# Decarbonisation scenarios for the transport sector in Georgia

Authors:
Thomas Day, Sofia Gonzales-Zuñiga, Swithin Lui

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**Authors**
Thomas Day, Sofia Gonzales-Zuñiga, Swithin Lui

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# Table of Contents

# List of Figures

# List of Tables

# Abbreviations

| | |
|---|---|
| **BAU** | Business-as-usual |
| **BRT** | Bus rapid transit |
| **CCD** | Climate Change Division (of MEPA, previously CCU) |
| **CCU** | Climate Change Unit (of MEPA) |
| **CENN** | Caucasus Environmental NGO Network |
| **CNG** | Compressed natural gas |
| **CSAP** | Climate strategy and action plan |
| **EBRD** | European Bank for Reconstruction and Development |
| **EU** | European Union |
| **EV** | Electric vehicles |
| **GCF** | Green Climate Fund |
| **GHG** | Greenhouse gas |
| **HDV** | Heavy duty vehicle |
| **ICCT** | International Council on Clean Transportation |
| **ICE** | Internal combustion engine |
| **LDV** | Light duty vehicle |
| **LEAP** | Low Emissions Analysis Platform |
| **LEDS** | Low emissions development strategy (drafted but not adopted) |
| **LTS** | Long-term low emissions development strategy |
| **MDG** | Millennium Development Goals |
| **MEPA** | Ministry of Environmental Protection and Agriculture |
| **MESD** | Ministry of Economy and Sustainable Development |
| **NDC** | Nationally determined contribution |
| **NEEAP** | National energy efficiency action plan |
| **OECD** | Organisation for Economic Co-operation and Development |
| **PM** | Particulate matter |
| **SDG** | Sustainable development goals |
| **SEAP** | Sustainable energy action plan |
| **SPWG** | Special purpose working group |
| **UNDP** | United Nations Development Programme |
| **UNFCCC** | United Nations Framework Convention on Climate Change |

# 1 Introduction

Georgia finds itself at an important crossroads with regards to decisions for the short-, medium- and long-term future of infrastructure and investments in the transport sector. At the same time, the transport sector is a key sector for Georgia's Climate Strategy and Action Plan (CSAP), which was prepared for parliamentary consideration in 2020 alongside Georgia's updated Nationally Determined Contribution (NDC) to the Paris Agreement. These documents were partially informed by the analysis compiled in this report, which supported the transport sector to identify actions for reducing emissions.

At this key time for climate change policy planning processes and transport sector planning, this compilation report explores potential pathways for the sector, in the context of the challenges currently faced in the sector, and the implications of international climate commitments and national development objectives. The report includes the following sections:

**Section 2 describes the current situation and political issues around the transport sector**, showing that important decisions are due to be made on the current critical issues of air pollution, road safety, and the economic opportunities of international freight transit, which will strongly affect the development trajectory of the sector.

**Section 3 gives a concise overview of the implications of the Paris Agreement for Georgia** and the transport sector, showing that the sector would be required to move towards full decarbonisation in the second half of the century and that Georgia is expected to prepare and communicate strategies for the achievement of the long-term goals of the Paris Agreement.

**Sections 4 presents three scenarios for GHG emission trajectories in the transport sector**, including a reference trajectory, a projection of the impacts from the implementation of selected mitigation actions, and a visualisation of a long-term emissions trajectory that would be compatible with the objectives of the Paris Agreement.

**Section 5 discusses the potential to enhance planning for the low carbon transition**, showing that several potential policies and measures remain available and attractive to implement, but that the institutional framework for coordinated planning in the sector could be improved to maximise these opportunities.

**Section 6 presents the implications of major national strategic and development priorities**, showing that there are considerable synergies with the EU Association Agreement, the Agenda 2030 Sustainable Development Goals (SDGs) and decarbonisation pathways.

**Section 7 closes this report with recommendations for enhanced action,** highlighting the need to improve the coordination of transport sector planning while pushing ahead with the implementation of readily available and economically attractive measures.

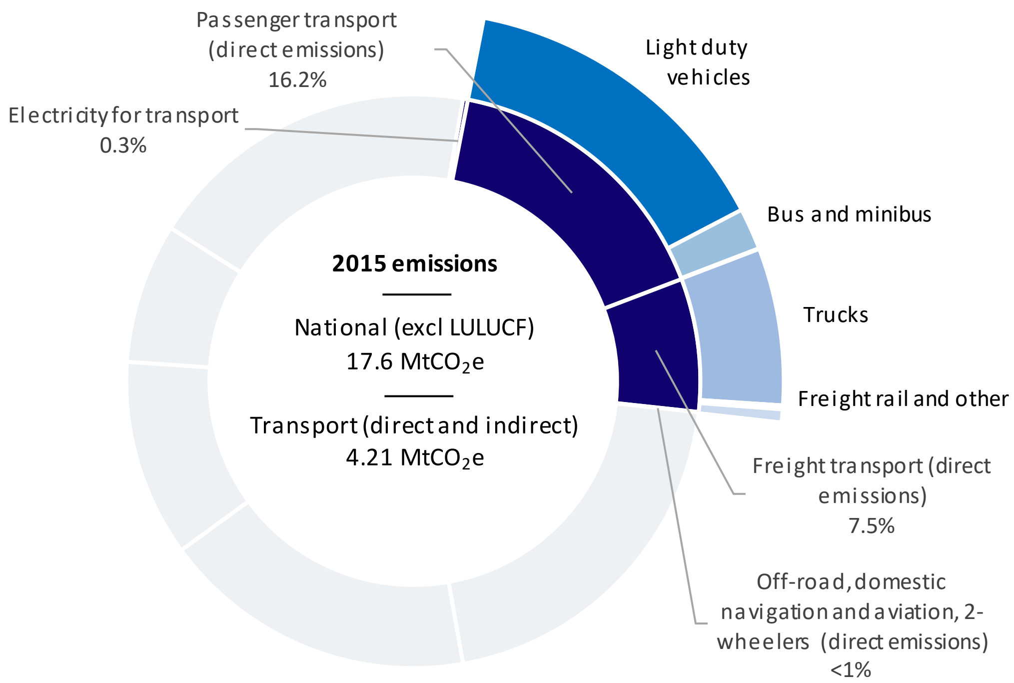
# 2 The transport sector at a crossroads

This section provides a concise snapshot of the status of the transport sector in Georgia in 2020, looking at key GHG emission drivers and other important challenges currently facing the sector.

## 2.1 Trends and emission drivers

**The transport sector constitutes one of the largest sources of greenhouse gas emissions in Georgia.** In 2015, the transport sector was responsible for emissions of 4.21 $MtCO_2e$ (direct and indirect), approximately 24% of total national emissions in Georgia (Figure 1). The emissions associated with the transport sector include direct energy emissions (>99%), and those from electricity generation (<1%). Road passenger transport accounted for approximately 68% of the sector's emissions in 2015, with light-duty vehicles (LDVs) accounting for 88% of passenger transport emissions, buses for 5%, and minibuses for 6% of emissions. Freight transport, consisting of trucks, rail, and off-road vehicles (mainly for agriculture), accounted for the remaining 31% of the sector's emissions, with emissions from heavy trucks responsible for the majority (94% of all freight emissions).

Figure 1: Transport sector GHG emissions breakdown in 2015




Source: Authors using PROSPECTS+ Georgia 2019 based on data from MEPA (2019)

**Passenger transportation in Georgia is dominated by road-based private light-duty vehicles.** LDVs accounted for an estimated 69% of passenger transportation activity in 2015. The shares of buses, minibuses and rail (including metro) accounted for an estimated 13%, 14% and 4%, respectively, with domestic aviation accounting for less than 1%. With LDV activity of 5,200 passenger-km per capita in 2015, LDV use in Georgia was significantly greater than in non-EU European countries, and only approximately 15% lower than the EU (ICCT, 2017). Emissions from LDVs were approximately 2.5 $MtCO_2e$ in 2015.

**First steps are being taken for the modernisation of an ageing LDV fleet.** The estimated average emissions intensity for non-electric private LDVs in Georgia is 189 $gCO_2e$/v-km, due to an ageing car fleet consisting of primarily second-hand models. As of 2017, over 80% of private LDVs registered in Georgia were over 10 years old. By comparison, the EU Emissions Standards will require a fleet average for new cars in the EU to be 96 $gCO_2e$/v-km in 2020 (European Commission, 2018). For internal combustion engine vehicles in 2015, gasoline and compressed natural gas (CNG) accounted for 53% and 36% of primary energy demand for LDVs respectively, while diesel fuel supplies the majority of buses, minibuses, trucks, and light trucks. The penetration of road-based electric vehicles (EVs) is still negligible in 2020 (less than 1% of all LDVs) but the number of low emissions vehicles is on the rise, particularly with hybrid vehicles. For comparison, the total stock of electric vehicles in 2016 in the EU stood at 126,030 EVs and 169,030 hybrid cars (Vieweg et al., 2017).

**Heavy goods road vehicles accounted for 65% of freight activity in 2020**, with rail accounting for most of the remaining activity. At 3,353 million-tkm per capita, the level of freight transport activity per capita in 2015 was approximately half that of the EU (ICCT, 2017). Heavy goods vehicles accounted for approximately 1.2 $MtCO_2e$ in 2015. Estimated emissions from rail-based freight accounted for just 0.01 $MtCO_2e$ in 2015, due to the high rate of rail electrification in recent years and the relatively low emissions intensity of the electricity grid. Emissions from rail-based freight are heavily influenced by the price of fossil fuels and the availability of hydropower-based electricity due to annual variation in water levels.

## 2.2 Current challenges for road-based transport

The transport sector in Georgia currently finds itself at the centre of several major social issues and political discussions. The sector is at a crossroads: investments in transport entail a high degree of lock-in due to long infrastructure and technology lifetimes, so decisions on how to address these current issues will determine how the sector develops in the coming years and decades.

### Road safety

Numerous protests have been held in Georgian cities in recent years to voice concerns about road safety; the road fatality rate in 2013 was 16.1 deaths per 100,000 population, approximately four times the EU average (WHO, 2016). Several factors compromise road safety in Georgia, including the high share of old and non-roadworthy vehicles, irresponsible driving behaviour, inadequate parking and poor road conditions. National government initiatives are currently ongoing to address some of these factors; for example, mandatory vehicle roadworthiness testing started to be introduced in 2018 (see section 5.1), whilst heavy-duty vehicles will become subject to speed-limiting devices (Agenda.ge, 2017; Trend News Agency, 2017). Measures to increase road safety have numerous links with decarbonisation pathways. Removing older and unsuitable vehicles from the roads will increase road safety whilst also removing the least fuel-efficient portion of the vehicle stock, thereby reducing the emissions intensity of the total stock. Likewise, measures to improve road conditions and parking management will also improve the fuel efficiency of vehicles and reduce total driving time. A modal shift to public transport, and designation of dedicated public transport lanes can also have a major impact on both road safety and decarbonisation objectives by improving traffic volumes and flows.

### Ambient air pollution

A national survey in 2017 ranked air pollution as the second most pressing “infrastructural” issue. Average levels of fine particulate matter $PM_{2.5}$ in urban locations were 25 µg/$m^3$ in Tbilisi in 2015, significantly higher than the maximum level of 10 µg/$m^3$ recommended by the WHO for urban areas. Georgia’s insufficiently developed transport system is a key contributor to this major burden: most of the vehicles registered in Georgia are old, used vehicles from Europe, running on outdated conventional fuel, with over 80% of cars older than 10 years.

Some national and municipal governments have already been responding to this issue (Trend News Agency, 2017). In addition to the national introduction of mandatory vehicle inspections to test vehicle roadworthiness mentioned above, at the municipal level, Tbilisi City Hall unveiled plans in December 2017 to purchase eco-friendly new buses for the city. At the time, up to 200 new buses were planned for purchasing in the initial stage and the full fleet of buses was planned to be replaced over approximately 3-4 years (Georgian Journal, 2017). Measures to decrease air pollution in Georgia have clear links to decarbonisation pathways. The transition from the old vehicle stock, introduction of less polluting technologies, and improved fuel regulations will not only affect local air pollutants but will also lead to a decrease in average vehicle GHG emission intensity and an overall reduction in GHG emissions from transport.

### Commercial opportunities for international transit

Due to its unique location, international transit represents a considerable commercial opportunity for Georgia. Improving the attractiveness of Georgian transport infrastructure for international transit is currently a key priority for the Department of Transport Logistics of the Ministry of Economy and Sustainable Development (MESD). In recent years, several development banks including the World Bank, the European Investment Bank and the Asian Development Bank have extended financial support for substantial investments to modernise Georgia's main transport routes, particularly the East-West highway. In addition to increasing the attractiveness of these routes for international transit, it is believed that this modernisation will directly contribute to domestic economic development by reducing freight transportation costs and better linking rural communities to Tbilisi and other urban centres in Georgia (World Bank, 2017). The highway infrastructure projects may have various impacts on decarbonisation pathways, depending on complementary measures and regulations. In the first instance, road infrastructure modernisation would likely encourage increased levels of road-based freight transportation activity and increased emissions along these routes. On the other hand, modernised roads will improve the fuel efficiency of vehicles travelling on these routes, and public modes of transport can benefit equally from inter-city road infrastructure modernisation. The attractiveness of highway developments for international transit will be greater if complementary measures are put in place to limit the volume of private vehicle traffic, for example, if through the provision of modern and convenient inter-city public transport, or if gains in commercial activity can be achieved through low-carbon alternatives, such as a shift from road-based freight to rail-based freight.

# 3 Climate change commitments, targets and plans

While the development of new future-proof infrastructure for the transport sector is pending, Georgia is also currently navigating its responsibilities to the international climate change negotiations and the collective mitigation efforts of all countries. This section sets out the implications of the Paris Agreement and national climate change planning processes for the transport sector.

## 3.1 The Paris Agreement

In December 2015, representatives of 196 nations negotiated a global agreement for responding to the threat of climate change, at the 21st Conference of Parties to the United Nations Framework Convention on Climate Change (UNFCCC) in Paris. The objectives of the Paris Agreement are to strengthen the global response to climate change by keeping global temperature rise to well below 2 °C above pre-industrial levels, pursue efforts to limit the temperature increase even further to 1.5 °C and to strengthen the ability of countries to deal with climate change impacts.

**As a country with high vulnerability to the impacts of climate change, Georgia stands for strong and ambitious action at the international level** from the Parties of the UNFCCC; former Prime Minister Irakli Garibashvili highlighted in the year that the Paris Agreement was struck that Georgia considers itself a "leader and an ambitious partner in addressing climate change" (Garibashvili, 2015). Georgia ratified the Paris Agreement in 2017.

**The objectives of the Paris Agreement have considerable implications for the decarbonisation of the transport sector in Georgia**, as for other countries. Having agreed to peak GHG emissions as soon as possible and to achieve net-zero emissions in the second half of the century, compliance with the Agreement would implicitly require Parties to *restrict short-term investments in fossil fuel-related transport infrastructure* as the minimum requirement and to transition to a *100% renewable energy-based transport sector in the medium- to long-term*. Table 1 gives an overview of available independent analysis on what Paris Agreement compatibility will require from the transport sector in non-OECD countries. At the global level, and in Georgia, transport is one of the sectors with the greatest discrepancy between current policy pathways and required pathways for 2 °C or 1.5 °C compatibility.

Table 1: Implications of the Paris Agreement targets for the transport sector globally

| Indicator / subsector | Implications of Paris Agreement for required pathways |
|---|---|
| **Emissions**<br>(whole sector – global targets) | **2 °C:** By 2030, transport emissions should peak and drop below current levels, despite increases in transportation activity (IEA, 2016c).<br><br>**2 °C:** Full decarbonisation of the entire energy sector (incl. transport) by 2060 to 2075 (UNEP, 2016).<br><br>**1.5 °C:** Full decarbonisation of the entire energy sector (incl. transport) by 2045 to 2055 (UNEP, 2016). |
| **Emissions intensity**<br>(whole sector) | **2 °C:** Between 2013 and 2030, emissions intensity of transport should reduce by at least 22% in non-OECD countries (IEA, 2016a). |
| **Road transport** | **2 °C:** Emissions intensity of light road transportation should decrease by roughly 70% between 2015 and 2050 (Climate Action Tracker, 2016).<br><br>**1.5 °C:** Full decarbonisation of light road transportation by 2050 (Climate Action Tracker, 2016). |

| | |
|---|---|
| | These pathways are likely to mean the full electrification of the sector from renewable energy sources.<br>**1.5 °C:** By 2035, 100% of vehicles sold should be zero-emission vehicles (Climate Action Tracker, 2016). |

**Support provisions under the Paris Agreement may provide technical or financial assistance for the decarbonisation of the transport sector**. Parties have pledged to collectively mobilise USD 100 billion per year for climate change mitigation and adaptation action, although current pledges fall significantly short of this. Several sources of international climate finance prioritise the transport sector; the Green Climate Fund has identified low-emission transport as one of four major impact areas which will deliver major mitigation benefits (GCF, 2017).

**Regular monitoring and communication of progress at the sector level in the transport sector will be required for compliance with the Agreement**. In the Paris Agreement text, Parties agreed that they shall be required to regularly communicate the status of NDC implementation, broader efforts towards pursuance of the Paris Agreement, and support needs for enhanced action, and that these communications shall be subject to technical expert review. Transport sector authorities and relevant statistical offices in all countries will need to cooperate with national UNFCCC focal points who will communicate aggregated information to other Parties.

## 3.2 Nationally Determined Contribution

Nationally Determined Contributions (NDCs) identify short- and medium-term action or targets which Parties commit to for pursuance of the long-term objectives of the Paris Agreement. Parties are required to update their NDCs by 2020 and at least every five years thereafter, enhancing their targets in line with developments in national circumstances. In addition, Parties are also requested to present long term low emission development strategies (LTS) which outline countries' plans for the long-term transformation of sectors in line with the goals of the Paris Agreement. Georgia's medium-term contribution to the Paris Agreement will be represented by the 2020-updated NDC, which was published in draft form for public consultation in June 2020. The draft updated NDC outlines Georgia's planned targets and action up to 2030. It includes climate change mitigation targets and measures and notes that adaptation measures will be covered in a separate National Action Plan for Adaptation.

**Georgia's draft 2020-updated NDC sets out an unconditional NDC mitigation target of a 35% reduction of economy-wide GHG emissions below 1990 levels in 2030**, or a 50-57% reduction subject to collective progress at the global level to follow a trajectory aligned with the objectives of the Paris Agreement, and the provision of international support (Government of Georgia, forthcoming).

Under the baseline reference scenario without additional measures to reduce emissions, economy-wide emissions (excluding land-use, land-use change and forestry) are projected to increase on average 4% per year between 2020 and 2030. On this trajectory, emissions would reach 30.8 $MtCO_2e$ in 2030, a total increase of 75% compared to 17.6 $MtCO_2e$ in 2015. By comparison, the 35% reduction target beneath 1990 levels set out in the NDC would limit GHG emission growth to a maximum of 27.2 $MtCO_2e$ in 2030.

**The draft NDC includes the sector-specific target to decrease GHG emissions in the transport sector by 15% below 1990 levels in 2030.** This target was informed by the impact of the transport sector measures proposed in the 2021-2023 Climate Strategy and Action Plan (CSAP), which was submitted for parliamentary approval in 2020 (see section 3.3 for details on the CSAP process).

## 3.3 Climate Strategy and Action Plan

Georgia's first Climate Strategy and Action Plan (CSAP), covering the period up to 2023, is being prepared for adoption in 2020. The CSAP is a national strategic policy document containing a list of committed policy actions for each sector, designed to set Georgia on the pathway to implementing the NDC.

The Climate Action Plan is to be updated every 2-3 years, informed by new developments within the sectors, and the monitoring and evaluation reports from the previous Climate Action Plan. The Ministry of Environmental Protection and Agriculture (MEPA), through the Climate Change Division (CCD), is responsible for overseeing the regular update of the CSAP, as mandated by the National Climate Change Council which oversees the development of all climate change planning processes in Georgia. MEPA involves other relevant institutions from across all ministries, as well as national experts, in the development of the CSAP.

Transport is included in the CSAP as one of seven key sectors for climate change mitigation action. Informed partially by the analysis compiled in this report, governmental and civil society stakeholders from the transport sector identified actions for reducing emissions in the transport sector and created an enabling environment for enhanced emission reductions in the future. Measures include those for public and private transport in urban and rural areas, envisaged to result in an increased modal shift to public transport mode, as well as improved efficiency and emissions intensity of existing transport modes.

# 4 Scenarios for GHG emission trajectories

This section provides an overview of greenhouse gas emission trajectories from the transport sector up to 2030, including a reference trajectory, a scenario with selected and planned mitigation actions, and a long-term Paris Agreement compatible trajectory.

## 4.1 Reference emission trajectory

### 4.1.1 Methodology

#### Definition of the reference scenario

The reference emission trajectory considers the estimated development of the sector in the absence of any additional policies and measures that were not already implemented in the base year. It considers a continuation of the currently existing policies and sector trends, from the base year.

**The base year for the scenario is 2016**, the year continuing Georgia's first Nationally Determined Contribution. This analysis provides an update to the original NDC baseline scenario, using a new bottom-up methodological approach and more up-to-date data and assumptions.

**The scenario includes energy-related greenhouse gas emissions from transport activity**, in a single metric expressed as tonnes of $CO_2$ equivalent ($tCO_2e$). The emissions accounted for in the sector include direct energy end-use emissions from fuel combustion in vehicles and emissions from electricity generation for electricity consumed in the transport sector. In line with the IPCC emission accounting guidelines, other emissions outside of transport activity energy-use (e.g. related to infrastructure construction or the supply chain for vehicles) are not included in the scenario.

The scenario includes activity from urban and rural passenger transport, domestic freight, other vehicular emissions (including special purpose vehicles and agricultural vehicles) and domestic aviation, which is accounted separately from other modes of passenger and freight transport.

**Projections for the reference scenario are built from applying calculations and assumptions to bottom-up indicator data** in the base year for both passenger and freight transport subsectors. Indicator data used to build the scenario include transport mode activity levels, fuel mix per transport mode, energy and emissions intensities per fuel type, share of EVs and rail, and load factors/occupancy rates per vkm per mode. Assumptions used to calculate projections are derived from a range of macro and microeconomic data and elasticities in academic and grey transport literature relevant to Georgia. These assumptions were established and refined in continuous consultation with national sector experts and line ministries throughout the analytical period. For more details, see below and Annex I.

#### Modelling approach

The baseline scenario for the transport sector was determined through the development of the Georgia-PROSPECTS+ tool.

PROSPECTS+ is a sector-level bottom-up tool which can track and predict the overall and sectoral GHG emissions trends of a country based on the historic and future development of relevant indicators for decarbonisation. PROSPECTS+ measures key indicators that shape emission trends (e.g. emission intensity of electricity generation for the power sector or passenger-km travelled per person for the transport sector). By breaking down macro-level emissions into sectoral-level indicators, the approach increases transparency on decarbonization and allows comparisons among regions and temporal scales at multiple levels of the economy. An aggregation of all sectoral trends in the model then leads to an overall emissions profile of a country.[1]

### Scenario input data

PROSPECTS+ requires inputs for **activity** and **intensity** metrics across transport sub-sectors:

1. **Passenger transport activity (million-pkm), by road, rail and domestic aviation.**

   Rail and aviation data were taken from the Statistical Yearbooks (in line with MARKAL data). Due to data availability, road activity was calculated using a bottom-up approach which was based on passenger transport activity levels of five of the largest cities of Georgia (Tbilisi, Batumi, Kutaisi, Gori, Zugdidi) using their respective SEAPs for data. The trend calculated based on these five cities was then used as a proxy to estimate total urban activity. The rural activity was estimated using the average of four cities (all except Tbilisi).

2. **Passenger transport modal split (%)**

   The country modal split was also calculated based on the city activity data, weighted by the proportion of the population. The split included the shares of light-duty vehicles (LDVs), buses and mini-buses (marshutkas), and when available, metro. This data was taken from Statistical Yearbooks and Sustainable Energy Action Plans (SEAPs, and later crossed checked with data included in the MARKAL model.

3. **Freight transport activity (million-pkm), by road and rail**

   Freight transport activity was broken down into only road and rail activity and gathered from the Statistical Yearbooks 2009-2017.

4. **Freight transport modal split (%)**

   Data was gathered from the Statistical Yearbooks 2009-2017 (in line with MARKAL data).

5. **Share of electrified transport (%)**

   The share of electrified rail passenger transport was estimated based on the electricity consumed by rail transport (taken from the MARKAL model data) versus the total energy consumption for rail transport in Georgia. The share of electrified freight transport was assumed to be equivalent to passenger transport for rail, and nil for road transport.

6. **Fuel economy for non-electrified transport modes (MJ/km)**

   Fuel economy was estimated separately for cars, buses and mini-buses, trains and aviation. The data was taken from the MARKAL model, which was based on the number of vehicles split by different types of power fuel, average annual mileage of every vehicle type and total fuel consumption. Fuel economy for freight transport was estimated based on the numbers reported by the ICCT Global Transportation Roadmap Model, using “non-EU” region as a proxy for Georgia. These numbers were taken over those included in the MARKAL model, given that MARKAL numbers were significantly lower than those reported for other similar regions.

Data sources and assumptions for these indicators are included in Annex I.

[1] For further details on the PROSPECTS tool, see https://newclimate.org/2018/11/30/prospects-plus-tool/

### 4.1.2 Scenario overview

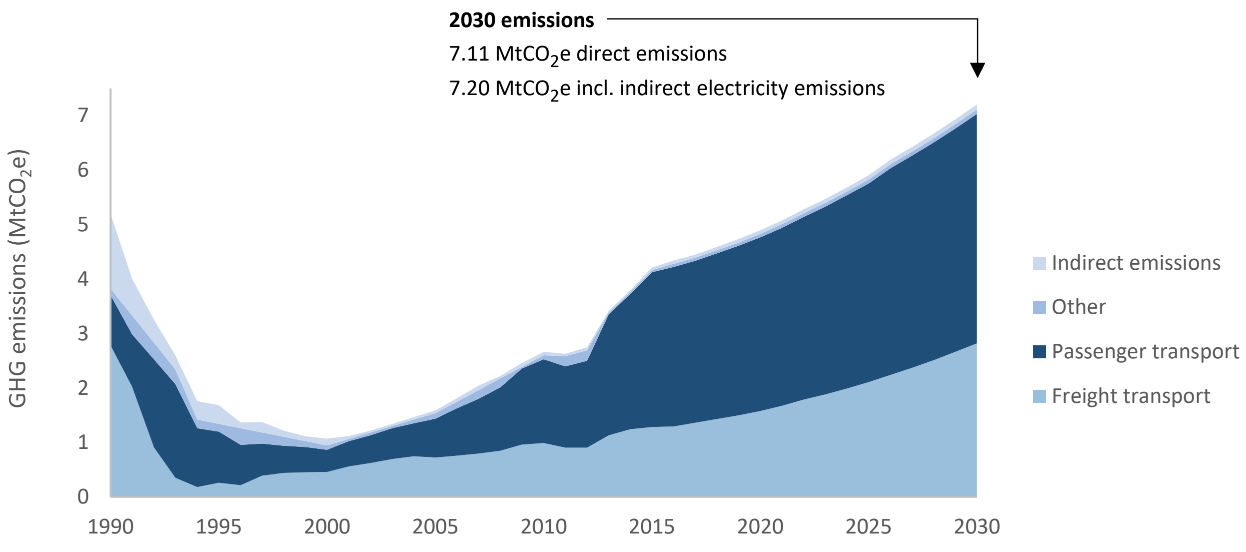
Under the reference scenario, direct GHG emissions from the transport sector are projected to increase by 71% from 4.16 $MtCO_2e$ in 2015 (4.21 $MtCO_2e$ if including indirect emissions) to 7.11 $MtCO_2e$ (7.2 $MtCO_2e$) if including indirect emissions in 2030 (

Figure 2).

Freight transport is projected to be the sub-sector with the largest growth in the reference scenario, with GHG emissions more than doubling due to the high projected increase in commercial activity. The GHG emissions projection for freight transport depends heavily on the extent to which freight activity can be shifted from road-based heavy goods vehicles to rail, and the rate at which the rail can be electrified. The reference scenario assumes that the modal split and the rate of rail electrification remain relatively constant, despite the large growth in activity. This entails a large increase in the volume of freight projected to be transported by rail between 2015 and 2030, which is in line with the objectives of several completed and ongoing projects for the modernisation of freight logistics and rail networks. In parallel, the volume of freight transported by heavy goods vehicles is also projected to increase, accounting for the majority of the projected emissions increase. Going beyond the existing and planned rail and freight logistics modernisation projects to shift more freight to rail could mitigate the projected increase in GHG emissions from this sub-sector considerably.

The 49% growth in GHG emissions from passenger transport between 2015 and 2030 is more modest than for freight but still highly significant. This increase is roughly in line with the increase in passenger transport activity over the same period since gradual improvements in the emission intensities of vehicles are projected to be offset by a gradual increase in the proportion of passenger activity in private light-duty vehicles, which is the most emissions-intensive mode of passenger transport.

Figure 2: Reference scenario emission trajectory per category for transport (1990-2030)




Note: the "Other" category contains off-road vehicles, domestic navigation and aviation, and 2-wheelers.

## 4.2 Climate Strategy and Action Plan emission trajectory

The Climate Strategy and Action Plan (CSAP) emission trajectory for the transport sector provides an overview of how greenhouse gas emissions from the sector may deviate from the reference scenario up to the year 2030, in the case that the identified actions are fully implemented.

### 4.2.1 Methodology

#### Definition of Climate Strategy and Action Plan scenario

The Climate Strategy and Action Plan scenario, or policy scenario, considers the impacts of transport sector measures proposed for the Plan in Georgia. This scenario uses the reference scenario (including all data indicators, historical data, calculations, and projections) as a base to calculate additional impacts of transport sector measures on activity, energy and emissions indicators up to 2030. For a description of the reference scenario and its modelling approach, see section 4.1.

#### Modelling approach

**The calculations for transport sector measures were quantified using transport policy tools developed by the authors as an extension to the Georgia-PROSPECTS+ tool**.[2] Policy impact calculations employed a bottom-up approach, with resulting outputs in activity and intensity metrics across transport sub-sectors (see section 4.1). **The calculated mitigation impact of each policy assumes it is introduced in isolation to other policies.** The combined implementation of these policies may lead to a degree of overlap in the mitigation outcome, which we address in two ways: 1) by accounting for 'partial overlaps', only quantifying aspects of policies not reflected elsewhere (e.g. – policies for Tbilisi and Batumi are quantified separately and not duplicated in the municipality transport measure quantification), and 2) by accounting for 'complete overlaps' by omitting counted policies when modelling aggregated impacts (e.g. the quantification of Euro 5 emission standard policy is included in the resulting scenario, instead of Euro 4). The resulting energy indicators of the transport sector in the policy scenario, adjusted for the effects of the Climate Strategy and Action Plan measures, were then integrated into a Low Emissions Analysis Platform (LEAP) model along with sector electricity consumption[3], to project the sector's emissions trajectory to 2030. The LEAP analysis involved an economy-wide (all energy sectors) modelling effort and included policy scenarios for other sectors. For the transport sector, electricity consumed (MWh) and energy consumed (TJ) were provided for each fuel type (natural gas, gasoline, diesel, LPG) and mode of transport (LDVs, bus, marshutka, rail, trucks, light trucks, two-wheelers, aviation, navigation). **Aggregated policy impacts on transport sector emissions for the scenario are in section 4.2.3.** Further details on the transport measures and quantification results can be found in the section below, while data and assumptions can be found in the Annexes.

### 4.2.2 Transport sector measures for the Climate Strategy Action Plan

The following actions for climate change mitigation in the transport sector were proposed for the Climate Action Plan and committed by the specific implementing institutions indicated. For further data tables and details on assumptions applied, see Annex I.

[2] For further details on the PROSPECTS tool, see https://newclimate.org/2018/11/30/prospects-plus-tool/

[3] Base year electricity fuel mix is taken from IEA open-access data and statistics. Emissions intensities are calculated and projected using IEA World Energy Outlook 2018 for Eurasia region. Due to minimal e-mobility penetration, assumptions on the electricity sector do not significantly affect the results in this report.

## Design and implement regulations for vehicle roadworthiness

**Objective of the policy:** To reduce the emissions intensity of vehicles.

**Description of the policy:** Cars will be tested for roadworthiness, with checks including for emissions standards. It is estimated that approximately 25% of private vehicles will not pass the tests in their current state and will need to be scrapped or refurbished.

**Policy impact:** The Ministry of Economy and Sustainable Development (MESD) reported the expectation that a certain proportion of light-duty vehicles will be either scrapped, improved or left unchanged (Table 2), depending on whether or not the vehicles can pass the new vehicle roadworthiness tests. While tests for buses and marshutkas had already previously been implemented (along with commercial vehicles), they are quantified here as previous policy impacts were not included in the reference scenario. This results in **changes to vehicle stock** and their **average emissions intensity** (Table 3), which are modelled as the policy scenario, in line with the assumptions listed below. The same methodologies are applied for marshrutkas and buses.

**Period of implementation:** As of October 2018, the test has become mandatory for all vehicles with engines of three cylinders; as of 2019, it became mandatory for all vehicles in Georgia.

**Annual emission reductions in 2030:** 160 kt$CO_2$e

Table 2: Proportion of fleet scrapped, improved, or unchanged

| | **Scrapped** (failed test and cannot be improved) | **Improved** (failed test but improved to pass it later) | **No change** (tests passed) |
|---|---|---|---|
| **LDV** | 10% | 21% | 69% |
| **Marshutka** | 7% | 23% | 71% |
| **Bus** | 7% | 23% | 71% |

Source: estimates were provided by MESD in an interview in Tbilisi on March 21, 2019.
Note: Policy impacts shown here are presented in isolation of other transport sector measures. Any impact on freight vehicles were not quantified for this policy. Sums that do not equal 100% are due to rounding. Further details on assumptions applied can be found in Annex I.

Table 3: Composition of the LDV vehicle stock before and after the introduction of the roadworthiness regulations

| **Vehicle age group** | **Before policy enforcement** (based on 2017 stock) | | **After policy enforcement** | |
|---|---|---|---|---|
| | **Proportion of vehicle stock** (LDVs) | **Average emissions intensity** ($gCO_2/km$) | **Proportion of vehicles** (LDVs) | **Average emissions intensity** ($gCO_2/km$) |
| **> 20 years** | 30% | 191 | 21% | 162 |
| **11-20 years** | 56% | 162 | 58% | 162 |
| **7-10 years** | 9% | 152 | 14% | 152 |
| **4-6 years** | 4% | 139 | 4% | 139 |
| **< 3 years** | 2% | 131 | 2% | 131 |

Source: The vehicle stock before policy enforcement was distributed in different age categories based on data from the Ministry of Internal Affairs (2017a). Further details on assumptions applied can be found in Annex I.
Note: Policy impacts shown here are presented in isolation of other transport sector measures.

## Tax incentives for electric and hybrid vehicles

**Objective of the policy:** To increase the proportion of passenger transport activity that is electrified, and to reduce the emissions intensity of transport activity through hybrid vehicles.

**Description of the policy:** This policy refers to the removal and reduction of excise taxes for the purchase of electric vehicles (100% tax reduction), hybrid vehicles less than 6 years old (60% tax reduction) and hybrid vehicles older than 6 years (50% tax reduction).

**Policy impact:** The policy leads to a change in vehicle purchase trends, which **increases the proportion of fully electric vehicles** in the LDV vehicle stock and **reduces the average emissions intensity** of the remaining LDV vehicle stock through increasing the proportion of hybrid vehicles. These impacts are summarised in Table 4.

**Period of implementation:** This policy was fully implemented by 2020.

**Annual emission reductions in 2030:** 405 kt$CO_2$e

Table 4: Projected share of electric and hybrid vehicles in the LDV vehicle stock with and without the introduction of the tax incentive

| | 2016 | 2030 (Reference scenario) | 2030 (Policy scenario) |
|---|---|---|---|
| **Share of electric vehicles** in the LDV stock | 0.01% | 0.01% | 0.3% |
| **Share of hybrid vehicles** in the LDV stock | 0.6% | 1% | 11% |
| **Average emissions intensity improvement** of the non-electric LDV stock | - | - | 8% |

Source: The anticipated trends in the electric vehicle market were modelled by national experts, and applied to the LDV stock with historical data from the Ministry of Internal Affairs and projections using a model based on Dargey et al (2007)..[4] Further details on assumptions applied can be found in Annex I.

Note: Policy impacts shown here are presented in isolation of other transport sector measures.

## Increase in taxes for fuels

**Objective of the policy:** To reduce the emissions intensity of vehicles by providing an incentive to use less emissions-intensive transport modes or technology options.

**Description of the policy:** This policy considers an increase of the price of 250 GEL/tonne of fuel for both gasoline and diesel.

**Policy impacts:** The policy leads to a **decrease in LDV passenger transport activity** and a partial **modal shift** from personal light-duty vehicle activity to modes of public transport, due to the increased operating costs of private vehicles entailed by the fuel tax increase. This impact is due to the combined effect of some LDV users giving up their ownership of vehicles and switching entirely to public transport modes, and other LDV users shifting a portion of their activity to public transport modes, with both effects estimated through short- and long-term transport demand elasticities (see Annex I for further details and assumptions). The policy also leads to a change in the **fuel mix of the remaining LDV stock**; diesel drivers are hit disproportionally higher by the tax, given that diesel pre-policy was priced cheaper than gasoline (150 GEL/tonne for diesel and 250 GEL/tonne for gasoline). These changes are summarised in Table 5.

[4] The methodology models vehicle ownership and saturation levels based on income growth, population density, and urban density.

**Period of implementation:** This policy was fully implemented by 2020.

**Annual emission reductions in 2030:** 380 kt$CO_2$e

Table 5: Projected LDV passenger transport activity with and without the fuel tax increase policy

| | 2016 | 2030 (Reference scenario) | 2030 (Policy scenario) |
|---|---|---|---|
| **Light-duty vehicle passenger transport activity** (billion pkm) | 21.5 | 31.7 | 26.3 |
| *Change relative to 2016* | - | + 47% | + 22% |
| *Gasoline vehicles (% share)* | 78.9% | 78.9% | 77.9% |
| *Diesel vehicles (% share)* | 9.4% | 9.4% | 7.9% |
| *Other fuel types (% share)* | 11.8% | 11.8% | 14.2% |

Source: Authors' calculations based on PROSPECTS+ modelling. Further details on assumptions applied can be found in Annex I.

Note: Policy impacts shown here are presented in isolation of other transport sector measures.

## Increase in import taxes for old vehicles

**Objective of the policy:** To reduce the emissions intensity of passenger transport vehicles by providing disincentives in purchasing older and less efficient vehicles.

**Description of the policy:** This policy increases the import tax imposed on vehicles older than 12 years (200% tax increase), vehicles between 10 to 12 years old (120-160% tax increase) and vehicles between six and 10 years old (14-80% tax increase).

**Policy impacts:** The policy incentivises a change in vehicle purchase trends, which reduces the share of older and less fuel-efficient vehicles on the road and **increases the share of newer and more fuel-efficient vehicles**. This policy **reduces the average emissions intensity of the non-electric personal vehicle stock**, while marshutkas and buses are unaffected by this policy. The distribution of vehicle kilometres driven by age group and class after policy implementation is presented in Table 6, while Table 7 shows that the average emissions intensity of the LDV stock is 2.4% lower compared to a reference scenario.

**Period of implementation:** This policy was fully implemented by 2020.

**Annual emission reductions in 2030:** 150 kt$CO_2$e

Table 6: Composition of new vehicle-kilometres driven by vehicle age class before and after the introduction of the import taxes for old vehicles

| Vehicle age group and class | Before policy enforcement (based on 2017 stock) | After policy enforcement in 2030 |
|---|---|---|
| **> 20 years** | 30% | 20.9% |
| **11-20 years** | 56% | 38.6% |
| **7-10 years** | 9% | 23.6% |
| **4-6 years** | 4% | 10.0% |
| **< 3 years** | 2% | 5.7% |
| **Hybrids** | - | 1.0% |
| **EVs** | - | 0.2% |

Source: The vehicle stock before the policy enforcement was distributed in different age categories based on data from the Ministry of Internal Affairs (Ministry of Internal Affairs, 2017b). Further details on assumptions applied can be found in Annex I.

Note: Policy impacts shown here are presented in isolation of other transport sector measures.

Table 7: Calculated average emissions intensity improvement for LDV fleet without (Reference) and with (Policy) the introduction of import taxes for old vehicles

| | 2030 (Reference scenario) | 2030 (Policy scenario) |
|---|---|---|
| **Average emissions intensity improvement** of the non-electric LDV stock, relative to 2016 | 1.6% | 4.1% |

Source: Authors' calculations based on PROSPECTS+ modelling. Further details on assumptions applied can be found in Annex I.

Note: Policy impacts shown here are presented in isolation of other transport sector measures.

## Measures to improve transport systems in cities

**Objective of the policy:** To shift the modal share from the use of private vehicles to public transport and non-motorised transport modes by improving the infrastructure and management of municipal public transport and non-motorised transport networks.

**Description of the policy:** This policy consists of a bundle of measures implemented in the cities of Zugdidi, Rustavi, Kutaisi and Gori (measures for Tbilisi and Batumi are calculated separately). The measures include:

A. Optimising public transport system routes through modern technology and automated systems
B. Implementing and enforcing public parking tariffs, and creating pedestrian and cycling routes
C. Improving road infrastructure and traffic management systems
D. Renewing the public transport fleet by improving bus stock and reducing activities for marshutkas

**Policy impacts:** Measure A (public transport systems) **decreases activity of passenger LDVs and increases activity of public road-based passenger transport modes** (buses and marshutkas), due to improved efficiency of public transport systems. Measure B (parking tariffs and non-motorised infrastructure) **decreases activity for all motorised passenger transport modes** (LDVs, buses, trains, marshutkas) due to a shift towards non-motorised transport from infrastructure and efficiency improvements. Measure C (road infrastructure and traffic management) **decreases activity of all road-based passenger transport** (LDVs, bus, marshutkas) due to improved efficiency of all road-based transport. Measure D (bus fleet renewal) **increases the passenger activity of buses at the expense of passenger LDVs and improves the load factor and emission intensity** of the overall public bus fleet, due to the purchase and integration of new bus models.

In aggregate, the bundle of policies implemented in Zugdidi, Rustavi, Kutaisi and Gori are estimated to **substantially reduce activity of LDVs** and **increase the activity of buses and marshutkas** towards 2030 (Table 8). Train (including metro) activity is slightly reduced due to a shift towards non-motorised transport modes. The **improvement in average emission intensity and load factor of the overall bus fleet** reflects the technological improvements of transport units after policy implementation.

**Period of implementation:** This policy was implemented prior to 2020.

**Annual emission reductions in 2030:** 120 kt$CO_2$e

Table 8: Aggregated policy impact on the activity of passenger transport modes, compared to a reference scenario without policy implementation

| Passenger transport modes | 2030 (Reference scenario, modal share) | 2030 (Policy scenario, modal share) |
|---|---|---|
| **LDV** | 71.2% | 67.4% |
| **Bus** | 10.7% | 12.5% |
| **Train** | 4.1% | 4.1% |
| **Marshutka** | 13.9% | 15.9% |

Source: Authors' calculations based on PROSPECTS+ modelling and assumptions. Further details on assumptions applied can be found in Annex I.

Note: Policy impacts shown here are presented in isolation of other transport sector measures. Remaining transport modes (two-wheelers, domestic aviation and navigation, off-road vehicles, are not included).

## Biodiesel production and sales

**Objective of the policy:** To increase the production, sales and consumption of biodiesel fuel for personal vehicle transportation.

**Description of the policy:** The policy starts large-scale production and sales for B10 biodiesel mixture (10% biodiesel, 90% diesel), starting with a production of 10 tonnes per month in 2019 in Tbilisi. Production and sales ramped up to double the starting amount in 2020. B10 will be sold for and consumed by personal vehicles (LDVs).

**Policy impacts:** This policy **increases the amount and share of biodiesel (B10) fuel consumed by the personal vehicle (LDVs) fleet** as a substitute for diesel fuel**,** which in turn **improves the average emission intensity of diesel personal vehicles.** The percentage share of vehicle activity consuming B10 fuel is 0.05% larger after policy enforcement in 2020 compared to the reference scenario and 0.03% larger in 2030 compared to the reference. This corresponds to an estimated 3.3 million-vkm and 6.0 million-vkm consuming B10 in 2020 and 2030 respectively. The increased consumption of B10 in LDV activity leads to a decrease in diesel consumption of the same magnitude, compared to the reference scenario.

**Period of implementation:** This policy is to be fully implemented by 2021.

**Annual emission reductions in 2030:** 8 kt$CO_2$e

Table 9: Percentage share of fuel consumption in LDV activity in 2016 and the change in share over time with and without the introduction of the B10 biodiesel policy

| Activity per fuel mix for non-electrified personal vehicles | 2030 (Reference scenario) | 2030 (% change in policy scenario, compared to reference) |
|---|---|---|
| *Gasoline (% share)* | 78.9% | - |
| *Diesel (% share)* | 9.4% | -0.03% |
| *B10 biodiesel (% share)* | - | +0.03% |
| *Other fuel types (% share)* | 11.8% | - |

Source: Authors' calculations based on PROSPECTS+ modelling, using biodiesel projection data from national experts and fuel density and content factors from ICCT (2017). Further details on assumptions applied can be found in Annex I.

Note: Policy impacts shown here are presented in isolation of other transport sector measures.

## Measures to improve transport systems (Tbilisi)

**Objective of the policy:** To incentivise modal shift from private passenger transport to public transport through service and infrastructure improvement in Tbilisi.

**Description of the policy:** This policy consists of a bundle of measures implemented for Tbilisi, including:

A. Purchasing of 100 8-meter buses in 2018 and 200 12-meter buses in 2019, with the goal to increase the number of public buses to 900 units in 2020. All marshutkas will be completely substituted with modern Euro VI CNG / electric buses by 2021
B. Expansion of 14 new trains for the Tbilisi Metro network in 2018-2019, to decrease waiting time and improve service
C. Implementing measures to prioritise bus lanes in the busiest avenues of Tbilisi
D. Implementing a zonal hourly parking system in Tbilisi with the creation of a non-uniform fee system in different districts of Tbilisi, from which electric vehicles are exempted

**Policy impacts:** Measure A (bus fleet renewal) originally planned to increase the share of electric buses and low-emission buses in the bus fleet, thus **changing the average fuel mix and decreasing the average emissions intensity**. The measure also **includes technological upgrades and an increase of passenger ridership for buses** due to the ongoing retirement of marshutkas, as well as service and comfort improvements. Measure B (metro expansion) increases the frequency of trains and passenger ridership activity for rail systems in Tbilisi, thus **increasing the modal share of rail in passenger transport and share of electrified transport in the sector**. A modal shift to electric rail also **decreases passenger LDV activity**. Measure C (bus network restructuring) **increases vehicle activity of the bus fleet and decreases passenger LDV activity** due to the improved efficiency of bus routes. Measure D (parking system) **decreases passenger LDV activity** due to policy disincentives for driving personal vehicles and **shifts transport activity towards public transport modes**.

Table 10 provides a summary of transport activity changes per mode due to the implementation of transport measures in Tbilisi. In aggregate, the measures result in **increased long-term passenger activity for the bus fleet**, which is more efficient and technologically upgraded. The **average emissions intensity of diesel buses is improved** by 13% in 2030 while **the average load factor is increased** by 35% in 2030, both compared to the reference scenario. **Increase in train capacity and frequency for the metro system** leads to a growth in ridership (+7.2% in 2030 compared to the reference scenario) for rail. Less regulated marshutkas are phased out in the short run due to policy objectives. **LDV activity decreases in the short run** due to the modal shift towards buses and disincentives for driving **but increases in the long run** as the bus fleet is not able to fully absorb both the full gap in ridership capacity left from the retirement of marshutkas and continual increasing passenger transport activity in Tbilisi. This result slightly offsets the emissions impact of the policy bundle. The addition and service improvement of new bus and trains in the public transport network also increases the share of electrified transport units for both modes (Table 11).

**Period of implementation:** These policies are to be implemented between 2018 and 2021.

**Annual emission reductions in 2030:** 95 kt$CO_2$e

Table 10: Aggregated policy impact on the activity of passenger transport modes in Tbilisi, compared to a reference scenario without policy implementation

| Passenger transport modes | Total activity change in 2030, compared to reference scenario |
|---|---|
| **LDV** | +0.4% |
| **Bus** | +27.1% |
| **Train** | +7.2% |
| **Marshutka** | -28.8% |

Source: Authors' calculations based on PROSPECTS+ modelling and assumptions. Further details on assumptions applied can be found in Annex I.

Note: Policy impacts shown here are presented in isolation of other transport sector measures.

Table 11: Share of passenger transport mode electrified in 2016 and with and without policy implementation in 2030

| Passenger transport modes | Share of mode electrified, 2016 | Share of mode electrified, 2030 (reference) | Share of mode electrified, 2030 (policy) |
|---|---|---|---|
| **LDV** | - | 0.12% | 0.15% |
| **Bus** | - | 2.0% | 7.0% |
| **Train** | 78.4% | 79.3% | 79.8% |
| **Marshutka** | - | - | - |

Source: Authors' calculations based on PROSPECTS+ modelling and assumptions. Further details on assumptions applied can be found in Annex I.

Note: Policy impacts shown here are presented in isolation of other transport sector measures. Shares of modes are shown at the national level and are not city-specific numbers.

## Emission quality standards on the import and production of vehicles (EUR4 / EUR5)

**Objective of the policy:** To improve the average emissions intensity of the road-based passenger transport modes.

**Description of the policy:** This policy action first conducts a cost-benefit analysis assessing the feasibility of banning imports and production of personal vehicles, buses and marshutkas below Euro 4/Euro 5 emission standards, with plans to implement measures depending on the results of the study.

**Policy impacts:** The full implementation of this policy to limit fuel consumption for road-based transport to Euro 4 or Euro 5 standards represent a stringent environmental regulation compared to the status quo, and **improves the average emissions intensity for non-electrified passenger transport** (LDV, bus, marshutka).

**Period of implementation:** The cost-benefit analysis is fully implemented as of 2020 and pending evaluation.

**Annual emission reductions in 2030:** 245 kt$CO_2$e (EUR4) / 335 kt$CO_2$e (EUR5) (if emission quality standard measures are fully implemented)

Table 12: Average emissions intensity of transport mode fleets with and without the implementation of emission quality standards, calculated for Euro 4 and Euro 5 standards

| Passenger transport modes | Average emissions intensity of fleet, 2016 ($gCO_2e/vkm$) | Average emissions intensity of fleet, 2030 (reference) ($gCO_2e/vkm$) | Average emissions intensity of EUR 4 fleet, 2030 (policy) ($gCO_2e/vkm$) | Average emissions intensity of EUR 5 fleet, 2030 (policy) ($gCO_2e/vkm$) |
|---|---|---|---|---|
| **LDV** | 192 | 187 | 175 | 172 |
| **Bus** | 660 | 650 | 621 | 609 |
| **Marshutka** | 435 | 428 | 399 | 389 |

Source: Authors' calculations based on PROSPECTS+ modelling and assumptions. Further details on assumptions applied can be found in Annex I.

Note: Policy impacts shown here are presented in isolation of other transport sector measures.

## Measures to improve transport systems (Batumi)

**Objective of the policy:** To create a modal shift from passenger LDVs to public transport modes and increase the proportion of electrified passenger transport units.

**Description of the policy:** This policy consists of a bundle of measures implemented for Batumi, including:

A. Creating city zones to assign payment tariffs for passenger cars to be introduced in 2019.
B. Optimising bus network routes and implementing several Bus Rapid Transit (BRT) corridors in 2019.
C. Renewing the public bus fleet by purchasing 40 new Euro 5 diesel buses and 10 electric buses, while retiring half the marshutka fleet by 2022.

**Policy impacts:** Measure A (reorganisation of on-street parking) **decreases LDV activity** due to the increase in costs for driving personal vehicles, **shifting passenger ridership to public transport modes**. Measure B (bus network optimisation) measure increases passenger ridership due to the enhanced efficiency and service of bus routes, **inciting a modal shift from LDV to bus activity**. Measure C (bus fleet renewal) leads to increased bus activity as the retiring of marshutkas **create a modal shift from marshutkas to bus activity**. Expansion of the bus fleet leads to **further increased bus activity**. New electric models **increase the share of electrified bus activity** while the new Euro 5 diesel models **increase the share of diesel buses** and **decrease the average emissions intensity** of the fleet.

Table 13 shows the aggregated impacts of the transport measure policy bundle in Batumi, which leads to an overall increase in bus activity in 2020 (+2.5%) and 2030 (+5.4%), compared to the reference scenario. The gradual retirement of marshutkas in Batumi, mostly implemented in the short term, lead to substantially reduced marshutka activity (-3.8% compared to reference in 2030) while disincentives for LDVs decrease activity slightly (-0.1% compared to reference in 2030). The integration of new bus models also **increases the share of diesel bus activity** by 0.1% in 2030 compared to the reference scenario and **improves the average emission intensity** of buses by 1.3% (compared to reference scenario).

**Period of implementation:** These policies are to be fully implemented between 2018 and 2022.

**Annual emission reductions in 2030:** 10 $ktCO_2e$

Table 13: Aggregated policy impact on the activity of passenger transport modes in Batumi, compared to a reference scenario without policy implementation

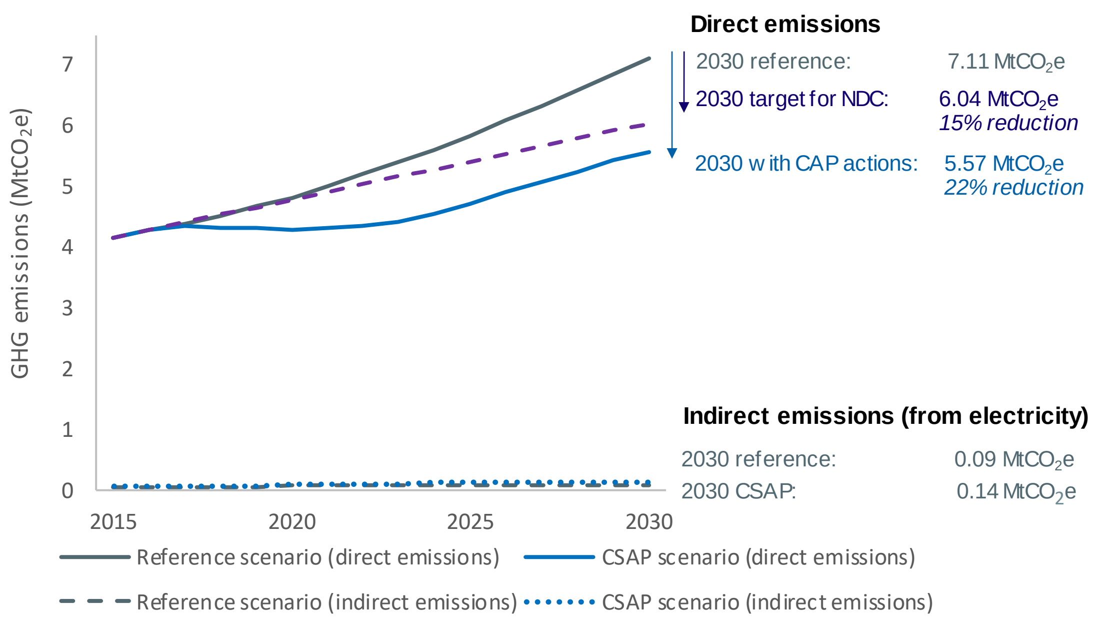
| Passenger transport modes | Total activity change in 2030, compared to reference |
|---|---|
| **LDV** | -0.1% |
| **Bus** | +5.6% |
| **Train** | - |
| **Marshutka** | -3.8% |

Source: Authors' calculations based on PROSPECTS+ modelling and assumptions, including national expert input. Further details on assumptions applied can be found in Annex I.
Note: Policy impacts shown here are presented in isolation of other transport sector measures.

### 4.2.3 Scenario overview

Under the Climate Strategy and Action Plan scenario, **transport sector emissions continue to increase from 4.16 $MtCO_2e$ in 2015 (direct emissions only) to 5.57 $MtCO_2e$ in 2030** (+34% compared to 2015 levels) after considering the aggregated impacts of non-overlapping policies. These emission levels represent a 22% reduction, or 1.54 $MtCO_2e$, in 2030 compared to the reference scenario.

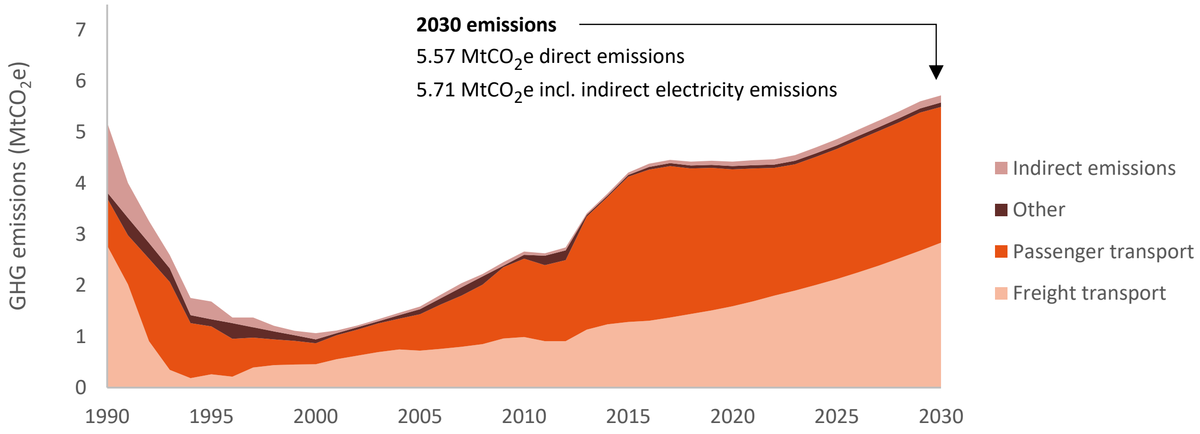
Figure 3: Impact of proposed measures of the Climate Strategy and Action Plan on the transport sector reference emission trajectory




In the policy scenario, virtually all transport measure impacts result from changes in the passenger transport sub-sector as most of the proposed actions did not include freight measures. Actions that did include freight measures were implemented before this analysis and thus included in the reference scenario. While freight transport emissions maintain the same upward trajectory in the policy scenario as in the reference case, **the trend for passenger transport emissions is reversed and leads to a 7% decrease in absolute emissions between 2015 and 2030** (

Figure 4). The modal share for LDVs decreases significantly between 2015 and 2030 (by 14.8%), while the modal share for buses almost doubles (from 11.9% to 21.7%). The modal share for rail and marshutkas also increases by 2.5% and 4.3% respectively. For more details, see Annex III.

Figure 4: Policy scenario emission trajectory per category for transport (1990-2030)




Note: the "Other" category contains off-road vehicles, domestic navigation and aviation, and 2-wheelers.

## 4.3 Long-term Paris Agreement compatible trajectory

The objectives of the Paris Agreement have considerable implications for the development of the transport sector in Georgia, as for other countries: **in contrast to the projected rapid growth of GHG emissions from transport in Georgia, emissions from the sector should peak as early as possible and reduce to zero in the second half of century** (IPCC, 2018). In other words, compliance with the Agreement would implicitly require Parties to restrict short-term investments in fossil fuel-related transport infrastructure to the very minimum required, and to transition **to a 100% zero carbon transport sector in the medium- to long-term**.

The Paris Agreement is based on a "common but differentiated responsibilities" principle, under which **all countries are expected to fully decarbonise**, although at different speeds and under different financial conditions. Developed countries are expected to mitigate at a faster rate in comparison to developing countries to allow for development, and to provide technical and financial assistance for the decarbonisation of developing economies. Moreover, the international climate negotiation process may also lead to increased financial support for clean pathways that have synergies for sustainable development objectives. Thus, **Georgia should already work on a decarbonisation pathway that is in line with achieving the Agreement's targets while also compiling with other national development priorities**.

The methodology and the pathways presented in this section are indicative and meant as a first-order estimate to illustrate the general trend transport emissions could follow under a decarbonisation scenario, compared to increasing emissions in the coming decades under current policies.

### 4.3.1 Methodology

We developed two different scenarios to represent different alternatives of how the transport sector could decarbonize:

i. **A "best-in-class" scenario**, based on the potential for replicating best practices that other countries are already taking on

ii. **A "Paris Agreement-compatible" scenario,** following global trends according to international sources

Both scenarios represent two different ways of how the transport sector could develop in the future. In that sense, they serve as boundaries for how successful decarbonisation of the transport sector can be achieved in the long run. The general assumptions of each scenario are summarized below in Table 14.

To ensure that the aggregated impact of these policies is sufficient to reach emission levels that are in line with the Paris Agreement's temperature goals, the resulting emission pathways are compared to a range of "2°C compatible" scenarios from international literature (IEA, 2017a, 2018; IPCC, 2018).

Table 14: indicator levels for two ambitious mitigation scenarios for the transport sector in Georgia

<table>
<tr><th colspan="2">Indicator</th><th>Best-in-class scenario</th><th>Paris Agreement-compatible scenario</th></tr>
<tr><td colspan="4">Passenger transport</td></tr>
<tr><td colspan="2">Average emission intensity for non-electrified personal vehicle transport</td><td colspan="2">European Union targets:<br>• 95 $gCO_2$/vkm by 2020 for new cars<br>• 15% reduction relative to 2020 by 2025 and 31-37.5% by 2030 (81 $gCO_2$/vkm by 2025 and 59-68 $gCO_2$/vkm by 2030)<br><br>Assumption for Georgia: similar developments and targets with a 10-year delay, achieving average emissions intensity of 95 $gCO_2$/vkm by 2030 and 59-68 $gCO_2$/vkm by 2040. Lower end for best-in-class scenario and upper end for Paris Agreement-compatible scenario.<br><br>Source: European Federation for Transport and Environment, 2018; Climate Action Tracker, 2018b.</td></tr>
<tr><td>Modal Split</td><td>Share of public transport activity</td><td>Mode shares according to the ambitious scenario developed for the European Transport Roadmap Report:<br>• 45% of all trips made in 2050 with public transport modes<br><br>Assumption for Georgia: Same recommendation as in European Transport Roadmap Report, assuming public transport includes bus and train activity and LDVs make up for the remaining share of rides (~55%).<br><br>Source: Greenpeace (forthcoming)</td><td>Target for OECD Asia region under the Robust Governance (ROG) scenario which assumes that local governments play an active role to slow down the ownership and use of personal vehicles (LDVs) from 2020 onwards:<br>• 56% of all trips made in 2050 with public transport<br><br>Assumption for Georgia: Same as assumption for Asia region, assuming public transport includes bus and train activity and LDVs make up for the remaining share (~44%).<br><br>Source: OECD/ITF Transport Outlook, 2017. Chapter 5, Table 5.2.</td></tr>
<tr><td colspan="2">Share of electrified passenger transport activity</td><td>'Good practice' scenario developed by Fekete et al. based on the 30% current share of EVs in new vehicle sales in Norway:<br>• 17% by 2030; 35% by 2040 and 54% of the LDV fleet to be electric by 2050<br>• 20% by 2030; 39% by 2040 and 58% of the bus fleet to be electric by 2050<br><br>Assumption for Georgia: Same trend as in the 'good practice' scenario above referred.<br><br>Source: Fekete et al., 2015; Climate Action Tracker, 2018b.</td><td>Global transport sector benchmarks to limit warming to 1.5°C targets:<br>• 43% by 2030; 94% by 2040 and 100% of the LDV fleet to be electric by 2050<br>• 55% by 2030; 98% by 2040 and 100% of the bus fleet to be electric by 2050<br><br>Assumption for Georgia: Same as global targets needed for LDVs and of public transport.<br><br>Source: Kuramochi et al., 2018.</td></tr>
</table>

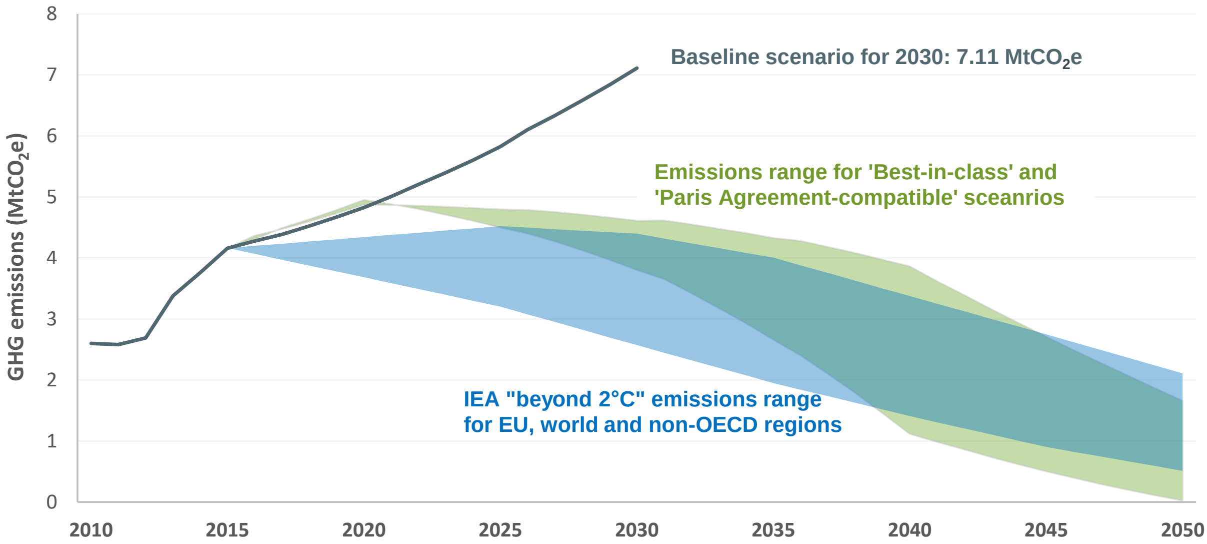
<table>
<tr><th colspan="4">Freight transport</th></tr>
<tr><td colspan="2">Average emission intensity for non-electrified truck transport</td><td colspan="2">European Union targets:<ul><li>In 2025, 15% lower than in 2019</li><li>In 2030, at least 30 % lower than in 2019</li></ul>Assumption for Georgia: Same targets as for EU but compared to emission intensity levels in the baseline year (2015).<br><br>Source: European Federation for Transport and Environment, 2018</td></tr>
<tr><td>Modal Split</td><td>Share of rail freight</td><td colspan="2">Best practice example of European countries that transport high shares of domestic cargo by train:<ul><li>Latvia, currently with 80% of freight by rail</li></ul>Assumption for Georgia: reach similar levels as in good practice example of Latvia, by 2050.<br><br>Source: Climate Action Tracker, 2018</td></tr>
<tr><td colspan="2">Share of electrified freight activity</td><td>Based on EU's 30% electric trucks in new truck sales by 2030 target:<ul><li>16% by 2030; 37% by 2040 and 58% of the truck fleet to be electric by 2050</li></ul>Assumption for Georgia: to reach similar levels as suggested for the EU and follow a similar increasing trend afterwards. Rail freight is 100% electric by 2030.<br><br>Source: Climate Action Tracker, 2018</td><td>Global transport sector benchmarks to achieve full decarbonisation by mid-century:<ul><li>33%-42% by 2030; 75%-91% by 2040 and 99%-100% of the truck fleet to be electric by 2050</li></ul>Assumption for Georgia: Same as in global targets, taking the lower end of the range as target. Rail freight is 100% electric by 2030.<br><br>Source: Climate Action Tracker, 2018</td></tr>
</table>

### 4.3.2 Scenario overview

Figure 5 illustrates how the "Best-in-class" and the "Paris Agreement-compatible" scenarios compare to sector emissions when following a "business-as-usual" (BAU) pathway. In striking contrast **to the projected emissions growth under a BAU scenario, emissions from the transport sector should peak and decline as early as possible to achieve the sector's decarbonisation in line with the Paris Agreement's objectives.** For comparison purposes, the graph also includes emissions pathways from the IEA's "beyond 2°C scenario" for three regions (World, non-OECD and European Union) scaled down to the historic emission path in Georgia (IEA, 2018). Transport emissions under IEA's scenario are reducing slower (with full decarbonisation expected in the second half of the century) partly due to the immense activity growth foreseen in the near future. The two scenarios calculated here for Georgia are still in line with the range of Paris compatible scenarios from IEA.

Emissions for the transport sector under both the "Best-in-class" and the "Paris Agreement-compatible" scenarios would peak in the short term and start a declining path over the following decades. The detailed results show that although prioritising modal shifts will reduce the level of electrification needed in the short term, a relatively high share of electric vehicles is necessary in all cases. Ambitious policies in this area are currently lacking as there is no widespread electrification strategy for public transport in place, and financial incentives insofar have had mixed results. The demand for electrification has important implications on large scale infrastructure developments, e.g. rolling out the needed technology and infrastructure to support the increase of electric vehicles in the country and to support a shift to rail (passenger and freight) transport. The task is now to find the right mix between modal shift and electrification for Georgia, considering its geographical, societal and political context. Achieving the full decarbonisation of the transport sector also significantly relies on the decarbonising of the electricity supply sector, in line with the Paris Agreement temperature limit.

Figure 5: Transport sector GHG emissions pathway (direct emissions) until 2050 under decarbonisation scenarios



# 5 Planning for the low carbon transition

Section 4.3 showed how a Paris compatible GHG emission trajectory would require a considerable shift away from current pathways. This section explores the policies and support programmes that could underpin that low carbon transition, as well as planning processes for transport policy and climate objectives.

## 5.1 Avoid – shift - improve

Sustainable pathways for transport are based on solutions that draw from the ***avoid – shift – improve*** logic (GIZ, 2004). This logic emphasises the importance of solutions to integrate approaches that:

- ***avoid*** unnecessary transportation activity by making journeys and urban spaces more efficient
- ***shift*** journeys to more sustainable modes such as public and non-motorised transport
- ***improve*** technologies and infrastructure for all modes of transport, including through fuel efficiency the increased uptake of electrification and sustainable fuels

National strategies for ***improving*** technologies are becoming more common: vehicle fuel economy and emission standards are increasing in stringency in countries worldwide, and large potential exists for the uptake of best practice policies in this regard (Healy et al., 2016). Several European countries are considering regulatory instruments for the phase-out of conventional motor vehicles in the near future, favouring the uptake of electric vehicles (IEA, 2016b), whilst China has also recently proposed a new regulation requiring car sales in 2018 to include a minimum quota of 8% electric vehicles (Wall Street Journal, 2016). Mitigation options for technological improvements in the transport sector are generally well researched, and becoming more affordable, and there is significant potential in Georgia for the replication of best practice policies from other countries.

New technology options can support continual improvements in emission intensities and potentially reduce emissions to net-zero through renewable energy-based electrification. However, strategies that integrate such improvements with the concepts of ***avoid*** and ***shift*** are key to the achievement of broader emission reductions in the short- or medium-term, given the steep increases in activity levels forecasted for the sector. The uptake of such measures to complement existing intensity improvement measures is important in case these ***improve*** efforts do not yield their full long-term potential, and because the broader societal and economic benefits of ***avoid*** and ***shift*** measures are compelling. Such strategies remain largely undeveloped and uncoordinated in Georgia, although promising examples of transformational transport planning are emerging on the subnational level in some cities. In many cases where ***avoid*** and ***shift*** strategies have been successfully implemented in other countries, these were not designed primarily for climate-related objectives but rather because they make logical sense for efficiency and safety of urban mobility (Copenhagen and Bogotá, for example, have seen significant developments in integrated urban transport planning, see United Nations, 2012).

Implementation of action for climate change mitigation in the transport sector can be impeded by several barriers. The inherent complexity of the sector and its interrelatedness with other sectors creates challenges for the development of widely suitable technical options and financing models that can leverage private sector capital. At the same time, transport infrastructure is costly and burdens public finances. In particular, sustainable infrastructure and transformational redesign of transport modes require investments that do not pay back within the short-term. They may also be subject to issues related to public acceptance, current mainstream cultural values and preferences, as well as psychological barriers related to the perceived risk of change.

## 5.2 Policies and support programmes

Various levels of governance and institutions have jurisdiction over policy interventions in different areas of the transport sector.

Table 15 provides an overview of good practice policies and measures for climate action in the transport sector, indicating which policies and measures are in place in Georgia (green), which are in planning or discussions (yellow) and which do not currently yet exist (red). These good practice policies are taken from a database that collects policies that were recurrently identified as good practice or of high mitigation potential in the literature (see climatepolicydatabase.org). This overview was complemented with additional studies reviewed to find actions or policies needed within the transport sector to be in line with the more ambitious 1.5°C temperature goal of the Paris Agreement (Climate Action Tracker, 2016).

Table 15: Strategies and regulatory instruments that address climate change and/or energy in the transport sector in Georgia, and responsible institutions.

**General policies and strategies addressing climate and/or energy in transport**

Policies are in place | Policies are proposed or in planning | Policies do not exist

| Policy | Responsible institution |
|---|---|
| Overarching transport sector specific strategy | No clear responsible institution |
| Inter-city transport logistics and strategy | No clear responsible institution |
| Air quality standards | Department of Air Quality, MEPA |
| Carbon tax or fossil fuel tax | |
| Removal of fossil fuel subsidies | |
| Informational campaigns for public awareness | MESD & municipalities |
| **Subnational action plans for transport sector** | Municipal governments |

| Changing activity | | Efficiency | | Renewables | | Fuel switch | |
|---|---|---|---|---|---|---|---|
| Urban planning strategies to minimise transport demand | | Mandatory vehicle testing for roadworthiness | MESD | Biofuel target | | E-mobility programme or strategy | |
| Incentive programmes for modal shift | Municipal government | Energy/emissions performance standards (LDVs) | | Support schemes for biofuels | | Mandatory EV targets | |
| Disincentive programmes for (private) transport activity | Municipal government | Energy/emissions performance standards (HDVs) | | Sustainability standards for biomass use | | Incentives for electric and low carbon vehicles | Ministry of Intern. Affairs |
| Infrastructure investments for modal shift | Municipal government | Incentive instruments for energy efficient vehicles | Ministry of Intern. Affairs | | | | |

| | | | | | |
|---|---|---|---|---|---|
| | Efficiency standards for rail transport | MESD | | | |
| Strategy and/or policy instruments for optimised and efficient freight and logistics | | | | | |
| | Direct investment in renewal of modern and more efficient public transport and municipal vehicles | | | | Municipal government |

Note: policy categorisation based on IPCC (Sims et al., 2014) and Climate Policy Database (NewClimate Institute, 2019). Green shading indicates that policies for the given category are in place, whilst red shading shows that they are not. Yellow shading shows that policies are proposed or in planning. The adjacent column indicates the institutions responsible for design or implementation of the measures.
Source: Authors' elaboration based on the good practice policies of the Climate Policy Database (NewClimate Institute, 2019)

### General cross-cutting strategies and policies

There is currently no overarching master transport sector strategy document in Georgia. Nor is there an institution mandated to compile such a strategy. In terms of an overarching strategy, the major strategy documents to date are the ***Sustainable Energy Action Plans (SEAPs)*** of the eleven cities that have become signatories to the Covenant of Mayors programme. These plans include measures that will shift passenger transport to public transport and non-motorised modes of transport, and measures that will increase the efficiency of transport in the cities, for example through traffic light and routing optimisation.

National strategies such as the **National Renewable Energy Action Plan** (NREAP), **National Energy Efficiency Action Plan** (NEEAP), and **Green Economy Strategy** both directly affect transport sector emissions through promoting the use of biofuels, and indirectly affect transport sector emissions through policies and actions aimed towards increasing renewables in the national grid for electricity generation. ***Directive 2009/28/EC Directive 2009/28/EC*** further requires that EU Member States derive at least 10% of their energy use in the transport sector from renewable energy sources, including biofuels, by 2020.

A significant policy that is currently being elaborated, which may have a cross-cutting influence on decarbonisation, is the ***Order of the Government Setting Ambient Air Quality Standards***, which will implement air quality standards for zoned areas in line with the commitments to the EU Association Agreement (see section 6.1). The design and implementation of the standards is the responsibility of the Department of Air Quality at the Ministry of Environmental Protection and Agriculture (MEPA).

***Informational awareness campaigns*** are also proposed by the NEEAP, to raise awareness about the opportunities and benefits of shifting to public transport and non-motorised transport. The measures would be implemented by MESD in cooperation with municipalities.

### Improving emissions intensity and penetration of low carbon vehicles ("*improve*")

There are currently no specific standards for vehicle fuel efficiency or $CO_2$ emissions, although standards for the emissions of local air pollutants will soon need to be developed in line with the commitments of the EU Association Agreement (see section 6.1). However, the NEEAP introduces ***mandatory vehicle tests for roadworthiness***, in line with the requirements of the EU Association Agreement, which may lead to the replacement of the oldest and least efficient vehicles of the existing stock. The NEEAP estimates that energy savings will result from improved energy performance due to improved maintenance of the vehicle fleet (NEEAP Expert Team, 2017). The Ministry of Internal Affairs would be responsible for implementation, alongside existing responsibilities for vehicle registration processes.

Policy instruments also *incentivise* the uptake of low-carbon vehicle technologies. A ***2016 Tax Law Amendment removed import taxes*** for electric vehicles and reduced import taxes of hybrid vehicles by 60%. Customs duties on other kinds of vehicles have remained unchanged or increased significantly (BPI, 2017). This policy is also implemented by Ministry of Internal Affairs, in cooperation with border inspection services. The market for electric and hybrid vehicles in Georgia, albeit still quite small, has seen approximately a ten-fold increase from 2015 to 2017 (Georgia Today, 2017).

Public investments are also ongoing for the ***modernisation of the public vehicle fleet***. The NEEAP proposes for major investments in modernising the vehicle stock for public transport in five cities, including higher efficiency diesel, CNG and electric bus technologies, which in some cities has already started. Municipal governments will be responsible for implementing the measures, with the support of international financial support in some cases. For example, in July 2017, the European Bank for Reconstruction and Development (EBRD) signed an agreement with Georgia for a grant that will be loaned on to the City of Batumi for the acquisition of 10 electric buses (revised to eight) – a first in Georgia and the first municipal electric bus project supported by the EBRD (EBRD, 2017).

In addition, the municipality of Tbilisi is encouraging the uptake of electric vehicle imports by developing its ***electric vehicle infrastructure*** with the set-up of around 100 charging stations by end of 2017 (Georgia Today, 2017). The draft Low Emissions Development Strategy (LEDS) also proposed a role for the Ministry of Regional Development and Infrastructure MRDI for establishing nationwide infrastructure for electric vehicle charging.

### Optimising transport activity ("*Avoid and shift"*)

Aside from the SEAPs, there are no existing strategy documents or policies that focus specifically on optimisation and reduction of transport activity. Two sets of measures are proposed by the NEEAP. Municipalities would be responsible for implementation, which may be dependent on international support for policy and programme design in each respective city:

- Infrastructure investments for modal shift: the NEEAP proposes infrastructure investments in specific cities for improving the quality, comfort and extensiveness of public transport.
- Incentive and disincentive programmes for modal shift: the NEEAP proposes pricing instruments for private vehicle parking, and the installation of new pedestrian and cycling routes.

### International technical support programmes for transport sector policy and strategy

A number of programmes are currently underway to support the development of national and subnational strategy in the transport sector:

- The ***Sustainable Low Emissions Transport Development*** project, implemented by CENN and the UN Environment Programme (UNEP) under Global Fuel Economy Initiative (GFEI), supports Georgia to put in place the policies required to comply with the EU Association Agreement, specifically with regards to measures that will impact air quality.

- The ***Green Cities*** project[5], implemented by UNDP, supports the cities of Batumi, Tbilisi and Ajara with the development of integrated sustainable transport strategies, including modelling technical urban transport parameters and designing specific policy interventions.
- The ***Capacity Development for Climate Policy (CDCP)*** project implemented by GIZ and NewClimate Institute, under which this report is prepared, has supported the institutions responsible for climate change planning processes to align transport sector climate change mitigation planning, and to identify additional measures for climate change mitigation, for the development of the transport sector chapter of the 2021-2023 Climate Strategy and Action Plan.
- The ***Urban transport advisory and technical assistance*** projects implemented by AFD and supporting Tbilisi City Hall in SUMP implementation, Coordination processes and advising the Head of the Tbilisi Urban and Transport Development Agency and to Tbilisi Transport Company in Capacity building in Operation and maintenance, project management and supervision.
- The ***Green Cities*** programme implemented by EBRD supports Tbilisi Transport Company with its different projects in Corporate Development, Capacity Building and Stakeholder Participation, implementation of reforms for bus services in the City, including implementing the PSC and introducing the new bus network, the preparation and implementation of a Gender Equality and Inclusion Strategy. Also, provides gender advisory services for six regional cities.
- The ***Sustainable Urban Mobility in the South Caucasus (Mobility4Cities)*** Programme implemented by GIZ supports Tbilisi and Batumi municipalities in developing and implementing concepts and strategies for urban mobility, e.g. Sustainable Urban Mobility Plans (SUMPs), improves opportunities for training and academic qualification on sustainable urban mobility and develops recommendations to improve the national framework for urban mobility are developed in cooperation with responsible Georgian institutions.
- The ***Sustainable Urban Mobility*** project implemented by KfW supports Tbilisi and Batumi City Halls and Transport Companies to reduce Greenhouse gas emissions by introducing new ITS system on certain corridors, data center, traffic lights, BRT Green Corridors, etc.

### Potential and priorities for additional action

Based on the gaps in the policy framework in Table 15, and the priority action areas identified by the transport sector working group for the development of the Climate Strategy and Action Plan, the following measures and areas of action remain options for additional action to decarbonise the transport sector.

**Urban planning strategies to minimize transport demand:** Available assessments show that transport tends to bring persistent and detrimental impacts, particularly regarding environment and health. The European Union recognises that urban transport needs to be addressed by a joint effort at the local, national and European levels of governance. Further, compliance with air and noise EU legislations requires that plans addressing urban transport are drawn up in as many cities as possible.

In Georgia, a National Strategy and Policy Framework on Sustainable Low-Carbon Urban Transport was developed with the support of UNDP and the Municipal government of Batumi. The strategy needs to be picked up by national stakeholders that can take responsibility to see its implementation.

**Instruments to improve efficiency of private light duty vehicles:** The efficiency of private light duty vehicles will improve due to several of the actions in the 2021-2023 CSAP, but due to the age and poor

[5] See further details of the Green Cities project on the UNDP website.

efficiency of the current vehicle fleet, further improvements will remain a priority action area. Further analysis is needed to understand what the best additional policy options would be to drive further improvements, in addition to those which are being implemented. The CSAP includes the enabling action of developing a cost benefit analysis and feasibility study in order to assess which would be the most attractive policy options in this area, additional to the measures that will already be implemented.

**Mandatory EV targets:** Research shows that to ensure energy-related emissions are reduced to zero fast enough to hold warming below 2°C, the transport sector must begin to decarbonise in the next few years and move quickly towards zero-emission options. Accelerating action in this sector has been identified in the scientific literature as a key factor for the more rapid effort required to limit warming to below 1.5°C, rather than 2°C (Rogelj et al., 2015). Following on this, several European countries are phasing out fossil fuel cars and switching to electric vehicles (EVs) with targets to do so varying between 2025 and 2040 (Dugdale, 2018). To ensure reaching the target, Georgia could also consider developing an **e-mobility programme or strategy** to support the implementation of actions needed to increase the share of EVs in the country.

**Shifting urban passenger transport to public transportation and non-motorised modes:** Several plans are currently being implemented in major cities (particularly Tbilisi and Batumi) to upgrade public transport infrastructure and services, as well as those for bicycle and non-motorised transport infrastructure. The options available for enhanced action in these cities, as well as other cities, are well understood. With more resources, more can be achieved. The 20213-2023 CSAP includes the enabling action of developing proposals for international climate finance to support action in this area, which is at the same time aligned with the climate action priorities of Georgia's Country Programme with the Green Climate Fund (GCF).

**Shifting inter-city passenger transport to public transportation:** Improvements are being made to passenger rail services, including the provision of new and modern trains. The options for upscaling these actions are understood if resources can be mobilised and further research developed. Further, improving inter-city passenger transport quality as well as the railway system, are national mitigation priorities, as indicated in Georgia's Country Programme with the Green Climate Fund (GCF).

**Strategy or policy instruments for optimised and efficient freight and logistics:** Road vehicles accounted for approximately 63% of freight activity in 2016, contributing to over 96% of freight transport emissions. This shows the importance of road-based freight transport and its significant contribution to the sector's emissions. Although not yet in place, the European Commission is preparing a regulatory proposal that would set mandatory $CO_2$ limits for the heavy-duty vehicle (HDV) categories with the highest share of emissions (ICCT, 2018). Several potential plans and strategies have been developed that would have a positive impact for shifting freight from road to rail, but there remains a lack of clarity on what would be the most effective options to pursue. The 2021-2023 CSAP includes the enabling action of developing a cost benefit analysis and feasibility study in the future, in order to assess which would be the most attractive policy options in this area.

**Support schemes for sustainable biofuels:** Georgia's EU Association Agreement includes Directive 2009/28/EC for the promotion of the use of energy from renewable sources, which requires that EU Member States derive at least 10% of their energy use in the transport sector from renewable energy sources, including biofuels, by 2020. The specific **biofuel target** for Georgia will be determined by a study carried out by the Energy Community Secretariat, based on a predetermined approach given in the Directive. The use of renewable energy and biofuels in Georgia's transport sector is currently negligible, although some studies have already been carried out with significant interest from the Municipal government of Tbilisi and highlighting the potential to impulse agriculture developments in the country (Ilia State University, 2017).

## 5.3 Planning processes for transport policy and strategy

Figure 6 provides an overview of institutional responsibilities and processes for planning in the transport sector in Georgia.

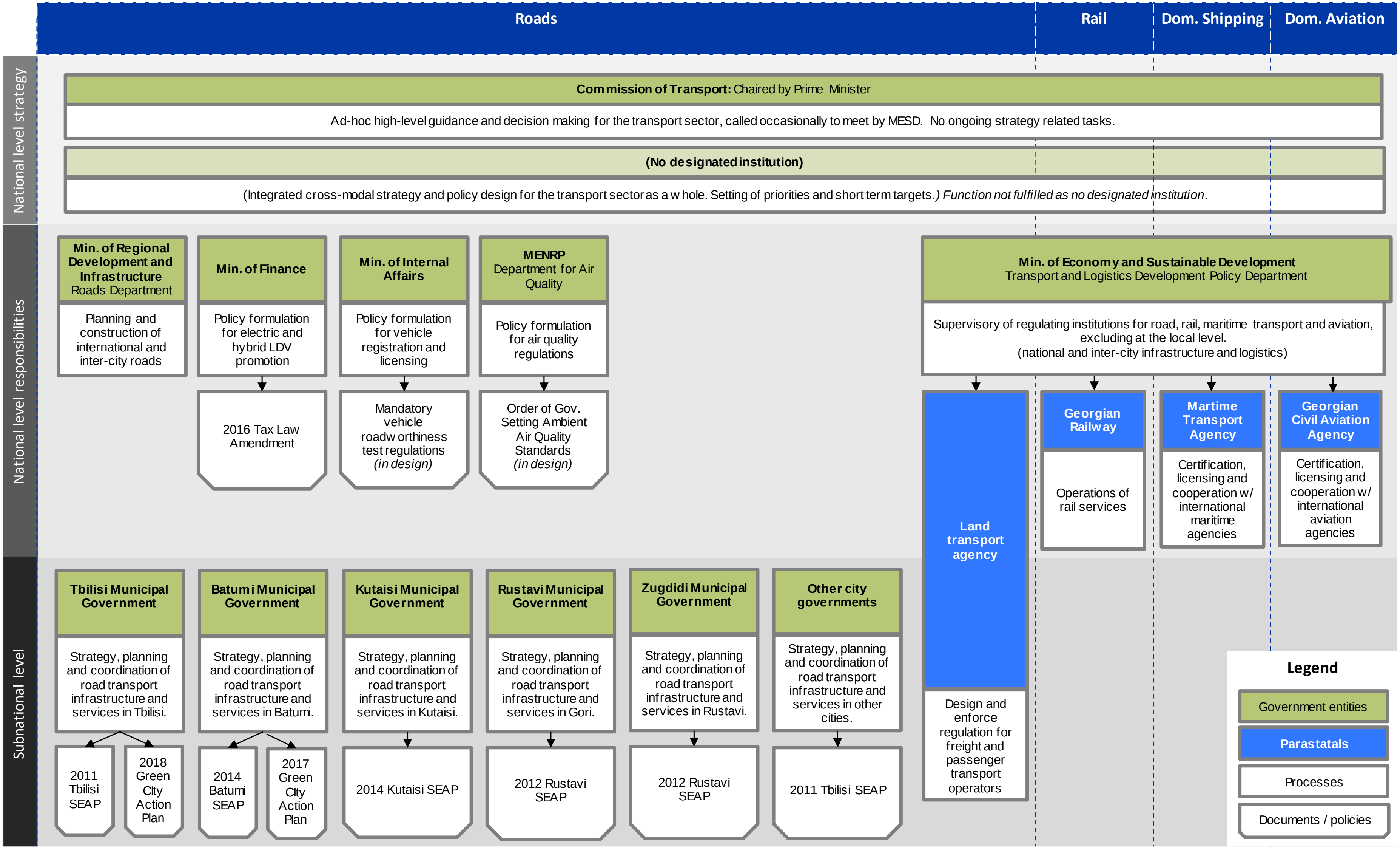
The chart shows that there is a wide range of actors involved in strategy, planning and regulation for different sub-sections of the transport sector. This clear division and devolution of responsibilities could be considered a strength of the institutional system (ADB, 2014). However, such division and devolution of responsibilities require a framework to coordinate devolved efforts and align them with overarching strategic objectives. Georgia is in an unusual situation, compared to many other countries, that there is not a single entity with responsibility for overarching national transport sector strategy and policy. The *Commission of Transport*, chaired by the Prime Minister, can be convened for high-level guidance and decision making on specific issues, but this is an irregular function and the Commission does not concern itself with ongoing sector strategy and coordination. This situation of having a highly devolved sector with no common strategic objectives and limited vertical or horizontal structures to align efforts leads to a degree of fragmentation in planning, and difficulties to determine common long-term pathways and strategic objectives.

Figure 6 shows that the share of emissions falling within the jurisdiction of municipal governments is high. Both the NEEAP and the draft LEDS also propose municipalities as responsible institutions for most of the energy efficiency measures listed for the sector within these documents. Municipal governments have, to date, been most proactive in designing a longer-term strategy for transport within their jurisdiction, although the implementation of these plans is hamstrung by a lack of supporting policy and coordination at the national level and a lack of consistent and reliable finance for their proposed actions. Municipalities are also typically more removed from sources of international financial and technical support, although several programmes recently have begun working more closely with cities, notably the Green Cities Action Plan project supported by UNDP and EBRD.

There is a lack of strategic guidance running through the sector for how different departments and municipalities should design their plans, and what long-term objectives should be considered. This means that there is no mandate to consider long-term objectives for climate change or sustainable development outcomes, in transport sector planning documents, despite these issues being heavily interlinked. City governments are generally the only institutions to have directly identified $CO_2$ emissions as a central objective in their planning, driven largely through the support of the international Covenant of Mayors programme, but there remains limited mandate or resources internally to deliver on these emission reduction targets.

Planning for the development of the transport sector may be more cost-effective and constructive for human and economic development, if it is guided and informed by broader sustainable development objectives, including for climate change. This requires that there is a means for linking transport sector targets and outcomes to sustainable development objectives (see section 6.2). It also requires that a coordinating institution or structure can support other institutions to perform their devolved responsibilities in line with common short- and long-term objectives.

Figure 6: Overview of institutional responsibility for transport sector strategy at the national and subnational level.




Source: Authors' elaboration.

## 5.4 Integration of climate objectives in transport sector plans

Climate change planning processes are coordinated by the Climate Change Division (CCD) of the Ministry for Environmental Protection and Agriculture. CCD coordinates the compilation of Georgia's communications to the secretariat of the United Nations Framework Convention on Climate Change (UNFCCC), including the Nationally Determined Contribution (NDC), as well as Georgia's Climate Strategy and Action Plan (CSAP, see section 3.3)

The elaboration of information on transport sector plans for the purpose of climate change planning is made difficult due to the lack of a single institutional entity with oversight for the development trajectory of the sector (see section 5.3). To date, transport sector information in climate change planning documents has been developed through a variety of methods:

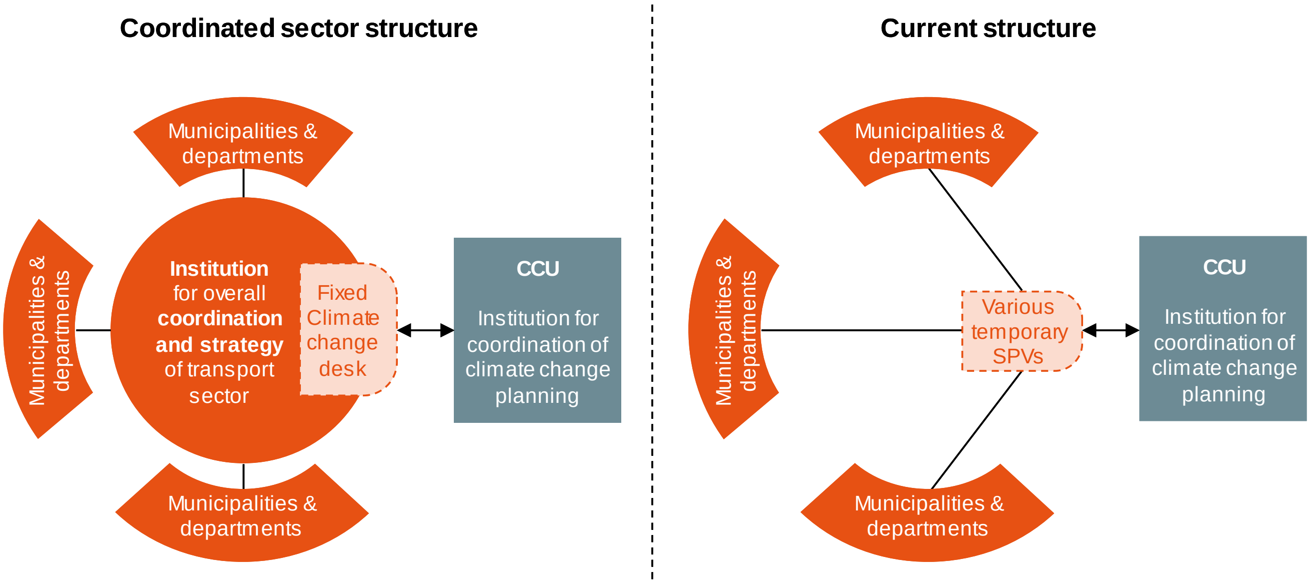
- For Georgia's Third National Communication (2016), private consultants were contracted temporarily to compile information about the status and pathways of the transport sector.
- For the draft Low Emissions Development Strategy (prepared 2013-2017), a technical working group for the transport sector was established. Due to the wide range of governmental and non-governmental stakeholders, and the lack of a single entity responsible for oversight, input from the sector into the planning of the LEDS document was reported to be somewhat fragmented, and the process of elaborating the sector's pathway options was lead primarily by independent consultants.
- For the Nationally Determined Contribution (2015), staff of the CCD compiled emissions trajectory projections for the sector, based on available inputs from other ministries and departments.
- For the 2021-2023 Climate Strategy and Action Plan, a combination of international and national consultants produced pathways and analysis through data collection and validation exercises with various national and subnational departments, and in cooperation with a sector working group made up of experts and relevant institutions.

Figure 7 shows how climate change planning processes for the transport sector could be structured. The *coordinated sector structure* shows how this process could be structured if the transport sector would have an institution responsible for overall coordination and strategy of the various municipal governments and relevant departments. A fixed climate change desk within this institution could cooperate with the institution responsible for the overall coordination of climate change planning (the Climate Change Division of MEPA). This embedded climate change desk would be well positioned to collect and communicate relevant information in both directions: information on national climate change goals and commitments can be communicated to the stakeholders of the transport sector, while information on the sector pathway, the aggregated impact of policies and support needs for further ambition could be communicated to the CCD.

The *current structure* in Figure 7 also shows how in the absence of a central coordinating institution for the transport sector, information is collected and communicated with various temporary special purpose working groups (SPWGs).

Two potential approaches would improve the sustainability and consistency of this approach for future climate planning processes. In the best-case scenario, a centralised institution with overarching responsibility for transport sector strategy would be formed, so that the *coordinated sector structure* model could be pursued. In the case that such developments remain unrealistic, it would be highly beneficial to create a permanent formalised climate-transport coordination entity, in place of the various temporary SPWGs that are currently established for this role.

Figure 7: Potential structures for climate change planning processes in the transport sector




Note: Climate change unit (CCU) is now referred to as Climate Change Division (CCD), which is the name primarily used throughout the document.
Source: Authors elaboration.

# 6 Benefits of decarbonisation in the transport sector

This section explores the extent to which there are synergies between a modern, efficient and decarbonised transport sector and other major national strategic and development priorities in Georgia.

Two key overarching national strategic and development priorities in Georgia are the EU Association Agreement and the Sustainable Development Goals (SDGs) of Agenda 2030. The synergies between these strategic priorities with decarbonisation pathways are presented in the following sub-sections.

## 6.1 Synergies with the EU Association Agreement

An Association Agreement between the European Union and Georgia was signed in June 2014 and fully entered into force in July 2016. **The Association Agreement aims to provide a framework that allows for deeper political and economic relationships between the EU and Georgia**, including through the increased alignment of some key regulations and standards. In addition to the Association Agreement, **Georgia acceded to the Energy Community Treaty in June 2017, which seeks to liberalise and align energy markets** with those of the EU Member States and other Energy Community Parties.

**Compliance with the Association Agreement and the Energy Community Treaty has particularly high political priority in Georgia** since the European Union is viewed as a key strategic partner, and since closer ties to the EU customs union and even to the EU membership process are consistently sought by the Government of Georgia in recent years. Thorough implementation of the Association Agreement and the Energy Community Treaty is understood to be a condition and potential vehicle for further developments in the EU-Georgia partnership.

The 2014 Association Agreement and the 2017 Protocol for the Energy Community Treaty commit Georgia to an ambitious reform agenda through the identification of a list of European Commission Directives for implementation in Georgia, with a timetable of implementation for each. Several of the identified Directives are relevant for the transport sector, as well as energy more broadly and aspects of environmental protection.

**Neither the Association Agreement nor the Energy Community Treaty binds Georgia to specific targets related to emissions trajectories or decarbonisation indicators for transport. However, the documents do include several elements for which the full implementation will most likely also lead to improvements for all key decarbonisation indicators.** The implications of the EU Association Agreement and Energy Community Treaty for climate change planning in the transport sector are assessed below, based on the type of decarbonisation indicators that they relate to.

### Cross-cutting decarbonisation

The following directives can have an impact on decarbonising transport through incentivising *avoid*, *shift* and *improve* measures.

- **Directive 2012/27/EU on energy efficiency requires the development of an energy efficiency strategy** with a specific target for reducing energy consumption in 2020 and specific measures for implementation. The *Energy Community Treaty Protocol* requires that Georgia fully implements the provisions of the Directive by the end of 2018. Georgia's National Energy Efficiency Action Plan (NEEAP), which contains these elements, was drafted in 2017 and is in the stages of formal approval in 2018. The draft NEEAP includes a wide range of measures for transport, some of which relate directly to the further requirements of the Association Agreement mentioned below.

- **Directive 2008/50/EC on ambient air quality and cleaner air specifies clear targets and limit values for local air pollutant concentrations**, including an annual mean limit for particulate matter (PM10) in any given location of 40 µg/$m^3$. Measurements in Tbilisi in 2014 showed an average annual PM10 concentration of 55 µg/$m^3$ (WHO, 2019), whilst some locations are understood to be even further in excess of this. The Association Agreement requires Georgia to adopt legislation and designate authorities to tackle this issue by 2020. By 2022, air pollution zones should be drawn, and a measurement and assessment regime should be put in place within these zones. By 2023, short-term and long-term air quality plans should be established for all zones assessed to be exceeding the air pollution limits, and public information systems should be made available. It is estimated that approximately 80% of local air pollution in Tbilisi is attributable to road transport (Karchkhadze, 2017); reducing air pollutant concentrations below the limits of the Directive will require that air pollutant emissions from the transport sector are cut. The measures implemented to achieve these air pollutant emission reductions are also likely to entail reductions in $CO_2$ emissions.

### Emissions intensity and penetration of electrified and low carbon vehicles ("*improve*")

Although the EU Association Agreement does not include bindings targets related specifically to vehicle emission standards, it does include several elements for which the implementation will likely also lead to improvements in the emissions intensity of road vehicles. The following four components of the Association Agreement are relevant, in addition to the two described in the cross-cutting sub-section above:

- **Directive 2009/40/EC, on roadworthiness tests for vehicles, requires regular vehicle testing including verification that emission control systems are functioning correctly and monitoring exhaust emissions for major air pollutants.** The Association Agreement requires that Georgia has a mandatory roadworthiness testing in place for buses and trucks by mid-2018, and for other vehicle types by 2020. The directive also indicates the maximum allowed values for carbon monoxide (CO), hydrocarbons (HC), and nitrogen oxides ($NO_x$) per km of vehicle travel. Whilst these restrictions do not directly refer to $CO_2$ emissions, measures to control these other air pollutants will likely include those that also would have an impact on reducing $CO_2$ emissions intensity. The tests would also be likely to make some older vehicles un-roadworthy and effectively remove them from the average vehicle stock. Since these vehicles have the greatest emissions intensity, this would also reduce the average emissions intensity of the total vehicle stock.

- **Directive 2009/33/EC on the promotion of clean and energy-efficient road transport vehicles requires that public entities in Georgia must evaluate and consider environmental impacts, $CO_2$ emissions, emissions of other air pollutants and lifetime costs of vehicles when considering options for the acquisition of road vehicles.** According to the Protocol for the Energy Community Treaty these measures should already be in place as of September 2017. This Directive requires no predetermined outcome but increases the likelihood that more efficient and less polluting vehicles are acquired, which could also have an effect of stimulating the industry for these vehicles. This may lead to the reduced emission intensity of non-electrified vehicles as well as the increased penetration of electrified transport and other low-carbon vehicle technologies.

- ***Regulation (EC) No 1222/2009* on the labelling of tyres, requires for Georgia that by 2021, all tyres sold are clearly labelled at the point of sale with details regarding fuel efficiency and other essential parameters**. The mandatory provision of information will increase the likelihood that consumers purchase more efficient tyres, thereby improving vehicle fuel economy and reducing the emissions intensity of vehicles.

- ***Directive 2009/28/EC* for the promotion of the use of energy from renewable sources, requires that EU Member States derive at least 10% of their energy use in the transport sector from renewable energy sources, including biofuels, by 2020.** The *Energy Community Treaty Protocol* indicates that the specific target for Georgia will be determined by a study carried out by the Energy Community Secretariat, based on a predetermined approach given in the Directive. The use of renewable energy and biofuels in Georgia's transport sector is currently negligible, although significant potential is estimated (Karchkhadze, 2017).

#### Optimising transport activity ("*Avoid and shift"*)

In addition to the requirements in the cross-cutting sub-section above, one further component of the Association Agreement may lead indirectly to decisions that reduce growth in transport activity or shift it to public modes of transit. ***Directive 2011/92/EU* on the assessment of the effects of certain public and private projects on the environment, requires that major public infrastructure investment projects are assessed for their impacts on various environmental indicators**, including fauna and flora, soil, water, air, climate and the landscape, amongst others. For transport sector infrastructure projects, these indicators are likely to lead to more scrutiny for infrastructure projects that may lead to increases in private transportation activity, such as road construction, which may make infrastructure projects for public transport more favourable. The extent to which this could have an impact on investment decisions in the transport sector cannot be estimated, but the evaluation could also catalyse increased public awareness and participation in planning issues, which could lead to significant impacts in some cases.

## 6.2 Synergies with the Sustainable Development Goals (2030 Agenda)

In 2015, member states of the United Nations adopted the 2030 Agenda, including 17 Sustainable Development Goals (SDGs) and 169 targets. The aim of the 2030 Agenda is to end poverty, protect the planet and ensure that all people live in peace and prosperity. In contrast to the Millennium Development Goals (MDGs), the SDG framework does not differentiate between "developed" and "developing" countries and incorporates additional areas such as climate change, economic inequality, sustainable consumption, innovation, peace and justice. The 17 SDGs of the 2030 Agenda officially came into force in January 2016, applying to all states with no exceptions. SDGs are not legally binding; however, each government is expected to establish an integrated, national SDG strategy to implement the new sustainable development agenda by 2030 (United Nations, 2018).

**Agenda 2030 and the SDGs include specific targets relevant to transport sector modernisation, such as road safety and emissions control**. Additionally, there are many other SDG targets, whose fulfilment would be directly or indirectly influenced by the decarbonisation of Georgia's transport sector. Some examples of global goals and targets which are related to transport sector decarbonisation measures are presented in Table 16. From this table, it is visible that most of the links between potential decarbonisation actions in Georgia's transport sector and nationally adjusted SDGs are positive. The acceleration of planning and implementation for transport sector decarbonisation would be of benefit not only from a climate change mitigation perspective but also would accelerate the implementation of the Agenda 2030 and the SDGs in Georgia.

A deeper understanding of the points of intersection between climate action on the transport sector and Agenda 2030 can help unlock further ambition and avoid potential conflicts. In some cases, interactions between the two may be mutually reinforcing, while in other cases action in one may undermine the achievement of the targets in the other. Being aware of potential linkages can support policymakers across different departments and state levels, to achieve greater policy coherence, to enable the achievability of multiple goals and to improve the efficiency of implementation. Further, financing the implementation of decarbonisation measures in the transport sector could require huge investments, which are more likely to be financed if embedded in and benefiting national development plans.

Table 16: Synergies and trade-offs between decarbonisation actions in the transport sector and selected Sustainable Development Goals for representation

| Sustainable Development Goals (SDGs) | | | Decarbonisation | Synergies and trade-offs | |
|---|---|---|---|---|---|
| SDG | Target | Georgia-adjusted target and indicator | Transport sector actions | Link | Link description |
| SDG 3 | 3.4 | Reduce premature mortality and promote mental health and well-being | | | |
| Good health and well-being | 3.4.1 | By 2030: decreased mortality rate attributed to cardiovascular disease, cancer, diabetes or chronic respiratory disease by one third | All decarbonisation measures | | Reduces outdoor air pollution due to reduced fuel use and improves mental health and well-being by reduced traffic-related stress and noise |
| | 3.6 | Reduce the number of deaths and injuries from road traffic accidents in Georgia | | | |
| | 3.6.1 | Death rate due to road traffic injuries; by 2030 baseline is reduced by 25-30%. | Changing activity: Transport demand optimisation/reduction and modal shift | | Reduction of private transportation activity will reduce the number of vehicles and consequently the number of road accidents, deaths and injuries on the roads |
| | | | Switch to low-carbon technologies such as electric vehicles | | Reduction of emissions intensity via switch electric vehicles may increase the number of car accidents due because EVs are very quiet at low speeds |
| | 3.9 | Reduce the number of deaths and illnesses from pollution and contamination | | | |
| | 3.9.1 | By 2030: reduce the mortality rate attributed to household and ambient air pollution to 65 | All decarbonisation measures | | Measures to decarbonise transport will reduce the use of fuel, leading to a reduction of air pollution which will reduce the mortality rate attributed to ambient air pollution |
| | 3.9.4 | By 2030: substantially reduce the prevalence of lower respiratory diseases | All decarbonisation measures | | Measures to decarbonise transport will reduce the use of fuel, leading to a reduction of air pollution and linked lower respiratory diseases |
| SDG 8 | 8.1 | Sustain per capita economic growth in accordance with national circumstances. | | | |
| Decent work and economic growth | 8.1.1 | By 2030: Average growth rate of real GDP per capita - 5% | Changing activity: Transport demand optimisation/reduction | | Increases economic growth due to people being able to save commuting time which they can spend in their businesses |
| | 8.2 | Achieve higher levels of economic productivity through diversification, technological upgrading and innovation | | | |
| | 8.2.1 | By 2030: average annual growth rate of real GDP per employed person should reach 2.5% | All decarbonisation measures | | measures to decarbonise the transport sector can increase economic productivity by reducing travel time which can be spent on other activities; most measures contribute to technological and infrastructure upgrading |
| | 8.3 | Promote development-oriented policies that support productive activities, decent job creation, entrepreneurship, creativity and innovation. | | | |
| | 8.3.2 | By 2030: Proportion of self-employed in non-agriculture employment - 10%; | Changing activity: Modal shift to public transport | | Implementation of mass transit schemes can support decent job creation among supply chain for construction and operation |

| | | | | |
|---|---|---|---|---|
| | 8.5 | Implement effective state policy in order to achieve productive employment and decent work for all | | |
| | 8.5.2 | By 2030: decrease the unemployment rate to 9.5% | Changing activity: Modal shift to public transport | Supports job creation through major infrastructure development and operation of public transport |
| | | | | Potential job losses in informal transport or personal vehicle value chain (manufacture of cars, servicing, petrol stations) |
| | 8.8 | Implement effective state policy in order to achieve productive employment and decent work for all | | |
| | 8.5.2 | By 2030: Increase in national compliance of labour rights (Freedom of Association and Collective Bargaining) based on International Labour Organization (ILO) textual sources and national legislation | All decarbonisation measures | All decarbonisation measures in the sector will contribute to reducing the use of conventional fuels, reducing unsafe jobs related to oil extraction and processing (drilling, refinery etc) |
| **SDG 11** | 11.2 | Provide access to safe, affordable, accessible and sustainable transport systems for all, improving road safety, notably by expanding public transport | | |
| **Sustainable cities and communities** | 11.2.1 | By 2030: increase the proportion of the population that has convenient access to public transport | All decarbonisation measures | All decarbonisation measures contribute to achieving sustainable transport and an increase in road safety (fewer cars). In particular modal shift measures contribute to increasing access to sustainable public transport |
| | 11.6 | Reduce the adverse per capita environmental impact of cities | | |
| | 11.6.2 | By 2030: annual mean levels of PM2.5 and PM10 in cities should be decreased to PM2.5 - 20 µg/m3 and PM 10 - 40 µg/m3 | All decarbonisation measures | All decarbonisation measures for transport contribute to reducing air pollution and improve ecosystem and habitat conservation due to reduced pollution and land use activities. This improves air quality of cities |
| | | | Switch to low-carbon technologies such as electric vehicles | Potential negative impact in air pollution is switch to biofuel, depending on fuel type, quality and % blended with standard fuels. Additional potential negative impact on waste management due to higher demand for car batteries (for hybrids and EVs) |

Source: SCAN-tool (2018). Authors' selection of potential linkages for the transport sector. For full list of linkages go to http://ambitiontoaction.net/scan_tool/

# 7 Recommendations for enhanced action

The transport sector in Georgia is at a crossroads. On the one hand, high passenger and freight activity growth in the coming years will lead to large increases in GHG emissions. On the other hand, technologies are emerging, and measures are available to shift the sector onto a lower carbon growth trajectory, entailing significant benefits for reducing air pollution and improving the quality of urban livelihoods, amongst other synergies with the national development agenda. Leadership and coordinated action to capitalise on these opportunities are restricted by the fragmented institutional responsibilities in the transport sector.

**Awareness of the implications of the Paris Agreement for the transport sector** and the synergies with development objectives could be increased. The Paris Agreement requires the transport sector to reach net-zero emissions by the second half of the century. Independent analysis finds that a 1.5 °C trajectory would require the full decarbonisation of light road transport by 2050. Awareness of these specific commitments and implications is not widespread amongst various transport sector stakeholders. Efforts to decarbonise the transport sector would be fully in-line with and mutually reinforcing other national strategic objectives, including the EU Association Agreement and the Agenda 2030 Sustainable Development Goals (SDGs). Enhanced awareness of these links amongst transport sector stakeholders and national development strategists can assist to identify the most constructive options for Georgia.

**The establishment of a permanent coordinated planning process for the transport sector** could ensure that policies, strategies, and data are better aligned between the various institutions' jurisdiction over transport-related issues, including various national government departments and municipal governments. Such a process should be established with permanence, to support the development of transport sector plans and strategies in the future, without needing to start from the beginning with the resource-intensive exercise of compiling an overview of the fragmented actions and plans from those various institutions. In the best-case, a centralised institution would be identified to assume overarching responsibility for transport sector strategy, so that the *coordinated sector structure* model could be pursued (see section 5.4). In the case that such developments remain unrealistic, it would be highly beneficial to create a permanent formalised transport coordination entity, in place of the various temporary special-purpose working groups that have been established for the role of transport and climate planning in the past.

**Improved transport activity data collection** would improve the accuracy of trajectory projections and the quality of policy formulation. The scenarios in this report are based upon the best available data and knowledge from national experts, but there are considerable uncertainties and knowledge gaps that may compromise the accuracy of activity and emission projections. More detailed and accurate information on transport activity at the national, regional and city-level can also better inform the development of policies and measures related to urban planning, modal shift and freight logistics.

**Georgia should proceed to draft policies and international climate finance proposals** for high-potential measures that are ready to be implemented. Despite uncertainties and data gaps, multiple options for enhanced action exist and are clear; stakeholders of the sector working group for the Climate Strategy and Action Plan discussed and prioritised these areas for further action (see section 5.2). For some priority areas, policy-specific analysis should be executed to determine the best regulatory instruments and policy design options, while for other areas it is already possible to proceed to draft policies and international climate finance proposals where necessary.

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# Annex I Reference scenario data sources and assumptions

| **Passenger transport** | |
|---|---|
| **Historical data** | |
| **Data source(s) used for historical data** | **Activity level data and modal split:**<br>• Road: bottom-up calculations based on the Sustainable Energy Action Plans (SEAP) of Tbilisi, Batumi, Kutaisi, Gori and Zugdidi (Council, 2014; Government of Tbilisi City, 2011; of Gori, 2013; of Rustavi, 2012)<br>• Rail: Statistical Yearbooks (GEOSTAT, 2017)<br>• Aviation: Statistical Yearbooks (GEOSTAT, 2017)<br>**Load factor for road transport:**<br>• Georgia's Low Emissions Development Strategy (LEDS) (Winrock International, 2017)<br>**Share of EVs and electric trains:**<br>• IEA data used for total energy consumption by trains for the entire time series (IEA, 2017b).<br>• EVs assumed at 0%<br>**Fuel mix**<br>• Data collected when developing the Georgia's LEDS (Winrock International, 2017)<br>**Fuel economy**<br>• ICCT Global Transportation Roadmap Model |
| **Last historical year** | 2016 |
| **Important assumptions** | **Road activity levels**: Tbilisi, Batumi, Kutaisi, Gori and Zugdidi were taken as a representative sample of the bigger cities. The selection was based on the size of the city's population and on whether or not the city had developed their SEAP. These cities represent over 40% of country's population and around 74% of the country's urban population. Calculations for "other cities" refers to all cities in Georgia except the selected five. The activity level for "other cities" and "rural areas" was assumed to follow a similar behavior as the average activity levels of Batumi, Gori, Zugdidi and Kutaisi and adjusted using total and rural population, respectively.<br>**Fuel mix:** for the share of CNG, data taken from LEDS – Georgia for 2014 and assumption that CNG share was 0% until 2005 (first year when CNG consumption appears in transport sector in Energy Balances); interpolation between 2005-2014.<br>**Fuel economy:** ICCT Global Transportation Roadmap Model taking "Non-EU Europe" region as proxy<br>As final step, there was a top-down calibration of the calculations with the Energy Balance. |
| **Projections** | |
| **Data source(s) used for projections** | Activity level data and modal split:<br>• Road<br>  ○ LDVs: growth and saturation of vehicles and activity (above) based on assumptions and methods from MARKAL-Georgia model (e.g. Goldstein et al., 2010; IEA, n.d.) and Dargay et al., (2007).<br>  ○ Buses, mini-buses, rail and air: changes in demand based on elasticities to GDP given in Thompson (2003) |

| | |
|---|---|
| | Load factor for road transport:<br>○ LDVs: load factor of vehicles are based on assumptions and methods from MARKAL-Georgia model (e.g. Goldstein et al., 2010; IEA, n.d.)<br>○ Buses, mini-buses, rail and air: assumed constant<br>Share of EVs and electric trains:<br>• For EVs based on consultations with sectoral experts, taking into account GDP forecast, demography forecast and the motorization rate forecast.<br>• For trains, assumed constant over time<br>Fuel mix and fuel economy<br>• Assumed constant over time |
| **Last projection year** | 2030 |
| **Important assumptions** | • Assumed GDP growth rate of 6.1% between 2017 and 2030<br>• LDV ownership follows an s-curve, where growth elasticities and the saturation threshold is dependent on population, population density, GDP per capita and urbanisation (see Dargay et al., 2007). |
| **Freight transport** | |
| **Historical data** | |
| **Data source(s) used for historical data** | Activity level data and modal split:<br>• Road: calculations based on data collected during development of the LEDS – Georgia (Winrock International, 2017)<br>• Rail: Statistical Yearbooks (GEOSTAT, 2017)<br>Load Factor:<br>• Calculations were based on data collected during development of the LEDS – Georgia (Winrock International, 2017)<br>Share of EVs and electric trains:<br>• IEA data used for total energy consumption by trains for the entire time series (IEA, 2017b)<br>• Share of electric trucks assumed at 0%<br>Fuel mix<br>• Data collected when developing LEDS – Georgia (Winrock International, 2017)<br>Fuel economy<br>• Domestic & int'l trucks: ICCT Global Transportation Roadmap Model |
| **Last historical year** | 2016 |
| **Important assumptions** | • Fuel mix: for share of CNG, data from LEDS – Georgia for 2014 and assumption that CNG share was 0% until 2005; interpolation between 2005-2014 (first year when CNG consumption appears in transport sector in Energy Balances).<br>• Fuel economy for trucks: based on data collected when developing the LEDS – Georgia and using ICCT Global Transportation Roadmap Model "non-EU Europe" region for trend until 1990<br>• As final step, there was a top-down calibration of the calculations with the Energy Balance. |
| **Projections** | |

| | |
|---|---|
| **Data source(s) used for projections?** | Activity level data and modal split:<br>• Trucks: changes in demand based on elasticities to GDP given in Thompson (2003)<br>• Rail: changes in demand based on elasticities to GDP given in Thompson (2003)<br>Load factor for road transport:<br>• Trucks and rail: assumed constant<br>Share of EVs and electric trains:<br>• For electric trucks, assumed constant at 0%<br>• For trains, assumed constant<br>Fuel mix and fuel economy<br>• Assumed constant over time |
| **Last projection year** | 2030 |
| **Important assumptions** | Assumed GDP growth rate of 6.1% between 2017 and 2030 |

# Annex II Policy impact calculation assumptions

The following assumptions were applied to estimate the impact and mitigation potential of the transport sector measures listed in section 4.2.2. Some of the assumptions include simplifications and estimates, which could be improved upon through the availability of improved information and data.

### Policy: Design and implement regulations for vehicle roadworthiness

- The average emissions intensity of the Georgian LDV fleet prior to the measure reflects the average emissions intensities of the respective age categories for the EU fleet, since most cars are imported from the EU.
- Vehicles which are required to be scrapped represent the oldest and most inefficient portion of the vehicle stock, while vehicle improvements lead to the moderate improvement of engine efficiency and emissions intensity.
- LDV activity after the measure reduces by the same proportion as the reduction of the LDV fleet due to the scrappage of vehicles.
- Consumers which possessed the oldest and most inefficient vehicles, which are scrapped, are not able to replace their vehicles in the short-term.
- Effective enforcement requires three years from the onset of the policy, with the calculated impacts of the policy then spread over a three-year period (2021-2024), before following a new BAU trend into the medium-term.
- Freight activity is not affected, as all vehicles in the commercial sector should already be replaced prior to the implementation of this policy.

### Policy: Tax incentives for electric and hybrid vehicles

- The resulting increasing demand for EVs and hybrids displaces the demand that would have gone towards purchasing internal-combustion-engine (ICE) LDVs.
- In 2016, 64% of Georgian hybrid imports were gasoline hybrids, while 36% were diesel hybrids.[6] This ratio is taken as representative of the entire Georgia hybrid stock and for imports in the following years.
- As a rough estimate, hybrids are assumed to be twice as efficient in their primary energy requirements per vehicle-km (v-km). A more accurate assumption would require more detailed information about technologies and user behaviour.

### Policy: Increases in taxes for fuels

- We assume that fuel taxes for gasoline and diesel are passed down to consumers for personal vehicles (given the purpose to disincentivise private LDV use) and not public transport users.
- Transport demand elasticities from the literature are used to estimate the impacts of transportation cost changes on short- and long-term transport demand. Table 17 presents a summary of the elasticities applied.

Table 17: Price elasticities from an increase in costs of using private LDVs

| Elasticity | | Source |
|---|---|---|
| **LDV use cost – LDV activity** (short term; global value) | -0.2 | Johansson and Schipper (1997a) |
| **Fuel price increase – LDV activity** (long-term; global value) | -0.25 | Goodwin et al., (2004) |

[6] Most imported hybrid models and number of cars are taken from: http://tbl.ge/2n79

| Elasticity | | Source |
|---|---|---|
| **LDV use cost – Public transport ridership** (based on EU/Australia/US) | 0.1993 | Litman (2019) |

### Policy: Increases in import taxes for old vehicles

- We establish the age distribution of vehicles using the same methodology and data sources as described in "Design and implement regulations for vehicle roadworthiness".
- Emissions intensity of vehicles in each age class are estimated using Euro 1 to Euro 6 emission intensity benchmarks, derived from historic average fuel emission intensities of new cars in the EU (Table 18).
- Projected total number of vehicle-kilometres (v-km) driven per age class and emission intensity is then established including hybrids and EVs. It is assumed that vehicle activity increases are from new vehicles and not from increases in v-km driven per capita.
- The new excise tax for imported vehicles, which tax per $cm^3$ of engine size, heavily target vehicles older than 10 years with tax price increases of 160% to 200% for vehicles in those age classes (Table 19).
- We assume that cars older than 10 years are disincentivised by the tax, but car sales are inelastic: future car purchasers that instead buy vehicles in the next cheapest age classes (including hybrids), based on their percentage share of the car stock.
- We use the global price elasticity of -0.2 (Johansson & Schipper, 1997b) to estimate the decrease of future LDV use from the cost increase of using new inefficient cars.

Table 18: Age class distribution and estimated emission intensities for Georgian LDVs

| Age class | Percentage share | Euro standard | Emission intensity ($gCO_2e/vkm$) |
|---|---|---|---|
| **20+ years** | 30.1% | Euro 1 & Euro 2 | 190.5 |
| **11-20 years** | 55.6% | Euro 3 & Euro 4 | 162.1 |
| **7-10 years** | 8.6% | Euro 4 | 152.1 |
| **4-6 years** | 3.7% | Euro 5 | 138.6 |
| **1-3 years** | 2.1% | Euro 6 | 131.4 |

Source: Authors' calculations based on Transport and Environment (2018a).

Table 19: Excise tax for import of vehicles, GEL per cm3 of engine

| Age, year | Before 2017 | From 2017 | Price difference (%) |
|---|---|---|---|
| **<1** | 1.5 | 1.5 | 0% |
| **1** | 1.5 | 1.5 | 0% |
| **2** | 1.4 | 1.5 | 7% |
| **3** | 1.3 | 1.4 | 8% |
| **4** | 1.2 | 1.2 | 0% |
| **5** | 1.1 | 1 | -9% |
| **6** | 0.7 | 0.8 | 14% |
| **7** | 0.5 | 0.8 | 60% |
| **8** | 0.5 | 0.8 | 60% |
| **9** | 0.5 | 0.9 | 80% |
| **10** | 0.5 | 1.1 | 120% |
| **11** | 0.5 | 1.3 | 160% |
| **12** | 0.5 | 1.5 | 200% |

| | | | |
|---|---|---|---|
| **13** | 0.6 | 1.8 | 200% |
| **14** | 0.7 | 2.1 | 200% |
| **>14** | 0.8 | 2.4 | 200% |

Source: Tax Code of Georgia (Paliament of Georgia, 2019).

**Policy: Measures to improve transport systems in cities**

- All measures in this policy are enacted in four major cities in Georgia (Kutaisi, Gori, Zugdidi, and Rustavi).
- We first establish the total passenger-kilometres (p-km) affected by the policy by establishing base year (2016) p-km estimations per mode per city from municipality documents and use national trends to extrapolate p-km per mode per city to 2030 and beyond. Due to lack of data, for Rustavi we estimate transport activity using p-km/capita ratio of Kutaisi, which has a similar population profile.
- We calculate the impact of these measures by integrating assumptions from the draft National Energy Efficiency Action Plan (NEEAP) (NEEAP Expert Team, 2017) into our PROSPECTS+ bottom-up sector model. The draft NEEAP calculations resulted in the following tables below.
- After calculating the activity impacts for each transport mode in each city, the impacts are aggregated them back to the national level to derive the percentage change from the reference scenario for each mode.

- Measure-specific assumptions are displayed below:

**Measure A (optimise public transport routes)**

- Activity reductions of LDVs in each city are distributed to other public transport modes based on the modal split in cities.

Table 20: National Energy Efficiency Action Plan calculations for measure A.

| City | Mode targeted | Reduction in activity | Base year | Target year | Modal shift to |
|---|---|---|---|---|---|
| **Kutaisi** | LDV | 10% | 2010 | 2020 | Bus/marshutka |
| **Gori** | LDV | 5% | 2016 | 2020 | Bus/marshutka |
| **Zugdidi** | LDV | 10% | 2016 | 2025 | Marshutka |
| **Rustavi** | LDV | 5% | 2016 | 2020 | Marshutka |

Source: NEEAP (NEEAP Expert Team, 2017)

**Measure B (parking tariffs, pedestrian and cycling routes)**

- Activity increases from non-motorised transport measures are assumed to equally impact (lower) personal and public passenger transport activity.
- Parking measures only decrease personal vehicle use.

Table 21: National Energy Efficiency Action Plan estimations for policy MT-5B

| City | Cycling measures (% energy consumption decrease from reference) | Parking measures (% energy consumption decrease from reference) | Base year | Target year |
|---|---|---|---|---|
| **Tbilisi** | 3% | - | 2017 | 2022 |
| **Batumi** | 1% | - | 2017 | 2022 |
| **Kutaisi** | 5% | 1% | 2016 | 2022 |

| | | | | |
|---|---|---|---|---|
| **Zugdidi** | 2% | 3% | 2016 | 2021 |
| **Gori** | 3% | 1% | 2016 | 2021 |

Source: NEEAP (NEEAP Expert Team, 2017)

Note: Parking measures for Tbilisi and Batumi are quantified in separate policies.

**Measure C (road infrastructure and traffic management systems)**

- The NEEAP calculations result in a 0.25% reduction in both passenger and freight fuel used, compared to BAU levels, per year from 2017-2020.

**Measure D (bus fleet renewal)**

- Bus fleets under a reference scenario for the cities are estimated by taking the activity (pkm) levels of those cities[7] and using the city of Batumi as a reference to estimate number of buses, proportional to the level of activity in the cities.
- For the policy scenario, we recalculated the bus fleet by adding 25 new buses in Zugdidi, 63 in Kutaisi and 8 in Rustavi between 2019 and 2020, according to what is indicated in the draft NEEAP (NEEAP Expert Team, 2017).
- Changes in fuel mix and emissions intensity were calculated for new buses, based on local transport expert assumptions that new buses will either be Euro 5 diesel (90%) or CNG (10%) buses.
- Estimations of average emissions intensity of Euro 5 diesel buses used proxies from emissions intensities reported for LDVs by the European Federation for Transport and Environment (Transport & Environment, 2018b). This was calculated using the following equation:

$$x = \frac{(\text{fuel emissions intensity of EUR 5 in LDVs}) * (\text{average emissions intensity for buses in 2014})}{(\text{average emissions intensity for LDVs in 2014})}$$

- Changes in activity per mode were estimated using the average of a set of elasticities collected from international sources to calculate the decrease in private LDV use due to an increase in public transport ridership in Table 22.

Table 22: Elasticities to estimate the percentage decrease in LDV activity due to increase in public transport ridership

| Scope | Elasticity value | Source |
|---|---|---|
| **Average** | -0.89 | |
| **US Cities** | -0.83 | TCRP (2004a) |
| **US Cities** | -0.64 | TCRP (TCRP, 2004b) |
| **US Cities** | -0.8 | TCRP (TCRP, 2004b) |
| **New Zealand** | -1.3 | Litman (2019) |

Note: inconsistencies in the average reported due to rounding.

## Policy: Biodiesel production and sales

- Average emissions reduction from combusting B10-biodiesel was calculated using the Biodiesel Emissions Calculator and resulted in 10.1% emission savings compared to typical petroleum diesel, equivalent to 153 $gCO_2e$/v-km in 2030 (National Biodiesel Board, n.d.).
- Emissions per unit volume of B10-biodiesel were taken from US EIA (n.d.)
- The energy content of B10 was calculated to be 98.8% of that of petroleum diesel, consistent with estimations from the US Department of Energy (n.d.).

[7] We assume Rustavi has same activity and development as Kutaisi (due to similar population size) in 2016.

- The amount of B10 fuel produced was converted to the amount of energy potential it carries, and used to calculate the amount of LDV activity it compensates for each year using an average biofuel energy content ratio of 41.5 MJ/kg and fuel density values of 0.88 kg/L (Abed et al., 2019; University of Washington, 2005).
- We assume that the B-10 v-km driven displaces petroleum diesel v-km driven under the reference scenario.

## Policy: Measures to improve transport systems (Tbilisi)

### Measure A (bus fleet renewal)

- Bus fleet under a reference scenario uses the number of buses reported by Tbilisi's City Hall in 2016, extrapolated with growth rates in line with the national trend.
- We recalculated the fleet and load factor for buses by adding 100 8-meter buses in 2018 and 200 12-meter buses in 2019 (MAN Truck & Bus, n.d.).
- We assume that the number of new buses to be added to the city's fleet to reach 900 units by 2020 to have the same load factor as the first 300 buses on average.
- For the share of electric buses and changes in fuel mix and emissions intensity, we assumed that 20% of new buses would be electric, 40% run on CNG and 40% would be Euro 6 diesel buses. This assumption was informed by discussions and documents shared by experts in the transport division of Tbilisi's City Hall.
- For Euro 6 buses, we estimated the average emissions intensity with emissions intensities reported for LDVs by the European Federation for Transport and Environment (2018b). This was calculated using the following equation:

$$x = \frac{(\text{fuel emissions intensity of EUR 6 in LDVs}) * (\text{average emissions intensity for buses in 2014})}{(\text{average emissions intensity for LDVs in 2014})}$$

- Changes in activity per mode were estimated using the average of a set of elasticities collected from international sources to calculate the decrease in private LDV use due to an increase in public transport ridership in Table 22.

### Measure B (metro expansion)

- In 2018, the Mayor of Tbilisi announced 43 trains serving Tbilisi's passengers and that 14 new trains will be added to metro system between 2018 and 2019 (Agenda.ge, 2018).
- Given that the network itself will not be extended, we assume that the increase in number of trains will be translated into an increase in frequency of trains, reducing passengers' waiting time in between trains.
- Under a BAU scenario, we assumed that the current frequency of trains is between 5 and 10 minutes. The change if train frequency was estimated based on the following equation:

$$frequency_{new} = \frac{frequency_{current} - (N\ of\ trains_{current} + N\ of\ trains_{new}) * frequency_{current}}{N\ of\ trains_{current}}$$

- We estimated an increase in ridership based on a set of elasticities collected from international sources in Table 22 and
- Table 23. This increase in ridership of the metro leads to a decrease in LDV use, readjusting the distribution of passenger per mode in the city's transport network.

Table 23: Elasticities for percentage increase in public transport ridership due to percentage increase in service frequency

| Scope | Elasticity value | Source |
|---|---|---|
| **North America** | 0.5 | TCRP (TCRP, 2004b) |
| **Global** | 0.5 | TCRP (TCRP, 2004b) |
| **North America** | 0.7 | TCRP (TCRP, 2004b) |
| **North America** | 0.5 | VTPI (2018) |
| **North America** | 1.05 | VTPI (VTPI, 2018) |
| **Global** | 0.5 | VTPI (VTPI, 2018) |
| **Global** | 1.05 | VTPI (VTPI, 2018) |

**Measure C (bus network restructuring)**

- For the calculations for BRT systems, we assume bus lanes will be introduced on several mains streets of Tbilisi and cover 50% of the city's bus ridership (based on discussions and documents shared by experts in Tbilisi City Hall). According to international sources, if 100% of the bus ridership of a city is covered by BRT systems, ridership increases in up to 20% (TCRP, 2004b).
- With the calculated increase in bus ridership we estimate the decrease in LDV use, readjusting the distribution of passenger per mode in the city's transport network.

**Measure D (parking system)**

- We estimated the monthly costs of private LDV use by considering both standing and running costs by polling local experts to fill in the average costs for maintaining a car in Tbilisi.
- Cost estimations were used to calculate the percentage increase in costs from the parking policy. For the purpose of the calculations, we assumed that parking costs in Tbilisi would triple on average, leading to a 5.9% increase in overall costs of LDV ownership.

  Elasticities were used to calculate a decrease in LDV use as well as an increase in public transport use due to increase in car ownership costs, which leads to a readjusted distribution of passenger activity per mode in the city's transport network. Elasticities used can be found in Table 24 and Table 25
  Table 24

Table 24: Elasticities for the percentage increase in public transport ridership due to increase in cost of private LDV use

| Scope | Elasticity value | Source |
|---|---|---|
| **United States** | 0.24 | Litman (2019) |
| **United States** | 0.085 | Litman (2019) |
| **Australia** | 0.07 | VTPI (VTPI, 2018) |
| **United States** | 0.34 | VTPI (VTPI, 2018) |
| **United States** | 0.4 | VTPI (VTPI, 2018) |
| **European Union** | 0.14 | VTPI (VTPI, 2018) |
| **United States** | 0.12 | VTPI (VTPI, 2018) |

Table 25: Elasticities for the percentage decrease in LDV use due to increase in cost of private LDV use

| Scope | Elasticity value | Source |
|---|---|---|
| **United States** | -0.26 | Schimek (1997) |
| **United States** | -0.26 | Brand (2009) |
| **United States** | -0.18 | Gillingham (2010) |
| **United States** | -0.29 | Li et al., (2012) |
| **Global** | -0.20 | Johansson and Schipper (1997a) |
| **Global** | -0.20 | Johansson and Schipper (1997a) |
| **North America and EU** | -0.30 | Goodwin et al., (2004) |
| **Long-run (global)** | -0.22 | Small and Van Dender (2007) |
| **United States** | -0.15 | Mcmullen and Eckstein (2011) |

**Policy: Emission quality standards on the import and production of vehicles (EUR4 / EUR5)**

- We estimate the Euro 4 and Euro 5 fuel emission intensity ($gCO_2e$/v-km) benchmarks for LDVs, proxied by the historic average fuel emission intensities of new cars produced in the EU (Transport & Environment, 2018a).
- Fuel emission intensities for marshutkas and buses are calculated by multiplying the LDV Euro 4/5 fuel emission intensity with the average percentage difference in fuel emission intensity between LDVs and other modes under the reference scenario, for the year under which the Euro 4/5 standard was first implemented.
- We assume that this does not affect the projected absolute amount of annual passenger transport activity per mode in the future under the reference scenario, but only influences the emissions intensity of transport modes.
- After isolating all new v-km travelled under each mode going to 2030, we apply the fuel emission intensity improvements for each fuel type to the additional v-km driven by newly produced or imported cars following Euro 4 or 5 standards. The previously existing vehicles not affected by the policy continue with fuel emission intensities from the reference scenario.

**Policy: Measures to improve transport systems in Batumi**

**Measure A (Reorganization of on-street parking)**

- We estimated the monthly costs of private LDV use by considering both standing and running costs by polling local experts to fill in the average costs for maintaining a car in Tbilisi. We assumed the costs of owning a car in Tbilisi are the same as (or do not differ significantly) from those of owning a car in Batumi.
- Cost estimations were used to calculate the percentage increase in costs from the parking policy. We assumed that parking costs would triple on average, leading to a 5.9% increase in overall costs of LDV ownership.
  Elasticities were used to calculate a decrease in LDV use as well as an increase in public transport use due to increase in car ownership costs, which leads to a readjusted distribution of passenger activity per mode in the city's transport network. Elasticities used can be found in Table 24 and Table 25
- Table 24

**Measure B (bus network optimisation)**

- For the calculations for BRT systems, we assume bus lanes will be introduced on several mains streets of Batumi and cover 50% of the city's bus ridership (based on discussions and documents shared by experts in Batumi City Hall). According to international sources, if 100%

of the bus ridership of a city is covered by BRT systems, ridership increases in up to 20% (TCRP, 2004b).

- With the calculated increase in bus ridership we estimate the decrease in LDV use, readjusting the distribution of passenger per mode in the city's transport network. The elasticities used for the calculations can be found in Table 22.

**Measure C (Bus fleet renewal)**

- Bus fleet under a reference scenario uses the number of buses reported by Batumi's City Hall in 2016, extrapolated with growth rates in line with the national trend.
- We recalculated the fleet and load factor for buses by adding 50 buses (40 EUR 5 diesel buses and 10 electric buses) according to discussions and information exchange with experts in Batumi's City Hall.
- For the share of electric buses, 20% of new buses would be electric (10 out of 50 new buses).
- We calculated changes in fuel mix and emissions intensity for the remaining 40 new buses which will be EUR 5 diesel buses. We estimated the average emissions intensity of Euro 5 diesel buses using the emissions intensities reported for LDVs by the European Federation for Transport and Environment (2018a). This was calculated using the following equation:

$$x = \frac{(\text{fuel emissions intensity of EUR 5 in LDVs}) * (\text{average emissions intensity for buses in 2014})}{(\text{average emissions intensity for LDVs in 2014})}$$

- Changes in activity per mode were estimated using the average of a set of elasticities collected from international sources to calculate the decrease in private LDV use due to an increase in public transport ridership in Table 22.
- Further, we assumed that ridership in marshrutkas would be cut in half after 2019 as part of the policy increasing new buses (assumption informed by local expert in Batumi's City Hall) and the level of activity of marshrutkas would thereafter stay constant at that level.

# Annex III Reference and policy scenario data

## Reference scenario (BAU) emissions data

| Indicator | Unit | 1990 | 1995 | 2000 | 2005 | 2010 | 2015 | 2020 | 2025 | 2030 |
|---|---|---|---|---|---|---|---|---|---|---|
| **Emissions (transport sector)** | $ktCO_2e$ | 8,395 | 1,495 | 1,971 | 2,231 | 2,729 | 4,163 | 4,827 | 5,826 | 7,110 |
| **Passenger transport** | | | | | | | | | | |
| **Emissions** | $ktCO_2e$ | 2,027 | 1,046 | 853 | 1,032 | 1,607 | 2,842 | 3,186 | 3,644 | 4,208 |
| **Transport activity** | pkm (billions) | 27.9 | 12.67 | 13.1 | 16.3 | 21.2 | 28.0 | 33.6 | 38.6 | 44.5 |
| **Emission intensity: LDVs** | $gCO_2e$/vkm | 196.4 | 189.5 | 182.5 | 179.1 | 195.0 | 205.0 | 189.1 | 188.0 | 187.0 |
| **Emission intensity: Bus** | $gCO_2e$/vkm | 1,063.1 | 956.0 | 848.9 | 741.6 | 693.7 | 672.1 | 653.8 | 650.7 | 649.5 |
| **Emission intensity: Rail** | $gCO_2e$/vkm | 19.2 | 19.0 | 18.9 | 18.7 | 18.7 | 18.7 | 18.7 | 18.7 | 18.7 |
| **Emission intensity: Marshutka** | $gCO_2e$/vkm | 698.0 | 627.7 | 557.4 | 481.0 | 456.4 | 442.6 | 431.0 | 429.0 | 428.2 |
| **Modal split: LDVs** | % | 44.8 | 69.1 | 44.6 | 47.9 | 59.7 | 68.7 | 70.5 | 70.8 | 71.2 |
| **Modal split: Bus** | % | 19.7 | 9.8 | 22.6 | 21.1 | 16.9 | 11.9 | 11.7 | 11.2 | 10.7 |
| **Modal split: Rail** | % | 13.6 | 10.4 | 9.0 | 8.7 | 5.5 | 4.0 | 4.0 | 4.1 | 4.1 |
| **Modal split: Marshutka** | % | 21.2 | 10.4 | 23.8 | 22.2 | 17.9 | 13.4 | 13.7 | 13.8 | 13.9 |
| **Freight transport** | | | | | | | | | | |
| **Emissions** | $ktCO_2e$ | 6,106 | 294 | 958 | 1,050 | 1,042 | 1,284 | 1,579 | 2,110 | 2,819 |
| **Transport activity** | tkm (billions) | 47.3 | 2.9 | 9.8 | 13.3 | 13.9 | 12.5 | 17.5 | 23.6 | 31.8 |
| **Emission intensity: HGVs** | $gCO_2e$/vkm | 1143.5 | 1057.7 | 972.0 | 886.5 | 819.9 | 790.6 | 771.6 | 749.2 | 728.0 |
| **Emission intensity: Light duty trucks** | $gCO_2e$/vkm | 527.8 | 488.2 | 448.6 | 409.2 | 378.6 | 365.1 | 356.5 | 346.2 | 336.6 |
| **Emission intensity: Rail** | $gCO_2e$/vkm | 15.6 | 15.6 | 15.6 | 15.2 | 14.8 | 14.8 | 14.7 | 14.7 | 14.7 |
| **Modal split: HGVs** | % | 66.6 | 55.7 | 59.4 | 53.2 | 54.6 | 65.1 | 58.9 | 60.1 | 61.4 |
| **Modal split: Light duty trucks** | % | 0.7 | 0.6 | 0.6 | 0.5 | 0.6 | 0.7 | 0.6 | 0.6 | 0.5 |
| **Modal split: Rail** | % | 32.7 | 43.7 | 40.0 | 46.2 | 44.9 | 34.2 | 40.5 | 39.3 | 38.1 |

Source: Historical data points come from official sources, such as national inventories and Biennial Update Reports submitted to UNFCCC. All other data points, including projections, come from authors calculations modelled using PROSPECTS+ and LEAP.

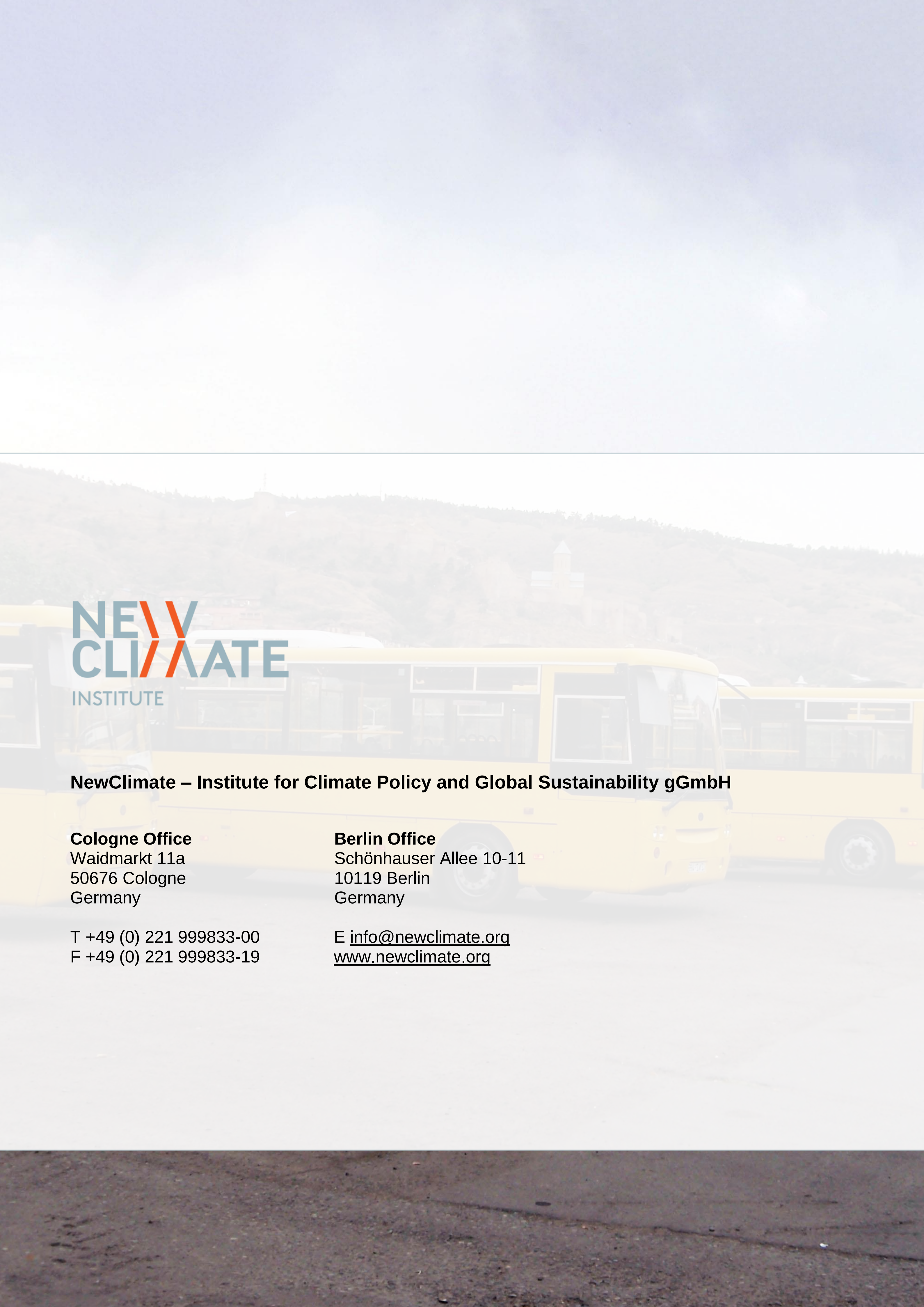
Note: Emissions reported for passenger and freight transport sectors only includes direct emissions and excludes indirect emissions from electricity. Total emissions from the transport sector are slightly larger than the sum of passenger and freight emissions as it also includes direct emissions from two-wheelers, domestic navigation, and off-road machinery. Emission intensities reported are averages for the non-electric fleet of the transport mode.

## Policy scenario emissions and transport sector key data

| Indicator | Unit | | 2020 | 2025 | 2030 |
|---|---|---|---|---|---|
| **Emissions (transport sector)** | $ktCO_2e$ | For 1990-2015 see *reference scenario* | 4,305 | 4,721 | 5,569 |
| **Passenger transport** | | | | | |
| **Emissions** | $ktCO_2e$ | | 2,661 | 2,532 | 2,654 |
| **Transport activity** | pkm (billions) | | 33.8 | 38.6 | 43.4 |
| **Emission intensity: LDVs** | $gCO_2e$/vkm | | 182.3 | 166.7 | 154.4 |
| **Emission intensity: Bus** | $gCO_2e$/vkm | | 640.5 | 523.1 | 515.5 |
| **Emission intensity: Rail** | $gCO_2e$/vkm | | 18.7 | 18.7 | 18.7 |
| **Emission intensity: Marshutka** | $gCO_2e$/vkm | | 421.7 | 400.7 | 389.0 |
| **Modal split: LDVs** | % | | 58.1 | 53.5 | 53.9 |
| **Modal split: Bus** | % | | 18.0 | 22.5 | 21.7 |
| **Modal split: Rail** | % | | 5.6 | 6.3 | 6.5 |
| **Modal split: Marshutka** | % | | 18.3 | 17.5 | 17.8 |

Source: 2015 emission data points come from official sources, such as national inventories and Biennial Update Reports submitted to UNFCCC. All other data points, including projections for emissions and activity comes from authors calculations modelled using PROSPECTS+ and LEAP.

Note: Emissions reported for passenger transport sectors only include direct emissions and excludes indirect emissions from electricity. Total emissions from the transport sector are slightly larger than the sum of passenger and freight emissions as it also includes direct emissions from two-wheelers, domestic navigation, and off-road machinery. Passenger modal split is only approximately 100% due to exclusion of domestic aviation. Emission intensities reported are averages for the non-electric fleet of the transport mode. Freight sector indicators are excluded here as they are unchanged from the reference scenario.




**NewClimate – Institute for Climate Policy and Global Sustainability gGmbH**

**Cologne Office**
Waidmarkt 11a
50676 Cologne
Germany

T +49 (0) 221 999833-00
F +49 (0) 221 999833-19

**Berlin Office**
Schönhauser Allee 10-11
10119 Berlin
Germany

E info@newclimate.org
www.newclimate.org