transformation, including pursuing these three pathways, is needed for the transport sector to stay within the 1.5-2* C goal by 2050 (SLOCAT, 2021).

Transportation has a significant, measurable impact on climate change (ITDP, 2015a, IPCC, 2021), accounting for nearly a quarter of all energy-related CO2 emissions (SuM4all, 2019; IEA, 2020b). It is the fastest growing emissions sector, of which road transport accounts for 78% of emissions (WRI, 2013; SLOCAT, 2021; SuM4All, 2019). Alongside the energy sector, the land transportation sector contributes the most to ozone and ozone exposure (IPCC, 2021).

1.3 Organisation of the document

The sectoral guide has 5 sections. Following this introduction, Section 2 provides an overview of the sector within the global context of climate action; Section 3 highlights the barriers and opportunities to achieving a paradigm shift for the transport sector; Section 4 discusses financing trends and models to catalyse public and private investment; Section 5 provides an overview of country experiences; and Section 6 provides specific guidance for the development of impactful projects and programmes in relation to the GCF investment criteria; and lastly, Section 7 is the conclusion.

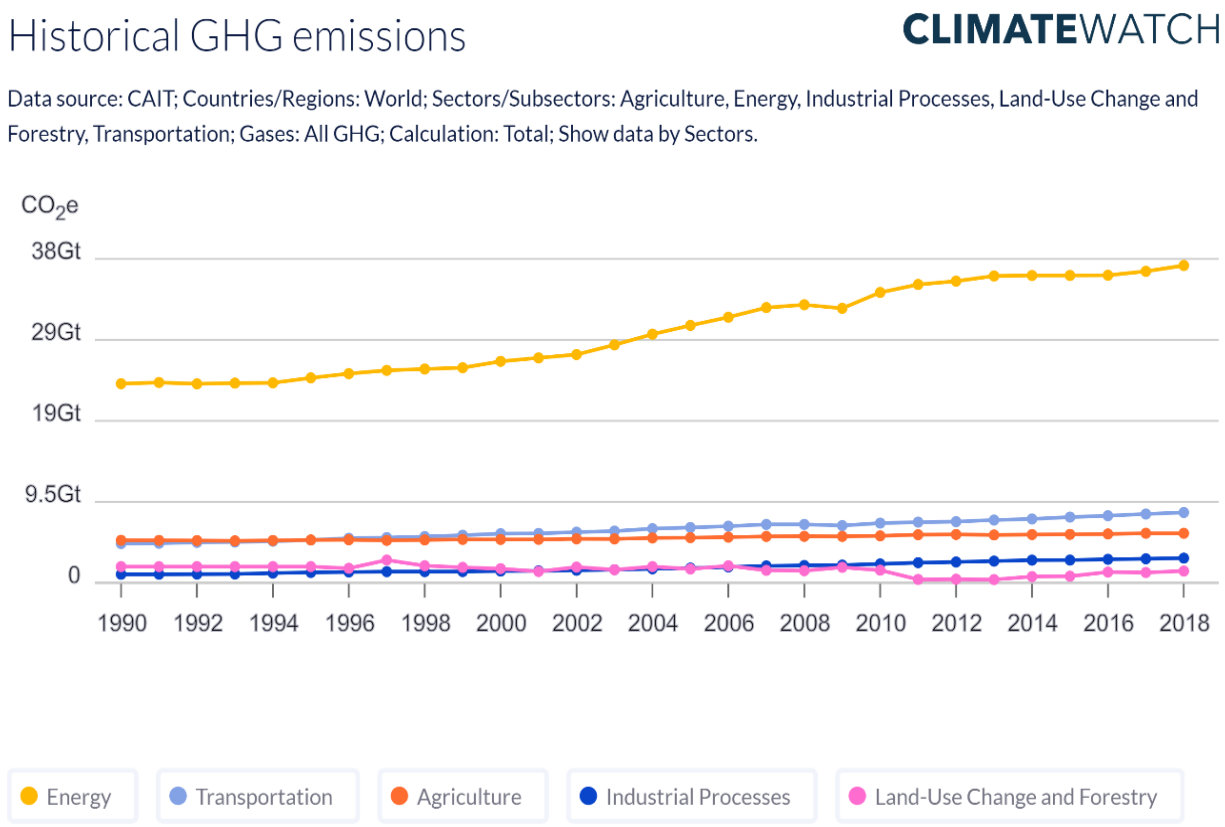
2 Global context

2.1 Scientific basis: why is transport relevant to climate action?

As shown in Figure 1, transportation and energy generation are the largest energy-consuming sectors worldwide (Sum4All, 2019). From 1970 to 2018, the transportation sector's direct GHG emissions grew from 2.8 Gt CO2eq to 8.2 GtCO2eq globally, and this number will rise to 13-14 Gt CO2eq annually by 2050, unless immediate and impactful change is enacted (IPCC, 2014; Gota et al., 2018; Climate Watch, 2021). Yet without mitigating actions passenger transport and freight volumes are forecast to more than double from 2015 to 2050 (ITF, 2021). If radical change is not enabled, the sector will be locked-in to a fossil fuel future to the detriment of the planet and the people.

Historically, global data shows that growth in transport is tied to growth in GDP, subsequently leading to increasing GHG emissions (ITF, 2021). At the same time, increased mobility allowing for greater access, particularly in LDCs, is essential to meeting social (health, education, and others) and economic goals as detailed in the Sustainable Development Goals (SDGs). As such, a paradigm shift to low emission transportation systems will reduce emissions while meeting social and economic development goals in the upcoming decades.

Figure 1: Transport is the second highest emitting sector after energy



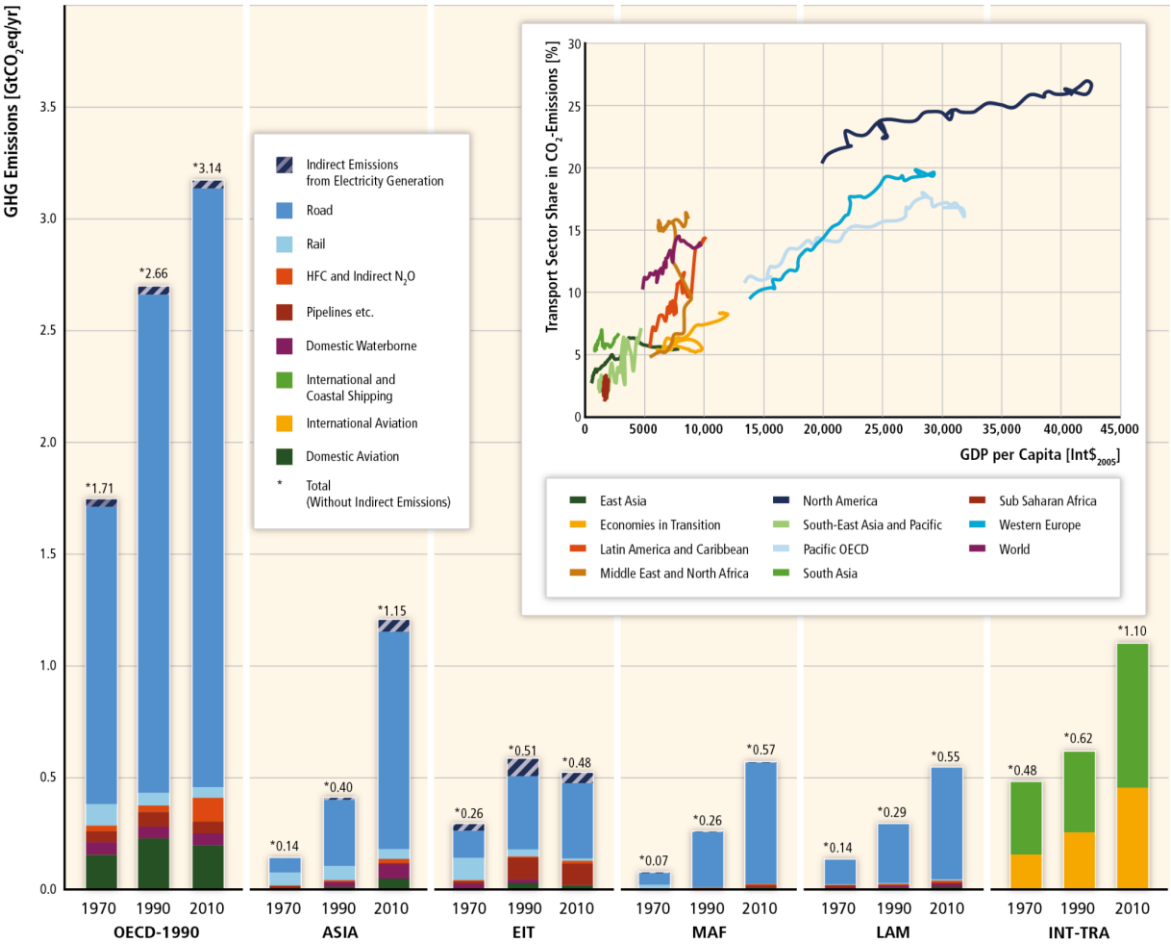
Source: Climate Watch, 2021

2.2 Mitigation and adaptation baseline: where is the sector today?

Transportation accounts for around 24% of direct greenhouse gas (GHG) emissions from fuel combustion worldwide (IEA, 2020). GHGs such as CO2, NO2, and tropospheric ozone precursors from transportation manufacturing and operations exacerbate climate change effects, negatively impact human health, and degrade local environments through air and runoff pollution (ADB, 2018; VTPI, 2020; Congressional Research Service, 2020; Gordon, 2010; ICCT, 2018). Even if current climate commitments from countries are met, emissions from the transport sector are forecast to rise 16% by 2050, and some sub-sectors will increase even faster, such as freight which is predicted to increase 22% (ITF, 2021).

Transport emissions are an exacerbator of climate change, and at the same time transportation systems' infrastructure and value chains are vulnerable to increasingly severe climate and weather events (Wang et al., 2020). As transport systems become more exposed to these risks, the maintenance, repair, and disruption costs, as well as the social and economic burden on communities, are expected to increase (World Bank, 2015). For developing countries, improving transportation systems is necessary for mitigation (avoiding increasing future carbon emissions by building sustainable, zero emissions mobility systems now) and adaptation (creating resilient infrastructure that enables persons, communities, and economies to thrive in a world of changing climate and more extreme weather events). Despite this, there is a lack of understanding or prioritisation of the role of the transport sector in coping with climate change. Ahead of COP21, 83% of Intended Nationally Determined Contributions included an adaptation component, but only 16 out of 137 parties listed transportation as a priority area for adaptation (World Bank, 2015; UNFCCC, 2016). As such, current mitigation and adaptation promises must increase in order to decrease emissions from 2015 levels, and countries must prioritise adaptation and mitigation measures specifically for the transport sector.

Figure 2: Transport emissions by mode and region, 1970-2010

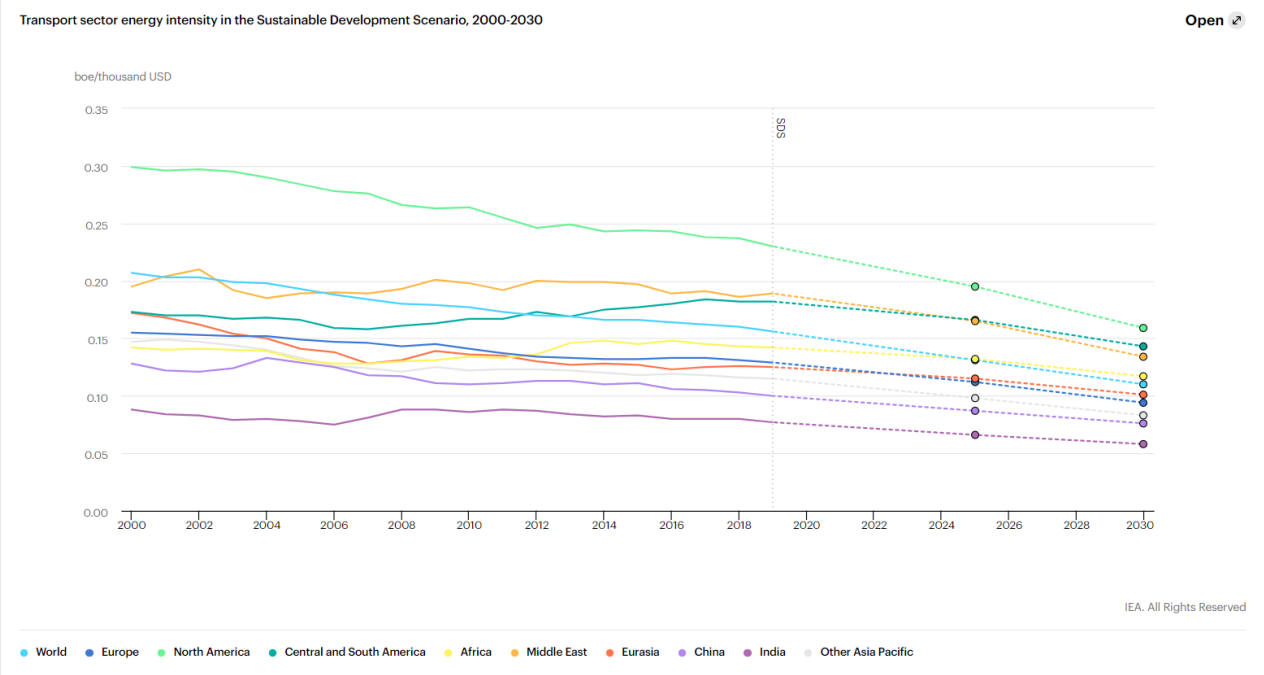


Source: 2014

Transportation development, emissions, and burden of emissions vary widely by region and country. The Rapid Transit to Resident ratio (a measure of kilometres of rapid transit per million residents in a given geography) provides an example of the global mobility gap. While the global range of RTR is 0-95 kilometres per million residents, the global average is 32 and the developing country average is 4 (SuM4All, 2019). Most developed countries (MDCs) represent the greatest emissions per capita (2.4 versus 0.7 annual tonnes of CO2 emissions for MDCs and LDCs, respectively), while people in LDCs on average have higher exposure to emissions per capita (SuM4All, 2019) further inducing significant health and economic costs. For MDCs, it is essential to mitigate emissions, as they represent both the highest emitters of historic transport emissions and the highest percentage of current emissions. By one estimate, if MDCs limit their emissions, transport-related GHG emissions would decrease from 23% to 15% of all energy-related emissions (SuM4All, 2019). For LDCs and SIDS, the objective is to rapidly expand transportation system capacity through low emission measures that promote sustainable development for future resilience. Where gaps for public transport supply exist, LDCs and SIDS have the opportunity for modal 'leapfrog' from individual motorised vehicle-oriented transport systems to high volume transport (HVT) systems that prioritise walking, cycling, and public transit.

Transport emissions by mode and region from 1970-2010 are shown in Figure 2. The International Energy Agency expects a decline in emission in a Sustainable Development Scenario (Figure 3).

Figure 3: Expected transport emissions from 2000-2030 in a Sustainable Development Scenario by IEA.



Source: IEA, 2020b

2.3 Global adaptation and mitigation targets: where does the sector need to be?

The transportation sector must reduce current CO2 emissions (currently about 8 Gt annually) by 4-6 Gt by 2050 to not surpass a global temperature rise of 1.5 °C (SLOCAT, 2021; SuM4All, 2019). In addition to greenhouse gas emissions, the transportation sector is one of the major contributors to emissions of black carbon, short lived climate pollutants. Moreover, without intervening action, passenger and freight travel is predicted to double between 2015 and 2050, and IEA estimates meeting this demand requires an additional 25 million kilometres of new paved lanes and 335,000 kilometres of rail from 2010 levels (ITF, 2021; IEA, 2013). To achieve net-zero emissions by 2050, transportation emissions must peak latest by 2025-2030 (SuM4All, 2019).

While this timeline is short, many of the policies, technologies, and strategies needed to reach these transportation needs, and to do it under a low-to-no emission scenario, currently exist and are well understood. For example, a dramatic increase in cycling from 6% to 11% of urban trips by 2030 and 14% by 2050 could lead to a 2 Gt reduction in CO2 emissions per year by 2050 (ITDP, 2015a). Modal shifts in the medium-to-long-term (2030-2050) from urban (re)development and investments in new infrastructure, linked with integrated urban planning, transit-oriented development and a more compact urban form that supports cycling and walking could "reduce GHG intensity by 20–50% below 2010 baseline by 2050" (IPCC, 2014). More recently, ITF projected that if countries implement stronger decarbonisation policies (including aggressively shifting to more sustainable transportation and zero emission technologies, avoiding unnecessary travel, and improving transportation network resilience), this could reduce emissions by 70% in 2050, compared to 2015 levels (ITF, 2021). What will it take to deliver maximum climate and sustainable development impact?

Global consensus and action is needed for the transportation sector to reach pressing climate goals (SuM4All, 2019). At a high level, global recommendations include creating and strengthening accessible public transport networks; improving the energy efficiency of freight transport by shifting to water and rail-based modes; improving fuel/energy efficiency of existing transport technologies as well as urban and national electricity grids; encouraging shifts to proven technologies such as electrification and enabling supply/value chain development; and restructuring urban systems to encourage shift to public transit, walking, and cycling with compact, transit-oriented development.

The 'A-S-I' approach is a global framework for reaching a low emission transportation system, which includes 'Avoid' (reduce or avoid the need to travel), 'Shift' (shift to/maintain low emission transport modes), and 'Improve' (improve the energy efficiency of existing transport technologies) (GIZ, 2016).

The three pathways for paradigm shift towards low emissions, climate resilient transport in developing countries as detailed below, provide a framework to develop high impact projects that can deliver significant climate and sustainable development impact. The first pathway focuses on 'Avoid' and 'Shift' strategies, while the second and third focus on 'Improve'. The GCF pathways include:

(1) Accelerating the shift to low emissions public transport: this pathway focuses on programmes and projects that leverage no-to-low emission public transport technologies and catalyse modal shift to walking, cycling, and public transport combined with supportive policies, financial enablers, and transit-oriented, compact development (ITDP, 2019a; IPCC, 2014; ITDP, 2015a; ITDP, 2017b; SLOCAT, 2021). This pathway also focuses on prioritising the access and safety of transport for marginalised groups such as women, elderly and children, and persons with disabilities as a key for shift and avoidance of motorisation. Accelerating the shift to low emissions bolsters land use and mobility planning. This includes reducing mobility demands, rethinking urban models, compact urban growth, smart mobility, low emission zones and transit-oriented developments such as more efficient logistics and shifting from road to rail (both passenger and freight).
(2) Rapidly electrifying the transport system: this pathway enables innovation and diffusion of charging infrastructure (powered by renewable energy) as a key driver for paradigm shift; adoption and scale-up of electric public transport vehicles and smaller modes such as bikes, rickshaws, and 2-and 3- wheelers. This pathway also supports the adoption of an EV enabling framework; realise interventions which allow cities to kick-start and accelerate deployment of EVs as well enables the market to reach commercial maturity at a faster rate to increase the pace of electrification; and enactment of policies and financial incentives that create a faster, easier transition from internal combustion engine vehicles (ITDP, 2019c; IPCC, 2014; ITDP & UC Davis, 2017; ITDP, 2021).
(3) Supporting scale up of new generation zero emission fuels: this pathway enables scale up of technological innovations and business model innovation for zero emission, alternative fuel technologies for transport. Technologies such as second-generation biofuels and hydrogen produced through fully sustainable and green value chains that do not interfere with the food supply chain, cause an increased strain on land, biodiversity, water usage or lead to net increased emissions for not-yet electrifiable uses. Scale up investments should receive a balanced approach with consideration for not only non-proven technologies but also existing technologies. This pathway also encourages creation of supportive policies such as more stringent fuel economy and efficiency standards and encourages green freight through financial incentives. It advocates for building knowledge and capacity as alternative fuels continue to evolve (World Bank, 2015; SuM4All, 2019; IPCC, 2014).

2.4 Financial requirements: how much is it going to cost to get there?

Global financial target for the Transport sector: While the cost effectiveness of the different pathways varies, it is important to highlight the need to allow for incremental compensation instruments to unlock the fundamental transitions in transportation. Current annual investment in the entire transportation sector is around USD 1.4-2.1 trillion, including public and private investments (WRI, 2016). To reach these significant emissions reductions targets by 2050, it is estimated this will cost approximately USD 2-3 trillion per year (SLOCAT, 2021; WRI, 2016; Dobbs et al., 2013; New Climate Economy, 2014; ITDP, 2019a; OECD, 2013; IEA, 2013). While there are a range of estimates, SLOCAT reports an additional USD 440 billion needed per year for a total of USD 2.7 trillion annually for transportation infrastructure to meet the SDGs by 2030, and estimates that 60-70% of the investments need to be in emerging economies (SLOCAT, 2021). Equally as important as the additional funds needed, the shifting of funding and finance away from private motorisation and towards public transportation, walking, cycling, compact urban development, and more efficient freight systems, all with low-to-no combustion emissions, is essential. This shift is needed to prevent a lock-in in fossil fuel-based transportation, and to reach the 2030 and 2050 climate goals.

A low emission transport future has lower cost in the long-term: while there must be a significant shift and increase in annual spending initially, a low emissions transport future is less costly than a business-as-usual scenario. By one estimate, an annual transport sector cost of USD 2 trillion per year is needed for a 2°C average global temperature increase by 2050, while annual cost of a 4°C scenario is actually higher, at USD 2.3 trillion (WRI, 2016). Another study focused solely on urban passenger transport found that a high shift away from motorised trips and towards cycling could save cities USD 25 trillion from 2015-2050 (ITDP, 2015a).

Public and private sector: investment and gaps for transport: general taxation and public transport fare revenue cannot fully cover the cost of transportation projects; thus government budgets must be supplemented by other public and private finance.

The greatest contributors beyond government budgets to finance transport projects are often from the private sector. In 2014, private sector investment in the transport sector was estimated at USD 814 billion to USD 1.2 trillion, a greater share than the public sector estimate of USD 569-905 billion (WRI, 2014). The most common private sector investment is for road infrastructure (ITF, 2019). The percentage of total private investment varies by country and is generally tied to income level. While private sector investment represents 58% of global transport investment, the share of private investment is 38% higher than public investment in high-income countries, and public investment is 27% higher than private investment in MICs and LICs (WRI, 2016). In 2015, transportation infrastructure investments in developing countries were financed approximately 80% by governments, 15% by the private sector, and 5% by official development finance, such as MDBs and IFIs (SLOCAT, 2021). To increase investment in sustainable mobility systems in developing countries, it will be important for the public sector to reduce financial risk and incentivise private sector investments.

For the public sector, bi-and-multilateral development banks are important partners, particularly in the past decade. The MDBs committed to providing more than USD 175 billion of loans and grants for transport in developing countries for the 2012-2022 period, and as of 2019 are set to meet or exceed this goal (MDB WGST, 2019). From 2016-2018, the majority of MDB funded projects were for roads (35-43% of all projects annually), with urban transport representing 19-31% of projects (MDB WGST, 2019). In this way, the prioritisation of financing projects is on economic development rather than sustainable, resilient transportation for mitigation and adaptation, which differs from the GCF perspective. For other non-private actors, transport finance from climate funds was relatively low in the decades prior to the 2010s. At the time of the IPPC 4th panel, transport projects represented only 43/6,707 UNEP projects, and the Global Environmental Facility (GEF) had only approved 28 transport projects in the course of 20 years (IPCC, 2014). Climate funds such as GCF are needed in mainstreaming climate-based solutions in transport sector for developing countries so that they can achieve the emission reduction goals. Co-finance from other IFIs can add climate-based project components such as electrification, non-motorised transport solutions, and integration with the energy sector that would otherwise not be pursued.

3 Paradigm shifting pathways: transport

GCF is prioritising three pathways to catalyse the transport sector paradigm shift: (1) accelerating the shift to low emissions public transport, (2) rapidly electrifying transport systems, and (3) supporting scale up of new generation zero emission fuels for not-yet electrifiable uses. These pathways encompass the sector's most impactful decarbonisation strategies (ITF, 2021; SLOCAT, 2021). For developing countries, these strategies bend the trajectory of emissions from the transport sector to keep them on track to meet climate goals for 2030 and beyond. Importantly, this means reducing the rapid motorisation trends seen in developing countries globally and avoiding future emissions which are expected to grow at a rapid pace in developing countries. The barriers and opportunities for investing in low emission transportation, as well as for each individual pathway, are detailed in the following subsections.

3.1 General barriers

There are multiple barriers to all three paradigm shifting pathways in the transportation sector.

Lack of sufficient funding/financing: the greatest and most common barrier is lack of sufficient funding/financing. Low emission transportation projects often require large sums of upfront capital costs for procurement and implementation, as well as ongoing funds and financing to operate and maintain the system (ITDP, 2017a; SLOCAT, 2021). Government funding for transport is in competition with other public needs that can have higher priority, such as health, while dealing with fiscal constraints, and more expensive low emissions technologies can be seen as a less necessary undertaking. TCO and associated risks are often greater for new emerging technologies making investment conditions less appealing. Similarly, governments may not have access to financial instruments with compatible terms (insufficient tenors or PPP contract periods for project lifecycles, infeasible payback terms) for transportation projects. Moreover, governments in developing countries can face the underfunding trap in which cities that have poor existing systems with low revenue and poor creditworthiness are unable to attract investment (particularly private investment). This trap acts cyclically, further disincentivising public transport investments (WRI, 2017).

Insufficient government planning: insufficient government planning and/or capacity such as lack of duly set up and empowered local or metropolitan level urban transport agency or authority can further complicate the feasibility and risk of transportation projects. Projects which are not well planned, lack a good overall integrated plan or lack sufficient capacity with low emission technologies, may not be completed or can exceed timelines and budgets, risking political confidence for future low emission projects (ITDP, 2017a; Fi-compass, 2020). Poor planning can also lead to inequitable low emission public transportation networks that may not meet travel demands, particularly for underserved communities.

Limited political support: another common barrier is a lack of or limited political support, particularly over transportation project lifecycles. Capital investment in low emission transport projects is often greater than comparable transport project without low emission considerations and is seen as having greater financial and political risk, which can prevent decision-makers from committing to them while the broader cost of inaction remains the long-term risk. With changing administrations, project continuity and financing can suffer (ITDP, 2017a).

Limited private sector investment: the risk associated with long project life cycles and high costs of low emissions transport projects, impacts the willingness of private sector investment. This is particularly true for newer and rapidly evolving low emission technologies (such as electric powered and hydrogen fuel cell public transportation vehicles or heavy freight vehicles) which can have limited on-the-ground application and proven business models because the technology is not mature and there is no or poor developed support infrastructure. It can also be a pervasive issue in emerging markets where unorganized, loosely organized and/or federated informal transport providers with limited investment capacity and horizons willingness are present and dominant as they need to capture the longer-term total cost of ownership benefits of a shift to EV transportation.

Perceived risk from volatile public transport user behaviour or unpredictable flows of goods and logistics leading to fluctuating or insufficient revenue can further disincentivise private sector investments. Financial models for transport, particularly with new low emission technologies, depend on the expected use and return on investments. This is due to zero emission technologies often having a longer timeline and smaller margins (ITDP, 2019a; WRI, 2015). The volatility of the revenue stream over a long period of time (depending on consumer behaviour/individual usage, which is difficult to model) when capital investment is all upfront can reduce likelihood of investments.

3.1.1 Pathway 1: Accelerating shift to low emissions public transport

Vision. This pathway envisions an accelerated shift to highly efficient public transport networks that are based on electric or zero emission propulsion. Within this vision, public transportation systems serve as the backbone to urban mobility with non-motorised transport and micro mobility integrated with the public transport network, and supportive policy and finance for modal shift away from private motor vehicles to climate resilient public transport.

Table 3: Selected barriers to accelerating shift to low emissions public transport

Barrier	Description
Strong culture around single- or low-occupancy vehicles and subsidisation of cars/roads	In many countries, strong culture around vehicle ownership results in car-owning constituents having a loud political voice and highly subsidised private vehicle use, through fuel subsidies, free and subsidised parking, and other benefits. This makes vehicles attractive, as users are unaware of true costs and are disincentivised from shifting to public transport (WRI, 2017). Governments and investors may be discouraged from tackling the motorisation issue, as there can be significant political pushback (ITDP, 2019a; Moody & Zhao, 2019).
Limited or poor-quality existing infrastructure/ transport options	Existing transport infrastructure and services which undersupply local travel demand and/or are poorly designed or maintained do not encourage transit use. This can be especially pervasive in urban/metropolitan peripheries. It can result in low fare revenues for operators/governments, and many public transportation systems cannot cover the cost of operations by fares alone (ITDP, 2019a). Subsidies are necessary for many systems, and are important for maintaining quality of service and ongoing operations (Stucki, 2015; ITDP, 2019a). This negatively impacts general public acceptability of investing in transport (SLOCAT, 2021). Low quality systems also may not attract needed investments from the private sector.
Limited understanding of the essential role of public transport, NMT, and TOD	Many decision-makers and technical planners for transportation, in addition to the public, do not understand the benefits of comprehensive transportation planning (including NMT and TOD) and are unwilling to invest (ITDP, 2019a; IPCC, 2014). Some decision makers lack awareness of the benefits of soot-free and low or zero emission public transport (e.g., quantifying health and economic benefits from reduced air pollution).

Table 4: Possible actions for accelerating shift to low emissions public transport

Drivers	Possible Actions
Transformational planning and programming	• Strengthen existing public transport systems, walking, and cycling infrastructure by enacting comprehensive transportation action plans and strategies, including non-motorised transport (NMT), TOD, compact development, and integration of multiple modes, land-use/urban planning, and energy/fuel systems – supported by the institution and empowerment of adequate urban/metropolitan transport agencies or authorities. • Enact time-bound national and cross-national policies and strategies that enable transition to low emission public transport. • Enact or revise policies/regulations to empower municipalities to raise investments and revenue streams for a sustainable transition to low emissions, climate resilient public transport. • Embed Avoid-Shift-Improve actions at city level planning and investment models to create universally accessible, integrated, multimodal systems (Sum4All, 2019; ITDP, 2019a; UNECE, 2020; SLOCAT, 2021). • Implement traffic demand management (TDM) policies and practices (such as parking management, congestion pricing, carbon prices, reform of fossil-fuel subsidies, or more stringent fuel economy standards) that reduce single-occupancy vehicle use and incentivise public transit, walking, and cycling (ITDP, 2021). • Promote protections for pedestrians and cyclists for safe walking and cycling. • Implement minimum standards and/or regulations for data collection/share/use to track operations and improve the system (SuM4All, 2019;OECD, 2013; ITDP, 2019b).

Drivers	Possible Actions
Catalyzing climate innovation	• Support scaling up of business model and regulatory/pricing innovations that enable large scale modal shift to low emissions public transport. • Take anchor investment positions in scaling up new technology for low emissions, climate resilience NMT technology for example ICT or new ultra-low carbon materials for cycling, bus/train shelters infrastructure). • Support new technologies that improve quality of service and safety for transit passengers and encourage more people to shift to public transit (such as payment services, real-time GPS and travel information, emergency response, or climate resilient urban mobility infrastructure). • Offer financial instruments to support 'leapfrog' opportunities, in which underserved transit cities in LDCs can 'skip' over high emitting vehicles, and instead adopt new, low-to-no emission technologies such as electric, hydrogen, or second-generation biofuel powered vehicles for their public transportation systems.
Mobilization of funds at scale	• Encourage proper apportionment of risk-reward allocation between entities through blended finance for transport projects to increase private sector investment. • Leverage investments from GCF and other donor agencies to embed climate impacts in transport project and/or add climate-based technologies, strategies, or solutions which otherwise would not be included in planning in developing countries. • Create transparent financial mechanisms to encourage investors and win public trust and buy-in. • Utilise large infrastructure recovery financial packages and policies from Covid-19 to shift funding/financing away from construction of motorways and towards sustainable transport systems (SLOCAT, 2021). • Invest in national or regional funding facilities which can leverage greater financing from the public and private sectors, such as the GCF supported Green Growth Equity Fund project in India or the Shandong Green Development Fund in China When these are nationally or regionally based, these facilities can better understand local contexts.
Coalitions and knowledge to scale up success	• Build capacity (governance, planning, and technical) through trainings, exchanges, communities of practice, update of norms/guidelines, development of professional associations, and institutional development to enable local stakeholders to implement, operate, and maintain transport systems much more efficiently, sustainably, and in a more cost-effective manner (Sum4All, 2019; ITDP, 2015b; Fi-compass, 2020) potentially leapfrogging (see above) more advanced emission transport technologies. • Support national platforms that align all relevant stakeholders to a national vision for climate and transportation and reduce the complexity of stakeholder engagement for decision-makers. • Include urban residents in transportation planning, such as through participatory planning workshops, to acquire important local knowledge for the success of new systems, as well as to ensure that technical planners, policymakers, and decision-makers can make informed decisions.

3.1.2 Pathway 2: Rapidly electrifying transport systems

Vision. The focus of this pathway is the rapid electrification of the transport system, including supportive policy and business model innovations to catalyse systemic electrification (including electric transit vehicles as well as charging, grid, and depot infrastructure) and renewable energy power generation which will enable a paradigm shift in developing countries.

Table 5: Selected barriers to rapidly electrifying transport systems

Barrier	Description
Dependence on energy sector & electricity pricing volatility	Rapid electrification of the transport system is dependent on the ability of local energy grid infrastructure to generate, store, distribute, and charge EV infrastructure. Grids will have to be upgraded and expanded in many localities to meet the electric needs of pilots and full-scale fleets and improving the energy grid infrastructure in these contexts is a first step to electrification. It is important that urban areas understand how electrification of the transport sector will impact their electricity demand, and what future updates/extensions will be needed to meet this. In addition, in some localities the cost of electricity can be demand based and vary based on location and time of charging. This will influence the total cost of ownership for BEVs and is difficult to predict electricity needs and urban energy demand profile for specific times of the day. Cost fluctuations with the increase in energy demand with electrified transport as well as with expanded/upgraded grids should be considered. These risks with grid capacity, pricing volatility, and future uncertainties can impact investor willingness.
High upfront costs and concerns with new technology adoption	Electric vehicles such as buses can have 2-3 times the upfront cost of diesel buses. BEVs are just reaching economies of scale, and while costs are falling, the higher-than-average initial investments can be prohibitive. (ICCT, 2017; WRI, 2019; Bloomberg Finance, 2018).
Developing technologies and underperformance of BEVs	Range anxiety, shorter than anticipated battery lifespans, limitations in the likely available lithium supply versus projected and implied global battery production targets as well as the environmental impacts of increased lithium production volumes, higher than expected operational costs, and high replacement ratios (in which multiple e-vehicles replace one ICE vehicle – particularly a barrier for public transport fleets) are common concerns with electric vehicles (IPCC, 2014; ITDP, 2021). Some electric technologies are not performing up to expected standards as guided by original equipment manufacturers (OEMs), which can significantly impact the financial model (Eudy & Jeffers, 2019). This can likewise impact investor confidence.
Infrastructure deficit	In most developing countries, charging infrastructure is still nascent or just emerging and is not sufficient for rapid electrification.

Table 6: Possible actions for rapidly electrifying transport systems

Drivers	Possible actions
Transformational planning and programming	• Plan for long-term integrated, compact planning of transportation, land-use/urban planning, sustainable urban mobility plans (SUMPs), and of energy/fuel systems, to ensure efficient uses of energy and stable grid capacity. • Implement policies and subsidies to encourage the uptake of electric vehicles and discourage internal combustion engine (ICE) powered motor vehicles, such as carbon prices, fuel taxes, and reforms of fossil-fuel subsidies, among others (ITDP, 2021). • Implement data collection/share/use standards for electric vehicles to improve EV operations, which can significantly impact the financial viability, sustainability, and quality of service of EVs. • Implement outreach-knowledge dissemination activities to target specific audience groups and stakeholders and address challenges by providing information from the data collection and assessment activities, sharing the results for low-emission transport assessments and the removal of knowledge and awareness barriers. • Enact policy for financial incentives to enable investments in electric vehicle supply chains & charging infrastructure (Sum4All, 2019). This can include technology-based standards

Drivers	Possible actions
	and public policies to support charging infrastructure (OECD, 2013) and ensure sufficient renewable energy to cover the additional demand from the transport sector.
Catalyzing climate innovation	• Invest in new business models for charging of electric vehicles as a service. • Take anchor investment positions in electric charging and electric vehicle supply chain. • Encourage investments in lower cost, higher efficiency, recyclable batteries or electric traction systems in developing countries. • Encourage the refit of existing vehicles where appropriate. • Co-invest in new business models for e-BRT depots' infrastructure. • Concessional investments in at-scale pilots in new countries using existing technology to test purpose designed new business models for the country context.
Mobilization of funds at scale	• Pursue new business models, such as bus leasing, financial leasing (as used in Shenzhen), pay-as-you-save/use, and utility ownership (as in Santiago) for electric buses (ITDP, 2021; Global Innovation Lab for Climate Finance, 2018; Gomez Jattin, 2019). This can reduce volatility of revenue streams for operators/owners if implemented with due consideration to local context and case-by-case review of adverse and beneficial impacts. • Encourage risk allocation through blended finance for transport projects to increase private sector investment. • Create transparent financial mechanisms to encourage investors and win public trust and buy-in. • Utilise large infrastructure recovery financial packages and policies from Covid-19 to shift funding/financing away from construction of motorways and electrification for sustainable transport systems (SLOCAT, 2021). • Invest in national or regional funding facilities which can leverage greater financing from the public and private sectors, such as the GCF supported Green Growth Equity Fund project in India or the Shandong Green Development Fund in China When these are nationally or regionally based, these facilities can better understand local contexts.
Coalitions and knowledge to scale up success	• Provide new technology-specific technical training for all operators and maintenance personnel. • Identify and promote best practices for financial and climate sustainability of electrification projects, particularly for public transport vehicles with great scalability as with BEBs, and global knowledge centres for e-mobility projects. • Build capacity for electrification (governance, planning, and technical) through trainings, exchanges, communities of practice, and institutional development to enable local stakeholders to implement, operate, and maintain electric vehicles and systems much more efficiently, sustainably, and in a more cost-effective manner (Sum4All, 2019; ITDP, 2015b; Fi-compass, 2020). • Support national platforms that align all relevant stakeholders to a national vision for climate and transportation and reduce the complexity of stakeholder engagement for decision-makers. • Include urban residents in electric transportation planning, such as through participatory planning workshops, to acquire important local knowledge for the success of new systems, as well as to ensure that technical planners, policymakers, and decision-makers can make informed decisions.

3.1.3 Pathway 3: Supporting scale up of new generation zero emission fuels for not-yet electrifiable uses

Vision. The new generation zero emission fuels pathway envisions catalytic actions to scale innovative fuel technology that links renewable energy and new non-carbon fuel production (such as hydrogen and second generation zero emissions biofuels). In addition, the pathway includes supportive policy and innovative

business models to enable the shift to and scaling of cradle-to-grave zero emissions solutions. New generation zero emission fuel projects should be structured around the entire value chain, from decentralised biofuel/hydrogen production, storage, distribution, and not-yet electrifiable use of these new generation fuels.

Table 7: Selected barriers to supporting scale up of new generation generation zero emission fuels

Barrier	Description
Infrastructure deficit and need for restructuring	Green hydrogen is more expensive than other zero emission technologies and requires an entire restructuring of fuel distribution systems, which adds further expense. While biofuels do not, there must be construction of biofuel production facilities and a conversion of infrastructure from fossil fuels to biofuels (IPCC, 2014).
Lack of developed supply chains	Alternative fuels, particularly green hydrogen, are relatively new technologies with high costs, limited uptake, a relatively undeveloped market (including still emerging generation capacity relative to the volume of hydrogen needed), and limited supply chain.
Concerns with biofuels and biofuel competition with food supply and demand	Biofuels may link to deforestation, destruction of biodiversity, water consumption and are able to be cultivated by non-sustainable agricultural means (e.g., fertiliser and pesticide, peatland and grassland adverse impact) and can even impact the future need for natural resources and ecosystem functions. Biofuels can compete with food supply, increase food prices, and affect food security (IPCC, 2014). Biofuel competition can disproportionately impact poor communities in the global south and increase land demand for agricultural expansion (Tomei & Helliwell, 2016). First generation biofuels (produced with sugar, starch, and oil-based feedstock) are a greater concern for food supply than second generation biofuels (from agricultural and forest residues, waste, and energy crops not a part of the food/ feed supply chain) (Di Lucia & Ribeiro, 2018). Governments may not be as encouraged to pursue these higher political and financial risk alternative fuels.
Concerns with environmental effects of alternative fuel systems	First generation biofuels do not deliver significant emissions reductions and environmental costs may outweigh the benefits. (Center for Sustainable Systems, 2020). First generation biofuels also increase water usage in addition to land use. The vast majority of hydrogen is currently produced using coal and natural gas (IRENA, 2019). While grey hydrogen (produced with high CO2 pollution), and blue hydrogen (produced with CO2 capture and storage) are not environmentally recommended, green hydrogen (powered entirely by RE with zero production emissions) is seen as the best climate-based hydrogen option (World Energy Council, 2019; Dawood et al., 2020). However, green hydrogen only represented 1% of all hydrogen produced in 2020 globally and would take significantly more technological and financial development than electric solutions (IRENA, 2020). Hydrogen production requires water usage and can output water and land pollution harmful local environs. In addition, hydrogen production is energy-intensive and about 20-40% of energy is lost in the process (Chatterji & Walkman, 2021). These risks may similarly deter investments and interest in alternative fuels.

Table 8: Possible actions to supporting scale up of new generation zero emission fuels

Drivers	Possible actions
Transformational planning and programming	• For vehicles which cannot yet be electrified (such as long-haul freight), implement supportive policies and practices for the diesel to alternative zero emissions, climate safe fuel (IPCC, 2014; SLOCAT, 2021) or modal shift (e.g., trucking to rail).

Drivers	Possible actions
Catalyzing climate innovation	• For vehicles which cannot yet be electrified (such as long-haul freight), support catalytic investments in emergence and diffusion of zero emission biofuels which are safe from an environmental perspective (biodiversity or environmental risks) and from a social perspective (adverse impacts concerning land rights or food security). • Invest in integrated business models along the entire value chain, such as, for hydrogen, including the production, distribution, storage, filling stations, vehicles, and vehicle financing. Such a business model can be similar to the pay-per-use model utilised for hydrogen trucks by Hyundai in Switzerland, which do not require initial investments (Reuters, 2020).
Mobilization of funds at scale	• Catalyse supportive finance to strengthen the value chain of next generation biofuels and green hydrogen (only where electrification cannot be adopted). • Create transparent financial mechanisms to encourage investors and win public trust and buy-in.
Expansion and replication of knowledge	• Build and test business models that enable adoption while alternative fuel markets scale, such as pay-as-you-use/save models. • Build capacity (governance, planning, and technical) through trainings, exchanges, communities of practice, and institutional development to enable stakeholders to implement, operate, and maintain new generation alternative fuel-powered transport systems much more efficiently, sustainably, and in a more cost-effective manner (Sum4All, 2019; ITDP, 2015b; Fi-compass, 2020).

3.2 Sustainable development potential: co-benefits

Low emission, electric- and zero emission alternative fuel-powered transportation projects and programmes which build and strengthen sustainable transportation systems may offer significant co-benefits. The balance of co-benefits and other potentially more adverse impacts must be optimized and reviewed on a case-by-case basis but generally expected co-benefits include:

- Environment: improved health and ecosystem from reduced urban air, water, and land pollution; and reduced land-use competition (IPCC, 2014; OECD, 2013) possibly with the exception of biofuel-based projects.
- Social (including health): reduction of most pollutants and increased air quality, as well as reduced noise pollution; improved road safety; increased physical activity from non-motorised mobility; optimised land usage; increased access to social and economic opportunities; improved access to basic food, water, health and shelter needs; increased access to affordable mobility and decreased mobility burden on lower socio-economic groups who pay a greater percentage of income on transport (IPCC, 2014; OECD, 2013; SLOCAT, 2021; WHO Europe, n.d.).
- Economic: decreased economic loss and percentage of GDP dedicated to preventable injury and death from motor vehicle collisions; increased productivity due to reduced congestion and time spent travelling; more efficient energy and resource use; and multiplier effects (increased jobs and returns) for investments in walking, cycling, and public transit (IEA, 2013; IPCC, 2014).
- Gender: greater access for women, particularly in urban areas in developing countries; increased diversity and flexibility of mobility for caregivers (the majority of whom are women, who average more trips to more destinations than the average male commuter); and decreased percentage of women who cannot access the labour market given lack of transportation (ITDP, 2018a; ITDP, 2018b; BVLF, 2019; ILO, 2017; SLOCAT, 2021).

3.3 Role of GCF in financing the paradigm shifting pathways

These key actions for each of the paradigm shifting pathways, across the four pillars of the GCF Strategic Plan 2020-2023 are summarised in Figure 4 followed by a detailed description of each driver.

Figure 4: Possible actions for each pathway following the four pillars of the GCF Strategic Plan

Sector		Actions across the drivers of the GCF Strategic Plan			
Low emission transport		**Transformational planning & programming**	**Catalyzing climate Innovation**	**Mobilization of finance at scale**	**Coalitions & knowledge to scale up success**
Paradigm shifting pathway	**Accelerating shift to low emission public transport**	• Prioritise TOD planning with electrified public transport powered by RE • Integrate public transit with NMT (protected bike lane networks, bikeshare systems, charging infrastructure, complete streets) • Develop national decarbonisation roadmap and central paltform for public transport • Integrate multimodal pulibc transport (fare/payment-ticketing/smart card), IT integration, physical integration	• Introduce policy/strategies to shift drivers to walking, cycling, public transport • Develop big data transport solutions for end-to-end integration and real-time-performance services (smart fare/multimodal systems with easy transfer infrastructure/payment) • Develop TDM strategies (parking management, electronic road pricing, LEZ/ZEAs) • Repurpose motor vehicle space to NMT, public transport, housing or green space	• Support syndication for mobilising public/private finance for BRT, LRT, MRT with min revenue/risk guarantees • Enhance credit and guarantees for municipal bonds • Develop innovative public-private financing models with investment in non-revenue infrastructure (PPPs, pay-as-you-use/save, vehicle leasing, utility ownership) • Introduce equity/green financing to multiply options and understand local challenges/opportunities	• Introduce standards and specification for emissions that encourage high occupancy public transit, walking, and cycling over private vehicles • Develop institutional capacity (workshops, trainings, exchanges, community of practice groups)
	Rapidly electrifying transport systems	• Introduce transition strategies/policies (grid-to-transport and carbon pricing, preferential access, purchase incentives) • Pilot with plan for scale up elecric public transit (vehicles, depots, charging infrastructure) • Develop procurement policies for commercial electric vehicles • Greening of charging infrastructure with integrated RE • Develop national decarbonisation roadmap/platform for unified vision	• Innovate business models for charging and storage as services • Innovate energy storage and vehicle-go-grid-to-depot service models • Build utility-operator partnership models for end-to-end electriciation • Prioritise charging infrastructure for electric transit uptake (buses, paratransit vehicles, high travel modes) • Develop cost-effective charging • Explore secondar market for batteries	• Develop lease PPPs (batteries, buses, operations) for changeover to electric • Support syndication for vehicle-to-depot electrification • Anchor investment in supply chain for commercial Evs • Integrate new stakeholders into funding/financing (utilities, new investors for leasing) • Explore options to bring in OEMs into financing (deferred payments or vendor finance schemes)	• Develop institutional capacity (workshops, trainings, exchanges) • Establish facilities, community of practice groups, or platforms to share lessons learned and best practices • Electric grid analysis for electric public transit capacity (C40, 2020)
	Supporting scale up of new generation zero emission fuels	• Use a cradle-to-grave planning approach for alternative fuel adoption to avoid encouraging growth of fuels which have negative impacts on resource use and overall emissions • Address regulatory standards • Unify vision through national decarbonisation platform	• Integrate decentralised RE to hydrogen production and storage solutions • Pilot or implement small-scale adoption to trial new technologies and infrastructure deployment • Utilise local resources for biofuel generation, particularly those removed from food supply competition (in other words, cattle manure as a deriative versus corn as direct competition)	• Introduce aay-as-you-use/save models for hydrogen or next generatopm zero carbon fuels • Integrate new stakeholders into planning and funding/financing • Allow subsidies and no-to-low interest financing for initial adoptions as technology develops	• Support additional research for risk reduction • Develop institutional capacity (workshops, trainings, exchanges) • Establish facilities, community of practice groups, or platforms to share lessons learned and best practices

4 Financing paradigm shifting pathways

GCF funding plays a critical role to catalyse public and private capital, particularly through de-risking instruments and in countries where markets are nascent or less mature, providing appropriate institutional, planning and policy support to build the public and private sector's focus on low emission transport.

GCF has a comparative advantage in financing low emissions transport in developing countries in that its primary aim is to de-risk investments through concessional finance at its point of greatest need. GCF can take on higher financial risks to catalyse rapid transition to low emission transport in developing countries. This unique financial mandate enables GCF to pioneer investments in developing countries and to deploy donor finance in highly innovative ways.

4.1 Role of GCF in financing the paradigm shift

At present, nine out of 177 total GCF projects and USD531.7 million in finance out of the USD9.8 billion committed are directed toward low emissions transport. Transformative low emission transport projects that were catalysed with GCF funding include the LRT system in San Jose, Costa Rica, and the BRT system in Karachi, Pakistan, which was the first GCF approved transport project. For the nine current transport projects, GCF will have an estimated impact of 382.7 Mt of emissions avoided.

This section provides an overview of financing trends, models, and opportunities to catalyse and scale up public and private investment in support of the paradigm shift identified in Section 2.

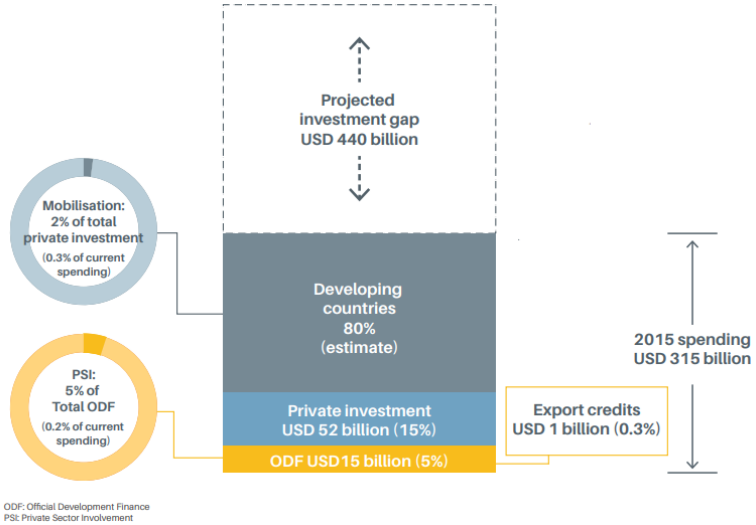
The most common financial instruments from GCF include grants, loans (senior and subordinate), equity, and guarantees (GCF/B.22/Inf.12). Local currency lending and climate bond issuance are not commonly used, but GCF may pursue these for future investments. Grants and loans in particular are compatible with transport sector needs. The high upfront capital costs of transportation projects require significant contributions beyond government budgets, and GCF is well suited to provide financing for these initial investments with clear climate rationale, especially for projects seen to have higher risk, such as emerging or innovative business models. GCF aims to use its scarce climate finance resources to attract public and private capital through a combination of its instruments to reduce risks (e.g. policy de-risking), transfer risks (e.g. financial risks transfer), compensate for residual risks (such as incentives), and strengthen local capital markets. In addition, GCF is well-positioned to support capacity development to spur long-term scaling of sustainable transportation systems, as well as increased private sector finance in LDCs by leveraging blended finance.

4.2 Climate finance landscape

The Transport sector needs an estimated USD 2.7-3.0 trillion annually from 2016-2030 to reach critical climate goals and 60-70% of this finance needs to be in emerging economies (SLOCAT, 2021; OECD, 2013). Governments often do not have sufficient funding, and therefore need access to low-cost debt finance, such as bonds, loans, and grants from MDBs, NDBs, IFIs, and export credit agencies (ITDP, 2015b). Private investments in transport finance are uneven, with LDCs with low creditworthiness sometimes unable to access capital for upfront and ongoing costs, such as in SSA. Prior to the Covid-19 pandemic, over 60 countries could not access capital with interest rates lower than 18% for two-year projects (GCF, 2021d). Of the estimated USD 440 billion annual financing gap to achieve the 2030 transport SDGs, this varies largely by region: an estimated 0.8 trillion is needed for Africa, while Asia (1.6 trillion) and the Americas (6.0 trillion) represent much higher gaps (SLOCAT, 2021). In this sense, while less total finance is needed in some regions, it is critically necessary to spur continuous and reliable long-term investments.

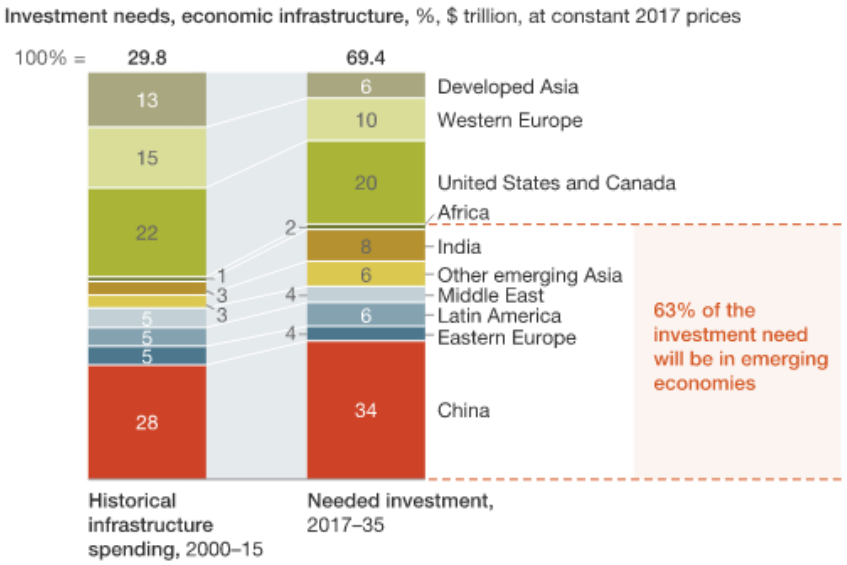
The transport sector is at an intersection between many international donor interests such as energy, climate, clean air, and sustainable development, among others. This creates opportunities for transportation projects (finance from various organisations and sectors), as well as challenges (competing donor visions, meeting various donor criteria/needs, and lack of unified vision).

Figure 5: Investment gap in the Transport sector from 2015 to 2030



Source: SLOCAT, 2021

Figure 6: Infrastructure investments, including transportation, are shifting to emerging economies



Source: Woetzel et al., 2017

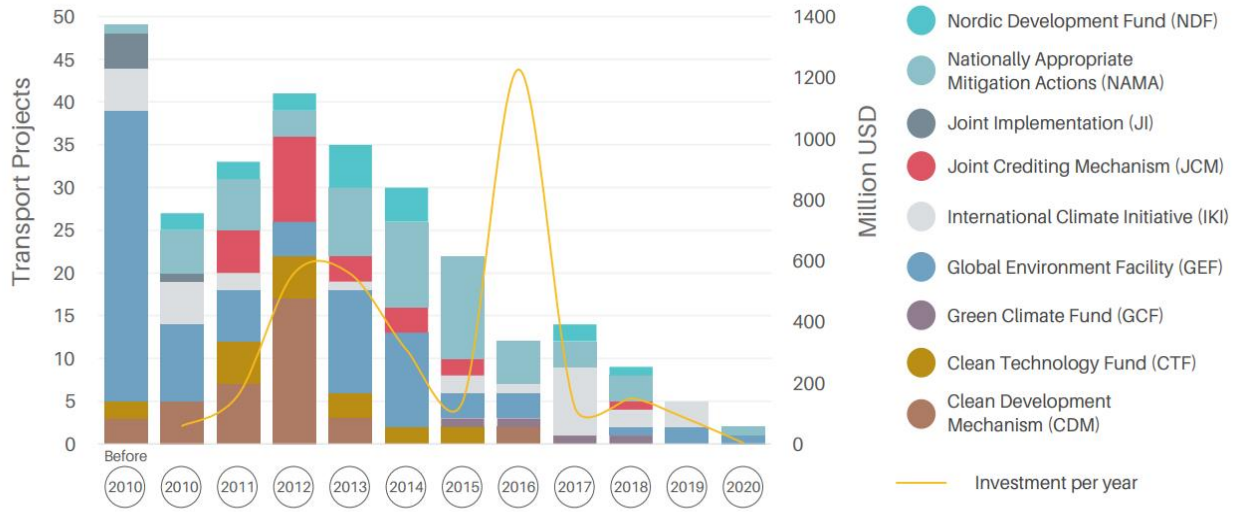
4.3 Co-financing

For the Transport sector, blended finance has been proven a successful financial strategy across a variety of road-based transport modes (SLOCAT, 2021). It is commonplace for multiple financial stakeholders to partially fund projects, such as with the BRT systems in Bogota, Quito, Dar Es Salaam, and Delhi (ITDP, 2017a). Climate funds generally provide a smaller portion of the overall assisted loans/grants, often around 5-15% of the overall budget (Binsted et al., 2013; GCF, 2018; GCF, 2021a). Empirical evidence shows that the private sector is more willing to invest in blended finance projects than non-blended projects (GEF, 2020). GCF is well suited for projects with co-financing alongside public and private entities. While no minimum amount of co-financing is required, all current GCF transport projects involve co-financing, and this method can maximise the impact of GCF financing.

4.4 Complementarity and coherence

GCF may work alongside organisations with similar visions and related sources of finance, such as GEF, CTF and GFDT and others to better achieve climate goals (GEF & CIF, 2020). Collaborative efforts may include coordinated support of major initiatives/programmes, facilitating national investment planning, or supporting financial facilities/platforms (GEF & GCF, 2021). For the Transport sector, this may be major regional initiatives or major financial facilities for paradigm shift, such as freight upgrading, electric bus fleet conversions, scaling charging in infrastructure, or other widespread coordinated efforts to reduce emissions and improve energy efficiency for road-based public transit and freight. When there is concerted effort on behalf of these organisations to build off of the others' work, by aligning projects to build off of each other, combining financing, or creating knowledge learning and sharing initiatives, positive impacts can be achieved (GEF & CIF, 2020). Given the financing gap in the Transport Result Area, these synergies should be pursued. The diagram below identifies related organisations and their level of involvement with the transport sector, which has declined in the past years.

Figure 7: Climate finance projects and investment volume by year



Source: Adapted from SLOCAT, 2021 from various sources. The ITF similarly lists key organisations in order of climate finance available for transport: GEF, CTF, GCCA, IDB SECCI, ADB CCF, ADB CEF, Japan Fast Start Fund Initiative, ICI, CDM, and voluntary carbon market (ITF, 2019). GIZ also provides a breakdown of relevant AEs (Binsted et al., 2013).

GCF, NDAs, and AEs can strategically collaborate to strengthen local capacity development (for political, financial, and technical expertise); finance initial, otherwise prohibitive investments into transport systems; leverage additional financing targeting LDCs and SIDS by establishing equity funds; and developing guidance for comprehensive planning that meets cross-sectoral goals. Opportunities for work alongside other IFIs, MDBs, and additional actors is outlined in Section 5.2.

4.5 Key Opportunities for Finance Instruments

4.5.1 Public Sector Finance

Where green interventions in low emission transport are being implemented by the public sector (either national government or regional/local government ministries or agencies), GCF funds can be deployed to overcome specific risks (such as policy, revenue, construction, viability, and others) for public sector projects. The financial can be structured using a combination of instruments include non-reimbursable or reimbursable grants, loans, and guarantees addressing country and project specific barriers to scaling up finance for low emissions transport projects.

The long-term character of GCF capital, as well as a comparatively flexible approach to terms and conditions relative to the risk profile of the intervention, renders GCF financing attractive for long-term transport infrastructure projects and programmes.

Figure 8: GCF public finance for acceleration of charging infrastructure implementation

Example for illustration purposes only

Provincial and local government investment in charging infrastructure and integration with grid network for rapid scale up of electric mobility.

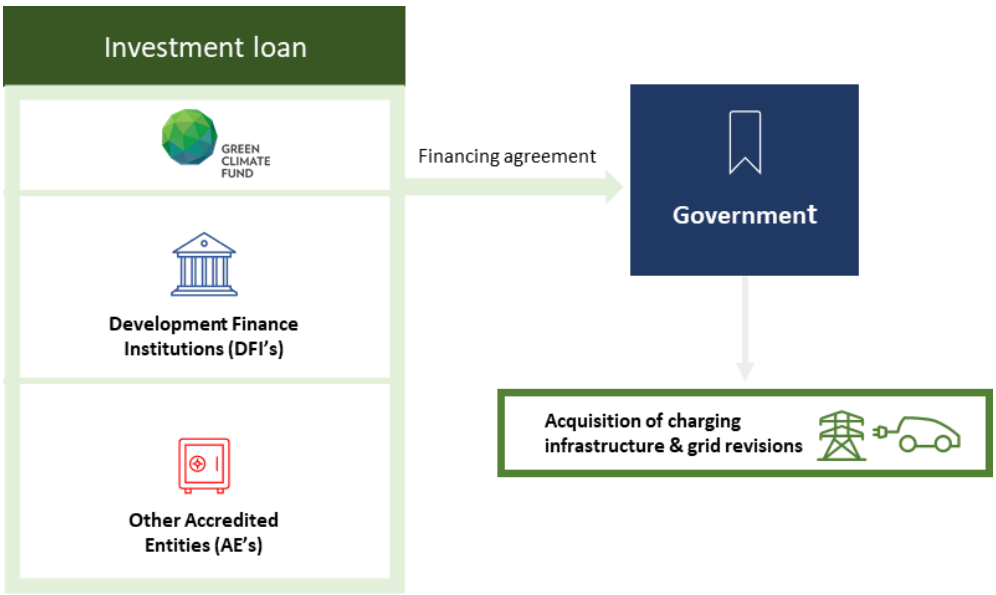
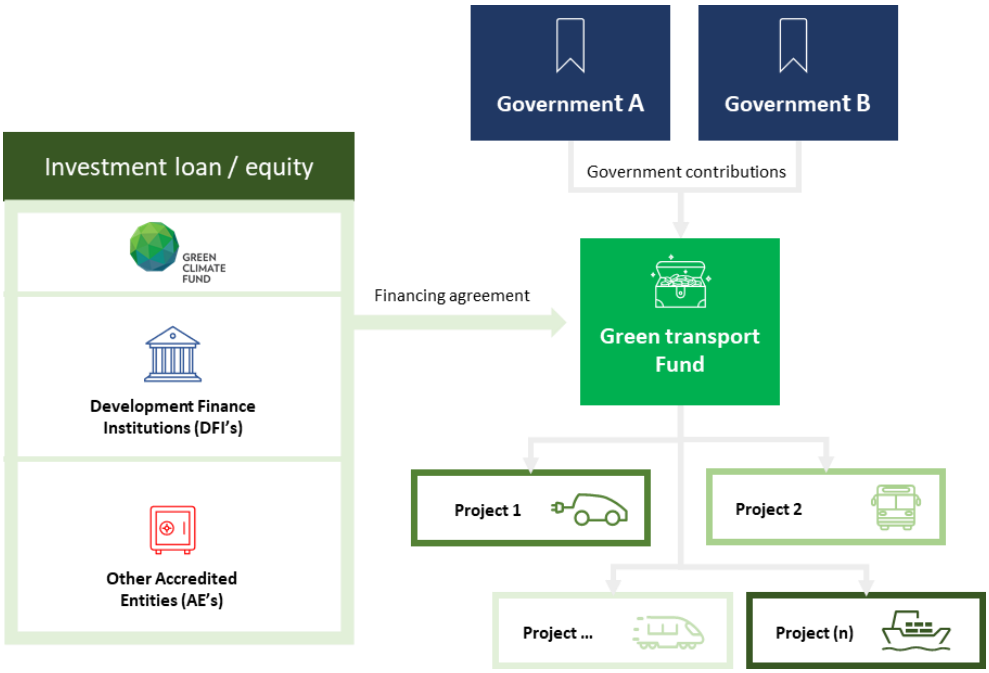


Figure 9: Fund/programmatic investing through green transport fund

Example for illustration purposes only

Green Transport Fund set up by cooperating funders in a low emissions, cross-border transport, and logistics corridor. The fund targets a set of well-defined interventions which together result in a holistic "green transition" of a large share of the movement of goods and people across the corridor. GCF funds can be used to crowd in other public and private funding.



The interventions may include combination of low emissions fleet/vessel renewal (heavy good vehicles and inland waterway shipping) and energy infrastructure (charging and green hydrogen filling).

4.5.2 Private Sector Finance

GCF offers catalytic financing to crowd in private capital through a combination of debt, equity and guarantees for technology, innovation, and development of financial markets, value chains, and MSME. Private sector funds can also be deployed for developed of financial products by local commercial banks or financial institutions.

Greening of Inland Waterway Transportation

Example for illustration purposes only

Green hydrogen fuel cell-electric powered inland water shipping can be financed by the private sector. Inland shipping companies are generally small entrepreneurs without the access to financing needed for such a transition. GCF can work with AEs in order to extend line of credit or credit enhancement instruments to shipping companies looking to finance the shift to green vessels, conditional on significant co-financing by third parties joining such a programme.

4.5.3 Capacity Building and Technical Assistance

Green transitions in transport do not only require new technologies and new actors, they also demand transition of investment environment that value the impacts created by low emissions transport. Transformational planning and programming can receive technical assistance grants which in turn lower policy and regulatory risks and mobilise private capital. TA components are integral part of GCF proposals.

Capacity building and technical assistance need not always target the 'core function' of an intervention. In addition, there are often necessary conditions that are just as critical to a successful intervention. The lack of a necessary skilled technical maintenance and management workforce in relation to new green infrastructure

is a good example of a gap in necessary conditions that could merit (a role for GCF in) a technical assistance programme in support of specific interventions.

4.5.4 Readiness and Project Preparation Facility

In addition to supporting governments in capacity building and technical assistance, GCF can also take a proactive and catalysing role by providing grants for project preparation and development activities. These activities include project definition and scoping, (pre-)feasibility studies, transaction support etc. in order to take away potential (financial) barriers for governments to undertake projects with new and unproven technologies. The TA grant could therefore increase the chance of realising the project.

4.5.5 Public Sector Investment Subsidy

GCF investment subsidies plays a catalytic role enabling public sector entities to implement innovative and transformative projects that would otherwise proof difficult to impossible to fund.

This is particularly relevant in the transport sector where technology innovations for greener transport services and infrastructure have in many cases not yet reached economies of scale and are still on an early section of the downward sloping cost curve.

In cooperation with partners, GCF can make viability gap funding available in the form of grant funding in order to meet the portion of the capital investment requirement which cannot be covered by the direct revenue potential of the intervention.

4.5.6 Public Sector Borrowing Credit Enhancement

In addition to revolving and non-revolving financing (the so-called 'funded instruments'), GCF can also offer credit enhancement instruments for public sector borrowing, such as partial sovereign loan or bond guarantees in order to increase capacity for the country to borrow other public sector funding for financing the transport sector paradigm shift.

4.5.7 Private Sector Borrowing Credit Enhancement

Similar to credit enhancement solutions for public sector borrowing linked to green transformations, GCF can offer guarantee products for private sector borrowing credit risk – if and where related to loan agreements, offtake agreements or other contractual obligations involving a public sector entity (government or parastatal) as one of the two counterparts.

5 Case studies

The following case studies demonstrate how public sector financing can support climate-based solutions in the low emission transport result area.

5.1 Pakistan: Green BRT in Karachi (FP085)

Theme	Assist Karachi in building a zero emission BRT system that is safe and accessible to all.		
Country	Pakistan	Project size	USD 583.5m (large) –
Emission reduction	2.6Mt	GCF financing	Loan: USD 37.2m Grants: USD 11.8m
EES category	Category A	Co-finance	Loan: USD 442m Grants: USD 92.5m
Accredited entity	Asian Development Bank	Co-finance ratio	91.6%
Approved	October 2018	Completion	March 2024
Information	https://www.greenclimate.fund/project/fp085		

Impact potential. Karachi, Pakistan has a population of 14.9 million people who will indirectly benefit from improved air quality, access, and safety, among other outcomes from this project, while 1.5 million will directly benefit from this change to the transport system. This project entails a 30km state-of-the-art BRT system, cycle lanes, a bike share system, integrated e-pedicabs for last-mile connectivity, and improved pedestrian facilities (GCF, 2018). Importantly, the BRT fleet will be powered primarily by bio-methane produced in new biogas production facilities from local cattle manure. The project is expected to mitigate 2.6 Mt CO2e over 30 years and is set to provide a replicable basis for future projects in other cities in Pakistan (GCF, 2018).

Climate fund additionality. The lower pricing of GCF loans compared to other IFIs (for this project, a 20-year tenor at 0.75%) enables the borrowers to include additional adaptation and mitigation measures otherwise may not have been possible. GCF support will directly finance the installation of bike sharing and NMT last-mile connectivity vehicles along the BRT corridor (in the form of a grant) and the construction of the biogas production facility (loan), and partially finance the adaptation costs for the BRT infrastructure (grant) and the hybrid BRT biogas bus fleet (loan) (GCF, 2018).

Country ambition. Pakistan's Nationally Determined Contribution (NDC) for the Paris Climate Agreement is stated to be a 20% reduction in emissions below the business as usual (BAU) scenario by 2030 (Climate Analytics, 2019).

Barriers addressed. This project enables Pakistan to overcome the high cost of hybrid buses, higher risk of new technologies (such as the biogas plant which is a new technology with complex organisation, legal, and contractual arrangement), and subsequent lack of interest and investment from the private sector, given that this work has not been done in the country before (GCF, 2018).

Approach to paradigm shift. This project features multiple factors for paradigm shift, including innovative use of local renewable resources (creating biogas from cattle waste within the greater Karachi metropolitan area), public transportation network restructuring (enabling sustainable future growth), inclusion of NMT facilitates, and integration between walking, cycling, and the BRT system infrastructure (targeting Avoid and Shift strategies for emissions reduction) (GCF, 2018).

5.2 Costa Rica: Light rail transit for the Greater Metropolitan Area (FP166)

Theme	Assist Costa Rica in building a 98% renewable energy electric light rail transit system in San José's Greater Metropolitan Area.		
Country	Costa Rica	Project size	USD 1.9b (large) –
Emission reduction	7.6Mt	GCF financing	Loan: USD 250m Grants: USD 21.3m
EES category	Category A	Co-finance	Loan: USD 300m Equity: USD 250m Loan: USD 1.052b
Accredited entity	Central American Bank for Economic Integration (CABEI)	Co-finance ratio	85.5%
Approved	July 2021	Completion	TBD
Information	https://www.greenclimate.fund/project/fp166		

Impact potential. Of the 10.9Mt CO2 emitted in Costa Rica in 2015, 51% of these were from transportation (GCF, 2021a). This electric-powered LRT project will improve local air quality and transport service for 63 million passengers and 2.7 million residents of the larger San Jose metropolitan area (GCF, 2021a). This project will avoid 7.62 Mt C02 over the project lifespan (GCF, 2021a).

Climate fund additionality. The lower pricing of GCF loans compared to other IFIs (for this project, a 40-year tenor at 0.00%) enables the borrowers to include these additional measures otherwise may not have been possible (GCF, 2021a). GCF financing will also support additive measures including NMT and connectivity/accessibility measures with long-term behavioural change impacts, which otherwise would not have been included in the project (GCF, 2021a).

Country ambition. Costa Rica is committed to a maximum of 9.11 Mt CO2 emissions in 2030, representing a 16% decrease from the 2015 level (Costa Rica, 2020). In addition, the country is committed to an absolute maximum of 106.53 Mt CO2 emissions from 2021-2030, and sims to achieve net zero emissions by 2050 (Costa Rica, 2020).

Barriers addressed. This project addresses the high private vehicle use in the country (Costa Rica has one of the highest vehicle shares per 1,000 inhabitants globally) and enables Costa Rica to overcome the high cost and risk of new rail transit projects (GCF, 2021a).

Approach to paradigm shift. By repurposing the existing, low-efficiency rail right-of-way into highly efficient, sustainably powered LRT in the greater San Jose metropolitan area, this project significantly reduces emissions from the highest polluting sector nationally, improves mobility for the most populated region of the country, and provides an example for other RE projects in Costa Rica, given the ample supply of renewable power. In this way, it capitalises on the Shift (creating accessible, sustainable public transportation that provides better quality of service and encourages modal shift) and Improve (upgrade existing infrastructure to renewable powered LRT) strategies.

6 GCF investment criteria for impactful proposals

For the Transport Result Area, GCF aims to reduce emissions through increased access to low emission transport, through supporting low-and zero emission public and private transport systems (GCF, n.d.). Quality GCF proposals must meet the investment criteria based on the GCF results and investment framework. Project developers should refer to GCF project preparation information and further instructions from the GCF programming manual. The following subsections outline guidance for proposals, for each of these six criteria.

6.1 Impact potential

Under the low emissions transport areas, GCF has a stated goal to support technologies and proposals that have a high mitigation potential. To deliver this impact there are three key technologies that can enable maximum impact:

- Shift to low or zero emissions public transport options that are seamlessly integrated with non-motorised transport and micro-mobility transport solutions.
- Electric charging infrastructure and supply chain for electrification.
- Zero emission fuel technologies for not-yet electrifiable uses.

6.2 Paradigm shift potential

Paradigm shift potential is the degree to which the proposed activity can catalyse impact beyond a one-off project or programme investment. When preparing proposals, AEs and NDAs should focus on the project planning and narrative in addition to modelling, as this is how transportation projects scale up and maximise the additionality potential of climate finance. GCF project proposals should meet GCF sub-criteria for assessing paradigm shift (GCF, 2021b):

- Scale - Proposals should identify the project path and plans for how the work will scale up (be able to articulate a compelling theory of change), in addition to the benefits the project will have at scale (meaning significant increases in quantifiable results beyond the singular project). For transportation, this will include estimating mitigation and adaptation impacts, among others. It is worth noting that impact estimates will be predictions, so emphasising a robust plan for how to scale the project/programme strategy or technology implementation is important.
- Sustainability - Proposals should identify how the project's impacts, specifically as a result of GCF investments, will create sustained benefits and can spur additional resilient climate practices for mitigation/adaptation in the transport sector. This could include development of local sustainable industry, restructuring of transport institutions for longevity (particularly for the operations and maintenance of GCF funded projects), or other changes that lead to climate-oriented medium-to-long term impacts. Proposals should address local risks to climate change, opportunities (such as ample renewable energy potential), and how the project/programme enables long term mitigation and adaptation measures.
- Replicability - Proposals should outline in detail how GCF investments will support key structural elements of the project or programme within the Transport sector and related sectors that can be replicated nationally and internationally. As transport contexts vary widely by country and region, it is important to address in what contexts the project/programme could be replicated.

In addition to these sub criteria, projects should be reflective of local challenges, visions, and stakeholders. In particular, underserved and/or vulnerable communities should be represented in project planning. Furthermore, the project planning should consider clearly defining the roles of the different stakeholders to ensure it is well implemented and managed.

6.3 Sustainable development potential

Proposals should address how actions align with national SDG priorities and the GCF pathways, as well as highlight expected environmental, social, gender, and economic co-benefits that align with national priorities. As the majority of people currently live in cities and this will continue to rise, particularly in developing countries, proposals should outline how a given project/programme will prepare localities for adaptive mobility solutions for the future and mitigate emissions for sustainable development. In particular, proposals should identify how they enable the country to decouple economic growth and transportation emissions.

Sustainable development co-benefits should be outlined. For the Transport sector, this will often include social and health, economic, and environmental co-benefits. Common social and health co-benefits include improved universal accessibility and mobility for all, decreased gender inequality, improved air quality, reduced injury and death from motor vehicle collisions, and healthier populations. Environmental co-benefits

may include increased use of renewable resources, decreased resource waste, and reduced water pollution. Economic co-benefits often include greater economic and social opportunities for various groups of people in cities (job creation, access to jobs, poverty alleviation, increased incomes and GDP), improved quality of life and increased attractiveness of cities for investors. In this sense, co-benefits from projects of transport, and their integration with other sectors development, may be equally or even more important than the carbon mitigation benefits.

6.4 Recipient needs

Recipient needs address the vulnerability and financing needs of the beneficiary country and population. National and local contexts should be taken into consideration for project proposals, including local needs, challenges, and opportunities for climate change, transportation development, and access to climate finance for the recipient. For LDCs and SIDS countries, concerns for the low emission transport sector may focus on imminent, non-climate-based challenges such as congestion, long travel times, lack of access, and air quality. It is important that along with adaptation measures, mitigation measures are included in proposals to align with GCF targets, as these are often less of a priority for LDCs and SIDS. Given the cross-sectoral nature of the transport sector, proposals should demonstrate how transportation projects will achieve advancement not only for the transport sector, but also for urban planning and sustainable development, energy, economic development, and other sectors.

6.5 Country ownership

Proposals should address the beneficiary country ownership of, and capacity to implement, a funded project or programme, policies, climate strategies, and institutions. For transportation, this is important given the ongoing effort (financial, political, technical) required to build, operate, and maintain transportation systems. Transportation projects often exceed budget and timeline expectations, and thus a country's ability to mitigate risks and implement projects within the allocated budget and timeline are important. In addition, proposals should discuss how the project will be developed in consultation with local stakeholders. Given the high capital costs of transportation projects, it is essential that local knowledge is integrated in the project, that decision-makers are in line with local stakeholders and the public, and that stakeholders can be involved in the technical, financial, or other supportive aspects of the project/programme (such as local utilities involved in electrification projects). Proposals for transportation projects should align with the given country's national and local plans, policies, and institutional structures, both for climate and transportation actions, and reasonably address gaps in capacity for implementation, operations, and maintenance. For example, proposals outlining how the given project/programme aligns with country NDCs.

6.6 Efficiency and effectiveness

Efficiency and effectiveness include the economic and financial soundness of the programme/project alongside the cost efficiency and effectiveness to achieve the expected climate impact. Investment in transportation projects can have significant reductions of transportation emissions at the time of implementation, but more importantly can significantly prevent growth of emissions, particularly in LDCs that are constructing their transportation systems in their initial and/or more formalised form. Transportation projects can have a much higher cost for each tCO2eq than other sectors (measures for EVs and HDVs in urban areas can exceed 200 USD2010 per tCO2eq), and even highly efficient transport projects which represent a relatively small investment compared to average transport projects are higher than other sectors' costs (IPCC, 2014). For example, the Pakistan BRT project has an estimated mitigation cost of 224 USD per tCO2eq, and a GCF cost of 19 USD per tCO2eq (GCF, 2018). Similarly, the Costa Rica LRT is estimated to cost 246 USD per tCO2eq, and a GCF cost of 36 USD per tCO2eq (GCF, 2021a). Other types of projects that focus on important 'softer' solutions, such as policy and capacity development are difficult to quantify emissions reductions overall (UNFCCC, 2018). However, while transport projects may have a higher abatement cost than other sectors, investment in sustainable mobility projects should be encouraged to avoid even higher corrective investments

in future years. In addition to significantly reducing GHG emissions, these interventions can have a huge multiplier effect of shifting local spending to low-carbon projects. This includes increased employment and economic activity, among many other benefits (IEA, 2020a; APTA, 2020).

Proposals should assess financing risks for the given country, which may include political instability or divided political support for transportation, market and currency fluctuations, lack of existing revenue to fund ongoing operations and maintenance (i.e. need for long-term investment), and insufficient stakeholder support, among others. In addition, they should clearly identify estimated cost efficiency of the expected impacts (i.e. cost per tCO2eq). If applicable, proposals should indicate how investments in capacity building could unlock big additional opportunities for climate impact by creating the conditions and institutions needed for additional finance opportunities. The GCF portfolio and Transport Result Area profile can provide examples of efficiency and effectiveness outlined in ongoing projects. However, as GCF support of transportation projects is relatively nascent, similar projects by AEs can be further consulted for comparative examples.

6.7 Coalitions and networks multiply GCF Transport portfolio impact

International entities with similar or overlapping agendas with GCF, such as national and multilateral development banks and finance agencies, act as key partners for GCF in financing transport projects. A brief overview of two key partner groups for GCF includes:

Climate funds (e.g., GEF, CIF) - These organisations have greater focus on the climate mitigation and adaptation measures of projects, often providing supportive financing to spur innovative climate technologies and strategies, alongside larger investments from the private sector and development banks. Finance from these organisations (outlined in Figure 7) in the transport sector fluctuates greatly, but increasingly there is interest in the benefits of comprehensive planning over a more narrow scope on climate mitigation for measuring project achievement (GEF, 2019). Other climate funds, such as GEF, may have much smaller investments and target different actions than GCF (e.g., supporting pilots and smaller projects pre-scaling up fleets).

NDBs and MDBs (e.g., World Bank, ADB, IDB) - While portfolio compositions for development banks vary, it is likely that projects will be more oriented towards infrastructure expansion, including road infrastructure for urban, peri-urban, and rural areas. Often, GCF value add when partnering with development banks can be speeding up the adoption of and enhancing the viability of low emission public transport technologies and shift away from traditional transport infrastructure project that spur greater lock-in of fossil fuel based personal vehicle. GCF funds also enable projects by NDBs and MDBs to accelerate paradigm shift to low emission transport, planning for cross-sectoral goals (energy efficiency, gender access and equity) and capacity development to enable countries for long-term paradigm shifts in planning priorities and frameworks (GEF, 2019).

Knowledge partners such as sectoral associations, engineering centres of expertise and other coalitions and partnerships including the Climate and Clean Air Coalition can also have role to play in providing technical assistance, resources and analysis, which can help developing countries identifying project needs.

Although particularly large consortia can pose certain challenges, GCF resources can have greater impact when paired with finance from NDBs, MDBs and climate funds alongside other private and public investments. Strategic partnerships that amplify GCF resources to larger networks and for greater impacts for the Transport Result Area include:

- Projects targeting emissions reduction at a larger scale, such as multiple projects in a country or a region may lead to higher emissions reductions through scale, particularly in countries or regions that are otherwise focused on addressing non-climate-based needs, such as congestion and air quality. This would necessitate broader coalitions to coordinate projects across multiple countries and/or levels of governments, and AEs.
- Given the high upfront costs of transportation projects, particularly those which are electric, or hydrogen fuel cell powered, it is recommended that GCF work with partners to support pilot demonstration projects

that have long term scaling plans, which allow cities to trial expensive, climate-based solutions and gain local expertise and capacity, with the intention of long-term scaling. The technology and capacity for alternative fuels for freight in particular is less developed than for other modes of land-based transportation.

- Strategic partnerships that crowd-in and spur private sector investments in LDCs. An example is the GCF partnership with the Development Bank of Southern Africa (DBSA), to create the Climate Finance Facility (FP098), which is a green finance operating unit intended to catalyse private sector climate-related investments to enhance credit for governments (GCF, 2020b).

7 Conclusion

The Transport sector has a significant and measurable impact on climate change accounting for nearly a quarter of all energy-related CO2 emissions. Among the different modes of transport, road vehicles – freight, cars, trucks, buses, and two- and three-wheelers – account for nearly three-quarters of transport carbon dioxide emissions. At the same time hundreds of millions of people in developing countries lack convenient access to efficient and low emissions public transport. For instance, in sub-Saharan Africa, only two among ten people have convenient access to public transport.

Research-based evidence, best practices and lessons learned indicate that the highest impact for a paradigm shift in low emissions transport can be achieved by three interlinked pathways: (1) accelerating the shift to public transport; (2) rapidly electrifying the transport system; and (3) supporting scale up of new generation zero emissions fuels for not-yet electrifiable uses.

These transformational pathways can also lead to greater adaptation and resiliency impacts. Alignment between long term strategic transport demand planning, national financial planning, and green budgeting that integrate climate and development goals are key factors. Public financing will not suffice for the projected investments needs for transition to low emissions transport in developing countries to meet the goals of the Paris Agreement and crowding in private investment must be given high priority. Therefore, GCF interventions that effectively blend finance from different sources for developing countries are of paramount importance. Even though low emission transport is more cost effective than other investments in the long term, the risks are higher because of significantly higher initial costs that need to be covered by long periods of high-risk revenue dependent on user behaviour and fluctuating user demand. Substantial investment in charging infrastructure, new value chain, and business models are also required.

Overall, the selection of the most appropriate financial mechanisms and structures for GCF and co-financers is highly dependent on many factors including country-specific factors (such as financial markets, legislation and regulatory environment, type and status of market actors, as well as market maturity). Moreover, technology and business models, and the financing mechanism itself (such as attractiveness to financiers, transaction costs, private sector leverage, cost effectiveness, and the sustainable development potential) will be guiding factors. Generally, for proven technologies and where markets are more developed, high levels of private co-finance are likely, and more sophisticated de-risking instruments are appropriate for rapid scale up. Where technology is more nascent, markets are immature, and beneficiaries more vulnerable, more public sources are likely, and GCF funding will likely be more concessional.

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