Green Finance and Investment

Promoting Clean Urban Public Transportation and Green Investment in Moldova

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Foreword

This report presents the main findings and conclusions from the project on "Promoting Green Growth and Low-Carbon Development: Analysis and Support to Policy Dialogue on Key Governance Elements of the Green Economy Concept in Moldova", implemented as part of a collaboration between the Organisation for Economic Co-operation and Development (OECD) and the Republic of Moldova (henceforth, also referred to as Moldova) under the GREEN Action Task Force, for which the OECD provides a secretariat.

The main objective of the OECD-Moldova co-operation was to assist the partner country in establishing a greener development path, in particular by reducing the energy and carbon intensity of its economy. Its specific goal was to assist Moldova's Ministry of Agriculture, Regional Development and Environment (previously, the Ministry of Environment) design a green public investment programme in line with good international practices, which estimates the overall costs compared with their environmental benefits but also identifies the financing sources.

This report outlines the results of a scoping exercise for creating an investment programme for reducing air pollution and greenhouse gas (GHG) emissions from the public transport sector in Moldova. Its aim is to demonstrate in practice how to use scarce public funds to encourage the private sector to invest in clean and socially important projects. The scoping study for the Clean Public Transport (CPT) Programme involved four main activity areas and outputs: 1) an initial scoping and analytical stage; 2) a costing methodology; 3) a programme design aligned with international good practice; and 4) an analytical report and training. This report summarises the results of a stepwise approach to the CPT Programme implementation by outlining two programme phases, two cities to participate in the first (pilot) phase and two scenarios for the second (scaling-up) phase.

The report relies not only on the extensive review of environmental legislation – reflecting standards in Moldova and the European Union – and technical regulations regarding public transport, but also on extensive collection of primary and secondary data on environment, transport and public services. The stocktaking analysis took into account the country's national green growth and climate change commitments and budgetary requirements. The report also draws from several visits of the project team to Moldova in the period 2016-2018, during which they discussed various elements of the investment programme with a number of experts from government offices and local public administrations in Chisinau and Balti, as well as with experts from various international and non-government organisations active in the country.

This programme builds on previous work carried out by the OECD in the areas of public environmental expenditure management, integrating the environmental sector into medium-term budgetary processes and on climate change economics. More specifically, it uses a programme costing methodology (called OPTIC) that was developed by the OECD, with support by Germany, and tested previously in Kazakhstan. The methodology is focused on climate-related investment programmes.

The project in Moldova was supported financially by Germany's Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU), through its 2014 International Climate Initiative (IKI). The project is part of a regional programme – Strengthening public finance capacity for green investments in the countries of Eastern Europe, Caucasus and Central Asia (EECCA) – that included two other country case studies: Kazakhstan (completed in 2017) and Kyrgyzstan (completed in 2019).

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The supportive role of the Ministry of Environment (and its successor, the Ministry of Agriculture, Regional Development and Environment) is highly appreciated in implementing the project. Special thanks for their time and contributions go to the State Chancellery, Ministry of Finance, Ministry of Economy and Infrastructure (as well as the former Ministry of Transport and Roads Infrastructure) and, very importantly, the Municipalities of Chisinau and Balti (and their public transport operators).

Appreciation is also extended to colleagues from the National Bureau of Statistics, Climate Change Office, National Agency of Road Transport, International Association of Road Hauliers of Moldova, Energy Efficiency Agency, National Agency for Energy Regulation, Congress of Local Authorities from Moldova, as well as the Ecological Movement of Moldova, all of which provided invaluable insights.

We are also grateful for co-operation with the European Bank for Reconstruction and Development, World Bank, Delegation of the European Union to the Republic of Moldova (as well as EU High-Level Advisers), German Development Cooperation through GIZ, KfW Development Bank, and the representatives of the United Nations Development Programme in Moldova throughout the entire project.

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Abbreviations and acronyms

ANRE	National Agency for Energy Regulation of Moldova *(Agenţia Naţională pentru Reglementare în Energetică a Republicii Moldova)*
ANTA	National Agency of Road Transport *(Agenția Națională Transport Auto)* of Moldova
BAU	Business as usual (scenario)
BMNT	(Austrian) Federal Ministry for Sustainability and Tourism *(Bundesministerium für Nachhaltigkeit und Tourismus)*
BMU	(German) Federal Ministry for the Environment, Nature Conservation and Nuclear Safety *(Bundesministerium für Umwelt, Naturschutz und nukleare Sicherheit*)
BRT	Bus rapid transit (system)
BTU	British thermal unit
CDM	Clean development mechanism
CHP	Combined heat and power (plant)
CI	Compression ignition
CIS	Commonwealth of Independent States
CNG	Compressed natural gas
COP	Conference of the Parties (to the UNFCCC)
CPT	Clean Public Transport (OECD Programme)
EaP	(EU) Eastern Partnership
EBRD	European Bank for Reconstruction and Development
EC	European Commission
EC	European Community
EEA	European Economic Area
EEA	European Environment Agency
EEC	Eurasian Economic Commission
EEC	European Economic Community

EECCA	Eastern Europe, Caucasus and Central Asia
EEV	Enhanced environmentally friendly vehicle
EIA	Environmental impact assessment
EIB	European Investment Bank
EMEP	European Monitoring and Evaluation Programme
EU	European Union
EUR	Euro (Eurozone currency)
GDP	Gross domestic product
GGE	Gasoline gallon equivalent
GHG	Greenhouse gas (emissions)
GIZ	German Development Cooperation *(Deutsche Gesellschaft für Internationale Zusammenarbeit)*
GoM	Government of Moldova
GOST	State/national *(Gosudarstvennyj)* (standard)
ICCT	International Council on Clean Transportation
IEA	International Energy Agency
IES	State Ecological Inspectorate *(Inspectoratul Ecologic de Stat)* of Moldova
IFI	International financial institution
IKI	International Climate Initiative *(Internationale Klimaschutzinitiative)* of Germany
INDC	Intended nationally determined contribution
IPCC	Intergovernmental Panel on Climate Change
IU	Implementation unit
JI	Joint implementation
KfW	Reconstruction Loan Corporation *(Kreditanstalt für Wiederaufbau)*
KPC	Kommunalkredit Public Consulting
LCU	Local currency unit
LEDS	Low-emission development strategy
LNG	Liquefied natural gas

LPA	Local public administration
LPG	Liquefied petroleum gas
LRTAP	Long-range Transboundary Air Pollution (Convention)
LULUCF	Land use, land-use change and forestry
MAC	Maximum allowable concentration
MARDE	Ministry of Agriculture, Regional Development and Environment of Moldova
MDL	Moldovan leu (national currency of Moldova)
MEM	Ecological Movement of Moldova *(Mişcarea Ecologistă din Moldova)*
MoE	Ministry of Environment of Moldova
MoF	Ministry of Finance of Moldova
MRDC	Ministry of Regional Development and Construction of Moldova
MTEF	Medium-term expenditure framework
NAMA	Nationally appropriate mitigations action
NBS	National Bureau of Statistics of Moldova
NCF	Net cash flow
NDC	Nationally determined contribution
NGO	Non-government organisation
NMVOC	Non-methane volatile organic compound
NPV	Net present value
NRDF	National Regional Development Fund
OECD	Organisation for Economic Co-operation and Development
OPTIC	Optimising Public Transport Investment Costs (OECD Model)
PCM	Project cycle management
PE	Programming entity
PI	Positive ignition
PM	Particulate matter
PPA	Public Property Agency of Moldova

PPP	Public-private partnership
PPP	Purchasing power parity
PTO	Public transport operator
PUA	Urban Bus Park *(Parcul Urban de Autobuze)*
PV	Photovoltaic
RDA	Regional Development Agency
RDC	Regional Development Council
RTEC	Chisinau Electric Transport Company *(Regia Transport Electric Chișinău)*
SEA	Strategic environmental assessment
SHS	State Hydrometeorological Service of Moldova *(Serviciul Hidrometeorologic de Stat Moldova)*
SME	Small and medium-sized enterprise
THE PEP	Transport, Health and Environment Pan-European Programme
TSU	Technical support unit
UN	United Nations
UNECE	United Nations Economic Commission for Europe
UNEP	United Nations Environment Programme
UNFCCC	United Nations Framework Convention on Climate Change
US	United States
USD	United States dollar
VAT	Value added tax
WHO	World Health Organization

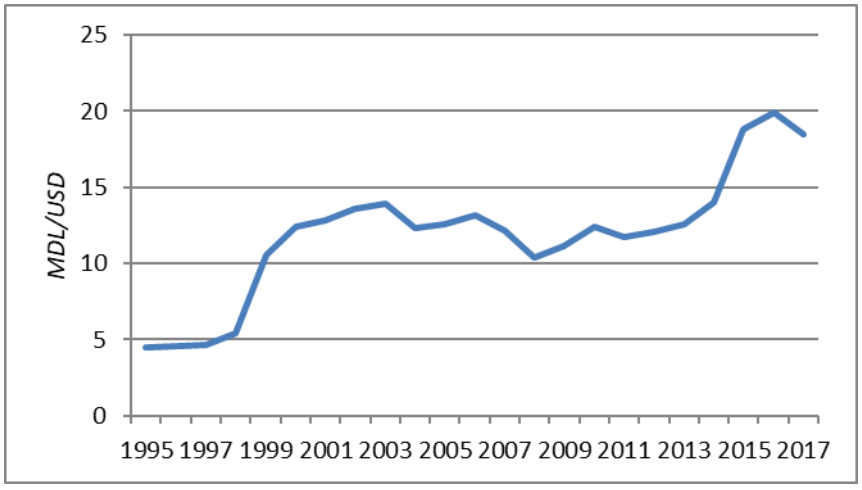
Units, quantities and compounds

cm^2	Square centimetre
CH_4	Methane
CH_2O	Formaldehyde
CO	Carbon monoxide

CO_2	Carbon dioxide
g	Gramme
GW	Gigawatt
GWh	Gigawatt hour
H_2O	Water
kg	Kilogramme
km	Kilometre
km^2	Square kilometre
km/h	Kilometres per hour
koe	Kilogramme of oil equivalent
kpvpd	Kilometre per vehicle per day
kt	Kilotonne
kWh	Kilowatt hour
l	Litre
m	Metre
mg	Milligramme
MJ	Megajoule
mln	Million
MW	Megawatt
MWh	Megawatt hour
MPa	Megapascal
m^3	Cubic metre
NO	Nitric oxide
NO_x	Nitrogen oxides
NO_2	Nitrogen dioxide
N_2O	Nitrous oxide
ppm	Parts per million
SO_2	Sulphur dioxide

t	Tonne
tCO_2	Tonne of CO_2
tCO_2e	Tonne of CO_2 equivalent
tNO_x	Tonne of NO_x
tSO_2	Tonne of SO_2
TJ	Terajoule
µg	Microgramme

Official exchange rate (LCU per USD, period average)



Note: LCU: local currency unit. MDL: Moldovan leu. As a reference exchange rate, the report takes the 2017 average of MDL 18.499 per 1 USD.
Source: World Bank (https://data.worldbank.org).

Executive summary

At less than 5%, transport makes a small contribution to Moldova's gross domestic product. Yet the sector is responsible for 22% of the country's greenhouse gas emissions – the second biggest contributor after the energy sector. The transport sector is the main source of air pollution, in particular in urban areas, accounting for at least 86% of total emissions. According to World Health Organization (WHO) data, the number of deaths in Moldova caused by ambient air pollution have more than tripled over the last 15 years. The Municipality of Chisinau in particular is experiencing a substantial increase in air pollution-related diseases.

In 2016, the Organisation for Economic Co-operation and Development (OECD) and Moldova joined forces to analyse how a public investment programme could spur the development of cleaner public transport, and reduce air pollution and greenhouse gas (GHG) emissions from the public transport sector in large urban centres in the country. It was agreed that the main focus of the Clean Public Transport (CPT) Programme would be on supporting the shift to modern buses powered by cleaner fuels, such as compressed natural gas and liquefied petroleum gas.

The preparation for the programme involved four main activity areas and outputs: 1) an initial scoping and analytical stage; 2) development of a programme costing methodology; 3) design of a programme in line with international good practices; and 4) preparation of an analytical report and training. This report is the culmination of the preparation process and presents the results of the four main activity areas.

What will the Clean Public Transport involve?

The CPT Programme is designed to be implemented in two phases. The first (pilot) phase targets Moldova's two biggest cities – Chisinau and Balti – where the public transport networks are the most developed. The second (scaling-up) phase is designed to cover the suburban areas of the pilot cities (under Scenario 1) and inter-city transport on the main (most frequent) routes in Moldova (Scenario 2).

- The pilot phase foresees replacing 77 old vehicles (60 in Chisinau and 17 in Balti), involving a **total investment of USD 19.1 million** over one year (after a one-year preparatory phase).
- Scenario 1 of Phase 2 envisages renewing 658 urban and suburban transport vehicles, at a cost of **USD 131.1 million**.
- Scenario 2 of Phase 2, aiming to replace 2 433 urban, suburban and inter-city vehicles will require **USD 479.5 million** of investments over a two to five-year period.

In total, Phase 1 together with Scenario 1 of Phase 2 would result in 735 urban and suburban transport vehicles, at a cost of USD 150.2 million. Phase 1, followed by Scenario 2 of Phase 2 would replace 2 510 urban, suburban and inter-city vehicles, at a cost of USD 498.6 million.

In all phases and scenarios, public support is estimated to be between 25-75% of the total resources required, depending on the financing options chosen.

What does it aim to achieve?

The **environmental objectives** of the CPT Programme are expected to be accomplished by using budget support to replace the existing public transport fleet with modern vehicles powered by cleaner fuels or technologies, including compressed natural gas (CNG)/liquefied natural gas (LNG), liquefied petroleum gas (LPG), diesel Euro 5/6 and electricity. In terms of **emissions reductions**, the most significant improvements are expected to be in nitrogen oxides (NO_x), whose annual cutback could amount to 30.7 tonnes in the pilot phase and between 403.8 and 1 444.1 tonnes in the scaling-up phase. Carbon monoxide (CO) emissions could decline by 6.8 tonnes annually (Phase 1) and between 85.4 and 300.6 tonnes (Phase 2), respectively. Particulate matter (PM) emissions should be reduced by 0.7 tonnes and between 9.9 and 35.1 tonnes annually, respectively; and sulphur dioxide (SO_2) by 0.6 tonnes and between 8.4 and 29.4 tonnes, respectively. Carbon dioxide (CO_2) emissions are likely to fall by 2.28 kilotonnes of CO_2 a year following Phase 1, and between 20.81 and 73.94 kilotonnes a year following Phase 2.

The **public service objectives** will be achieved – in line with the country's transport strategies (municipal and national) – by purchasing modern (brand-new) vehicles (to increase reliability and comfort) and extending/improving service delivery outside of cities (to increase outreach). By modernising the urban transport fleet, the CPT Programme will also contribute to the **socio-economic development** of municipalities and, ultimately, of the country. This will be achieved for instance through increasing the efficiency, reliability and radius of public transport networks. Improved mobility not only fosters productivity (access to jobs, markets), but also social inclusion (access to hospitals, schools) especially for low-income groups. The CPT Programme could also stimulate the domestic market to produce, or at least assemble, modern buses and trolleybuses through supporting the purchase of new buses, rather than the modernisation of engines. This could also generate new employment opportunities.

How will it be run and financed?

Implementing the CPT Programme will require **institutional arrangements** that ensure transparent and cost-effective decision making. The report suggests a three-level institutional structure comprising: 1) a programming entity, 2) an implementation unit and 3) a technical support unit. It also lays out clear project cycle management procedures.

There are a number of institutions in Moldova that could potentially be selected to manage the programme. Whatever the choice, the implementing entity should have a degree of independence to ensure that decisions be made using rules and criteria in line with the programme objectives, and not subject to undue political influence.

There are several **financing mechanisms** available in Moldova that can be used to support the transition to clean public transport. It should be noted, however, that it is not necessary for the programme to be completely grant-financed. The nature of the public transport sector – in which operating cost savings can be achieved by replacing old fleet components with new models and the use of clean fuel – means that financing should be designed to increase investment, without having to support profitable projects that would have occurred regardless of government involvement.

The analysis identifies two possible options for funding the CPT Programme pipelines; the first would be with the involvement of the local banking sector, while the second would not. The proposed combinations of financing instruments are as follows:

1. Commercial loans, combined with public support in the form of loan guarantees and a relatively smaller subsidy (a grant) to help public transport operators to repay a portion of the loan.
2. Public support in the form of a relatively larger subsidy (a grant) to motivate public transport operators to allocate more of their own financial resources to purchase cleaner vehicles – which generally require a higher initial investment (in terms of purchase cost) but are less expensive to operate (in terms of fuel costs).

Creating the policy framework for green investment

There are various policy barriers to the implementation of the programme, listed below. It is important that before the programme is developed and financed, the Government of Moldova reviews the relevant regulatory basis and eliminates any barriers to the extent possible.

- **Inadequate resources for programme preparation and management.** The CPT Programme requires significant work on programme preparation (including fundraising) and implementation. This will require building capacity for project selection, implementation and monitoring (project cycle management).
- **Limited creditworthiness of private operators in public transport.** Regardless of how the CPT Programme is co-financed, bus owners will need to use loans or leasing for the programme co-financing. However, their creditworthiness is limited. One solution would be for the Ministry of Finance (as the main guarantor of public debt) to issue guarantees on bank loans.
- **Inadequate passenger fares.** Fares for public transport are low in Moldova – as low as USD 0.11 for a single ride ticket – and some of them have not been adjusted since 2007. A fare increase is obviously needed (based on a sensitivity analysis to determine the optimal fare levels); otherwise, fleet operators may not be able to repay their loans.
- **Insufficient co-ordination and changes in urban public transport.** On the municipal level, the intent to improve the public transport service and to reduce traffic congestion and air pollution in the urban centres – mainly by limiting the number of minibus operators – is visible but not clearly communicated to all stakeholders. A co-ordinating role by the Ministry of Finance – which is also involved in project preparation for external financial assistance – could ensure inter-ministerial co-operation.
- **Low engine emission norms/technical inspection standards.** Moldova's emission norms are based on old diesel emission standards (Euro IV and lower) and the system of technical inspections of vehicles does not function properly. On the other hand, the availability of (imported) high-quality fuels (Euro 5) on the Moldovan market seems to be sufficient for a country-wide fleet upgrade. However, Moldova needs to introduce European standards. Currently, the only requirement is that new buses and trucks be Euro 0 or Euro I-compliant by 2020.

- **Weak pricing signals for the use of CNG and LPG-fuelled buses versus diesel.** Although CNG and LPG are cheaper than diesel, there are no other pricing signals, such as VAT or duty tax exemption for clean(er) transport or infrastructure. As the initial investment in alternatively fuelled/powered buses is higher, the decision to invest can be influenced by financial stimulus. Until critical mass is achieved (i.e. a sufficient market share and revenues), tax incentives could complement state support mechanisms such as grants, loans and loan guarantees.
- **Lack of proper financial products tailored to the needs of the sector**. Although Moldova's financial sector is dominated by banks, their function as financial intermediaries is limited due to high interest rates and collateral requirements. Banks, on the other hand, face constraints such as a lack of bankable projects and low rates of loan recovery (which, in the case of public transport operators, might be caused by the low passenger fares mentioned above).
- **Lack of interest in purchasing more fuel-efficient vehicles.** Apart from setting the right policy incentives, the government also needs to tackle consumer uncertainty about new technologies (e.g. their useful life) and fuels (e.g. future fuel prices). This would be helped through providing correct, sufficient and timely information – a possible role for the government implementation unit of the CPT Programme.

1. Setting the scene for a green public investment programme

This chapter provides a brief overview of the main environmental issues facing Moldova's energy and transport sectors, to set the scene for the proposed Clean Public Transport Programme. It reviews the key policy documents and international environmental agreements to which the country is committed in order to adopt a greener development path, and outlines the structure of this report.

1.1. What are the main air pollution and climate change challenges?[1]

Since gaining independence from the Soviet Union in 1991, the Government of Moldova has committed to promoting sustainable development. National policies, programmes and action plans have been developed and approved in the main sectors affecting the Moldovan economy and environment – including energy, industry, transport, agriculture, forestry or waste.

However, the country's energy intensity is much higher than the average of the countries of the European Union (EU), the Organisation for Economic Co-operation and Development (OECD) or the world average. In 2014, Moldova's energy use stood at about 195 kilogramme of oil equivalent (koe) per 1 000 USD of gross domestic product (GDP), using 2011 prices, compared with about 88 for the EU, 110 for the OECD countries and 126 for the world as a whole (see Section 6.1.3).[2] These high intensities are likely to continue as the share of the energy and industrial sectors in total national greenhouse gas (GHG) emissions is expected to increase significantly by 2030.

At less than 5%, transport makes a small contribution to the country's GDP. Yet the sector is responsible for 22% of the country's GHG emissions, and is the second biggest contributor after the energy sector. The transport sector is the main source of air pollution, in particular in urban areas, accounting for 86% of total emissions (GoM, 2018[1]). According to the latest available data (2018) from the National Bureaus of Statistics of Moldova (NBS), the share could in fact be as high as 96%.[3]

Within the transport sector, the vast majority of fuel is consumed in road transport (over 90% in 2017), although Moldova has rail, air and water transport as well (NBS, 2018[2]). The number of road vehicles increased in the period 1990-2013: by 93% for buses and minibuses, 101% for trucks and 193% for passenger cars. However, due to the population's low purchasing power, new registrations are mainly imported used vehicles. These, combined with a weak technical inspection system, are contributing significantly to air pollution – especially in urban areas where inadequate infrastructure causes frequent traffic jams (MoE/UNEP, 2016[3]).

Analysis shows that around 75% of the more than twofold increase in sulphur dioxide (SO_2) emissions in the period 2005-2011 (from 2 400 to 5 800 tonnes annually) can be attributed to transport (UNECE, 2014[4]). World Health Organization (WHO) data suggest that the number of deaths caused by ambient air pollution in Moldova have more than tripled since 2004.[4] The WHO statistics also show that diseases of the circulatory system – which air pollutants (especially particulates) are increasingly known to contribute to – constitute the main causes of death in Moldova.[5] The Municipality of Chisinau in particular is experiencing a substantial increase in air pollution-related diseases (GoM, 2013[5]).

While the basic policy and regulatory framework to adopt clean (public and private) transport is in place (see below), Moldova still lags behind given its outdated passenger cars as well as heavy-duty truck and bus engines. In 2017, about 40% of all vehicles failed to comply with any EU emission norm (and only about 6% complied with Euro 5/V or 6/VI emission norms – see Annex B for more details). The advanced age and high wear rate of the bus fleet increase environmental pollution, health costs and maintenance costs and reduce road safety. Upgrading the bus fleet is a vital issue for Moldovan transport operators but would require significant financial resources, both private and public.

At the same time, Moldova's economy and natural resources are significantly vulnerable to climate change impacts. Agriculture and water availability are important issues in a

country where more than half of the population lives in rural areas. According to Moldova's Climate Change Adaptation Strategy by 2020, the country's average annual economic losses due to natural disasters were about USD 61 million in the period 1984-2006. The 2007-12 droughts and 2008-10 floods alone cost the country a total of USD 180 billion (GoM, 2014[6]).

1.2. What steps have already been taken?

In the recent past, Moldova has taken a number of concrete steps to mitigate the negative impacts of transport on its citizens (especially in urban areas). Since 2002, Moldova has been part of a policy knowledge-sharing platform called the Transport, Health and Environment Pan-European Programme (THE PEP), jointly serviced by the WHO Regional Office for Europe and the United Nations Economic Commission for Europe (UNECE). Moldova also traditionally participates in European Mobility Week that promotes the importance of the issue and the severe (environmental but also economic and social) consequences of motor transport among the population and local public authorities.[6]

Moldova is also committed to tackling air pollution and climate change. In 1994, it joined the United Nations (UN) Convention on Environmental Impact Assessment in a Transboundary Context, and in 1995 it joined the UN Convention on Long-Range Transboundary Air Pollution (LRTAP Convention). Since 1992, Moldova has been a party to the United Nations Framework Convention on Climate Change (UNFCCC, ratified in 1995) and the Kyoto Protocol since 2003 (as a non-Annex I country). In 2016, Moldova signed the Paris Agreement on Climate Change, adopted at the 21st Conference of the Parties (COP21) in Paris in 2015 (which it ratified in 2017).[7]

Box 1.1. Moldova's greenhouse gas emissions targets

The Paris Agreement requires all Parties to put forward their best efforts to reduce greenhouse gas emissions through nationally determined contributions (NDCs), and to strengthen these efforts in the years ahead. Moldova's NDC identifies both "conditional" (those that depend on sufficient international support) and "unconditional" targets on mitigation and adaptation. The country's "unconditional" mitigation target is to reduce GHG emissions by 64-67% below the 1990 level by 2030, whereas the "conditional" target is set at 78%, subject to international support available to the country (including low-cost financial resources, technology transfer and technical co-operation). See Section 6.3.2 in Chapter 6 for further details.

Source: (GoM, 2015[7]), Republic of Moldova's Intended National Determined Contribution, https://www4.unfccc.int/sites/ndcstaging/PublishedDocuments/Republic%20of%20Moldova%20First/INDC_Republic_of_Moldova_25.09.2015.pdf.

National legislation and strategic documents on environmental policy and climate change have also been developed to address the challenge. The Government of Moldova has approved the Low-Emission Development Strategy (LEDS) until 2020 (MoE, 2011[8]) and adjusted the strategy's targets to the year 2030 (GoM, 2016[9]). The LEDS effectively consolidated the various GHG mitigation objectives stipulated in a number of national policies and legislative acts, including the National Development Strategy "Moldova 2020" (GoM, 2012[10]) , the Energy Strategy until 2030, including a roadmap for implementation (GoM, 2013[11]), and the National Energy Efficiency Programme 2011-2020 (GoM,

2011[12]). The action plan annexed to the LEDS 2030 Strategy includes a list of prioritised national appropriate mitigation actions as provided for non-Annex I Parties to the UNFCCC.

Amendments have also been introduced to Moldova's laws on environmental protection (adopted 1993 and last amended 2018), atmospheric air protection (adopted 1997, last amended 2018), energy efficiency (adopted 2010), and renewable energy sources (adopted 2016, last amended 2018).

Moldova's LEDS 2030 Strategy and the NDC consider different scenarios for reducing emissions and adapting to future expected climate changes. In order to achieve its ambitious mitigation and adaptation targets, Moldova will have to make significant investments, including infrastructure projects in energy, transport, buildings, industry, agriculture, land use, land-use change and forestry and waste sectors. Implementing the "conditional" targets identified in the NDC would cost about USD 4.9-5.1 billion (about USD 327-340 million per year) until 2030 (GoM, 2015[7]). Although the costs of the scenarios vary, achieving low-carbon economic growth will require significant public domestic and international support in either case.

The Environmental Strategy of Moldova 2014-2023 aims to further align national legislation with EU directives. It puts a particular emphasis on promoting various measures to reduce the emissions of air pollutants and GHGs generated by road traffic, both by improving the technical condition of vehicles as well as adopting fiscal measures or special programmes that would encourage the replacement of old polluting vehicles (GoM, 2014[13]).

In the same vein, the Association Agreement with the EU – which Moldova signed in June 2014 – sees transport co-operation as a necessary tool for Moldova's integration into the EU's internal market, and an efficient, safe and secure (road) transport system as one of the key elements for the country's modernisation efforts.

The concerns over climate change in Moldova are particularly linked to energy security. In fact, Moldova imports around 96% of its energy needs (see Chapters 3 and 6).[8] As identified in the Energy Strategy 2030, the Government of Moldova plans to diversify the energy mix with more renewable energy resource development – this will require substantial investments in the medium and long term. Moldova also adopted its National Renewable Energy Action Plan in 2013 with targets to be achieved by 2020 (GoM, 2013[14]).

1.3. What does the country aim to achieve?

A key document that sets out targets for Moldova in the area of transport is the Programme on Promotion of Green Economy in the Republic of Moldova for 2018-2020 and the Action Plan for its Implementation (GoM, 2018[1]), approved recently by Government Decision No. 160 of 21 February 2018. The programme emphasises effective, efficient and ecological (urban) public transport, including a focus on larger public transport means and its prioritisation over private transport in urban centres. It also advocates for the adoption of clear environmental objectives – e.g. the use of alternative fuels and new technologies in all modes of transport – in current transport policies.

Among the major challenges to the "functioning of the institutional, management and implementation systems in the field of green economy promotion", the programme cites "emissions from transport" that "have an increasing impact on environment and public health."

At this point, activities are planned up to the end of 2020 to implement the programme, in order to achieve specific objectives. Those related to the transport sector include:

1. reduce air pollution by 30% by 2020 through the development of sustainable transport
2. ensure the promotion of measures to implement the green economy in construction by 15% by 2020
3. increase the level of public awareness about the green economy and sustainable development by at least 30% by the year 2020.

Under the first objective, the following actions are foreseen:

- gradual elimination of old cars through a state programme in collaboration with private companies
- creating fiscal incentives for importing cars with electric or hybrid engines, as well as developing the national infrastructure necessary for electric cars
- applying restrictions on the use of vehicles (of all types, including for public transport and industrial/commercial purpose) older than 15 years
- modernising outdated public transport means by replacing them with ecological means (electric)
- regulating the entrance of vehicles into cities and city centres (to reduce traffic jams and air pollution)
- developing regulations to promote the use of public transport, significantly reducing (by 30%) the number of minibuses, creating routes (ring roads) around urban centres
- organising and promoting European Mobility Week
- integrating transport policies to encourage the use of alternative fuels and new technologies in all types of transport.

Under the second objective, the following actions are foreseen that are relevant to transport:

- promotion of the green cities principles and application of the European Green City Index[9]
- monitoring the development of general urbanisation plans that integrate sustainable transport infrastructure (bus lanes, electric transport, bike lines, parking and charging stations for electric transport units).

And finally, under the third objective, the following actions are foreseen that are relevant to transport:

- conducting information and awareness campaigns on the green economy in the areas of energy efficiency, cleaner production, resource efficiency, sustainable public procurement, sustainable transport
- organisation a biannual national conference on the green economy.

The programme also includes an action plan with deadlines and budget estimates for the implementation of the various activities and measures. While the programme provides a

much-needed policy framework for sustainable urban transport, the targets it sets out are very ambitious.

1.4. What needs to be done?

In order to achieve its ambitious emissions reductions, Moldova will have to make significant investments across all sectors of economy. For example, achieving the "conditional" GHG emissions reduction targets identified in the NDC (Box 1.1) would cost around USD 5 billion by 2030. Although the costs of the two proposed scenarios ("conditional" and "unconditional") vary, achieving low-carbon economic growth will require significant public domestic and international support.

As the global climate regime is evolving, donors and international financial institutions have already started to invest significant resources to support non-Annex I countries, including Moldova. International carbon finance mechanisms, such as the Green Climate Fund, are known to rely to a great extent on country-based systems for programme and project identification and implementation. Those countries that develop the necessary skills to prepare sound public expenditure programmes and identify a pipeline of cost-effective projects will be more competitive and will stand better chances of benefiting from international support.

In order to be successful in attracting international climate finance, Moldova needs to put in place economically sound climate and air pollution-related investment programmes that identify the most cost-effective projects that can be supported by public funds. Such public investment programmes can effectively leverage funds from both budgetary and donor sources. Strengthening Moldova's administration capacities to manage its public environmental expenditure in line with good international practices is key to accessing both budgetary and international carbon finance sources and gaining support for climate change measures that will be vital for the further economic and social development of the country.

These programmes need to be integrated into national development strategies and medium-term budgetary processes, such as medium-term expenditure frameworks (MTEFs). In addition, government administrations need to be willing to apply good practices in public expenditure management, such as accountability, transparency and efficiency. Indeed, Moldova is among the first countries in the EECCA region to introduce a medium-term perspective to its annual budget process. Although the Moldovan Government has accumulated significant experience with MTEF design, including in the environmental sector, more efforts are needed to implement these provisions in practice.

1.5. What is this report about?

In 2016, the OECD and Moldova joined forces to analyse how a country-wide public investment programme could spur the development of cleaner public transport and reduce air pollution and GHG emissions from the sector in the country's large urban centres. The foundations for this work were laid in 2011 when the OECD provided targeted training on designing and managing environmental investment programmes to Moldovan environmental experts.

The preparation for the programme involved four main activity areas and outputs: 1) an initial scoping and analytical stage; 2) development of a programme costing methodology; 3) design of a programme in line with international good practices; and 4) preparation of an analytical report and training.

Activity areas 2 and 3 constituted the backbone of the project, which aimed to demonstrate in practice how to use scarce public funds to encourage the private sector to invest in environmentally and socially important projects.

This report is the culmination of the investment programme preparation process (henceforth, the "project"), and presents the results of the scoping analysis. It is organised as follows:

- Chapter 2 describes the proposed Clean Public Transport (CPT) Programme, and provides estimates of its costs and expected environmental and socio-economic benefits. The chapter also lays out the financing strategy and optimal co-financing levels.
- Chapter 3 presents an economic assessment of the viability of the investment programme. It includes market analyses of clean technologies and fuels in the bus transport sector in Moldova, and of the domestic production versus import of buses for meeting the need for bus replacements.
- Chapter 4 discusses the institutional arrangements for managing the CPT Programme.
- Chapter 5 presents an overview of the project cycle management (PCM) procedures for each project pipeline identified as part of this programme.
- Chapter 6 briefly describes the main demographic, macro-economic and environmental issues in Moldova of relevance to the transport sector. It also presents an overview of the urban public transport system in the country, levels of GHG emissions and air pollution in the main urban centres and the major health risks associated with the main air pollutants.
- Chapter 7 describes the current policy and regulatory framework in the transport sector.
- Annex A presents an overview of clean technologies and fuels in the transport sector, while Annex B explains the use of the OPTIC (Optimising Public Transport Investment Costs) model. Annexes C-E contain sample project application and appraisal forms.

Notes

1. This brief review draws on a more detailed analysis presented in Chapter 6.

2. See OECD/IEA statistics on energy use (kg of oil equivalent) per USD 1 000 GDP (constant 2011 PPP) from 2014 at: https://data.worldbank.org/indicator/EG.USE.COMM.GD.PP.KD?locations=MD-OE-EU-1W&view=chart.

3. See NBS data on polluting substances emitted in atmospheric air by road transport at: http://statbank.statistica.md/pxweb/pxweb/en/10%20Mediul%20inconjurator/10%20Mediul%20inconjurator__MED030/MED030400.px/table/tableViewLayout1/?rxid=b2ff27d7-0b96-43c9-934b-42e1a2a9a774; and emission of pollutants in atmospheric air by stationary sources of economic agents at: http://statbank.statistica.md/pxweb/pxweb/en/10%20Mediul%20inconjurator/10%20Medi

ul%20inconjurator__MED030/MED030100.px/table/tableViewLayout1/?rxid=e30e37d0-43ff-4b5b-835f-c0252bf87a4d.

4. Compare (WHO, 2009[15]) with the WHO Global Health Observatory data repository from July 2018 at: http://apps.who.int/gho/data/node.main.BODAMBIENTAIRDTHS?lang=en.

5. For WHO data and statistics on Moldova, see: www.euro.who.int/en/countries/republic-of-moldova/data-and-statistics.

6. European Mobility Week is an international campaign to promote and explore other means of transportation. Countries are encouraged to organise events. In 2018, these took place on 16-22 September. However, Moldova did not have any registered events. For more information, see www.mobilityweek.eu.

7. 21st Conference of the Parties of the United Nations Framework Convention on Climate Change (UNFCCC COP21). For more information on COP, see https://unfccc.int/process/bodies/supreme-bodies/conference-of-the-parties-cop.

8. Moldova's energy mix is dominated by imported natural gas – supplied entirely by Gazprom from the Russian Federation and prospectively by OMV Petrol from Romania.

9. The European Green City Index measures the environmental performance of 30 major European cities against indicators for CO_2, energy, buildings, transport, water, water and land use, air quality, and environmental governance. For the report, see www.siemens.com/entry/cc/features/greencityindex_international/all/en/pdf/report_en.pdf.

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2. Main elements of the Clean Public Transport Programme

This chapter introduces the proposed Clean Public Transport Programme. The programme is designed to be implemented in two phases: Phase 1, a pilot phase that includes urban transport in two selected cities (Chisinau and Balti); and Phase 2, an extension of the programme to cover suburban areas of the pilot cities and inter-city public transport in Moldova. The chapter summarises the programme's expected environmental and socio-economic benefits, the costs involved, as well as a possible financing strategy and optimal co-financing levels.

2.1. What are the objectives of the programme?

The overall objective of the proposed Clean Public Transport (CPT) Programme is to reduce the harmful emissions responsible for creating smog in urban centres (so called emissions from "low"-level sources). These include emissions of carbon monoxide (CO), sulphur dioxide (SO_2), nitrogen oxides (NO_x) and particulate matter (PM). This objective meets one of the targets of Moldova's Environmental Strategy 2014-2023, which aims to reduce air pollution levels to 30% of 1990 levels by 2023, and to create an integrated air quality management system (GoM, 2014[1]). The new Programme on Promotion of Green Economy in the Republic of Moldova for 2018-2020 (described in Chapter 1) brings this overall target forward to 2020, with a focus on developing sustainable transport (GoM, 2018[2]).

The CPT Programme is also designed to contribute to Moldova's climate change mitigation efforts and its transition to a green economic model of development. The programme will help achieve the country's goal of reducing greenhouse gas (GHG) emissions by 64-78% by 2030[1] compared to 1990 emission levels, as specified in the intended nationally determined contribution prepared by the Government of Moldova for the 2015 Paris Climate Conference (see Box 1.1 in Chapter 1) (GoM, 2015[3]).

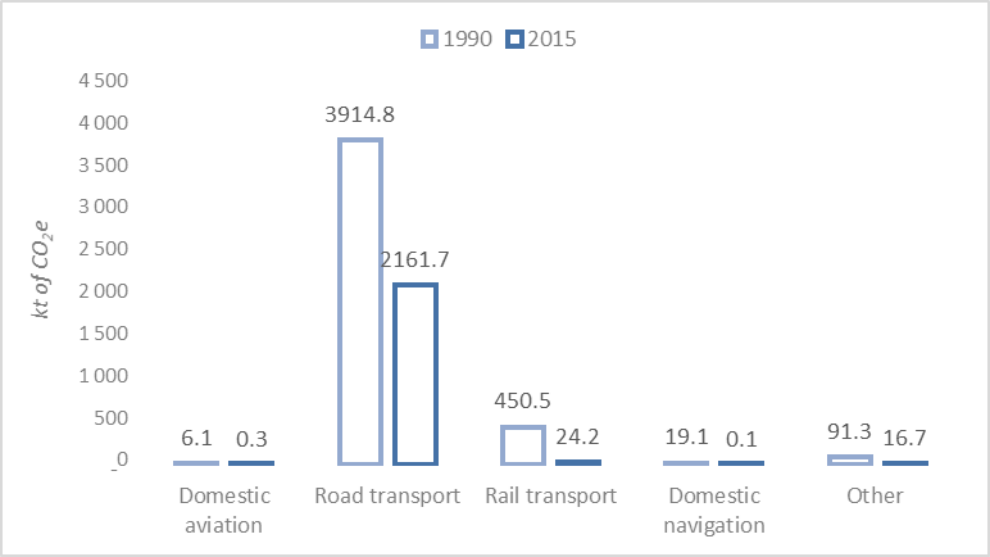
The Environmental Strategy 2014-2023 foresees a general GHG emissions reduction of 20% by 2020 compared to the 1990 baseline, with reductions in the transport sector of 15% driven by support to alternative (fossil and bio) fuels and power use (GoM, 2014[1]). This reduction is in line with the National Energy Efficiency Programme 2011-2020 and its target of reducing energy consumption by 20% by 2020 (GoM, 2011[4]).

The 2007 Renewable Energy Law (No. 160 of 12 July) set a target of 20% of energy demand to be met from renewable energy sources by 2020, with bioethanol and biodiesel making up each 20% of petrol and diesel fuel sold. According to the National Energy Efficiency Programme 2011-2020 (GoM, 2011[4]), the Environmental Strategy 2014-2023 (GoM, 2014[1]), and Energy Strategy 2030 (GoM, 2013[5]), 10% of biofuels are to be produced from renewable sources by 2020.

Besides the national target mentioned above, the National Renewable Energy Action Plan 2013-2020, and the new 2016 renewable energy law (No. 10 of 26 February) outline Moldova's obligation to the Energy Community (resulting from its accession in March 2010) to reach at least 17% of gross final consumption of energy from renewable sources by 2020. This target is echoed in the Programme on Promotion of Green Economy (GoM, 2018[2]). In 2015, the country had achieved 14.3% of final energy consumption and 5.4% of total electricity output from renewable energy sources.[2]

As the data in Figure 2.1 show, the transport sector experienced a 49% decline in direct GHG emissions in 1990-2015 (including road transport emissions falling by 55%). Nevertheless, as this report's environmental review outlines (see Section 6.3) road transport is responsible for more than 98% of the country's GHGs (Figure 2.1) and mobile sources of air pollution emit 96% of all the harmful substances stemming from the entire transport sector (see Section 1.1 and Figure 6.14). This is why road transport has been chosen as a focus of the CPT Programme.

Figure 2.1. Direct GHG emissions from transport in Moldova, 1990-2015



Note: kt of CO_2e: kilotonnes of carbon dioxide equivalent.
Source: (GoM, 2018[6]), *Environmental Audit Report on Air Quality in the Republic of Moldova,* http://lex.justice.md/UserFiles/File/2018/mo18-26md/raport_65.doc.

While 21.4% (Table 6.9) of vehicles in inter-city transport meet (or are below) Euro 1/I standards (see Annex A), these low standard (i.e. high emission) categories account for as much as 67.8% of the entire public transport fleet (Table 6.6). Therefore, the CPT Programme is primarily designed to cover major urban areas with public transport networks.

As of mid-2017, except for 414 trolleybuses (see Table 6.5) and two compressed natural gas (CNG)-powered public transport vehicles, the entire public transport fleet (i.e. 98%) was running on diesel (see Section 6.2).

2.2. What will the programme involve?

In practice, the overall environmental objectives of the CPT Programme – i.e. the reduction of air pollutants and GHG emissions – will be accomplished by supporting investment in replacing the dominant diesel-powered bus and minibus fleet used in urban, suburban and inter-city public transport with modern vehicles either powered by cleaner fossil fuels, or by electricity generated by renewable energy resources or cleaner fossil fuels.

The study conducted a market analysis (see Chapter 3) which identified four groups of projects ("pipelines") to replace the old urban, suburban and inter-city bus fleet:

1. Investment in vehicles fuelled by compressed natural gas (CNG)
2. Investment in vehicles fuelled by liquefied petroleum gas (LPG)
3. Investment in vehicles fuelled by diesel that meets Euro 5 and Euro 6 emissions standards

4. Investment in electricity-powered vehicles (trolleybuses and battery trolleybuses).

As Moldova's bus fleet is ageing, the proposed "pipelines" are intended to support the purchase of new vehicles (buses/minibuses and trolleybuses) rather than the modernisation of existing engines. By renewing the bus fleet, the reliability and efficiency of public transport will be increased and the domestic market will be encouraged to produce, or at least assemble, modern buses and trolleybuses.[3]

The proposed investment pipelines should be accompanied by other investments in infrastructure, such as new trolleybus lines, CNG/LPG refuelling and electricity charging stations and other supporting activities to improve the transport system in urban centres (e.g. the creation of bus lanes, improvement of bus stops and smart traffic control).

In 2016, there were 892 000 transport units in Moldova (an increase of about 25 000 units from 2015). In major urban areas, the number of registered vehicles almost matches the number of inhabitants, causing severe traffic problems (GoM, 2018[6]) and creating challenges for urban public transport networks. Because the bus fleet in Moldova consists of too many minibuses, the CPT will give priority to replacing a part of the minibus fleet with regular buses.

The CPT Programme is designed to be implemented in two phases:

- The first (pilot) phase will be launched in two cities (Chisinau and Balti) and will focus primarily on electric transport (trolleybuses). In total, 62 trolleybuses will be purchased: 31 will replace the old trolleybuses and the other 31 will extend the network by replacing old diesel buses. Also, a pilot replacement of a small number (15) of minibuses should be carried out during the pilot phase.
- The second (scaling-up) phase will extend the pilot phase. There are two possible scenarios for this phase: Scenario 1 will extend it to the suburban areas of the pilot cities (735 new vehicles), while Scenario 2 will include inter-city public transport across the country (2 510 new vehicles).

2.2.1. Phase 1 (pilot phase)

Two cities were identified for the pilot phase: Chisinau and Balti. The pilot phase in each of the two cities will last two years, including a one-year preparatory phase (see Section 2.5).

City of Chisinau

Being the capital and main industrial and commercial centre of Moldova, Chisinau also serves as the main transportation hub in the country due to its geographical position. As the largest and most populated city in Moldova (in 2018, the city's population was 690 000 while that of Chisinau municipality was 825 900[4]), the city has the most developed public transport network. Since 2010, Chisinau has participated in a programme to renew part of the trolleybus fleet, co-financed by the European Bank for Reconstruction and Development (EBRD; see Sections 3.2.2 and 3.3.4).

In the pilot phase in Chisinau, the CPT Programme proposes purchasing 60 new vehicles for public transport. This will include:

- replacing 25 old trolleybuses with the same number of new vehicles (including battery trolleybuses)
- purchasing another 25 trolleybuses (including battery trolleybuses) to strengthen the existing fleet – these will replace diesel buses that are more than 15 years old (currently about 25)
- replacing 10 diesel-fuelled minibuses with CNG-powered models
- extending the trolleybus network to reach more remote areas where the trolleybus power-delivered network is not available (extending the trolleybus power-delivered network to cover the whole area would be too costly)

Even though trolleybuses have only small batteries, they are cheaper to buy than electric buses. While they can travel on battery for a limited number of kilometres (depending on battery capacity, which is proportional to the costs of the battery price), most of the journey is done using the typical electricity-supplied wire network in the city. The batteries can be charged while the trolleybus travels in the urban centre.

It is suggested that the pilot phase should financially support the purchase of minibuses powered by CNG rather than LPG (see Section 5.1.2). Although LPG is often used in Moldova, the emissions of carbon dioxide (CO_2) from LPG-powered engines are higher than from CNG-powered ones (see Section 3.1 and Annex A to this report).

Since most diesel engines in Moldova do not meet Euro 6/VI standards (see Section 6.2), the introduction of Euro V and Euro VI diesel engines might also be considered as a step towards modernising public transport in the country. However, the fuel consumption of modern diesel engines is higher than older ones so beneficiaries would not see their operating costs reduce. Given the currently very low transport fares in Moldova (see Section 3.2.3), the amount of public support that will be needed to purchase Euro VI diesel buses will be very high. For this reason, it remains the least preferred option.

The key (financing) input and (environmental) output parameters of the pilot implementation are provided in Table 2.1. The total cost of the CPT Programme for Chisinau is estimated to be Moldovan leu (MDL) 280 million (USD 15.1 million), of which MDL 141 million (USD 7.6 million) will be co-financed from the programme and MDL 139 million (USD 7.5 million) is expected to come from investment by private or public bus operators.

Table 2.1. Key input and output parameters of the CPT Programme`s pilot phase in Chisinau

	Unit		
Total number of new trolleybuses	No.	50	
Total number of new minibuses replaced	No.	10	
Total costs of vehicles replaced	MDL mln	280	
Of which co-financed by the programme*	MDL mln	141	
Of which co-financed by private/municipal bus operators	MDL mln	139	
		Calculated using normative pollution factors**	Calculated using real pollution factors**
Total CO_2 reduction	tCO_2/year	1 824	2 776
Total CO reduction	kg/year	5 440	5 440
Total NO_x reduction	kg/year	24 422	24 422
Total PM2.5 reduction	kg/year	518	518
Total SO_2 reduction	kg/year	473	473

Note: *Option 1 (see Section 2.3.3); **for a discussion of normative and real pollution factors, see Section 2.3.1.
Source: OECD calculations, OPTIC Model.

As shown in Table 2.1, the pilot phase could allow Chisinau to achieve a reduction of 1 824 tCO_2/year. This CO_2 reduction is low due to the small scale of the pilot phase (for details on CO_2 emission factors, see Annex B). The largest decrease could be achieved in NO_x emissions, which could be reduced by 24 442 kg/year (see Section 2.3.2).

City of Balti

Balti is the second largest city in Moldova by population (146 600 in 2018, and a further 4 900 people in the surrounding communes of Balti municipality[5]), and the only city other than Chisinau that has a trolleybus network and a well-developed public transport system. It is also located on the route of a natural gas pipeline going from the Russian Federation to the European Union (EU) via Ukraine. Similar to Chisinau, Balti has participated (since 2013) in the EBRD-supported programme to renew part of the trolleybus fleet (see Section 3.3.4).

In the pilot phase in Balti, the CPT Programme proposes purchasing 17 new vehicles for public transport. This will include:

- replacing 6 old trolleybuses with the same number of new vehicles (including battery trolleybuses)
- purchasing another 6 trolleybuses (including battery trolleybuses) to strengthen the existing fleet – these will replace diesel buses that are more than 15 years old (currently about 6)
- replacing 5 old diesel minibuses with the same number of new vehicles running on cleaner fuels (CNG or LPG)

In Balti, as Table 2.2 shows, the total cost of purchasing 12 trolleybuses and 5 minibuses would amount to MDL 72 million (USD 3.9 million), of which the CPT Programme can support MDL 37 million (USD 2 million) and public and private bus operators could contribute MDL 36 million (USD 1.9 million).

Table 2.2. Key input and output parameters of the CPT Programme's pilot phase in Balti

	Unit		
Total number of trolleybuses	No.	12	
Total number of minibuses replaced	No.	5	
Total costs of vehicles replaced	MDL mln	72	
Of which co-financed by the programme*	MDL mln	37	
Of which co-financed by private/municipal bus operators	MDL mln	36	
		Calculated using normative pollution factors**	Calculated using real pollution factors**
Total CO_2 reduction	tCO_2 /year	454	689
Total CO reduction	kg/year	1 359	1 359
Total NO_x reduction	kg/year	6 243	6 243
Total PM2.5 reduction	kg/year	136	136
Total SO_2 reduction	kg/year	122	122

Note: *Option 1 (see Section 2.3.3); **for normative and real pollution factors, see Section 2.3.1.
Source: OECD calculations, OPTIC Model.

As shown in Table 2.2, the expected NO_x reduction is 6 243 kg/year following implementation of the pilot. In terms of CO_2 emissions, the reduction is estimated to be 454 tCO_2/year after the pilot phase (see Section 2.3.2).

Summary

The pilot phase will lead in all to the purchase of 62 new trolleybuses and 15 minibuses. This assumes that Moldova has the market capacity to supply the required quantity of modern vehicles on an annual basis, that private and municipal bus operators have the capacity to invest in new assets over a one-year period, and that the government has the capacity to invest in relevant infrastructure.

This phase will in a broader sense build on and add to the experience of previous (EBRD-supported) trolleybus replacements that began in 2010-2013. Also, both pilot cities have a large number of minibuses (usually diesel-fuelled) in their public transport fleets that are in urgent need of replacement.

The investment costs of the pilot phase of the CPT Programme would amount to MDL 353 million (USD 19.1 million), of which MDL 178 million (USD 9.6 million) would be needed in public support (Table 2.3).

Table 2.3. Key input and output parameters of the CPT Programme's pilot phase

	Unit		
Total number of trolleybuses purchased	No.	62	
Total number of minibuses replaced with CNG powered	No.	15	
Total cost of vehicles replaced	MDL mln	353	
Of which co-financed by the programme*	MDL mln	176	
Of which co-financed by private/municipal bus operators*	MDL mln	177	
		Normative pollution factors**	Real pollution factors**
Total CO_2 reduction	tCO_2/year	2 277	3 465
Total CO reduction	kg/year	6 800	6 800
Total NO_x reduction	kg/year	30 665	30 665
Total PM reduction	kg/year	655	655
Total SO_2 reduction	kg/year	595	595

Note: *Option 1 (see Section 2.3.3); **for normative and real pollution factors, see Section 2.3.1.
Source: OECD calculations, OPTIC Model.

2.2.2. Phase 2 (scaling-up phase)

Taking into account the significant potential for environmental improvements from modernising the public transport fleet, two scenarios for the second phase of the CPT Programme (which would last up to five years; see the timeline in Section 2.5) were costed using the OPTIC (Optimising Public Transport Investment Costs) model (Section 2.3.1):

- **Scenario 1:** modernising the remaining old bus/minibus fleet in Chisinau and Balti, including those on the suburban routes. Scenario 1 would involve replacing all old buses (including minibuses), i.e. below Euro 5/V standard across the urban and suburban areas of Chisinau and Balti. This would mean purchasing 393 modern regular buses and 280 minibuses (including the 15 minibuses from the pilot phase) powered with CNG or LPG, or possibly modern diesel engines.
- **Scenario 2:** modernising the remaining old bus/minibus fleet in Chisinau and Balti, including suburban routes, as well as the public transport fleet operating inter-city connections in the entire country. The inter-city routes were chosen since there is little urban transport in other cities in Moldova and they act as a substitute (i.e. covering suburbs and centres of towns on the route). Scenario 2 assumes replacing all buses (including minibuses) that are below Euro 5/V standard and which are providing public transport within and between cities in Moldova. This would involve purchasing 1 456 modern buses and 992 minibuses (including 15 minibuses from the pilot phase) that run on cleaner fuels.

The environmental cost-effectiveness of Scenario 1 is expected to be greater than Scenario 2 as the concentration of air pollutants is higher in urban and suburban areas than in rural ones. Urban areas of other cities will also benefit from improved inter-city connections, though to a lesser extent than the pilot cities. Therefore, it is advisable to start with Scenario 1 in the scaling-up phase.

The number of buses to be purchased in Phase 2 of the CPT Programme was calculated based on the number of old diesel buses (with engines of up to Euro IV standard) and

minibuses providing public passenger transport services. This estimation also considers the possibility that the overall number of minibuses will be reduced and a certain share of these minibuses (about 50%) will be replaced with regular buses.

Public transport in Moldova is currently dominated by minibuses; regular buses (i.e. buses that are more than 10 metres long), which can carry up to five times more passengers, only service a small number of urban and inter-city routes. Therefore, the second phase of the programme would replace half of the old minibuses with minibuses powered by cleaner fuels (or sources of power), while the other half would be replaced by regular buses. For example, after Scenario 2 there would be 992 new minibuses, whereas 3 957 minibuses would be replaced (given the larger capacity of regular buses).

In total, the programme will result in 77 new urban public transport vehicles in the pilot phase (62 trolleybuses and 15 buses) (Table 2.4). After the scaling-up phase (Scenario 1), there will be 735 new urban and suburban vehicles (62 trolleybuses, 393 buses and 280 minibuses). Assuming the more ambitious scaling-up phase (Scenario 2) is implemented, Moldova will have 2 510 new urban, suburban and inter-city vehicles (62 trolleybuses, 1 456 buses and 992 minibuses). Their distribution between the pilot cities of Chisinau and Balti, and other regions of Moldova, is shown in Figure 2.2.

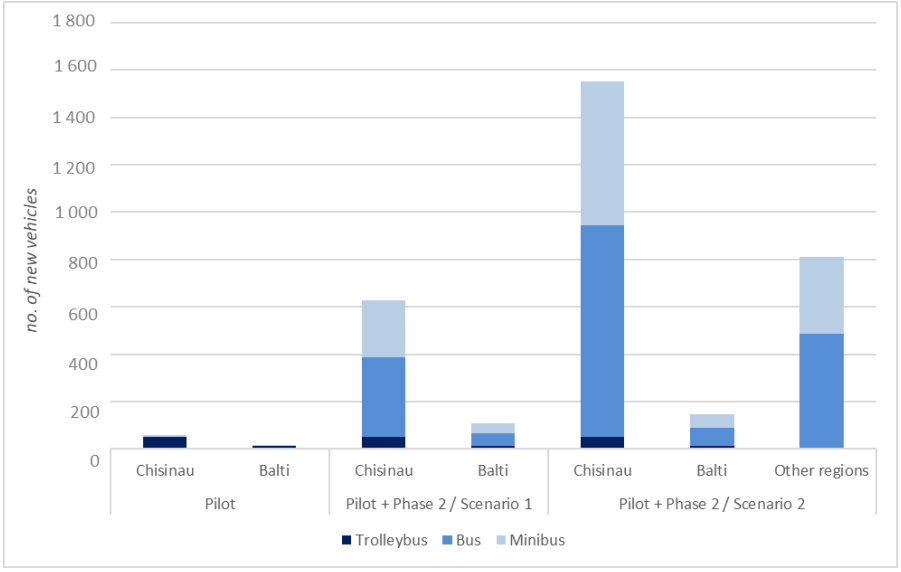
There are potentially 943 urban, 1 139 suburban and 7 135 intercity transport vehicles that need to be replaced in Chisinau, Balti and primary inter-city connections. Of these, the full implementation of the CPT Programme will involve replacing 328 urban (34.8%), 407 suburban (35.7%) and 1 175 inter-city (16.4%) transport vehicles.

Table 2.4. Key input and output parameters of the assessed CPT Programme scenarios

	Unit	Phase 1 & Phase 2 - Scenario 1 (suburban routes in Chisinau and Balti)	Phase 1 & Phase 2 - Scenario 2 (Scenario 1 + inter-city connections in Moldova)
Total number of trolleybuses purchased	No.	62	62
Total number of buses purchased	No.	393	1 456
Of which modern diesel	No.	131	648
Of which CNG	No.	132	325
Of which LPG	No.	130	483
Total number of minibuses purchased	No.	280	992
Of which modern diesel	No.	133	489
Of which CNG or LPG	No.	147	503
Total costs of buses/trolleybuses/minibuses purchased	MDL mln	2 779	9 223
Of which co-financed by the programme (Option 1*)	MDL mln	783	2 394
Of which co-financed by private / municipal bus operators (Option 1*)	MDL mln	1 996	6 829
Of which co-financed by the programme (Option 2*)	MDL mln	1 593	5 542
Of which co-financed by private / municipal bus operators (Option 2*)	MDL mln	1 187	3 681
Total CO_2 reduction**	tCO_2/year	20 812	73 944
Total CO reduction	kg/year	85 422	300 637
Total NO_x reduction*	kg/year	403 752	1 444 075
Total PM reduction	kg/year	9 890	35 123
Total SO_2 reduction	kg/year	8 391	29 463

Note: *For the two options, see Section 2.3.3; **normative pollution factors (for normative and real pollution factors, see Section 2.3.1).
Source: OECD calculations, OPTIC Model.

Figure 2.2. Renewed public transport fleet in Moldova after CPT Programme implementation



Source: OECD calculations, OPTIC Model.

2.3. What will the costs and benefits be?

2.3.1. Using the OPTIC Model to estimate costs and benefits

The costs and benefits of the CPT Programme were estimated using an Excel-based model called Optimising Public Transport Investment Costs (OPTIC). This analytical tool has been developed by the OECD to help public authorities prepare and estimate, as precisely as possible, the costs and environmental benefits of green public investment programmes (Box 2.1). The model was first designed and tested in Kazakhstan (OECD, 2017[7]). The assumptions surrounding cost calculation and emission reduction factors are described in Annex B in the section "Programme costing for Phase 1 (pilot phase) and Phase 2 (scaling-up phase)".

Box 2.1. The OPTIC model

The Optimising Public Transport Investment Costs (OPTIC) model was developed along with this study and is one of the main outputs of the project.

OPTIC's spreadsheet-based model is a simple, easy-to-use decision support tool prepared exclusively to calculate and optimise total programme costs, as well as the potential CO2 emission reductions and reductions of other pollutants from urban public transport (CO, NOx, PM, SO2) that could be achieved by implementing the proposed project pipelines. The model also enables the optimal level of subsidy that can be offered to potential beneficiaries to be calculated.

Optimisation of costs and benefits implies achieving given targets at the lowest possible cost for the public financier. If underlying economic conditions in the country change over the programme period (e.g. tariffs are increased, interest rates on commercial loans are lowered) and/or available public financing is reduced or augmented, both targets and subsidy levels can be re-calculated (or optimised) and adjusted accordingly.

The model consists of seven modules: 1) assumptions; 2) emission factors; 3) transport sector overview with information on current bus fleet and age; 4) determining of the subsidy level; 5) cost calculation; 6) emission reductions calculation; and 7) programme costing and environmental effects.

2.3.2. Emission reductions

In order to estimate the environmental outcomes of the CPT Programme, the OPTIC model uses two different sets of pollution factors: normative and real. This was necessary as normative pollution factors are declared and checked in laboratory conditions and differ from actual pollution factors measured in the urban transport cycle. Normative emission factors take into account various modern emission standards for heavy-duty diesel engines and estimations for CNG and LPG-fuelled engines. The emission factors introduced by standards, however, are based on maximum emission levels according to specific norms. Real emissions may vary, mainly because normative emissions are tested in laboratory conditions and not in actual traffic. This is a concern mostly for diesel engines, where emission reduction depends on the installed emission reduction equipment. As for CNG and LPG, emissions are less problematic because their lower level mostly results from the use of cleaner fuels. In this case, the real level of emissions was also calculated from the results published by the International Council

on Clean Transportation (ICCT)[6] based on real-world exhaust emissions from modern diesel cars (Franco et al., 2014[8]). A detailed discussion of emissions factors is provided in Annex B.

Using the OPTIC Model, the CPT Programme costs and benefits (reduction of emissions of air pollutants and greenhouse gases) were calculated for the pilot phase and for both scenarios. While no sensitivity analysis for the scenarios was performed, changes in the programme's cost-effectiveness might occur if the prices used for the costing change (e.g. passenger fares).

In terms of air pollution and CO_2 emission reductions, the most significant achievements are expected to be in NO_x emissions (under both scenarios). Under Phase 2/Scenario 1, NO_x emissions are estimated to decline by 403 752 kg/year (Table 2.5), while under Phase 2/Scenario 2, the decline could be as much as 1 444 075 kg/year (Table 2.6). CO_2 emissions are estimated to decline by 20 812 tCO_2/year under Phase 2/Scenario 1, and 73 944 tCO_2/year under Phase 2/Scenario 2.

Table 2.5. Key parameters of the assessed CPT Programme – Phase 1&2, Scenario 1

(normative pollution factors)

Type	New buses						Investment costs	Subsidy	Subsidy	Emission reductions per year				
	Bus			Minibus		Trolley bus		Option 1	Option 2					
	Diesel	CNG	LPG	Diesel	CNG or LPG		MDL mln	MDL mln	MDL mln	CO2 (t)	CO (kg)	NOx (kg)	PM2.5 (kg)	SO2 (kg)
Chisinau urban	42	42	43	43	52	50	1 063	336	597	8 839	33 071	154 976	3 711	3 183
Balti urban	8	8	7	8	13	12	216	72	121	1 653	6 278	29 331	700	602
Chisinau suburban	71	71	70	71	71	0	1 307	327	762	9 072	40 305	192 002	4 790	4 027
Balti suburban	10	11	10	11	11	0	194	48	113	1 248	5 768	27 443	689	579
Chisinau inter-city	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Balti inter-city	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other regions	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	131	132	130	133	147	62	2 779	783	1 593	20 812	85 422	403 752	9 890	8 391

Source: OECD calculations, OPTIC Model.

Table 2.6. Key parameters of the assessed CPT Programme – Phase 1&2, Scenario 2

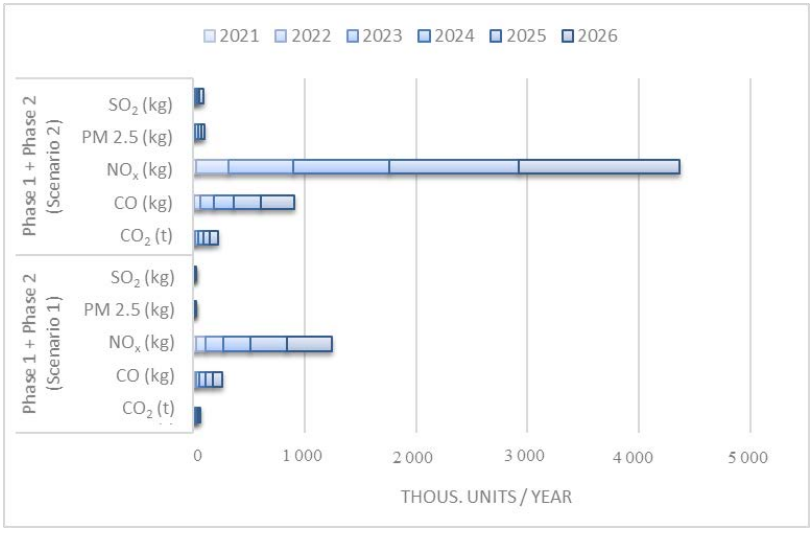
(normative pollution factors)

Type	New buses						Investment costs	Subsidy	Subsidy	Emission reduction per year				
	Bus			Minibus		Trolley bus		Option 1	Option 2					
	Diesel	CNG	LPG	Diesel	CNG or LPG		MDL mln	MDL mln	MDL mln	CO_2 (t)	CO (kg)	NO_x (kg)	PM2.5 (kg)	SO_2 (kg)
Chisinau-urbn	42	42	43	43	52	50	1 063	336	597	8 839	33 071	154 976	3 711	3 183
Balti-urban	8	8	7	8	13	12	216	72	121	1 653	6 278	29 331	700	602
Chisinau-suburban	71	71	70	71	71	0	1 307	327	762	9 072	40 305	192 002	4 790	4 027
Balti-suburban	10	11	10	11	11	0	194	48	113	1 248	5 768	27 443	689	579
Chisinau-inter-city	185	185	184	185	185	0	3 413	853	1 990	26 771	112 134	531 843	13 140	11 101
Balti-inter-city	8	8	7	8	8	0	143	36	84	1 014	4 500	21 251	526	445
Other regions	324	0	162	163	163	0	2 887	1 875	1 875	98 580	487 229	11 567	9 526	324
TOTAL	648	325	483	489	503	62	9 223	2 394	5 542	73 944	300 637	1 444 075	35 123	29 463

Source: OECD calculations, OPTIC Model.

Figure 2.3 presents the possible GHG and air pollution reductions under both phases and scenarios in Moldova's two major cities, including their suburban networks and main inter-city connections.

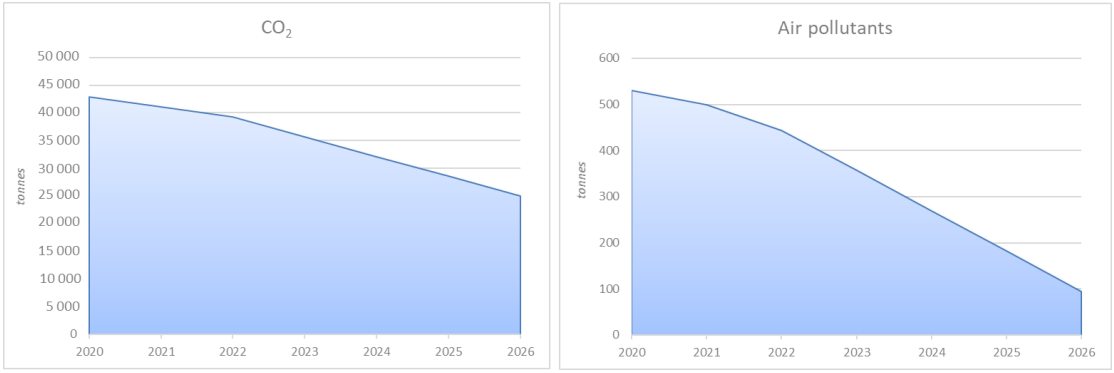
Figure 2.3. Aggregate annual emissions reductions resulting from CPT Programme, 2021-26



Source: OECD calculations, OPTIC Model.

Figure 2.4 projects environmental outcomes for the city of Chisinau, including the second (scaling-up) phase, which along with the pilot phase will take six years to implement. It shows that these investments can bring significant emission reductions. Whereas CO_2 emissions will be reduced by 41.8% (24 950 tonnes/year), the combined reduction of air pollutants will be 82.2% (95 tonnes/year) after the scaling-up phase, compared to the baseline.

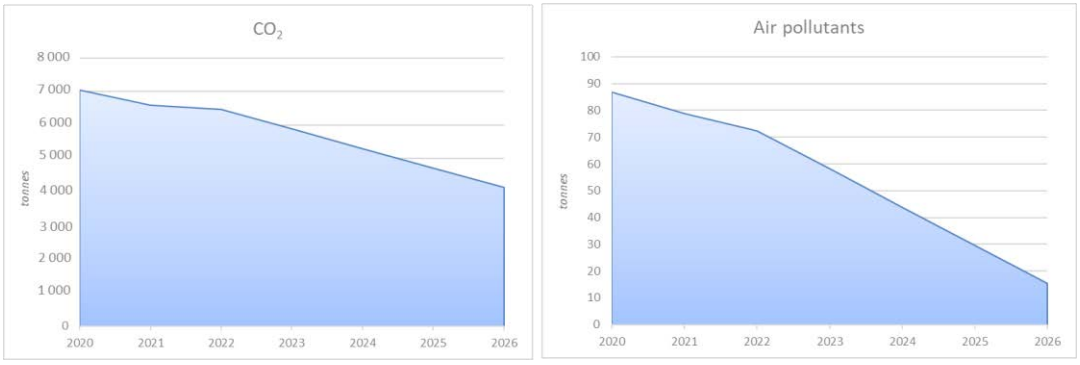
Figure 2.4. CO_2 and air pollutant emissions following fleet modernisation in Chisinau, 2020-26



Note: The values reflect only emissions of the vehicles to be replaced (baseline value) and the new fleet (target value), not the total emissions from all public transport in Chisinau. Air pollutants include CO, NO_x, PM2.5 and SO_2 and the total emissions value is based on simple summation of individual pollutant emission weights.
Source: OECD calculations, OPTIC Model.

Figure 2.5 projects the environmental outcomes in Balti, including the second (scaling-up) phase. Whereas the CO_2 reduction will be 41.2% (4 144 tonnes/year), the combined reduction of air pollutants will amount to 82.3% (15 tonnes/year) after the scaling-up phase, compared to the baseline.

Figure 2.5. CO_2 and air pollutants emissions following fleet modernisation in Balti, 2020-26

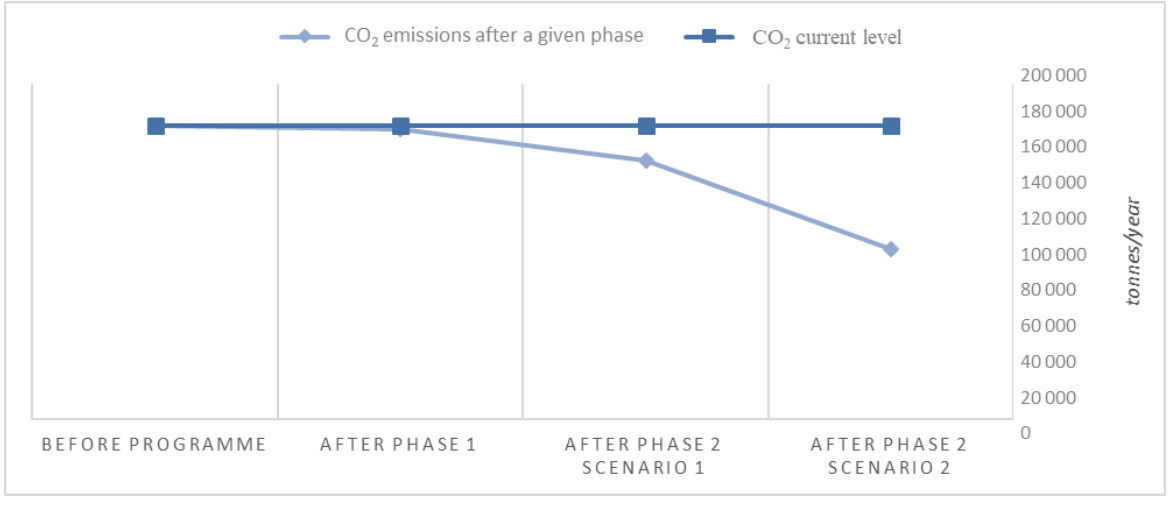


Note: The values reflect only emissions of the vehicles to be replaced (baseline value) and the new fleet (target value), not the total emissions from all public transport in Balti. Air pollutants include CO, NO_x, PM2.5 and SO_2 and the total emissions value is based on simple summation of individual pollutant emission weights.
Source: OECD calculations, OPTIC Model.

Figure 2.6, Figure 2.7 and Figure 2.8 compare possible GHG and air pollution reduction resulting from the CPT Programme's phases and scenarios with current levels of emissions from the ageing public transport fleet.

CO_2 and NO_x promise the greatest emission reductions. Obviously, significant emission reductions start accumulating with the implementation of Phase 2 of the CPT Programme. By the end of Scenario 2, CO_2 emissions are estimated to begin to decrease by about 73 944 tonnes/year (meaning a reduction of 42.2% compared to the baseline), while in the case of NO_x emissions, this reduction is estimated at about 1 444 tonnes/year (meaning a reduction of 83.5% compared to the baseline). These reductions are estimated using the normative pollution factors approach (Figure 2.6 and Figure 2.7).

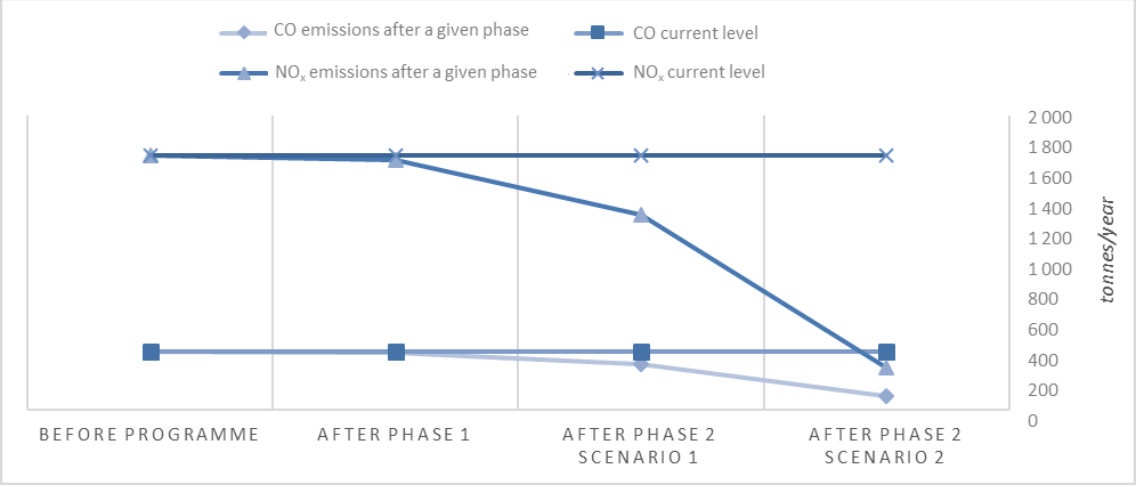
Figure 2.6. Potential carbon dioxide reductions resulting from the CPT Programme



Note: The values reflect only emissions of the vehicles to be replaced (baseline value) and the new fleet (target value), not the total emissions from all public transport in Moldova.
Source: OECD calculations, OPTIC Model.

In addition to NO_x mentioned above, the CO emissions reductions will amount to 301 tonnes/year (meaning a reduction of 76.3% compared to baseline).

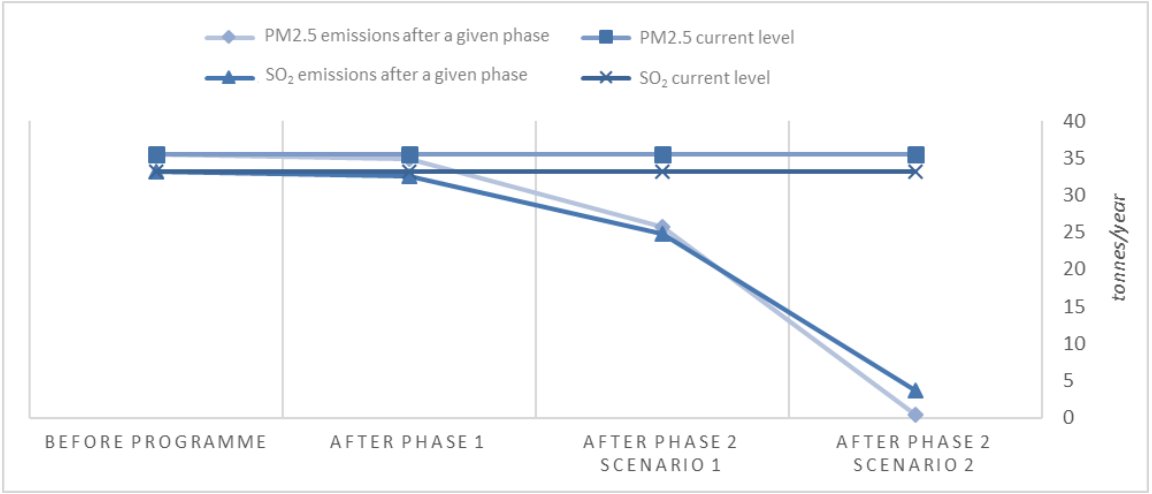
Figure 2.7. Potential carbon monoxide and nitrogen oxides reductions resulting from the CPT Programme



Note: The values reflect only emissions of the vehicles to be replaced (baseline value) and the new fleet (target value), not the total emissions from all public transport in Moldova.
Source: OECD calculations, OPTIC Model.

The greatest relative improvement would be in the emissions of small particulate matter – PM2.5 (Figure 2.8). This would be reduced by 98.8% (or 35 tonnes/year) after the end of Scenario 2 of the scaling-up phase. Sulphur dioxide emissions will decrease by 29 tonnes/year (a reduction of 88.9% compared to the baseline).

Figure 2.8. Potential particulates and sulphur dioxide reductions resulting from the CPT Programme



Note: The values reflect only emissions of the vehicles to be replaced (baseline value) and the new fleet (target value), not the total emissions from all public transport in Moldova.
Source: OECD calculations, OPTIC Model.

2.3.3. Investment costs and financing options

Analysis suggests that the total costs of the CPT Programme will be substantial. It is estimated that the pilot phase of the programme will amount to MDL 353 million (USD 19.1 million). The investment cost of Phase 1 and Scenario 1 of Phase 2 is estimated at MDL 2 779 million (USD 150.2 million) (Table 2.5), of which between MDL 783 and 1 593 million (USD 42.3 and 86.1 million) in public support will be needed, depending on the financing option selected. The investment cost of Phase 1 and Scenario 2 of Phase 2 is estimated at MDL 9 223 million (USD 498.6 million) (Table 2.4), of which between MDL 2 394 and 5 542 million (USD 129.4 and 299.6 million) in public support will be needed.

It will therefore be challenging for the public financier to cover all these costs alone. In order to address this challenge, public financial and guarantee support will need to be provided, including by international public financiers.

The analysis identifies two possible options for funding the CPT Programme pipelines: the first would be with the involvement of the local banking sector, while the second would not. The proposed combinations of financing instruments are as follows:

- **Option 1.** Commercial loans, combined with public support in the form of loan guarantees and a relatively smaller subsidy (a grant) to help public transport operators to repay a portion of the loan (Figure 2.9).
- **Option 2.** Public support in the form of a relatively larger subsidy (a grant) to motivate public transport operators to allocate more of their own financial resources to purchase cleaner vehicles – which generally require a higher initial investment (in terms of purchase cost) but are less expensive to operate (in terms of fuel costs) (Figure 2.10).

The provision of the loan guarantee (under Option 1) is a particularly important element in the CPT Programme financing. Although the overall financial support (in the form of subsidies) may not be that high, the Ministry of Finance (as the main guarantor of public debt) can issue guarantees on bank loans to overcome the lack of creditworthiness of smaller municipalities and private operators (in addition to municipal transport operators in Chisinau and Balti). Involving the Ministry of Finance (MoF) in programme design is therefore of crucial importance.

It is proposed that the loan guarantee consist of two components (Table 2.7 and Table 2.8):

- a fixed cost for issuing the guarantee (equal to 0.5% of the loan)
- cost of the guarantee in case of default by borrowers (equal to 5% of the loan provided by the bank).

These shares are based on similar international programmes. The 5% guarantee cost – although rather low – is achievable providing the government sets very strict conditions on loan provision that will result in a low default rate. In any case, should there be a need to change the rates, all major programme outputs (e.g. total programme cost, level of subsidy) will need to be recalculated.

The loan component will be provided through banks that sign an agreement with the Ministry of Agriculture, Regional Development and Environment (MARDE). The source of financing for the loans granted by the banks could include:

- the banks' own resources
- loans to banks from international financial institutions (IFIs).

Figure 2.9. Option 1 – Financing from commercial loans

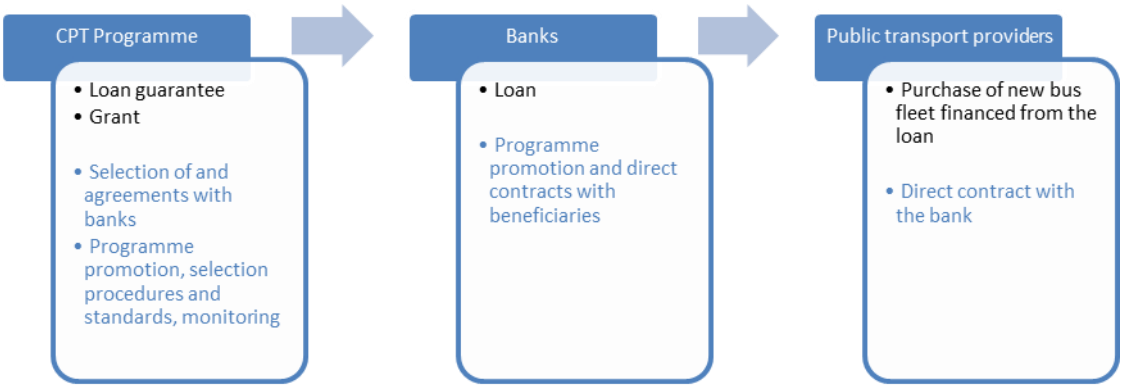


Figure 2.10. Option 2 – Financing from own sources and public grant

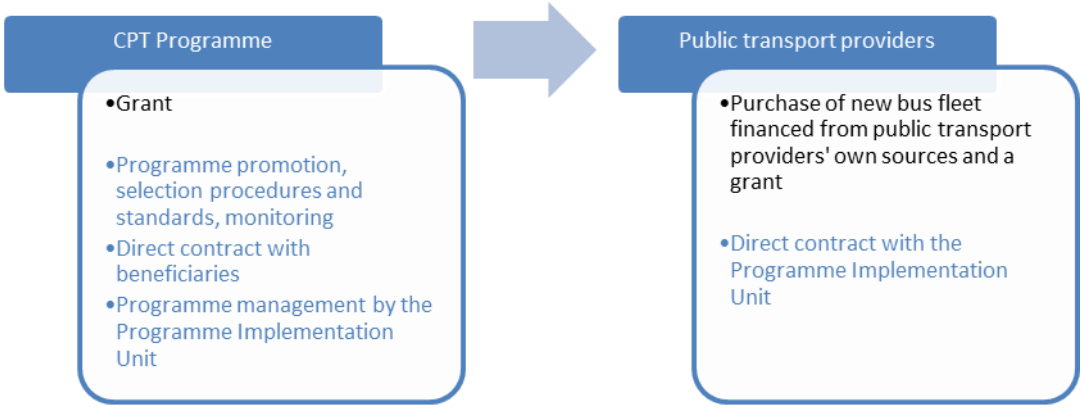
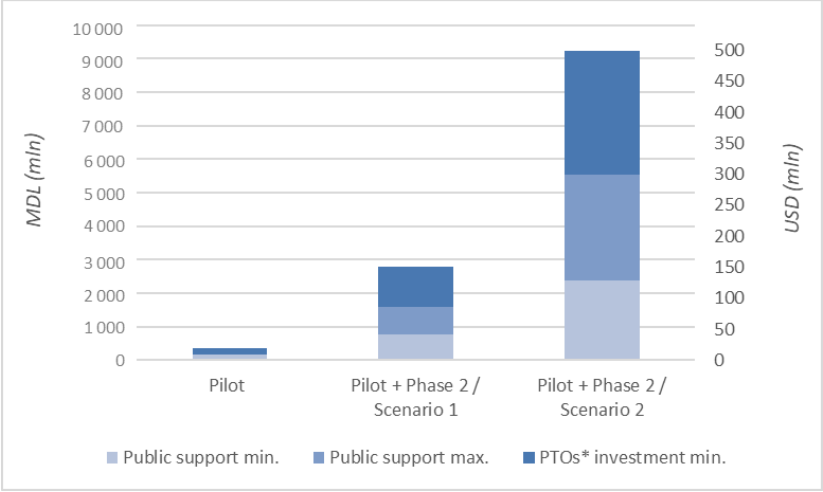


Figure 2.11 presents the overall CPT Programme costs for investors (i.e. private and municipally-owned public transport companies) and public sector financiers (both national and international) in the pilot phase and in the two scenarios of the scaling-up phase. Option 1 is represented in the table as "Public support minimum" (i.e. the lowest level of public support), whereas Option 2 is the highest level of public support (shown as "Public support maximum"). Conversely, the minimum required amount for the investor refers to Option 2 (i.e. the highest level of public support), whereas the maximum amount to Option 1 (i.e. smaller public support), where the investor will partly cover its contribution by commercial loans.

Figure 2.11. Overview of CPT Programme's total investment costs

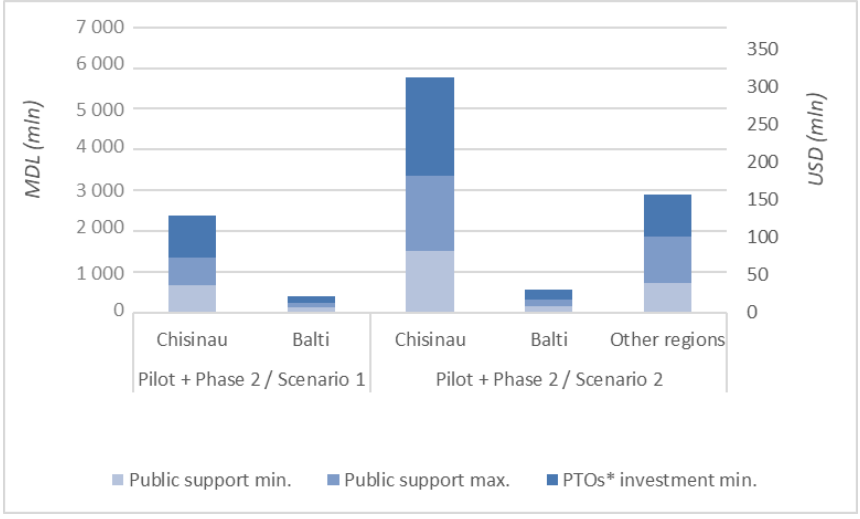


Note: *PTOs – public transport operators.
Source: OECD calculations, OPTIC Model.

The main difference between the two scenarios is that Scenario 1 foresees that only buses in Chisinau and Balti will be supported financially through the investment programme (i.e. urban and suburban public transport), while under Scenario 2, the CPT Programme will also support buses on inter-city routes (in cities other than Chisinau and Balti urban public transport *de jure* does not exist and is *de facto* provided by inter-city transport). The costs of both scenarios also include the estimated costs for the pilot phase.

Figure 2.12 shows the investment costs for public financiers (national as well as international) and investors (private and municipally-owned enterprises) broken down by pilot city and other regions.

Figure 2.12. Total investment costs of the CPT Programme in Chisinau and Balti



Note: *PTOs – public transport operators.
Source: OECD calculations, OPTIC Model.

In terms of total investments (Phases 1 and 2), Scenario 1 assumes that almost MDL 400 million (USD 21.5 million) will be disbursed annually from both public and private sources – calculated as MDL 2 779 million divided by seven years (two years for the pilot phase and five years for the second phase). Scenario 2 assumes that the CPT Programme will require an annual expenditure of MDL 1 317 million (USD 71.2 million), i.e. MDL 9 223 million (USD 498.6 million) in total divided by seven years.

Table 2.7 below summarises the size, results and associated costs of the CPT Programme over the seven years, assuming that it is implemented through banks (Option 1 as in Figure 2.9).

Table 2.7. Summary of CPT Programme costs under Option 1, both Phases 1 and 2 (MDL)

	Overall costs	Public co-financing							
		Total public co-financing	Year						
			1	2	3	4	5	6	7
	MDL million								
Scenario 1									
Preparation costs (including fundraising)	0.2	0.2	0.1	0.1					
Pilot phase	353	176		176					
Implementation unit (operating costs)	0.6	0.6			0.1	0.1	0.1	0.1	0.1
Second phase	2 427	607			121	121	121	121	121
Costs of guarantees (0.5% +5%)	33	33			7	7	7	7	7
Total Scenario 1	**2 814**	**817**	**0**	**176**	**128**	**128**	**128**	**128**	**128**
Scenario 2									
Preparation costs (including fundraising)	0.2	0.2	0.1	0.1					
Pilot phase	353	176		176					
Implementation unit (operating costs)	0.6	0.6			0.1	0.1	0.1	0.1	0.1
Second phase	8 871	2 218			444	444	444	444	444
Costs of guarantees (0.5% +5%)	122	122			24	24	24	24	24
Total Scenario 2	**9 436**	**2 517**	**0**	**176**	**468**	**468**	**468**	**468**	**468**

Source: OECD calculations, OPTIC Model.

The CPT Programme preparation costs (including fundraising) are estimated on the assumption that one person will be working full time on the programme during the first year and that this will cost approximately MDL 100 000 (USD 5 400), given an average monthly salary for administrative employees of MDL 6 144.2/person (according to the National Bureau for Statistics of Moldova)[1] and 50% overheads (social security and other administrative costs).

Table 2.8 summarises the size, results and associated costs of the CPT Programme assuming that the programme is implemented directly by a government-established implementation unit (Option 2, Figure 2.10). The annual amounts are estimated by dividing the public co-financing required for a given scenario (excluding the pilot phase) by the five years of programme implementation in the second phase.

The CPT Programme preparation costs in this second financing option (including fundraising) assume that two people will be working during the first year and that this will cost approximately MDL 200 000 (USD 10 800), given an average monthly salary for administrative employees of MDL 6 144.2/person (according to the NBS) and 50% overheads (social security and other administrative costs). In addition, the implementation

unit will consist of five people whose costs, including the costs of running the office, are estimated to amount to MDL 1.1 million annually (USD 59 500).

Table 2.8. Summary of CPT Programme costs under Option 2, both Phases 1 and 2 (MDL)

	Overall costs	Public co-financing							
		Total public co-financing	Year						
			1	2	3	4	5	6	7
	MDL million								
Scenario 1									
Preparation costs (including fundraising)	0.4	0.4	0.2	0.2					
Pilot phase	353	178		178					
Implementation unit (operating costs)	5.5	5.5			1.1	1.1	1.1	1.1	1.1
Second phase	2 427	1 415			283	283	283	283	283
Costs of guarantees (0.5% +5%)	0	0			0	0	0	0	0
Total Scenario 1	**2 785**	**1 599**	**0**	**178**	**284**	**284**	**284**	**284**	**284**
Scenario 2									
Preparation costs (including fundraising)	0.4	0.4	0.2	0.2					
Pilot phase	353	178		178					
Implementation unit (operating costs)	5.5	5.5			1.1	1.1	1.1	1.1	1.1
Second phase	8 871	5 365			1 073	1 073	1 073	1 073	1 073
Costs of guarantees (0.5% +5%)	0	0			0	0	0	0	0
Total Scenario 2	**9 229**	**5 548**	**0**	**178**	**1 074**	**1 074**	**1 074**	**1 074**	**1 074**

Source: OECD calculations, OPTIC Model.

Table 2.9 and Table 2.10 mirror Table 2.7 and Table 2.8, but all costs are recalculated in US dollars.

Table 2.9. Summary of CPT Programme costs in Option 1, Phases 1 and 2 (USD)

	Overall costs	Public co-financing							
		Total	Year						
			1	2	3	4	5	6	7
	USD million								
Scenario 1									
Preparation costs (including fundraising)	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00
Pilot phase	19	10	0	10	0	0	0	0	0
Implementation unit (operating costs)	0.03	0.03	0.00	0.00	0.01	0.01	0.01	0.01	0.01
Second phase	131	33	0	0	7	7	7	7	7
Costs of guarantees (0.5% +5%)	2	2	0	0	0	0	0	0	0
Total Scenario 1	**152**	**44**	**0**	**10**	**7**	**7**	**7**	**7**	**7**
Scenario 2									
Preparation costs (including fundraising)	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00
Pilot phase	19	10	0	10	0	0	0	0	0
Implementation unit (operating costs)	0.03	0.03	0.00	0.00	0.01	0.01	0.01	0.01	0.01
Second phase	480	120	0	0	24	24	24	24	24
Costs of guarantees (0.5% +5%)	7	7	0	0	1	1	1	1	1
Total Scenario 2	**505**	**136**	**0**	**10**	**25**	**25**	**25**	**25**	**25**

Source: OECD calculations, OPTIC Model.

Table 2.10. Summary of CPT Programme costs in Option 2, Phases 1 and 2 (USD)

	Overall costs	Public co-financing							
		Total	Year						
			1	2	3	4	5	6	7
	USD million								
Scenario 1									
Preparation costs (including fundraising)	0.02	0.02	0.01	0.01	0.00	0.00	0.00	0.00	0.00
Pilot phase	19	10	0	10	0	0	0	0	0
Implementation unit (operating costs)	0.30	0.30	0.00	0.00	0.06	0.06	0.06	0.06	0.06
Second phase	131	76	0	0	15	15	15	15	15
Costs of guarantees (0.5% +5%)	0	0	0	0	0	0	0	0	0
Total Scenario 1	151	86	0	10	15	15	15	15	15
Scenario 2									
Preparation costs (including fundraising)	0.02	0.02	0.01	0.01	0.00	0.00	0.00	0.00	0.00
Pilot phase	19	10	0	10	0	0	0	0	0
Implementation unit (operating costs)	0.30	0.30	0.00	0.00	0.06	0.06	0.06	0.06	0.06
Second phase	480	290	0	0	58	58	58	58	58
Costs of guarantees (0.5% +5%)	0	0	0	0	0	0	0	0	0
Total Scenario 2	499	300	0	10	58	58	58	58	58

Source: OECD calculations, OPTIC Model.

2.4. What is the optimal co-financing level?

Calculating the optimal level of public co-financing for the purchase of new, cleaner vehicles is an important element of the analysis. Our estimates suggest that the level of public funds should not exceed the rates provided in Table 2.11. These rates, which represent the optimal subsidy level per project pipeline, were calculated using the OPTIC model based on the net present value (NPV) of each type of investment.

The rate of financial assistance (subsidy rate) should be set to ensure that it does not replace, but instead leverages, beneficiaries' spending. The economic significance of this calculation is that the subsidy will encourage potential beneficiaries to participate in the CPT Programme without aiming to make a profit based on the subsidy. Therefore, the level of the subsidy should be kept at the absolute minimum, especially given the scarcity of public resources. This optimal minimum can be defined as the rate of assistance that makes environmentally and economically important projects financially viable (see Annex B to this report).

The calculation takes into account current fare prices and the daily distances covered by operators (which are not optimal). If the CPT Programme is financed with bank loans and the programme provides a loan guarantee (i.e. Option 1), part of the costs will include providing these guarantees. In addition, beneficiaries will enjoy additional benefits due to the lower interest rates associated with the loan guarantee. This is why it is proposed that a fixed average grant rate of 25% of the vehicle purchase costs (a single value is used for the sake of simplicity) should be provided by the programme and the grant should be used to reduce the loan repayment (Table 2.11).

Table 2.11. Summary of public support for the CPT Programme

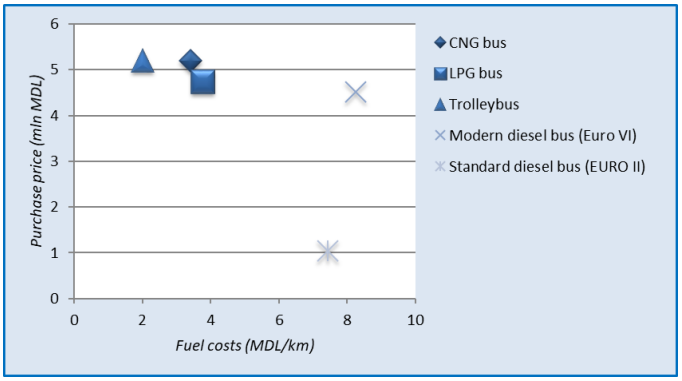
Programme pipeline	Estimated public co-financing for Option 2	Estimated public co-financing for Option 1
Trolleybus	50%	25% + loan guarantee
Buses and minibuses with engines fuelled by CNG	60%	25% + loan guarantee
Buses and minibuses with engines fuelled by LPG	55%	25% + loan guarantee
Buses and minibuses with engines fuelled by modern diesel (Euro V and Euro VI)	75%	25% + loan guarantee
CNG stations	Provided by the private sector	
LPG stations	Provided by the private sector	
Side investments	Provided by cities	

Note: Percentage values denote the level of public support in the bus purchase costs.
Source: OECD calculations, OPTIC Model.

Two issues need to be noted regarding the calculation of this optimal subsidy level. First, once a public transport operator modernises its fleet, the operator will not need to replace buses for some time (in particular, considering that buses that are more than 15 years old would need to be replaced in any case). Thus, only the price difference between modern (low-emission) buses and traditional buses is taken into account when calculating the subsidy level.[2] Second, some fuels will be cheaper than diesel. For example, CNG and LPG are cheaper than diesel and result in lower driving costs per kilometre, even when their increased consumption per kilometre compared to petrol fuel is taken into account (as they similarly use internal-combustion-engines). These savings in fuel costs for public transport operators are also taken into account when calculating the subsidy level.

Figure 2.13 and Figure 2.14 contrast purchase price and fuel cost for the different types of buses, as an aid in the decision-making process. As seen in Figure 2.13, while the purchase price of (or the initial investment in) cleaner fuel buses is significantly higher than for a traditional diesel engine bus, the much lower fuel costs over the useful lifetime of the cleaner bus allow for additional savings.

Figure 2.13. Relationship between purchase price and fuel costs for diesel and cleaner buses

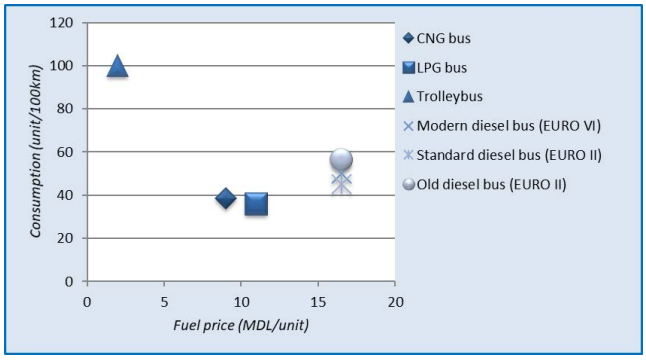


Source: OECD calculations, OPTIC Model.

Similarly, Figure 2.14 shows that CNG fuel is cheaper than diesel, and the consumption of CNG-powered buses per 100 kilometres is lower than for old diesel buses (for exact fuel consumption values, see Table B.1 in Annex B). While electricity consumption by trolleybuses is very high, the unit cost of electricity is the lowest of all fuels. The potential

savings from using storage batteries and the low pollution levels from electric transport make trolleybuses a particularly attractive option for investment.

Figure 2.14. Relationship between consumption and fuel price for diesel and cleaner buses



Source: OECD calculations, OPTIC Model.

It is essential to monitor market developments regularly (e.g. changes in bus/trolleybus and fuel/electricity prices, development of the market for new engines/technologies, and availability of other financing sources) and how they interact with the CPT Programme design (see Chapter 3). Such market changes need to be reflected in the programme, and the state subsidy level adjusted accordingly. The section on "Programme costing for Phase 1 (pilot phase) and Phase 2 (scaling-up phase)" in Annex B provides an indicative calculation of the optimal subsidy level based on current (around mid-2017) bus and fuel prices. These, however, are offered more as an illustration of how the subsidy level needs to be calculated, rather than as absolute values. The model provides an opportunity to adjust and optimise the programme assumptions and its effects by changing the basic data as appropriate.

2.5. What will the timeframe look like?

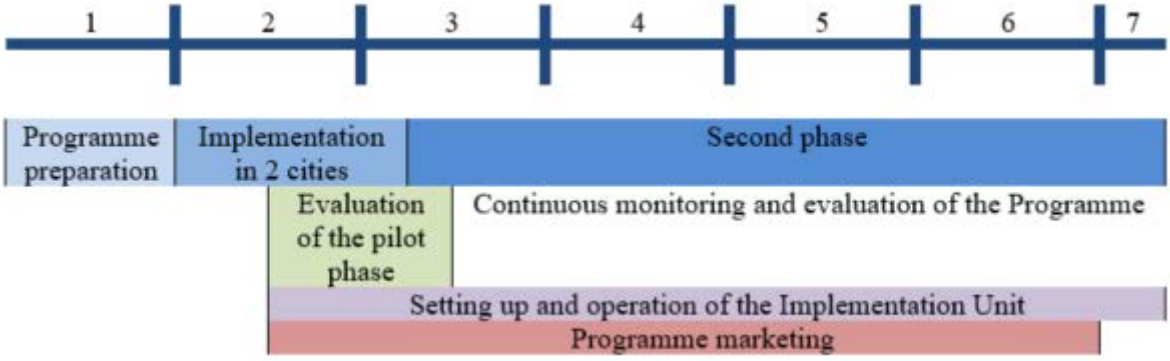
Given that the CPT Programme will be co-financed with public funds, a preparation period will be needed before the first phase to include the programme provisions in the state budget process as well as to identify and apply for funding from additional financing sources (including donors).

Once project financing is agreed, the rollout of the programme in the two selected pilot cities will be relatively rapid, as it involves purchasing 62 trolleybuses and 15 minibuses and no construction of infrastructure. The major constraint will be procurement procedures. The pilot phase could thus take up to a year. The implementation of the second phase will take about five years (Figure 2.15).

In addition, annual evaluations of the CPT Programme should be conducted to see whether the selected and implemented projects are helping to meet government objectives and to revise the programme, if necessary. Since the programme is designed to be co-financed through the state budget, any update should be co-ordinated with the existing multi-year budget and its requirements. On this basis, annual financial plans for financing through the regular annual budget should be prepared.

The experience of other countries with similar publicly supported investments suggests that programmes are best implemented over the medium to long term (namely, 5-10 years) and linked to government targets. The results of the first phase will be evaluated to decide whether to continue with the second phase. If this is the case it is proposed that the second phase of the CPT Programme be carried out over a period of five years and then reviewed in detail. A decision can then be made as to whether it should be extended or brought to a close, reflecting possible new policy objectives and government goals or market developments.

Figure 2.15. Proposed timeline (in years)



2.6. What is the proposed implementation set-up?

The programme implementation will require institutional arrangements that ensure entail transparent and cost-effective decision-making. The report analyses several institutional options. The institutional set-up proposed in this study includes three levels: i) programming entity, ii) implementation unit and iii) a technical support unit. Their roles and responsibilities are presented in detail in the report.

The analysis suggests the Ministry of Agriculture, Regional Development and Environment (MARDE) to perform the role of the programming entity (supervisory body). Programme implementation, which should be a separate and distinct function from the programming role, could be performed by local banks that sign a cooperation agreement with the MARDE Ministry based on a successful public tender bid to provide this service. Regardless of the choice, the implementing entity should have a degree of independence to ensure that decisions are made using rules and criteria in line with the programme objectives, and not subject to undue political influence.

Inter-ministerial co-operation is vital for the successful implementation of the programme. Such a programme can help increase the profile of the environment and climate on the transport policy agenda. In transitioning to clean public transport, the MARDE Ministry would benefit from closer co-operation with other ministries, in particular the Ministry of Economy and Infrastructure and the Ministry of Finance, in order to mobilise existing funds and potential external financing sources in order to achieve low-carbon mobility in the country.

2.7. Conclusions

As the OPTIC model calculations have shown, the total cost of implementing the CPT Programme will be substantial. Since new technologies are more expensive before they reach market maturity, public financial support will be necessary to help the public transport operators (both municipal and private) upgrade to a modern and environment-friendly fleet.

The investment programme foresees public grants, commercial and preferential loans and public loan guarantees as the most targeted support options. The financing sources are available, and can be provided by several actors – national public authorities (grants and loan guarantees), national commercial banks (commercial loans) or international/development financial institutions (preferential loans and grants).

When calculating the optimal level of public support (subsidies in the form of grants), the programme analysis takes into account several contributory factors – such as lower running costs (as alternative fuels are less expensive), lower operational and maintenance costs (due to higher reliability of new vehicles) or the overall need to replace the vehicles that have been fully depreciated.

For these reasons, it is not necessary for the CPT Programme to be completely grant-financed. The programme is designed to increase investments by public transport operators in the vehicle fleet without making the replacement too profitable (or support purchases that would/could take place without public support).

In any case, applying a robust methodology – to estimate the costs of the investment programme, set the optimal level of subsidy and forecast the expected environmental benefits – can make the CPT Programme more credible for both national and international public financiers.

Currently there is no clean bus production in Moldova largely because there is no demand for new buses. As the EBRD project in Chisinau has shown (discussed in Chapter 3), when demand is created by public investments, such as the CPT Programme, this may encourage domestic vehicle production in co-operation with a bigger producer, or at least the local assembly of such vehicles.

Notes

1. Moldova's unconditional reduction target varies between 64% and 67% depending on the scenario selected – either self-sufficient power system development (the former share) or 30% import of electricity (the latter). The reduction targets have been set for the January 2021-December 2030 emission budget. The conditional target is set at 78% (GoM, 2015[3]); Box 1.1).

2. See renewable energy consumption (% of total final energy consumption) in Moldova at: https://data.worldbank.org/indicator/EG.FEC.RNEW.ZS?locations=MD; and renewable electricity output (% of total electricity output) in Moldova at: https://data.worldbank.org/indicator/EG.ELC.RNEW.ZS?locations=MD.

3. Currently there is no (clean) bus production in Moldova because there is no demand for the purchase of new buses. However, a European Bank for Reconstruction and Development (EBRD) project in Chisinau (which brought about a follow-up project for the licensed assembly of Belarusian trolleybuses) has demonstrated that creating demand through the CPT Programme may help start domestic production in co-operation with a bigger producer, or at least local assembly (see Sections 3.2.2 and 3.3.4).

4. Figures as of 1 January 2018. See NBS on resident population by cities and districts at: http://statbank.statistica.md/pxweb/pxweb/en/20%20Populatia%20si%20procesele%20demografice/20%20Populatia%20si%20procesele%20demografice__POP010/POP010300reg.px/table/tableViewLayout1/?rxid=b2ff27d7-0b96-43c9-934b-42e1a2a9a774.

5. Ibid.

6. International Council on Clean Transportation (www.theicct.org).

1. National Bureau of Statistics (www.statistica.md).

2. Given that most public transport operators would rather buy used motor vehicles, the price of a used bus served as the basis for the calculation.

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3. Economic analysis of the Clean Public Transport Programme

This chapter summarises the economic analysis conducted to assess the viability of the proposed Clean Public Transport Programme. It begins with a general overview of clean technologies and fuels in the transport sector, as well as a specific review of the energy market in Moldova. It then describes the economic aspects of purchasing and running buses, including options for the local assembly of trolleybuses as opposed to importing them. Finally, it assesses potential sources of government financing available for the programme.

Globally, the transport sector relies almost entirely on oil, with about 94% of transport fuels being petroleum products. According to prognoses, these will dominate road transport at least up to 2050 (although the exact fuel mix might vary), even in the most stringent mitigation scenario (Sims and Schaeffer, 2014[1]). There is often a time lag between when new technologies first appear in OECD countries and when they reach developing countries, which mostly import second-hand vehicles. It may take five years or longer before new technologies reach second-hand vehicle markets in large quantities.

In this context, an economic analysis was undertaken to determine the feasibility of the Clean Public Transport (CPT) Programme and its potential focus and scope. This chapter presents its findings, which include an assessment of the market for cleaner technologies and fuels, as well as the options for the domestic production and import of trolleybuses, fares for urban transport, and the available co-financing for investment projects.

For further information, Annex A to this report provides a detailed comparison of the key parameters, as well as advantages and disadvantages, of compressed natural gas (CNG)/liquefied natural gas (LNG), liquefied petroleum gas (LPG) and diesel as transport fuels, and electricity to power buses (see, for instance, Table A.3)

3.1. Overview of clean technologies and fuels in the bus transport sector

This section provides an overview of the three cleaner fossil fuel options available in Moldova:

- compressed natural gas (CNG)
- liquefied petroleum gas (LPG)
- diesel fuel Euro 5 combined with Euro 6/VI engines.

Electricity is also described as a power carrier, and can be produced by the above-mentioned cleaner fossil fuels (natural gas) or renewable energy resources (wind, solar, hydro power).

For a detailed description of each fuel type and its main features, comparative advantages and drawbacks of each technology, and its market penetration, see Annex A of this report. For example, the adoption of CNG may require additional infrastructure in some cities.

3.1.1. Compressed natural gas (CNG)

CNG is used in traditional petrol (internal-combustion-engine) automobiles that have been modified or in vehicles specially manufactured for CNG use. Although vehicles can use natural gas as either liquid (i.e. LNG) or gas (i.e. CNG), most vehicles use the gaseous form. Besides fossil gas (CNG and LNG), methane vehicles can also be fuelled with biomethane or power-to-methane (a concept that converts electric energy into chemical energy using water and carbon dioxide, also called power-to-gas).

CNG combustion produces fewer undesirable gases than other fuels and is safer in the event of a spill, because natural gas is lighter than air and disperses quickly when released.

The energy efficiency of driving on CNG is typically similar to gasoline or diesel, but with a reduction of up to 25% in tailpipe emissions (CO_2/km) because of differences in fuel carbon intensity. Lifecycle greenhouse gas (GHG) analysis suggests lower net

reductions, in the range of 10-15%, for natural gas fuel systems. This is because methane emissions are largely associated with leakage – i.e. unburnt methane leaking into the atmosphere – from the production of natural gas and the filling of CNG vehicles (in smaller amounts basically throughout the whole supply chain, ranging from 0.2% to 10% ones (T&E, 2018[2]).

In cars, the GHG savings range from -7% to +6% compared to diesel. In heavy duty vehicles (HDVs), the range is -2% to +5% compared to the best-in-class diesel trucks and depending on the fuel and engine technology. Therefore, CNG vehicles perform similarly to petrol vehicles and only slightly better than diesel ones (T&E, 2018[2]).

On the other hand, CNG vehicles require larger fuel tanks than conventional petrol-powered vehicles and the cost of fuel storage tanks is a major barrier to rapid and widespread adoption of CNG as a fuel. Denser storage can be achieved by the liquefaction of natural gas (LNG), which is successfully being used for long-haul HDVs and ships. The indicative average distance between LNG refuelling points for heavy duty vehicles is 400 km (T&E, 2018[2]).

CNG vehicles have been introduced in a wide variety of commercial applications, from light-duty (<3.5t) to medium-duty (<7.5t) and even heavy-duty (>7.5t) vehicles.

3.1.2. Liquefied petroleum gas (LPG)

Also known as propane-butane, LPG is a flammable mixture of hydrocarbon gases used as fuel in heating appliances, cooking equipment and vehicles. In some countries, LPG has been used since the 1940s as an alternative to petrol for spark ignition engines.

LPG has a lower energy density than either petrol or fuel oil, so the equivalent fuel consumption is higher by about 10%. Many governments (not including Moldova) impose less tax on LPG than on petrol or fuel oil, which helps offset the greater consumption of LPG.

LPG burns more cleanly than petrol or fuel oil – causing less wear on engines – and is especially free of the particulates present in fuel oil.

3.1.3. Diesel with Euro V/VI engines

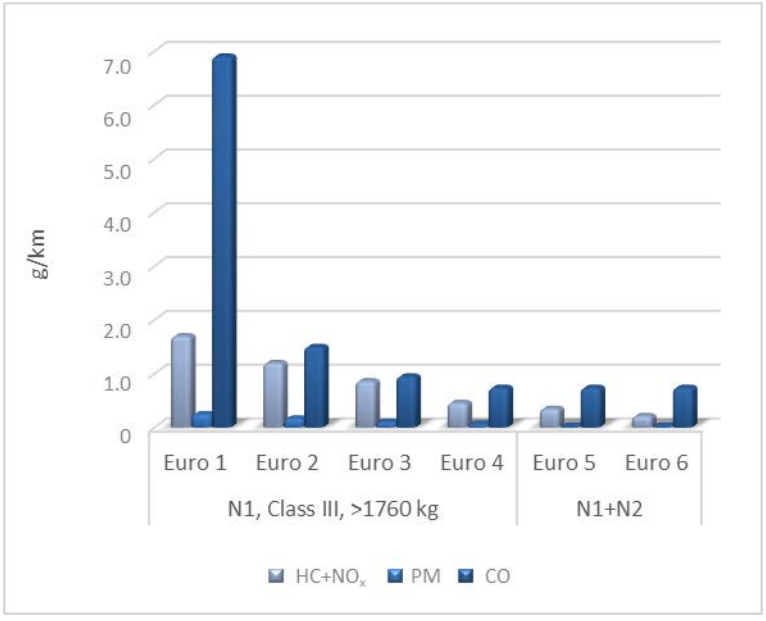
Diesel engines are one of the most common combustion engine choices for buses and other commercial vehicles globally. For the time being, buses that run on diesel and biodiesel – brought to the market mainly by blending with conventional diesel – constitute by far the largest part of the bus fleet.

A standard diesel city bus emits fewer carbon emissions per rider than cars, therefore lower emissions can be achieved by encouraging more passengers to shift to public transport (see Annex A). Since the 1990s, the Euro emission standards – that define the acceptable limits of nitrogen oxides (NO_x), total hydrocarbons (THCs), non-methane hydrocarbons (NMHCs), carbon monoxide (CO) and particulate matter (PM) – have considerably reduced pollutant emissions of new vehicles sold in the European Union (EU) and the member states of the European Economic Area (EEA).

The vast majority of Moldova's minibus fleet is composed of light and medium-duty commercial diesel vehicles. As can be deduced from Figure 3.1, in these types of vehicles, the biggest reductions in absolute terms have been achieved in CO emissions (a Euro 6 vehicle emits 6.2 grams per kilometre less than a Euro 1 vehicle), whereas in relative terms

the biggest improvement can be seen in PM emissions (reduction of 98%)[1] (see also Table A.1 and Table A.2 in Annex A to this report).

Figure 3.1. The impact of Euro standards on air pollution from light commercial diesel vehicles



Note: N1: commercial vehicle not exceeding 3.5t (light-duty truck); N2: commercial vehicle exceeding 3.5t but not 12t (truck).
Source: DieselNet (www.dieselnet.com).

On the other hand, a shift from Euro V to Euro VI engines for heavy-duty vehicles will require considerable investments by manufacturers and public transport agencies and demand a major outlay by bus manufacturers. Similar to light-duty vehicles shown in Figure 3.1, the shift to Euro VI engines will also have significant environmental impact in the form of reduced emissions of particulates from engine exhaust (in particular, as compared Euro I-IV categories).

Using biofuel blends (such as ethanol, for internal-combustion-engines, and biodiesel for spark-ignition-engines) with conventional fuels (i.e. petrol and diesel) offers large potential for further CO_2e emission reductions due to their lower fuel carbon intensity (CO_2/megajoule); however, the GHG impact assessment is rather complex.

However, as mentioned in Section 4.5.1, the support for diesel-fuelled vehicles requires strengthening regulatory measures to assure lower negative environmental impact of these vehicles.

3.1.4. Electricity

Due to current limits in battery capacity and in driving range (generally 100-200 kilometres for a small to medium-sized car), electric vehicles are at present best suited to urban and suburban driving. An urban bus can have a range of 200 kilometres per charge, but the full battery electrification of heavy-duty vehicles and long-haul bus and coach fleets is not likely to be a realistic option in the near future. On the other hand, trolleybuses are, at this point, a more viable alternative to an electrically-powered vehicle

for reducing emissions. In addition, trolleybuses can be rendered "autonomous" over portions of their route by storing electricity in add-on batteries. This is currently applied on two routes in Chisinau, including from the city centre to the airport (Vlas, 2017[3]).

3.2. Main economic variables in Moldova's public transport

3.2.1. The energy market in Moldova

This section briefly reviews the energy supply and consumption patterns in Moldova and assesses their implications for the CPT Programme. The concerns over climate change in Moldova are particularly linked to energy security. In fact, Moldova imports around 96% of its energy needs (see Section 6.4).[2] Moldova produced 5 000 tonnes of petroleum products in 2017, which was sufficient to cover just 0.5% of its gross domestic consumption of these products (NBS, 2018[4]).

Moldova primarily obtains its refined petroleum from Romania (73%), with the Russian Federation (16%), Bulgaria (4.2%), and Belarus (3.7%) being the other main suppliers. It imports all of its natural gas, with the main suppliers being the Russian Federation (54%), Romania (37%), and Kazakhstan (6.3%), and with smaller shares coming from Belarus and Bulgaria (Simoes and Hidalgo, 2011[5]).

Table 3.1 and Table 3.2 present the stocks, inputs and consumption of petroleum products and natural gas respectively in Moldova.

Table 3.1. Stocks, input and consumption of petroleum products in Moldova, 2015-17

	2015	2016	2017*
		tonnes	
Production	12 396	15 232	13 972
Import	797 730	902 785	871 288
Stock change	8 587	-718	-8 166
Export	18 518	15 176	31 085
Gross inland consumption	783 020	903 559	862 342
Refineries	6 189	8 357	17 806
Final consumption	776 831	895 202	844 536

Note: *11 months.
Source: National Bureau of Statistics (www.statistica.md).

Table 3.2. Stocks, input and consumption of natural gas in Moldova, 2015-17

	2015	2016	2017*
		thous. m^3	
Production	0	-	-
Import	1 008 519	1 020 660	881 195
Stock change	-1 025	1 569	73
Export	-	-	-
Gross inland consumption	1 009 545	1 019 091	881 122

Note: *11 months.
Source: National Bureau of Statistics (www.statistica.md).

Table 3.3 presents the retail prices for various fuels in Moldova. Natural gas prices for the end user are regulated by the national regulator – National Agency for Energy Regulation of Moldova (*Agenţia Naţională pentru Reglementare în Energetică a Republicii Moldova* – ANRE). The CNG retail prices are 40-45% lower than in Bulgaria and neighbouring Romania, whereas LPG prices are more comparable, within the 90-110% range (as of mid-2017).[3]

Table 3.3. Retail fuel prices in Moldova, 2017*

No.		Unit	Retail price, MDL (EUR)
1.	Maximum price according to ANRE for Euro 5 diesel	Litre	16.51 (~0.80)
2.	Maximum price according to ANRE for petrol 95	Litre	18.47 (~0.90)
3.	Euro 6 diesel (assumption)	Litre	16.51 (~0.80)
4.	LPG	Litre	10.60 (~0.50)
5.	CNG	Kg	8.90 (~0.43)
6.	Electricity	Kwh	2 (~0.14)

Note: *July 2017.
Source: ANRE (www.anre.md), Lukoil-Moldova (www.lukoil.md), Bemol (https://bemol.md).

3.2.2. Local trolleybus assembly

As mentioned in Section 2.2, due to the high degree of wear the CPT Programme intends to support the purchase of new vehicles (buses/minibuses and trolleybuses) rather than the modernisation of existing engines in the public transport fleet. EBRD-supported programmes in Chisinau and Balti have shown that creating demand by a public financier may encourage the launch of domestic production in co-operation with a bigger producer (or at least local assembly) as this represents a distinct purchase cost advantage over importing completed buses.

Until recently, Moldova did not have a domestic automobile industry and did not manufacture buses. The city of Chisinau, however, now assembles trolleybuses at the municipal enterprise Chisinau Electric Transport Company (*Regia Transport Electric Chişinău* – RTEC). The plan in 2018 was to assemble 20 new trolleybuses, including five buses with an autonomous (battery-powered) propulsion system.[4]

The ability to assemble trolleybuses came about as the result of an agreement in 2010 with the EBRD to support the renewal of the trolleybus fleet in Chisinau. In the end, the project was also supported by the European Investment Bank (EIB) and the European Union's (EU) Neighbourhood Investment Facility (NIF).[5] The total cost was estimated at EUR 13 million, of which EUR 5 million was to be financed by the EBRD, EUR 5 million by the EIB and EUR 3 million by the NIF as a grant (the Chisinau Public Transport Project, see Section 3.3.4 below).

The public tender was won by the Belarusian company Belcommunmash, which delivered 102 low-floor trolleybuses of the AKSM-321 model during 2010, together with maintenance stations and equipment. In 2012, as a follow-on project, the city of Chisinau supported the assembly of the AKSM-321 trolleybuses purchased from Belcommunmash in Chisinau at the municipal enterprise RTEC.[6] The parts and components to be assembled were exempted from excise and customs duties. The aim of this project was to phase out all depreciated (older than 15 years) trolleybuses by 2020. However, sufficient financing has not been secured to achieve this.

The project created more than 20 jobs and reduced the price of the trolleybuses. The reported costs of a trolleybus assembled in Chisinau are approximately EUR 135 000, representing savings of EUR 10 000 per trolleybus compared to the price of buying them already assembled from Belarus. Between 2012 and 2016, 88 new trolleybuses were assembled and put into operation. Together with the 102 vehicles delivered as part of the previous project in 2010, 190 new low-floor trolleybuses were supplied between 2010 and 2016.

RTEC reports the following benefits from the trolleybus replacement project:

- reduced average journey time thanks to the use of low-floor trolleybuses, which reduces passenger boarding time
- greater comfort (modern design and access for disabled passengers)
- greater average revenue (reported as 12% higher for the AKSM-321) compared to other models in use
- less time for technical repairs (10 times fewer breakdowns than in 2010)
- reduced maintenance costs
- reduced electricity consumption (20-30% lower than older models).[7]

After supplying Chisinau, the plan is to provide assembled buses to Tighina, Tiraspol and Balti, and then for export.

3.2.3. Domestic bus prices and fares

Other than the trolleybuses assembled in Moldova under licence, the country does not manufacture any private or commercial vehicles. Therefore, Moldova's public transport operators must purchase vehicles, either new or used, at world prices. Table 3.4 shows the prices of buses purchased in Moldova in recent years.

Table 3.4. Actual purchase price of buses, 2010-18

#	City	Year of purchase	Model of bus	Country of origin	Type of engine/motor	Price per unit, EUR thousand	Units purchased	Note
1	Chisinau	2010-2011; 2012-2016	Trolleybus AKSM-321	Belarus	Electric	135-150	10	102 (purchased); 88 (assembled)
2	Chisinau	2017	n.d.	China	Electric	200 (est.)	4	Public procurement
3	Balti	2014	Trolleybus	-	Electric	200	23	Public procurement
4	Balti	Various	20-seat	Various	Diesel	15	1-2	Purchased directly by private carrier (not a public procurement); inter-city buses. Purchased used buses (10-15 years old)
5	Cahul	Various	Minibus Mercedes-Benz, 20 seat; Etalon, 21 seats; PAZ, 28 seats	Various	Diesel	6-11	3	Public procurement; used (at least 5 years old)
6	Chisinau	Various	Mercedes-Benz Sprinter	Various	Diesel	8.5	1-2, as needed	Purchased directly by private carrier (not a public procurement); used (typically 5-10 years old)
7	Chisinau	Various	Mercedes-Benz Sprinter	Various	Diesel	1-18	1-2, as needed	Purchased directly by private carrier (not a public procurement); used (typically 7-9 years old)
8	Chisinau	Various	MAN LS 233 E3, 26 seats; MAZ 230069 E5, 28 seats	Hungary, Germany, Russia, Belarus	Diesel	250 165	As needed	Public procurement
9	Chisinau	Various	MAZ 230069 E5, 28 seats	Belarus	Diesel	165	As needed	Purchased directly by private carrier (not a public procurement); used (5-10 years old)
10	Edinet	Various	Mercedes-Benz 412, 18 seat	Germany	Diesel	8–12	As needed	Public procurement; used (typically 5-10 years old)

Source: Data collected by OECD from individual carriers.

As part of the design of the CPT Programme, average and reference prices for new and used buses were defined based on market data from actual purchases in Moldova (Table 3.4), as well as reference prices.

The following unit prices were assumed in the design of the CPT Programme:

- new trolleybus (domestically assembled): EUR 135 000/MDL 2.8 million
- new trolleybus (with "autonomous" capability), reference price (imported): EUR 255 000/MDL 5.2 million[8]
- new CNG bus, reference price (imported): EUR 255 000/MDL 5.2 million
- new LPG bus, reference price (imported): EUR 232 000/MDL 4.73 million

- new diesel Euro VI bus, reference price (imported): EUR 222 000/MDL 4.52 million
- new Euro VI minibus, reference price (imported): EUR 99 000/MDL 2.02 million
- new LPG minibus, reference price (imported): EUR 99 000/MDL 2.02 million.

The CPT Programme will not include used minibuses.

Passenger fares (solely or in combination with an operational subsidy) should be set at a level that ensures profitability for private bus operators (since these are not subsidised, unlike municipal operators). Currently, a single ride ticket is as low as USD 0.11 in both pilot cities, often combined with further discounts (see lists below). The last tariff adjustments took place in 2009 in Chisinau (for private operators even in 2007) and in 2013 in Balti.

The following fares for single rides apply in the pilot cities and can be used to estimate fare schedules in other cities (2018 figures):

Chisinau – based on Municipal Council Decision No. 8/8 of 15 September 2009[9]:

- standard trolleybus: MDL 2 (USD 0.11)
- standard diesel bus: MDL 3 (USD 0.16)
- monthly pass: MDL 180 (USD 9.73)
- reduced rate monthly pass (e.g. students): MDL 70 (USD 3.78)
- reduced rate monthly pass (e.g. socially vulnerable families): MDL 50 (USD 2.7)
- minibus: MDL 3 (USD 0.16)
- various exemptions (veterans of the Second World War and Transnistrian conflict, pensioners, police, intelligent office, members of municipal council): free.

Balti – based on Municipal Council Decision No. 2/4 of 28 March 2013:

- standard trolleybus: MDL 2 (USD 0.11)
- standard diesel bus: MDL 3 (USD 0.16)
- monthly pass for (e.g. students): MDL 100 (USD 5.4)
- reduced rate monthly pass (e.g. socially vulnerable families): MDL 70 (USD 3.78)
- minibus: MDL 3 (USD 0.16)
- various exemptions (veterans of the Second World War and Transnistrian conflict, pensioners, police, intelligent office, members of municipal council): free.

3.3. What co-financing is available for investment projects?

Large-scale investment programmes in public transport in Moldova have been financed by international financial institutions (IFIs), donors, public money, and private investment. This section reviews some of the potential financing sources for the CPT Programme.

3.3.1. The Road Fund

The Road Fund was established by Law No. 720 of 2 February 1996, in order to finance road-related activities in Moldova, including maintenance and repair of public roads. While the Road Fund **cannot be used to replace vehicle fleets**, it can be used to increase road and traffic safety. This may include accompanying measures such as dedicated bus lanes.

The Road Fund has a special designation for the repair and maintenance of national and local public roads included in the "National and Local Public Road Lists", approved by Government Decision No. 1468 of 30 December 2016. Amendments approved by Law No. 24 of 4 March 2016 allowed 50% of the road tax (paid by the owners of motor vehicles registered in Moldova) to be used to fund road repairs.

These funds can be used by the local public administrations (based on number of inhabitants in the respective territorial-administrative unit) to maintain and repair the communal roads and streets they administer (applies to both levels of local public administrations, local and *rayonal*, i.e. district).

According to the State Budget Law for 2016, No. 154 of 1 July 2016, and subsequent modifications and completions, the volume of the Road Fund was set at MDL 1 000 million (USD 54.1 million). According to the provisions of the Transport and Logistics Strategy for the years 2013-2022, approved by Government Decision No. 827 of 28 December 2013, the volume of the Road Fund in 2016 was planned to be MDL 1 650 million (USD 89.2 million) (GoM, 2013[6]). In fact, during 2016, the Road Fund was MDL 1 837 million (USD 99.4 million). In 2018, however, the Road Fund was planned for MDL 972 million (USD 52.5 million) (GoM, 2018[7]).

According to the Law on the Road Fund, the revenue sources for the Road Fund are as follows:

- excise duties on gasoline and diesel fuel (at least of 80% of total)
- road toll for vehicles not registered in Moldova
- road toll charged by vehicle owners registered in Moldova
- fees for importing old cars (older than 10 years)
- fees for using natural gas as fuel in cars
- fees for issuance of international transport authorisations
- fines for passenger transport infractions, damage to roads etc.

3.3.2. The National Ecological Fund

The Report on the Environmental Audit of Air Quality in the Republic of Moldova points out that while the National Ecological Fund was financed with a total of MDL 786.1 million (USD 42.5 million) from 2014-2016 (Table 3.5), **no projects were funded** to address air pollution Moldova (GoM, 2018[8]),.

For 2018, the fund approved projects worth in total MDL 382.8 million (USD 20.69 million), mainly in the areas of water supply and sanitation, waste management, and environmental and biodiversity protection.[10]

Table 3.5. Revenues of the National Ecological Fund, 2014-16

(MDL mln)

	2014	2015	2016	Total
Total revenues, of which	250.8	233.8	301.5	786.1
- air pollution charges from mobile sources (1%)*	32.5	25.2	15.4	73.1
- environmental pollution charges*	-	-	241.6	241.6
- transfers of 30% of environmental fines	2.8	3.6	-	6.4
- payments of imported goods (including automobiles)	215.5	205.0	-	420.5
- state budget financing	-	-	43.2	43.2
- Other payments for environmental pollution	-	-	1.3	1.3

Note: *Mobile air pollution charges are calculated as a % of the sold fuel whereas environmental (stationary) pollution charges are based on actual emissions.
Source: (GoM, 2018[8]), *Environmental Audit Report on Air Quality in the Republic of Moldova,* http://lex.justice.md/UserFiles/File/2018/mo18-26md/raport_65.doc, based on data from the Ministry of Environment of Moldova.

3.3.3. The National Regional Development Fund

The National Regional Development Fund (NRDF) is the main source of financing for Regional Development Agencies (RDAs) in implementing projects for promoting regional development (see also Section 6.1). Under law, the NRDF has a designated line in the state budget for its financing (1% of budget revenues).

The financial operations for investment projects are administrated by RDAs via territorial treasury branches; RDAs serve as secretariats to Regional Development Councils (RDCs), which themselves are advisory bodies on regional development policy. All approved projects are included in an annually updated unified (generic) programme. Road infrastructure projects do not include upgrading the vehicle fleet (Table 3.6). Therefore, this fund cannot be used to finance such projects either (see also Section 6.1).

Table 3.6. National Regional Development Fund expenditures by sector, 2013-15

No.	Sector	2013		2014		2015	
		MDL mln	%	MDL mln	%	MDL mln	%
1.	Road infrastructure	99.92	54.2	121.79	64.6	102.4	69.7
2.	Water supply and sanitation	40.15	21.8	17.2	9.0	17.9	12.2
3.	Environmental improvements*	19.13	10.4	2.4	1.3	0	0.0
4.	Tourism	22.38	12.0	22.74	12.1	9.0	6.1
5.	Business support	2.92	1.6	24.43	13.0	17.6	12.0
6.	Total	184.5	100.0	188.38	100.0	146.9	100.0

Note: *These include mainly air pollution, solid waste management and nature conservation measures
Source: (MRDC, 2016[9]), *Report on the Implementation of the National Strategy for Regional Development for 2013-2015,* http://madrm.gov.md/sites/default/files/Raport%20privind%20implementarea%20SNDR%20pentru%20anii%202013-2015.pdf.

3.3.4. International financial institutions

As discussed earlier (Section 2.2), the European Bank for Reconstruction and Development (EBRD) has been involved in financing the public transport sector in Moldova through the following projects:[11]

- **Balti Trolleybus Company** (2013-2015): Public Transport Twinning Partnership and Public Transport Modernisation Project in Balti. These projects involved the purchase of 23 new trolleybuses using a EUR 3 million loan from the EBRD to the company, under a municipal guarantee, and a EUR 1.6 million grant from the EU's Neighbourhood Investment Facility (NIF). The projects also involved support to the company to prepare a corporate development plan and to finalise a public service contract between the city and the company. No state budget funds were used to finance these projects.[12]
- **Chisinau Municipality** (2010-2013): Chisinau Public Transport Project. This project involved the purchase of up to 102 new trolleybuses (90 were delivered) using a EUR 5 million loan from the EBRD, under a municipal guarantee. The investment was co-financed by a EUR 5 million loan from the European Investment Bank (EIB) and a EUR 3 million grant from the EU's NIF. The project also involved preparing a public service contract between the city and the company. No state budget funds were used to finance these projects (TTK and Metroul, 2016[10]).[13]

3.3.5. Other types of financing

Other types of financing that could be considered are:

- **Local banks**: local banks can provide loans as part of the financing mix. Moreover, these banks can manage the project cycle as an implementation unit (see Section 4.1).
- **Loan guarantees**: the Ministry of Finance can provide loan guarantees to private and municipally-owned public transport enterprises (PTOs) and municipalities can provide loan guarantees to private PTOs.
- **Interest rate subsidies**: public money can be used to cover the difference between the interest rate a commercial bank would need to charge in order to be involved in a given project and the interest rate the borrower has the capacity to pay.

3.4. Conclusions for the CPT Programme

Given that the majority of buses – except for the new trolleybuses purchased under the EBRD projects in Chisinau and Balti – are old and diesel-powered, a support programme aimed at replacing the ageing public transport fleet is justified. The CPT Programme could build upon the previous projects in this sector and, with its programming approach, facilitate blending public and private financing. Since Chisinau and Balti already have experience with replacing the trolleybus fleet under the EBRD co-financed projects, their replacement by new models should continue.

Apart from a municipal enterprise in Chisinau that assembles Belarusian trolleybuses, there is no domestic production of buses. This assembly, however, represents a distinct purchase cost advantage over importing completed buses. The reference prices of new vehicles, as well as the socio-economic benefits linked to assembling vehicles in Moldova, provide an argument for the domestic production (assembly) of public transport vehicles as a preferred option to importing them. However, Moldova's capacity for assembling trolleybuses needs to be expanded.

The market analysis reviewed various options for replacing the public transport fleet. Our analysis shows that buses with modern diesel, CNG or LPG-powered engines are a

suitable replacement for the outdated and fully depreciated diesel models currently in operation in Moldova. New models of diesel, CNG or LPG-powered buses have lower operating costs than old diesel-powered models due to their lower maintenance costs and fuel prices.

Where CNG and LPG are not available, improved diesel fuels, such as Euro 5 and 6, offer viable alternatives. However, Moldova needs to introduce European standards for diesel fuels. Presently, the only requirement is that new buses and trucks must be Euro 0 or Euro I-compliant by 2020. It is also important to point out that diesel buses need special equipment to ensure that emission reductions are met. This equipment increases operating costs, leading some operators to dismantle the equipment. This practice should be discouraged and avoided.

Since Moldova does not have natural gas reserves, the use of electricity in transport in cities should be considered alongside the use of cleaner buses.

Given that the purchase cost of CNG and LPG-powered buses is higher than new model diesel-powered buses, the programme should provide enough assistance for the project to become profitable. This is defined as the point at which the net present value (NPV) of the investment is equal to zero from the point of view of the investing entity (see 6.5. Annex B). This approach provides an opportunity for direct assistance to the service provider (for example, in the form of a grant) together with a loan, for example from the EBRD or a local bank or banks.

The review also revealed that there are public financing mechanisms available in Moldova that could be used for funding the CPT Programme. In the past, IFIs and donors have played key roles in the modernisation of the public transport fleet in Moldova. State budget financing, either directly through the budget or from special funds – such as the National Ecological Fund – has not been used. Municipal guarantees were provided to public transport operators in order to secure their creditworthiness.

If the reviewed domestic financing sources – such as the National Ecological Fund, National Regional Development Fund and the Road Fund – cannot be used directly to provide purchase subsidies (grants) for new public transport vehicles, they could perhaps finance necessary accompanying measures (e.g. infrastructure and technical assistance).

Notes

1. See EU emission standards for passenger cars and light-duty trucks at: www.dieselnet.com/standards/eu/ld.php.

2. Moldova's energy mix is dominated by imported natural gas – supplied entirely by Gazprom from the Russian Federation and prospectively by OMV Petrol from Romania.

3. For CNG retail price development, see http://cngeurope.com; for LPG retail price development, see: www.mylpg.eu.

4. For Chisinau's municipality production plan for 2018, see www.chisinau.md/libview.php?l=ro&idc=403&id=20915&t=/Presa/Comunicate-de-presa/Asamblarea-troleibuzelor-la-Chisinau-in-anul-2018/%20.

5. European Investment Bank (www.eib.org), Neighbourhood Investment Facility (https://ec.europa.eu/europeaid/tags/neighbourhood-investment-facility-nif_en).

6. See Project "Renovation of passenger electric transport in the Republic of Moldova": www.rtec.md/116-proiect-transport-public-chiinu.html.

7. Chisinau Electric Transport Company (http://rtec.md).

8. The autonomous trolleybuses serving the airport from the city centre were imported from China and included an assembly of batteries.

9. Discussions were going on in 2018 as to whether to increase these rates.

10. National Ecological Fund of Moldova (www.madrm.gov.md/ro/content/fondul-ecologic-na%C8%9Bional; in Romanian).

11. See Aid Management Platform of the State Chancellery of the Government of Moldova: http://amp.gov.md.

12. See Project "Balti Trolleybus Company – Twinning Partnership in Public Transport": http://amp.gov.md/aim/viewActivityPreview.do~public=true~pageId=2~activityId=6094~language=ro.

13. See Project "Chisinau Urban Transport Upgrade": www.ebrd.com/news/2012/a-transport-revolution-in-the-moldovan-capital.html.

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Laws and regulations

(Listed by most recent date of adoption – all are in Romanian/Russian)

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4. Institutional arrangements and implementation barriers

This chapter proposes some institutional arrangements for managing the Clean Public Transport Programme as an investment programme. It begins by outlining good practice in setting up institutional frameworks for large environmental investment programmes. It then suggests a three-level institutional structure for managing the programme, comprising: 1) a programming entity; 2) an implementation unit; and 3) a technical support unit. The chapter suggests a possible division of responsibilities across these three entities, and describes the minimum operating regulations required to manage the programme. The chapter also reviews the barriers to implementation in the form of regulations and policy distortions, and suggests ways of addressing them.

4.1. Good practice institutional arrangements for managing public investment programmes

There are a number of different good practice institutional forms for managing public environmental expenditure. Simple expenditure programmes (e.g. financing research or education, purchasing simple equipment or standard services) may be managed directly by assigning additional responsibilities to existing government institutions at a variety of levels, using their regular staff and routine budget processes. For larger-scale, targeted programmes – in particular, programmes that involve financing capital investments, such as the Clean Public Transport (CPT) Programme – special institutional arrangements are recommended. These special arrangements may take many institutional forms and involve various types of implementing units (OECD, 2007[1]).

Deciding which form is most appropriate will generally depend on a variety of factors related to the sources of finance, the types of disbursements envisaged, and the legal and political culture of governance in a given country. Regardless of the institutional form, public environmental expenditure management should involve institutional structures and procedures that promote environmental effectiveness, embody fiscal prudence, and use financial and human resources efficiently.

Experience shows that these arrangements can take four basic forms:

1. government implementation units
2. environmental funds or a similar public finance institution
3. directed credit or a line of credit to financial intermediaries (such as banks under Option 1 – see Figure 2.9)
4. outsourcing.

Government implementation units are the most common arrangements, and include the following institutional forms:

- government departments with responsibility for procuring goods and services or financing specific projects within the state budget
- project implementation units established in a government department to implement projects within a specific government expenditure programme included in the budget
- autonomous/decentralised government units financed by the budget but created to decouple the delivery of services or administrative tasks from policy formulation.

Government implementation units mainly manage government budget resources, although project implementation units may also manage multilateral or bilateral grant resources. Regardless of the type of government implementation unit chosen, carrying a programme to completion requires capacity for project selection, implementation and monitoring. This means hiring skilled, trained personnel with a dedicated focus on the programme. Environmental programmes of EUR 50 million (USD 57 million) annually and about 200 contracts per year implemented in Central and Eastern Europe generally need staff of more than 20 people. In the case of the programme discussed in this study, given the relatively small number of contracts and homogenous types of investments required, only 5 people will be needed (see Table 2.7 and Table 2.8 for programme implementation costs).

In most instances, the institutional arrangement for large-scale (investment) programmes includes both a management (implementation) unit and a supervisory body. The

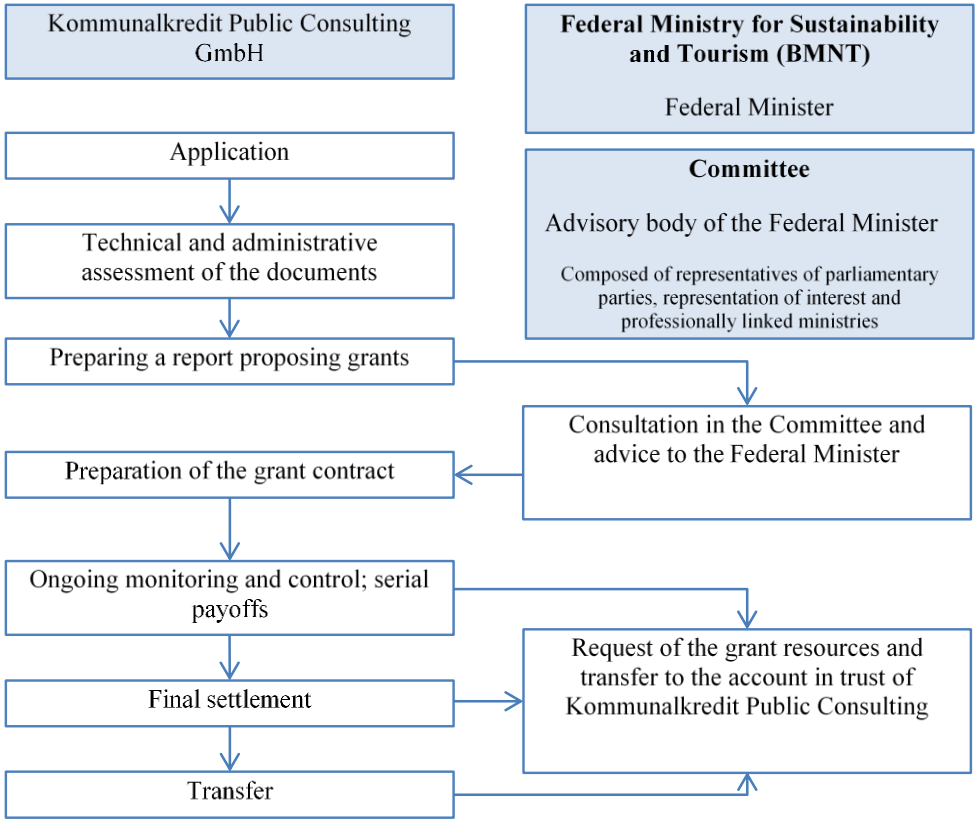
implementation unit's management and staff are responsible for the day-to-day project cycle activities (identification, selection, appraisal and monitoring of projects), development of the annual expenditure plan and budget, and monitoring and preparation of reports. The supervisory body usually focuses on taking strategic decisions, and approving internal operating procedures and rules (including eligibility and appraisal criteria to guide project selection). This division of responsibilities provides a system of checks and balances and improves the accountability of the programme. The supervisory body retains the final decision-making authority to approve financing of the individual projects recommended by the implementation unit's technical staff after the appraisal process (see Section 5.1). In the case of the CPT Programme, supervision will be performed by the programming entity (Section 4.2.1).

Outsourcing or contracting out is another option if the government department does not have the capacities to fulfil its duties as an implementation unit. This allows an implementation unit to enter into a contract with an outside supplier for the provision of goods and services typically provided internally. If this option is chosen, good practice requires that outsourcing be conducted through competitive tendering.

To take one example, since 1993 the Austrian Federal Ministry for Sustainability and Tourism (BMNT)[1] has delegated the management of the grant schemes for Austria's Environmental and Water Management Fund to a private consulting company, Kommunalkredit Public Consulting (KPC) GmbH. KPC is also responsible for the Austrian Joint Implementation (JI)/Clean Development Mechanism (CDM) programme and serves as one of the four managers of the newly established Climate and Energy Fund. KPC manages more than 3 000 projects annually. Its role is to advise the ministry during the programme development phase and on the development of support programmes, as well as to provide technical, economic and legal assessment of support and consultancy projects. KPC also advises the decision-making bodies of these institutions – the BMNT in this case – on the drafting of contracts, monitoring of project implementation and management of disbursements. Significantly, when the management of the Environmental and Water Management Fund was outsourced to KPC in 1993, its administrative costs were immediately reduced by more than half and have fallen since 2000 to only 20% of the 1993 cost.

Figure 4.1 presents the management scheme for the Austrian JI/CDM programme.

Figure 4.1. Management scheme for the Austrian Joint Implementation/Clean Development Mechanism programme



Source: Provided to the OECD by Kommunalkredit Public Consulting.

4.2. A proposed institutional set-up for the CPT Programme

In preparing any public investment programme, the public financier needs to ensure that the essential individual elements of the programme are carefully designed and in place before the programme is launched. This section summarises these elements for the green public investment programme in Moldova proposed as part of this study, and explains how and why the project team arrived at these solutions.

Effective programme implementation requires the following elements:

- stable and predictable sources of finance for the programme
- institutional arrangements to manage the programme expenditure, with sufficient resources, qualified staff and instruments to meet its objectives
- well-documented principles, rules and operating procedures for project cycle management (PCM)
- clearly defined and robust criteria for appraisal, selection and financing of investment projects
- clearly defined procurement rules.

To facilitate the implementation of this investment programme, this chapter and the next (Chapter 5) provide detailed information on the following arrangements:

- a proposal for institutional arrangements comprising three levels: 1) programming entity (PE); 2) implementation unit (IU); and 3) a technical support unit (TSU)
- a proposal for PCM procedures, including eligibility criteria, project appraisal criteria, project-ranking procedures and financing rules (Chapter 5).

The institutional set-up needs to ensure that sufficient resources are allocated to meet the programme's objectives, and that qualified staff and instruments to implement the programme are made available. In general, programming and project appraisal should be strictly separated. Programming is the responsibility of the programming entity in the government agency appointed to manage the investment programme. Project appraisal is a technical process conducted by competent technical staff recruited on a competitive merit basis and held responsible for their decisions. The implementation unit should be operationally and technically independent and shielded from political pressures by rules and procedures developed by the programme's technical staff.

Importantly, the IU and the TSU cannot be the same entity.

4.2.1. The role of the programming entity

The Ministry of Agriculture, Regional Development and Environment (MARDE)[2] is best suited to act as the programming entity. It could use its available staff and resources to undertake its programming duties, while consulting with other relevant government agencies, professional associations, local municipalities and non-government organisations, as appropriate. In addition, representatives of these bodies may be invited to sit on and have an advisory role on the programme's supervisory board.

The programming entity is responsible for designing the programme, including (adapted from (OECD, 2007[1]):

- Defining priority environmental objectives for the investment programme that are specific, measurable, realistic and time-bound.
- Developing an investment programme that responds to the overall environmental and climate-related objectives. This programme should include specific targets, cost estimates, descriptions of eligible project types and beneficiaries, terms of financing, procedures, principles and criteria of project appraisal and selection, procurement rules, programme timeframe and indicators of performance.
- Determining sources of funds and the size of the financial envelope of the investment programme.
- Selecting the best institutional arrangements for managing the investment programme – in particular, deciding whether the programme can be managed directly by existing government institutions at different levels, or whether special institutional arrangements are required.
- Selecting, contracting and monitoring the implementation unit to manage the investment programme.
- Selecting and monitoring the technical support units required to implement the programme.

4.2.2. Deciding on an implementation unit

The implementation unit (IU) is charged with drafting the programme's operating regulations, as described in Section 4.3 below. The IU needs to consult with the technical support unit(s) (see below) in drafting and using its operating regulations. Because programming is a political process, it is important that the responsibilities for programming and project cycle management are separate and distinct, with the IU managing the project cycle. The IU conducts marketing activities for the programme, identifies beneficiaries and appraises beneficiaries' project proposals for eligibility. It would also provide MARDE with information on the planned number of beneficiaries and programme financial needs. The IU would report to MARDE on programme expenditure so that MARDE can monitor the budget implementation for a given year (or programming cycle) and project type (project "baskets").

The role of IU could be fulfilled by a local bank or banks selected through public tender, and which would sign a co-operation agreement with MARDE. The newly established Environmental Protection Agency is another potential IU (though at the time of writing it was only at the concept stage).

4.2.3. Appointing a technical support unit

The technical support unit (TSU) would give specialised assistance, advice and expertise in the areas of energy and fuel efficiency, compressed natural gas (CNG), liquefied petroleum gas (LPG), modern diesel buses/trolleybuses, and air pollution and greenhouse gas (GHG) emission reductions. The National Agency of Road Transport (*Agenția Națională Transport Auto* – ANTA)[3] under the Ministry of Economy and Infrastructure (formerly, Ministry of Transport and Roads Infrastructure) – could play this role. Other TSUs may be defined as deemed necessary and prudent.

4.3. Fundamental operating regulations

The effective implementation of the programme requires that the implementation unit (IU) define and publicise its operational rules and regulations. At a minimum, the core elements of such rules should include:

- definitions
- general provisions
- definition of eligible projects
- rules for awarding grants
- rules for modifying or terminating a grant contract
- procedures for programme review.

The grant agreement with the beneficiary should include the following terms and conditions:

- amount of grant award (as an absolute value or as a share of total project investment cost)

- start and end dates of the project to be financed, as well as planned environmental effects
- date on which the grant, or its instalments, will be transferred to the recipient
- rights of the IU to control the awarded grant, as well as the method of recovering the grant if the project fails to meet its stated objectives
- grantees' specific obligations arising under the contract with the programme IU
- conditions under which the contract loses its force
- consequences of contract dissolution.

Typically, the maximum grant for a project should not exceed 50% of the funds earmarked for that type of project in the IU's annual financial plan. This is to leverage resources from other sources and ensure the commitment of the recipients to implementing the project using their own resources.[4]

Given the nature of investments to be financed under the CPT programme, it is proposed that the programme should be financed by the state budget within the medium-term expenditure framework (MTEF) process. Financial support should be provided in the form of grants and bank guarantees (see Section 2.3.3).

There are other procedural rules that need to be considered. For example:

- The grant may be transferred to the applicant all at once or in instalments (tranches).
- A portion of the grant may be transferred in advance (up to 20% of the total value of the project), if project start up is impossible without advance funding.
- The recipient of a grant advance should be required to return to the IU any interest resulting from holding the grant in its bank account (or the amount may be deducted from future tranches).
- The dates for making grant transfers are determined by the IU based on funds at its disposal and upon consideration of an applicant's proposal, as presented in the application.
- Financial resources from the grant are transferred exclusively for the purpose of meeting the payments required by the grantee. The recipient should allow the IU full access to original invoices prepared by contractors or suppliers.

The OECD *Handbook for Appraisal of Environmental Projects Financed from Public Funds* includes a detailed discussion of all the rules that need to be considered in defining the procedures for the programme IU. It could be useful in further defining procedural rules for the CPT programme (OECD, 2007[1]).

4.4. Promoting the programme

Promotion is essential for the success of the programme and is the responsibility of the IU. The promotion package might include the following elements:

- sending programme information to local administrations and potential beneficiaries
- distributing programme rules to local administrations and potential beneficiaries

- maintaining the IU's website with information on rules for awarding grants and application forms
- issuing press releases.

The costs of programme promotion should be included in the programme costs envelope.

4.5. Eliminating policy distortions

Various regulatory barriers may complicate the implementation of even a well-designed investment programme. It is important that before a programme is developed and financed, the Government of Moldova reviews the relevant regulatory basis and eliminates any barriers to the extent possible. Combining such regulatory improvements with financial support from the state is more likely to lead to the modernisation of the bus fleet in Moldova and result in significant reductions in air pollution and GHG emissions.

One of the biggest obstacles for an investment programme in the public transport sector in Moldova is the very limited creditworthiness of bus operators. There are several reasons for this, including weak pricing signals for new technologies and fuels (which ultimately favour the old type of buses), a fare system for urban public transport that does not allow for covering the capital cost of new buses, and a tender system that favours short-term contracts and makes it difficult to invest in a new bus fleet.

These distorted policies explain why the bus operator market is fragmented and dominated by small companies that lack creditworthiness and that are not attractive to international financial institutions (IFIs), such as the European Bank for Reconstruction and Development (EBRD). Eliminating these barriers is key for the success of the programme; however, not all of them have to be addressed at the same time and some are interchangeable. For example, a better fare system and long-term contracts will help to increase creditworthiness, but this can also be achieved through loan guarantees or a higher level of public support provided by the CPT Programme.

Some of the key actions needed to remove implementation barriers are presented below.

4.5.1. Strengthen technical regulations in transport

Many of the policy and regulatory barriers identified by this study are comparable to challenges experienced in other countries. To ensure the programme's successful implementation, the government will need to:

- **Strengthen (diesel) engine emission norms and bring them closer to European standards.** Moldova has still not adopted modern emission norms for passenger cars and heavy-duty truck and bus engines. The equivalent of the Euro IV emission standard, introduced in the European Union (EU) in 2005, has not yet been adopted in Moldova (see Chapter 3 and Annex B). In 2014, the European Commission (EC) adopted Euro 6/VI vehicle emission standards (see Table B.16 and Table B.17 in Annex B). Moldova has only introduced requirements for buses and coaches to meet Euro I norms starting on 1 January 2020. However, the Programme on Promotion of Green Economy in the Republic of Moldova for 2018-2020 suggests a restriction on the movement of all vehicles older than 15 years and a ban on importing vehicles older than seven years and below Euro 5 standard (GoM, 2018[2]).

- **Strengthen (diesel) fuel standards.** Latest diesel engine emission norms cannot be introduced if the available fuel does not meet certain standards. Modern engines include equipment sensitive to low-quality fuel, and sulphur dioxide (SO_2) emissions directly depend on the fuel's sulphur content. Although diesel fuel available in Moldova meets Euro 5 standards (and seems to be sufficient for a country-wide fleet upgrade), the legal requirements are based on post-Soviet standards that are incompatible with the EU standards (see Section 1.1).
- **Strengthen technical inspection standards.** Although buses and minibuses in Moldova must pass technical inspections, these inspections are not strict on emissions. Technical inspections have become a mere formality, with the fault detection rate range between 4 and 8% in 2013-17, compared to 30-40% for cars older than nine years in Germany or Great Britain. In Moldova, however, more than 50% of registered vehicles are over 20 years old (Ghiletchi, 2018[3]).[5] The weak inspection system means that public transport operators have no incentive to comply with emissions standards. The existing standards for technical inspection need to be better enforced.

4.5.2. Introduce adequate financial and pricing signals

Regardless of how the CPT Programme is co-financed, their limited creditworthiness means that bus owners will need to use loans or leasing for their co-financing. Cities – which are also owners of the public transport fleet (i.e. Chisinau and Balti) – have already been financing bus purchases by loans and their creditworthiness is limited. One solution is for the CPT Programme to provide bank guarantees (Chapter 2).

The analysis showed that the average price of CNG and LPG fuels is much lower than the average price of petrol and diesel (Chapter 3), which are also subject to an additional excise tax (see Section 7.1.6). Given that there are significant efficiency gains to be realised from replacing ageing and inefficient diesel and electricity-powered vehicles, the programme should provide financial incentives to attract investment into the sector.[6]

Although CNG and LPG fuels are cheaper than diesel, CNG and LPG-fuelled buses are more expensive (as they require the installation of additional equipment). Bus operators have not been given clear signals to shift to cleaner fuels (either from renewable resources or cleaner fossil fuels). The government could thus consider introducing targeted tax exemptions (including value added tax and import duties) for CNG/LPG vehicles and for owners of refuelling stations.

The experience of EU countries shows that the uptake of fossil gases in transport is highest in countries with the lowest tax rates, i.e. where CNG or LPG enjoy tax rates below the EU minimum. In some countries (such as Italy) this can make them half the price of diesel. This support has continued despite the declining EU domestic fossil gas production and increasing dependence – similar to Moldova – on energy imports from Russia[7] (T&E, 2018[4]).

The Government of Moldova has already acquired considerable experience with such fiscal instruments.[8] The Programme on Promotion of Green Economy in the Republic of Moldova for 2018-2020 foresees the use of tax incentives for importing electric and hybrid motor vehicles, as well as the development of national infrastructure for electric cars (GoM, 2018[2]). Until critical mass is achieved (for the system to become profitable), such fiscal measures could complement state support mechanisms such as grants, loans or loan guarantees.

4.5.3. Adjust the fare system for urban public transport

Fares should be aligned with good international practices and designed to maximise the social welfare of both passengers and public transport providers (subject to budget and capacity constraints).

The benefit for public transport service providers can be defined as revenues minus costs. The benefit for the user of such services can be expressed as the generalised price citizens are willing to pay before switching to non-public transport alternatives, minus the actual generalised price of the ticket. To some extent, the producer's benefit and user's benefit may be negatively correlated.

Given the economic and financial situation of public transport providers in Moldova, the focus should be on the providers' benefit. The users' benefit should be minimised as much as possible (possibly close to zero).

Apart from single fares, subscription fares could also be considered. This option is usually favoured by passengers who do not own a car and are therefore less price sensitive. On the other hand, in developing countries, people who do not own a car usually belong to lower income groups than in the developed world.[9]

In the case of Moldova, almost all public transport operators are private – with the exception of three municipal operators (one in Balti for buses and trolleybuses and two in Chisinau, separately for buses and trolleybuses). Private operators work for profit, and passenger fares need to cover capital and operating costs. At the same time, fares for public transport are low in Moldova (see below). Consequently, the quality of service provided by private operators is rather low, with operators using very old buses to allow them to minimise capital costs (and depreciation).

Given that the CPT Programme may be financed via loans or with the use of bank guarantees, a fare increase is obviously needed (Box 4.1). The current single-journey fares of MDL 2 (USD 0.11) for a bus/trolleybus and MDL 3 (USD 0.16) for a minibus are extremely low (see Section 3.2.3). They do not guarantee that fleet operators can repay their loans (according to information from private entrepreneurs in public transport, 70% of the revenues cover only operation and maintenance costs). Thus, if fares are kept at their current level, the programme and the public budget will be exposed to default by operators and will have to consume the guarantee, which implies significant costs for the programme.

Box 4.1. Sensitivity analysis

An increase in transport fares could theoretically be used to co-finance the CPT Programme. Conducting a sensitivity analysis on how many new buses/trolleybuses could be bought by increasing single-journey fares by MDL 2 (USD 0.11), for example, could be very informative. Generally, the sensitivity analysis should take into account the fact that an increase in the price of tickets may discourage people from using public transport and may make them switch to using private cars, resulting in higher levels of air pollution. In economic language, public transport fare increases lead to an exposure-response relationship with a high price elasticity of demand – i.e., a price increase leads to a decrease in demand for a given service. The analysis also depends on local circumstances, including the length of routes and the number of passengers. All these issues make conducting a sensitivity analysis a rather complex exercise which should be carried out as part of a separate study as it requires significant additional data collection and discussion with the government and municipal authorities.

4.5.4. Change public tenders for providing public transport in urban centres

Public transport is provided by city-owned and private operators under short-term contracts (one to three years). This approach encourages a short-term perspective and encourages operators to minimise their outlays and to make quick a return on their investment. As a result, private operators tend to favour cheaper, older and thus more polluting minibuses.

Using medium to long-term contracts (at least 10 years) would encourage operators to invest in a modern minibus fleet, especially when backed up by an adjusted fare system, regulatory improvements and financial support from the state.

The review of the urban public transport system as part of this study (see Section 6.2) showed that there are 32 service providers operating urban public transport in Chisinau and Balti; 29 of them are private entities, while the other 3 are municipally-owned companies. In 2016, private entrepreneurs transported 36% of all passengers using public transport (see Figure 6.6). This indicates that most of the programme financing needs will have to be tailored to the private sector, or at least to public-private partnerships (PPP).

4.5.5. Encourage (energy) efficiency in public transport

Public transport in Moldova is dominated by minibuses, which are generally less energy-efficient (in terms of megajoule/passenger-km) than regular buses. However, currently regular buses service only a small number of urban and inter-city routes in Moldova.

The plan to reduce the number of operators and provide larger buses in the urban centres (which can carry up to five times more passengers) – outlined in the Promotion of Green Economy in the Republic of Moldova for 2018-2020 (see Section 1.3) (GoM, 2018[2]) – is not clearly communicated to all stakeholders (including information on possible future routes, transport means used, number of buses needed, number of buses provided by city-owned operators, etc.).

It does not make economic sense to invest in public transport if streets are congested with traffic. More specifically, if there were more single-journey fares than subscription tickets

sold in Moldova, it would not be financially viable for public transport operators. The Programme on Promotion of Green Economy in the Republic of Moldova for 2018-2020 suggests regulating the entry of motor vehicles into cities and in the centre of cities to reduce traffic jams and air pollution.

Journey time (and related fuel) savings can be further achieved by increasing efficiency in the operation of public transport. For example, dedicated bus lanes could reduce the need to use inefficient mechanical braking. In Moldova, this is primarily applicable to Chisinau and Balti (for example trolleybus lanes are often blocked by waiting or even parked cars). Eco-driving – a driving awareness technique that can reduce fuel consumption – could be taught to trainee bus drivers.

A recent initiative is the introduction of an "autonomous" trolleybus line (which can operate independently from the power network for short periods/distances) from the Chisinau city centre to the Chisinau International Airport in the summer of 2017. While the airport bus service has attracted the biggest attention – as the airport transfer had been provided solely by minibuses before – the city has also introduced another wireless trolleybus route from the Vatra suburb to the city centre (Vlas, 2017[5]). The fare remains the same as for all buses and trolleybuses, i.e. MDL 2 per person (USD 0.11) and ride (without transfer).

4.6. Conclusions for the CPT Programme

While there are several possible institutional set-ups for managing the programme, the optimal institutional set-up should be selected only after all elements of the programme are clarified and consensus has been reached on its priorities.

Regardless of the type of institutional set-up, the programme management should involve an institutional structure and procedures that promote environmental effectiveness, embody fiscal prudence, and use financial and human resources efficiently. Subsequently, the government needs to ensure that resources, qualified staff and instruments are sufficient to implement the programme.

Not least, it is advisable for larger (investment) programmes – such as the CPT Programme – to also appoint a supervisory body to adopt strategic documents and undertake strategic decisions, as well as oversee the implementation capacity of the management in terms of project selection, implementation and (EU, 2009[6]) monitoring (project cycle management).

Importantly, both the management and the supervisory body should be protected from political pressures by adopting operating rules and procedures. The Government of Moldova should also aim to eliminate the policy and regulatory barriers that could hamper the implementation of the CPT Programme. A reflection on other countries' experience could provide an indicative checklist of measures and approaches to tackle these problems.

Increases to fares, coupled with the introduction of separate bus lanes and smart traffic lights, could improve the overall management of the public road transport sector in Moldova.

Notes

1. Known as the Federal Ministry of Agriculture, Forestry, Environment and Water Management (BMLFUW) until January 2018. Its website is at www.bmnt.gv.at.

2. Ministry of Agriculture, Regional Development and Environment of Moldova (www.madrm.gov.md).

3. National Agency of Road Transport (https://anta.gov.md).

4. Given the nature of the projects to be financed, the grant should be determined at a level at which the net present value (NPV) for the project is equal to zero (see Section 3.4 and Annex B).

5. A new regulation on periodical technical inspections conforming to requirements imposed by the Association Agreement with the EU (Directive 2009/40/EC) is still in the inter-ministerial co-ordination process (EU, 2009[6]). This would, among other things, prohibit the removal of the diesel particulate filter (DPF). See also: http://autoblog.md/moldova-vrea-sa-treaca-la-normele-de-poluare-europene-masinile-vor-fi-verificate-cat-de-mult-polueaza-mediul (in Romanian).

6. Unlike these (cleaner) fossil fuels, electricity-powered vehicles have the advantage of cheap electricity (OECD, 2018[7]).

7. In 2016, the EU imported 86.7% of its petroleum products and 70.4% of its natural gas, so its energy dependence on natural gas is not significantly smaller than on oil, especially given the larger share of natural gas imports coming from Russia (39.9%) than oil (31.6%) (EC, 2018[8]).

8. Unlike in the other EU Eastern Partnership (EaP) countries, most of the government support (especially in energy sector) in Moldova is a result of reduced taxes and tax exemptions (OECD, 2018[7]).

9. Usually, a single or monthly ticket fare system is considered more operator-friendly, and a distance-dependent fare system more customer-oriented (and more technically demanding for the operator). A single or monthly ticket fare system is generally more attractive for passengers travelling longer distances, and a distance-dependent fare system more attractive for passengers travelling shorter distances. Finally, with a distance-dependent fare system, the operator can gather information both on the number of trips per route over a defined period and the average length of the route that a passenger travels in a given period. This information may be useful for making better management decisions.

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5. Proposed procedures for project cycle management

This chapter presents an overview of the project cycle management procedures developed for each project pipeline identified as part of this green public investment programme. Essentially, the implementation unit should ensure that the programme is executed in accordance with the adopted procedures. A well-designed process – which is a responsibility of the programming entity – should guarantee that only eligible projects compete for public support and that the most cost-effective ones are selected for financing and implementation.

Project cycle management (PCM) comprises several distinct stages: 1) identifying and assessing projects for eligibility; 2) preparing programmes; 3) project development; 4) financing projects; 5) implementing projects; and 6) controlling and monitoring project impacts. Each of these stages is detailed in the sections below.

5.1. Identifying, assessing, and developing projects

The first step in the PCM process is to identify eligible projects that respond to the strategic and specific objectives of the national environmental/climate and energy policy, as well as the objectives defined in the CPT Programme. Eligible projects would involve the following activities:

- Replacing buses used for public urban (Phase 1), suburban (Phase 2, Scenario 1) and also inter-city transport (Phase 2, Scenario 2) with environmentally acceptable models equipped with diesel, CNG or LPG or electricity-powered engines.
- Investing in support activities (studies, construction of CNG filling stations, establishment of a maintenance workshop for new buses, and additional investments that improve public transport services) relevant to the bus replacements in the three pipelines (CNG/LPG, diesel, electric).

Only investment projects (i.e. those involving capital outlays) are eligible for financing under this programme. The list of eligible projects will be reviewed on an annual basis by the implementation unit to ensure that the list still meets national environmental/climate and energy policy objectives.

Another crucial step defines the manner in which projects are developed. Under Option 1, the banks will actively promote the CPT Programme by distributing information about it. Under Option 2, promotion will be done by the implementation unit. This will involve publishing leaflets that can be distributed to potential beneficiaries, which define eligible projects and eligible beneficiaries, eligibility criteria, and the type of financing.

5.1.1. Project eligibility criteria

Clearly specifying the eligibility criteria (in terms of project types, beneficiaries and project costs that will be supported by the programme) and setting robust project appraisal criteria will make the implementation of the programme more transparent and efficient. It will also make the programme credible for financiers – be they public or private, local or foreign.

This section lists and describes the minimum eligibility criteria. These are "knock-out criteria", i.e. failure to meet even one of these criteria at this stage results in rejection of the project (though the option of re-designing the project proposal could be considered). Projects that pass the eligibility assessment but lack sufficient information can be returned to the applicant with a request for clarification. Annex D contains a template of an eligibility evaluation form that could be adapted for project screening.

The criteria include the types of eligible **projects**, eligible **costs** and eligible **beneficiaries** (project owners) for screening individual projects that apply for public support. The purpose of eligibility criteria is to conduct an initial and simple assessment of those projects that appear to address all the objectives related to the CPT Programme and that can potentially qualify for financing.

The following eligibility criteria could be used in screening projects (detailed lists should be prepared by MARDE before the programme launch):

1. Location of the project: limited to urban centres and suburban areas (for Scenario 1) and inter-city connections (for Scenario 2).
2. Criteria related to the types of eligible projects:
    a. the project type should be identified in the list of eligible projects
    b. all proposed costs of the project should be possible to identify in the list of eligible costs
    c. replacement of public transport vehicles that are more than 10 years old and equipped with below Euro V engines.
3. Criteria related to the types of eligible beneficiaries. The following bodies would be eligible to receive support from the Clean Public Transport (CPT) Programme:
    - private public transport operators that currently provide services in eligible urban centres (Phase 1) and suburban areas of the pilot cities (Phase 2, Scenario 1), or inter-city connections (Phase 2, Scenario 2; see Section 2.2)
    - municipal public transport operators that currently provide services in eligible urban centres (Phase 1) and suburban areas of the pilot cities (Phase 2, Scenario 1)
    - administrations of pilot cities (for preparing necessary studies and support investments).
4. Other eligibility criteria: existing city plans for additional (support) investments to improve the city's urban public transport system.

If a project does not meet the eligibility criteria (i.e. if it receives a "no" response to any of the questions in the eligibility assessment), it is rejected and a written explanation is sent to the applicant. The project may be re-evaluated upon modification and re-submission of the proposal.

Under Option 1, the banks will select employees to review and evaluate projects and the implementation unit will also select/assign employees. The employees must gain a minimum understanding of the programme by participating in training run by MARDE. After the training, bank employees are expected to be able to conduct project evaluation and decide if a project meets the CPT Programme objectives and complies with the eligibility criteria.

A list of eligible vehicle models on the market could be prepared in order to simplify the procedure and eligibility evaluation by banks. The list could be updated in the future when new models become available on the market.

If the type of vehicle that is proposed for purchase is on the list of approved means of transport, the bank continues to work on the project without contacting MARDE. If the vehicle is not on the list, the project documents, especially technical specification (which shall be submitted by the applicant, bus producer or importer on request) of the vehicle is sent to MARDE (i.e. the implementation unit) for evaluation (with assistance, if need be, from the technical support unit).

MARDE evaluates whether the proposed vehicle meets the objectives of the programme. If it is found to comply, it is added to the list. If not, MARDE informs the bank that it has

been rejected. In this case the applicant is informed and the project may be re-evaluated upon the applicant's agreement to consider a different type of vehicle.

For those projects that have passed the eligibility assessment (i.e. those projects that have received a "yes" response to **all** questions on the eligibility criteria list), a further creditworthiness screening is performed according to the bank's procedures.

5.1.2. Project appraisal criteria

A project that meets the eligibility criteria then needs to be appraised to assess if it is worth funding. The appraisal is also done on the basis of clearly specified and rigorous criteria. These allow programme managers to compare, rank and select the most cost-effective projects for financing. When these criteria are applied uniformly across all (similar) projects, they can also help reduce management bias in selecting individual projects for financing.

Experience shows that a well-designed appraisal system is fundamental for selecting the most cost-effective investment projects for financing through public resources. However, Option 1 in this programme – involving financing through commercial loans (see Figure 2.9) – assumes that all the projects that meet basic eligibility criteria are accepted (especially if the project selection process is done by banks with no expertise in the public transport sector and which have not received targeted training, e.g. through public authorities).

Under Option 2 – where operators themselves provide the financing, coupled with a public grant (see Figure 2.10) – all projects that pass through the eligibility screening should be appraised and ranked according to the appraisal and ranking criteria listed below, and scored using an evaluation table (see Annex E). Projects with the highest scores would provide the biggest contribution to the CPT Programme objectives and therefore should be the first to be selected for co-financing. They are then contacted by the bank in writing to inform them that their project has been selected for financing. The process of selecting projects for financing and implementation ends when the budget allocated to the type of projects or the CPT Programme as a whole (whichever comes first) is exhausted for the given time period.

The following appraisal criteria are proposed:

1. Project preparation:
    a. prepared business plan or strategic plan for implementation of the clean public transport in the city.
2. Project location:
    a. buses that will be replaced operate in polluted districts of the cities (list of polluted districts)
    b. buses that will be replaced run only in the centre of the eligible city
    c. buses that will be replaced run in the city centre and on the outskirts/suburbs of the eligible city
    d. buses that will be replaced run in the city and in connecting rural areas outside the eligible city.
3. Project type:

   a. buses have higher priority than minibuses
   b. compressed natural gas (CNG) buses are assigned higher priority than liquefied petroleum gas (LPG) buses
   c. modern diesel buses are assigned the lowest priority.
4. Project size:
   a. replacement of more than 20 buses
   b. replacement of between 10 and 20 buses
   c. replacement of fewer than 10 buses.[1]
5. Proposed system of improvements of the urban public transport system in the city:
   a. length of new bus lanes
   b. number of traffic lights with priority for public transport
   c. number of bus stops newly equipped with online information for passengers
   d. number of new bus stops.
6. Environmental efficiency: cost per reduction of a unit of particulate matter – PM2.5.

For the implementation of the pilot phase in Chisinau and Balti, it is recommended that the selection procedure is based on negotiations between the city administration and potential beneficiaries (public and private operators of the public transport system). The Ministry of Agriculture, Regional Development and Environment (MARDE), in co-operation with the Ministry of Economy and Infrastructure, being responsible for overall oversight of the programme, should give clear directions to local administrations, in particular on:

- the amount of funds allocated for the pilot phase for each city
- the maximum share of co-financing from public funds
- the criteria that pilot projects should meet in order to be eligible for financing (see Section 5.1.1 and Annex D to this report)

5.2. Preparing programmes

The programme preparations under Option 1 (see Figure 2.9) will consist of negotiations with banks, signing agreements and designing procedures and forms that will be used by the banks. Under Option 2 (see Figure 2.10), programme preparations will consist of preparing internal procedures, forms and instructions for successful applicants and beneficiaries (either by MARDE or the IU).

Signing the agreement with banks under Option 1 should be based on negotiations that cover the following criteria. The bank's selection process could be organised in the form of a tender which meets these criteria:

- accessible for beneficiaries (e.g. branch offices in cities where the CPT Programme is implemented)
- previous experience working with small and medium-sized enterprises (SMEs)

- previous experience financing the transport sector
- previous experience working with IFIs
- previous experience offering loans in foreign currency
- low interest rate margin and bank fees
- clear terms of the loans for SMEs, especially loan repayment period
- availability of different forms of programme financing, e.g. loans and leasing
- flexibility and low costs of loan collateral.

In addition, the loan agreement should oblige the banks to:

- market the programme to potential beneficiaries
- identify, assess and select eligible projects and beneficiaries, prepare and sign loans according to the programme and conduct project verification
- ensure operations comply with the programme, especially applying the procedures and criteria established by MARDE on selecting beneficiaries and their projects
- report on financial and physical implementation to MARDE and the Ministry of Finance (MoF) on a regular basis (every three months)
- report the forecasted financial involvement in the next reporting period.

5.3. Financing projects

Once the priority projects have been selected for financing, the proposed financing scheme for the project needs to be designed. This involves determining the size of the grant required for the project to be viable.

When the proposed financing schedule has been defined, the bank invites the applicant to negotiations and to sign the loan contract. The contract should detail the rights and responsibilities of each party to the agreement, measures to be taken in the event of the beneficiary's non-compliance with the terms and conditions of the contract, as well as a disbursement schedule for financial support.

During project implementation, paying contractors is an important practical issue. Two schemes for settling payments with contractors are suggested:

- Scheme 1: The bank transfers the funds to the beneficiary (i.e. public transport operator), who pays the contractor/supplier (of public transport vehicles) upon invoicing.
- Scheme 2: The bank agrees the amount of financing with the beneficiary, but pays the contractor/supplier directly, upon presentation of a copy of the invoice.

Under Scheme 1, at the end of the agreed time period (for example monthly), MARDE receives from the bank the list of supported beneficiaries, the number and types of purchased motor vehicles, the cost of the purchase and information on the amount of the loan that was provided to beneficiaries. Based on this information, MARDE pays to the bank the grant portion (calculated as a fixed percentage of the purchase cost). In general,

Scheme 1 is more widely used than Scheme 2 (which has benefits under special circumstances, such as lack of trust).

After receiving the payment from MARDE, the bank reduces the capital of the respective loan and informs the beneficiary about the grant that was received together with the new loan repayment schedule that takes into account the lower capital to be repaid.

Under Scheme 2, the implementation unit pays the grant individually for each beneficiary.

These two schemes are schematically presented in Figure 5.1 and Figure 5.2 for Option 1 (see Figure 2.9). In case of Option 2 (see Figure 2.10), this schematic is similar but no banks/loans are involved. In both options, if the bus supplier has not already been selected, the beneficiary initiates a tender procedure (in accordance with the public procurement law, if the purchases of this beneficiary fall under this law).

Public support is transferred to the beneficiary, who organises a tender to select a contractor, the contractor is paid upon delivery of service and submission of invoice (Figure 5.1).

Figure 5.1. Payment Scheme 1: Beneficiary receives public funds

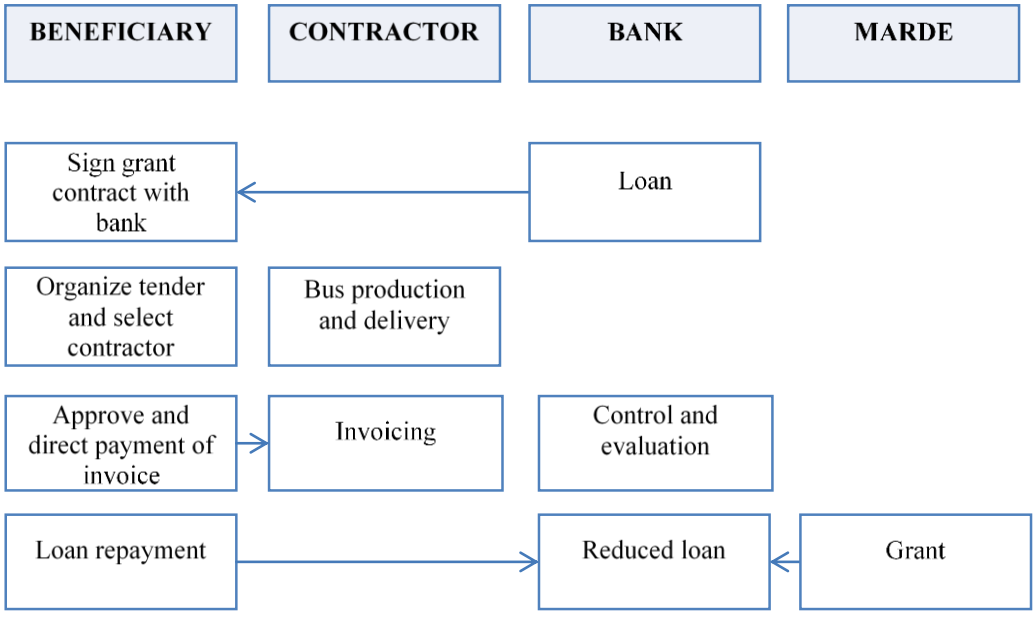
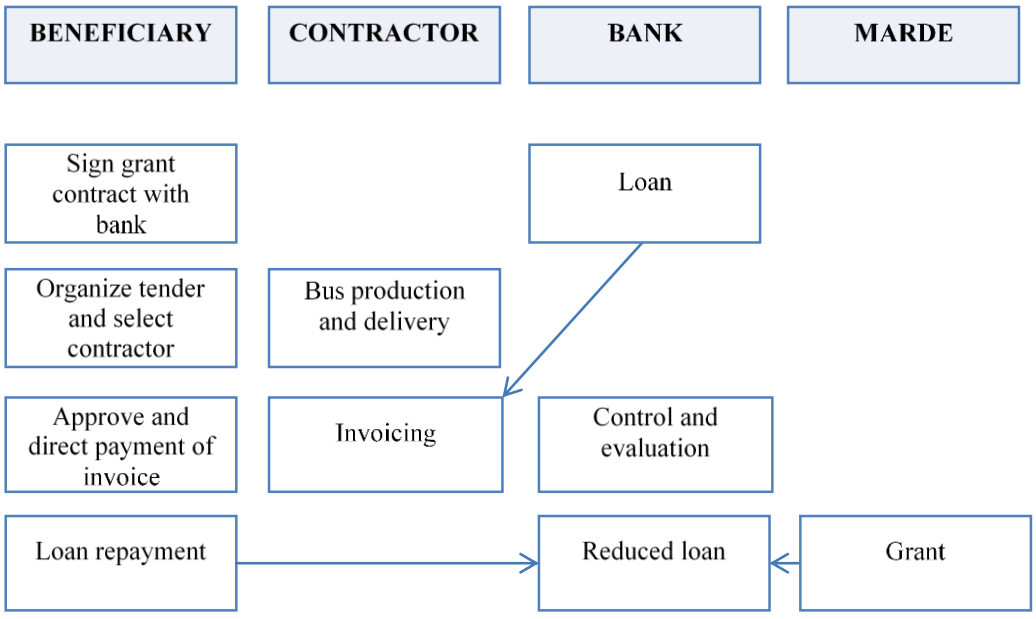


Figure 5.2. Payment Scheme 2: Contractor is paid directly



It is important to highlight once again (see Section 2.4) that the rate of financial assistance (subsidy rate) should be set to ensure that it does not replace, but instead leverages, the beneficiary's spending. Thus, public resources should be seen as a last resort for covering financing gaps in green priority projects (following the principle of additionality). For this reason, the level of the subsidy should be kept at the absolute minimum. This optimal minimum can be defined as the rate of assistance that makes environmentally and economically important projects financially viable.

5.4. Controlling and monitoring project impacts

Once implementation has commenced, the bank (under Option 1) or other IU (under Option 2), as per the contract with the beneficiary, maintains the right to monitor and inspect the implementation of the project. This can include:

- comparing actual with planned results in physical terms (e.g. number of buses, type of buses, etc.)
- determining whether buses are being used for providing public transport in urban/suburban centres
- monitoring the implementation of accompanying investments (e.g. dedicated bus lanes, improved bus stations).

5.4.1. Performance indicators

The following performance indicators could be used by the institution managing the expenditure programme:

- number of buses replaced, 15 years or older, including minibuses

- number of buses replaced, 10 years or older, including minibuses
- number of LPG-fuelled buses replacing outdated buses
- number of CNG-fuelled buses replacing outdated buses
- number of new trolleybuses
- number of model diesel-fuelled (Euro V or better) buses replacing outdated buses
- kilometres of dedicated bus lanes
- tonnes of carbon dioxide (CO_2) reduced per year
- tonnes of particulate matter – PM10 – reduced per year
- tonnes of particulate matter – PM2.5 – reduced per year.

5.4.2. Impact assessment

In contrast to the control and monitoring procedures during project implementation described above, control and monitoring post-implementation (*ex-post* evaluation) involve determining whether the project has met its stated objectives. This is the primary responsibility of the bank (under Option 1) or other IU (under Option 2), which reports the results to MARDE (manager of the CPT Programme).

Since direct and immediate measurement of project outcomes in terms of air pollution reduction and fuel consumption is very difficult, it is proposed that only the physical outcomes of the project should be monitored, namely:

- the number of buses by engine type and whether buses are used to provide public transport services in urban centres
- verification that emission reduction equipment remains installed in diesel engines
- implementation of accompanying investments.

If the objectives have not been met, the beneficiary may have to return a part or all of the financial support provided under the programme. The contract must clearly cover such a possibility.

5.4.3. Maintaining a database of project and programme impacts

A final element of PCM is creating and maintaining a database of project and programme impacts. MARDE should determine the best format for the database, such as an Excel-based system or a database software. The following parameters need to be included and maintained in the database:

Programme:

- expenditures by year for each type of project
- actual expenditures compared to those budgeted
- calculated emission reductions by year.

Projects:

- number of projects by type, by year

- physical outcomes by year: number of buses by engine type
- calculated emission reductions by year (estimated based on buses replaced)
- project cost-effectiveness: cost per unit of emission reduction.

The database should be used to inform future applicants and beneficiaries in order to adjust eligibility and appraisal criteria as needed and to ensure relevance.

5.5. Conclusions for the CPT Programme

The major purpose of the public support under this programme is to provide incentives to local communities and enterprises to undertake green investments and spend more of their own resources on environmental-friendly products and technologies.

Some additional points emerged from the discussion of programming and project cycle management, as follows:

- **Programming is a political process**, focused on defining priorities and goals and setting out rules for the project cycle (e.g. MARDE). **Appraisal – but simplified – is conducted by professional technical staff** (e.g. the bank), who are held accountable for their decisions. Responsibilities for programming and project cycle management should be separated.
- **Transparency is key**. Information (on project cycle procedures, eligibility criteria, and achieved results and benefits) should be disseminated widely. All potential applicants should be treated equally; decisions should be explained on time; stakeholders should be invited to participate.
- While a two-step appraisal process is preferable, due to the involvement of many small enterprises and banks **the appraisal process should be simplified** as follows: MARDE approves the list of buses that are eligible for financing, which makes it simple for banks to approve projects for financing. If a type of bus is not on the approved list, it will not be financed and no further assessment is necessary.
- **The process does not stop once a decision to finance a project has been made**: contracting, monitoring project implementation and assessing project outcomes are also essential, as programme managers will learn from this experience.
- **Attracting and retaining qualified staff is key**: the capacity to challenge project owners and to manage the complex process of project appraisal requires experience in the field.

Note

1. The appraisal system should award fewer points to projects involving CNG buses when CNG filling stations are commercially unprofitable (less than 100 CNG buses) or do not exist in the city.

6. Macro-economic and environmental overview

This chapter briefly describes the main demographic, macro-economic and environmental issues in Moldova of relevance to the transport sector. It presents an overview of the public transport system in the country as well as the level of greenhouse gas emissions and air pollution in its main urban centres. It also analyses the major health risks associated with the main air pollutants. This review forms part of the justification for the need for public support for investments in the transport sector.

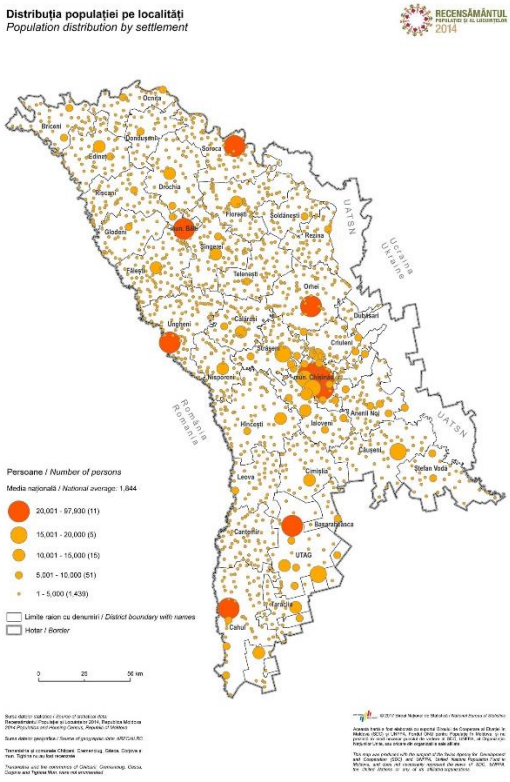
6.1. Demographic and macro-economic situation

6.1.1. Geographic location and territorial division

The Republic of Moldova is in south-east Europe, in the north-eastern Balkans, on a territory of 33 843 km^2. To the west it shares a border with Romania, and to the north, east and south with Ukraine (Figure 6.1). The total length of the national boundaries is 1 389 km, including 939 km with Ukraine and 450 km with Romania.[1] According to the data from National Bureau of Statistics (NBS), the population of Moldova as of 1 January 2018 was 3.55 million.[2]

The Republic of Moldova's administrative-territorial organisation involves two local government levels: [3] 1) LPA 1 (local public administration): villages (communes) and towns/cities (municipalities); and 2) LPA 2: districts (*rayons*), and two second-tier municipalities (Chisinau and Balti). Currently, Moldova is divided into 32 districts, 13 municipalities and 2 regions with special status: 1) Autonomous Territorial Unit Gagauzia; and 2) administrative-territorial units on the left bank of the Dniester River. Six development regions have been established, aiming to attract funds and investments and to ensure sustainable development.[4]

Figure 6.1. Population distribution by settlement



Source: National Bureau of Statistics (www.statistica.md).

6.1.2. Demographic and socio-economic development

The process of urbanisation is happening very gradually, and has even been reversing since 1989, as census data show (Table 6.1).[5] Urbanisation, especially in smaller cities and towns, slowed down in the 1990s, either as a result of poor competitiveness of the old-style industry under free-market conditions (combined with mismanagement during the transition process) or administrative changes (a significant number of large villages were assigned the status of urban settlement). Also population decline (contrary to 1950-1990 growth) and emigration after 1990 have posed challenges to urbanisation, leading to a decline in the supply of public services, especially in smaller cities and towns (GoM, 2016[1]).

As Table 6.1 shows, the level of urbanisation in 2014 resembled the level in 1970.

Table 6.1. Census results in Moldova, 1970-2014

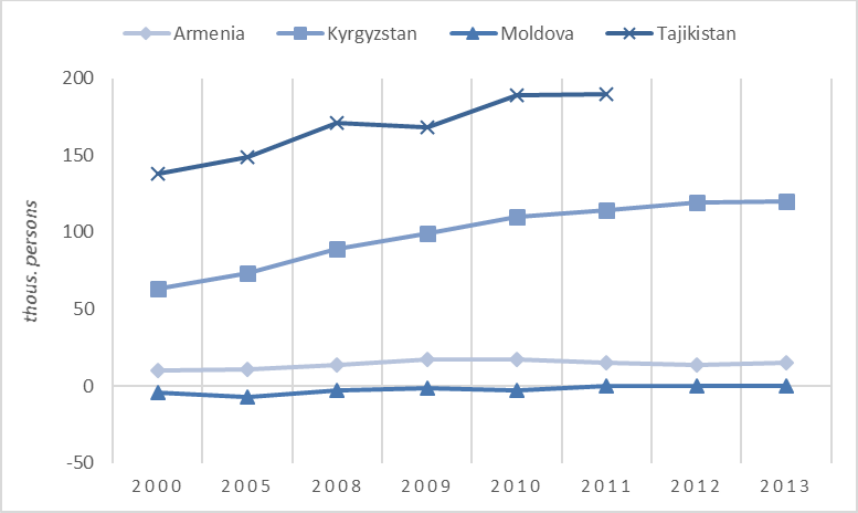
Census	Urban	Rural	Total	Urban	Rural
		mln people		percentage	percentage
1970	1.13	2.44	3.57	31.7%	68.3%
1979	1.53	2.42	3.95	38.8%	61.2%
1989	2.02	2.32	4.34	46.6%	53.4%
2004	1.31	2.08	3.38	38.6%	61.4%
2014	0.95	1.85	2.81	33.9%	66.1%

Note: 2004 and 2014 information do not include data on districts on the left bank of the Dniester River or the Bender Municipality.
Source: National Bureau of Statistics (www.statistica.md).

In 2018, out of the total population of 3.55 million people, 51.9% were women, whereas in urban areas the ratio was 53.2%.[6] Of the total population, 83.1% of men are of working age (16-61 years), whereas the ratio for women is 59.0% (16-56 years). The ratio of retired people is very similar for urban and rural areas: 19.4% and 18.7%, respectively.[7]

Moldova is one of the Eastern Europe, Caucasus and Central Asia (EECCA) countries whose population is declining (Figure 6.2). Compared with 1991 figures, in 2018 Moldova had 441 000 fewer females and 376 000 fewer males.[8]

Figure 6.2. Natural population increase in selected EECCA countries, 2000-13



Note: 2012 and 2013 data for Tajikistan not available.
Source: (CIS, 2014[2]), *Commonwealth of Independent States in 2013 – Statistical Yearbook*.

According to a 2013 household survey (based on a sample of 20 850 households), 12.4% of household members were abroad more than 12 months in previous year, 68.4% of whom came from rural areas (Nexus, 2013[3]). In total, 271 600 people were living abroad for a longer period (one year or more), whereas the foreign population living in Moldova reached only 21 700 people (at the end of 2014). In 2014, 26.4% of rural households and 20.6% urban households benefitted from remittances. In relative terms, rural households benefitted more from remittances as they accounted for 61.6% of their total disposable income, compared with 50.2% for urban households (IOM, 2017[4]).

Average disposable household income in 2017 stood at MDL 2 245 (USD 121) per capita per month. This figure is composed of MDL 2 671 (USD 144) per capita in urban areas and MDL 1 917 (USD 104) per capita in rural areas. In urban areas 55% of this income comes from employment, 22% from social payments, and 11% from remittances from abroad. In rural areas, employment accounted for just 30%, self-employment in agriculture 15%, social protection payments 25%, and remittances 22%. For the country as a whole, 43% comes from employment, 23% from social protection payments, and 16.5% from remittances.[9]

In 2016, employment was mainly in agriculture (33.7%); public administration, health care, education and social services (18.3%); trade (16.4%); and industry (12.1%). In urban areas, employment is chiefly in trade (26.8%); public administration, health care, education and social services (20.9%); and industry (17.3%). In rural areas on the other hand, employment in agriculture dominates (58.2%) followed by public administration, health care, education and social services (16.1%). In no other sector does employment in rural areas exceed 8%.[10]

In 2016, the annual unemployment rate was 4.2%. Men experienced a higher unemployment rate overall (5.5%), including an 8% rate in urban areas and 3.2% in rural areas. Women, in contrast, experienced unemployment rates of 2.9% overall, with 4% in urban areas and 1.9% in rural areas.[11]

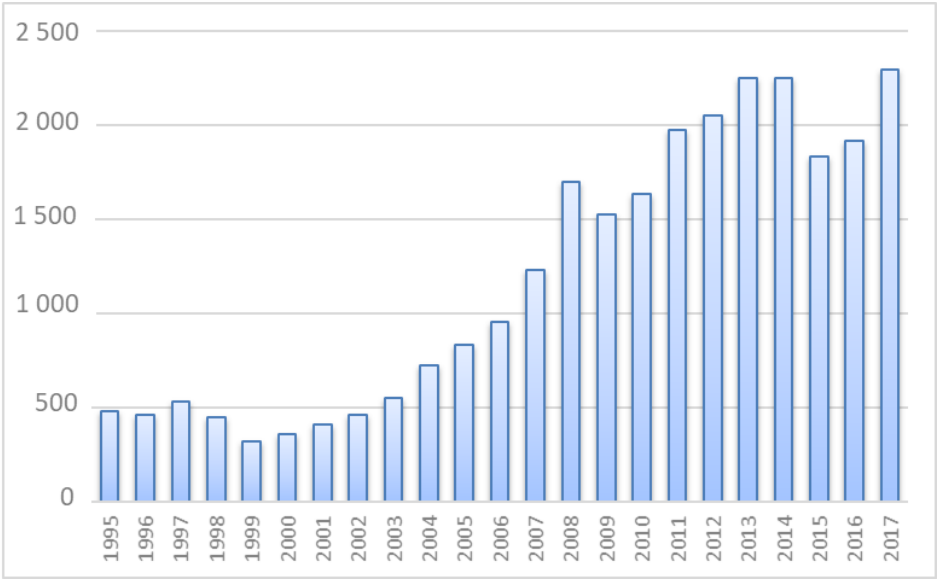
6.1.3. GDP and energy intensity

Globally, the link between growing GDP and transport has been a major reason for increased greenhouse gas (GHG) emissions due to the greater movement of goods and people. The per capita emissions from transport correlate strongly with annual income (Sims and Schaeffer, 2014[5]).

The country's estimated GDP in 2016 was USD 18.9 billion, measured according to purchasing power parity, and has been growing at an average annual rate of 5.3% since 2002. As shown in Figure 6.3, Moldova's GDP per capita has multiplied by more than four in the period 2003-13 (according to purchasing power parity, it had almost doubled from 2 393 to 4 700 in current international USD[12]).

Figure 6.3. Moldova's GDP per capita, 1995-2017

(current USD)



Source: World Bank (https://data.worldbank.org).

GDP is mostly generated by trade (15.2%), followed by mining and manufacturing (12.0%), agriculture (11.6%) and the public sector (11.6%) (NBS, 2018[6]). The country does not have any coal or natural gas production and is dependent on imports. Moldova produced 5 000 tonnes of petroleum products in 2017, which was sufficient to cover just 0.5% of its gross domestic consumption of these products (NBS, 2018[6]).

Despite the fact that Moldova contributes relatively little to climate change – while the country accounted for 0.05% of the world's population in 2012, it was responsible for 0.02% of the global GHG emissions[13] – its economy is both highly energy and carbon-intensive. Moldova's energy use is much higher than the averages for the European Union (EU), OECD, and the world. In 2014, Moldova's energy use stood at about 195 kilogramme of oil equivalent (koe) per 1 000 USD of purchasing power parity (PPP) GDP, using 2011 prices, compared with about 88 for the EU, 110 for the OECD countries and 126 for the world as a whole.[14]

While in absolute terms Moldova's carbon dioxide (CO_2) emissions have significantly declined over the years, the carbon intensity of the Moldovan economy (or "CO_2 emissions

per GDP") is still very high (0.276 kg CO_2 per PPP GDP 2014 USD) compared to the EU (0.17 kg) and OECD countries (0.239 kg).[15]

6.1.4. The financial sector

Moldova's financial sector is dominated by banks. The banking sector comprises the National Bank of Moldova (*Banca Naţională a Moldovei* – BNM) and 11 commercial banks (BC Moldova Agroindbank S.A., BC Comertbank S.A., BC EuroCreditBank S.A., BC Energbank S.A., BC Eximbank S.A., FinComBank S.A., BC Mobiasbanca - Groupe Société Générale S.A., BC Moldindconbank S.A., BC ProCredit Bank S.A., BCR Chisinau S.A., BC Victoriabank S.A.).

The BNM licenses, supervises and regulates the activity of financial institutions operating in Moldova. The shareholders of Moldova's banking sector are mostly from abroad, as foreign investors own 86.1% of the banks' share capital.[16] Four Moldovan banks have full foreign capital (i.e. they are branches of foreign banks or foreign financial groups).

Currently, banks in Moldova do not play a significant role in the country's economic development and business activity. Moldova's high sovereign credit risk combined with high inflation rates (up until 2016) have led to high interest rates and limited availability of affordable and long-term bank loans. The lack of funds with longer tenors is a particularly persistent problem in the country's banking system.

One of the factors contributing to this situation was the off-the-scale bank fraud unveiled in November 2014, when it came to light that more than USD 1 billion – equivalent to 15% of the country' annual GDP or half of the reserves of the BNM – had disappeared from three of Moldova's leading banks (Banca de Economii,[17] Unibank and Banca Sociala).[18] The resultant bailout of these (suddenly bankrupt) financial institutions cost national authorities almost half Moldova's annual budget and prompted an overdue clean-up of the banking sector.

This led to a currency "collapse" (from a European perspective) and put the national economy into its third annual GDP decline within a period of only six years (after 2009 and 2012). However, this third "collapse" turned out to be not as steep as the first one.[19] Between November 2014 and November 2015, the Moldovan currency lost about 18% of its value against the Euro,[20] also due to a run on Moldovan leu caused by the "missing" billion. This resulted in a general rise in prices (e.g. household electricity, which increased by 30%[21]), whereas salaries and pensions remained frozen. The World Bank, the International Monetary Fund of the European Union suspended financial aid to the country.

Since then, trust in the country's banking sector has, to a large extent, been restored, though corruption still remains an issue. In October 2016, the BNM took measures to increase ownership transparency: its newly established Shareholder Transparency Unit (STU) took supervisory action in line with the new Bank Recovery and Resolution Law (No. 232 of 3 October 2016) and blocked and finally cancelled 43% of shares at Moldova Agroindbank – the largest bank in Moldova, holding almost a third of all the country's retail deposits, and one of its oldest banks[22] – and almost 64% at Moldindconbank – the second largest bank.[23]

The major reason behind this move was the need to improve transparency in the banking sector, rather than to improve solvency. The Law on Financial Institutions (No. 550 of 21 July 1995) now requires that shares in the banks should not be purchased without prior written consent of the BNM (IMF, 2016[7]); (NBM, 2016[8]). In October 2018, the European

Bank for Reconstruction and Development (EBRD) and two private equity firms bought a 41% stake (EUR 23 million) in Agroindbank (Foy, 2018[9]). Since April 2018, the BNM has been trying to sell the majority stake in Moldindconbank (Banila, 2019[10]).

In November 2016, Banca Transilvania S.A. (the second largest bank by total assets in Romania) together with the EBRD (a leading investor in Moldova and previously a major lender to the country's banking system) announced its intention to acquire 39.2% of shares in Victoriabank (Moldova's third largest lender). The deal was closed in January 2018 – with EBRD's minority share of 27.5%. The two foreign banks now hold a controlling stake of 66.7% and have demonstrated that the fraud-hit banking sector in Moldova has stabilised (previous foreign bank acquisitions took place in 2007[24]). Victoriabank's shareholders also plan to diversify their financial products and to offer, among others, SMEs longer-term lending options.[25] Banca Transilvania (in which EBRD also owns 8.6% of shares) sees opportunities in the country's SME, micro and retail sectors and is expected to bring necessary experience gained on the Romanian lending market (Fitzgeorge-Parker, 2017[11]).

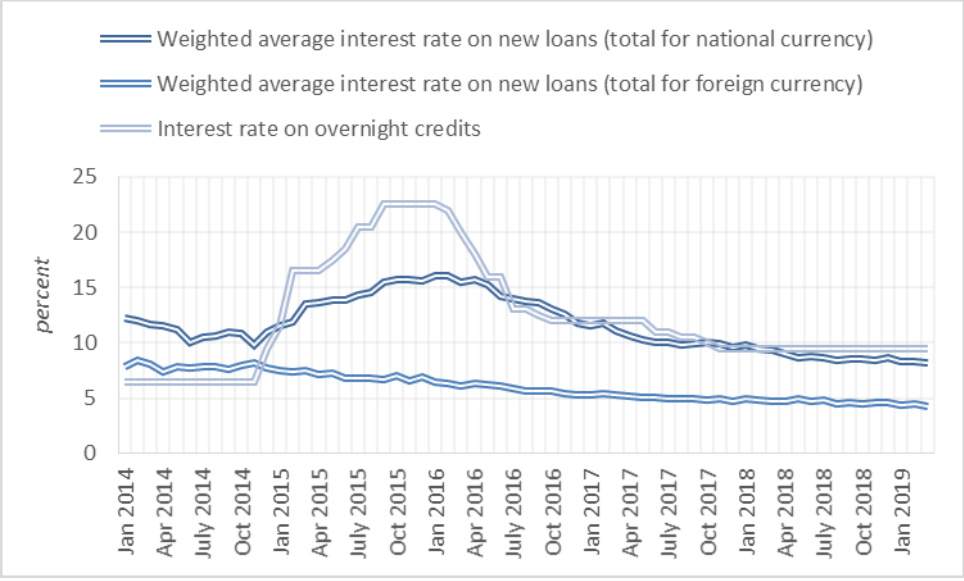
The concentration of the banking sector is quite high in Moldova – the five largest banks account for 79% of capital and 84% of all assets. However, this concentration is not a major obstacle. Besides the above-mentioned transparency issues, the total assets of the banking sector in Moldova make up less than 40% of the country's GDP.[26] Also gross domestic savings have been in negative figures since 2000, having an average annual value of -10.1% of GDP until 2016.[27]

The loan-to-deposit ratio has decreased from 80% (September 2015) to the current 58% (March 2019), showing that banks have become more prudent in their lending operations after the banking crisis, and are keeping a larger portion of deposits in reserve.[28] These requirements constrain bank lending, and the role of the banking sector in Moldova as a contributor to the growth of the national economy remains limited. Because banks do not function properly as financial intermediaries, access to credit for SMEs and private entrepreneurs is complicated. Conversely, banks face challenges in diversifying their clients, as well as channelling their large deposit base into healthy credits (Wrobel, 2019[12]). These challenges are amplified, among others, by the lack of good bankable projects and other (structural) issues, such as loan recovery.

On a positive note, the share of non-performing loans in the total loan portfolio decreased from 18.4% to 12.5% between 2017 and 2018 (ends of year).[29] The average inflation rate stabilised in 2016 at 6.5% (from 9.7% in 2015) and was as low as 3.1% in 2018.[30] This fall in inflation allowed for the base interest rate set by the BNM to be lowered to 6.5% from the end of 2017 from 19.5% in September 2015.[31] The current single-digit interest rates might contribute to higher lending and an overall lending recovery.

In 2018, the average interest rate on long-term (over five years) credit for businesses equalled 9.76% p.a. (in national currency) and 4.60% p.a. (in foreign currency; see Figure 6.4). In terms of credit volumes, long-term loans totalled MDL 598.13 million out of the total of MDL 10 763.4 million granted to businesses (in national currency) and MDL 1 293.82 million out of the total MDL 10 015.14 (in foreign currency). This higher demand by the business sector for long-term credit denominated in foreign currency is largely due to the fact that foreign currency loans come with longer maturities.

Figure 6.4. Interest rates on new loans and overnight credits, 2014-19*



Note: *Data until 03/2019.
Source: National Bank of Moldova (www.bnm.md).

Total loan volumes in 2018 were MDL 18 544.69 million (in national currency) and MDL 10 260.99 million (in foreign currency). Loans to businesses made up 58% of all loans in national currency and 98% of all loans in foreign currency. Thus, long-term loans in foreign currency can be considered more interesting for financing the CPT Programme.[32] However, potential currency risk[33] means that the government or a donor may want to set up a facility to hedge this risk for companies that choose to borrow in foreign currency. The required reserves ratio on liabilities in national currency was increased to 42.5% and the reserve ratio of the attracted funds in foreign currency was maintained at 14%.[34]

In November 2018, Moody's investors service affirmed the Government of Moldova's B3 rating (stable outlook) taking into consideration the country's progress in financial stability on the one hand and persisting weaknesses and unpredictability of the domestic political environment (which also entail fiscal risks) on the other. However, Moldova's debt burden is relatively low (also due to small budget deficits[35]), with a government debt-to-GDP ratio of 31.5% at the end of 2017 (i.e. well below the B-rated median of 56% of GDP). Besides high debt affordability, the large share of foreign currency-denominated debt is currently balanced by the significantly appreciated Moldovan leu in 2017 on the back of stronger remittances and capital inflows.[36]

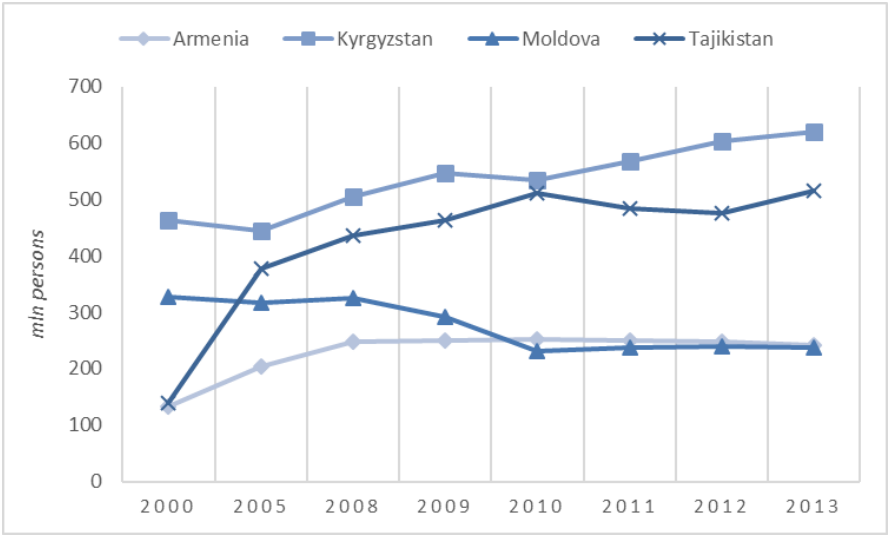
6.2. Road and transport infrastructure in Moldova

Moldova ranks low among the EECCA countries for the number of passengers using public transport (both in total volume as well as percentage share of population). Moldova ranked second after the Russian Federation for its decrease in numbers of passengers transported (27.5% and 56.3% respectively) over 2000-2013 period (CIS, 2014 [2]).[37]

Moldova was the only country of its peers to see levels of passenger transport decline (Figure 6.5), which fell to the same level as Armenia in 2013 (both countries are

comparable in terms of population size). The latest development (2014-2016), however, shows an increasing trend (Table 6.11).

Figure 6.5. Passenger transportation by transport enterprises in selected EECCA countries, 2000-13



Source: CIS (2014) [2].

The amount of transported goods, on the other hand, rose in Moldova from 28.9 million tonnes in 2000 to 36.9 million tonnes in 2016.

In January 2017, the total length of public roads in the Republic of Moldova was 9 352 km,[38] comprising 3 336 km of national roads and 6 016 km of local roads (Table 6.2). The resulting road density is high for a country of the size and population of Moldova. The State Road Administration – a state enterprise within the former Ministry of Transport and Roads Infrastructure (which is now part of the Ministry of Economy and Infrastructure)[39] – manages the national roads, and controls much of the financing of local road maintenance.

Table 6.2. Length of public roads, 2010-16

(end of year, km)

	2010	2011	2012	2013	2014	2015	2016
Public roads - total	9 344	9 352	9 352	9 352	9 360	9 373	9 386
of which, hard surface	8 811	8 827	8 835	8 836	8 861	8 879	8 894
National roads - total	3 336	3 336	3 336	3 336	3 339	3 339	3 346
of which, hard surface	3 336	3 336	3 336	3 336	3 339	3 339	3 346
Local roads - total	6 008	6 016	6 016	6 016	6 021	6 034	6 040
of which, hard surface	5 475	5 491	5 499	5 500	5 522	5 539	5 547

Note: Data from July 2017.
Source: National Bureau of Statistics (www.statistica.md).

Table 6.2 shows that the public road density over the reference period has not undergone any major change. The structure of the public road network as of 1 January 2017 is presented in Table 6.3.

Table 6.3. Structure of public road network

Surface		Total public roads	National			Local
			Total	Including		
				Highways	Republican	
Total length, km		9 386	3 346	820	2 526	6 040
of which:						
Upgraded surface (modernised surface)	km	5 476	2 983	799	2 184	2 493
	%	58.3	89.1	97.4	86.5	41.3
Light bituminous surface	km	459	117	18	99	342
	%	4.9	3.5	2.2	3.9	5.7
Cobbled roads	km	2 959	246	3	243	2 713
	%	31.5	7.4	0.4	9.6	44.9
Dirt roads	km	492	-	-	-	492
	%	5.3	-	-	-	8.1

Note: July 2017.
Source: State Road Administration (www.asd.md).

According to the Tourism Agency of Moldova, there are 20 tourist routes registered in the country. At present, agrotourism is developing, involving the organisation of festivals and fairs, as well as wine routes. The agency's estimates show that over 25% of Moldovan residents travel around the country in their own cars. The liberalised visa regime with the EU and the Commonwealth of Independent States (CIS) has also boosted foreign tourism.[40]

6.2.1. Moldova's vehicle fleet

This analysis provides a brief review of the current situation of Moldova's existing bus stock (in terms of ownership status, vehicle age, emission norms, fuel type, etc.).

According to the State Information Resource Centre, "Registru" (*Întreprinderea de Stat Centrul Resurselor Informaționale de Stat „Registru" – ÎS CRIS „Registru"*), on 1 July 2017, 924 122 means of transport were registered in the country, including 281 349 transport units in Chisinau and 43 739 transport units in Balti (Table 6.4).[41]

Table 6.4. Structure of vehicle fleet (by type of transport)

No.	Type of transport unit	No. of transport units	Share of total, %
1	Cars	573 265	62.00
2	Trucks	179 554	19.42
3	Trailers	51 681	5.60
4	Tractors	40 638	4.40
5	Motorcycles	38 623	4.20
6	Buses	20 910	2.26
7	Semi-trailers	16 493	1.80
8	Others	2 958	0.32
Total		**924 122**	**100**

Note: July 2017.
Source: State Information Resource Centre "Registru" (www.registru.md), now located under the Public Services Agency (www.asp.gov.md/en/date-statistice).

While other official statistics present slightly different data (Table 6.5), the overall figures for buses and minibuses correspond. These are the main means of transport of concern for the proposed CPT Programme. The number of cars increased by 169 000 from 2010 to 2017; the number of buses decreased by 485 and the number of trolleybuses increased by 71 over the same period.

Table 6.5. Motor vehicles registered in Moldova, 2010-17

(end of year, units)

	2010	2011	2012	2013	2014	2015	2017*
Freight transport vehicles	131 243	141 696	151 830	154 163	160 199	164 533	179 554
Buses and minibuses	21 395	21 349	21 433	21 344	21 359	21 134	20 910
Cars (including taxis)	404 290	426 973	456 379	487 418	512 561	529 813	573 265
Trailers and semi-trailers	54 127	56 482	58 827	60 797	63 076	64 953	68 174
Passenger trolleybuses	343	443	357	380	396	391	414
Total	**611 398**	**646 943**	**688 826**	**724 102**	**757 591**	**780 824**	**842 317**

*Note: *July 2017.*
Source: National Bureau of Statistics (www.statistica.md) and State Information Resource Centre "Registru" (www.registru.md); now located under the Public Services Agency (www.asp.gov.md/en/date-statistice).

Table 6.6 categorises vehicles by type of diesel engine using the European emission norms (see Annex B to this report for information on Euro norms).

Table 6.6. Analysis of transport units registered in Moldova (by year of manufacture)

No.	Type of transport unit	Before 1992 (non-Euro)	1993-1996 (Euro 1/I)	1997-2000 (Euro 2/II)	2001-2005 (Euro 3/III)	2006-2009 (Euro 4/IV)	2010-2014 (Euro 5/V)	After 2014 (Euro 6/VI)	TOTAL
1	Cars	206 208	69 629	31 990	101 193	93 003	32 513	4 508	**539 044**
2	Trucks	63 400	17 594	37 701	42 725	11 756	2 417	294	**175 887**
3	Tractors	24 629	1 628	1 822	4 022	2 069	4 069	654	**38 893**
4	Motorcycles	19 023	1 166	1 288	2 582	6 178	6 787	329	**37 353**
5	Buses	11 790	2 438	2 649	2 511	1 167	418	21	**20 994**
6	Others	1 717	257	284	327	270	255	38	**3 148**
Total		**326 767**	**92 712**	**75 734**	**153 360**	**114 443**	**46 459**	**5 844**	**815 319**
%		**40.1**	**11.4**	**9.3**	**18.8**	**14.0**	**5.7**	**0.7**	

Note: July 2017.
Source: State Information Resource Centre "Registru" (www.registru.md), now located under the Public Services Agency (www.asp.gov.md/en/date-statistice).

The data presented in Table 6.6 can be summarised as follows:

- 11 790 buses (56% of the bus fleet) do not correspond to any Euro standard. According to Art. 153 par. (9) of the Road Transport Code, these units should be renewed or replaced by 2020.
- In total, 326 767 vehicles do not meet any Euro norms (40.1% of the vehicle fleet).
- 321 806 vehicles comply with Euro 1/I to Euro 3/III (39.5% of the vehicle fleet).
- 114 443 vehicles comply with Euro 4/IV (14% of the vehicle fleet).
- 52 303 vehicles meet Euro 5/V and 6/VI (6.4% of the vehicle fleet).

As of May 2017, 840 companies involved in road freight transport were registered in Moldova, according to information provided by the National Agency of Road Transport (*Agenția Națională Transport Auto* – ANTA). Nearly three-quarters of the registered trucks are between 11 and 20 years old. In total, 2 638 units are up to 10 years old (45.7% of the fleet), while 1 237 units are over 16 years old (21.4% of the total fleet). Thus, much of the fleet will require replacement in the near future.

Table 6.7. Truck fleet (by age)

No.	Age	No. of units	Share, %
1	Up to 1 year	4	0.07
2	From 1 to 5 years	275	4.8
3	From 6 to 10 years	2 359	40.8
4	From 11 to 15 years	1 902	32.9
5	From 16 to 20 years	880	15.2
6	From 21 to 25 years	210	3.6
7	From 26 to 30 years	114	2.0
8	Over 31 years	33	0.6
Total		**5 777**	**100**

Note: May 2017
Source: National Agency of Road Transport (http://anta.gov.md).

On the other hand, nearly half of the trucks comply with Euro V norms, as this is required for international transport activity (Table 6.8). Just over 6% of the truck fleet (359 trucks) only comply with Euro 0 norms and these must be renewed or replaced by 2020, according to the provisions of Art. 153, par. (9) of the Road Transport Code.

Table 6.8. Compliance of Moldova's truck fleet with Euro norms

No.	Age	No. of transport units	Share, %
1	Euro 0	359	6.21
2	Euro I	5	0.09
3	Euro II	614	10.63
4	Euro III	1 626	28.15
5	Euro IV	271	4.69
6	Euro V	2 809	48.62
7	Euro VI	93	1.61
Total		**5 777**	**100**

Note: May 2017
Source: National Agency of Road Transport (http://anta.gov.md).

The ANTA keeps track of the regular route network according to approved transport programmes. At present, the Moldovan route network includes 480 operators serving 11 130 regular routes, including 6 890 district (*rayon*) routes, 3 368 inter-district routes and 872 international routes. Regular routes are served through railway stations and bus stations.[42] The State Enterprise "Railway and Bus Stations" – which operates under the Public Property Agency (PPA) of the Ministry of Economy and Infrastructure – provides bus services in Moldova and includes 28 branches and 9 private bus stations.[43] According to the data submitted by ANTA, 540 transport operators are registered in the State Register of transport operators to provide services for road passenger transport through regular, special regular and occasional services, including 6 179 owned or leased buses.

The data in Table 6.9 show that 98.6% of the public transport vehicles on inter-city routes were manufactured in 2010 and before, including 50% with a high degree of wear (exceeding the average useful life of 7 years for minibuses, 12 years for buses and 15-20 years for trolleybuses, depending on mileage and service). The high wear rate of the bus fleet increases environmental pollution and maintenance costs and reduces road safety. The renewal of the bus vehicle fleet is a vital issue for Moldovan transport operators.

Table 6.9. Inter-city bus fleet (by year of manufacture)

No.	Year of manufacture	No. of transport units	Share, %
1	Up to 1995	1 321	21.4
2	1996-2000	1 558	25.2
3	2001-2010	3 210	52
4	2011-2017	89	1.4
Total		**6 179**	**100**

Note: July 2017.
Source: National Agency of Road Transport (http://anta.gov.md).

From Table 6.10, it can be seen that 38.5% of the inter-city bus fleet has a capacity of up to 20 seats, 48% has a capacity of 21 to 40 seats and only 13.5% has a capacity of 41 seats or more.

Table 6.10. Inter-city bus fleet (by transport capacity)

No.	Number of seats	No. of transport units	Share, %
1	Up to 9	45	0.7
2	9-20	2 333	37.8
3	21-40	2 964	48
4	Over 40	837	13.5
Total		**6 179**	**100**

Note: July 2017.
Source: National Agency of Road Transport (http://anta.gov.md).

Table 6.11 shows that the number of passengers transported by public transport in Moldova increased by about 4% from 2014 to 2016. Buses and trolleybuses account for nearly 97% of public transport in 2016 (with 105 988 passengers travelling by bus and 137 708 by trolleybus). That said, the number of bus passengers decreased by 6%, whilst trolleybus passengers increased by 14% in the period 2014-2016. This is due to the modification of the public transport networks in Chisinau and Balti, where the number of bus routes has been reduced in favour of the trolleybus network.[44]

Table 6.11. Passenger transport (by means of transport and ownership form), 2014-16

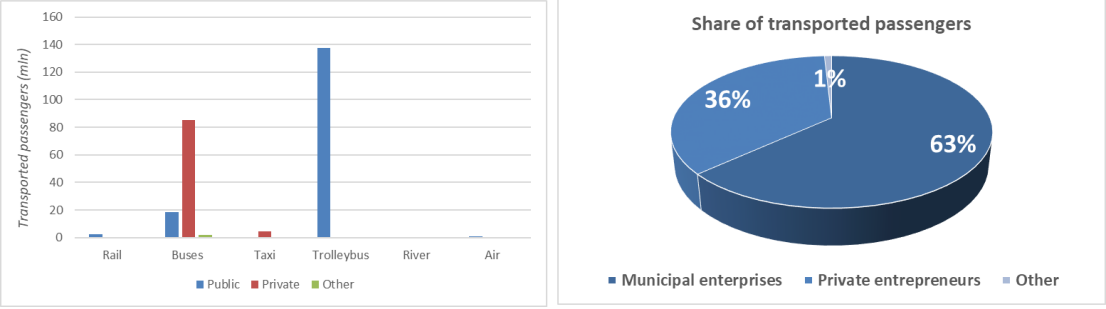
	Total			Of which:								
				Public			Private			Other forms		
	2014	2015	2016	2014	2015	2016	2014	2015	2016	2014	2015	2016
Transported passengers (no.)	241 485	249 540	251 970	145 692	160 482	159 447	92 345	86 624	90 342	3 448	2 434	2 182
Of which:												
Rail	3 838	3 268	2 258	3 838	3 268	2 258	-	-	-		–	–
Buses	112 608	103 454	105 988	19 885	19 367	18 389	89 276	81 654	85 417	3 448	2 434	2 182
Taxi	3 048	4 951	4 749	-	-	-	3 048	4 951	4 749		–	–
Trolleybus	120 951	136 642	137 708	120 951	136 642	137 708	-	-	-		–	–
River	142	139	139	142	139	139	-	-	-		–	–
Air	898	1 085	1 129	877	1 066	953	21	19	176		–	–
Passenger journeys – million passenger-km	4 785	5 160	5 397	2 003	2 285	2 106	2 675	2 802	3 219	107	73	72
Of which:												
Rail	257	181	122	257	181	122	-	-	-		–	–
Buses	2 874	2 922	3 106	195	184	177	2 573	2 665	2 858	107	73	72
Taxi	63	101	102	-	-	-	63	101	102		–	–
Trolleybus	367	413	416	367	413	416	-	-	-		–	–
River	0	0	0	0	0	0	-	-	-		–	–
Air	1 225	1 543	1 651	1 185	1 506	1 392	40	36	259		–	–

Note: Data from July 2017.
Source: National Bureau of Statistics (www.statistica.md).

In 2016, three municipal enterprises that operate in Moldova (two in Chisinau and one in Balti) accounted for 63% of transported passengers (Figure 6.6). In terms of passenger kilometres, the situation is the opposite – private transport operators provided 60% of total passenger journeys by length. This high share is influenced by the fact that trolleybus

transport is solely publicly operated (both in Chisinau and Balti), whereas inter-city transport is provided only by private companies.

Figure 6.6. Public transport operators, passengers and journey share, 2016



Note: Data from July 2017.
Source: National Bureau of Statistics (www.statistica.md).

6.2.2. City of Chisinau's public transport fleet and network

Public transport fleet

At present, in Chisinau municipality, passenger transport services are provided by the municipal enterprises Chisinau Electric Transport Company (*Regia Transport Electric Chișinău* – RTEC) and Urban Bus Park (*Parcul Urban de Autobuze* – PUA),[45] as well as by 15 private operators (administrators of light class buses, also known as minibuses). Taxi services are carried out through 35 economic agents which hold the licences. General information on the city's urban transport set up is presented in Table 6.12.

Table 6.12. Overview of urban public transport fleet, Chisinau

	Indicator	Trolleybus	Bus	Light class bus
1	Total network length, km	534	875.7	1 808.1
2	Routes, no.	23	24	55
3	Vehicle inventory, no.	366	160	1 290
4	Daily entering into traffic, no.	298	125	1 180
5	Average operating speed, km/h	17.1	19.4	25.6
6	Average nominal transport capacity, passengers	100	115	18
7	Trips per day (turns), no.	2 380	750	8 800
8	Average trip per day, km	58 422	28450	99 100
9	Route duration, hours	17	16	18

Note: July 2017.
Source: Chisinau Municipality, Department of Public Transport.

As of July 2017, the RTEC owned and operated a total of 366 trolleybuses, including 88 units with a service life of up to 5 years, 124 units aged 5 to 10 years, 30 units with a service life of 11 to 15 years, 13 units with a service life of 16 to 20 years and 111 units with a service life of above 20 years. If we assume the operational lifespan of a trolleybus is 15 years (depending on the manufacturer), then 124 trolleybuses, or approximately 36% of the vehicle fleet, should be replaced as they have met or exceeded their operating terms. Every year RTEC organises the repair of 80 trolleybuses. The total of 366 trolleybuses

includes 191 new AKSM-321 trolleybuses, accounting for around 52% of the trolleybus fleet, according to information provided by RTEC.

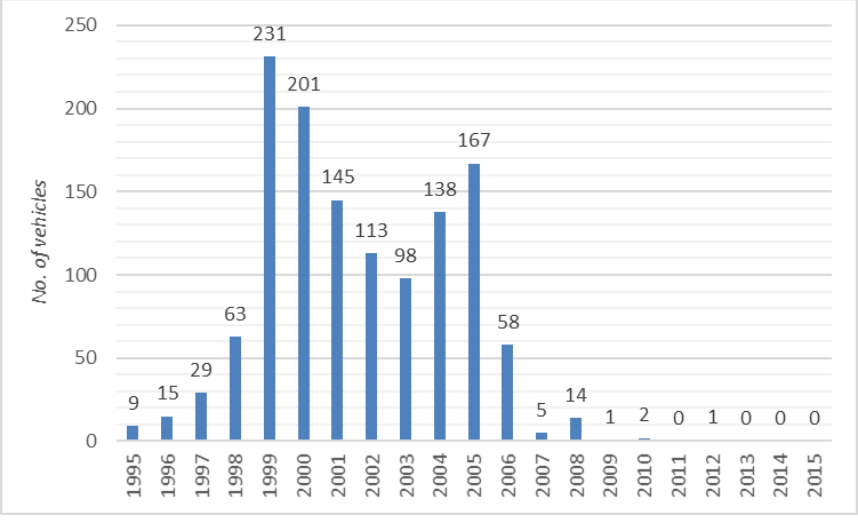
Also in July 2017, PUA had 136 buses, 60 of which had a service life of 10 to 15 years, 49 with a service life of 16-20 years and 7 with a service life of more than 20 years. The remaining 20 buses are reserve units either requiring capital repairs or scrapping. The normal lifespan of a bus is 12 years according to statements by PUA officials based on the recommendations of manufacturers. Thus, at least 56 vehicles (48%) in the running fleet and 76 vehicles (56%) of the total fleet should be replaced. Although the PUA mentions that it has not obtained sufficient funds from local public authorities, it has managed to keep its fleet in operation.

Another four bus routes are managed by private transport operators (No. 23, 10, 28 and 122). On these routes there are 42 bus stops with increased capacity, including route No. 23 (22 units), route No. 10 (2 units), route No. 28 (8 units) and route No. 122 (12 units).

There are 15 private transport operators serving 55 suburban bus routes with a total fleet of 1 290 light class buses (minibuses). Although these have a nominal transport capacity ranging from 11 to 21 seats, it is well-known that this capacity is typically exceeded, in particular during peak hours. The most common light class buses are Mercedes-Benz Sprinters. The age structure of the light class fleet is shown in Figure 6.7. As mentioned above, the typical life of a minibus is around 7 years.

Between 2014 and 2017, the Public Transport and Communications Directorate optimised the public transport route network following the Chisinau Transport Strategy. This seeks to minimise the duplication of trolleybus and bus routes with secondary bus routes. Thus, 12 secondary bus routes have been cancelled, reducing the number of light class buses from 1 850 units in 2014 to 1 290 in 2017.

Figure 6.7. Age of minibus fleet (by year of manufacture)



Note: July 2017.
Source: Authors' depiction based on information from minibus operators.

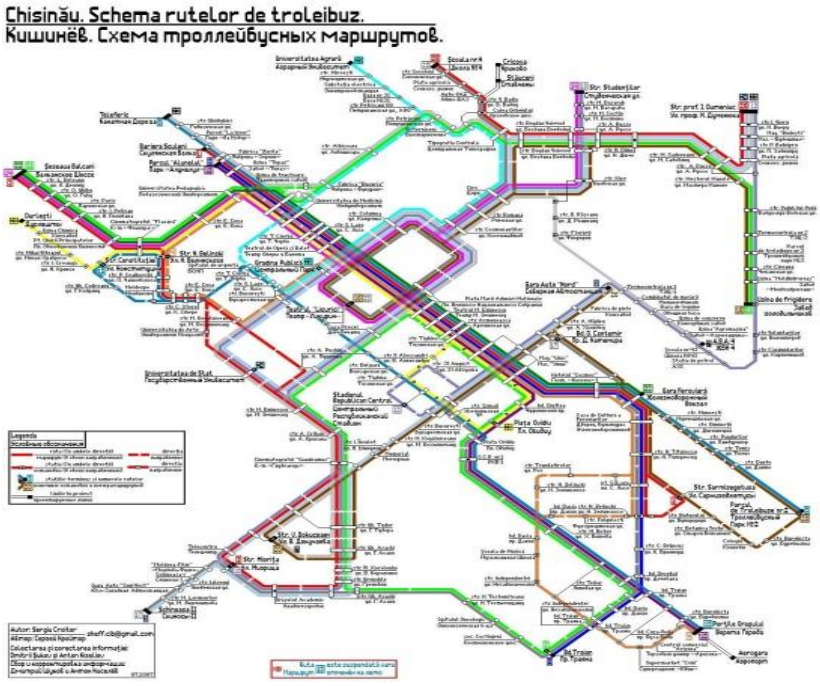
Street and transportation network

The Municipality of Chisinau owns and maintains 102.8 km of public roads.[46] The public road transport network is a radial type, which provides relatively short direct links on the radial routes between the suburbs and the city centre. Links between peripheral districts involve tangential paths. Most routes are made to or through the city centre and radial routes are the most requested; thus, over 70 streets and boulevards in the city centre are overloaded. The trolleybus network also includes two ring routes. The scheme of the trolleybus network in Chisinau is shown in Figure 6.8.

Urban highway sections are characterised by high traffic density, involving 7 to 12 bus routes. Thus, about 50% of public transport vehicles cross the city centre, creating a number of traffic problems. Public transport vehicles are not separated from other traffic and there are no high-speed buses, although there are some low-floor buses in service. Low-floor buses not only speed up passenger embarkation and disembarkation, but they are also user-friendly for older people, people with disabilities and people with pushchairs.

The development of urban public transport in Chisinau has been influenced by the fact that the relatively small historical part of the city is quite distant from the four contemporary residential sectors (Botanica, Buiucani, Ciocana, and Riscani), which are connected with the city centre by a few magistral (arterial) roads. Interconnections across the sectors is underdeveloped. The situation is complicated by the fact that there are very few alternative routes to redirect traffic (lack of ring roads for transit, especially north-south), which causes 50% of the inter-urban transit to flow through central Chisinau. For these reasons, during peak hours all the bridges connecting the periphery with the centre are congested.

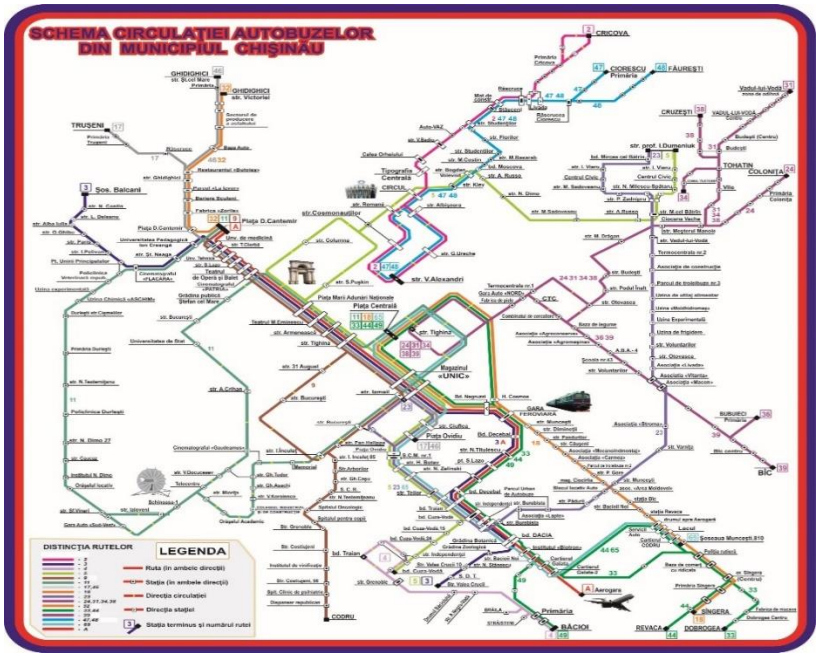
Figure 6.8. Chisinau trolleybus network



Source: Chisinau Electric Transport Company (http://rtec.md).

Of the 24 bus routes, only 7 are urban; the others serve the suburbs of Chisinau. The bus route scheme is shown in Figure 6.9.

Figure 6.9. Chisinau bus network



Source: Urban Bus Park (www.autourban.md).

Light class buses serve 55 routes, representing 54% of the public transport network (in terms of the number of routes, not their total length), and predominantly serve streets and districts that are hard to reach by larger public transport vehicles. The characteristics of the public transport network in Chisinau are shown in Table 6.13.

Table 6.13. Summary of public transport routes in Chisinau

Indicator	Total	Trolleybus routes	Bus routes	Light class bus routes
No. and share of routes	102	23 (22.5%)	24 (23.5%)	55 (54%)
Type:				
- urban	53	22	4	27
- suburban	49	1	20	28
Route length, km	2 873.8	534	810.9	1 528.9
Type:				
- urban	1 396	514.1	128.6	753.3
- suburban	1 477.8	19.9	682.3	775.6

Source: Consultant calculations based on Chisinau Electric Transport Company and Urban Bus Park.

There are 17 dispatchers in the regular public transport network: 4 on the bus routes and 13 on the trolleybus routes. There are 752 intermediate public stops along the routes, of which 520 are in urban areas and 232 in suburbs or along routes to them. In 330 public stations, bus shelters are installed, including 132 that are located in common with commercial units. It should be noted that 422 public stations are not equipped with a roof or pavilion. Some stations even lack name signs to indicate location, despite this being required under the

Road Traffic Regulation, approved by the Government Decision No. 357 of 13 May 2009 (see Section 7.1.15).

6.2.3. City of Balti's public transport fleet and network

The public transport network in Balti municipality comprises 4 trolleybus routes (Table 6.10), 11 main bus routes and 9 secondary bus routes (minibuses). The first trolleybus line in Balti was opened in 1972, with a length of 15 km. Twenty trolleybuses were run by the Trolleybus Directorate, which was reorganised in 1992 as a municipal enterprise called the Trolleybus Directorate of Balti. At the beginning of the 1990s, three routes covering 40 km were served by 90 trolleybuses.

Over time, however, insufficient funds led the trolleybus fleet in Balti to become outdated. Failure to replace vehicles meant that they fully exceeded their useful operating lives. Eleven trolleybuses were older than 10 years, while 24 had a working age of over 30 years. In order to renew the trolleybus stock, on 17 October 2012, Balti signed a EUR 3 million loan agreement with the European Bank for Reconstruction and Development (EBRD) for the purchase of 23 new trolleybuses. At the same time, the EBRD provided a EUR 1.6 million grant to improve the infrastructure of the Trolleybus Directorate of Balti.

In 2013 and 2014 EBRD assisted in replacing 23 trolleybuses with new and used buses. By 2014 there were 35 trolleybuses, including 22 ZIU-9 trolleybuses, 3 AKSM-20101 trolleybuses from Belarus, 11 AKSM-30101 trolleybuses from Belarus, 1 Škoda 14Tr13/6M trolleybus from the Czech Republic and 7 VMZ-5298 trolleybuses from the Russian Federation. Today the age of the trolleybus fleet is as follows: 23 units are less than 5 years old and 11 are more than 10 years old. The others are not operational.

In July 2014, two new routes (No. 4 and 5) were opened. In 2015, the opening of route No. 6 to link the Dacia neighbourhood to the "Bessarabia - North" sausage plant was proposed, but the project was not implemented. Moreover, in January 2016, the trolleybus traffic was stopped on route No. 4 due to unprofitability.

Today the city of Balti has 48 trolleybuses. Thirty operate daily, while four are reserve buses. The remaining 14 buses are in various stages of disrepair and disuse. The trolleybus network is 47.8 km long and includes 66 stations.

Public transport is also provided by 48 regular buses and 116 minibuses. All are diesel-powered and the vast majority are 15 years or older.

Figure 6.10. Balti trolleybus network

Source: https://ro.wikipedia.org/wiki/Troleibuze_în_Bălți.

6.3. Greenhouse gas emissions and air pollution in Moldova

6.3.1. Greenhouse gas emissions and transport

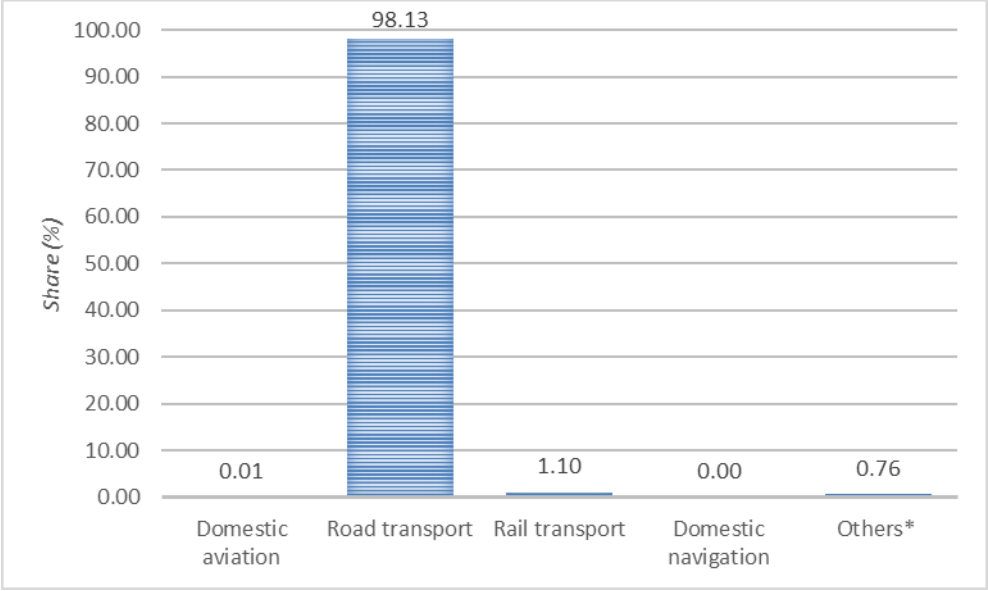
In 2015, overall GHG emissions in Moldova amounted to 13.95 million tCO_2e, excluding land-use change and forestry (LULUCF), or 11.11 million tCO_2e including the LULUCF sector (total net emissions are lower as Moldova's LULUCF sector is a net carbon sink). GHG emissions from the transport sector accounted for 2.2 million tCO_2e, (accounting for 23.2% of GHG emissions from the energy sector, which totalled 9.5 million tCO_2e) (GoM, 2017[13]).

From these data it can be seen that the energy sector contributed the largest share of total emissions (68.1% without LULUCF in 2015). Emissions from the transport sector are included in the energy sector. The agriculture, waste management, and industrial production sectors account for the remainder of the emissions (15.2%, 11% and 5.7% in 2015, respectively).

Figure 2.11 presents the transport sector's contribution to overall GHG emissions in Moldova in 1990 and 2015. Although in absolute terms GHG emissions (both overall and those from transport) decreased over the period – mainly due to the fall in GDP and population decline – the transport sector's share in total emissions increased from 10.3% in 1990 to 15.8% in 2015.

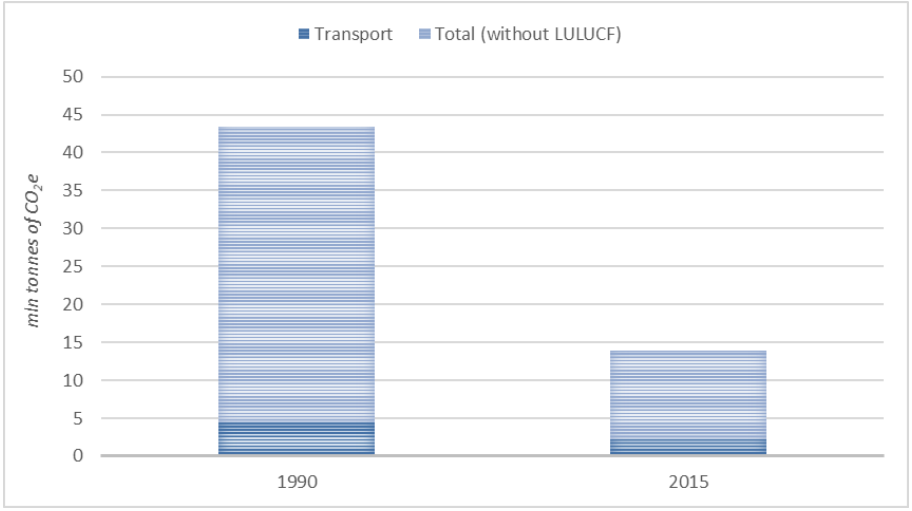
Figure 2.12 shows that emissions from road transport make up the bulk of GHG emissions from the transport sector. Whereas in 1990, road transport was responsible for 87.3% of transport emissions, by 2015 it had reached 98.1% (GoM, 2017[13]).

Figure 6.11. Share of transport sector in direct GHG emissions in Moldova, 2015



Note: *Including pipeline and off-road transportation
Source: (GoM, 2017[13]), *National Inventory Report 1990-2015: Greenhouse Gas Sources and Sinks in the Republic of Moldova*, p. 98, www.clima.md/download.php?file=cHVibGljL3B1YmxpY2F0aW9ucy80MjAwODJfZW5fbmlyNV9lbl8yOTEyMTcucGRm.

Figure 6.12. Transport's contribution to direct GHG emissions in Moldova, 1990 and 2015



Note: LULUCF: land use, land-use change and forestry.
Source: (GoM, 2017[13]), *National Inventory Report 1990-2015: Greenhouse Gas Sources and Sinks in the Republic of Moldova*, pp. 57, 97. www.clima.md/download.php?file=cHVibGljL3B1YmxpY2F0aW9ucy80MjAwODJfZW5fbmlyNV9lbl8yOTEyMTcucGRm.

GHG emissions per capita decreased by 65.2% between 1990 and 2015 (i.e. from 9.95 tonnes of CO_2e to 3.46 tonnes of CO_2e). GHG intensity decreased in the same period by

54.5% (i.e. from 4.39 kg CO_2e to 2.0 kg CO_2e 2010 USD). However, these values are still among the highest of the transition economies (GoM, 2017[13]).

In Table 6.14, we see that CO_2 and NO_x emissions also decreased by half and SO_2 emissions by more than 65% in the period 1990-2015.

Table 6.14. Trend in transport GHG emissions, 2010-15

(% change from 1990)

	1990	2010	2011	2012	2013	2014	2015
CO_2	100	46.2	48.7	42.9	45.4	47.2	49.7
CH_4	100	33.4	33.6	28.6	28.6	28.7	30.2
N_2O	100	34.3	35.5	32.4	32.2	30.4	34.0
NO_x	100	47.1	49.7	43.9	46.4	47.9	50.8
CO	100	33.5	34.8	29.4	28.7	29.0	30.1
NMVOC	100	33.6	35.11	29.6	29.0	29.3	30.3
SO_2	100	57.8	61.4	55.1	59.4	62.2	65.8

Note: NMVOC: non-methane volatile organic compounds
Source: (GoM, 2017[13]), *National Inventory Report 1990-2015: Greenhouse Gas Sources and Sinks in the Republic of Moldova*, pp. 96-97, www.clima.md/download.php?file=cHVibGljL3B1YmxpY2F0aW9ucy80MjAwODJfZW5fbmlyNV9lbl8yOTEyMTcucGRm.

Between 2010 and 2015, direct GHG emissions from transport increased by 7%: from about 2.05 million tCO_2e in 2010 to 2.2 million tCO_2e in 2015 (Table 6.15).

Table 6.15. Volume of GHG emissions from transport, 2010-15

(kilotonnes of CO_2e)

	2010	2011	2012	2013	2014	2015
CO_2	2 007.4	2 116.7	1 862.9	1 862.9	2 049.6	2 158.1
CH_4	10.9	11.0	9.3	9.3	9.4	9.9
N_2O	35.4	36.6	36.6	33.4	31.3	35.0
Total	**2 053.7**	**2 164.3**	**1 905.6**	**2 015.0**	**2 090.3**	**2 203.0**

Source: (GoM, 2017[13]), *National Inventory Report 1990-2015: Greenhouse Gas Sources and Sinks in the Republic of Moldova*, p. 97, www.clima.md/download.php?file=cHVibGljL3B1YmxpY2F0aW9ucy80MjAwODJfZW5fbmlyNV9lbl8yOTEyMTcucGRm.

In the period 2010-2015 the road sub-sector experienced an 8% increase in total direct GHG emissions, while those from the railway sub-sector decreased by 58% (Table 6.16).

Table 6.16. Breakdown of GHG emissions from transport, 2010-15

(kilotonnes of CO_2e)

	2010	2011	2012	2013	2014	2015
Domestic aviation	0.01	0.01	0.02	0.02	0.01	0.03
Road transport	1 993.9	2 111.2	1 845.1	1 965.7	2 070.4	2 161.7
Rail transport	57.3	52.7	56.6	36.2	3.0	24.2
Domestic navigation	0.2	0.2	0.3	0.3	0.3	0.1
Others*	2.1	0.0	3.3	12.6	16.5	16.7

Note: *including pipeline and off-road transportation.
Source: (GoM, 2017[13]), *National Inventory Report 1990-2015: Greenhouse Gas Sources and Sinks in the Republic of Moldova*, p. 98, www.clima.md/download.php?file=cHVibGljL3B1YmxpY2F0aW9ucy80MjAwODJfZW5fbmlyNV9lbl8yOTEyMTcucGRm.

The emission factors outlined in Table 6.17 were used to estimate the GHG emissions from transport in Moldova presented in the tables and graphs above, which use data from the National Inventory Report 1990-2015 (GoM, 2017[13]). According to the revised 1996 and 2006 IPCC Guidelines (IPCC, 1996[14]) (IPCC, 2006[15]), the carbon intensity of natural gas and petroleum gas is lower than for diesel and petrol fuels, even if we consider the high global warming potential (GWP) coefficients for methane (CH_4), nitrous oxide (N_2O) and most probably GHGs among the non-methane volatile organic compounds (NMVOCs).[47] In terms of air pollution, natural gas provides the best (i.e. the lowest) combined value of CO and NO_x emissions per energy used.

Table 6.17. Comparison of emissions from fuels used in the transport sector

(kilogramme per terajoule)

Fuel type	CO_2	CH_4	N_2O	NO_x	CO	NMVOC
Petrol	69 300	33	3.2	600	8 000	1 500
Diesel	74 100	3.9	3.9	800	1 000	200
Natural gas	56 100	92	3	600	400	5
Petroleum gas	63 100	33	3.2	600	8 000	1 500

Source: (GoM, 2017[13]), *National Inventory Report 1990-2015: Greenhouse Gas Sources and Sinks in the Republic of Moldova*, p. 98, www.clima.md/download.php?file=cHVibGljL3B1YmxpY2F0aW9ucy80MjAwODJfZW5fbmlyNV9lbl8yOTEyMTcucGRm.

6.3.2. Nationally appropriate mitigation actions

Moldova has submitted to the UNFCCC Secretariat its intended nationally determined contribution – INDC (GoM, 2015[16]). The INDC sets out the expected environmental goals and actions after 2020. The main goals are as follows:

- Unconditional goal: 64-67% reduction of GHG emissions by 31 December 2030 from the baseline year 1990.
- Conditional goal – 78% reduction of GHG emissions by 31 December 2030 from the baseline year 1990. This goal is conditional on additional international investment, and access to the mechanism for the transfer of low-carbon technologies, green climate funds and the "flexibility" mechanism for countries in transition.

Nationally appropriate mitigation actions (NAMAs) refer to a set of policies and actions that countries undertake as part of their commitment to reduce greenhouse gas emissions. These aim for transformational change within a single sector or across two or more sectors of the economy. Developed countries can support the implementation of NAMAs in transition countries by financing technologies or capacity building activities.

The UNFCCC website provides a NAMA Register – a publicly accessible platform for uploading all countries' NAMAs. This makes it possible to inform the public where financial or other support for the development or implementation of NAMAs is needed.

The UNFCCC Register contains three NAMA projects for Moldova:

1. "Use of energy willow for heat generation in the Republic of Moldova" in the section "NAMA Seeking Support for Implementation". Implementing agency – Ministry of Agriculture, Regional Development and Environment.[48] The total project cost is about USD 94 million, with expected international support of about 90%. The project has not yet received support.
2. "Afforestation of degraded land, riverside areas and protection belts in the Republic of Moldova", in the section "NAMA Seeking Support for Implementation". Implementing agency – Ministry of Agriculture, Regional Development and Environment.[49] The total project cost is about USD 151 million, with expected international support of about 73%. The project has not yet received support.
3. "Implementation of soil conservation tillage system in the Republic of Moldova", in the section "NAMA Seeking Support for Implementation". Implementing agency – Ministry of Agriculture, Regional Development and Environment.[50] The total project cost is about USD 258 million, with expected international support of about 70%. The project has not yet received support.

6.3.3. Air pollution

Law No. 1422 of 17 December 1997 on Atmospheric Air Protection, as amended, is the main legislation regulating atmospheric emissions. Art. 17 regulates emissions from transport. It states that maximum emissions standards must not be exceeded.

Article 56 of Law No. 1515 of 16 June 1993 on Environmental Protection, as amended, states that the management bodies in the energy, industry, agriculture sectors, as well as the local public administration authorities and the environmental and health authorities, are obliged, among others, to:

- define and propose to the government for approval the annual limits of energy production and consumption, and the admissible annual limits of harmful emissions in the atmosphere from fixed and mobile sources, and to not allow the established limits and norms to be exceeded
- create and ensure the functioning of an air quality surveillance system throughout the country, based on international standards.

The Environmental Audit Report on Air Quality in the Republic of Moldova (GoM, 2018[17]), as approved by Government Decision No. 65 of 30 November 2017, reviews the situation with regard to addressing air quality problems in the country. While the report notes that air pollution from vehicles has declined (8-10 times below the levels 30 years ago), it also cites transport as the main source of air pollution, in particular in urban areas. It also states that on the country level transport accounts for 86.2% of all harmful substances

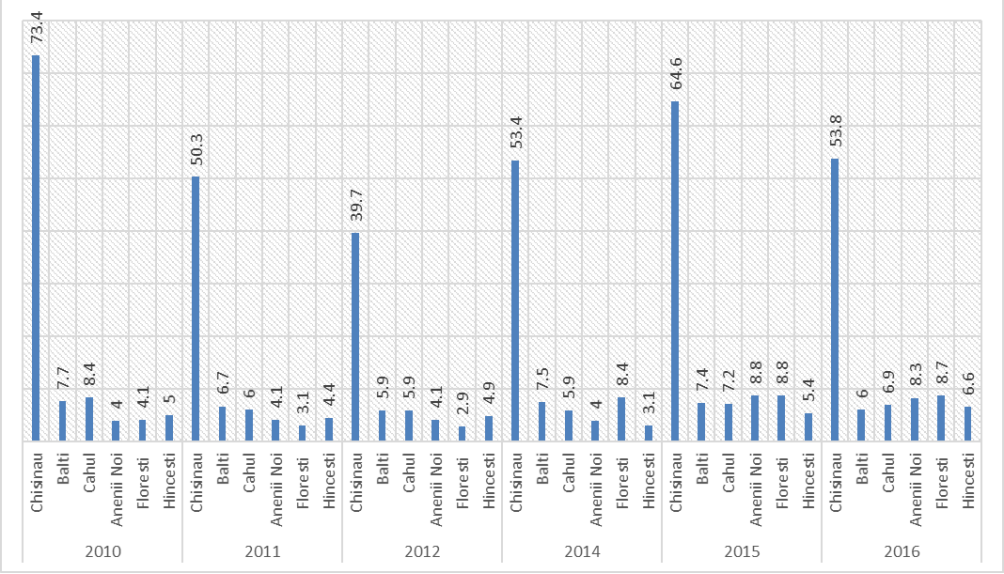
emitted into the air. This results from the increase in the number of vehicles, exacerbated by the fact that old used vehicles – those in operation for seven years or more – are being imported. The report states that between 2014 and 2016, the number of vehicles registered increased by 51 200 units.

However, total pollution from combustion engines decreased by 13 000 tonnes in 2016 from 2014 levels (from 179 000 to 166 000 tonnes), due to the increased in registered electric and natural gas-powered vehicles. But a significant proportion of registered vehicles still in circulation use diesel as fuel (35%), including those in urban public transport.

Figure 6.13 shows the emission trends of harmful substances from road transport in key cities in Moldova for 2010-2016.

Figure 6.13. Emissions of harmful substances from automobiles in major cities in Moldova, 2010-16

(thousand tonnes)



Source: (GoM, 2018[17]), *Environmental Audit Report on Air Quality in the Republic of Moldova*, p.12, http://lex.justice.md/UserFiles/File/2018/mo18-26md/raport_65.doc (based on data from 2016 IES Yearbook on Environmental Protection in the Republic of Moldova).

The audit report cited the lack of timely information on air quality as an important problem to be addressed. In 2015, the State Environmental Inspectorate submitted a proposal to the National Environmental Fund to finance the project "Strengthening the material and technical basis of ecological investigation centres (in Chisinau, Balti and Cahul)", valued at MDL 2 million (USD 108 000). The project objective was to modernise environmental monitoring equipment, including equipment capable of measuring emissions from road transport. The project was not funded.

The audit report points out that the existing institutional organisation is not integrated, is characterised by poor co-operation among public authorities and institutions responsible for air quality management, and does not ensure an organised or unified approach to problems related to air quality. Moreover, measures taken to prevent and mitigate air pollution are inefficient. In the past, the Ministry of Environment did not have a division

responsible for air pollution. Following government reforms, however, the Ministry of Agriculture, Regional Development and Environment (MARDE) has established the Air and Climate Change Office.

The audit revealed weaknesses in vehicle testing, including the failure, or even absence, of particular meters and gas analysers. Automobiles "imported" from abroad, with foreign registration numbers, are often not tested for their technical condition, instead relying on technical inspection certificates from the country of origin. Moreover, information on vehicle testing is general and therefore it is difficult to assess the impact of vehicle traffic on air quality.

Moldova does not apply EU standards for vehicle emissions. These are still regulated according to regional, Commonwealth of Independent States (CIS)-administered, formerly Soviet, GOST (Russian for "state", "national") standards, which require the removal of 50% of particulates from diesel engines (ГОСТ 17.2.2. 03-87 and ГОСТ-21393-75).[51] According to experts cited in the audit report, emissions do not exceed current GOST standards, largely because they are equivalent only to Euro 0 or Euro 1/I standards.

The audit found no real environmental factors in the strategic documents in the transport sector, such as the National Transport Strategy 2008-2017 (GoM, 2008[18]) and the Transport and Logistics Strategy 2013-2022 (GoM, 2013[19]).

There are two main public entities in Moldova responsible for air monitoring:

1. The State Ecological Inspectorate (Inspectoratul Ecologic de Stat – IES[52])
2. The State Hydrometeorological Service (Serviciul Hidrometeorologic de Stat – SHS[53]).

Both of these fall under the remit of the Ministry of Agriculture, Regional Development and Environment (MARDE). According to Government Decision No. 847 of 18 December 2009 on the Approval of Regulation on Organisation and Operation of the Ministry of Environment, as subdivisions of MARDE, the IES and SHS are responsible for air pollution monitoring and air protection.

The monitoring network comprises 17 stationary monitoring stations located in five industrial centres (Chisinau – 6 stations; Balti – 2; Bender – 4; Tiraspol – 3; and Ribnita – 2). These collect air samples for testing for 8-9 pollutants: particulates, sulphur dioxide (SO_2), carbon monoxide (CO), nitrogen dioxide (NO_2) and four to five specific pollutants.[54] The daily values as well as seasonal maps of atmospheric air pollution for these five cities (urban areas) are published on the SHS website.[55]

The audit report noted, however, that the results from the 17 stations do not sufficiently reflect the real air quality situation because they are collected only three times a day. Moreover, the results are not live, but processed and presented the following day (GoM, 2018[17]).

The Ministry of Health, Labour and Social Protection sets out the norms for the maximum allowed concentrations of pollutants in the atmosphere, while compliance with air quality standards is monitored by the Ministry's National Agency for Public Health.

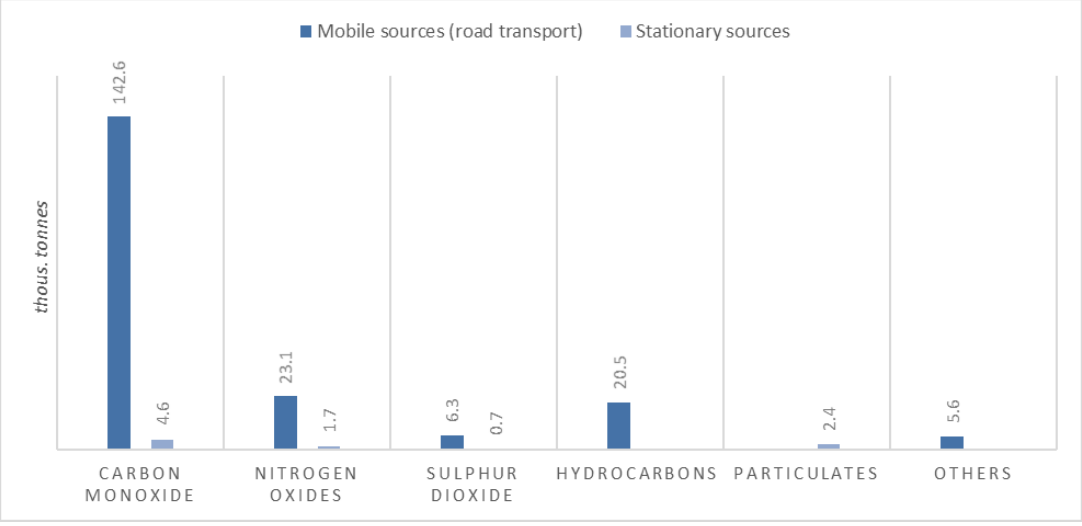
Road transport is the main source of air pollution in Moldova, in particular in urban areas. According to measurements carried out by the Municipal Centre of Preventive Medicine in eight points in Chisinau, and the data of the national meteorological service "Hydrometeo", the air in Chisinau is polluted with one or more types of toxic gas on 50% of the days of the year (BCI and TUM, 2006[20]).

Laboratory surveys of air samples carried out by the Municipal Centre for Preventive Medicine on the orders of Chisinau's chapter of the non-government organisation (NGO) Ecological Movement of Moldova (*Mişcarea Ecologistă din Moldova* – MEM)[56] showed that high levels of pollution are recorded near the main routes, such as in the area of Bănulescu-Bodoni Street, Vasile Alecsandri St. – Hancesti St., Iu. Gagarin Bd., Tighina St., Ismail St., Alba-Iulia Street; and transport node Ismail - Calea Basarabiei - Varniţa - Calea Moşilor. In these locations, the maximum concentrations of formaldehyde – CH_2O (1.2–5.7 times the maximum allowable concentrations – MAC), particulates (1.2–3.6 times MAC), sulphur dioxide (1.2–7.0 times MAC), and ozone (1.1–3.6 times MAC) are exceeded substantially. Heavy concentrations of formaldehyde have been detected even in the air samples in the middle of Valea Morilor Park. Another acute environmental and health problem is the increased amount of dust in the atmosphere due to the poor state of roads (BCI and TUM, 2006[20]).

While air pollution data in other Moldovan cities are not readily available or reported,[57] they too experience air pollution problems typical of cities in the eastern part of Europe. Of particular concern are levels of PM2.5 and PM10 from using wood and coal for home heating and from diesel fuels.

According to the WHO database (2018), every year ambient air pollution in Moldova causes about 3 500 deaths, most of which are due to ischaemic heart diseases.[58] This is a significant increase on the figure stated in the 2009 WHO Moldova profile, which estimated that outdoor air pollution had caused 1 000 deaths a year since 2004 (WHO, 2009[21]). As can be seen in Table 6.5 above, in 2010-2017 the number of registered vehicles in Moldova increased by 37.8%. It is therefore not surprising that in 2018 road transport emitted 31 times more carbon monoxide (CO), 14 times more nitrogen oxides (NO_x) and 9 times more sulphur dioxide (SO_2) than stationary sources (Figure 6.14).

Figure 6.14. Air pollution from transport versus stationary sources in Moldova, 2018



Note: Values for the last three categories (hydrocarbons, particulates, others) were available only for one source group. Data on districts on the left bank of the Dniester River and the Bender Municipality not included.
Source: National Bureau of Statistics (www.statistica.md).

6.3.4. Influence of air pollution from diesel engines on human health

Diesel engines emit carbon dioxide (CO_2), carbon monoxide (CO), nitrogen oxides (NO_x), sulphur dioxide (SO_2) and particulate matter (PM). The air pollution from diesel engines, especially older ones, poses major environmental and health risks to the population (Box 6.1). Increased air pollutants carry a risk of mortality, in particular among people of over 65 (Pope et al., 1995[22]). Above all, diesel exhaust is a Group 1 carcinogen,[59] causing lung cancer and being linked to bladder cancer.

Box 6.1. The impact of diesel exhaust emissions

Carbon dioxide (CO_2*)*: non-toxic, but as a greenhouse gas it causes climate change.

Carbon monoxide (CO): a temporary atmospheric pollutant in some urban areas, chiefly from the exhausts of internal combustion engines. Carbon monoxide is absorbed through breathing and enters the bloodstream through gas exchange in the lungs. It is toxic when encountered in concentrations above about 35 ppm.

Nitrogen oxides (NO_x*)*: NO_x refer to a mixture of nitric oxide (NO) and nitrogen dioxide (NO_2). They are produced during combustion, especially at high temperatures. Due to reactions and photolysis by sunlight, they are the main source of tropospheric ozone. NO_x may react with water to make nitric acid, which may end up in the soil where it makes nitrate, which is of use to growing plants. NO_x in combination with other pollutants creates urban smog. High concentrations of nitrogen dioxide are harmful to humans because they cause inflammation of the airways.

Sulphur dioxide (SO_2*)*: SO_2 pollution levels from diesel mainly depend on the quality of the fuel. If the fuel contains more sulphur, the diesel exhaust will contain more SO_2. Sulphur dioxide emissions are a precursor to acid rain and atmospheric particulates. Inhaling sulphur dioxide is associated with increased respiratory symptoms and diseases, and difficulty in breathing.

Particulate matter (PM): the major pollutants with negative health effects are PM (2.5 and 10). The particles are so small they can penetrate into the deep regions of the lungs. It is estimated that approximately 3% of cardiopulmonary and 5% of lung cancer deaths are attributable to PM globally. Exposure to PM2.5 reduces life expectancy by about 8.6 months on average.

Since 2000, PM pollution has been estimated to cause 22 000 to 52 000 deaths every year in the United States. It also contributed to about 370 000 premature deaths in Europe in 2005, and 3.22 million deaths globally in 2010, according to a study of the global burden of disease (Lim et al., 2012[23]).

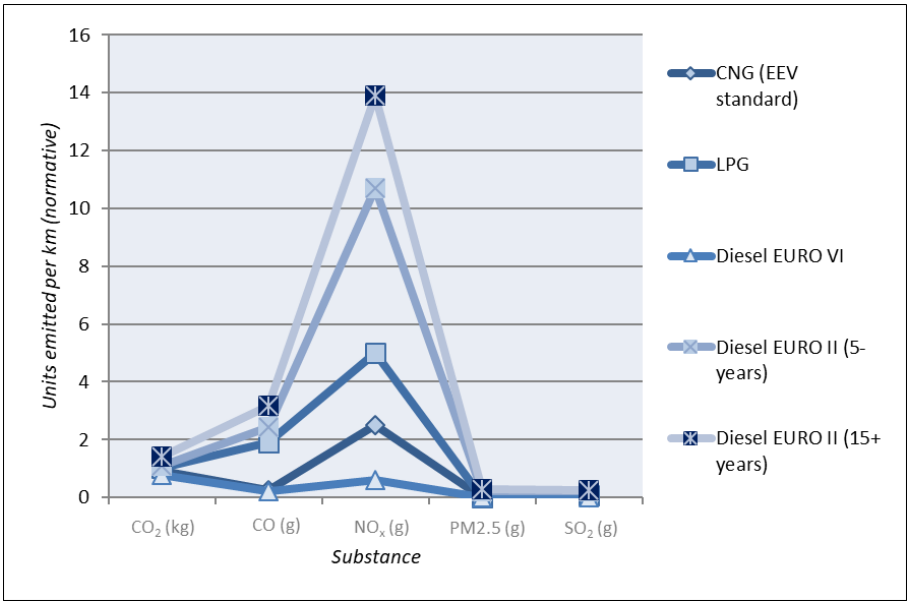
There is no evidence of a safe level of exposure to PM, or a threshold below which no adverse health effects occur. The World Health Organization Air Quality Guidelines values for PM in 2005 were as follows (WHO, 2013[24]):

- for PM2.5: 10 micrograms per cubic metre ($\mu g/m^3$) for the annual average and 25 $\mu g/m^3$ for the 24-hour mean (not to be exceeded on more than 3 days/year)
- for PM10: 20 $\mu g/m^3$ for the annual average and 50 $\mu g/m^3$ for the 24-hour mean.

Figure 6.15 and Figure 6.16 compare the increased emissions of health-damaging substances by old diesel-powered engines (especially those aged at least 15 years) with

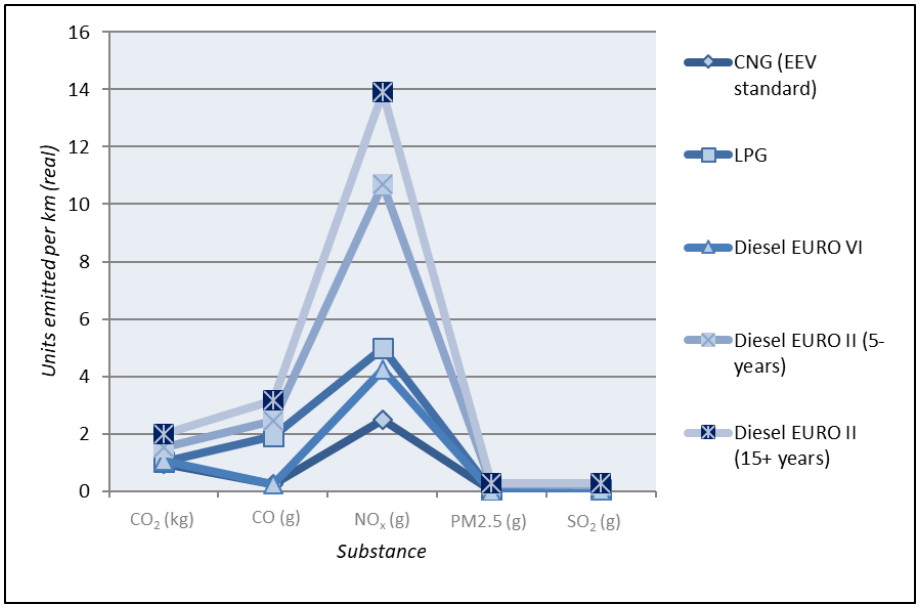
modern diesel engines and alternative fuels, compressed natural gas (CNG) and liquefied petroleum gas (LPG).

Figure 6.15. Assumed amount of health-damaging substances emitted per distance travelled (normative*)



Note: *for a discussion of normative and real pollution factors, see Section 2.3.1.
Source: (DieselNet, 2016[25]), "EU: Heavy-Duty Truck and Bus Engines: Regulatory Framework and Emission Standards", *DieselNet website*, www.dieselnet.com/standards/eu/hd.php (last accessed 30 March 2017).

Figure 6.16. Assumed amount of health-damaging substances emitted per distance travelled (real*)



Note: *for a discussion of normative and real pollution factors, see Section 2.3.1.

Source: (DieselNet, 2016[25]), "EU: Heavy-Duty Truck and Bus Engines: Regulatory Framework and Emission Standards", *DieselNet website*, www.dieselnet.com/standards/eu/hd.php (last accessed 30 March 2017).

The replacement of outdated buses with modern diesel-powered or natural gas-powered buses – or the expansion of trolleybus networks in place of diesel-powered vehicles – would help significantly to reduce the amount of major air pollutants, such as particulates, NO_x and SO_2. A clean public transport programme is thus justified from a public health standpoint.

6.4. The energy sector

6.4.1. Energy efficiency and fuel standards

Law No. 461 of 30 July 2001 on the Petroleum Products Market provides for the formation of an organisational, legal and economic framework for ensuring the economic security of the country and regulating the import, transport and marketing of petroleum products on the domestic market as strategic products with a special regime of activity.

Law No. 142 of 2 July 2010 on Energy Efficiency regulates activities meant to reduce the energy intensity of the national economy and the negative impact of the energy sector on the environment. This law creates the necessary legal framework for the implementation of EU Directive 2006/32/EC on energy end-use efficiency and energy services (EU, 2006[26]). The Energy Efficiency Agency, subordinated to the central specialised body in the energy field (i.e. the Ministry of Economy and Infrastructure), has a separate legal entity status and a separate budget (Art. 8, par. (1) of the law).

The Energy Strategy of the Republic of Moldova until 2030 (GoM, 2013[27]), approved by Government Decision No. 102 of 5 February 2013, provides benchmarks for the development of the energy sector in Moldova in order to create the necessary basis for economic growth and social welfare. Through this document, the government presents its vision and identifies the country's strategic opportunities in the rapidly changing energy landscape of the geopolitical space that includes the Central, Eastern and Southern Europe region, Russian Federation and the Caucasus region.

The strategy highlights the country's priority issues, which call for quick solutions and a reshaping of objectives to achieve an optimal balance between internal resources (both currently used and projected) and the country's emergency needs, and the Energy Community (see the next section) and national targets, international obligations on treaties, agreements and programmes (including neighbourhood policy) of which the Republic of Moldova is a member. The strategy outlines the general strategic objectives and implementation measures for the period 2013-2030, as well as the specific strategic objectives for the 2013-2020 and 2021-2030 phases.

The National Energy Efficiency Programme 2011-2020 (GoM, 2011[28]), as approved by Government Decision No. 833 of 10 November 2011, sets long-term energy saving targets of up to 20% by 2020. It states that 10% of biofuels are to be produced from renewable sources by 2020, with intermediate targets (by 2015) of:

- 6% of ethanol and petrol blends in the volume of petrol sold
- 5% of biodiesel blend in the volume of gas oil sold.

According to the Road Transport Code, from 1 January 2020, only buses and coaches complying with at least Euro I norms (Art. 153 par. (9)) will be allowed for road transport.

6.4.2. Electricity network

Moldova's energy security depends on Russian gas and electricity delivered from Transnistria.[60] The limited options for diversifying energy routes and supplies make the country reliant on political stability in Romania and Ukraine. Moldova's electricity sector is partially unbundled and privatised. Electricity generation is separated from the transmission and distribution system. The electricity distribution system is privatised, while generation and transmission are under state ownership.

A self-sufficient power sector is not an option for a country the size of Moldova. The country's electricity network is connected to Ukraine only and the countries' two systems operate in parallel. Both systems were originally designed as an integral part of the Soviet grid in its southern region.[61] At the moment, Moldova serves only as an island mode for local supply.[62] However, integrating with the regional power market is a policy priority for Moldova. In 2010, Moldova joined the Energy Community – an international organisation that aims to create a pan-European (EU and non-EU countries) energy market – and plans to fully synchronise its network with the European electricity market.[63] As a first step, Moldova introduced market principles, especially for the management of its natural gas and electricity sectors, based on the adoption of core EU energy legislation which is part of its *acquis communautaire* (IRENA, 2019[29]).

Its planned integration into the EU system via Romania and Bulgaria[64] will not only help to improve country's efficiency in the electricity market, but will also secure a more diversified power supply and extend the country's generation capacity. Connecting to the competitive Romanian market will also help to increase transparency in Moldova's electricity procurement (currently based on bilateral contracts mainly through intermediaries). Conversely, while continued dependency on Ukraine (and Transnistria) will possibly secure lower electricity prices, this will be at the cost of market dysfunctionalities, vulnerability to supply disruptions and uncertainty for potential (European) investors.

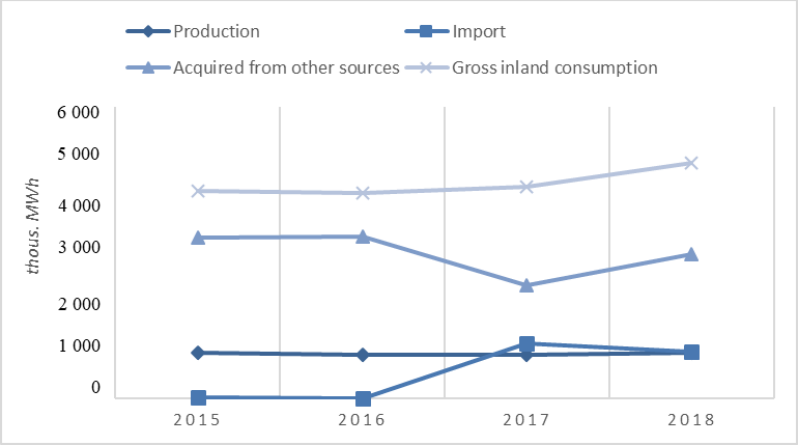
In 1997, after implementing reforms in the energy sector, Moldenergo – a state monopoly for the production of heat and electricity – broke up into 16 new entities (i.e. eight electricity generation companies, three district heating companies and five electricity distribution companies). This power sector reform was largely prompted by supply shortages and service disruptions. In 2000, three of the five regional electricity distribution networks (REDs Chisinau, Centru and Sud) were sold in an open tender to the Spanish utility and investor company Union Fenosa International. In 2008, the three Moldovan distribution companies merged into RED Union Fenosa, which in 2010 became part of the international group Gas Union Fenosa (UNECE, 2009[30]).[65] This company holds around 70% of market shares in Moldova (covering 19 regions, including the capital of Chisinau; (PRNewswire, 2019[31]), while the remaining 30% are held by the state-owned RED enterprises (RED Nord based in Balti and RED Nord-Vest based in Donduseni). The transmission network is operated by one state-owned company, Moldelectrica.[66]

The National Agency for Energy Regulation of Moldova (*Agenţia Naţională pentru Reglementare în Energetică a Republicii Moldova* – ANRE)[67] still regulates most electricity tariffs for production, transmission and distribution based on generation costs so that the recovery of investment can be guaranteed (cost-recovery tariffs). Electricity prices

are adjusted and approved on a yearly basis applying a five-year rate-of-return methodology. On the policy level, the Ministry of Economy and Infrastructure is responsible for energy sector policy making and for leading the sector dialogue.[68] The main directions of Moldova's energy policy are reflected in its Energy Strategy until 2030 (GoM, 2013[27]).

Electricity generation in/for Moldova is mainly fuelled by Russian-supplied natural gas. In 2018, total domestic generation stood at about 882 gigawatt hours (GWh), whereas gross inland (domestic) consumption was 4 852 GWh (Figure 6.17). Since domestic generation capacity only covers 18% of consumption (see below), the shortage is covered by imports (totalling 956 GWh) and other sources (Transnistria, totalling 2 965 GWh).[69]

Figure 6.17. Supply and demand in Moldova's electricity sector, 2015-18



Note: MWh: Megawatt hour. Data on districts on the left bank of the Dniester River and the Bender Municipality not included.
Source: National Bureau of Statistics (www.statistica.md).

Moldova's limited domestic electricity supply comes primarily from two combined heat and power (CHP) plants in Chisinau. These CHP plants are operated by Termoelectrica (with a total capacity of 306 MW) which accounts for 69% of the installed capacity in Moldova on the right bank.[70] There are a few other power plants, including CHP-Nord in Balti (24 MW),[71] a run-of-river hydropower plant in Costesti (Stanca-Costesti – 16 MW), as well as four additional coal-fired CHP plants built to service four sugar producing enterprises (98 MW).

Due to the *de facto* separation of the Transnistria Region, Moldova's most important power plant, Moldavskaya GRES (MGRES),[72] is located in Dnestrovsc on the shores of Lake *Cuciurgani (Kuchurgan)* in Transnistria (bordering Ukraine). MGRES is a gas-fired power plant[73] which is operated by a subsidiary of the Russian Public J.S.C. Inter RAO UES. MGRES is not controlled by the Moldovan authorities but its installed capacity (of 2 520 MW) accounts for 84% of the total generation capacities on both banks of the Dniester River. The second (minor) power plant on the left bank is HPP Dubasari (with a capacity of 48 MW) (Zachmann and Oprunenco, 2010[32]).

Due to difficult relations with Transnistria and the deterioration of generating capacities (leading not only to high generation costs but also inflexibility), Moldova imports cheaper electricity from Ukraine (via J.S.C. Energocom) and from Romania (Transelectrica S.A.). The location of the MGRES gives the Transnistrian authorities a competitive advantage

resulting from "free" natural gas supplied by Tiraspol-Transgaz. MoldovaGaz – the leading supplier and distributor of natural and petroleum gas in Moldova and Transnistria – operates as a subsidiary of the Russian company Gazprom.

It is interesting to note that Transnistria's contract is with MoldovaGaz, not with Gazprom. However, for all the years since it was established, Tiraspol-Transgaz (the Transnistrian gas supplier) has failed to pay MoldovaGaz for the gas supplied, which resulted in a huge debt between MoldovaGaz and Gazprom (OECD, 2018[33]). In addition to MoldovaGaz's debt, Gazprom raised gas prices by 25% in 2019 (Livadari, 2019[34]); (Necsutu, 2019[35]). The sustainability of this non-transparent payment arrangement is also questionable given the decreasing supplies from the Russian Federation to Ukraine.

6.4.3. Diversifying energy sources

Clearly, diversifying its energy supply is a priority for the Government of Moldova.[74] A new gas power plant would only slightly contribute to achieving this goal, given the dependence on gas supplied by the Russian Federation. As a member of the Energy Community, Moldova needs to meet obligations under Directive 2009/28/EC on promoting the use of energy from renewable sources (EU, 2009[36]). This established a mandatory target of producing 20% of energy from renewable sources by 2020. This target has been incorporated into national legislative documents – such as the National Energy Efficiency Programme 2011-2020 (GoM, 2011[28]), the Energy Strategy to 2030 (GoM, 2013[27]) and the Renewable Energy Law from 2007 (No. 160 of 12 July).

This 20% target seems difficult to achieve, even if renewables were to include sources other than wind and solar (e.g. biomass). Currently Moldova's renewable energy production capacity is rather limited, i.e. up to 21 GW for wind and 4.5 GW for solar photovoltaic (PV). These together constitute about 3% of total domestic energy production. To support the production of renewable energy, in 2013, the Moldovan government introduced a green (feed-in) tariff. Although Moldova recently announced the development of 168 MW of renewable generation capacity (mainly wind and solar PV), this is still more of a vision rather than a realistic development plan and cannot be seen as a major generation source for the near future (IRENA, 2019[29]).

6.5. Conclusions for the CPT Programme

Since 1991, Moldova has adopted a significant number of national legislative acts and made international commitments with regard to environmental protection, GHG reduction, energy efficiency and air quality improvement and also, lately, green economy transformation.

Still, Moldova needs to make several legislative and policy improvements, in particular passing more stringent emissions and fuel standards – i.e. moving away from GOST standards to EU standards – and ensuring their enforcement. Real-time information about air pollution should also be provided in order to raise awareness of the problem of air pollution from road transport in the cities.

The analysis in this chapter provides a sound justification for the CPT Programme – both in terms of improving the quality of public transport, as well as quality of life, health and the environment.

With road transport contributing the bulk of air pollution (up to 96%) in Moldova, the replacement of the worn-out public vehicle fleet with modern CNG, LPG or diesel Euro V/VI buses would help reduce ambient air pollution – especially particulate matter (PM), NO_x and SO_2 – and bring GHG emissions in line with the country's emission-reduction objectives.

However, improved energy intensity of vehicles (megajoule/passenger-km or megajoule/tonne-km) and carbon intenstity of fuels (CO_2e/megajoule) cannot stand alone. In addition to investments to replace vehicle fleets, reducing pollution from urban public transport will require a combination of measures:

- avoiding or reducing the need for travel (either through better urban planning or changing personal behaviour)
- shifting travel from private cars to non-motorised modes (walking, cycling) or public transport
- improving existing forms of transport through technical improvements (especially in energy intensity of vehicles and carbon intensity of fuels and energy carriers).

The combination of mass public transport with non-motorised modes of transport offers the greatest mitigation potential. The first step in this direction would be to increase the capacity and number of public transport vehicles (bus and trolleybuses). The diversification of the fleet structure, increasing energy efficiency and a modal shift from car to public transport would also improve resiliency against future energy price rises (diesel, gas, electricity). Regulations on the operation of ageing vehicles, sufficient maintenance, and technical inspection of vehicles are necessary prerequisites.

However, there also needs to be an increased demand for these services, as the economic and environmental viability of public transport will only be achieved through increased demand. Improving the quality of the public transport to meet passenger expectations, including redesigning the urban transport network, would make it more attractive. It would also help to reduce the social costs of transport – such as time lost due to congestion, air pollution, accidents etc. – which can generally account for several percent of GDP (though this has not been assessed in Moldova).

Developing countries have greater opportunities to shape urban infrastructure and transport systems than OECD countries where transport systems are largely locked-in.

Notes

1. See geographical description on the official website of the Republic of Moldova: http://moldova.md/en/content/geography.

2. Excluding the eastern districts and the city of Bender, which have a population of about 505 000.

3. According to the provisions of Law No. 764 of 27 December 2001 on the Administrative-Territorial Organisation of the Republic of Moldova.

4. Pursuant to Law No. 438 of 28 December 2006 on Regional Development in the Republic of Moldova. The development regions are: North, Centre, South, Chisinau, ATU Gagauzia, and Transnistria. Regional Development Agencies, subordinate to the Ministry of Agriculture, Regional Development and Environment have been established in all but the Chisinau and Transnistria regions.

5. Note there is a discrepancy between the latest NBS (2018) and the last census (2014) data – which are also made available on the NBS website – possibly because the former might take into account citizens of Moldova living/working abroad.

6. Figures as of 1 January 2018. See NBS on resident population by age group, years, area and sex at at: http://statbank.statistica.md/pxweb/pxweb/en/20%20Populatia%20si%20procesele%20demografice/20%20Populatia%20si%20procesele%20demografice__POP010/POP010100.px/table/tableViewLayout1/?rxid=b2ff27d7-0b96-43c9-934b-42e1a2a9a774.

7. Ibid.

8. Since 1998, figures do not include data on districts from the left bank of the river Nistru and municipality Bender (449 800 inhabitants in 1997). See ibid. and resident population by cities 1980-2018 at: http://statbank.statistica.md/pxweb/pxweb/en/20%20Populatia%20si%20procesele%20demografice/20%20Populatia%20si%20procesele%20demografice__POP010/POP010500reg.px/?rxid=b2ff27d7-0b96-43c9-934b-42e1a2a9a774.

9. Household Budget Surveys (HBSs) were conducted by the National Bureau of Statistics (NBS) in 2007-2014. See also (World Bank, 2016[37]).

10. National Bureau of Statistics (www.statistica.md).

11. Ibid.

12. See WB data on GDP per capita, PPP (current international USD), for Moldova at: https://data.worldbank.org/indicator/NY.GDP.PCAP.PP.CD?locations=MD.

13. Calculated using WB population data, available at: https://data.worldbank.org/indicator/SP.POP.TOTL?view=chart; and WB total GHG emissions (kt of CO_2 equivalent) data available at: https://data.worldbank.org/indicator/EN.ATM.GHGT.KT.CE.

14. See OECD/IEA statistics on energy use (kg of oil equivalent) per USD 1 000 GDP (constant 2011 PPP) from 2014 at: https://data.worldbank.org/indicator/EG.USE.COMM.GD.PP.KD?locations=MD-OE-EU-1W&view=chart.

15. See the World Bank database on CO_2 emissions (kg per PPP USD of GDP) at: https://data.worldbank.org/indicator/EN.ATM.CO2E.PP.GD?end=2014&locations=MD-OE-EU&start=1990&view=chart.

16. Figure from March 2019. For BNM's information on financial and economic activities of banks, see: www.bnm.md/bdi/pages/reports/drsb/DRSB1.xhtml?id=0&lang=en.

17. Then the country's largest bank.

18. In 2010-14, an amount equivalent to one-eighth of the country's GDP was laundered – mainly through Latvia's financial system – to overseas (UK- and Hong-Kong-based firms) through a series of transactions that made no sound economic rationale (dodgy loans, asset swaps and shareholder deals). See (Whewell, 2015[40]) and (Tanas, 2017[39]).

19. For Moldova's GDP growth from World Bank national accounts data, see: https://data.worldbank.org/indicator/NY.GDP.MKTP.KD.ZG?locations=MD.

20. See BNM's official exchange rates at: www.bnm.md/en/content/official-exchange-rates.

21. Between the first half of 2015 and the first half of 2016. See: www.statistica.md/public/files/serii_de_timp/resurse_energetice/infraanuale/Energy_prices_HH_eng.xls.

22. The shares had first been blocked in December 2015 and the shareholders were requested to resell them within a period of 90 days. Since this did not happen, the shares were cancelled in March-June 2016 and new shares of a similar amount were to be issued by Agroindbank on the Moldova Stock Exchange in September 2016 (IMF, 2016[7]).

23. In October 2016, the Moldindconbank was put under temporary special administration by the BNM based on an on-site inspection launched in June 2016, which covered the three largest banks (i.e. together with Agroindbank and Victoriabank).

24. Banca Transilvania became the third EU banking group with operations in Moldova. In 2005, Erste Group acquired a branch in Chisinau through its purchase of the Romanian market leader BCR and in 2007, Société Générale bought Mobiasbanca.

25. For information on the acquisition and future plans, see for instance: www.ebrd.com/news/2018/ebrd-welcomes-banca-transilvanias-acquisition-of-victoriabank-stake.html.

26. Data as of March 2019. Before the impact of the banking crisis began to be felt, the ratio was as high as 86% (September 2015), and then declined deeply to 59% (August 2015), reflecting the removal of "inflated" assets of the three banks (which became insolvent in the course of 2015). See BNM's information on financial and economic activities of banks in Moldova at: www.bnm.md/bdi/pages/reports/drsb/DRSB1.xhtml?id=0&lang=en.

27. See World Bank and OECD national accounts data at: https://data.worldbank.org/indicator/NY.GDS.TOTL.ZS?locations=MD.

28. See BNM's information on financial and economic activities of banks in Moldova at: www.bnm.md/bdi/pages/reports/drsb/DRSB1.xhtml?id=0&lang=en.

29. Partly due to banks' sale of collateral, and collaboration with real estate in finding buyers for it. See BNM's statement on the financial situation of the banking sector at: www.bnm.md/en/content/financial-situation-banking-sector-2018.

30. Inflation has remained within a stable range since May 2016, not surpassing 8.0% on a monthly basis. See BNM for current annual inflation data at: www.bnm.md/en/content/inflation.

31. See www.bnm.md/en/content/nbm-interest-rates.

32. See BNM's weighted average interest rates on new loans and deposits attracted and associated volumes at: www.bnm.md/bdi/pages/reports/dpmc/DPMC4.xhtml.

33. Currency risk (or a foreign exchange risk) is the potential risk of loss from fluctuating foreign exchange rates.

34. See BNM's monetary policy decision of 4 September 2018 at: https://www.bnm.md/en/content/monetary-policy-decision-4-september-2018. For BNM's required reserves, see: www.bnm.md/en/content/required-reserves.

35. And in part reflecting under-execution of capital expenditure.

36. See Moody's rating action from November 2018 at: www.moodys.com/research/Moodys-affirms-Moldovas-B3-rating-outlook-stable--PR_390985.

37. Georgia and Turkmenistan – as they are not members of the Commonwealth of Independent States (CIS) – are not included in the statistics of the Interstate Statistical Committee of the CIS (www.cisstat.com).

38. Including the left bank of the Dniester River.

39. Ministry of Economy and Infrastructure (https://mei.gov.md).

40. Tourism Agency of the Republic of Moldova (www.turism.gov.md).

41. Public Services Agency (www.asp.gov.md/en/date-statistice).

42. National Agency of Road Transport (http://anta.gov.md).

43. Railway and Bus Stations Enterprise (https://autogara.md).

44. National Bureau of Statistics (www.statistica.md).

45. Urban Bus Park (www.autourban.md).

46. National Bureau of Statistics (www.statistica.md).

47. For current global warming potential assessments, see IPCC AR5 reports at: www.ipcc.ch/assessment-report/ar5.

48. See "NS-284 – Use of energy willow for heat generation in the Republic of Moldova" at: http://www4.unfccc.int/sites/nama/_layouts/un/fccc/nama/NamaSeekingSupportForImplementation.aspx?ID=195&viewOnly=1.

49. See "NS-283 – Afforestation of degraded land, riverside areas and protection belts in the Republic of Moldova" at: http://www4.unfccc.int/sites/nama/_layouts/un/fccc/nama/NamaSeekingSupportForImplementation.aspx?ID=194&viewOnly=1.

50. See "NS-282 – Implementation of soil conservation tillage system in the Republic of Moldova" at: http://www4.unfccc.int/sites/nama/_layouts/un/fccc/nama/NamaSeekingSupportForImplementation.aspx?ID=193&viewOnly=1.

51. For GOST 17.2.2. 03-87, see: http://docs.cntd.ru/document/1200005818 (Russian version). For GOST 21393-75, see: http://stroysvoimirukami.ru/gost-21393-75 (Russian version).

52. State Ecological Inspectorate (http://ies.gov.md).

53. State Hydrometeorological Service (www.meteo.md/index.php).

54. See SHS' Background Ambient Air Pollution Forecasting Division (BAAPFD): www.meteo.md/index.php/en/about-us/enviroment-quality-monitoring/mbient-air-quality-

monitoring-and-radioactive-background-level-center/background-ambient-air-pollution-forecasting-division.

55. For daily maps of atmospheric air pollution in Chisinau and Balti, see: http://www.meteo.md/index.php/calitatea-mediului/hri-zilnice-privind-poluarea-aerului-atmosferic

56. Ecological Movement of Moldova (http://mem.md).

57. In 2018, the GIZ drafted the Strategy for the Implementation of EU Compliant Ambient Air Quality Monitoring and Management in the Republic of Moldova as part of the project "Developing capacities for alignment with the EU climate targets in the Eastern Partnership countries". This strategy foresees creating at least 18 fixed and 1 mobile monitoring station (depending on finances) and will replace technology from the 1970s (which measures only the amount, but not sources, of air pollution). See also Section 1.1 of this report.

58. Data for July 2018. See WHO Global Health Observatory data repository: http://apps.who.int/gho/data/node.main.BODAMBIENTAIRDTHS?lang=en.

59. The Group 1 category is used when there is sufficient evidence of carcinogenicity in humans.

60. Although Transnistria declared independence in 1990, the UN considers the region to be part of Moldova (its sovereignty is recognised only by three UN non-member states).

61. This means it was overdesigned for Moldova's consumption needs. Nowadays, it still operates synchronously with the Integrated Power System/United Power System (IPS/UPS) (which includes Moldova and Ukraine). See also World Bank's "Moldova Competitive Power Market Project (P160829)" information document at: http://documents.worldbank.org/curated/en/470181541064261708/pdf/Concept-Project-Information-Document-Integrated-Safeguards-Data-Sheet-Moldova-Competitive-Power-Market-Project-P160829.pdf.

62. In other words, part of the country is not synchronised with one system (i.e. UPS/IPS) but synchronised with the other (i.e. ENTSO-E). This allows at least for an indirect trade between the two systems.

63. This also applies to environmental issues; for instance, Moldova needed to comply (by the end of 2017) with Directive 2010/75/EU of the European Parliament and of the Council of 24 November 2010 on industrial emissions (integrated pollution prevention and control) (EU, 2010[38]).

64. The former Eastern bloc countries in the region – Romania, Bulgaria and Hungary – have redesigned their electricity systems in the past three decades and are now connected to the Western system (formerly Union for the Co-ordination of Transmission of Electricity, now European Network of Transmission System Operators of Electricity ENTSO-E).

65. See Gas Natural Fenosa in Moldova at: www.gasnaturalfenosa.md/page/despre-noi.

66. Moldelectrica I.S. (http://moldelectrica.md).

67. ANRE is an independent public administration authority established in 1998. It is responsible for regulating and supervising electricity, gas, petroleum and (partly) district heating sub-sectors. ANRE is not subordinated directly to any central public authority but has reported to parliament since the regulatory reform of 2010. Despite its de jure independence, the government can assert its influence over the regulator through annual budget approval and appointment/dismissal of ANRE's directors.

68. See energy area of MoEI at: https://mei.gov.md/en/content/energy.

69. Excluding data on districts on the left bank of the Dniester River and municipality Bender. See http://statbank.statistica.md/pxweb/pxweb/en/40%20Statistica%20economica/40%20Statistica%20economica__15%20ENE/ENE010100.px/table/tableViewLayout1/?rxid=5360837a-13b5-4912-a2e0-12892e96d2ab.

70. Termoelectrica Moldova S.A. (www.termoelectrica.md).

71. CET-Nord S.A. (http://cet-nord.md).

72. ZAO Moldavskaya GRES (http://moldgres.com). Moldovan authorities, for instance, do not recognise the privatisation of MGRES, however, they issue certificates allowing electricity exports from Transnistria to the Balkans.

73. Previously also burning coal and fuel oil.

74. See, for instance, the EBRD power interconnection project between Moldova and Romania: www.ebrd.com/work-with-us/projects/psd/moldova-romania-power-interconnection-phase-i.html.

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7. Policy and regulatory framework for the transport sector

This chapter briefly discusses the main regulatory, institutional and organisational framework dealing with or having an impact on urban public transport in Moldova (including energy efficiency and air pollution control). All the legislative requirements and set-ups presented here – both technical and administrative – are discussed in the context of the extent to which they can facilitate the creation of demand for green investments in Moldova's public transport sector.

7.1. Regulatory framework affecting urban transport in Moldova

The general regulatory framework includes various acts that affect public transport, such as the legal relationships between the transport operators and passengers, and between operators and public administration bodies. Besides technical and road safety regulations, it also includes fiscal (such as customs duties for imported vehicles) and social (consumer) and environmental protection (such as emissions or energy efficiency standards).

The analysis of the acts regulating transport services shows that several provisions are insufficiently adapted to current economic realities and only partly harmonised with relevant European Union (EU) directives such as Directive 2014/23/EU on the award of concession contracts (EU, 2014[1]) or Directive 2006/32/EC on energy end-use efficiency and energy services (EU, 2006[2]).

7.1.1. The law on transport

Law No. 1194 of 21 May 1997 on transport sets out the general framework for the operation of all modes of transport in the territory of the Republic of Moldova. According to Art. 15, the country's transport system includes rail, car, air, naval, electric urban transport and pipeline transport. State administration of the transport system is carried out by the Ministry of Economy and Infrastructure (which now incorporates the former Ministry of Transport and Roads Infrastructure), the local public administration authorities and other authorised bodies (Art. 3). Article 4, par. (6) of the law stipulates that interference by local public administration authorities in the economic activity of transport companies, as well as the diversion of their operating personnel to other works, will only be permitted in the cases provided for under legislation. According to Art. 5, par. (2) of the law, the companies that are part of the transport system, irrespective of the type of property and the legal form of organisation, benefit from state protection on equal principles. The transport companies carry out transport and provide other services covered in contracts and orders for the carriage of passengers and goods, based on market economy principles (Art. 7). The law also deals with the liability of transport companies (Art. 10), as well as their obligations to ensure transport safety (Art. 13). Compliance with transport legislation is checked by the respective central and local public authorities within the limits of their competence (Art. 22).

7.1.2. The law on local public administration

Law No. 436 of 28 December 2006 on local public administration establishes and regulates the organisation and functioning of the public administrative authorities in the administrative-territorial units. Thus, according to Art. 14, par. (2), lit. c) and h), the competences of the councils of the first level local public administrative authorities include the “concession of public services of local interest, in accordance with the law” and “organisation of public communal services”.

The competences of the local government executive (mayor, local government of the first level) of relevance to public transport include:

- proposing to the local council the organisational structure and the terms and conditions for the provision of public utility services
- taking measures to ensure the proper functioning of communal services
- approving tariffs/fares for public transport in their jurisdiction

- ensuring the safety of road and pedestrian traffic by organising the circulation of transport; maintaining roads and bridges; and installing road signs within the boundaries of the administered territory
- ensuring the registration and record-keeping of trolleybuses.[1]

The district councils' (local public administration, second level) competences include:

- granting concessions for public services of district interest
- organising public services of district and/or regional interest
- approving tariffs for services provided.

7.1.3. The law on public services

Law No. 1402 of 24 October 2002 on Public Services of Communal Households is one of the most important acts affecting public transport, as it establishes a legal framework for the creation and organisation of public utilities in the administrative-territorial units, and for monitoring and controlling their operations, including the public transport service (Art. 3, par. (1), lit. e). The law establishes the principles and conditions for the organisation and operation of public utilities (Art. 3 – Art. 12), as well as the attributions and responsibilities of the central public administration (Art. 13) and local public administrative authorities (Art. 14 – Art. 15).

According to the law, the management of public utilities is organised through direct or delegated management (Art. 17). Direct management implies that local public administrative authorities assume all the tasks and responsibilities related to the organisation, operation, administration and management of public services through specialised departments. Each public utility established and operated under the direct management regime operates under a statute that is prepared and approved by the local public administration (Art. 18). In the case of delegated management, the local public administrative authorities may call upon one or more operators to manage the provision of public utility services (Art. 19) on a contractual basis (Art. 20).

Although the provisions of the law on public services are broadly harmonised with EU legislation, inconsistencies in secondary regulations mean these provisions remain theoretical and difficult to apply in practice.

7.1.4. Regulation of concessions in public services

The legal framework for concessions is provided for under Law No. 534 of 13 July 1995 on Concessions and Governmental Decision No. 1006 of 13 September 2004 on Approval of Regulation of Public Services Concession for Communal Households. While this legal framework allows, solely from a legal perspective, for the use of a concession contract for activities related to local public transport, this does not mean that the concession complies with the minimum requirements defined in EU legislation (Directive 2014/23/EU on the award of concession contracts). These requirements include transparent, non-discriminatory and proportionate selection criteria that allow continuous access by all economic operators to the provision of specific services, such as social services (which, in turn, allows customers to choose between such operators).

When defining concession (Art. 1), the law includes public services as a possible object of the concession contract. The law and the regulation, however, do not provide for a procedure to ensure equal treatment and non-discrimination of economic operators.

Consequently, the contracting authorities lack a framework for ensuring they act in a transparent and proportionate manner.

Compliance with minimum requirements established by EU legislation should be ensured from the very beginning, starting with the definition of concession. EU legislation defines a concession in relation to the risks assumed by the operators. The concession involves transferring risk (demand or supply risk or both) to the concessionaire in operating the works or services. The concession, as it is regulated by the national legal framework, does not reflect any kind of risk.

In terms of transparency, there are also major deficiencies in proportionality and equal treatment principles. The Regulation of Public Services Concession for Communal Households refers to Government Decision No. 102 of 27 February 1996 on Measures for the Enforcement of the Law on Concessions, which was revoked by Government Decision No. 118 of 11 February 2013 on Government Decisions Abrogation. The aforesaid decisions described the procedural stages of the tender, but the regulation still does not comply with EU minimum requirements.

The deficiencies in the entire national legal framework for public concessions are as follows:

- **Publicising the tender.** The content of the notice is not very clearly defined.
- **Selecting candidates.** Conditions for participation related to the professional and technical capacity and the financial and economic standing of the candidates are not indicated/specified. This means the contracting authority can include some "artificial" conditions that will restrict participation by possible candidates to the point where there are not enough candidates to ensure genuine competition. Moreover, conditions for excluding candidates, such as fraud, distortion of competition, or non-payment of taxes, are not stipulated.
- **Concession award criteria.** The law does not impose the adoption of an evaluation method prior to the appraisal process.
- **Conflict of interest.** There are no provisions related to this topic.
- **Framework for value and corresponding duration of the contract.** There are no indications of the methods for calculating the estimated value of the concession. This means the duration of the contract is not determined in a consistent manner. Ideally, the maximum duration of the concession should not exceed the time that a concessionaire could reasonably be expected to pay off the investments made in operating the works or services, together with making a return on invested capital, taking into account the investments required to achieve the specific contractual objectives. The actual legal framework establishes a maximum term of 50 years, but there are no specific data on the investment and revenues obtained by the concessionaire.
- **Royalty.** There is no methodology for determining royalties. While this is not a mandatory inclusion in the Law on Concessions, the Regulation on Concession should define a precise methodology for royalty calculation in order to ensure the sustainability of the systems. The level of the royalty should allow at least for the replacement of outdated infrastructure and the development of facilities. For example, at the end of the operating life of a means of transport, the contracting authority should have enough funds to replace it.

- **Asset property regime.** The property regime for the concession's assets is not defined. Ownership of the assets when the concession contract expires or the contract is cancelled is therefore not regulated.
- **The right to appeal in court** against the terms of reference or the award notice is not stipulated. The right to appeal should be very clearly defined by specifying the terms of appeal, the competence and jurisdiction of the courts and the applicable procedure.

In conclusion, these deficiencies demonstrate that the current legislation does not ensure genuine competition for awarding concession contracts, which also applies to the public transport sector. From a legal perspective, if the legal framework promoted fair competition, the concession system could apply to all activities related to public transport.

7.1.5. The law on local public finance

The provisions of Law No. 397 of 16 October 2003 on Local Public Finance do not raise any major difficulties for the provision of public transport services. The law lays out the structure of the budgets of the administrative-territorial units, as well as how they are prepared, approved and executed. In the context of discussions on the possibility for local authorities to finance projects in local public passenger transport, the need to promote tax incentives for transport operators in order to encourage the development of this type of transport should also be included in the law.

7.1.6. The fiscal code, including excise and duties

Several provisions of the Fiscal Code of the Republic of Moldova No. 1163 of 24 April 1997 affect urban public transport. According to Art. 103 par. (1), p. 18, "value added tax (VAT) does not apply to supply deliveries, performed services by taxable persons, which are the result of their entrepreneurial activity in the Republic of Moldova: services provided by urban transport, as well as services provided by the transport of suburban passengers".

Excise taxes are regulated by Title IV of the Fiscal Code (Art. 119 – Art. 128). The excise tax rate for means transport is expressly stipulated in Annex 2 to Title IV of the fiscal code. Under this, when importing cars into Moldova, import duties are assessed depending on engine type, capacity and year of manufacture. From 1 January 2017, excise tax or import duty rates have been set in MDL and not in EUR. A vehicle grading system has also been introduced, divided into 7 age categories: 0-2 years, 3-4 years, 5-6 years, 7 years, 8 years, 9 years and 10 years. For hybrid cars, the excise tax or import duty rate has been reduced by 50%. For vehicles with truck status, 20% VAT is applied on import and the excise tax amount is a fixed fee of MDL 222 440 (USD 11 916).

The procedure and principles for setting, modifying and cancelling local taxes, their maximum rates, the mode of payment, the criteria for granting tax relief, etc., are also determined by Title VII of the fiscal code. Accordingly, Art. 289 par. (2). lit. and Art. 291, lit. (i) provides that the fees for providing passenger transport services on municipal, town and village (communal) routes are to be paid by operators per transport unit, depending on the number of seats. Thus, the maximum tax rate for the provision of passenger services is:

- MDL 500 (USD 27) per month for each car with a capacity of up to 8 seats inclusive

- MDL 1 000 (USD 54) per month for each motor vehicle (minibus) with a capacity of 9 to 16 seats inclusive
- MDL 1 500 (USD 81) per month for each bus with a capacity of 17 to 24 seats inclusive
- MDL 1 700 (USD 92) per month for each bus with a capacity of over 24 seats.

It should be noted that this tax is only paid by private operators and not by municipal transport companies. These municipal exemptions violate competition protection provisions, thus creating a privileged position in relation to other operators in the market.

Title IX of the fiscal code regulates road taxes, including the road tax disc (Art. 335 – Art. 366).

7.1.7. The customs code

The Customs Code of the Republic of Moldova No. 1149 of 20 July 2000 sets out the legal, economic and organisational principles of customs activity. Articles 19 to 27 of the code regulate the general principles of transporting goods and means of transport across customs borders. According to Art. 20, par. (4) of the code, the following are forbidden from being entered and/or placed under customs imports procedure, customs warehousing or customs clearance free zones:

- means of transport with a service life exceeding 10 years classified under heading 8 702 for the transport of more than 20 persons, and under tariff headings 8 704 and 8 705, and their engines and bodies
- vehicles with a service life exceeding 10 years classified under heading 8 703 (except motor vehicles), and their engines and bodies
- motor vehicles with a service life exceeding 7 years designed for carrying a maximum of 20 people classified under tariff heading 8 702, and their engines and bodies
- motorcycles with a service life exceeding 10 years classified under heading 8 711, and their engines.

7.1.8. The civil code

The Civil Code of the Republic of Moldova No. 1107 of 6 June 2002 includes provisions for the establishment, organisation and dissolution of legal persons, as well as regulations related to the entrepreneurial activity of natural persons (transport operators), general provisions in matters of contracts (training, execution and effects of non-execution), calculation of deadlines, tort liability, etc. The Book III, Title III, Chapter XII - "Transport" includes provisions regulating the transport contract in general (Art. 980 – Art. 985), the transport contract for persons (Art. 986 – Art. 992) and the transport of goods (Art. 993 – Art. 1029).

7.1.9. The contravention code

The Contravention Code of the Republic of Moldova No. 218 of 24 October 2008 lists a series of contraventions in the field of public passenger transport. Violations that can be prosecuted include violation of transport sanitary-hygienic and sanitary-anti-

epidemic rules (Art. 80 par. (1)), and breach of fire safety rules (Art. 358). Among the contraventions in the field of environmental protection set out in Chapter IX of the code, the following sanctions apply to transport:

- failure to fulfil the registration obligations for operations involving harmful substances and mixtures (Art. 150)
- breach of technical and ecological testing rules (Art. 151)
- commissioning and operating terrestrial vehicles, ships and aircraft that exceed pollutant emissions and noise emission standards (Art. 152 – Art. 153).

Chapter XII "Contraventions against the transport regime" provides sanctions for violating rules for the transport of persons and goods (Art. 197) and travelling without a ticket (Art. 204). Contraventions in road traffic are found in Chapter XIII of the Code (Art. 228 – Art. 245).

7.1.10. Entrepreneurial activity

Law No. 451 of 30 July 2001 on Business Activity Licensing determines the legal, organisational and economic regulatory framework for licensing entrepreneurial activity. The law stipulates the types of activities subject to licensing, including paid transport routes, bus station activity and training staff in road transport (Art. 8, par. (1), points 11, 111 and 321). At the same time, the law establishes the content of the licence (Art. 9), the documents required for obtaining the licence (Art. 10), the licence validity term (Art. 13), the licence-issuing procedure (Art. 11, Art. 14 – Art. 18), the organisations/bodies and control arrangements in the field of licensing (Art. 19), the conditions for suspension (Art. 20) and licence withdrawal (Art. 21). The Public Services Agency is the only licensing authority for passenger-paying road transport and bus station activity.

7.1.11. Consumer protection

Law No. 105 of 13 March 2003 on Consumer Protection establishes general consumer protection requirements, the necessary framework for unlimited access to products and services (including full information of their main features), and the protection and safeguarding of consumers' legitimate rights and interests in the event of unfair commercial practices and in decisions that interest them as consumers. The law regulates the protection of consumers' life, health, heredity and security (Chapter II); protection of consumers' economic interests (Chapter III); the execution of works (Chapter IV); consumer information (Chapter V); and the bodies empowered with consumer protection functions (Chapter VI).

7.1.12. Road safety

Law No. 131 of 7 June 2007 on Road Safety regulates the legal and social relations in the field of road traffic; establishes the rights, obligations, responsibilities of the competent authorities and the participants in this traffic; and determines the principles for organising the activity of staff training units in the field of road transport, as well as the conditions for the admission to traffic of motor vehicles drivers. The provisions of this law deal with road traffic in terms of ensuring its smooth and safe deployment, which implies the protection of the legitimate rights and interests of individuals and legal entities; the defence of their property; the health, bodily integrity and lives of passengers; as well as the protection of the environment (Art. 1 par. (2)). The Law on

Road Safety outlines the responsibilities of the competent authorities in the field of road traffic (Chapter II), including the competence of the Ministry of Economy and Infrastructure (Art. 8). The law also regulates the process of organising the initial training, re-qualification and periodic training of drivers (Art. 18 – Art. 31), as well as the process of admission to road traffic and erasure from the state transport register (Art. 37 – Art. 55). Approval and certification of motor vehicles is provided for under Art. 39.

7.1.13. The law on competition

Law No. 183 of 11 July 2012 on Competition establishes the legal framework for the protection of competition, including the prevention and countering of anti-competitive practices and unfair competition, and market concentration. It also establishes the legal framework for the Competition Council's activity and competences, and responsibility to take measures in the event of a violation of the Competition Law.

7.1.14. Insurance laws

Law No. 407 of 21 December 2006 on Insurance regulates the organisation and functioning of insurers, reinsurers and insurance and/or reinsurance intermediaries, as well as the supervision of their activity. According to Art. 5, par. (4), lit. a) of the law, the approval and the establishment of insured risks, the assessment of damages, the establishment and payment of indemnities and insurance indemnities shall be made under the law in the case of compulsory insurance, or on the basis of the insurance conditions and the insurance contract, in case of voluntary insurance.

Law No. 414 of 22 December 2006 on Mandatory Insurance of Civil Liability for Damage Caused by Motor Vehicles regulates the legal relations between insurers, insured persons and third parties deriving from the compulsory third party liability motor insurance contract, as well as the method for realising this type of insurance.

7.1.15. Road traffic and the road transport code

Government Decision No. 357 of 13 May 2009 on Approval of the Road Traffic Regulation establishes traffic rules, the interaction of public transport means with other road users; the technical conditions to be met for a vehicle to be permitted to circulate; as well as the responsibilities related to the safety of all parties involved in traffic. All of these ensure the smooth running of traffic.

Government Decision No. 415 of 8 April 2003 on Approval of the Regulation on the Technical Supervision by Road Police includes provisions for regulating and ensuring the effectiveness of technical surveillance, establishes the obligations of all road police subdivisions responsible for technical surveillance, as well as the modalities for its accomplishment in order to ensure road safety. The regulation also rules on the exercise of control over vehicle conformity with standards for ensuring road safety, including the conditions under which motor vehicles can be re-used.

The special regulatory framework includes acts that directly regulate road transport activity, including public passenger transport. A first group of acts to be analysed is represented by the Road Transport Code of the Republic of Moldova No. 150 of 17 July 2014 and the secondary regulations edited in its application, namely:

- Government Decision No. 257 of 28 April 2017 on Approval of the Regulation of Issuance and Use of Road Transport Authorisations

- Government Decision No. 437 of 12 April 2016 on Approval of Regulation of Issuance, Replacement, Changing and Renewing Tachograph Cards, Downloading and Storing Tachograph Data and Tachograph Cards
- Order of the Ministry of Transport and Roads Infrastructure No. 9 of 10 February 2015 on Elaboration of Continuous Training Programmes
- Order of the Ministry of Transport and Roads Infrastructure No. 43 of 20 February 2012 on Provisional Instruction on Issuance and Use of Books of Journey (Interbus)
- Government Decision No. 539 of 23 April 2008 on the Creation of the National Agency of Road Transport
- Government Decision No. 1167 of 29 October 2007 on Approval of the Methodology of Calculation of Tariffs in Transportation Services in Public Passenger (Passengers) and Baggage Road Transport
- Government Decision No. 854 of 28 July 2006 on Regulation of Passenger and Baggage Road Transport
- Regulation of the Ministry of Transport and Communications No. 9/12 of 9 December 1999 on Bus Station (Auto Station)
- Regulation of the Ministry of Transport and Communications No. 9/12 of 9 December 1999 on Regulation of Traffic Safety of Businesses, Institutions and Organisations which Perform Passenger and Freight Transport
- Government Decision No. 1047 of 8 November 1999 on Reorganisation of the Automated Information System 'AutoTEST' in the State Transport Registry and Introduction of Vehicles and Trailers Testing.

The Road Transport Code is the main legislative act that establishes the legal framework for organising and carrying out safe and high-quality transport of goods and people by road; as well as road transport activities on the territory of the Republic of Moldova, respecting the principles of free competition and measures for protecting the environment; the legitimate rights and interests of natural and legal persons benefiting from such services; and the rights, obligations and responsibilities of public bodies organising road transport, including natural and legal persons.

Article 6, par. (3) of the code provides that public administration in the field of road transport is exercised by the central public administrative authorities, the local public administrative authorities and other authorities authorised by law within the limits of their competencies.

7.2. Institutional framework

The **National Agency of Road Transport** (*Agenția Națională Transport Auto* – ANTA) ensures the implementation of public policy and national development strategies in the field of road transport. It controls and supervises compliance with national and international legislation by road transport operators and companies performing activities related to road transport (pursuant to Art. 8 par. (1) and Art. 147). The functions and rights of the agency are regulated by Art. 9 and Art. 10 of the Road Transport Code (see Section 7.1.15).

In order to carry out their functions under the Road Transport Code, local, municipal and district councils can set up commissions for organising road passenger transport by regular services and can approve their operating regulations. The local public administrative authorities develop and approve, after co-ordinating with the central specialised body, medium and long-term strategies for developing and modernising road transport, taking into account urban and spatial plans, local economic and social development programmes and the transport needs of the population.

Rayon councils (district councils) co-operate with local and municipal councils in order to ensure and develop fee-based road transport for regular passenger services in the *rayon*, as well as to co-ordinate payments for passenger transport by regular services in local/municipal traffic. Local, municipal and *rayon* councils must ensure equal and non-discriminatory treatment, in a competitive and transparent environment, for all road transport operators (Art. 12).

At the same time, the *rayon* councils (Art. 13):

- approve and update the *rayonal* road transport programmes after obtaining the approval of the central specialised body in accordance with the transport needs of the population
- have the right to provide transport facilities at a discounted rate for certain categories of people within the respective territorial-administrative unit, while ensuring sources of compensation for the lost revenue to the service provider
- authorise routes for fee-based passenger transport by regular services in the *rayon,* and monitor its use.

In turn, local and municipal councils, in the context of the need to organise local routes for fee-based passenger services, may (Art. 14):

- establish **subsidies** from the local and/or municipal budget, as appropriate, to cover the difference between the costs incurred by the road transport operator for the provision of regular road transport services in local traffic and the amounts actually received as a result of the transport
- provide, within the respective territorial-administrative unit, transport facilities for certain categories of people
- develop, approve and update, according to their competence, local road transport programmes to meet the transport needs of the population
- authorise routes for fee-based passenger transport through regular services in local and municipal traffic, and monitor its deployment, where appropriate
- organise electric transport services
- develop and approve urban mobility plans
- approve the charges for regular road passenger transport services in municipal and/or local traffic.

Other important competences of the local public administrative authorities related to road transport operators include the right to (Art. 15):

- regularly monitor the provision of passenger transport services in local, municipal and district traffic, by jurisdiction

- notify the National Agency of Road Transport (ANTA) of the need to withdraw authorisations in case of violations
- request the competent bodies to cancel a licence.

7.3. Organisational framework

The provision of a route for fee-based transport services is subject to licensing (Art. 22). Title III/Chapter 2 of the Road Transport Code regulates access to the provision of transport services, and contains special provisions for the **licensing (authorisation)** regime. These state that registered enterprises in the Republic of Moldova intending to provide transport services must fulfil conditions on technical and material assets, reputation, financial capacity and professional competence. The road transport licence is valid for eight years (Art. 28 par. (2)).

Chapter 3 of the code sets out the authorisation regime for regular passenger transport services. Authorisation for road passenger transport on regular services is a nominative act of the road transport operator, is not transferable and has an eight-year validity period. During the validity period, a route may be modified by up to 30% of its initial length (Art. 37, par. (3)). Authorisation road passenger transport on regular services can be given upon request without conducting a competition procedure if the road transport operator, during the period of validity of the authorisation, has not had its road transport licence suspended (Art. 40). Art. 38, par. (21) of the code expressly provides for situations in which the agency may withdraw the authorisation for road passenger transport on regular services in local, municipal, district and inter-district traffic.

The authorisation for passenger transportation by regular services in local, municipal, district (*rayon*), inter-district and international transport is issued by the ANTA for the routes included in the local, municipal, district, inter-district and international road transport programmes, together with the service schedule for the road haulage operator (Art. 32, par. (1)). Regular road passenger transport services in local and municipal traffic can be managed through direct management, delegated management or mixed management.

The code also provides for road transport programmes at the local, municipal, district (*rayon*), inter-district and international (Art. 33) levels. For each route, road haulage programmes establish **bus and public stations** used for departures, transit stops and arrivals. The location of public passenger stops and stations is determined by local public administrations with the advice of the specialised services of the Ministry of Internal Affairs and the administrator of the respective road. The placement,of road signage and maintenance of public passenger stops are provided by the local public administrative authorities or the road manager, as the case may be. Passenger embarkation/disembarkation is allowed at all public stops directly on the route, even if they are not shown on the traffic charts. Access to public stops by transport operators that have assigned routes is free and non-discriminatory, according to the traffic schedules (Art. 34).

The procedure for defining, approving and modifying road transport programmes is stipulated in Art. 35 – Art. 37 of the Road Transport Code. Thus, the modification of international road transport programmes can only be carried out between 1 January and 15 February; while the dates for local, municipal and district (*rayon*) programmes are between 1 March and 1 May, and 1 September and 1 November. All road transport operators providing services on the concerned route must be informed of the

modification within 30 calendar days. When modifying a road transport programme, passenger flow analysis and the impact of the proposed changes on the existing routes are taken into consideration (Art. 37, par. (7) – par. (9)).

Regular road transport services on the routes included in the local, municipal, district and inter-district road transport programmes are awarded by competition commissions as part of public tenders. This includes the:

- introduction of new routes
- withdrawal or expiration of the authorisation for transport of passengers on regular service routes
- lack of certified copies of the licence road transport required for the route (Art. 38, par. (1)).

The competent authorities (central specialised body, local, municipal and/or *rayon* councils) may assign an entire route, group of routes, or group of lines along the same route. Routes and lines can be grouped if an economically unattractive route is deemed necessary to meet the transport needs of the population.

In the case of operation of several bus stations in the locality, the central specialised body, depending on the territorial location of the bus stations and the travel directions of the routes that start from these bus stations or transit them, can determine the priority directions for servicing the routes for the respective bus stations. The establishment of priority directions does not limit the right of road transport operators to choose their own bus stations on the respective route (Art. 86, par. (8)).

When providing passenger services on domestic public transport over a distance of less than 50 km, passengers can be transported according to the vehicle's capacity provided by the manufacturer. In international traffic, however, all passengers must be seated. For passenger transport, the use of re-equipped vehicles (converted from light-duty trucks[2]) is prohibited (Art. 63).

Tariffs can be freely determined on the basis of demand and supply for road passenger transport on regular and occasional services, as well as for the provision of related services (except for the activity of buses and periodical technical inspection). Tariffs for road transport services by regular services in district and inter-district traffic, bus services and technical inspection stations are established by the central specialised body (ANTA). In local or municipal traffic tariffs are determined by the local or municipal councils, as the case may be, according to the methodology approved by the government (Art. 145). In practice, however, municipal councils have tended to provide financial support to public transport operators, in particular in order to keep bus fares low. This has had a detrimental impact on those that do not receive subsidies from the municipal budget. This, in turn, has substantially affected the competitive balance, ultimately leading to a significant deterioration in the quality of transport services as insufficient funds are available to renew vehicles and transport infrastructure.

An important impediment to the application of the provisions of the Road Transport Code is the lack of framework rules, which should have been developed by the central public authorities. These would allow local public administrative authorities to develop and approve the local norms for regulating public passenger transport activity.

Government Decision No. 854 of 28 July 2006 on Regulation of Passenger and Baggage Road Transport rules on the categories and types of passenger transport defines the basic

notions; establishes the rights, obligations and responsibilities of the parties – passengers, crew, transport operator, regular and irregular transport organisation, for own use, in taxi arrangements, the organisation of the transport and storage of baggage and hand luggage; the control of road passenger activity and the arrangements for solving disputes in this area. However, the Regulation of Passenger and Baggage Road Transport has not been brought into line with the provisions of the Road Transport Code.

The **regular routes** are organised following an analysis of the economic and social links between localities, taking into account the frequency of population movements, correlation with other modes of transport and passenger transport routes in service (point 17).

The organisation of new regular urban routes, and modification or closure of existing ones is carried out by the local public administrative authorities – municipalities (city halls). The local public administrative authorities draw up, in accordance with the legislation in force, rules for the carriage of passengers and luggage on their territory (be electric, car and taxi) and submit them to the specialised body of the central public administration for coordination (point 29). The priority right to serve regular urban routes is granted to hauliers registered in the municipality (town hall) which have more than one transport unit (point 30).

The Regulation of the Ministry of Transport and Communications No. 9/12 of 9 December 1999 on Regulation of Traffic Safety of Businesses, Institutions and Organisations which Perform Passenger and Freight Transport determines the tasks and the main requirements regarding the activity of the operators of passenger and goods transportation to ensure road traffic. Pursuant to Point 1.4 of the regulation, the responsibility for organising work to ensure the **safety of road traffic** on behalf of enterprises falls to the manager of the company or a responsible appointed person (specialist). Their basic tasks include: 1) ensuring the professional efficiency of drivers; 2) ensuring the technical state of operation of vehicles; 3) ensuring the security of passenger and goods traffic (Point 2.1). For each of these tasks the regulation lays down a series of concrete measures to be implemented and respected by transport operators.

7.4. Conclusions for the CPT Programme

This regulatory review has demonstrated that there is a legislative and policy framework in place for replacing outdated public transport fleets. Depending on the number of buses on a given route, a replacement schedule is provided in the standard contract for provision of public transport services.

Existing laws and regulations also provide for the introduction of more efficient models for buses, as well as more efficient and cleaner fuels.

Moldova's multi-level institutional and organisational framework for the transport sector is functional, but public authorities should adopt a unified approach in order to tackle the air pollution issue (also from road transport) and better co-ordinate the (priority) actions, both horizontally and vertically.

Notes

1. As a rule, trolleybuses do not have registration plates; instead the Chisinau Electric Transport Company (RTEC) assigns a registration number to each transport unit. Other entities, such as the National Agency of Road Transport (ANTA), register buses.

2. Permitted technical modifications of vehicles are further specified by Government Decision No. 415 of 8 April 2003 (such as changing the seating plan, side of the steering wheel, etc.).

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Annex A. Overview of clean technologies and fuels in the transport sector

This overview looks at buses that run on four major types of cleaner fossil fuels or other sources of power. These include compressed natural gas (CNG)/liquefied natural gas (LNG), liquefied petroleum gas (LPG), diesel with Euro VI engines and electricity.

For each fuel type we discuss the following:

- the main features of the fuel
- comparative advantages of the technology
- comparative drawbacks of the technology
- worldwide market penetration of the technology.

Table A.3 summarises the main points for each type of fuel.

Compressed natural gas vehicles

Description

Compressed natural gas (CNG) is a natural gas under pressure that remains clear, odourless and non-corrosive. Although vehicles can use natural gas as either a liquid or a gas, most vehicles use the gaseous form, compressed to about 218 kg/cm^2. CNG can be used as an alternative to conventional petrol and diesel fuels. Methane (CH_4) – which is the main component of CNG – is found above oil deposits or may be collected from landfills or wastewater treatment plants, where it is known as biogas.

It is stored and distributed in hard containers at a pressure of 20-25 MPa (Megapascals), usually in cylindrical or spherical shapes. Most natural gas comes from three types of wells: natural gas-and-condensate wells, oil wells and coal bed methane wells. Well-extracted natural gas requires treatment before it can be used in vehicles.

CNG is used in traditional petrol (internal-combustion-engine) automobiles that have been modified or in vehicles especially manufactured for CNG use, either with a dedicated system separate from the petrol system to extend range (dual-fuel), or in conjunction with another fuel, such as diesel (bio-fuel). CNG vehicles have been introduced in a variety of commercial applications, from light-duty trucks and sedans, like taxicabs; to medium-duty trucks, like UPS (United Parcel Service) delivery vans and postal vehicles; and heavy-duty vehicles such as transit buses, street sweepers and school buses.

CNG's volumetric energy density is estimated to be 42% of that of LNG (because it is not liquefied; see Box A.1) and 25% that of diesel fuel.

Box A.1. A comparison of CNG and LNG

CNG and LNG are often confused. However, while both are stored forms of natural gas, the key difference is that CNG is stored as a gas at high pressure, while LNG is stored at a very low temperature, becoming liquid in the process. CNG is cheaper to produce and store than LNG, as it does not require an expensive cooling process or cryogenic tanks. CNG requires the use of very high pressures and a much larger volume of storage for the same mass of petrol. Therefore, natural gas is often transported over large distances in the form of LNG – in ships, trains or pipelines – and then converted into CNG before distribution to the end user.

Advantages

CNG combustion produces fewer undesirable gases than other fuels and is safer in the event of a spill, because natural gas is lighter than air and disperses quickly when released. In 2014, a comparison of Euro VI heavy vehicles on CNG and diesel, conducted by the Danish Technological Institute,[1] showed that CNG had a higher consumption of fuel but that NO_x emissions were lower. The levels of noise, CO_2 (contrary to other findings, see below) and particulate pollution were the same, however.

Natural gas is produced worldwide at a relatively low cost and is cleaner burning than petrol or diesel fuel. Natural gas vehicles emit on average 80% fewer ozone-forming emissions – i.e. carbon dioxide (CO_2) and nitrogen oxide (NO_x) – than petrol-powered vehicles. In addition:

- CNG does not contain any lead, thereby eliminating fouling of spark plugs
- CNG-powered vehicles have lower maintenance costs than other hydrocarbon-fuel-powered vehicles
- CNG fuel systems are sealed, preventing fuel losses from spills or evaporation
- CNG-powered vehicles are considered to be safer than petrol-powered vehicles
- CNG-powered vehicles produce less pollution and are more efficient.

CNG emits significantly fewer direct carbon emissions than petrol or oil when combusted. An engine running on petrol emits 22 kilograms of CO_2 per 100 kilometres, whereas a CNG-powered engine emits 16.3 kilograms of CO_2 per 100 kilometres. Therefore, switching to CNG can help mitigate greenhouse gas (GHG) emissions. However, natural gas leaks increase GHG emissions. The ability of CNG to reduce GHG emissions over the entire fuel lifecycle will depend on the source of the natural gas and the fuel it replaces.

Natural gas emits 30% less CO_2 per British thermal unit (BTU) than oil, 90% fewer particulates than conventional fuels, and fewer pollutants such as sulphur dioxide (SO_2) and nitrogen oxides (NO_x).

Drawbacks

The cost of fuel storage tanks is a major barrier to more widespread and rapid adoption of CNG as a fuel. Municipal governments are the most visible adopters of CNG technology in public transport vehicles, as they can more quickly amortise the money invested in the new (and usually cheaper) fuel. In other parts of the world, as the industry has expanded, the cost of fuel storage tanks has fallen.

CNG-powered vehicles require bigger fuel tanks than conventional petrol-powered vehicles. Since it is a compressed gas rather than a liquid like petrol, CNG takes up more space for each GGE (gasoline gallon equivalent).[2] Usually, CNG tanks take up space in the trunk of cars or bed of pickup trucks modified to run additionally on CNG. This problem is solved in CNG vehicles that have factory-built tanks under the body of the vehicle, leaving the trunk free. Another option is roof installation (typically for buses), which requires attention to structural strength. Besides taking up space, tanks also add to the vehicle weight (especially when filled). Rapid refuelling technology also requires expensive infrastructure investment and may lead to gas leaks.

Further, where an insufficient number of alternative fuel vehicles are in use investors may be reluctant to invest in infrastructure, while the manufacturing industry will not offer alternative fuel vehicles at competitive prices when demand is low because consumers are reluctant to buy them given the lack of an alternative fuel infrastructure.

Market penetration worldwide

CNG-powered vehicles are increasingly used in Iran, Pakistan and the Asian-Pacific region. India and China have witnessed rapid growth in recent years, and India, in particular, is forecast to become the world's largest natural gas vehicle market (EC, 2016[1]), with their use especially common in New Delhi, and other large cities like Ahmedabad, Mumbai, Kolkata, Lucknow and Kanpur.

Their use is also increasing in South America, Europe and North America given rising petrol prices.

About 1.2 million vehicles run on CNG in Europe, but these represent only 0.7% of the European Union (EU)-28 and Switzerland's vehicle fleet. Italy alone accounts for 75% of the market. More than 3 000 refuelling points are available, two-thirds of them in Germany and Italy. In total, 18 million CNG vehicles are in operation worldwide, representing 1.2% of the world's vehicle fleet (EC, 2016[2]).

While the number of vehicles using CNG worldwide continues to grow steadily, alternative fuel vehicles in general only represented 3.4% of the European car fleet in 2012, and the use of alternative fuels in heavy-duty vehicles and maritime and aviation modes is negligible (EC, 2016[2]).

By 2025, LNG use in heavy-duty transport is expected to grow to 12 000 vehicles, mainly in Poland and Hungary. This is according to national plans submitted to the European Commission, which also foresee in total 431 refuelling stations and other infrastructure development in the EU – as a part of Trans-European Transport Networks (TEN-T) – to a total value of up to EUR 257 million by 2025 (T&E, 2018[3]).[3]

Liquified petroleum gas vehicles

Description

Also known as propane-butane mixture, liquified petroleum gas (LPG) is a flammable mixture of hydrocarbon gases used as fuel in heating appliances, cooking equipment and vehicles. LPG is prepared by refining petroleum (crude oil) or "wet" natural gas extracted from petroleum or natural gas streams as they emerge from the ground. It currently provides about 3% of all energy consumed worldwide, and burns relatively cleanly, without soot and very few sulphur emissions. As a gas, it does not pose ground or water pollution hazards, but it can contribute to air pollution. Further, its energy density per unit of volume is lower than either that of petrol or fuel oil, as its relative density is lower.

In some countries, LPG has been used since the 1940s as an alternative to petrol for spark ignition engines. In some cases, additives in the liquid extend engine life, and the ratio of butane to propane is kept quite precise in fuel LPG. Two recent studies have examined LPG and fuel oil mixes and found that smoke emissions and fuel consumption are reduced but hydrocarbon emissions are increased. The studies were split on carbon monoxide (CO) emissions, with one finding significant increases, and the other finding slight increases at low engine load but a considerable decrease at high engine load.

LPG has a lower energy density than either petrol or fuel oil, so the equivalent fuel consumption is about 10% higher. Many governments impose lower taxes on LPG than on petrol or fuel oil, which helps offset the greater consumption of LPG. LPG is the third most widely used motor fuel in the world after diesel and petrol. Estimates from 2013 show that over 24.9 million vehicles are fuelled by LPG worldwide. Over 25 million tonnes are used annually as a vehicle fuel.

Advantages

LPG is non-toxic, non-corrosive and free of tetraethyl lead or any additives, and has a high octane rating. It burns more cleanly than petrol or fuel oil and is especially free of the particulates present in the latter.

Commercially available LPG is currently derived mainly from fossil fuels. Burning LPG releases CO_2. The reaction also produces some CO. LPG does, however, release less CO_2 per unit of energy than coal or oil. It emits 81% of the CO_2 per kilowatt hour (kWh) produced by oil, 70% of that of coal, and less than 50% of that emitted by coal-generated electricity distributed via the grid.

Other advantages of LPG include the following:

- LPG burns more cleanly than higher molecular weight hydrocarbons, because it releases fewer particulates.
- The inherent advantage of LPG over CNG is that it requires far less compression (20% of CNG cost), is denser (because it is a liquid at room temperature) and thus requires far cheaper tanks (consumer) and fuel compressors (providers) than CNG.
- Its advantages over petrol and diesel include cleaner emissions and less wear on engines than petrol.

Drawbacks

LPG main disadvantages may be summarised as follows:

- Safety: LPG is heavier than air, which causes it to collect in a low spot in the event of a leak, making it much more hazardous to use than CNG; more care is needed in handling.
- Environment: LPG is not as efficient or environmentally friendly as CNG and electric options for alternative fuels for buses.
- Technology: LPG provides less upper cylinder lubrication than petrol or diesel, so LPG-fuelled engines are more prone to valve wear if they are not appropriately modified.

Market penetration worldwide

LPG is currently the most adopted alternative fuel in road transport in terms of number of vehicles. The LPG market is dominated, in terms of vehicles, by five countries, which together account for almost half of global consumption: Turkey (4 million vehicles), the Russian Federation (3 mln), Poland (2.8 mln), Korea (2.4 mln) and Italy (2 mln) (EC, 2016[1]).

However, LPG is losing momentum in the European Union, United States and Japan, because compared to electric mobility and even CNG, its environmental benefits over conventional fuels are limited. However, LPG is still promising in developing markets in China, India and the Russian Federation.

Diesel vehicles with Euro VI engines

Description

Petrol and diesel remain the most common fuels for all vehicles.

Biodiesel – which is being increasingly used in diesel engines – is brought to the market mainly via blending with conventional diesel. The largest market is the European Union (EU), followed by the United States and Brazil. Biodiesel does not, however, reduce NO_x emissions from vehicles, which is an increasing focus of attention for cities.

US regulations attempting to reduce the impact of these fossil fuels on the environment have mandated the supply of ultra-low sulphur diesel and the use of ethanol (also known as E85) in petrol.

Table A.1 and Table A.2 contain a summary of the EU emission standards that apply to diesel buses. They show two different types of testing requirements: 1) steady state testing (Table A.1), which lists emission standards applicable to diesel (compression ignition – CI) engines only, with steady-state emission testing requirements; and 2) transient testing (Table A.2), which lists standards applicable to both diesel and gas (positive ignition – PI) engines with transient testing requirements.

Table A.1. EU emission standards for heavy-duty diesel engines (steady-state testing)

Tier	Date	Test cycle	CO	HC	NO_x	PM	PN	Smoke
			g/kWh				1/kWh	1/m
Euro I	1992 < 85 kW	Economic Commission for Europe of the United Nations (ECE/UN) Regulation-49	4.5	1.1	8.0	0.612		
	1992 > 85 kW		4.5	1.1	8.0	0.36		
Euro II	October 1996		4.0	1.1	7.0	0.25		
	October 1998		4.0	1.1	7.0	0.15		
Euro III	*October 1999 Enhanced environmentally friendly vehicles (EEVs[b] only*	European Stationary Cycle (ESC) and European Load Response (ELR)	*1.5*	*0.25*	*2.0*	*0.02*		*0.15*
	October 2000		2.1	0.66	5.0	0.10 - 0.13[a]		0.8
Euro IV	October 2005		1.5	0.46	3.5	0.02		0.5
Euro V	October 2008		1.5	0.46	2.0	0.02		0.5
Euro VI	31 December 2013	World Harmonized Stationary Cycle (WHSC)	1.5	0.13	0.4	0.01	$8.0x10^{11}$	

Note: [a] PM = 0.13 g/kWh for engines < 0.75 dm3 swept volume per cylinder and a rated power speed > 3 000 min-1; [b] EEV is a European emissions standard for buses and trucks (> 3.5t in the category M_2 and M_3). Vehicles equipped with EEV engines exceed the emissions quality of the Euro 5 standard applicable to all new vehicle types from 1 September 2009 on trucks and buses.
Source: (DieselNet, 2016[4]), "EU: Heavy-Duty Truck and Bus Engines: Regulatory Framework and Emission Standards", www.dieselnet.com/standards/eu/hd.php (accessed 30 March 2017).

Table A.2. EU emission standards for heavy-duty diesel engines (transient testing)

Tier	Date	Test cycle	CO	MNHC	CH_4[a]	NO_x	PM[b]	PN[c]
			g/kWh					1/kWh
Euro III	October 1999 Enhanced environmentally friendly vehicles (EEVs) only	European Transient Cycle (ETC)	3.0	0.40	0.65	2.0	0.02	
	October 2000		5.45	0.78	1.6	5.0	0.16[d]	
Euro IV	October 2005		4.0	0.55	1.1	3.5	0.03	
Euro V	October 2008		4.0	0.55	1.1	2.0	0.03	
Euro VI	31 December 2013	World Harmonized Transient Cycle (WHTC)	4.0	0.16[e]	0.5	0.46	0.01	$6.0x10^{11}$

Notes: a – for gas engines only (Euro III-V: NG only; Euro VI: NG + LPG).
b – not applicable to gas-fuelled engines at the Euro III-IV stages.
c – for diesel engines; particle number (PN) limit for positive ignition engines to be defined.
d – PM=0.21 g/kWh for engines < 0.75 dm^3 swept volume per cylinder and a rated power speed > 3 000 min^{-1}.
e – total hydrocarbon content (THC) for diesel engines.
Source: (DieselNet, 2016[4]), "EU: Heavy-Duty Truck and Bus Engines: Regulatory Framework and Emission Standards", www.dieselnet.com/standards/eu/hd.php (accessed 30 March 2017).

Advantages

The main advantages of shifting to diesel buses with Euro VI engines include:

- The purchase price of modern diesel-fuelled engines is typically lower than moving to cleaner technologies (such as LPG or CNG).
- The need for additional investments in the vehicle itself or in supporting infrastructure is not as great as for LPG and CNG, which often require vehicle modifications or supporting infrastructure (such as specialised filling stations or maintenance centres).
- A standard diesel city bus delivers lower carbon emissions per passenger than a standard car and CO_2 emissions can be achieved by encouraging more passengers to shift to public transport.

Drawbacks

The main drawbacks of introducing diesel buses with Euro VI engines are:

- The shift from Euro V to Euro VI for heavy-duty vehicles will require considerable investments by manufacturers and public transport operators and huge outlays from bus manufacturers.
- They cause significant harm to the environment, in the form of particulate matter (PM) from engine exhaust.

Market penetration worldwide

Diesel engines are globally one of the most common choices for combustion engines for buses and other commercial vehicles. For the time being, diesel and biodiesel buses constitute by far the greatest part of the bus fleet (90% of the bus fleets in Europe, according to the results of the 3iBS survey, which surveyed 70 000 buses operated in 63 European cities and regions) (UITP, 2015[5]).

Electricity-powered public transport

Description

The electrification of road transport is expanding in Europe driven by the need for clean public transport, which is encouraging manufacturers to develop new models.

Trams are one of the oldest means of public transport and their popularity has come and gone depending on the country. But recently many cities seeking sustainable urban development are reintroducing tramways into the urban space.

Trolleybuses have followed a similar evolution, and are also experiencing an upsurge in popularity. Their main advantage over trams is that they require no battery or special rail infrastructure (overhead wires are less expensive to construct than rails), and they are also quieter. On the other hand, trolleybuses can be hybridised to run "autonomously" using an on-board battery.

In this context and as the result of technological changes and improvements in vehicle efficiency, all-electric buses are a new strategic means for achieving greenhouse gas

mitigation targets and need even less infrastructure than trams or trolleybuses. The technology is still not as mature as diesel buses, but it is on the way to market maturity. This is confirmed by the increasing number of pilots and plans (Vienna, Berlin, Paris, London, Stockholm, China) that are emerging.

There are several sizes of electric buses to be found on the market, depending on demand and needs. While electric mini and mid-size buses already exist, larger (>10m) buses are still being developed.

With this technology, in addition to transport capacity, it is important to consider vehicle autonomy and charging technologies (i.e. charging at the bus depots or on-board along the bus route).

"Traditional" cable charging takes place at night, after the daily service is complete. It is usually done on normal recharge, so as not to disturb the electricity network. A further possibility is to integrate a fast-charging solution at the end of the line, in order to guarantee continuous operation of the service. This technology has been adopted in Vienna (Austria) – the batteries charge in 10 to 15 minutes and last for 120 to 150 kilometres.

On-board "flash charging" technology allows buses to connect to the charging point on an overhead high-power charging contact when they pull into selected stops, topping up the batteries while passengers get on and off. This very fast charging mode is already used in Geneva (Switzerland) and at the airport of Nice (France).[4]

A similar technology is the pantograph, already used by trains and tramways. For buses, this charging mode can be used at bus stops, at end stops or in depots. A bottom-up pantograph is mounted on the bus roof. The charging procedure starts as the pantograph is raised and comes into contact with the mast pantograph, centred above vehicles' front axle reference position. Several cities – e.g. Gothenburg (Sweden), Namur (Belgium) and Vienna (Austria) – have started adopting this technology.

Induction may become the technology of the future for charging vehicles. When the bus stops at a station equipped with a recharge system buried underground, the on-board charging coil lowers and power transmission can begin. Charging only lasts for the time the passengers get disembark and embark and can restart again at the next station, offering unlimited autonomy. Berlin is the first capital city to adopt this wirelessly charged e-bus line.

Advantages

Electric vehicles offer several advantages over conventional internal combustion engine vehicles:

- Less dependence on oil.
- Lower greenhouse gas emissions and air pollutants when using electricity from "low-carbon" sources of power (Box A.2).
- They are more efficient and better at converting energy from batteries into moving the vehicle than the conventional internal combustion engine. They also recover energy while braking, thus reducing total energy consumption.
- Less noise pollution.

- Significant savings can be made over the lifetime of the vehicle because although investment is higher, the costs of fuel (electricity) and maintenance are lower than for an internal combustion vehicle.
- When the battery has lost some of its capacity it can be used for other purposes, such as a means of storing renewable electricity that can help regulate the power grid and the development of renewable energy.

Box A.2. How clean is electricity production?

Electricity is an energy carrier that can be converted domestically from a wide variety of primary energy sources. When electricity is produced from renewable energy sources, this can offer a nearly zero-emission well-to-wheel pathway, although this is not always the case (e.g. when a combination of renewable and non-renewable sources is used). Electricity will continue to become increasingly low-carbon as the power sector continues to reduce carbon intensity.

Drawbacks

- The development of electric vehicles depends mostly on the price of the vehicles and their battery (which can be expensive) as well as on the battery performance and energy autonomy.
- Electric buses are more expensive than diesel-powered vehicles; however, over their lifespan the total costs of electric buses are lower.
- Investment in new infrastructure in addition to the bus and battery is needed. The cost varies according to the system chosen and the number of charging points.
- The power grid must be made compatible with the energy requirements of a fleet of vehicles at economically acceptable costs.
- Electric buses can have a negative impact on the environment depending on the battery technologies, resource extraction and cell production processes, as well as the type of electricity production, and how they are disposed of at the end of their lives (e.g. recycling).

Market penetration worldwide

The number of electric buses increased tenfold between 2014 and 2016, reaching a global stock of about 345 000 vehicles in 2016. China leads in the use of electric buses, with more than 343 000 units in operation, followed by Europe with only 1 273 vehicles.

Nevertheless, only 3% of the worldwide bus fleet is currently electric. The increase in the stock does suggest that the market is moving beyond the demonstration phase into commercial development, however.

Table A.3. Comparison of fuels for urban public transport

Parameter	CNG	LPG	Diesel EEV
Purchase cost (diesel = 100 baseline)	120	110	100 (higher than traditional diesel)
Fuel type	Natural gas		Diesel
Range (km)	300	500	750
Consumption per 100 kilometres	60-70 m^3	36 kg	40-50 l
Operating costs	+	+	++
Re-fuelling time	Long; 3-6 hours	Quick (minutes)	Quick (minutes)
Re-fuelling complications	Average (compression)	Very high (liquefaction, storage)	Low
Noise	Low	Low	Low
Pollution	Low emissions of particulates, SO_2, NO_x. Nearly zero contribution to smog	Low emissions of particulates, SO_2, NO_x, nearly zero contribution to smog	Lower emissions than traditional diesel. Higher emissions than CNG and LPG
Use	Small/medium buses	Large buses	All types
Other opportunities and advantages	Fuel can also be made from biomass or landfill gas.	Low temperatures in winter support LNG storage	
Other challenges and disadvantages	Heavy fuel tanks and buses with higher clearance required Dedicated refuelling stations required (for example, at bus depot) Dedicated workshops required Rapid refuelling requires expensive infrastructure investment and may lead to gas leaks	Limited storage time for LPG (buses have to be constantly used, and after five days without use require venting) Fuel is transported and stored at low temperature Requires complicated installations for cleaning and liquefaction at stations	New norms (such as Euro VII or Euro VIII) may impose stringent quality requirements

Annex B. Explanatory guide for using the OPTIC Model

Purpose of the OPTIC Model

The spreadsheet-based Optimising Public Transport Investment Costs (OPTIC) Model is a simple, easy-to-use decision support tool prepared by the OECD to support the Government of Kyrgyzstan in preparing and estimating the costs and environmental benefits of the Clean Public Transport (CPT) Programme. It was used in particular for costing the replacement of the old bus fleet in urban centres with modern buses equipped with engines that run on:

- compressed natural gas (CNG)
- liquefied petroleum gas (LPG)
- diesel, ideally (imported) Euro 5 fuel
- electricity (trolleybuses and battery-powered trolleybuses)

The OPTIC Model was used to estimate programme costs, and the emission reductions of carbon dioxide (CO_2) and other pollutants from urban public transport – i.e. carbon monoxide (CO), nitrogen oxides (NO_x), particulate matter (PM) and sulphur dioxide (SO_2) – that could potentially be achieved by implementing the proposed project pipelines.

Similar models that exist on the market estimate the greenhouse gas (GHG) emission reductions for a country or for groups of countries. These models mainly focus on GHG emissions from industry and take into account various scenarios for the country's economic development. Such models, however, are not particularly suitable for this investment programme, which focuses on reducing emissions from urban public transport only.

Preparations for using the OPTIC Model

The OPTIC Model consists of seven modules: 1) assumptions; 2) emission factors; 3) transport sector overview with information on current bus fleet and age; 4) determining the subsidy level; 5) cost calculation; 6) emission reductions calculation; and 7) programme costing and environmental effects.

Assumptions

The model has been prepared in Excel and uses macros. Therefore, when starting the model, the macros in Excel should be enabled. This requires setting the security settings to "medium". For earlier versions of Excel (before 2010), security settings can be changed using the following commands: Tools>Macros>Security. For Excel 2010 and 2013, the macro security settings can be set in the "Developer" tab. If the Developer tab is not visible, it can be accessed by going to: File>Options>Customize Ribbon and then selecting "Developer" from the options in the right-hand window.

The user needs to fill in the cells that are highlighted yellow in the Excel sheets. Then these steps should be followed:

1. Complete the information on assumptions and emission factors. Assumptions can be found under the "Assumptions" tab. The following information is essential for the model:

- the average price of a new CNG bus
- the average price of a new LPG bus
- the average price of a new diesel bus equipped with a Euro VI engine
- the average price of a new trolleybus
- the average price of a new CNG minibus
- the average price of a new LPG minibus
- the average price of a new diesel minibus equipped with a Euro VI engine.

For the purpose of this model, the average bus is understood to be a 10-metre-long bus with a total capacity of about 100 passengers.

1. Input the average level of fuel consumption for each type of bus listed above. This information should also be provided for old diesel buses that will be replaced. For the purpose of the model, old diesel buses are divided into several categories: new and more than 5, 10 and 15 years old.
2. Input fuel costs for each type of bus. The average kilometres per vehicle per day (kpvpd) [1], which is found in the last column in Table B.1, is essential.

Table B.1. Basic assumptions: bus prices and fuel consumption

	Unit price	Fuel consumption		Fuel price		kpvpd	Fuel costs
	MDL mln		Unit		Unit		MDL/vehicle/day
New CNG bus	5.2	38.5 (53.7 m³/100 km)	kg/100 km	8.9	MDL/kg	200	684.4
New LPG bus	4.73	35.7 (70 kg/100 km)	l/100 km	10.6	MDL/l	200	755.0
New diesel Euro VI bus	4.52	50.0	l/100 km	16.5	MDL/l	200	1 651.0
New diesel standard bus	1.04	45.0	l/100 km	16.5	MDL/l	200	1 485.9
Old diesel bus > 15 years	n.a.*	56.3	l/100 km	16.5	MDL/l	200	1 857.4
Old diesel bus > 10 years	n.a.*	51.8	l/100 km	16.5	MDL/l	200	1 708.8
Old diesel bus > 5 years	n.a.*	49.5	l/100 km	16.5	MDL/l	200	1 634.5
Trolleybus	5.2**	100.0	kWh/100 km	2	MDL/kWh	200	400.0
New CNG minibus	2.02	9.6	kg/100 km	8.9	MDL/kg	200	371.5
New LPG minibus	2.02	8.93	l/100 km	10.6	MDL/l	200	188.8
New minibus equipped with a Euro 6/VI engine	2.02	11.25	l/100 km	16.5	MDL/l	200	171.1

Note: * The CPT Programme does not foresee purchase of used vehicles; ** average price for trolleybuses and trolleybuses with batteries.
Source: OECD, OPTIC Model.

Emissions factors

After inputting information on the basic assumptions, next the user inputs information on emissions from buses. This can be found under the "Emission factors" tab. The emissions will be identified in kilograms or grams of the emitted pollutant per kilometre of bus operation. The information on emissions is key for calculating emission reductions (Table B.2).

Table B.2. Assumed emission factors according to emission norms (per km)

	CO_2 (kg/km)	CO (g/km)	NO_x (g/km)	PM2.5 (g/km)	SO_2 (g/km)
Diesel Euro 2	1.0812	2.4400	10.7000	0.2200	0.2050
Diesel Euro 2>5 years	1.1893	2.6840	11.7700	0.2420	0.2255
Diesel Euro 2>10 years	1.2974	2.9280	12.8400	0.2640	0.2460
Diesel Euro 2>15 years	1.4056	3.1720	13.9100	0.2860	0.2665
Diesel Euro VI	0.7632	0.2230	0.5970	0.0023	0.0205
CNG (EEV standard)	0.9350	0.2400	2.5000	0.0050	0.0000
LPG	1.0258	1.9200	5.0000	0.0050	0.0652
Trolleybus	0.3384	0	0	0	0
Minibus Euro VI	0.1908	0.0558	0.1493	0.0006	0.0051
Minibus Euro II	0.3514	0.7930	3.4775	0.0715	0.0666
Minibus LPG	0.2564	0.4800	1.2500	0.0013	0.0163

Source: OECD, OPTIC Model.

There are two tables containing emission factors:

- normative emissions according to the standards
- real emissions according to actually measured emissions

The source of information and the reason for providing two different sets of emission factors are discussed at the end of this annex.

Transport sector overview

Next, the information on the existing urban public sector in Moldova needs to be provided under the "Transport" tab (Table B.3). This is done by providing information on the existing bus fleet in Moldova. The fleet will be divided by bus type. The last two columns contain information on the availability of CNG stations. This information is provided by entering "Yes" or "No" into the respective cells.

Table B.3. Public transport and transport infrastructure in Moldova

Type	City	Buses					Potential for replacement			Existing CNG stations	Existing trolleybus network
		Fuel									
		Bus	Mini-bus	Trolleybus	Diesel	Electricity	Bus	Minibus	Trolleybuses		
Urban	Chisinau	28	618	366	646	366	59	309	50	Yes	Yes
Urban	Balti	20	52	48	72	48	15	26	12	Yes	Yes
Sub-urban	Chisinau	132	672	0	804	0	173	336	0	Yes	No
Sub-urban	Balti	28	64	0	92	0	29	32	0	Yes	No
Inter-city	Chisinau	11	3 096	0	3 107	0	318	1 548	0	Yes	No
Inter-city	Balti	11	86	0	97	0	17	43	0	Yes	No
Inter-city	Other regions	8	2 724	0	2 732	0	279	1 362	0	No	No
Total		238	7 312	414	7 550	414	891	3 656	62		

Source: OECD, OPTIC Model.

Determining the subsidy level

The module on determining the subsidy level takes into account both the investment costs and savings for public service providers by replacing old buses. New buses using alternative fuels are more efficient because of technological improvements and also due to the lower price of CNG and LPG fuels compared to diesel.

The module takes into account the fact that the investments should generate at least a minimum return for public transport providers; thus, the social discount rate is used to determine the net present value (NPV) of the project. The subsidy is then determined at the level at which NPV is equal to zero (see Box B.1). The economic significance of this calculation is that the subsidy will encourage potential beneficiaries to participate in the CPT Programme without encouraging the beneficiary to make a profit based on the subsidy. The various calculations required to establish the subsidy level for CNG buses are presented in Table B.4 and Table B.5.

Box B.1. Determining the optimal subsidy level

The subsidy should be sufficient to attract potential investors/beneficiaries to apply for support from the CPT Programme, but without making the projects too profitable. This approach to calculating the subsidy will enable the government to avoid over-investing, while at the same time provide an investment incentive for potential beneficiaries without making it too profitable for them as investors. Essentially, the subsidy level should provide just the necessary leverage for individual potential beneficiaries to invest in clean transport.

In order to evaluate a given project, the net present value (NPV) is calculated by totalling the expected net cash flows (cash inflows, or receipts, minus cash outflows, or expenses) over the project operating period and discounting them using a rate that reflects the costs of a loan of equivalent risk on the capital market. An investment will yield a profit if the NPV is positive. All measures that yield a positive NPV using a discount rate that corresponds to the applied rate of return can be deemed beneficial.

The NPV is calculated as in the following formula:

$$\mathrm{NPV} = \sum_{i=1}^{n} \left(NCF_i \times \frac{1}{(1+r)^i} \right)$$

where:

- NCF_i is the net cash flow in the i-th year

- r is the discount rate.

Using discounting considers two factors: the investor's expectations with respect to the measure and that the NPV can be greater than zero during the operating period.

The calculation of the subsidy level should be based on economic principles. If the project is socially significant rather than profitable for the beneficiary, the subsidy should make a small amount of profit. In simple terms, the financial NPV including the subsidy should be approximately at the level of zero KGS, which means that the project yields an acceptable rate of return for the investor/project promoter (revenues from fares combined with lower operating costs).

The "determination of the subsidy level" module uses this principle by making a simple financial analysis of the cash inflows and outflows in each year of the analysis. Cash inflows (receipts) generated by the project include fuel savings expressed in terms of the money saved by customers (public transport providers). In terms of cash outflows (expenses), the simple financial analysis totals the difference between the investment costs of a clean and a traditional bus calculated in the other modules. In the subsidy module, the subsidy is included on the cash outflow side as a negative value.

It was assumed that the investments will be made during the first year of the project and the savings averaged over the nine years of operation. The period of analysis is 10 years, a typical lifetime for this type of project. The subsidy is calculated so that the result of the NPV calculation is equal to zero KGS.

First, the savings on fuel costs were calculated, given the lower price of CNG. The parameters used to calculate fuel savings are presented in Table B.4.

The cost of a new CNG bus (EUR 255 000; MDL 5.2 million) was compared with the average cost of a used bus (MDL 1.04 million), which beneficiaries would have been likely to purchase in the absence of public support (Table B.5).

Table B.4. Assumptions for calculating the level of public support for CNG buses

	Fuel consumption	Fuel price	Annual distance	Fuel costs per year MDL
CNG bus	38.5 kg/km	8.9 MDL/kg	46 000 km	157 000
Old diesel bus (> 15 years)	56.3 l/100 km	16.5 MDL/l	46 000 km	427 000
Annual difference				**270 000**

Source: OECD, OPTIC Model.

Table B.5. Calculation of the level of public support for CNG buses

(MDL)

Year	0	1	2	3	4	5	6	7	9
Investment costs for a new bus	5.2 million								
Difference in price compared to a standard bus	4.16 million								
Required public support	2.241 million								
Annual fuel cost savings	270 000	270 000	270 000	270 000	270 000	270 000	270 000	270 000	270 000
NPV	0								

Source: OECD, OPTIC Model.

Similar calculations are made for LPG buses (Table B.6 and Table B.7) and for modern diesel buses (Table B.8 and Table B.9).

Table B.5. Assumptions for calculating the level of public support for LPG buses

	Fuel consumption	Fuel price	Annual distance	Fuel costs per year, MDL
LPG bus	35.7 l/100 km	10.6 MDL/l	46 000 km	174 000
Old diesel bus (> 15 years)	56.3 l/100 km	16.5 MDL/l	46 000 km	427 000
Annual difference				245 000

Source: OECD, OPTIC Model.

Table B.6. Calculation of the level of public support for LPG buses

(MDL)

Year	0	1	2	3	4	5	6	7	8
Investment costs for a new bus	4.73 mln								
Difference in price compared to a standard bus	3.69 mln								
Required public support	1.883 mln								
Annual fuel cost savings	254 000	254 000	254 000	254 000	254 000	254 000	254 000	254 000	254 000
NPV	0								

Source: OECD, OPTIC model.

Table B.7. Assumptions for calculating the level of public support for modern diesel buses

	Fuel consumption	Fuel price	Annual distance	Fuel costs per year MDL
Diesel Euro VI bus	50 l/100 km	16.5 MDL/l	46 000 km	380 000
Standard diesel bus	45 l/100 km	16.5 MDL/l	46 000 km	342 000
Annual difference				-38 000

Source: OECD, OPTIC Model.

Table B.8. Calculation of the level of public support for modern diesel buses

(MDL)

Year	0	1	2	3	4	5	6	7	8
Investment costs for a new bus	4.52 mln								
Difference in price compared to a standard bus	3.48 mln								
Required public support	3.14 mln								
Annual fuel cost savings	-47 000	-47 000	-47 000	-47 000	-47 000	-47 000	-47 000	-47 000	-47 000
NPV	0								

Source: OECD, OPTIC Model.

The above calculations do not take into account possible reduced maintenance costs, as old buses tend to require more maintenance over time. On the other hand, the maintenance of modern technologies can be is more expensive, especially in terms of security concerns in using CNG or LPG, so it is assumed that bus replacement will be neutral in terms of maintenance costs.

The results of the calculation are presented in the "Subsidy" tab (Table B.10).

Table B.9. Subsidy calculation for public support for replacement of buses

	Costs per bus	Difference in price to standard bus	Annual distance	Annual fuel costs	Annual reference fuel costs*	Subsidy required per bus	Net cost to beneficiary per bus
	MDL mln	MDL mln	km	MDL mln	MDL mln	MDL mln	MDL mln
CNG	5.20	4.16	46 000	157 000	427 000	2.241	2.960
LPG	4.73	3.69	46 000	174 000	427 000	1.883	2.840
Diesel Euro VI	4.52	3.48	46 000	380 000	427 000	3.141	1.380

Note: *Reference fuel costs refer to old diesel buses.
Source: OECD, OPTIC Model.

Cost calculation

The cost calculation module under the tab "Costs" shows the estimated investment costs and the subsidy required by the CPT Programme. This information is provided in a table format that contains data on public transport in Moldova, the number of buses to be replaced, the type of new buses, total investment costs, the level of subsidy and the net costs to beneficiaries. In this module, users simply input factual information without making any decisions on the programme.

Table B.10. Investment costs, subsidies and net costs for beneficiaries

№	Type	City	Buses to be replaced			New buses						Need for CNG station	Investment costs							
			Type			Bus			Mini-bus		Trolley bus		Bus			Mini-bus		CNG stations	Trolley buses	Total
			Buses	mini-buses	Trolley buses	Diesel	CNG	LPG	Diesel	LPG	Electricity		Diesel	CNG	LPG	Diesel	LPG			
1	Urban	Chisinau	60	555	25	42	42	43	43	52	50	0	190	218	203	87	105	0	260	1 063
2	Urban	Balti	16	86	6	8	8	7	8	13	12	0	36	42	33	16	26	0	62	216
3	Suburban	Chisinau	173	337	0	71	71	70	71	71	0	0	321	369	331	143	143	0	0	1 307
4	Suburban	Balti	29	32	0	10	11	10	11	11	0	0	45	57	47	22	22	0	0	194
5	Inter-city	Chisinau	319	1 545	0	185	185	184	185	185	0	0	836	962	869	373	373	0	0	3 413
6	Inter-city	Balti	18	41	0	8	8	7	8	8	0	0	36	42	33	16	16	0	0	143
7	Inter-city	Other regions	279	1 361	0	324	0	162	163	163	0	0	1 464	0	765	329	329	0	0	2 887
Total			894	3 957	31	648	325	483	489	503	62	0	2 929	1 689	2 282	986	1 014	0	322	9 223

№	Type	City	Subsidy								Net costs for beneficiary							
			Bus			Mini-bus		CNG stations	Trolley bus	Total	Bus			Mini-bus		CNG stations	Trolley buses	Total
			Diesel	CNG	LPG	Diesel	LPG				Diesel	CNG	LPG	Diesel	LPG			
1	Urban	Chisinau	142	109	102	56	58	0	130	597	47	109	102	30	47	0	130	466
2	Urban	Balti	27	21	17	10	14	0	31	121	9	21	17	6	12	0	31	95
3	Suburban	Chisinau	241	185	165	93	79	0	0	762	80	185	165	50	64	0	0	545
4	Suburban	Balti	34	29	24	14	12	0	0	113	11	29	24	8	10	0	0	81
5	Inter-city	Chisinau	627	481	435	243	205	0	0	1 990	209	481	435	131	168	0	0	1 423
6	Inter-city	Balti	27	21	17	10	9	0	0	84	9	21	17	6	7	0	0	59
7	Inter-city	Other regions	1 098	0	383	214	181	0	0	1 875	366	0	383	115	148	0	0	1 012
Total			2 197	845	1 141	641	558	0	161	5 542	732	845	1 141	345	456	0	161	3 681

Source: OECD, OPTIC Model.

Emission reductions calculation

The emission reductions calculation module, under the tab "Emissions", shows the estimated annual emission reduction by type of pollutant. This information is provided in an Excel table (Table B.12) that contains data on transport sector in Moldova, the number of buses to be replaced, the type of new buses, the emissions from old buses, emissions from new buses, and emission reduction. In this module, users simply input the factual information without making decisions on the CPT Programme.

Table B.11. Emission reductions based on the purchase of new buses

№	Type	City	Buses to be replaced			New buses						Buses to be replaced				
			Type			Bus			Mini-bus		Trolley-bus	Emissions				
			Buses	Mini-buses	Trolley-buses	Diesel	CNG	LPG	Diesel	LPG	Electricity	CO_2 (t)	CO (kg)	NO_x (kg)	PM 2.5 (kg)	SO_2 (kg)
1	Urban	Chisinau	60	555	25	42	42	43	43	52	50	26 371	41 609	182 464	3 752	3 496
2	Urban	Balti	16	86	6	8	8	7	8	13	12	5 004	7 851	34 427	708	660
3	Suburban	Chisinau	173	337	0	71	71	70	71	71	0	33 410	53 856	236 171	4 856	4 525
4	Suburban	Balti	29	32	0	10	11	10	11	11	0	4 805	7 746	33 968	698	651
5	Inter-city	Chisinau	319	1 545	0	185	185	184	185	185	0	91 593	147 645	647 462	13 312	12 405
6	Inter-city	Balti	18	41	0	8	8	7	8	8	0	3 669	5 914	25 935	533	497
7	Inter-city	Other regions	279	1 361	0	324	0	162	163	163	0	80 424	129 641	568 509	11 689	10 892
Total			894	3 957	31	648	325	483	489	503	62	245 277	394 262	1 728 936	35 548	33 124

№	Type	City	New buses (Emissions)					Emission reduction				
			CO_2 (t)	CO (kg)	NO_x (kg)	PM 2.5 (kg)	SO_2 (kg)	CO_2 (t)	CO (kg)	NO_x (kg)	PM 2.5 (kg)	SO_2 (kg)
1	Urban	Chisinau	11 572	8 538	37 583	40	312	14 799	33 071	144 881	3 711	3 183
2	Urban	Balti	2 249	1 573	7 019	8	58	2 755	6 278	27 408	700	602
3	Sub-urban	Chisinau	17 062	13 551	61 234	66	498	16 349	40 305	174 937	4 790	4 027
4	Sub-urban	Balti	2 516	1 978	8 928	10	72	2 290	5 768	25 040	689	579
5	Inter-city	Chisinau	44 565	35 511	160 084	172	1 304	47 029	112 134	487 377	13 140	11 101
6	Inter-city	Balti	1 862	1 414	6 607	7	52	1 807	4 500	19 328	526	445
7	Inter-city	Other regions	40 552	31 061	159 153	122	1 366	39 872	98 580	409 355	11 567	9 526
Total			120 377	93 625	440 610	425	3 662	124 900	300 637	1 288 326	35 123	29 463

Source: OECD, OPTIC Model.

Programme costing and environmental effects

The CPT Programme costing and environmental effects module is under the tab "Decision". This is the main module for supporting decision making. It can be used for the automatic calculation of the programme costs as well as for manual adjustments.

The upper part of the screen contains the information on the programme target. Users may define one of the following programme targets:

- investment costs
- subsidy budget (amount of funding available for subsidies)
- CO_2 emission reduction
- CO emission reduction
- NO_x emission reduction
- PM2.5 emission reduction
- SO_2 emission reduction.

By clicking on the "Go" button to the right of the respective target (Table B.13), the model calculates the programme financial envelope necessary to achieve the target, for that target only, excluding the other targets.

Table B.12. Adjusting programme costs and environmental effects

Programme target	Costs			Emissions								
	Investment costs	100 000	Go	CO2 (t/a)	10 500	Go	NOx (kg/a)	150 000	Go	SO2 (kg/a)	5 000	Go
	Subsidy budget	10 000	Go	CO (kg/a)	60 000	Go	PM2.5 (kg/	45 000	Go			

Source: OECD, OPTIC Model.

The algorithm for the programme cost calculation is as follows:

- The model reviews the information on public transport for each city, in the order provided in the table in the "Transport" tab. The review is done in three iterations, starting from the urban centres and then respectively for suburban and inter-city connections.
- First, the model determines whether the city has any potential for CNG buses; if so, the model proposes the replacement of an old bus by a CNG bus.
- Then, the previous step is repeated until the target is reached or all old buses in a given iteration are replaced.
- If the city does not have the potential for CNG buses, the model completes the same steps with Euro VI diesel buses.
- If the city lacks the potential for either CNG or Euro VI diesel buses, the model proceeds through the same steps with LPG buses.
- The costs of CNG stations are also taken into account. If the number of buses replaced is higher than 100, it is assumed that a CNG station is a commercial project and a subsidy is not required. Existing CNG stations in Bishkek and Osh are taken into account.

The results are presented in an Excel table (Table B.14) that contains basic information on the number of new buses, investment costs, subsidies and emission reductions per year. If users want to see details, the "Emissions" or "Costs" tabs should be used (described earlier).

Table B.13. Relationship between programme costs and environmental effects

№	Type	City	New buses						Investment costs	Subsidy	Emission reduction per year				
			Bus			Mini-bus		Trolleybus							
			Diesel	CNG	LPG	Diesel	LPG		million MDL	million MDL	CO_2 (t)	CO (kg)	NO_x (kg)	PM 2.5 (kg)	SO_2 (kg)
1	Urban	Chisinau	42	42	43	43	52	50	1 063	597	14 799	33 071	144 881	3 711	3 183
2	Urban	Balti	8	8	7	8	13	12	216	121	2 755	6 278	27 408	700	602
3	Sub-urban	Chisinau	71	71	70	71	71	0	1 307	762	16 349	40 305	174 937	4 790	4 027
4	Sub-urban	Balti	10	11	10	11	11	0	194	113	2 290	5 768	25 040	689	579
5	Inter-city	Chisinau	185	185	184	185	185	0	3 413	1 990	47 029	112 134	487 377	13 140	11 101
6	Inter-city	Balti	8	8	7	8	8	0	143	84	1 807	4 500	19 328	526	445
7	Inter-city	Other regions	324	0	162	163	163	0	2 887	1 875	39 872	98 580	409 355	11 567	9 526
Total			648	325	483	489	503	62	9 223	5 542	124 900	300 637	1 288 326	35 123	29 463

Source: OECD, OPTIC Model.

Users may change the project pipelines by providing their own information on the number of new buses. Then the calculations are updated accordingly.

Programme costing for Phase 1 (pilot phase) and Phase 2 (scaling-up phase)

In the spreadsheet titled "Programme targets", (Table B.15) users may define whether the calculation is being done for the pilot phase (Phase 1), which covers only two cities, or for Phase 1 and 2. The user may also define whether normative or real emission factors are used in the calculation. The third parameter defined by the user is the scenario for Phase 2, which may be as follows:

- Scenario 1: Replacement of oldest buses (those remaining after Phase 1) operating in urban/suburban areas of the pilot cities.
- Scenario 2: Replacement of the buses as in Scenario 1, as well as those operating inter-city connections (which covers urban/suburban transport in other cities).

Table B.14. Adjusting programme targets

Phase	1 & 2	Emissions	real	Scenario	1	Go

Source: OECD, OPTIC Model.

By clicking on the "Go" button to the right of the defined scenario, the model calculates the programme costs and emission reductions. The targets are thus ignored.

Sources of information used in the assumptions

The current version of the model uses information from different sources, both Moldovan and international. This section describes the sources of information for each assumption used:

- **Data on urban public transport** (number of buses, fuel type and age) were provided by the cities of Chisinau and Balti, the National Agency of Road Transport (ANTA), the Ministry of Transport and Roads Infrastructure (since September 2017, within the Ministry of Economy and Infrastructure), and the Ministry of Environment (since September 2017, part of the Ministry of Agriculture, Regional Development and Environment), as well as by private minibus operators in Chisinau and Balti.
- The **average prices of buses** were obtained from estimates from European Bank for Reconstruction and Development (EBRD) tenders, municipal tenders, statements of bus and minibus operators in questionnaires, and market research on the internet.
- The **fuel prices** were obtained from market research on the main distribution companies on the internet and in particular the national regulator ANRE.
- **Fuel consumption** was calculated by reviewing technical information of bus producers and several bus utilities introducing new buses (*Der Betrieb mit Flüssiggas als Alternative zum Dieselantrieb/(Operating with LPG as an alternative to diesel propulsion)*;[2] *Cost and Benefits of Clean Technologies for Bus Rapid Transit (BRT): Summary of Results for Kampala* (ICCT, 2012[6]); C*omparison of Modern CNG, Diesel and Diesel Hybrid-Electric Transit Buses: Efficiency and Environmental Performance* (MJB&A, 2013[7]); *CNG vs. Diesel Bus Comparison*; *Infrastructure for Alternative Fuels* (European Expert Group on Future Transport Fuels, 2011[8]) [3] and *A Realistic View of CNG Vehicles in the US* (Nath R. et al, 2014[9]).

Emission factors

The emission factors were taken from:

- The section on "Exhaust Emissions of European Monitoring and Evaluation Programme" in the European Environment Agency (EEA) *Air Pollution Emission Inventory Guidebook 2013; Technical Guidance to Prepare National Emission Inventories* (EEA, 2016[10]).
- Euro II-VI emission standards.
- Euro II-V fuel standards (for SO_2).
- The revised 1996 Intergovernmental Panel on Climate Change (IPCC) *Guidelines for National Greenhouse Gas Inventories, Vol. 3: The Reference Manual* (IPCC, 1996[11]).
- The Emissions Factors Toolkit (EFT) published by Defra and the Devolved Administrations (Defra and the Devolved Administrations, 2017[12]).

- For electricity, the CO_2 Emission factor & transmission and distribution loss factor provided in the U4E Country report: http://united4efficiency.org/wp-content/uploads/2017/05/MDA_U4E-Country-Assessment-Report.pdf.

The various emission standards used in the calculations are provided in Table B.16. They are practically entirely based on the European emission regulations for new heavy-duty diesel engines, commonly referred to as Euro I-VI.

Table B.15. EU emissions standards for heavy-duty diesel engines

(g/kWh)

Tier	Date	Test cycle	CO	HC	NO_x	PM
Euro I	1992 < 85 kW	Economic Commission for Europe of the United Nations (ECE/UN) Regulation-49	4.5	1.1	8.0	0.612
	1992 > 85 kW		4.5	1.1	8.0	0.36
Euro II	October 1996		4.0	1.1	7.0	0.25
	October 1998		4.0	1.1	7.0	0.15
Euro III	*October 1999 Enhanced Environmentally friendly Vehicles (EEVs) only*	European Stationary Cycle (ESC) and European Load Response (ELR)	1.0	0.25	2.0	0.02
	October 2000	ESC & ELR	2.1	0.66	5.0	0.10 - 0.13
Euro IV	October 2005		1.5	0.46	3.5	0.02
Euro V	October 2008		1.5	0.46	2.0	0.02
Euro VI	31 December 2013		1.5	0.13	0.4	0.01

Source: (EC, 2017[13]), *Transport Emissions: Air Pollutant from Road Transport*, http://ec.Europa.eu/environment/air/transport/road.htm (accessed 16 February 2017).

Similarly, the EU fuel standards for sulphur content for Euro 2-5, used in the calculations, are provided in Table B.16.

Table B.16. EU fuel standards for sulphur content

Name	EU Directive	European Committee for Standardization (CEN) Standard	Implementation date	Sulphur limit (ppm)
n/a	-	EN 590:1993 (d) EN 228:1993 (g)	October 1994	2 000
Euro 2	93/12/EEC	-	October 1996	500 (diesel)
Euro 3	93/12/EEC	EN 590:1999 (d) EN 228:1999 (g)	January 2000	350 (diesel); 150 (petrol)
Euro 4	98/70/EC	EN 590:2004 (d) EN 228:2004 (g)	January 2005	50*
Euro 5	2003/17/EC	EN 590:2009	January 2009	10, 10**

Note: * "Sulphur-free" 10ppm fuel must be available; ** non-road fuels limit
Source: (EC, 2017[13]), *Transport Emissions: Air Pollutant from Road Transport*, http://ec.Europa.eu/environment/air/transport/road.htm (accessed 16 February 2017).

On the other hand, the estimated CO_2 emission factors for a number of pollutants emitted by European heavy-duty diesel vehicles come from the *Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories* and its *Reference Manual* (IPCC, 1996[11]) (Table B.18).

Table B.17. Estimated CO_2 emission factors for European heavy-duty diesel vehicles

	CO_2
Total g/km	770
g/kg fuel	3 140
g/MJ	74

Source: (IPCC, 1996[11]), *Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 3: The Reference Manual*, Intergovernmental Panel on Climate Change, Mexico City, www.ipcc-nggip.iges.or.jp/public/gl/invs6.html.

The current norms for air pollution and CO_2 emissions can be taken from the *EMEP/EEA Air Pollution Emission Inventory Guidebook 2016* (EEA, 2016[10]). Table B.19 presents the Tier 1 approach to measuring exhaust emissions (explained in the source document for the table).

Table B.18. Tier 1 air pollution emission of heavy-duty diesel vehicles

(g/kg fuel)

	CO	NMVOC	NO_x	PM	N_2O
Diesel	7.58	1.92	33.37	0.94	0.051
CNG (buses)	5.70	0.26	13.00	0.02	n.a.

Source: (EEA, 2016[14]), *EMEP/EEA Air Pollution Emission Inventory Guidebook 2016. Technical Guidance to Prepare National Emission Inventories. Part B: Sectoral Guidance Chapters – Road Transport 2018*, www.eea.europa.eu/publications/emep-eea-guidebook-2016/part-b-sectoral-guidance-chapters/1-energy/1-a-combustion/1-a-3-b-i/view.

The *EME/EEA Air Pollution Emission Inventory Guidebook 2016* is also used as a source for estimating the CO_2 emission factors for different fuels used in operating heavy-duty vehicles (Table B.20).

Table B.20. Tier 1 CO_2 emission factors for different road transport fossil fuels, all vehicle types

Fuel type	gCO_2 / kg of fuel*
Petrol	3 169
Diesel	3 169
LPG**	3 024
CNG (or LNG)***	2 743

Note: *CO_2 emission factors are based on an assumed 100% oxidation of the fuel carbon (ultimate CO_2); ** LPG assumed to be 50% propane + 50% butane; *** CNG and LNG assumed to be 100% methane.
Source: (EEA, 2016[14]), *EMEP/EEA Air Pollution Emission Inventory Guidebook 2016. Technical Guidance to Prepare National Emission Inventories. Part B: Sectoral Guidance Chapters – Road Transport 2018*, www.eea.europa.eu/publications/emep-eea-guidebook-2016/part-b-sectoral-guidance-chapters/1-energy/1-a-combustion/1-a-3-b-i/view.

A couple of sources were used for fuel consumption values used in the model, combined with the authors' own assumptions, particularly for LPG consumption volumes (Table B.21).

Table B.19. Assumed fuel energy content and consumption of heavy-duty vehicles

Fuel type	Energy (unit)	Consumption (g/km)
Petrol	8.77 (kWh/l)	300*
Diesel	9.86 (kWh/l)	240
CNG	13.16 (kWh/kg)	500
LPG	6.6 (kWh/l)	340*

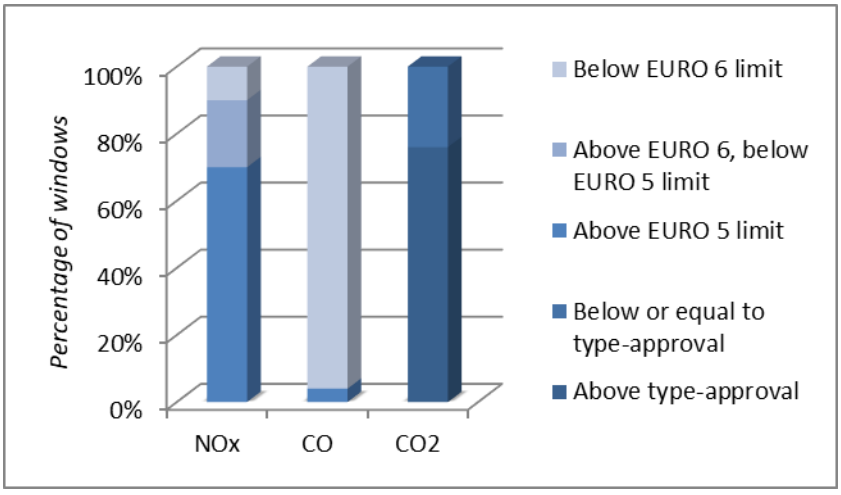
Note: * Own assumptions.
Source: (EEA, 2016[14]), *EMEP/EEA Air Pollution Emission Inventory Guidebook 2016. Technical Guidance to Prepare National Emission Inventories. Part B: Sectoral Guidance Chapters – Road Transport 2018*, www.eea.europa.eu/publications/emep-eea-guidebook-2016/part-b-sectoral-guidance-chapters/1-energy/1-a-combustion/1-a-3-b-i/view; www.erdgasautos.at (in German, accessed 14 March 2019).

It was assumed that the emission factors for old engines are the same as for a new one. However, in new engines energy efficiency is higher and fuel consumption 10% lower than in buses more than 5 years old, 15% lower than buses of more than 10 years old, and 25% lower than buses of more than 15 years old.

The specific emission factors used in the model are provided in Table B.2 above. The emission factors presented in Table B.2, however, are based on maximum levels, according to specific norms. The real emissions may vary, mainly because normative emissions are tested in laboratory conditions and not in actual traffic. This is a concern primarily in the case of diesel engines, where emission reduction depends on the installed emission reduction equipment. In the case of CNG and LPG, emissions are less problematic, because lower emissions are mainly the result of using cleaner fuels.

In 2014, the ICCT issued a report on real-world exhaust emissions from modern diesel cars presenting measurements of real emissions. The analysis showed that real-world emissions of CO_2 and NO_x are higher than the limits (respective Euro norms) – by an average of 40% and 70%, respectively (Franco et al., 2014[15]).

Figure B.1. Percentage of tested vehicles that exceed Euro limits in urban cycle



Note: The "window" represents a sample.
Source: (Franco et al., 2014[15]).

Thus, the model also offers an alternative set of emission factors taking into account the fact that real emissions may exceed normative ones. Table B.21. presents the real emission factors used in the model.

Table B.20. Assumed emissions factors adjusted to real values (per km)

Engine and fuel type	CO_2 (kg/km)	CO (g/km)	NO_x (g/km)	PM2.5 (g/km)	SO_2 (g/km)
Diesel Euro II	1.5137	2.4400	10.7000	0.2200	0.2050
Diesel Euro II>5 y.	1.6650	2.6840	11.7700	0.2420	0.2255
Diesel Euro II>10 y.	1.8164	2.9280	12.8400	0.2640	0.2460
Diesel Euro II>15 y.	1.9678	3.1720	13.9100	0.2860	0.2665
Diesel Euro VI	1.0685	0.2230	4.2387	0.0023	0.0205
CNG (EEV standard)	0.9350	0.2400	2.5000	0.0050	0.0000
LPG	1.0258	1.9200	5.0000	0.0050	0.0652

Source: OECD, OPTIC Model.

The user can change both normative and real emission factors according to modelling needs.

Annex C. Example of a project application form

Bus/minibus/trolleybus replacement

Project Name					
Name of the project applicant					
Address					
Contact details					
Legal status					
Bank account number, bank, branch and address					
Location of the project (city)					
Description of the project:					
Number of buses used for regular services in the city					
Number of minibuses used for regular services in the city					
Number of bus lines operated by the company in the city					
Number of minibus lines operated by the company in the city					
Planned bus replacement	Buses that will be replaced		New buses		
	Older than 15 years	10 to 15 years old	CNG	LPG	Diesel
Number of buses (#)					
Costs (MDL 1 000)	X	X			
Total costs (MDL 1 000)	X	X			
Planned minibus replacement	Buses that will be replaced		New buses		
	Older than 15 years	10 to 15 years old	CNG	LPG	Diesel
Number of minibuses (#)					
Costs (MDL 1 000)	X	X			
Total costs (MDL 1 000)	X	X			
Planned trolleybus replacement					
Number of trolleybuses (#)					
Costs (MDL 1 000)					
If CNG buses are proposed: Does a CNG filling station exist in the city?					

Annex D. Example of a project pre-appraisal form

Bus replacement

Criteria	Yes/No
Criteria related to the location of the project	
Is the project located in the urban centre of the city listed in the list of eligible costs?	
Criteria related to the type of eligible projects	
Is the project type on the list of eligible projects?	
Are all the proposed project costs found in the list of eligible costs?	
Is the number of older buses (of between 10 and 15 and more than 15 years old) equal to new buses (using the factor 1 bus = 5 minibuses)?	
Criteria related to the type of eligible beneficiaries	
Is the type of beneficiary found on the list of eligible beneficiaries?	
Other eligibility criteria	
Are there existing plans for the city to implement additional investments that improve the urban public transport system in the city?	
Total: “Yes” if all answers are checked yes, “No” if at least one answer is no	

Annex E. Example of a project appraisal form

The best-suited project receives the highest score (max. 10 points) in each sub-category (A1-F5) the worst the lowest score (min. 0 points); other projects receive number points proportional to their ranking. The sum of received points in each category (A-F) is multiplied by a coefficient (0.1-0.2) to receive a weighted sum which is the final appraisal score for the respective project.

	Criteria	Weight	Max no. of points	Points
A	**Project preparation**	0.1		
1	Prepared business plan or strategic for project implementation in the city		0-1	
B	**Project location**	0.2		
1	Buses that will be replaced are used only in polluted districts of the eligible city		5	
2	Buses that will be replaced are used only in the centre of the eligible city		5	
3	Buses that will be replaced are used in the city centre and on the outskirts/suburbs of the eligible city		3	
4	Buses that will be replaced are used in the city and connecting the rural area outside the eligible city		0	
C	**Project type**	0.2		
1	CNG-powered buses		10	
2	Trolleybuses		5	
3	LPG-powered buses		1	
4	Modern diesel buses		1	
D	**Project size**	0.2		
1	More than 20 buses to be replaced		10	
2	Between 10 and 20 buses to be replaced		5	
3	Fewer than 10 buses to be replaced		1	
E	**Proposed system of improvements of urban public transport in the city:**	0.1		
1	Length of the new bus lanes (0 points < 2km, 1 p.– up to 2km, 2p. > 2km)		2	
2	Number of traffic lights with priority for public transport (0 points < 2, 1 p.– up to 4, 2p. > 5)		2	
3	Number of bus stops newly equipped with online information for passengers (0 points < 2, 1 p.– up to 4, 2p. > 5)		2	
4	Number of new bus stops (0 points < 2, 1 p.– up to 4, 2p. > 5)		2	
5	Other measures (points according to expert opinion)		2	
F	**Environmental efficiency**	0.2		
1	Unit efficiency	(F2-F3)/F4		
2	Calculated annual PM2.5 emissions from old buses [PM2.5 kg]*			
3	Calculated annual PM2.5 emissions from new buses [PM2.5 kg]			
4	Project costs			
5	Points for environmental efficiency – the best project with unit efficiency U_{best} receives 10, the worst with unit efficiency U_{worst} receives 0, others with unit efficiency U receive $10*(U-U_{worst})/ (U_{best}-U_{worst})$		10	
G	**Total: (weights x points)**			

Note: *Measuring the environmental efficiency of an investment involves calculating the unit cost of decreasing emissions – in this example, PM2.5 emissions. The unit cost should be calculated as the difference between PM2.5 emissions from old diesel buses and from new buses. The calculation should use real emission factors from the OPTIC Model.

Notes

1. See Danish Technological Institute on emissions reduction: www.dti.dk/specialists/emission-reduction/37141 (accessed 20 March 2017).

2. GGE is the amount of alternative fuel it takes to equal the energy content of one liquid gallon (ca. 3.785 litres) of petrol. GGE allows consumers to compare the energy content of competing fuels against a commonly known fuel, petrol. GGE also compares petrol to fuels sold as a gas (natural gas, propane or hydrogen) and electricity.

3. According to Directive 2014/94/EU (EU, 2014[16]) on the deployment of alternative fuels infrastructure, natural gas (CNG and LNG) and liquefied petroleum gas (LPG) are considered as alternative fuels in addition to electricity, hydrogen, biofuels (as defined by Art. 2 of Directive 2009/28/EU), and synthetic and paraffinic fuels (EU, 2014[16]).

4. See new generation of buses: http://new.abb.com/grid/technology/tosa; and autonomous electric buses in France: www.avere-france.org/Site/Article/?article_id=5730 (accessed 26 April 2017).

1. The model assumes that an average bus operates 330 days per year.

2. For information on CNG vehicles, see www.erdgasautos.at (in German).

3. See www.bus.man.eu/cng_optimizer/index.html (accessed 25 February 2017).

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