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ABBREVIATIONS AND ACRONYMS

AFDJ	Lower Danube River Administration
BCR	Benefit / Cost Ratio
BRT	Bus Rapid Transit
CEF	Connecting Europe Facility
CF	Cohesion Fund
CFR	<i>Căile Ferate Române</i> or Romanian Railways
CHF	Swiss Franc
CNG	Compressed Natural Gas
DRPC	Danube River Protection Convention
EAFRD	European Agricultural Fund for Rural Development
EBRD	European Bank for Reconstruction and Development
EIB	European Investment Bank
ERD	Electronic Road Pricing
ERDF	European Regional Development Fund
ERTMS	European Rail Traffic Management System
ESIF	European Structural and Investment Funds
ETC	European Territorial Cooperation
ETS	Emission Trading System
EU	European Union
GBP	Great Britain Pound
GHG	Greenhouse Gas Emissions
GIS	Geographic Information System
GIZ	<i>Deutsche Gesellschaft für Internationale Zusammenarbeit</i>
GTMP	General Transport Master Plan
HGV	Heavy Goods Vehicle
HOT	High Occupancy Toll
HOV	High Occupancy Vehicle
HST	High Speed Train
HVF	Heavy Vehicle Fee
IA	Implementing Agency
ICAO	International Civil Aviation Organization
ICPDR	International Commission for the Protection of the Danube River
IP	Investment Priority
IPCC	Intergovernmental Panel on Climate Change
ITI	Integrated Territorial Initiative
IWT	Inland Waterway Transport
UIC	Interio
JASPERS	Joint Assistance to Support Projects in the Regions
KM	Kilometer
LRT	Light Rapid Transit
MA	Managing Authority
MFF	Multiannual Financial Framework
MOT	Ministry of Transport
MRDPA	Ministry of Regional Development and Public Administration
MRT	Mass Rapid Transit
NGS	Natural Gas Vehicle

NGV	Natural Gas Vehicle
NTM	National Transport Model
OP	Operational Programme
ORT	Open Road Tolling
PAYD	Pay as You Drive
PEV	Plug in Electric Vehicle
RATB	<i>Regia Autonomă de Transport Bucureşti</i>
RAS	Reimbursable Advisory Service
ROP	Regional Operational Programme
RUC	Road User Costs
PIANC	World Association for Waterborne Transport Infrastructure
SOP-T	Sectoral Operational Programme - Transport
SUMP	Sustainable Urban Mobility Plan
SEAP	Sustainable Energy Action Plans
STIF	<i>Syndicat des transports d'Île-de-France</i>
TA	Technical Assistance
TEN-T	Trans-European Transport Network
TOR	Terms of Reference
TRACE	Tool for Rapid Assessment of City Energy
TREMOVE	Economic transport and emissions model
UIC	<i>Union Internationale des Chemins de Fer</i>
UK	United Kingdom
USSR	Union of Soviet Socialist Republics
VQS	Vehicle Quota System
VKT	Vehicle Kilometer Travelled

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EXECUTIVE SUMMARY

This Report has been prepared by the World Bank for the Government of Romania, as part of an Advisory Services program on climate change and low carbon green growth. In order to meet EU requirements for future use of EU funds, the Government of Romania has to prepare the 2014-2020 Operational Programmes incorporate climate change considerations. This Report has identified climate change actions for the 2014-2020 Operational Programmes, with the aim of presenting recommendations for transport specific climate actions. This Report presents the results of a rapid assessment conducted to assess transport sector specific climate risks, opportunities for mitigation and adaptation, and preliminary prioritization of climate actions. Mitigation refers to measures that reduce GHG emissions growth from transport sources, while adaptation refers to preparing for the impacts of global climate change on the nation's transportation infrastructure and systems. It includes both general transport and urban transport, but excludes international air transport and sea transport, which are both subject to international regulation and initiatives, rather than being an exclusively national issue for Romania.

For Romania to become a climate resilient society that has mainstreamed climate policies and actions into its sustainable economic growth strategy, all sectors need to reorient their policies towards achievement of these goals. Climate friendly policies are in line with the strategic goals of supporting the development of an integrated and environmentally friendly transport system, and ensuring its sustainability and optimized performance. These goals are in line with the draft strategy of Romania's Ministry of Transport, which is expected to be adopted before the end of the year. The ministry's mission is to support the development of a safe integrated transport system that serves the Romanian people and economy efficiently and equitably while protecting the environment, for a sustainable development of Romania within the EU. One of its strategic pillars is to support the development of an integrated and environmentally friendly transport system through the development of a transport system that protects the environment and supports integrated social and economic development without harm to human health or to environment for the benefit of today's and future generations. Local co-benefits of green policies include, but are not limited to reduced traffic congestion and road accidents, improved air quality—a recent study found that poor quality in Bucharest reduces life expectancy by 2 years and is a leading cause of respiratory diseases in the city, with road congestion, being one of the main drivers of air quality—and these can become important drivers of transport policies and investments.

The Common Provisions Regulation governing the use of European Structural and Investment Funds (ESIF), currently in draft form, sets out the means to achieve consistency with the economic policies of the EU and its Member States, coordination mechanisms among the ESIF and with other EU policies and instruments, horizontal principles and cross-cutting policy objectives.¹ It lays down arrangements to address territorial challenges, suggests action with high added value and sets out the principles and the

¹ European Commission (2013), Draft Assessment of Climate Action: How to Assess the Mainstreaming of Climate Action in Operational Programmes. ERDF and CF. European Regional Development Fund and Cohesion Fund 2014-2020.

priorities for action. Based on a proposal put forward by the European Commission, the European Council concluded on 7-8 February 2013 that ‘Climate action objectives will represent at least 20 percent of EU spending in the period 2014-2020 and therefore be reflected in the appropriate instruments to ensure that they contribute to strengthen energy security, building a low-carbon, resource efficient and climate resilient economy that will enhance Europe’s competitiveness and create more and greener jobs.’

The European Commission Position Paper on Romania translates the EU transport policy into a Romania-specific environment and is thus a useful reference during the programming phase within 2014-2020 Multiannual Financial Framework. The Position Paper sets out its vision of what are the key priorities for the transport sector in Romania to be funded out of EU funds. This is a key consideration for developing the Operational Programmes going forward. The European Commission sets out one particular ex ante conditionality related to transport in its Position Paper. This is that a comprehensive transport Master Plan, resting on a multimodal approach, needs to be adopted. This should reflect financing constraints and benefit from sound political endorsement. The development of a General Transport Master Plan for Romania is in progress, with considerable work remaining to be done to develop a prioritized list of investment projects.

GHG emissions generated from transport are among the fastest growing in Europe, posing a challenge in creating a low-carbon future, as economic development has been paralleled with a modal share increasingly dominated by roads. This modal shift has been driven by a number of factors, including growing affluence, suburbanization, and falling land use densities in urban areas, which have translated into more widespread vehicle ownership, increasing trip numbers and lengths, while reducing the financial viability of public transport and non-motorized transport. On the freight transport front, while a number of East European countries had relatively high rates of rail modal share, these have generally been declining and have been approaching EU levels. Thus, Eastern European countries, including Romania, are moving toward EU motorization rates for passenger transport—with much higher GHG growth than in the EU-27, although overall levels remain lower—while trucks are making significant inroads vis-à-vis rail. Without any changes to transport policy, these trends Romania are likely to continue unabated in the next decades.

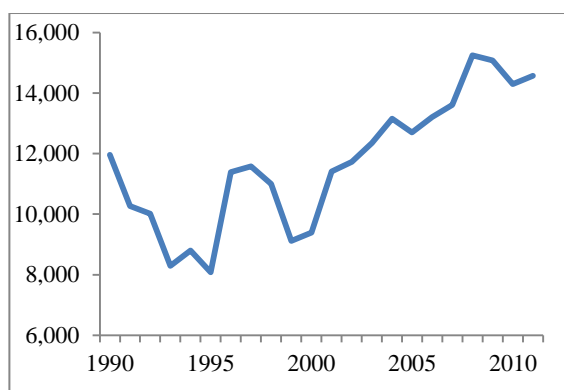
Climate change is expected to have a significant impact on transportation, affecting the way transportation professionals plan, design, construct, operate, and maintain transportation systems. Decisions taken today, particularly those related to the redesign and retrofitting of existing infrastructure, or the design of new transportation infrastructure, will affect how well the system adapts to climate change far into the future. Focusing on the problem now should help avoid costly future investments and disruptions to operations. However, research on climate change impact on transportation is relatively scarce.

The 2013 Intergovernmental Panel on Climate Change (IPCC) synthesis report of impacts, adaptation and vulnerability of recognizes potential transportation-related impacts and sensitivities: “Transport infrastructure is vulnerable to extremes in temperature, precipitation/river floods, and storm surges, which can lead to damage in road, rail, airports, and ports”. This is in line with prior research and growing awareness among transport specialists around the world of the importance of climate change,

and the need for an adaptation strategy in the transport sector. The 2013 IPCC report notes that “roads and railways are typically replaced every 20 years and can accommodate climate change at the time of replacement”, suggesting that it is only longer lived assets where it may be critical to factor in adaptation considerations.

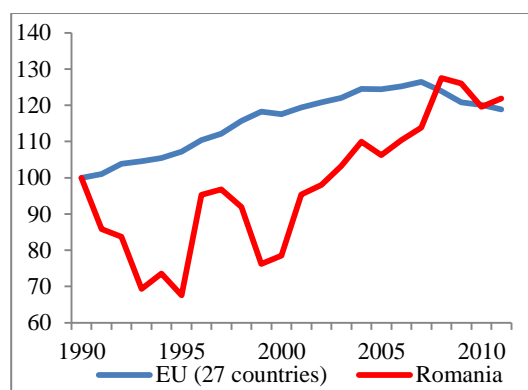
Annual GHG emissions from the domestic transport sector in Romania have grown significantly since 1990. The steady upward trend since the turn of the century is particularly noteworthy. The figures below show domestic GHG emissions over time as well as how these compare to the EU-27. As a percentage of total GHG emissions across all sectors, Romanian transport accounts for 11.8 percent (2011 figures). While this is smaller than the EU’s average of 20.2 percent, it is rising more quickly than the EU average. Among the different transport modes, road transport is the source of the great majority of GHG emissions in the transport sector, being responsible for 93 percent of domestic transport emissions. This is a similar proportion to the EU-27 average of 94 percent.

GHG Emissions from Domestic Transport in Romania
(1,000 tons CO₂)



Source: EEA.

Trends in Emissions Compared to EU-27
(2000=100)



Source: EEA.

Extreme weather events which may be linked to climate change have been experienced in some parts of Romania in recent years. These include severe floods in 2005, 2006 and 2007, and an expansion of drought-affected areas in the south and south-east of Romania. According to the draft Romanian Climate Change Adaptation Strategy, the expectation is that in the future, Romania can expect:

- A rise in average temperature overall.
- A higher increase in mean minimum winter temperature in and around the Carpathians than in the rest of the country.
- A higher increase in mean maximum summer temperature in the south and south-east than in the north of the country.
- More frequent summer droughts, especially in the south and south-east.
- More frequent heat waves.
- More intense rainfall across short periods of time, leading to more frequent flash floods.

- An overall decrease in summer precipitation, especially in the south and south-east.

The Transport Rapid Assessment conducted by the World Bank has drawn on published documents and discussions with key stakeholders in Government ministries and transport infrastructure and operating companies. It has also drawn on information and experiences from other countries, both within the EU and around the world. Based on these activities, the overall conclusion is that there is significant potential for climate change mitigation through reduction of transport sector GHG emissions growth in Romania. The World Bank has recommended mitigation actions for further consideration and investigation prior to their integration within Romania's 2014-2020 Operational Programmes. Some of these involve Technical Assistance while others are Investment actions. The recommended actions complement and reinforce transport measures that may be proposed for the Operational Programmes for other reasons, such as economic development, connectivity, safety and security.

The Transport Rapid Assessment exercise was necessarily qualitative in nature, given its wide-ranging scope and the large number of possible measures. However, it was based on use of the following broad selection criteria:

- Potential for cost-effective GHG reduction or adaptation to a changed climate – this was based on reported experience and studies from countries around the world.
- Appropriateness to the Romanian environment – prioritized measures needed to be able to fit within the developing cultural, administrative and social framework of Romania.
- Appropriate measures for Operational Programmes – in general, the focus was on investment projects, or on technical assistance (TA) actions that could guide further investment from both EU and national funds.
- The need for in-depth investigation in the Romanian local context – The World Bank has proposed feasibility and research studies through TA actions for some interventions that appear to have potential for GHG reduction and making infrastructure resilient but have not been considered fully in Romania.
- Implementation barriers / risks to benefit delivery – The World Bank considers the implementation barriers and risks to benefit delivery in Romania; where appropriate we have suggested further TA actions or pilot implementations that would address such barriers and risks prior to significant investment.

Within the recommended actions the World Bank has highlighted that, while certain infrastructure investment measures are potentially positive from a climate change mitigation perspective, the climate change benefits—and indeed economic and other benefits—will only be realized if all aspects of transport service provision are addressed holistically to ensure that the transport mode is able to attract new users. This is particularly relevant to the rail sector, where rail travel is in decline, but also applies to urban public transport services and to Inland Waterway Transport. In all of these areas, maintenance, vehicles or rolling stock, customer service, operational efficiency and service prices need to be considered as part of an attractive package 'offer' to customers. The impact of investments financed

through the Operational Programmes for rail and public transport could be monitored through changes in occupancy rates—low emission rail transport or public transport is not only failed investment but can be more emission intensive per passenger-km or ton-km than use of cars and trucks.

A summary of the specific recommended mitigation actions in each transport sub-sector is provided in the following summary table. Further detail is provided in the body of the Report.

Action	Specific objective	Type of action
All modes		
Methodology for measuring emission intensity per passenger-km and ton-km for different transport modes using different technologies and under alternative operational conditions.	Monitoring of GHG emissions by mode	Technical Assistance
Rail transport		
A comprehensive review of the rail network prior to further investment in any rail infrastructure outside the priority TEN-T network.	Mode switch from road to rail transport.	Technical Assistance
Implementation of the recommendations of the energy audit study previously undertaken, particularly with respect to equipping the railway network with equipment to allow regenerative braking.	Reduced GHG emissions per train-mile	Investment
Individual railway infrastructure projects in line with the results of the General Transport Master Plan (GTMP) appraisal and prioritization process, provided that they are implemented as part of a holistic package to improve the attractiveness of rail transport.	Mode switch from road to rail transport.	Investment
Road transport		
Study on fiscal measures to influence private car/LDV purchase and use choices	Increased low GHG emission vehicle purchase and use.	Technical Assistance
Study on which alternative fuels will best suit Romania and how best to encourage take-up of those alternative fuels and support roll-out of the associated fuelling / charging infrastructure. Such a study should look at the feasibility of introducing alternative fuels and assess costs and likely uptake, while also reviewing vehicle efficiency standards for vehicles using conventional fuels (gasoline and diesel), and the scope for introducing minimum standards for used vehicles.	Greater use of alternative (lower GHG) fuels and/or improved vehicle efficiency standards for vehicles using conventional fuels.	Technical Assistance
Study on measures to encourage freight hauliers to accelerate take-up of lower emission vehicle technology and behavior.	Increased take-up of low emission technology, behavior and operations.	Technical Assistance
Consideration of high-occupancy vehicle (HOV) restrictions and/or lift-sharing schemes in the design stages of national road infrastructure projects given a high national priority by the General Transport Master Plan.	Reduction in GHG emissions per passenger-km	Investment
Inland Waterway Transport		
Study on measures to improve GHG emission from inland	Reduction in GHG per ton-	Technical

Action	Specific objective	Type of action
navigation on Romania's waterways.	km	Assistance
Studies of river morphology and assessment of alternative river interventions to maximize river navigability while taking account of ecological considerations and sensitivities.	Mode switch from road to IWT	Technical Assistance
General port infrastructure improvements to improve operational efficiency, in line with GTMP priorities.	Mode switch from road to IWT	Investment
New and improved freight interchange facilities at river ports, including improved road and rail access, in line with GTMP priorities.	Mode switch from road to IWT	Investment
Improving navigability of waterways to link the Danube with Bucharest metro area, subject to the outputs of the GTMP prioritization process.	Mode switch from road to IWT	Investment
Urban transport		
Improvement of integrated urban planning – as covered in the Urban sector rapid assessment report	Long-term reduction of the need to travel, and facilitation of use of low emission modes.	Policy
Development of sustainable urban mobility plans (SUMP) for all cities with populations of over 100,000.	Mode switch from car travel to lower emission modes	Technical Assistance
Study on the potential role of 'harder' demand management measures to address congestion and emissions in Romanian cities.	Mode switch from car travel to lower emission modes	Technical Assistance
Bus Rapid Transit (BRT) feasibility studies in cities where the SUMP indicates that this is likely to provide a cost-effective solution to urban mass transit.	Mode switch from car travel to BRT	Technical Assistance
Investment in urban public transport, in accordance with the framework provided by the SUMP, provided that investment is part of a holistic package to improve the attractiveness of urban public transport.	Mode switch from car travel to lower emission modes; and reduction in GHG per passenger-km	Investment
Investment in cycling and walking infrastructure, in accordance with the framework provided by the SUMP, coupled with better enforcement and promotional campaigns.	Mode switch from car travel to zero emission modes	Investment
Pilot project to demonstrate and test the feasibility, costs and benefits of urban freight consolidation centers.	Reduction in GHG per ton-km	Investment
Pilot projects on alternative fuels for buses and other urban fleet vehicles – linked to the Technical Assistance study on alternative fuels.	Greater use of alternative (lower GHG) fuels.	Investment
Extension of the metro system in Bucharest to provide a more complete network, with specific projects in line with the GTMP prioritization process.	Mode switch from car travel to metro.	Investment
Implementation of urban intelligent transport systems, in line with any priorities established in these areas by the SUMP.	Reduction in GHG emissions per veh-km and reduction in vehicle-km	Investment

Action	Specific objective	Type of action
	travelled.	
Domestic air transport		
Studies to develop sustainable mobility plans for ground transportation connections to Romanian airports.	Mode switch to public transport or other low emission modes.	Technical Assistance

Adaptation to climate change is a key requirement for the transport sector in Romania in future. It needs to become an integral part of all transport sector activities, and become embedded in the day-to-day thinking of people working in the sector. As well as use of new design norms (for example, increased drainage provision or heat-resilient materials) that take account of climate change, consideration of climate change adaptation needs to be built into tendering procedures across all parts of the transport sector, and into infrastructure asset management systems, emergency preparedness planning, and revised planning and project development cycle. The starting point for the adaptation work in the transport sector is to conduct sectoral or agency level Vulnerability Assessments in order to identify the relative vulnerability of assets and services to the impacts of climate change—through the development of vulnerability maps, among other things—in order to define short-term, medium-term, and long-term actions for implementation. Within this Report the World Bank has recommended adaptation actions for further consideration and investigation prior to their integration within Romania’s 2014-2020 Operational Programmes. Again, some of these involve Technical Assistance while others are Investment actions. A summary of the specific recommended adaptation actions in each transport sub-sector is provided below—with illustrations on the kind of factors that need to be considered for each mode—with the top part of the table describing measures that apply to all modes and that are required in order to have the information basis to make investments that factor in climate considerations.

Action	Specific objective	Type of Action
All modes		
National study of vulnerability by sector/model which would involve conducting a comprehensive and detailed risk assessment should be undertaken, using the best available climate change forecasts from the National Meteorological Administration. Outputs include a mapping of risks, as well as an action plan of short-term, medium-term, and long-term actions.	Development of vulnerability assessments for each transport mode.	Technical Assistance
Revised planning and project development documentation. Require climate adaptation to be addressed in the transportation planning and project development processes, by (a) making changes supporting longer planning timeframes; (b) providing guidance on the incorporation of quantitative and qualitative climate considerations and how to address uncertainty; (c) require climate change adaptation screening in Environmental Impact Assessments by reviewing and updating regulations and procedures where climate impacts and	Climate proof transport investment projects through changes to project cycle and planning process	Technical Assistance

adaptation are relevant; and (d) require inclusion of adaptation considerations in project tender documentation. In addition, the planning process should require the maintenance of nationally standardized data sources and modelling techniques for transportation climate adaptation planning and for input to project development.		
Review of design standards for transport mode to factor in expected climatic risks which emerge from the Vulnerability Assessment and the mapping of risks.	Review of design standards for each transport mode	Technical Assistance
Development of Emergency Preparedness Planning for each agency/sector, in line with projected climatic impacts	Updating emergency preparedness planning to projected climate changes	Technical Assistance
Inclusion of projected future climate impacts into infrastructure asset management systems. Given that transportation agencies have some form of an asset management system, it is a convenient and targeted approach to incorporate climate-induced change into transportation decision making, including project selection and implementation.	Inclusion of climate consideration in transport agency asset management systems.	Technical Assistance
Rail transport		
National study of vulnerability of existing rail infrastructure and rolling stock to changed climate conditions to form the basis of a network-wide adaptation action plan and which would include a mapping of risks.	Development of an action plan for rail transport adaptation.	Technical Assistance
Review of design standards to factor in expected climatic risks, including flash floods, higher precipitation intensity, and extreme heat and cold weather.	Review of design standards for new investments	Technical Assistance
Feasibility study on an improved weather warning system to better prepare for extreme weather events in advance, reducing disruption and damage.	Improvement of responses to weather events.	Technical Assistance
Implementation of resilience infrastructure measures (to address for instance the requirements from lower cold temperatures that may result in higher snow and ice accumulation, and higher warmer temperatures that may result in kinks), including improved design measures, improved track maintenance, wooden sleeper replacement and vegetation management.	Increasing resilience to high temperature episodes.	Investment
Improvement of resilience of rolling stock to higher and lower service temperatures, including more efficient ventilation / air conditioning	Increasing resilience to high temperature episodes.	Investment
Implementation of flood resilience measures, including increased drainage provision and flood protection on new infrastructure and retrofit of flood protection measures in vulnerable locations.	Increasing resilience to flooding and consequent infrastructure damage and disruption.	Investment
Road transport		

National study of vulnerability of existing road infrastructure to changed climate conditions, to form the basis of a network-wide adaptation plan, which would include a mapping of risks.	Development of an action plan for road transport adaptation.	Technical Assistance
Review of design standards to factor in expected climatic risks. As a result of higher precipitation intensity (a) reassess parameters used for design storm for drainage systems and structures; (b) investigate the need for river training and increased channel maintenance and bridge scour protection; (c) review culvert designs to ensure they cause limited damage to roads during flooding; (d) reassess methods for slope stabilization and protection; and (e) prepare new pavement specifications.	Development of revised road design and safety standards.	Technical Assistance.
Review of road asset management system to incorporate adaptation considerations during the planning of investments and operations and maintenance of roads.	Incorporate adaptation in road asset management systems	Technical Assistance
Implementation of resilience infrastructure measures (design and/or material specifications to address for instance lower cold service temperatures and higher warmer service temperatures) in design and implementation of new road infrastructure and in any refurbishment or upgrading.	Increasing resilience to high and low temperature episodes.	Investment
Implementation of flood resilience and improved slope stabilization measures, including increased drainage provision and flood protection on new infrastructure, retrofit of flood protection measures in vulnerable locations, revised design and standards for improved slope stabilization. Higher precipitation intensity to be reflected in revised design standards for tunnels, bridges and culverts.	Increasing resilience to flooding and consequent infrastructure damage and disruption.	Investment
Inland Waterway Transport and Ports		
National study of vulnerability of existing IWT and port infrastructure to changed climate conditions, to form the basis of a national IWT adaptation plan, including a mapping of risks.	Development of an action plan for IWT adaptation.	Technical Assistance
Review design of ports lying in low coastal areas to reflect new water levels arising from expected sea level changes and update dredging requirements of rivers in light of expected hydrological and morphological changes.	Review of port design and dredging practices	Technical Assistance
Implementation of improved river information systems adapted to, for instance, lower and more variable water levels.	Maximization of river navigability through river traffic management.	Investment
Implementation of carefully selected river-based measures, including ecosystem-based measures, and river engineering measures but only after detailed consideration of their ecological and biodiversity impacts.	Maximization of river navigability.	Investment
Adapt designs of ports in low lying coastal areas to reflect new	Making ports and IWT	Investment

water levels due to sea level changes. Adapt IWT dredging practices to expected climatic changes.	climate resilient	
Urban transport		
Studies of vulnerability of urban transport infrastructure and systems to climate change, for Romanian cities, and development of city-wide adaptation plans, as well as mapping of risks.	Development of city action plans for urban transport adaptation.	Technical Assistance
Implementation of resilience infrastructure measures on local rail and tram tracks, including design measures and improved maintenance.	Increasing resilience to high and low temperature episodes.	Investment
Implementation of more efficient ventilation and/or air conditioning at metro or rail stations.	Increasing resilience to high temperature episodes.	Investment
Introduction of more efficient ventilation and/or air conditioning in public transport vehicles.	Increasing resilience to high temperature episodes.	Investment
Implementation of flood resilience measures, including provision of greater drainage capacity and flood protection.	Increasing resilience to flooding and consequent infrastructure damage and disruption.	Investment
Domestic air transport		
Studies of vulnerability of airport transport infrastructure and systems to climate change, for all Romanian airports, and development of airport-specific adaptation plans.	Development of airport-specific action plans for climate change adaptation.	Technical Assistance
Implementation of heat and cold resilience infrastructure measures (design and/or material specifications) in design and implementation of all new airport infrastructure and in any refurbishment or upgrading.	Increasing resilience to high and low temperature episodes.	Investment
Implementation of flood resilience measures, including provision of greater drainage capacity and flood protection.	Increasing resilience to flooding and consequent infrastructure damage and disruption.	Investment

Given all the measures which are proposed, an important question is the sequencing or prioritization of such measures in terms of implementing the proposed Action Plan. The measures proposed are aimed at being implemented in the 2014-2020 period, in line with the time line of the Operational Programmes. With regard to adaptation the key immediate priority is to develop mode by mode national vulnerability studies which would form the basis of an adaptation plan, which would include a mapping of risks. This information base which identify key risks and vulnerability of transport infrastructure and transport services must be carried out before implementing other proposed measures, such as modifying planning and project preparation documentation, reviewing design standards, or implementing resilient infrastructure and rolling stock measures.

With regard to mitigation, the most pressing action is to develop a methodology for measuring emission intensity per passenger-km and ton-km for different transport modes, different technologies and under different operational conditions, in order to be able to monitor GHG emissions by mode, assessing the impact of measures that will be undertaken to reduce the growth of GHG emissions. Such an information base is at present absent. A second urgent priority is implementing policies to ensure improvement in the performance of the rail infrastructure manager and public rail operators—including allocating funding to maintain infrastructure investments—so that investments in rail infrastructure financed under the Operational Programme translate into higher ridership and higher ton-km of freight transported in the rail network, contributing to a modal shift. A third priority is to launch a series of studies aimed at (a) reviewing fiscal measures to influence private car purchase and use; (b) assessing options in using alternative fuels; and (c) measures to encourage freight hauliers to accelerate take-up of lower emission vehicle technology; and (d) the potential role of ‘harder’ demand management measures to address congestion and emissions in Romanian cities. Reducing the growth rate of emissions from the road sector is critical for decelerating transport sector emission growth. This will require changes in pricing and other policies—but the critical step is launching the studies which will guide policy choices to be implemented over the 2014-2020 period and beyond.

In order to meet the target of spending 20 percent of ESIF funds on climate change—or whatever percentage as decided by the Romanian government—it will be essential to make large investments in railways, IWT, ports, multimodal transport, and urban transport. At the moment the coefficients for the calculation of activities supporting climate change activities for the sub-sectors listed above are 40 percent. This means that the modal composition of the investment program will need to allocate significant resources to non-road infrastructure projects. Road investments could be counted as supporting climate change activities if they are made climate resilient—this is why undertaking a vulnerability study for the road sector early on in the 2014-2020 period will be important, not only for helping to meet the spending target on climate actions, but to make the infrastructure resilient to projected climate change impacts.

Going forward, the key next step is finalization of the General Transport Master Plan (GTMP), as this is an ex-ante conditionality of the European Commission for the transport interventions to be financed from the Operational Programmes. It is also critical in terms of coming up with a list of prioritized projects and policies that could be financed from the Technical Assistance and Investment Action window available through the Operational Programmes. It is understood by the World Bank that there is considerable work required in order to finalize the GTMP, and that this will be a critical input for prioritizing investments to be financed out of EU funds. This provides a window of opportunity to incorporate the recommendations of this Report into the finalization of the GTMP, thus ensuring adequate consideration of climate change interventions.

A second critical step is for Romania to decide on how it will implement the requirement that 20 percent of European Structural and Investment Funds be used for climate action. This is important, as it is not clear at the moment for the Large Infrastructure Operational Programme—which includes transport, energy and environment—what percentage of climate expenditure the transport sector will need to meet. This could have an impact on the modal composition of the transport programme. Likewise, the same

applies for the Regional Operational Programme, which includes county roads and urban transport (excluding the metro of Bucharest).

Lastly, it will be important to coordinate the preparation of transport related aspects in the Large Infrastructure Operational Programme and the Regional Development Operational Programme, particularly with regard to roads. Motorways and national road projects will be financed through the Large Infrastructure Operational Programme while county roads will be financed through the Regional Development Operational Programme, and these need to be coordinated, to ensure that when a motorway section is built, access roads and roads in the surrounding area are also upgraded, in order to derive the full benefit of the investments. While this is not a climate related issue, it is nevertheless important in order to develop an integrated and optimized transport system. The General Transport Master Plan, which is based on a National Transport Model, could serve as the basis for the selection of road projects in both Operational Programmes.

1 INTRODUCTION

1.1 Introduction

1. The Europe 2020 Strategy and the legislative package from the European Commission provide EU member states a framework and means for moving towards a greener and more competitive low carbon economy that makes efficient use of resources and is resilient to climate risk. The European Council further determined in February 2013 that the Multiannual Financial Framework (MFF) will mainstream climate objectives. The period of 2013-14 is an important one for EU member states and the move to low-carbon green growth because of the new EU budget cycle. The programming of the next cycle of Operational Programmes will need to reflect and integrate climate action on mitigation and adaptation. As a member state of the EU, the Government of Romania is committed to fighting climate change and pursuing a low carbon development. The integration of both mitigation and adaptation actions into Romania's national policies, programs, and strategies will be a critical step in shifting its development path towards a climate resilient, low carbon and green economy.

2. In this context, the Government of Romania has requested the World Bank to provide Advisory Services on climate change, including operationalizing its national climate change strategy and action plan, identifying and integrating climate-related actions in new Operational Programmes, building a solid analytical base for impact assessment and climate-related decision making, and enhancing climate-friendly practices and monitoring system. The Program development objective is to assist the Government of Romania to: (i) develop a comprehensive national climate change and low carbon development strategy and action plan; (ii) integrate associated climate-related actions into the 2014-2020 EU-funded Operational Programmes; (iii) develop the institutional tools necessary to inform climate change policies and monitor their economic and environmental impacts; and (iv) identify future carbon trading opportunities.

3. This Report is a deliverable under Component B of the Advisory Services, *Support the preparation of the climate change-related actions under the 2014-2020 Operational Programmes*. This component assists the Government of Romania in identifying eligible climate change actions for the EU Strategic Coherence Framework (SCF) Operational Programmes. This activity will identify and include climate change actions in the 2014-2020 Operational Programmes, which will be a basis for the future use of EU funds (2014-2020), with the aim of presenting recommendations for sector-specific climate actions for relevant EU-funded Operational Programmes. This Report presents the results of the rapid assessment process for the transport sector. This includes both general transport (which previously fed into the sector Operational Programme for transport (SOP-T)) and urban transport (which previously fed into the regional Operational Programme (ROP)). The scope of work excludes international air transport and sea transport, which are both subject to international regulation and initiatives rather than being a national issue for Romania.

4. Concern over climate related issues is in line with the draft strategy of Romania's Ministry of Transport, which is expected to be adopted before the end of the year. Its strategic objective or mission is to support the development of a safe integrated transport system that serves the Romanian people and economy efficiently and equitably while protecting the environment, for a sustainable development within the EU. One of its strategic pillars is to support the development of an integrated and environmentally friendly transport system through the development of a transport system that protects the environment supports integrated social and economic development without harm to human health or to environment for the benefit of present and future generations. Local co-benefits of green policies include reduced traffic congestion, improved air quality—a recent study found that poor quality in Bucharest reduces life expectancy by 2 years and is a leading cause of respiratory diseases in the city, with road congestion, being one of the main drivers of air quality—and fewer road accidents, and these are important drivers of transport policies and investments and have positive economic impacts.

5. This chapter presents a brief overview of the EU's transport strategy, before presenting the funding framework for 2014-2020 Operational Programmes and the European Commission's Position Paper for Romania, outlining what its vision of the key priorities to be financed under the 2014-2020 Programming Period, as well as setting out ex-ante conditionalities. This provides the broad context in which the Operating Programs must be prepared.

1.2 EU Transport Strategy and Policies

6. There are several formal documents adopted by the EU that are relevant for Romania's transport sector. Key among them is the European Commission White Paper "*Roadmap to a Single European Transport Area: Towards a competitive and resource efficient transport system*" (White Paper) adopted in March 2011.² The White Paper adopted by the European Commission is a key document setting the targets and directions for transport sector development—EU transport policy is focused on assuring sustainable mobility for people and goods with a strong emphasis on contributing to a very ambitious greenhouse gas emission (GHG) targets set for the EU as a whole. More specifically, the policy and related activities are expected to significantly reduce Europe's dependence on imported fuels (mostly oil) and cut carbon emissions in transport by 60 percent by 2050 compared to 2005. By 2050, key transport strategic goals include:

- (a) no new conventionally-fuelled cars in cities;
- (b) at least 40 percent use of sustainable low carbon fuels in aviation;
- (c) at least 40 percent reduction of emissions from maritime transport;
- (d) at least 50 percent shift of medium distance intercity passenger and freight journeys from road to rail and waterborne transport.

² European Commission (2011), *White Paper: Roadmap to a Single European Transport Area – Towards a competitive and resource efficient transport system*. Brussels, March 28, 2011, COM (2011) 144 final.

7. Several important interim goals are also included in the White Paper and have to be taken into account when designing and implementing country specific transport strategies and programs. They are grouped into three categories: (a) developing and deploying new and sustainable fuels and propulsion systems; (b) optimizing the performance of multimodal logistic chains, including by making greater use of more energy-efficient modes; and (c) increasing the efficiency of transport and of infrastructure use with information systems and market-based incentives. The White Paper also includes 40 concrete initiatives for the next decade, which are expected to result in a competitive transport system that will increase mobility, remove major barriers in key areas, and stimulate growth and employment.

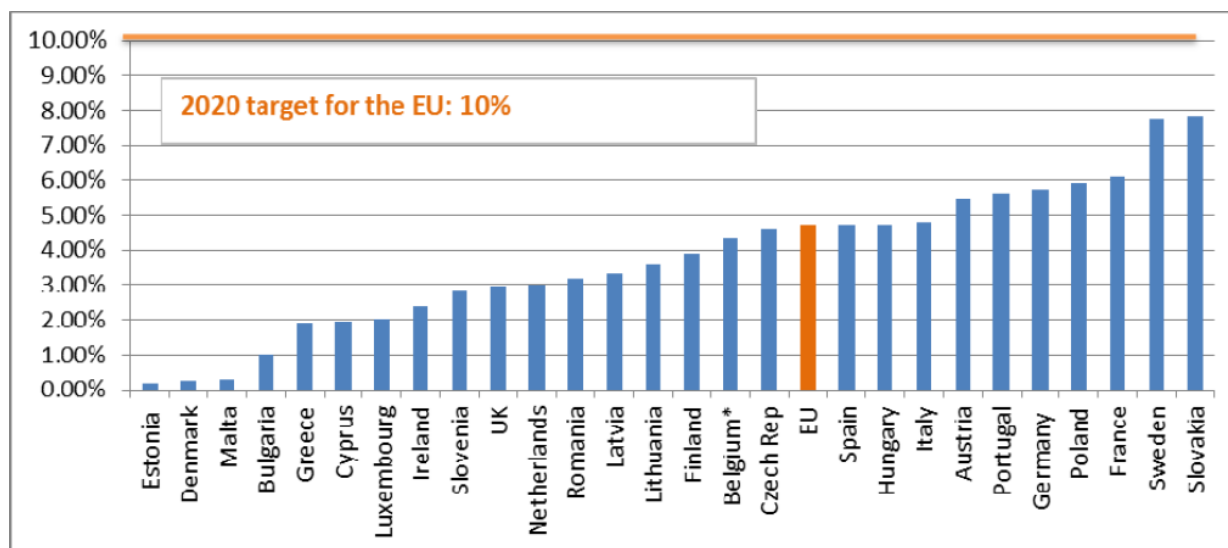
8. In order to strengthen the coordination of transport network planning and development at European level, the EU has defined the Trans-European Transport Network (TEN-T) in close collaboration with national governments. The implementation of TEN-T is one of the EU priorities supported by several EU funds and financial instruments - Connecting Europe Facility (CEF), Cohesion Fund (CF), (European Regional Development fund (ERDF) and European Investment Bank's (EIB) loans and credit guarantees. Grants, in particular under CEF, the Cohesion and European Regional Development Funds, play a major role in both project preparation and implementation phases. The TEN-T corridor infrastructure is expected to be a core part of the network and will form the backbone of an EU-wide transport system. The European Commission Position Paper on Romania translates the EU transport policy into a Romania-specific environment and is thus a useful reference during the programming phase for EU funds absorption within MFF 2014-2020.

9. In order to ensure complementarity, the country specific strategic and policy directions should be coherent with the EU-level transport strategy, as well as country-wide specific programs and policy measures. In practice this means that national-level strategy, programs or Master Plan(s) should complement and “transpose” the guidelines from the European Commission White Paper and other important components of EU transport sector policy framework into Romania’s transport sector. In addition, any regional, local or municipal transport strategies or programs should complement and be fully coherent with national level policies and EU policies. Therefore, Romania's transport strategy and policies across all modes of transport and all levels of transport sector public governance (from the national level down to the local level) should be internally coherent and should complement the EU transport strategy and policies by “translating” EU level documents into Romania reality. While all EU member states have to follow the general directions of the EU transport policy, they also have significant flexibility in designing their own transport strategies, programs and implementation arrangements reflecting country-specific needs in infrastructure development programs and policy measures. At the same time, country-level strategies should be aligned with and contribute to EU-wide transport policy goals.

10. The European Commission undertook a recent assessment of progress towards achieving the Europe 2020 targets, that is to say, to create 20 percent of energy consumption from renewables and increasing energy efficiency by 20 percent by 2020. For the transport sector, Romania needs to make significant efforts to increase the share of renewable energy used, which has an EU wide target of 10 percent (Figure 1). There is a need for further efforts aimed at reducing the energy intensity of the

transport sector, as well as raising the use of renewable energy powering the transportation system. As this Report will emphasize, there is a need to make investments in the transport sector that can contribute to an increase in the modal share of cleaner transport modes—urban transport, rail, and inland waterways transport—not only because of GHG considerations, but because it makes sense when confronting issues such as safety, congestion, and overall efficiency of Romania’s transport system. The low degree of efficiency of Romania’s transport system was flagged in a recent European Commission assessment of Romania’s progress with the national reform program.³

Figure 1: Share of Renewable Energy in the Transport Sector in 2010⁴



Source: European Commission.

1.3 Overview of European Structural and Investment Funds in 2014-2020

11. It is important to understand and discuss briefly the three most relevant EU funding mechanisms available to Romania for supporting transport programs and investments during the period 2014-2020. Cohesion Policy will remain an important element of the upcoming MFF 2014-2020 and annual EU budgets. The current proposal foresees two priority objectives for the EU Cohesion Policy: (i) Investing in Growth and Jobs, and (ii) European Territorial Cooperation”. The first objective will be implemented in all regions and member states with the objective of eliminating the obstacles to development. In accordance with the proposal the regions would be divided into groups according to their development level (more or less developed and the transition regions), with the assistance intensity and the set of substantive priorities determined accordingly. The second objective promotes cross-border, transnational and inter-regional cooperation.

³ European Commission (2013), Recommendation for a Council Recommendation on Romania’s 2013 National Reform Programme and Delivering a Council Opinion on Romania’s Convergence Programme for 2012-2016. COM (2013) 373 final. Brussels, 29.5.2013. Available at:

http://ec.europa.eu/europe2020/pdf/nd/csr2013_romania_en.pdf

⁴ http://ec.europa.eu/clima/policies/g-gas/progress/docs/13_energy_and_ghg_en.pdf

12. Key eligibility criteria for the CF are the following:

- (a) EU countries with a gross national income less than 90 percent of the EU average are eligible for support; most represented by countries that joined the EU in 2004 and 2007 as well as Croatia;
- (b) Support mainly goes to large infrastructure projects which form part of national development programs for transport and environment.

13. The scope of the CF will remain largely similar to the current period, with support for investments to comply with environmental standards, energy projects, provided they present a clear benefit to the environment, for example by promoting energy efficiency and the use of renewable energy; and investments in TEN-T, as well as urban and low-carbon transport systems. For the first time, part of the CF will additionally contribute to the *Connecting Europe Facility* (CEF) – a centrally managed (at the EU-level) facility aimed primarily at supporting investments in the core TEN-T network, which is crucial for a competitive and sustainable Europe-wide transport system.

14. In addition to the CF, the ERDF also aims to strengthen economic and social cohesion in the EU by correcting imbalances between its regions. In short, the ERDF finances:

- (a) direct aid to investments in companies (in particular SMEs) to create sustainable jobs;
- (b) infrastructures linked to research and innovation, telecommunications, environment, energy and transport;
- (c) financial instruments (capital risk funds, local development funds, etc.) to support regional and local development and to foster cooperation between towns and regions;
- (d) technical assistance measures.

The ERDF can support the three objectives of regional policy:

- *Convergence* - in regions covered by the Convergence objective, ERDF focuses its intervention on modernizing and diversifying economic structures as well as safeguarding or creating sustainable jobs, with action in the following areas: (i) research and technological development; (ii) innovation and entrepreneurship; (iii) information society; (iv) environment; (v) risk prevention; (vi) tourism; (vii) culture; (viii) transport; (ix) energy; (x) education; (xi) health.
- *Regional Competitiveness and Employment* - the priorities are based on three sections: (i) innovation and knowledge-based economy: strengthening regional capacities for research and technological development, fostering innovation and entrepreneurship and strengthening financial engineering notably for companies involved in knowledge-based economy; (ii) environment and risk prevention: cleaning up polluted areas, boosting energy efficiency, promoting clean public transport within towns and drawing up plans to prevent and limit natural and technological risks; (iii) access to transport and telecommunications services of general economic interest.
- *European Territorial Cooperation* - for the European Territorial Cooperation objective, the ERDF focuses its aid on three main areas: (i) development of economic and social cross-border

activities; (ii) establishment and development of transnational cooperation, including bilateral cooperation between maritime regions; (iii) increasing the efficiency of regional policy through interregional promotion and cooperation, the networking and exchange of experiences between regional and local authorities.

15. The third funding facility is the European Social Fund (ESF) which is set to improve employment and job opportunities in the EU. It intervenes in the framework of the (i) *Convergence* and (ii) *Regional Competitiveness and Employment* objectives of EU regional policy and supports actions in member states in the following areas: adapting workers and enterprises: lifelong learning schemes, designing and spreading innovative working organizations; access to employment for job seekers, the unemployed, women and migrants; social integration of disadvantaged people and combating discrimination in the job market; and strengthening human capital by reforming education systems and setting up a network of teaching establishments.

16. The new EU regulations for the 2014-2020 programming period should make the preparation and implementation of complementary financed projects easier. In particular because: (i) in the 2014-2020 programming period the EU is introducing a set of common rules for EU financial assistance, called the Common Strategic Framework (CSF) to increase strategic planning and programming quality and to optimize synergies and efficiency of EU funded measures through better coordination between different Managing Authorities (MAs), Implementing Authorities (IAs) and beneficiaries involved in the utilization of EU funds; CSF replaces the current separate sets of strategic guidelines for cohesion policy, rural development policy and fisheries and maritime policy, strengthens the integration of EU policies and ensures greater impact for citizens and businesses on the ground; (ii) there is increased space for use of complementarity and cross-funding in the next programming period, especially between the CF and ERDF but also possibly some areas of ESF (for example for technical assistance or institutional support/modernization and training) or even the European Agricultural Fund for Rural Development (EAFRD) for rural roads; (iii) CEF will play additional role with regard to financing core TEN-T projects and will most likely welcome also strong coordination with other transport projects (for example access roads or railway lines modernization or upgrade).

17. In the case of Romania, EU financial support to transport infrastructure will primarily be provided through the CF and to some degree through the ERDF, as is the case with most other EU member states. However, the possibility for selective utilization of the EAFRD should not be entirely discarded, for example for construction or modernization of selected rural access roads. This may be possible in cases when such projects will contribute directly to rural development goals by for example: (i) improving significantly transport accessibility of rural community (including access to markets) or (ii) linking specific rural regions or communities to a new or modernized road or railways line of national or regional importance.

18. Additionally, it is also possible to consider support to the transport sector through the ESF by including projects aimed at strengthening capacity of public administration in transport related areas. For example, some training related to modernization or restructuring of public institutions in charge of managing transport infrastructure or transport planning at the central or county level may be included in

the respective OP. In the cases of restructuring of public sector transport companies some support can be also provided to employees of retrenched companies, who may need some support in updating or expanding their qualification resulting in better chances for finding alternative employment or opening small private companies.

19. As integrated territorial strategies are vital for the achievement of the smart, sustainable and inclusive Europe envisaged by the Europe 2020 Strategy, the proposed Common Provisions regulation introduces the Integrated Territorial Initiative (ITI) as a key instrument to implement such strategies, which is of particular relevance for urban transport activities financed through EU funds. The proposal provides a flexible mechanism for formulating integrated responses to diverse territorial needs, without losing the thematic focus through which cohesion policy is linked to the Europe 2020 Strategy. The ITI is a tool to implement territorial strategies in an integrated way. It is not an operation, nor a sub-priority of an Operational Programme. Instead, ITI allows member states to implement Operational Programmes in a cross-cutting way and to draw on funding from several priority axes of one or more Operational Programmes to ensure the implementation of an integrated strategy for a specific territory. As such, the existence of ITI would provide flexibility regarding the design of Operational Programmes and enable the efficient implementation of integrated actions through simplified financing.

20. The actions to be implemented through ITI shall contribute to the thematic objectives of the relevant priority axes of the participating Operational Programme(s), as well as the development objectives of the territorial strategy. They can be financed by the ERDF, ESF, and Cohesion Fund, but it is not compulsory to combine all funds in each ITI. Nevertheless, it is encouraged that ITI combine ERDF and ESF as the integrated approach requires that soft investments be linked to investments in physical infrastructure. This is particularly relevant in the case of sustainable urban development. It is important to underline that ITIs can only be effectively used if the specific geographical area concerned has an integrated, cross-sectoral territorial strategy.

1.4 Climate Change and European Structural and Investment Funds

21. The Common Provisions Regulation, currently in draft form, sets out the means to achieve consistency with the economic policies of the EU and its Member States, coordination mechanisms among the ESIF and with other EU policies and instruments, horizontal principles and cross-cutting policy objectives.⁵ It lays down arrangements to address territorial challenges, suggests action with high added value and sets out the principles and the priorities for action. Based on a proposal put forward by the European Commission, the European Council concluded on 7-8 February 2013 that ‘Climate action objectives will represent at least 20 percent of EU spending in the period 2014-2020 and therefore be reflected in the appropriate instruments to ensure that they contribute to strengthen energy security,

⁵ European Commission (2013), Draft Assessment of Climate Action: How to Assess the Mainstreaming of Climate Action in Operational Programmes. ERDF and CF. European Regional Development Fund and Cohesion Fund 2014-2020.

building a low-carbon, resource efficient and climate resilient economy that will enhance Europe's competitiveness and create more and greener jobs' (Box 1).

Box 1: EC Methodology for Tracking Climate Change Related Expenditure

The EC has prepared a draft methodology for tracking climate change related expenditure. Where operations supported from the ERDF and the Cohesion Fund involve several intervention field codes, the managing authority has two options:

- To use the most prominent part of the operation to choose the intervention field code
- To use several codes, allocated based on the approximate pro rate divisions of expected costs across different intervention fields.

The Commission recommends managing authorities the use of multiple codes for major projects. The approach involves two phases; (a) attaching weights to the codes under the intervention category; (b) in the case of intervention fields with a zero weighting, the information could be filtered through Thematic Objective N.4 "supporting the shift to the low carbon economy in all sectors" and Thematic Objective N.5 "promoting climate change adaptation, risk prevention, and management". The financial data reported (in connection with codes which generally having a weighting of 0 percent) under these two climate related thematic objectives would be counted as contributing to the climate objective with a 40 percent weight. The draft nomenclature of categories of intervention for transport has the following coefficients for the calculation of support to the climate change objectives:

- Railways: 40%
- Roads: 0%
- Multimodal transport: 40 %
- Airports: 0%
- Seaports: 40%
- Inland waterways and ports: 40%
- Urban transport infrastructure: 40%
- Intelligent transport systems for urban transport: 40%

What this means is that roads and airports have a weight of zero, and do not contribute to reaching the 20 percent target, unless the case can be made that they address Thematic Objective No.4 or Objective No.5 Thus a new motorway that is built with revised design standards that has made the infrastructure resilient to expected climate patterns (increased heat or flooding) could be counted as contributing to the climate objective.

The Implementing Regulations with the methodology for tracking climate related expenditure (and other implementing regulations) for the five ESI funds are under preparation and will be published later in spring 2014. Romania has the legal target of minimum 12 percent of ERDF for low-carbon (= thematic objective 4), but are expected to reach 20 percent climate related expenditure (for the five ESI funds) either by spending more on thematic objective 4 or by including thematic objective 5 (adaptation) and through the mainstreaming of climate action across the remaining eleven thematic objectives. The decision on how the 20 percent of climate change expenditure for all Operational Programmes will be applied is a decision left to each member state. It remains to be defined how this target will be applied, and whether transport will need to make a contribution larger than 20 percent or not. It will potentially affect the final modal composition of the proposed infrastructure investments.

Source: European Commission (2013), Fiche 28 Draft Implementing Act on the Climate Change Tracking Methodology for the ESI Funds, the Arrangements for the Set-up of the Performance Framework, the Categories of Intervention for the IGT Goal and for the ETC Goal Based on Fiche No.2 and 24A, Version I, 29 November 2013. 3

22. The Common Provisions Regulation defines eleven Thematic Objectives, which will contribute to the implementation of the EU's strategy for smart, sustainable and inclusive growth. Of particular relevance are Thematic Objective 4, supporting the shift toward a low-carbon economy in all sectors and Thematic Objective 5, promoting climate change adaptation, risk prevention, and management, representing respectively mitigation and adaptation climate action. The fund-specific regulations define for each Thematic Objective particular investment priorities. In this manner, ESIF can significantly contribute to the achievement of the climate objectives and the transition to a low-carbon and climate-resilient economy.

23. The European Commission has prepared a series of materials that outline the main issues to be considered when mainstreaming climate action in Operational Programmes. Fact Sheets have been prepared, outlining proposals for how climate action could be mainstreamed into the Member States' programmes supported through various European Funds, offering an overview of the potential for climate mainstreaming in and examples of mitigation and adaptation.

24. What these examples bring out clearly is the importance of not only investing in infrastructure, but also focusing on transport demand management, as well as the need to give consideration to adaptation, and not only mitigation actions.

25. The mainstreaming of climate action across the Operational Programmes will be assessed, with a focus on those investment priorities which have the greatest potential for climate action. For each of the priority axes, the climate assessment will cover the relevant investment priorities, the types of actions, and selection of operations. The assessment will verify consistency between, on the one hand, the strategic approach and the anticipated contribution to the Europe 2020 strategy and, on the other, the specific objectives, anticipated actions and principles for selection of operations. The assessment will furthermore investigate how the principle of sustainable development has been addressed.

26. A key indicator for climate action at Member State level is the share of ESIF support that will be used for climate change objectives. This relates to the target that climate related expenditure will correspond to at least 20 percent of the EU budget in the period 2014-2020. The indicative share envisaged for the Programme will be assessed against this objective and against the Programme scope. It needs to be noted that the information in this section is preliminary and does not prejudge the outcome of the ongoing legislative process and the resulting regulations including on the eligibility of various actions.

27. Table 1 presents a summary of measures proposed for consideration for the transport sector, under the ERDF, CF, and the ETC. Examples have also been provided of mitigation and adaptation actions in the transport sector that have been financed under the current 2007-2013 funding period, including, for example:

- **Greener buses in Athens.** The replacement of old buses with 500 new Compressed Natural Gas (CNG) and diesel buses (with EURO IV or V engines) will contribute to modernizing Athens urban transport network and reduce air pollution and greenhouse gas emissions.

- **Extending Sofia's metro system:** The project brings the metro within the reach of an additional 190.000 residents and will provide reduced travel times to all users. The project will bring with it improved services and coverage, and improved rail connections with European, national and local transport networks. This will help to support a modal shift away from car dependency, resulting in reduced GHG emissions.

What these examples bring out clearly is the importance of not only investing in infrastructure, but also focusing on transport demand management, as well as the need to give consideration to adaptation, and not only mitigation actions.

28. The mainstreaming of climate action across the Operational Programmes will be assessed, with a focus on those investment priorities which have the greatest potential for climate action. For each of the priority axes, the climate assessment will cover the relevant investment priorities, the types of actions, and selection of operations. The assessment will verify consistency between, on the one hand, the strategic approach and the anticipated contribution to the Europe 2020 strategy and, on the other, the specific objectives, anticipated actions and principles for selection of operations. The assessment will furthermore investigate how the principle of sustainable development has been addressed.

29. A key indicator for climate action at Member State level is the share of ESIF support that will be used for climate change objectives. This relates to the target that climate related expenditure will correspond to at least 20 percent of the EU budget in the period 2014-2020. The indicative share envisaged for the Programme will be assessed against this objective and against the Programme scope. It needs to be noted that the information in this section is preliminary and does not prejudge the outcome of the ongoing legislative process and the resulting regulations including on the eligibility of various actions.

Table 1: Examples of Potential Climate Measures in the Transport Sector

Fund	Selected Investment Priorities	Mitigation/Adaptation	Potential Measure
ERDF, CF	Sustainable urban mobility	Mitigation	Promote and facilitate the use of sustainable modes of transport, which include transport demand management measures such as congestion-charging systems, parking management and low emission zones, complemented by improved public transport systems. Civitas MIMOSA (REGIOSTAR finalist 2011) supported innovative and sustainable mobility in the city of Funchal, Portugal
CF	Realignment of existing roads	Adaptation	More intense precipitation and rises in sea levels may make certain roads more exposed to flooding. Realigning roads may be the most cost-effective risk reduction measure in some high-risk coastal areas. New roads may also use heat-resistant asphalt to cope with the risk of more extreme high temperatures.
CF	Construction of climate resilient rail and roads infrastructure	Adaptation	Rail and road infrastructure must be designed to be resilient to changing climate risks e.g. higher temperatures or heavier rainfall. New rail projects will also provide mitigation co-benefits by reducing greenhouse gas emissions if traffic is diverted from roads. Network Rail, UK (responsible for the safety and operation of 32,000 km of railway track across the UK) is an example of an institution investing heavily in securing the long-

			term viability of its critical assets and ensuring the security of supply for its customers.
CF	Developing comprehensive, high quality and interoperable railway systems	Mitigation	Comfortable, affordable, fast and available public transport is central to encourage car users to switch to low-carbon modes. The CF-funded project in Tallinn replaces old trains with more energy-efficient versions, resulting in 30 % less energy use and an expected rise of 21 % in additional commuters.
ETC	Ensuring transport infrastructure is climate resilient	Adaptation	Design transnational railway and road infrastructure to be resilient to climate risks, including higher temperatures, heavier rainfall and associated increased risks of ground movements and landslides.

Source: European Commission.

1.5 European Commission Position Paper

30. As noted above, the key role of the Transport Rapid Assessment Report is to deliver recommendations that can help the Government of Romania shape its Operational Programmes. These need to be in line with European Union policies and strategies on climate change, in order that EU funding allocations can be agreed. The European Commission has prepared a Position Paper that sets out its views on the main challenges faced in Romania and on funding priorities.⁶ The main points of that paper that relate to the transport sector are discussed below.

31. Within its analysis of the challenges being faced, the European Commission highlights *underdeveloped infrastructure*. In particular, on transport, it states that “railway is witnessing decline in freight and passenger demand, due to decreased speed, increased travelling time and reduced reliability and safety of the network, resulting from underinvestment and poor maintenance. The length of the network is excessive with respect to the traffic and the financing capacity. It requires sharp restructuring and upgrading of the priority network. The international accessibility and interregional connections, in particular between growth poles, suffer from the very low motorway endowment, hampering the attractiveness of Romania for industrial investment. It also contributes to the high rate of fatalities and congestion, a source of important economic costs. Inland navigation stands far below its actual potential, mainly on the Danube, and intermodal transport is underdeveloped.” The Position Paper also identifies *inefficient use of resources* as a particular challenge for Romania. In the transport sector, it comments that “the lack of consistent sustainable urban transport Master Plans has, together with obsolete infrastructures and inefficient management, led to increasing urban traffic congestion, a source of economic costs and polluting emissions.”

32. *Funding priorities.* Within the Position Paper, the European Commission identifies five priority areas for funding in Romania, with thematic objectives and specific actions grouped under those five

⁶ European Commission (2012), Position of the Commission Services on the development of Partnership Agreement and programs in Romania for the period 2014-2020. European Commission, Ref. Ares (2012)1240252 - 19/10/2012.

areas. Two priority areas are particularly relevant for the transport sector - *Developing modern infrastructure for growth and jobs* and *Optimizing the use and protection of natural resources and assets*. Specific transport-related priority actions under the *Developing modern infrastructure for growth and jobs* priority area include:

1. Develop a high quality railway network, reversing the current decline:
 - Continue upgrading the core network corridors and designated lines (aiming especially at boosting rail freight transport) at the appropriate design speeds and standards, and carry out the necessary European Rail Traffic Management System (ERTMS) investment;
 - Support the restructuring of the network and modernization of the railway companies, which may include the upgrading of rolling stock and enhancing accessibility.
2. Promote sustainable urban transport:
 - Design sustainable urban mobility plans based on low-carbon transport modes for urban areas; and invest in the necessary infrastructure and accessible rolling stock to deliver those plans, while providing institutional support for local transport management.
3. Support the development of the Trans-European Transport Network (TEN-T) road network:
 - Complete motorways on the core network corridor and develop other parts of the core network to appropriate standards, in line with priorities established under a comprehensive transport Master Plan for Romania.
4. Enhance regional connectivity and mobility:
 - Ensure the connectivity of the regional road networks to the TEN-T network and develop other modes of transport with a view to improving accessibility of the country's regions.
5. Support inland navigation, in particular along the Danube, in cooperation with other countries, and interoperability of transport modes:
 - Develop infrastructure, such as berthing, port facilities and transport connections with the hinterland in order to foster maritime connectivity and develop maritime and coastal tourism;
 - Develop multimodal platforms.
6. Improve road safety:
 - Promote monitoring and mapping tools, identifying the most problematic "black spots" and implement the necessary preventive investments.
7. Advance cross-border and customs border crossing points for fast, secure and efficient EU external trade:
 - Modernize customs infrastructure, equipment, and systems at external borders, as well as administrative capacity building, as appropriate.

33. Priority actions relevant to the transport sector are also included under the *Optimizing the use and protection of natural resources and assets* priority area:

8. Promotion of low-carbon transport and public infrastructure in urban areas:

- Support sustainable urban transport strategies and infrastructure in agglomerations, as part of larger low carbon strategies in urban areas.

9. Reinforce adaptive capacity and support the national adaptation strategy:

- Promote the mainstreaming of required adaptation and risk prevention measures in sector policies, including the modification of technical norms.

34. *Ex ante conditionalities.* The European Commission sets out one particular ex ante conditionality related to transport in its Position Paper. This is that a comprehensive transport Master Plan, resting on a multimodal approach, needs to be adopted. This should reflect financing constraints and benefit from sound political endorsement. The development of a General Transport Master Plan for Romania is in progress, and is discussed in subsequent chapters of this Report. In addition, the Commission paper makes suggestions to “improve governance, effectiveness and delivery”, some of which are relevant to the transport sector. These include:

- A mature and realistic project pipeline is needed with attention paid to operation and maintenance, including the designing of maintenance strategies and earmarking the required financing and human resources. The proposed projects will need to be screened for their climate resilience;
- The rail and road agencies should be restructured and reinforced, granting higher accountability and appropriate resources to project managers, and financial sustainability should be ensured in particular in the railway sector;
- For inland navigation along the Danube key priorities identified with other concerned countries, in particular Bulgaria, need to be taken in to account;
- The current shortage of skilled civil engineers on the local market should be tackled, through requalification measures in particular;
- The adaptation component of the National Climate Change Strategy should be finalised, providing a framework and guidelines for sector action plans and for lower administrative levels; and
- Flood risk mapping should be undertaken in all river basins, in cooperation with neighbouring countries with regard to the Danube, and industrial risk mapping needs to be updated.

35. It is worth reiterating that the European Commission has set out its vision of what are the key priorities for the transport sector in Romania to be funded out of EU funds over 2014-2020. This is a key consideration for developing the Operational Programme going forward. A 2013 European Commission assessment of progress with reforms in Romania has highlighted a number of key issues facing the

transport sector, echoing the assessment of the Position Paper.⁷ Going forward, a critical issue will be raising the overall absorption rate of EU funds, in order to make use of the funds available through the Operational Programmes in order to address the key challenges faced by the transport sector in Romania

1.6 Transport and Greenhouse Gas Emissions

36. Transport is responsible for around a quarter of EU greenhouse gas (GHG) emissions making it the second biggest greenhouse gas emitting sector after energy. Road transport alone contributes about one-fifth of the EU's total emissions of carbon dioxide (CO₂), the main greenhouse gas. While emissions from other sectors are generally falling, those from transport have increased 36 percent since 1990. The EU has policies in place to reduce emissions from a range of modes of transport, such as including aviation in the EU Emissions Trading System (EU ETS) and CO₂ emissions targets for cars. The majority of domestic transport-related greenhouse gas emissions are from road transport. However, there are also significant emissions from the aviation and maritime sectors and these sectors are experiencing the fastest growth in emissions, meaning that policies to reduce GHG emissions are required for a range of transport modes.

37. GHG emissions generated from transport are among the fastest growing in Europe, posing a challenge in creating a low-carbon future, as economic development has been paralleled with a modal share increasingly dominated by roads.⁸ This modal shift has been driven by a number of factors, including growing affluence, suburbanization, and falling land use densities in urban areas, which have translated into more widespread vehicle ownership, increasing trip numbers and lengths, while reducing the financial viability of public transport and non-motorized transport. On the freight transport front, while a number of East European countries had relatively high rates of rail modal share, these have generally been declining and have been approaching EU levels. Thus, Eastern European countries are moving toward EU motorization rates for passenger transport—with much higher GHG growth than in the EU-27, although overall levels remain lower—while trucks are making significant inroads vis-à-vis rail. Without any changes to transport policy, these trends in Eastern Europe, and in Romania, are likely to continue unabated in the next decades.

38. Transport is a key facilitator of economic well-being worldwide and is likely to continue to grow to meet continued demand and growing transport needs in Romania. Affordable transport services are crucial for development. They connect rural areas to sales opportunities and inputs, and nations to export markets and foreign technologies. Affordability refers not just to consumer prices but also to all costs to society: the time losses due to congestion, the sometimes dramatic consequences of accidents, the health costs of local pollution, and the damage that severe climate events inflict on the population. Transport decisions, particularly those for infrastructure investments, will determine these costs for decades to come, offering opportunities to countries whose transport systems are not yet mature.

⁷ European Commission (2013), Commission Staff Working Document, Assessment of the 2013 National Reform Programme and Convergence Programme for Romania, SWD (2013) 373 Final, Brussels, 29.5.2013.

⁸ In the case of the EU-27 in 2007 CO₂ emissions from the transport sector accounted for 25.1 percent of the total, up from 18.1 percent in 1990. Projections from the European Environment Agency estimate that the sector's emissions will increase by 25 percent over 1990-2020, whereas they are expected to decline from industrial and energy sectors.

39. Recognition of climate implications in transport, unlike other sectors, has had a slow start. One reason is that the transition to a low-carbon context appears to be more costly than in other sectors. But broadening the policy agenda to shift behavior changes the cost picture completely, especially measures to reduce congestion, local air pollution, safety risks, and road safety.⁹ For example, a recent survey of 25 European cities found that Bucharest was the most polluted, and that air pollution reduced life expectancy by 2 years, due to high concentration of fine particles, largely due to emissions from diesel engines and heating.¹⁰ Policies to guide demand to low-emission modes and technologies must be part of investment programs and projects. Such policies can reduce transport demand in the longer run by changing the economic geography of cities and countries. But that will take close coordination of transport, urban, environmental, and health policies.

40. Decoupling GHG emissions from the transport sector and economic growth or at least lowering the GHG intensity of future transport growth represents the key challenge and will require departure from the “business as usual” policies in the transport sector.¹¹ As noted in the EU’s 2011 White Paper on transport, the main issue facing the transport sector is how to reduce the system’s dependence on oil without sacrificing efficiency and compromising mobility—curbing mobility is not an option. The World Bank’s own climate change strategy for the transport sector adopts a similar approach, arguing that climate change mitigation in the transport sector has to be seen in a broader context: sustainable transport should limit GHG emissions from transport and minimize other externalities, without compromising economic growth.¹²

41. Concerns about climate change are not likely to be the key driver of transport policies or investment decisions. Instead local co-benefits—such as reduced traffic congestion and noise, improved air quality and road safety, or enhanced energy security—are much more likely to drive the development of transport policies.¹³ This is the same argument recently put forward in the World Bank’s transport climate change strategy: attempting to sell measures to reduce GHG by marketing them as policies aimed at other social costs of transport can be much more attractive to policy-makers, who may not be concerned about climate change or who cannot gain political traction for policies if they are sold to the public exclusively on a climate change angle.¹⁴ Looking at congestion levels in a city like Bucharest and trends toward increased motorization, the issue is as much a classic problem of transport and urban

⁹ The number of road fatalities in Romania is 58 percent higher than the EU-27 when adjusted for population. In 2012, 32 percent of road accidents involved a vehicle and a pedestrian, suggesting that much can be done in urban areas to make cities safer.

¹⁰ See http://www.aphekom.org/c/document_library/get_file?uuid=5532fafa-921f-4ab1-9ed9-c0148f7da36a&groupId=10347

¹¹ OECD/International Transport Forum (2008), *Greenhouse Gas Reduction Strategies in the Transport Sector*. Preliminary Report. Paris: OECD /International Transport Forum.

¹² World Bank (2011), *Turning the Right Corner: Ensuring Development through a Low-Carbon Transport Sector*, Andreas Kopp, Rachel I. Block, and Atsushi Iimi. Available at: http://www-wds.worldbank.org/external/default/WDSCContentServer/WDSP/IB/2013/05/31/000445729_20130531125005/Rendered/PDF/780860PUB0EPI0050240130right0corner.pdf

¹³ James Leather and the Clean Air Initiative for Asian Cities Center Team (2009), *Rethinking Transport and Climate Change*, Asian Development Bank Development Working Paper Series No.10, December 2009.

¹⁴ One of the barriers to the use of a co-benefit approach to climate change is the cost and time it takes to measure co-benefits in a transport project, vis-à-vis the direct benefits.

planning as it is a GHG emission problem. Co-benefits can motivate discussions on improved transport policies which are also GHG friendly policies.

42. The financing of the transport sector needs to be supported by adequate pricing policies, which can help change existing behavior and thus transport demand, allocate resources more efficiently, and raise funds to invest in more sustainable forms of transport. This means interlocking discussions about financing of transport infrastructure with pricing, as adequate financing needs to be supported by sound pricing policies. However, at present pricing does not reflect the full costs of transport, including costs of negative externalities, while investments tend to be heavily focused on roads, based on a motorization future which assumes ever growing vehicle ownership and usage.

43. Changing pricing would require adoption of the user pays principle, including the costs of congestion, accidents, infrastructure wear and tear, noise and air pollution, not to speak of GHG emissions. Innovative pricing mechanisms are ones where governments often express considerable interest, given the need to finance new transport infrastructure or upgrade existing infrastructure. Introduction of road tolling can lead to important changes in the relative price of using the road network, both inside and outside urban areas, and can be an attractive policy option for officials searching to obtain funding to finance infrastructure investments; potential co-benefits include reduced congestion and GHG emissions.

Box 2: Incorporation of Externalities in Economic Assessment of Infrastructure Projects

The Harmonised European Approaches for Transport Costing and Project Assessment (HEATCO) was an EU research program undertaken under the 6th Framework 2002-2006. HEATCO's primary objective was the development of harmonized guidelines for project assessment on EU level. This included the provision of a consistent framework for monetary valuation based on the principles of welfare economics, aimed at contributing in the long run to consistency in transport costing. HEATCO included consideration not only of pollutants but also of a range of appraisal parameters, such as the value of time.

HEATCO concluded that the valuation of air pollution effects should be based on the damage caused by air pollutant emissions. The types of impacts for which damage function (dose-response relationships) were established were identified as human health impacts, agricultural and forestry production losses, as well as soiling and corrosion of building materials. Proximity to regions of high population density, emission height (e.g. close to the ground from a car exhaust pipe or from a high power plant stack), local environment around the emission source, and geographical location within Europe were identified as the main parameters of the damage cost.

In order to reflect the fact that damage effects differ according to both the local environment and receiving population, HEATCO recommended using country-specific values taking into account local population density. Cost factors in euro per ton of pollutant emitted in different environments (urban areas, outside built-up areas) are provided below. The list of pollutants covers primary PM2.5 for transport emissions (PM10 for emissions from power plants), NO_x (as precursor of nitrate aerosols and ozone), SO₂ (direct effects and as precursor of sulphate aerosols), NMVOC (as precursor of ozone). It may be noted that HEATCO did not develop values for Carbon Monoxide or Ammonia.

The General Transport Master Plan has developed a methodology for incorporating the cost of externalities in the cost-benefit analysis of projects.

Source: http://heatco.ier.uni-stuttgart.de/HEATCO_D5.pdf

1.7 Impact of Climate Change on Transport

44. Climate change is expected to have a significant impact on transportation, affecting the way transportation professionals plan, design, construct, operate, and maintain transportation systems. Decisions taken today, particularly those related to the redesign and retrofitting of existing infrastructure, or the design of new transportation infrastructure, will affect how well the system adapts to climate change far into the future. Focusing on the problem now should help avoid costly future investments and disruptions to operations. However, research on climate change impact on transportation is scarce.¹⁵

45. The 2013 Intergovernmental Panel on Climate Change (IPCC) synthesis report of impacts, adaptation and vulnerability of recognizes potential transportation-related impacts and sensitivities: “Transport infrastructure is vulnerable to extremes in temperature, precipitation/river floods, and storm surges, which can lead to damage in road, rail, airports, and ports”.¹⁶ This is in line with prior research and growing awareness among transport specialists around the world of the importance of climate change, and the need for an adaptation strategy in the transport sector. The 2013 IPCC report notes that “roads and railways are typically replaced every 20 years and can accommodate climate change at the time of replacement”, suggesting that it is only longer lived assets where it may be critical to factor in adaptation considerations. Although there is no comprehensive, quantitative assessment of the various transport sector costs and opportunities associated with the current, let alone changed, climate, a few studies have been published describing qualitatively the vulnerabilities of transport-related activities to climate variability and change. These include publications from the US National Research Council on potential impacts of climate change on US Transportation¹⁷, as well as papers presented at the US Federal Research Partnership Workshop¹⁸, research undertaken by Natural Resources Canada¹⁹, and by the UK Department for Transport.²⁰

46. Storm surge and sea level rise are of prime concern. Storm surge, sea level rise, and flooding are expected to damage or render inaccessible low-lying coastal infrastructure including road and railway

¹⁵ Infrastructure Canada, *Adapting Infrastructure to Climate Change in Canada's Cities and Communities*, December 2006

¹⁶ IPCC (2013), *Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation: Special Report of the Intergovernmental Panel on Climate Change*, Cambridge University Press. Available at: http://www.ipcc.ch/pdf/special-reports/srex/SREX_Full_Report.pdf

¹⁷ National Research Council, *Potential Impacts of Climate Change on US Transportation*, February 2008

¹⁸ USA, Federal Research Partnership Workshop, *The Potential of climate Change on Transportation*, October. 2002

¹⁹ Natural Resources Canada, *Climate Change Impacts and Adaptation: a Canadian Perspective*, October 2007

²⁰ UK Department for Transport, *The Changing Climate: its impact on the Department for Transport*, September 2003

beds, tunnels and underground rail/subway corridors.²¹ Expected sea level rise will also aggravate coastal flooding because storm surges will build on a higher base, reaching farther inland.²² Flooding and inundation of coastal areas in the Black Sea will require costly retrofits and in some cases the relocation of coastal infrastructure. Strong winds and storms could result in bridge collapse and infrastructure failures. The structural integrity of long span bridges is vulnerable to strong winds. Other auxiliary infrastructure can be largely damaged by high winds: road signs, traffic signals, overpasses, train stations, toll collection stations are all vulnerable to strong winds. Since railroad locomotives and cars are high-profile vehicles, high-speed crosswinds can influence their stability. In addition, an increased incidence of high winds, expected for Central Europe, could create overhead line damage, and increased tree-fall and debris requiring improved vegetation management.

47. Flooding from increased precipitation intensity will affect Romania. Increase in precipitation intensity affects moisture levels in the soil and hydrostatic build up behind retaining walls and abutments and the stability of pavement subgrades, therefore affecting the frequency of landslides and slope failures. Flash floods can lead to washout of roads and railway tracks and consequent derailment, and seasonal floods from rivers may make adjacent roads and track segments impassable. Excess rain causes erosion and scouring of bridge supports. On the other hand, reduced summer rainfall and longer drought periods, might result in lower water tables precipitating the settlement of infrastructure and road beds.

48. Temperature extremes and variations will precipitate the deterioration of the road network. The thermal movement of a concrete pavement, or the magnitude of the stress built-up in a restrained pavement, is a function of the range of in-service temperatures. Extreme heat and cold, and freeze-thaw cycles can lead to precipitated failure of road infrastructure: An increase in the maximum service temperature will increase the incidence of rutting, asphalt softening, and bleeding on an asphalt pavement, whilst a decrease in the minimum service temperature will increase the likelihood of thermal cracking. Traffic increases, coupled with decades of neglect and poor maintenance have resulted in excessive rutting and cracking of the road network. For instance, in Romania, restrictions on weight as well as time of travel (during the day) are sometimes imposed on trucks during the summer period to reduce road deterioration when the asphalt is soft. Extreme cold winter temperatures on the other hand have resulted in an increase in thermal cracking and the brittle failure of pavements.

49. Temperature extremes, heat and cold, will damage the railway infrastructure. Build-up of snow and ice on the tracks in the winter can lead to decreased speeds and derailment. Increased heat can result in the buckling of railway tracks resulting in train derailment and speed restrictions.²³ When exposed to the summer sun, railroad tracks occasionally develop heat kinks that may in turn create a hazardous

²¹ Titus, *Does Sea Level Rise Matter to Transportation Along the Atlantic Coast?*, October 2002

²² U.S Climate Change Science Program Synthesis and Assessment Product 4.7, *Impacts of Climate Change and Variability on Transportation Systems and Infrastructure: Gulf Coast Study*, March 2008.

²³ Rossetti, *Potential Impacts of Climate Change on Railroads*, October 2002

condition for oncoming traffic.²⁴ Increased summer temperatures may also lead to settlement of structures.²⁵

50. In addition, temperature variations, particularly extreme heat and heat waves, will affect the construction period and practices. Extreme heat will create unfavorable working conditions for workers, and inhibits certain types of construction activities. For example, high temperature, low humidity and high wind are factors that reduce the setting times and strength of concrete. Nevertheless, warming temperatures can bring some benefits, particularly in very cold areas. Warmer temperatures could translate into a longer construction season and improved cost efficiencies in certain regions (Russia, Kazakhstan). It will result in reduced winter maintenance costs, reduced adverse environmental impacts from the use of salt and chemicals, and longer construction season.

51. Rural and isolated communities will be most affected by the impact of climate change on the land transportation and road network. Isolated communities and rural communities in mountainous areas are particularly vulnerable to the impacts of climate change on the road network as these communities are generally connected to the transportation network by only a single road and are thus largely depending on it for access. In addition rural and local roads are generally designed at lower standards and tend to suffer from neglect and lack of maintenance. Climate change impacts rural roads and communities through various avenues: Heavy precipitation after drought seasons can largely damage earth and gravel roads, and increased precipitation may affect the frequency of landslides and slope failures that could damage road infrastructure particularly in mountainous regions.

52. Bridges and tunnels are vulnerable to flooding and strong winds. Because of their relatively high construction and maintenance costs, tunnels and bridges are particularly important features of any land transportation network. In addition, in many cases, there are no particularly convenient alternative routes to a tunnel or a bridge. Expected increase in flooding and runoff due to higher precipitation intensity can render tunnels non-operational and disrupt traffic. It may precipitate tunnel failure and damage tunnel power supply, ventilation, and other utilities. Flooding will also result in the erosion and scouring of bridge supports, and an increase in precipitation will increase the risk of failure of cuttings and retaining walls located at and around tunnel portals. Runoff from increased precipitation levels will also affect stream flow and sediment delivery in some locations, with potentially adverse effects on bridge foundations. The structural integrity of long span bridges is also vulnerable to strong wind as the load applied by wind is a function of the square of its speed.²⁶ In addition, turbulence also increases with speed resulting in potential aerodynamic instability. This might lead to bridge closure and failure in extreme cases. Higher temperatures can affect the thermal expansion of bridge joints affecting bridge operation and increasing maintenance cost.

²⁴ UK Department for Transport, *The changing climate: its impact of the department for Transport*, October 2002

²⁵ Rail Safety & Standards Board, *Safety Implications of Weather, Climate and Climate Change*, April 2003

²⁶ Wilson and Burtwell, *Prioritizing Future Construction Research and Adapting to Climate Change: Infrastructure*, February 2002

53. Sea level rise, storm surge, and increased precipitation intensity and runoff will affect coastal ports and harbors along the Black Sea. Marine transportation infrastructure includes ports and harbors, and supporting intermodal terminals. Expected climate change impacts differ for coastal and inland waterways. Coastal ports and harbor facilities will be affected by increased intense precipitation and sea level rise. Landsides facilities will be particularly vulnerable to flooding from an increase in intense precipitation events and from the impacts of higher tides and storm surges from rising seas. Sea level with respect to dock level is an important consideration at both wet and dry locks, general cargo docks, and container berths for clearance of dock cranes and other structures. Changes due to increased intense precipitation and sea level rise could require some retrofitting of facilities. At a minimum, they are likely to result in increased weather-related delays and periodic interruption of shipping services. Over the long run, sea level rise may require ports relocation and the construction of dykes and levees. Storm surges and stronger waves will require the construction of larger breakwaters. In addition, a combination of sea level rise and storm surge could eliminate coastal waterway systems entirely by creating land subsidence.

54. The navigability of several shipping channels and inland waterways are likely to be affected due to expected lower water levels. The navigability of shipping channels is likely to change and need to be properly reassessed (Romania's Danube-Black Sea Canal). Some channels may be more accessible to shipping farther inland because of sea level rise. The navigability of others could be adversely affected by changes in sedimentation and the location of shoals. The navigability of inland waterways can be significantly affected by flooding, drought periods, and the resulting variations in water levels. This will result in significant maintenance and dredging costs, as well as fewer days for navigation. Low water levels will particularly affect the Danube River and its tributaries.

1.8 Structure of the Report

55. Following this introductory chapter, Chapter 2 presents a brief overview of the transport sector in Romania and associated greenhouse gas emissions and discusses the potential impacts of climate change in Romania and vulnerability in the transport sector. Chapter 3 reviews options for controlling transport emissions based on international experience, while Chapter 4 presents an overview of options for make transport more resilient to climate change. Chapter 5 summarizes some key drivers for future transport interventions within the context of Romania's Operational Programmes. Chapter 6 presents the rapid assessment and prioritization of mitigation and adaptation measures, while Chapter 7 completes the Report with recommendations and conclusions.

2 THE TRANSPORT SECTOR IN ROMANIA

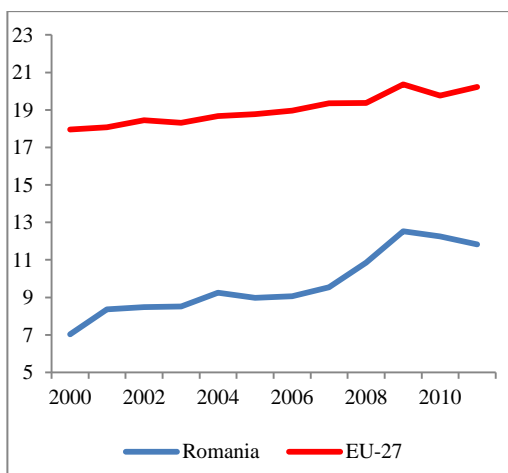
2.1 Introduction

56. Transport is a key facilitator for modern societies to flourish. It keeps the economy moving and gives people freedom to participate in a wide range of social activities. This chapter presents an overview of emissions generated from the transport sector, passenger, freight, and urban transport, before turning to the issue of likely impacts of climate change on transport infrastructure and services.

2.2 Greenhouse Gas Emissions from Transport

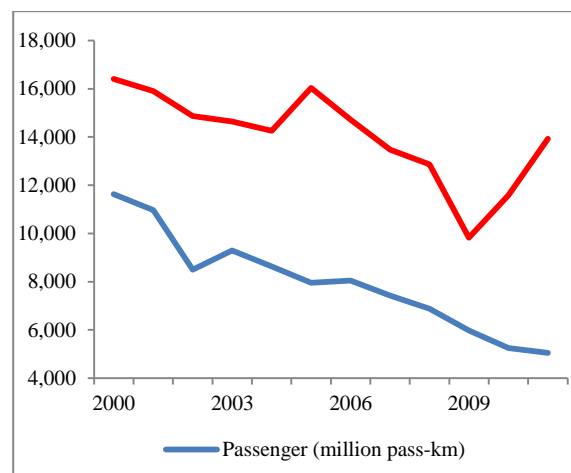
57. Figure 2 shows the annual GHG emissions from the domestic transport sector in Romania and how it has grown since 1990.²⁷ The steady upward trend since the turn of the century is particularly noteworthy. Figure 3 shows how greenhouse gas emissions from transport have grown in Romania since 2000, in comparison with the EU-27) and growing significantly faster than the EU average. As a percentage of total GHG emissions across all sectors, Romanian transport accounts for 11.8 percent (2011 figures). While this is small than the EU's average of 20.2 percent, it is rising more quickly than the EU average, as shown in

Figure 4: Transport GHG Emissions as a Percentage of Total GHG Emissions



Source: EEA.

Figure 5: Rail Traffic in Romania (2000-2012)



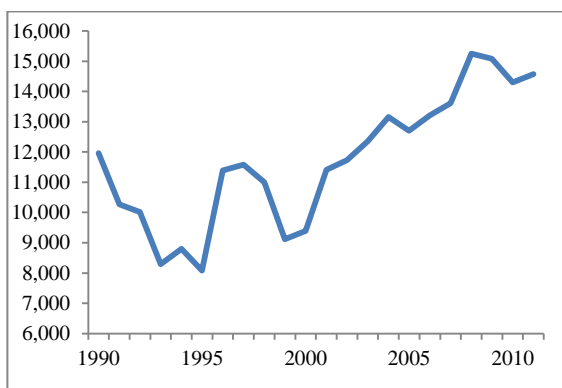
Source: UIC.

58. , driven in part by the declining modal share of rail (Figure 5) and increased motorization.. Among the different transport modes, road transport is the source of the great majority of GHG emissions in the

²⁷ This includes emissions from transport (road, rail, inland navigation and domestic aviation) of the GHG regulated by the Kyoto Protocol. Only three gases are relevant in the context of transport (carbon dioxide, methane, and nitrous oxide) and these have been aggregated according to their relative global warming potentials.

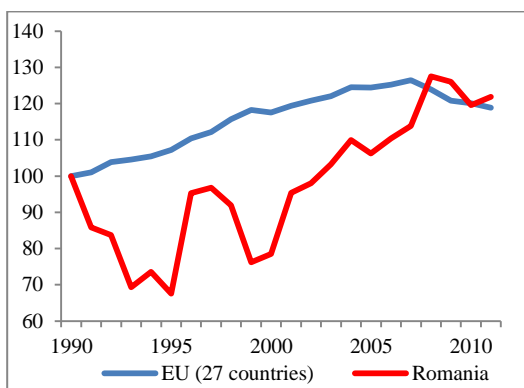
transport sector, being responsible for 93 percent of domestic transport emissions.²⁸ This is a similar proportion to the EU-27 average of 94 percent.

Figure 2: GHG Emissions from Domestic Transport in Romania (1,000 tons CO₂)²⁹



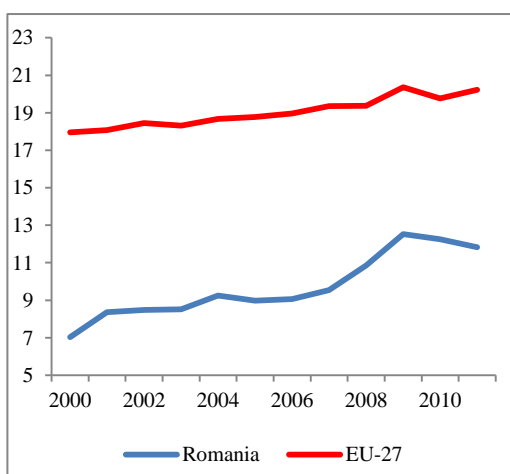
Source: EEA.

Figure 3: Trends in Emissions Compared to EU-27 (2000=100)



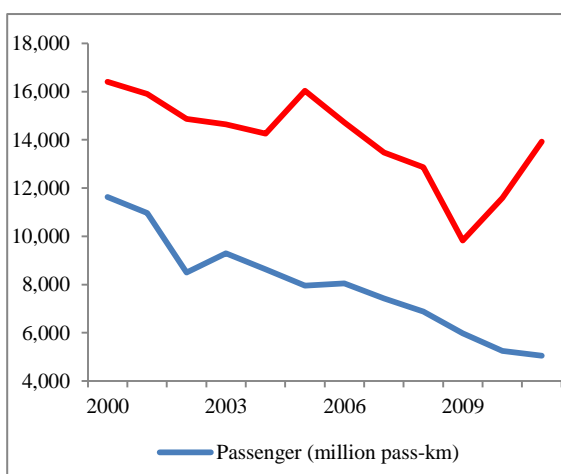
Source: EEA.

Figure 4: Transport GHG Emissions as a Percentage of Total GHG Emissions³⁰



Source: EEA.

Figure 5: Rail Traffic in Romania (2000-2012)



Source: UIC.

2.3 Passenger Transport

59. *Passenger land transport.* Figure 6 shows the modal split for passenger transport (in terms of percentage of total person-km travelled) between the three main land-based modes of domestic travel – private car, rail and bus/coach since 2000. This shows a marked rise in mode share of the private cars and a significant decline in rail mode share (with 2011 rail mode share being approximately one third of

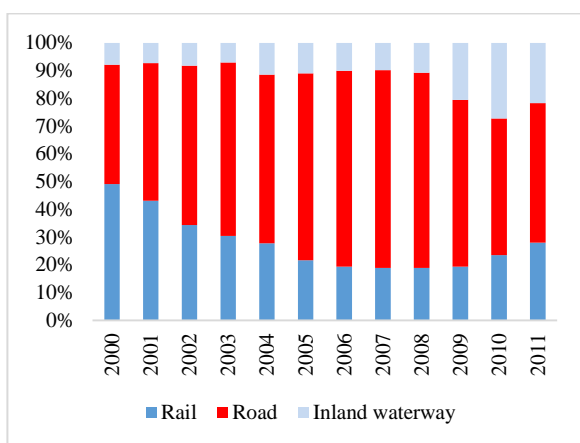
²⁸ European Environment Agency data, as of June 2013.

²⁹ <http://epp.eurostat.ec.europa.eu>.

³⁰ European Environment Agency data as at June 2013.

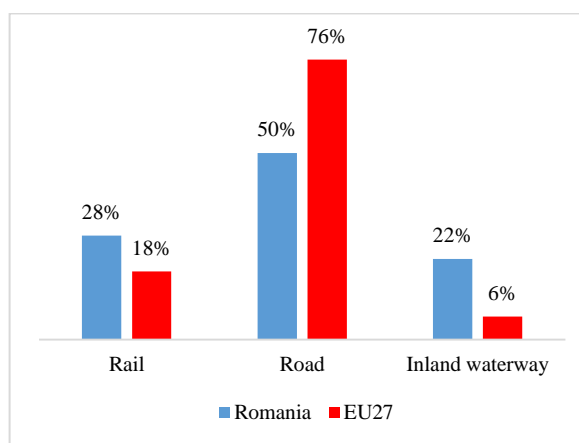
the 2000 figure). Bus and coach travel mode share has grown slightly between 2000 and 2011. Figure 7 shows how the modal split figures for Romania compare with the EU average. Private car mode share is now approaching the EU average, having been considerably lower at the turn of the millennium. Rail mode share is lower than the EU average, having been above average in 2000.

Figure 6: Passenger Transport Mode Share (land-based modes)



Source: Eurostat.

Figure 7: Comparison of Modal Split with EU average (2011)



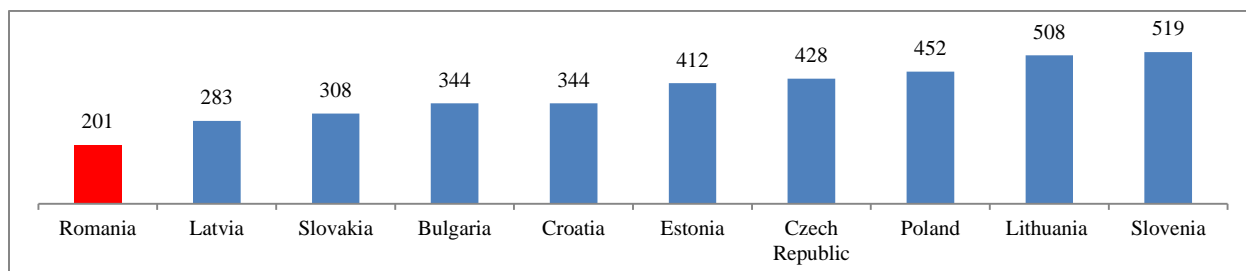
Source: Eurostat.

60. Although car mode share in Romania is at a similar level to the EU average, the motorization (or car ownership) rate in Romania is the lowest in the EU at 201 cars per 1000 inhabitants in 2010,³¹ but has grown significantly in recent years, up from 150 cars per 1000 inhabitants in 2004.³² Experience across the world suggests that as the Romanian economy grows, it will continue to grow in future. Without intervention to provide better transport alternatives and encourage their use, as car ownership grows, car use is also likely to grow. The reasons for the decline in rail passengers are linked to the decaying state of the Romanian railway system. In its Position Paper on Romania in preparation for the 2014-2020 funding round, the European Commission notes that the railway system is suffering from underinvestment and poor maintenance, leading to slow and unreliable train services. Discussions with the rail infrastructure company CFR in the early stages of our work suggested that the problems are well recognized – in July 2013 it was reported that around 580 km of the rail network had long term speed restrictions in place for safety reasons due to infrastructure problems that could not be fixed with existing maintenance budgets.

Figure 8: Motorization Rates in Selected EU Countries (passenger cars/1,000 inhabitants, 2010)

³¹ Energy, transport and environment indicators. Eurostat Pocket Books 2012 Edition. European Commission.

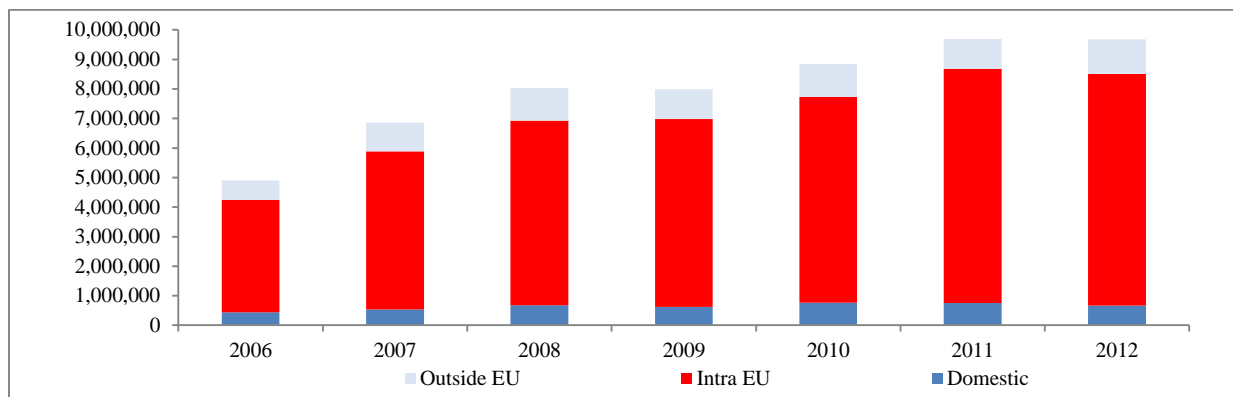
³² Study on Strategic Evaluation on Transport Investment Priorities under Structural and Cohesion funds for the Programming Period 2007-2013. Country Report Romania by Ecorys for European Commission DG Regio, 2006.



Source: Eurostat.

61. *Domestic air transport.* Air transport is well known as being an intensive emitter of greenhouse gases³³ – although there are a number of industry initiatives to reduce emissions. Domestic air passenger transport activity (internal within Romania) forms a small part (7 percent) of total passenger movements through Romanian airports. This is a relatively low level compared to other EU countries (the EU-27 average is 18 percent), although it has increased in recent years, as shown in Figure 9. Passengers flying to and from other EU countries form the great majority of passengers using Romanian airports (81 percent), with the remainder (12 percent) flying to and from destinations outside the EU. Discussions with the Head of the Air Transport Directorate in the Ministry of Transport indicated that there were pressures to further develop regional and local airports in Romania to ensure connectivity of the country's regions to other areas. This was seen as a particular issue while rail and road connections are seen as inadequate.

Figure 9: Air Passengers using Romanian Airports (excluding transit passengers)



Source: Statistical Office.

2.4 Freight Transport

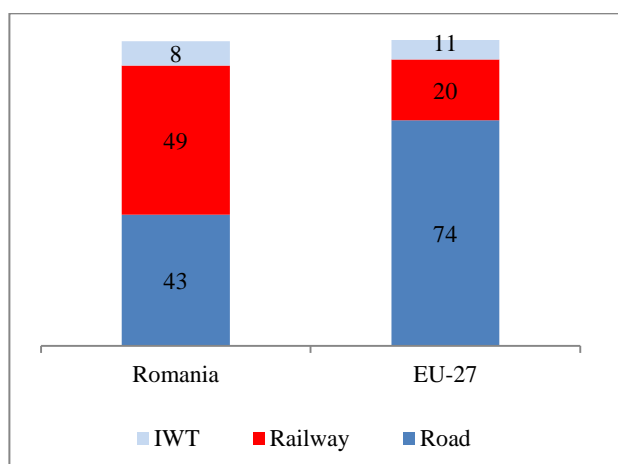
62. The modal split for freight movements in Romania (in terms of ton-km) and how it has changed in recent years is shown in Figure 10 and Figure 11.³⁴ This shows a marked fall in rail freight mode share in recent years, together with a marked rise in road freight mode share. Also notable is the much larger

³³ Factsheets: UK transport greenhouse gas emissions. UK Department for Transport. Available at www.gov.uk.

³⁴ Eurostat data at <http://epp.eurostat.ec.europa.eu>. The amount of freight moved by air (which is excluded from the modal split figures shown above) is very small - 28,523 tons in 2011, up from 19,229 tons in Romania's first year of EU membership in 2007. For comparison, some 65 million tons of freight were transported on Romania's railways in 2007.

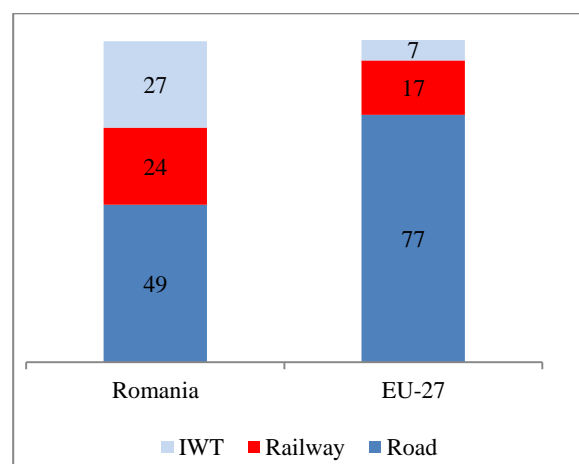
waterborne freight mode share since 2009. The reasons for the decline in rail freight and transfer to road and inland waterways are likely to be similar to those set out above for passenger transport. Rail freight mode share is higher than the EU average, in spite of its decline. Inland waterborne freight also has a much higher mode share than the EU average, while road freight is still below the EU average, despite its recent growth.

Figure 10: Freight Land Modal Share (2000)



Source: Eurostat.

Figure 11: Freight Land Modal Share (2010)



Source: Eurostat.

2.5 Urban Transport

63. Urban transport forms a major part of overall transport movements in Romania. Some 54 percent of the country's population lives in towns and cities, according to the 2011 national census³⁵. Transport within urban areas forms a vital part of the functioning of those areas as economic and social entities. There are nine cities in Romania with populations in excess of 200,000. As well as Bucharest (by far the largest city at 1.9 million) seven others (Constanta, Craiova, Ploiesti, Iasi, Brasov, Cluj-Napoca and Timisoara) have been designated as regional "growth poles". Galati is the other city of over 200,000 people. There are also 11 Romanian cities with populations between 100,000 and 200,000 and a further 21 towns/cities with populations between 50,000 and 100,000.

64. However, readily available quantitative information on the urban transport situation across Romania is limited, and consultation and information gathering with all the individual municipal authorities is beyond the scope of the Transport Rapid Assessment Report. Recent TRACE³⁶ studies assessing the potential for energy efficiency improvements undertaken by the World Bank in individual cities (Brasov, Cluj, Ploiesti) have yielded information, and some further information is also available through the Sustainable Energy Action Plans prepared by various Romanian towns and cities through the European Covenant of Mayors program.³⁷ In addition, the World Bank held an initial discussion meeting

³⁵ <http://www.recensamantromania.ro/rezultate-2/>

³⁶ <http://esmap.org/TRACE>

³⁷ <http://www.covenantofmayors.eu/actions/sustainable-energy-action-plans>

with the Executive Director for Transport in the Municipality of Bucharest on challenges and ambitions in Bucharest. This section presents information from these sources which, while not comprehensive, “paints a picture” of the urban transport scene in Romania. As described later in this Report, eight of the main cities (the seven “growth poles” plus Bucharest/Ilfov County) will soon be in the process of developing sustainable urban mobility plans, which will each investigate the urban transport challenges in depth and develop an overarching strategy for addressing them.

65. As noted in the TRACE study reports, there is limited reliable information on modal split in many Romanian cities. The Brasov study sums the situation up as follows “Like in other growth poles, the city lacks information on the transport mode split. The local government does not have information on how many people use public transport, how many walk, and how many of them commute using their own cars. City authorities should document information on trips, to understand exactly how many people complete trips and commute in the city and by what means. Without documenting such information, it is almost impossible to do proper transport planning.”

66. *Traffic congestion.* Traffic congestion is reported to be an increasing problem in a number of cities, as vehicle ownership grows. For example, the rapid review of the situation in the TRACE studies in Brasov,³⁸ Cluj-Napoca³⁹ and Ploiesti⁴⁰ all identified traffic congestion as a problem issue. In Bucharest, congestion is also a significant problem,⁴¹ as confirmed in our discussion with the Municipality of Bucharest. Congestion, with the resulting start-stop nature of the driving cycle it imposes on vehicles, significantly increases greenhouse and other gaseous emissions from road traffic. Bucharest has a traffic signal and control system, which is currently in the process of being upgraded. Other cities are also known to have traffic signal systems – but there is no readily available information on their type or operating status.

67. *Parking.* With the rapid growth in ownership and use of private vehicles since Romania started the transition to a market economy, the supply of designated parking spaces in Romania’s cities has come under pressure and the number is often inadequate to meet demand. This often leads to “informal” parking arrangements, with vehicles parking on footways, cycle tracks and public spaces as well as on every available meter of legitimate roadside parking space. As well as causing difficulties for pedestrians, cyclists and other road users, this also adds to the congestion problems noted above. Management of parking in some Romanian cities is rudimentary or non-existent, with little or no enforcement of parking regulations, nor any attempt to use parking restraint (through charging or enforcement of restrictions) as a demand management tool. In other cities such as Brasov and Cluj-Napoca, new parking management systems including use of parking meters, mobile phone payment, among others, are however taking hold.

³⁸ Improving energy efficiency in Brasov, Romania: TRACE city energy efficiency diagnostic study. World Bank (under the Romania Regional Development Program), undated.

³⁹ Improving energy efficiency in Cluj-Napoca, Romania: TRACE city energy efficiency diagnostic study. World Bank (under the Romania Regional Development Program), undated.

⁴⁰ Improving energy efficiency in Ploiesti, Romania: TRACE city energy efficiency diagnostic study. World Bank (under the Romania Regional Development Program), undated.

⁴¹ Bucharest - sustainable mobility case study. Mihaila Raducu, Goteborg University, 2010.

68. *Public transport.* Public transport in Bucharest includes a metro system (operated by Metrorex), a tram network, trolley buses, and an extensive bus network (all operated by RATB). RATB is an operating company overseen by the Municipality of Bucharest, while Metrorex is an operating company under the auspices of the Ministry of Transport and Infrastructure. Rail lines also exist which could potentially provide suburban transport services for commuting.⁴² In other Romanian cities and towns, public transport consists of buses, minibuses, trolley buses and trams. The city of Brasov took the decision in 2005 to abandon its tram line due to the prohibitive cost of upgrading and maintaining it. It now focuses on buses and trolley buses. Cluj-Napoca has upgraded its tram system, while other cities have similar plans but lack funding to implement them.

69. Although data is hard to obtain, it is understood that public transport patronage in many Romanian towns and cities is in decline, with a corresponding increase in private traffic levels. For example, in Ploiesti, public transport patronage fell from 7 million trips per month in 2011 to 6.7 million in 2012. Ridership is going slightly down⁴³. Some cities are making concerted efforts to reverse this trend through modernization of infrastructure and services, although lack of funding remains a serious constraint. For example, the Brasov Municipality and by operating company renewed its bus fleet with 109 new vehicles in 2006, using an EBRD loan, and purchased a further 15 Euro V diesel buses in 2011⁴⁴. The whole fleet purchased in 2006 is reaching the end of its life, however, and will need replacement by 2015.

70. *Taxis, pedestrian and cycling infrastructure.* There is a plentiful supply of taxis in most Romanian cities. However, many of the vehicles are old and not fuel-efficient, mirroring the make-up of the national vehicle park. Some cities have an age limit for taxi vehicles, but this varies significantly (Brasov has an age limit of five years, while in Cluj-Napoca the age limit is 12 years). Pedestrian and cycling infrastructure varies greatly in quality and quantity between different towns and cities, and within different city areas. A number of Romanian towns and cities have recognized the value of these modes in improving energy efficiency, reducing congestion and creating pleasant urban environments. For example, efforts to improve walking and cycling facilities are reported in all three TRACE studies cited above, and mention is made of encouraging these modes in some Sustainable Energy Action Plans.⁴⁵ As with other modes, however, data is hard to come by on the numbers of urban trips being made on foot or bicycle.

71. In Brasov in 2008, the Municipality developed a pedestrian area in the historical center with 10 streets closed to car traffic and streets repaved with cobblestones, using funding from the 2007-2013 Regional Operational Programme. In Ploiesti, an EU-supported CIVITAS project promoted walking and

⁴² European funds warm up modernization works in Romania. Railway Pro, 26th February 2013 issue, available at <http://www.railwaypro.com/wp/?p=11645>

⁴³ Improving energy efficiency in Ploiesti, Romania: TRACE city energy efficiency diagnostic study. World Bank (under the Romania Regional Development Program), undated.

⁴⁴ Improving energy efficiency in Brasov, Romania: TRACE city energy efficiency diagnostic study. World Bank (under the Romania Regional Development Program), undated.

⁴⁵ Sustainable Energy Action Plan of Vaslui 2011-2020. Municipality of Vaslui, 2009.

a pedestrian zone was created in the city center, backed by a campaign to encourage behavioral change. As a consequence, there has reportedly been a 20 percent improvement in public transport speed, in addition to a 15 percent reduction in pollution in the central zone of the city.

72. In terms of cycling, good cycling infrastructure exists in some cities but it is generally patchy and does not form a coherent network, and is often poorly maintained. As noted above, parking on cycle lanes is also a problem, reducing their usability further. However, there are examples where the cycling environment is being improved. In Cluj-Napoca, the municipality is extending its cycle lane network by 18km (to 58km in total) in the city and out to the suburbs; 50 self-service bicycle docking stations in the metropolitan area are also being built. The Municipality of Ploiesti also took part in SPICYCLES⁴⁶, a project developed under the EU Intelligent Energy Europe program, along with Barcelona, Bucharest, Berlin, Goteborg, and Rome. Ploiești ran a bike-sharing pilot scheme which was promoted among commercial companies, local government institutions and educational institutions.

2.6 Climate Change in Romania

73. Romania has already seen some extreme weather events since 2000 which may be linked to climate change.⁴⁷ These include: (a) the 2005 floods on the inland rivers, which resulted in the loss of 76 human lives and huge property damage; (b) the 2006 floods on the Romanian sector of the Danube that again caused again huge property damage; and (c) the 2007 drought, which was the most severe in 60 years. Drought-affected areas have also expanded over recent decades, with the most affected areas being the South and South-East of Romania. These extreme weather events cause significant economic loss in a number of sectors including transport.

74. According to the draft Romanian Climate Change Adaptation Strategy⁴⁸ (citing the Fourth IPCC Report⁴⁹), the expectation is that in the future, Romania can expect:

- A rise in average temperature overall.
- A higher increase in mean minimum winter temperature in and around the Carpathians than in the rest of the country.
- A higher increase in mean maximum summer temperature in the south and south-east than in the north of the country.
- More frequent summer droughts, especially in the south and south-east.
- More frequent heat waves.
- More intense rainfall across short periods of time, leading to more frequent flash floods.

⁴⁶ Newsletter Spicycles Available at:

http://www2.trafikkontoret.goteborg.se/resourcelibrary/SPICYCLES_percent20Newsletter_percent201.pdf

⁴⁷ Draft Final Climate Change Adaptation Strategy for Romania. 21 Nov 2011.

⁴⁸ Ibid.

⁴⁹ IPCC, 2007: Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, M.L. Parry, O.F. Canziani, J.P. Palutikof, P.J. van der Linden and C.E.Hanson, Eds., Cambridge University Press, Cambridge, UK, 976pp.

- An overall decrease in summer precipitation, especially in the south and south-east.

75. In the absence of adaptation measures, higher temperatures and more frequent heat waves (particularly in the south and south-east) are likely to cause problems with road and rail infrastructure. Asphalt roads may become soft and deform more under the weight of vehicles, causing traffic restrictions to be put in place (particularly for heavy vehicles). This issue is already recognized by the Romanian national roads company, with use of adjusted material standards and design norms in vulnerable areas to cope with higher temperatures and minimize deformation. Similar issues may also arise with asphalt surfaces (eg. runways) at Romanian airports. Railway lines also buckle under high temperatures, which can again lead to speed and usage restrictions.

76. In urban public transport (and in national rail services), higher temperatures and heat waves are likely to cause discomfort and possible safety risk to passengers. This will lead to a need for improved ventilation at stations (eg. Metro stations) and improved ventilation or air conditioning on trains, metro trains, trams, trolleybuses and buses. This will be important if these modes are to remain attractive in competition with private cars, in which air conditioning is becoming more common.

77. Rail, road and waterborne transport infrastructure are potentially vulnerable to the effects of more intense rainfall and increased frequency of flash floods. Bridge abutments, piers, road and rail embankments and riverbanks are potentially vulnerable to such flash floods unless measures are taken to protect them. Some roads and railways may also be more prone to flooding, unless drainage and flood protection measures are implemented. Intense rainfall can also have adverse impacts on road safety, although in some areas a reduction in icy and snowy days may counterbalance this.

78. Reduced precipitation, droughts and the associated reduced runoff may affect river navigation on the major waterways such as the Danube. This is something that is already being seen, according to the Lower Danube River Administration, with reduced water depths, meaning that the number of days on which navigation restrictions are implemented is increasing.

2.7 Conclusion

79. This chapter has reviewed GHG from the transport sector in Romania and presented a brief overview of modal share, as well as some of the challenges facing urban transport. In order to contain GHG from the transport sector Romania will need to ensure that as it grows and becomes wealthier it avoid the characteristics of the transport sector in the EU, which has continued to see a growing share of GHG from the transport sector—20.2 percent in 2009, up from the 13.8 percent in 1990. This trend in the EU is linked to a sizeable increase in transport volumes, as a result of globalization, higher motorization rates, and an increase in the number of holidays and short breaks. In a do nothing scenario, Romania's GHG emissions from transport are set to continue growing rapidly compared to the EU, particularly if its motorization rates converges to the EU average. At the same time, there are opportunities, particularly in the urban transport sector, to develop urban transport policies that reduce

congestion and improve system efficiency. It will also be critical to reversing the modal decline of rail and contain the modal share of roads.

80. With regard to potential impacts of future climate change on Romania's transport infrastructure, while the expected impacts are known, they have not been quantified, and a detailed vulnerability assessment has not been carried out for the transport sector as a whole or for any of the individual modes. This means that there is considerable uncertainty over exact impacts and whether changes in infrastructure design are warranted or not. This suggests that further analytical work is necessary before embarking on what could be expensive climate resistant infrastructure, and the upcoming Operational Programmes present an opportunity to finance such analysis.

3 OPTIONS FOR CONTROLLING TRANSPORT EMISSIONS

3.1 Introduction

81. Transport activity normally grows in parallel with economic activity, but actions to slow down growth may be warranted to help solve local or national transport problems—such as high accident rates, poor air quality, noise pollution, and congestion—or to reduce dependence on imported fuels, among other reasons. Given the preponderance of road transport within the sector, slowing the growth rate of vehicle kilometers travelled (VKT), particularly for passenger vehicles, will be critical. A good way of thinking of mechanisms to reduce emissions in the transport sector is the avoid-shift-improve (A-S-I) paradigm, associated with Holger Dalkmann:⁵⁰

- (a) **Avoid** growth of CO₂ emissions through urban and interurban development that reduces the need for long-distance travel in passenger vehicles. Singapore is a good example of a coherent and comprehensive set of land use and development policies aimed at reducing the dependence on passenger vehicles, in contrast to the US suburbanization model. This is clearly linked to urban development issues and transport policies developed in response to these.
- (b) **Shift** transport to modes with lower emissions, by shifting passenger traffic to buses, rail or metro and freight to rail, and away from passenger vehicles and trucks. Given that cities produce a large share of emissions, this would require developing policies to encourage modal shift from passenger vehicles to mass transit, either to increase the modal share of public transport or to slow down a declining modal share. Increasing the role of rail, particularly for freight, is critical; a successful example that comes to mind is Switzerland.
- (c) **Improve** vehicles, fuels and operations in order to mitigation emissions with existing and future vehicles technologies, fuel economy standards, and through traffic management policies.

82. The set of policies aimed at dealing with A-S-I can be broadly considered to be prices, regulations, and investments. Pricing policies, such as the introduction of a congestion charge aimed at encouraging modal shift from passenger vehicles to public transport and non-motorized transport, but could be combined with restrictive parking regulations—for example, a policy of reducing the number of

⁵⁰ This chapter is substantially based on Monsalve, Carolina (2013), Controlling Greenhouse Gas Emissions Generated by the Transport Sector in ECA: Policy Options, World Bank Transport Paper TP-40, February 2013. Available at: <http://siteresources.worldbank.org/INTTRANSPORT/Resources/336291-1227561426235/5611053-1229359963828/TP40-Final.pdf>

parking spaces—and investing funds from the congestion charge for improving and extending mass transit. All three sets of policies, pricing, regulatory, and investment decisions are clearly needed, and in practice, it is a whole set of policies, rather than one policy introduced in isolation, which has helped reduce the usage of passenger vehicles in a number of European cities. In what follows a menu of individual policy options is presented, with a greater focus on roads, as this is the sector which generates the most emissions in the transport sector. It goes without saying that greater investments in public transport is needed in order to reduce vehicle use, and this has not been elaborated in this section.

3.2 Road Pricing Instruments

83. **Internalizing costs through road user charging (RUC).** When deciding to make a journey a driver will normally consider the costs to him/herself, that is to say the cost of fuel, personal cost if delayed due to heavy traffic, and parking costs, when in fact there are many other associated costs. Road pricing theory argues that the socially optimal amount of transport in total and by mode requires that users be confronted with a price at the point of use that reflects the full social cost of his/her trip at the margin or marginal social cost pricing.⁵¹ Social costs are defined to include private marginal costs (fuel, vehicle maintenance, driver and passenger time for a specific vehicle trip), together with any damage done to the infrastructure, the capital costs of the infrastructure, the impact of exhaust emissions locally, regionally or globally in the form of CO₂ or GHG emissions, and the contribution to congestion, noise, and accidents. Internalizing these costs—adopting the user pays principle—requires making each driver pay for their part of the general costs generated.

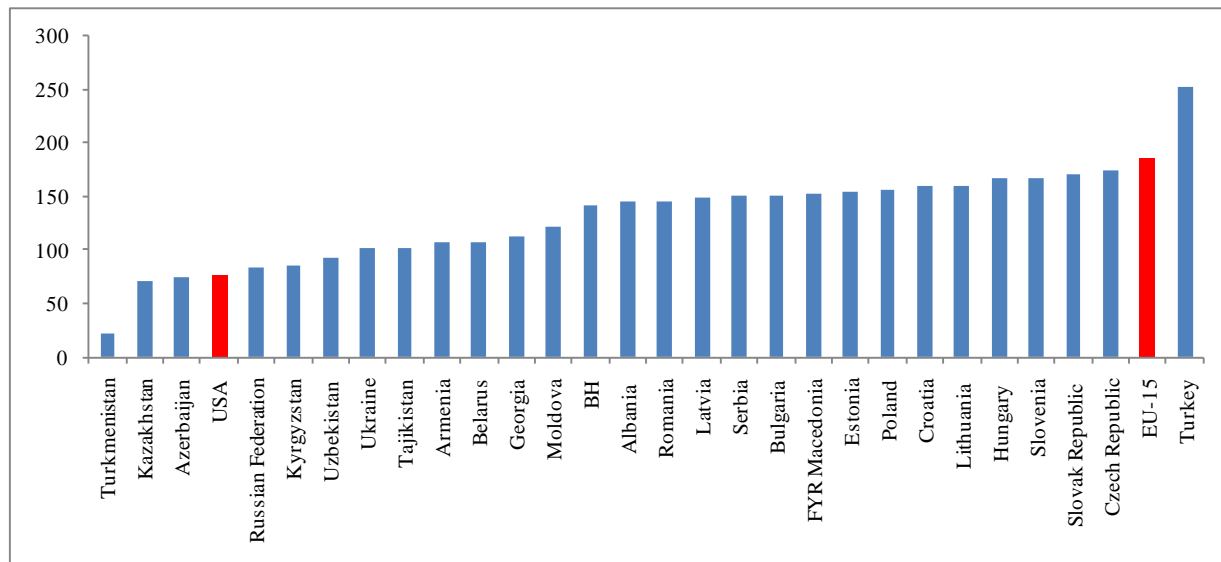
84. Road pricing can be used as a flexible way of charging people and can help end the idea that one can drive a vehicle without thinking about the external consequences to society. Pricing is critical to reducing GHG emissions and represents one of the key transport policies to reduce demand by raising the relative price of vehicle use to alternative mass transit in cities or other modes outside of urban areas. This section presents a brief overview of some of the pricing policy options available to policy makers wishing to contain the growth of the modal share of vehicles, drawing on international experience. The pricing options under consideration include: (a) fuel pricing; (b) toll road pricing; (c) high-occupancy vehicle and toll (HOV and HOT) lanes, express toll lanes; (d) vignette; (e) heavy good vehicle tolling; (f) urban congestion pricing; (g) vehicle registration fees; (h) parking policy; and (i) insurance per km of driving. Box 3 provides a concise typology road charging principles.

85. **Fuel pricing.** Fuel pricing is a particularly effective policy instrument in that it can discourage vehicle usage—although this is a function of the short, medium, and long-term price elasticity of demand—and encourage the purchase of more fuel-efficient vehicles, thereby reducing vehicle-fuel intensity. In general, high fuel tax countries, predominantly in the EU-15, are associated with much lower levels of vehicle usage than in low fuel price countries such as the US. In the US, modest fuel

⁵¹ Richard Martin Humphreys (2011), “A Short Primer on Road User Charging.” Policy Note prepared for the Albanian Government. Europe and Central Asia Transport Division, World Bank.

taxes of about US\$0.10 per liter of diesel and gasoline are levied to cover all direct expenditure for roads and highways—maintenance, refurbishment, new construction, and capital recovery for the roads and highways departments. For comparison, in November 2010, the US price (including taxes) for diesel was US\$0.78 per liter and for super gasoline US\$0.56 per liter. This is considered by *Deutsche Gesellschaft für Internationale Zusammenarbeit* (GIZ), which publishes annual international gasoline and diesel retail price data—as the international minimum benchmark non-subsidized fuel transport policy (Figure 12).

Figure 12: Retail Price of Gasoline in mid-November 2010 (US cents per liter)



Note: At a crude oil price of US\$81/bbl Brent.

Source: GIZ.

86. Fuel taxes are relatively inexpensive to collect, easy to administer and reasonably equitable, since the charge is broadly proportional to road use. They do not however discriminate between road type, location of the road, or time of usage. On the latter point, this means that fuel taxes cannot tackle the issue of high externalities associated with congestion in peak traffic times. Another weakness is that they do not fully reflect the additional damage done and road space demanded by heavy vehicles.⁵² Although trucks consume more fuel per kilometer than vehicles and therefore pay more in tax per kilometer travelled, this is not in proportion to the higher impact in terms of damage to the road surface.⁵³ For this reason, fuel taxes are frequently supplemented by additional charges on heavy vehicles. Taxes on fuel are also used by governments for other purposes such as restraining fuel consumption or more commonly raising revenues for the budget, reflecting weaknesses in revenue collection in developing and emerging economies.

⁵² Humphreys (2011), *ibid*.

⁵³ The relative damage to the road surface increases by the fourth power of the axle load.

87. Increasing fuel taxes remains an option for Romania, although issues of affordability need to be taken into account when considering fuel tax rises. Shifting the tax burden to pollution and pollution-generating activities creates powerful incentives to use less energy and emit less CO₂ into the atmosphere while simultaneously promoting tax equity and minimizing the impact of the fuel tax on those with lower incomes. In a number of countries, the motivation for increasing fuel taxes can be to capture the damage done to road infrastructure—something which the World Bank is often advocating to road agencies—and not within a context or framework where the primary motivation is an environmental one.

Box 3: A Typology of Road Charging Principles

Area Licensing: Allows for provision of a license, which enables the user to enter a certain defined area and can be paper, or electronic, by storage of a registration number. It does not restrict how many journeys one can make within the charging area so its usefulness as a congestion or GHG reducing tool is limited. It is, however, easy to set up and maintain.

Cordon/zone charging: Involves setting up a linear cordon and charging at access points to the zone. The user would then pay a charge depending on how many crossings into the zone were made, or in some cases for how long. It is very versatile and can incorporate varying charging scales according to type of vehicle, time of day etc. However, a disadvantage is that vehicles will often 'skirt' around the edges of zones to avoid paying the charges, increasing the congestion outside the zone.

Distance-based charging: The fee levied is proportional to the distance travelled, and in simple terms, the amount that the driver would pay reflects more accurately the cost of the pollution caused. In urban areas, a cordon might be defined and drivers charged according to the distance travelled within the cordon.

Time-based charging: The driver is charged a fee related to how much time is spent on roads subject to the charge, or in an urban area, within a cordon. Implications of this mean that if traffic congestion is higher, then the driver spends more time in the zone, and hence would be charged more. The driver would then perhaps choose not to enter the zone/cordon at busy times of day. One problem with time-based charging is that it would encourage drivers to drive faster to spend less time in the charging zone.

Congestion charging: It is generally accepted that congestion brings with it a set of consequences relating to pollution and increased journey times amongst other things, and is therefore undesirable. So any means to reduce congestion are important. Through satellite positioning and road-side sensors, it would be possible to tell if a particular vehicle is adding to congestion, and therefore the driver could be financially penalised for this. This would mean that, in an urban area, within a defined cordon, use of any road at any time could result in a *congestion charge* being levied, depending entirely on the traffic conditions. The definition of 'congestion' is critical to the way the scheme is implemented and how users are charged.

Source: University of Nottingham. Available at http://www.nottingham.ac.uk/transportissues/cong_roadcharging.shtml

88. **Toll road pricing.** Tolls have been generally used for specific roads, bridges and tunnels, although increasingly they are being introduced for networks. There are two main types—a closed toll

system, where any vehicle entering the facility collects a ticket and pays a graduated fee at the exit point—as occurs in motorways in the EU.⁵⁴ The introduction of such a system requires that the road be fully ‘closed’ so no user can gain access to the road without collecting the ticket and paying the toll. The level of facilities required increases, and the provision of a free alternative route is usually mandated by law. Open road tolling (ORT), also known as free-flow tolling, is the collection of tolls without the use of toll booths. The major advantage is that users are able to drive through the toll plaza at highway speeds without having to slow down to pay the toll. ORT may also reduce congestion at the plazas, and hence GHG emissions, by allowing more vehicles per hour per lane. A disadvantage is the increased risk of violators who do not pay. Collection of tolls on open toll roads is usually conducted through the use of transponders or automatic plate recognition. Both methods aim to eliminate the delay on toll roads by collecting tolls electronically by debiting the accounts of registered vehicle owners without requiring them to stop. Given the technological requirements, ORT is more expensive and may be appropriate for only some countries in EU-12.

89. **High-occupancy vehicle (HOV) lanes, high-occupancy toll (HOT) lane, express toll lanes (ETL).** The traditional approach to increased congestion has been the addition of general-purpose road lanes. However, because of the high costs and impacts of creating new capacity, increasing attention is also being given to strategies that make the maximum use of existing highway capacity—HOV, HOT, and ETL lanes respond to this demand management focused approach.

- *HOV lanes* are designated for use only by vehicles containing two, three or more occupants. HOV restrictions can sharply reduce the number of vehicles using such lanes, permitting vehicles that qualify for the lanes to travel rapidly during peak hours. This should create an incentive for people to switch from driving alone to carpooling, thereby expanding road capacity.
- *HOT lanes* can be used by both high-occupancy vehicles—either without charge or with a reduced toll—and single-occupancy vehicles with a variable toll during peak hours. The toll is determined by hourly vehicle flows and is set high enough in peak hours to keep the number of users down and, consequently, speeds of vehicles on the road up.
- *Express toll lanes (ETLs).* The main difference between HOT and ETLs is that in HOT lanes, HOVs are granted free access, whereas in ETLs all vehicles pay according to the same schedule.

90. Those who criticize the concepts claim that the lanes provide congestion relief to higher income drivers. With HOT the attempt to address this criticism typically consists of special treatment for HOVs. Vehicles carrying more than a specified amount of passengers are permitted to use the HOV lanes at a reduced toll (hybrid lanes) or for free (HOT lanes). Additionally, public transit vehicles are typically exempted from the toll. A counter-argument is that high income drivers already have ways to ease their

⁵⁴ The introduction of a closed system requires the availability of a free alternative route for road users who chose not to use the tolled route.

commute that are not available to the poor, such as buying a home closer to where they work. Creation of both HOV and HOT lanes is much more acceptable if it is done by adding capacity to an existing road, as the conversion of existing lanes reduces the overall capacity of the road, thereby increasing congestion on the remaining normal lanes. HOT, HOV, and ETL should be created only as part of the entire highway network in which they will be located, with full recognition of how those lanes will affect the whole network and impact on congestion in the network. Compared to general-purpose lanes, HOT, HOV, and ETL may provide environmental advantages by eliminating GHG emissions caused by stop-and-go traffic, and by encouraging people to use carpools and mass transit, thereby reducing the number of vehicles on the road.⁵⁵ Such lanes can only be implemented in high density road corridors typical of larger metropolitan area with limited travel options and a lack of parallel highway routes.

Box 4. Financing Greater Paris Public Transport through the *Versement Transport*

In the Ile de France—an administrative region composed mostly of the Paris metropolitan area—the French tax, *versement transport* is a key resource of public transport financing. Funding for public transport comes from a variety of sources, including users (ticketing), the region of Ile de France, the city of Paris, the French government, county contributions and company contributions through the *versement transport* or transport tax.

The transport tax is a tax calculated on wages and was created in France in 1971. The tax rate applicable to companies is defined by the Board of the *Syndicat des transports d'Ile-de-France* (STIF), the authority that controls the Paris public transport network and coordinates the different transport companies operating in the region. The actual rate depends on the Paris metropolitan area where employees work, with three rates: 1.4 percent, 1.7 percent, and 2.6 percent. Every company employing more than nine staff in Ile-de-France has to pay the transport tax. A regressive system is applied to companies who employ more than nine staff: they pay nothing the first three year, and then the three following years the amount is reduced by 75 percent, 50 percent, and then 25 percent. The taxes are collected by the same public body that recovers social security contributions, retaining 1 percent of the value collected.

Payment is reimbursed by STIF for companies that (a) provide permanent accommodation to their employees on worksite; (b) provide their employees with transport to and from the workplace, and (c) those companies located in new towns, of which there are currently two.

The transport tax is one of the main sources of income to finance public transport in Ile de France, accounting for 35 percent of funding (covering both operations and investments) in 2008, slightly below the 36.9 percent of funding through transportation fares—of which the user receives a refund from his employer of at least 50 percent of the fare. In contrast, public contributions make up only 12.6 percent of funding, and parking fines only 0.4 percent.

As a percentage of STIF's budget, the tax generated Euro 2.97 billion in 2008, equal to 67 percent of STIF's budget. In contrast, the income from parking fines was only Euro 36 million or 1 percent of STIF's budget—50 percent of parking fines collected go to STIF and the funds are used for investments in quality of service and renovation of rolling stock.

Source: Syndicat des Transports d'Ile-de-France (STIF).

⁵⁵ For a discussion of the US experience, see the Federal Highway Administration (2003), *A Guide to HOT Lane Development*. US Department of Transportation, March 2003. Available at: http://ntl.bts.gov/lib/jpodocs/repts_te/13668_files/images/13668.pdf

91. **Vignette.** A road tax vignette is a form of tax on vehicles, used in several non-English speaking European countries. Vignettes are used in Austria, Bulgaria, Czech Republic, Hungary, Montenegro, Romania, Slovakia, Slovenia and Switzerland, while other types of road toll are being imposed on drivers in several other European countries. The small, colored toll sticker is affixed on a vehicle passing through motorways and expressways, which indicates that the road tax has been paid. Vignettes are valid for a fixed period of time, often one year but usually also available for less, and can be obtained at border crossings, gas stations and labelled points. A vignette system is cheap to operate as it does not need toll plazas or the infrastructure of a modern toll system. After the initial purchase, vignettes represent a sunk cost, so there is no disincentive to travel at a particular time or route, as cost is not based on distance travelled. It is therefore less effective in limiting distance travelled when compared to tolls and in that sense the value in terms of reducing GHG emissions is more limited.

92. **Heavy-goods vehicle (HGV) tolling.** Given the higher environmental and road damage caused by HGV, a number of countries in Europe have introduced HGV tolling. Switzerland introduced a toll-system for trucks over 3.5 tons in January 2001, Austria introduced an electronic toll collection system for trucks over 3.5 tons in January 2004, and Germany introduced a toll system for trucks over 12 tons on January 1, 2005.⁵⁶ In 1999 the EU adopted the Eurovignette Directive on charging HGV for the use of trans-European road infrastructure, authorizing countries to levy road time-based or distance-based charging on HGV above 3.5 tons, provided the charges did not exceed the recovery of costs necessary to maintain and replace road infrastructure. It prohibited the recovery of external costs based on the polluter pay principle. Since the beginning of 2008 the Eurovignette is an electronic system and physical vignettes are no longer printed, although as mentioned earlier individual EU states can have their own national vignette system. A revision to the Eurovignette Directive was adopted by the European Parliament on June 7, 2011, and is awaiting the European Council's formal approval—the changes include: (a) allowing charging for traffic-based air and noise pollution; (b) wider differentiation of toll rates to allow for better traffic management and to reduce congestion; (c) usage of revenue for construction of alternative infrastructure, research and development into clean vehicle technology; and (d) extension to all of the EU's 30,000 km tolled motorway. An example of an EU country adopting an HGV toll is the Czech Republic.⁵⁷

93. **Urban congestion pricing.** Congestion pricing is a system of charging users of a transport network to reduce traffic congestion. The application on urban roads is limited to a small number of cities, including London, Stockholm, Singapore, and Milan. The London Congestion Charge is a fee paid by drivers travelling within the Congestion Charge Zone and as its name suggests was introduced with the aim of reducing congestion, as well as raise investment funds for London's transport system. The zone was introduced in central London in February 2003, and extended into parts of west London in

⁵⁶ The German Toll Collect system is based on a technology using satellites; truck operators may choose to either install on-board units for automated tracking of movements or to book their route in advance using the internet or computerized booking terminals.

⁵⁷ The obligation of motor vehicles and trailer combinations with a total weight equal to or greater than 12 tons to have a toll sticker affixed on the windshield was cancelled as of January 1, 2007, and replaced with a distance-based toll charge based on modern microwave technology. Vehicles that are subject to the toll must be equipped with a small electronic device which communicates with the tolling system.

February 2007, although this was discontinued in 2008. The 2007 report prepared by Transport for London found that traffic entering the charging zone was 21 percent lower than in 2002, creating opportunities over this period for re-use of a proportion of the road space made available. Reduced levels of traffic mean that when compared to conditions without the scheme congestion charging continued to deliver congestion relief that was broadly in line with the 30 percent reduction achieved in the first year of operation. Congestion charging was also estimated to have led directly to reductions of about 16 percent in CO₂ emissions from traffic within the charging zone over 2002-2003, these more directly reflecting the overall traffic reductions and efficiency gains. Over the post-charging period 2003-2006, vehicle fleet improvements are estimated to have reduced emissions from road traffic, both within the central London charging zone and more widely, by 17 percent for NO_x, 24 percent for PM₁₀ and 3 percent for CO₂, assuming a stable traffic mix. In terms of revenues and costs, over 2006-2007, the London Congestion Charge generated GBP 213 million (US\$ 346 million) in total revenues, compared to total operating and administrative costs of GBP 90 million (US\$147 million), with the near totality of revenues used for upgrades to bus infrastructure and operations.

94. **Vehicle registration tax.** In a number of countries this is a tax when registering a vehicle and the tax can be included in the retail price of the new vehicle or it is paid by the owner of a vehicle imported from abroad upon applying for registration. This tax can be linked to GHG emissions in different ways. In the Netherlands, for example, this tax is equal to 45 percent of the selling price of a vehicle and provides a discount or overcharge based on CO₂ emissions.⁵⁸ In the case of Norway, the vehicle registration fee is designed to make large-engine sports vehicles costlier than compact vehicles through the payment of a GHG tax at the time of registration, which is a function of the hydro-fluoro carbon (HFC) content in the air-conditioning system of the vehicle. Critics of high registration taxes argue that a tax on vehicle ownership rather than usage—through fuel taxes for example—creates little incentive to reduce vehicle usage once the high fees, which represent a sunk cost, are paid. However, when combined with high fuel taxes, as is the case in Norway, the overall impact is to reduce both motorization rates and vehicle usage.

95. **Parking policy.** One pricing mechanism to discourage using vehicles is adopting a policy of high parking pricing, particularly if parking is expensive in relation to mass transit public transport. An annual survey on daily parking rates shows that Bucharest's parking fees are quite low compared to other EU-12 cities (Figure 13).⁵⁹ In the EU, changing parking policies are part of larger goals, such as complying with air quality standards or reducing GHG emissions. While London and Stockholm and a few other cities have introduced congestion charging, this has not spread widely, whereas charging for parking is widespread, and thus raising rates would be relatively straightforward. However, parking pricing policies are usually complemented with policies aimed at controlling the growth of parking spaces. Generally, the amount of on-street parking is a function of municipal policy, while off-street parking is controlled

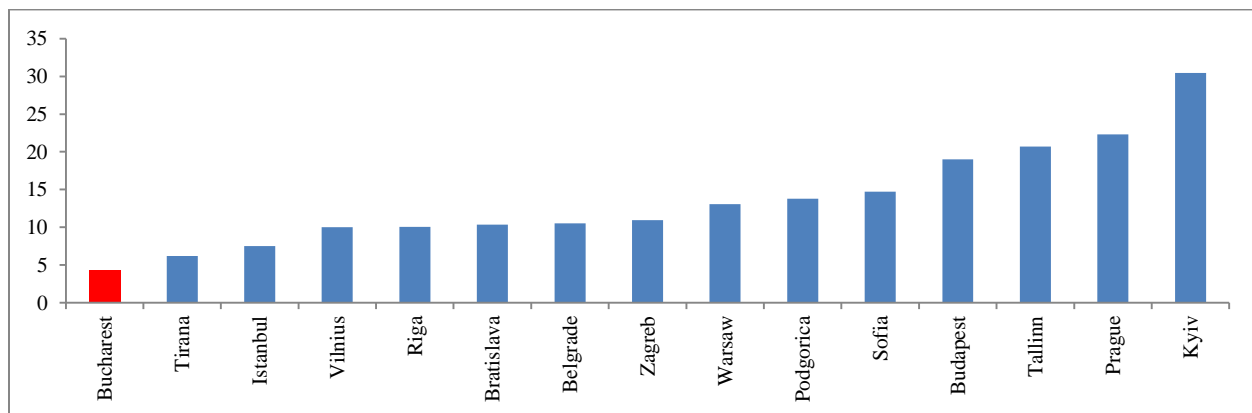
⁵⁸ The CO₂ charge applies only to passenger vehicles which were first put into service on or after February 1, 2008. Higher vehicle registration taxes have to be paid when more than 232 grams of CO₂ per km (for petrol vehicles) or more than 192 grams of CO₂ per km (for diesel vehicles) is emitted. See <http://www.cleanvehicle.eu/info-per-country-and-eu-policy/member-states/netherlands/national-level/>

⁵⁹ A critical aspect in Bucharest is enforcement of parking regulations—cars occupy sidewalks, forcing pedestrians on to streets. Enforcement of parking regulations and recovery of penalties are essential steps, in addition to higher parking pricing.

by zoning and building regulations. Parking management options include, among others (a) high pricing; (b) emissions based parking charges; (c) parking supply caps; (d) regulating the location of parking; and (e) earmarking parking fee revenues for non-vehicle transport development.⁶⁰ A recent study reviewing parking policy in the EU reviews some innovative options that can be used as a mechanism for controlling vehicle usage, which are not pricing policies but can complement parking pricing policies, including⁶¹:

- *Reducing parking spaces.* The city of Copenhagen (Denmark) aims to discourage travel to the city by vehicle and parking fees are high. Traffic to the city center has declined by 6 percent since 2005 despite a 13 percent rise in vehicle ownership. The city has been replacing existing parking spaces with increased cycle tracks at a rate of about 32 spots per year, but spaces have also been declining to make way for pedestrians and bus lanes. Cycling has risen from 30 percent of journeys to 38 percent by 2008, followed by vehicles (31 percent), public transit (28 percent), and walking (4 percent).
- *CO₂ based residential parking permits.* The city of London is divided into 33 boroughs, and each local authority handles parking issues. Emission standards are recorded at the time a vehicle is registered this has allowed several boroughs to charge CO₂ based parking fees. Richmond-Upon-Thames introduced CO₂ based residential parking permits back in 2007. In the City of Westminster, the cost of residential parking permits is a function of engine size and is free for electric, gas, and hybrid vehicles. Vehicle sharing services are also permitted free on-street parking.

Figure 13: Daily Parking Rate (US dollars)⁶²



Source: Colliers International (2011), Global/Central Business District Parking Rate Survey.

⁶⁰ While supply caps and regulating the location of parking are not pricing policies, they have been included here as part of a broader parking policy review.

⁶¹ Michael Kodransky and Gabrielle Hermann (2011), Europe's Parking U-Turn: From Accommodation to Regulation. Institute for Transportation & Development Policy, Spring 2011. Available at http://www.itdp.org/documents/European_Parking_U-Turn.pdf.

⁶² Available at: http://downtownhouston.org/site_media/uploads/attachments/2011-07-19/Colliers_International_Global_Parking_Rate_Survey_2011.pdf

- *Parking supply cap.* Zurich has adopted a restrictive parking policy in response to limited road capacity, as well as air and noise pollution concerns. Total NO₂ emissions are considered when determining the amount of parking space allowed. Parking prices are normally as high in residential as in city center areas, and in 1996 the city adopted a parking supply cap, which means if a space is created off-street in the capped area, an on-street space must be removed to keep the overall supply unchanged.
- *Park and ride facilities.* The building of park and ride facilities at the end of trams lines has been a key strategy to increase public transit usage and reduce the number of vehicles driving through the city center of Strasbourg in France. A number of other policies have been adopted to discourage vehicle usage, including parking policy, bicycle promotion, investments in public transit, and pedestrianization, and these have led to a decline in the modal share of vehicle use from 52 percent in 1997 to 46 percent by 2009. Warsaw has developed park and ride facilities to reduce downtown congestion.

96. **Insurance per km of driving.** Insurance per km of driving or pay as you drive (PAYD) insurance directly incorporates distance travelled as a rate factor. Studies suggest that accident costs increase with annual vehicle kilometers driven and as a result, PAYD increases actuarial accuracy. PAYD pricing rewards motorists when they reduce their mileage, providing financial savings and additional benefits including increased safety, congestion reduction, road and parking facility cost savings, energy conservation, GHG emission reductions, and increased insurance affordability.⁶³ Such insurance is available in the US and Australia. Mileage can be verified with odometer readings at the start and end of the insurance policy term, which is relatively inexpensive to implement. Critics argue that distance based insurance premium penalize suburban and rural motorists, who would pay more and lack public transit. However, one way to address this is to adopt an optional PAYD approach—as opposed to universal PAYD—which would allow drivers to choose this type of policy if they save compared to standard premiums. As several private insurance companies already sell PAYD policies this suggests the existence of consumer demand for such a product. However, if optional PAYD is used a recent study suggests the impact of optional insurance policies fully prorated by annual VKT driven would reduce total travel by 3 percent, compared to universal PAYD, which would reduce travel by 11.5 percent.⁶⁴

97. **Efforts to model the potential effects of pricing policies on GHG emissions in transport require significant amounts of information.** Pricing strategies may affect: (a) the number and type of vehicles owned by a household; (b) where people live and work; (c) the number of trips they take; (d) the time of day trips are taken; (e) whether they choose to drive or use transit or another transport mode; and

⁶³ Todd Litman (2011), *Pay-As-You-Drive Vehicle Insurance in British Columbia*. Victoria Transport Policy Institute. Available at: http://www.pics.uvic.ca/assets/pdf/publications/PAYD_percent20Insurance_May2011.pdf

⁶⁴ Todd Litman (2011), *ibid*.

(f) vehicle operating speed and frequency of accelerations and decelerations.⁶⁵ This means that the impacts of road pricing on GHG emissions depend on each of these factors over time and the resulting impact on VKT and vehicle operating conditions. However, to date in the US “improved and more detailed analytical approaches are being developed at the national level but are not yet widely used. New and emerging comprehensive analytical approaches to quantifying transportation and GHG impacts are both data and resource intensive, thereby limiting their use to larger agencies with access to more advanced analytical tools.”⁶⁶ This means that for most countries in EU-12 data on GHG emissions based on fuel consumption will continue to be the norm in the foreseeable future, providing much less accurate information than what would be required to measure the mitigation impact of specific pricing policies.

98. **A key variable affecting the impact of the various pricing policies is the sensitivity of vehicle travel with regard to costs.** If price insensitive, then pricing reform can be considered ineffective, but if on the contrary price changes have large impacts on travel, then pricing reforms can be considered more effective and rebound effects stemming from increased fuel efficiency are higher. Recent evidence from the US finds short-term elasticities of -0.1 to 0.3 and long-term elasticities of -0.3 to -0.6—a 10 percent price increase reduces vehicle travel by 3 to 6 percent.⁶⁷ As high transport elasticities suggest that pricing strategies are relatively effective and beneficial, and that fuel efficiency improvements provide smaller net energy savings, this would provide an argument for implementing pricing policies to contain congestion, road accidents, air pollution, and GHG emissions. There is a need to estimate short-term and long-term transport elasticity values in Romania, in light of fuel price rises in recent years, and other pricing changes, in order to gauge the potential impact of various pricing policy options.

3.3 Urban Form

99. **Urban form, which refers to the physical layout and design of a city, impacts on daily travel patterns and thus on annual VKT.** Growth management issues, such as urban sprawl, growth patterns, and phasing of development heavily influences urban form. In turn, urban form plays a key role in determining transport mode choice and travel distance—many studies have shown that vehicle dependence and transportation energy consumption per capita are far greater for low-density suburban neighborhoods. The relationship between transport and urban form is mutually reinforcing, in the sense that transportation investment decisions influence spatial patterns of development, which in turn influence patterns of travel, and these in turn influence future transport investment decisions and investments. Clearly, changing what can be a “vicious circle” requires addressing urban development and planning issues, which will set the transport demand needs for decades to come.

⁶⁵ Oregon Department of Transportation (2009), *Potential Effects of Tolling and Pricing Strategies on Greenhouse Gas Emissions*, Final Report prepared by Cambridge Systematics, Inc. with CH2M Hill, February 2009. Available at <http://www.oregon.gov/ODOT/TD/TP/docs/LRPU/twp1.pdf?ga=t>

⁶⁶ Ibid.

⁶⁷ Todd Litman (2011), *Changing Vehicle Travel Price Sensitivities: The Rebounding Rebound Effect*. Victoria Transport Policy Institute. March 2011. Available at: http://www.vtpi.org/VMT_Elasticities.pdf

100. **Once a country has developed an urban form characterized by extensive urban sprawl, it becomes exceedingly difficult to control GHG emission growth.**⁶⁸ This is because low-density development where there is separated land use, as is common in the US, makes a passenger vehicle the only efficient transport option. A recent study looking at 142 US cities found that population density has been declining by 9 percent during the 1970s, by 14 percent during the 1980s, and by 32 percent during the 1990s, suggesting an accelerated decline in population density, which if unchanged, would make it exceedingly hard to reduced GHG emissions generated by passenger vehicle transport.⁶⁹ The population density-VKT relationship can be weakened according to the type of land-use policies in place, such as zoning for mixed use, raising density maximums, and eliminating minimum parking regulations. Avoiding the development of a US high-energy model and instead developing one based on more compact, transit served urban city, could reduce transport energy needs by up to three-quarters. From a transportation perspective, urban sprawl has a number of negative effects, apart from increasing VKT. It also makes it more difficult to develop financially viable mass transit systems.

Box 5. Growth of Poland's Suburbs

Poland has a relatively high urbanization rate (61 percent), and most recent population growth in Poland has happened in and around larger cities. The suburbs of larger metropolitan areas have absorbed much of the population growth and been the site of the majority of new housing developments. While population overall is declining, the suburbs of Warsaw are growing, as are smaller cities' suburbs.

The shift towards suburban sprawl of Polish cities has significant implications for urban transport as well as other urban services. It is accompanied by a shift towards single-family units, likely with greater per capita residential energy requirements. Importantly, expansion into peri-urban areas has been occurring at great distances from the city center, with haphazard new developments along main arteries driven by low land prices. Residents depend on private vehicles for commuting into the city. Meanwhile, public investment has focused on improving and expanding roads rather than public transport. Most metropolitan areas do not have properly integrated public transportation networks: Warsaw's network is fragmented and focused in the center city.

A main result has been that the hard urban cores that defined Polish cities before 1990 have given way to scattered suburban developments that make public transportation networks in those areas impractical as well as raising challenges for provision of water, sewage, electricity, and solid waste management services. All of these aspects will contribute to raising GHG emissions in metropolitan areas. The jurisdictions that make up Polish metropolitan areas need to come together around an integrated regional urban planning approach to guide new developments in a more sustainable fashion.

Source: World Bank (2011), *Transition to a Low-Emissions Economy in Poland*. Poverty Reduction and Economic Management Unit, Europe and Central Asia Region, February 2011. Washington DC: The World Bank.

⁶⁸ From 1969 to 1989 the population of the US increased by 22.5 percent, while the number of miles driven by the population, measured in vehicle-miles traveled increased by 98.4 percent. See Susan Handy, Robert Paterson, Jumin Song, Jayanthi Rajamani, Juchul Jung, Chandra Bhat, Kara Kockelman (2002), *Techniques for Mitigating Urban Sprawl: Goals, Characteristics, and Suitability Factors*. Research Report 4420-I. Conducted for the Texas Department of Transportation in cooperation with the US Department of Transportation, Federal Highway Administration by the Center for Transportation Research, Bureau of Engineering Research, the University of Texas at Austin. Available at: http://www.utexas.edu/research/ctr/pdf_reports/0_4420_1.pdf

⁶⁹ Steve Hanket and Julian D. Marshall (2009), *Impacts of Urban Form on Future US Passenger-Vehicle Greenhouse Gas Emissions*. Energy Policy, doi:101016/j.enpol.2009.07.005.

101. East European countries saw very large changes in residential housing following the post-socialist transition, which have contributed to rising suburbanization.⁷⁰ While population growth has not been significant in many cities, this has been compensated by a large reduction in the size of the average household, reflecting a response cramped living conditions in former communist times. Other significant changes to the housing market have been the privatization of the existing housing stock, development of residential mortgages, high demand for residential property from international buyers, and a marked increase in average dwelling unit size. As a result of these changes, there has been (a) a decrease of residential use in the urban core, as commercial uses outbid other activities from central zones, leading to residential depopulation and gentrification; (b) an increased rate of residential suburbanization; and (c) a relaxation of land development controls. In the case of Estonia, construction of single family housing increased five times between 1990 and 2002, while other types of residential property has not even doubled, with most of the new construction taking place in the suburban periphery. The high growth of vehicle ownership seen over the same period in the region has reflected in large part suburbanization, which has been supported by large public investments. Thus, unlike many other developing regions, suburbanization is taking place in the context of slow or negative population growth. On the positive side, suburbanization patterns have tended to be much denser than in the US. Nevertheless, the trend of rapid suburbanization over the last two decades is a worrying one if projected forward into the next decades.

102. A number of policy measures are available to produce more compact urban forms. These include urban codes and land regulations, including urban growth boundaries, density controls, and spatial planning. However, a number of other policies include ones already discussed: urban development patterns can be affected by transport policies including pricing policies such as taxes, tolls, and parking fees, and by avoiding undue concentration on low-density road transportation infrastructure, at the expense of urban mass transit. More generally, transportation investments and policies can be used in the selection of sprawl mitigation or sprawl avoidance techniques. In the case of the US it is well known that the development of federal transportation investment policies and the construction of interstate highways contributed to the development of urban sprawl, as have subsidies and regulatory incentives for companies to relocate from cities to suburbs, zoning regulations which limit population densities, and separate land use. Restraining the growth of urban sprawl can also benefit from changes to development and property taxes, as well as taxes toward urban regeneration. In the case of EU-12 there is evidence of an accelerated development of the suburbs in the post-socialist period (Box 5).

⁷⁰ This section is based on Kiril Stanilov (2007), "Housing Trends in Central and Eastern European Cities During and After the Period of Transition", in Stanilov (ed), *The Post-Socialist City: Urban form and Space Transformations in Central and Eastern Europe After Socialism*. Dordrecht: Springer. Turkey was obviously not affected by the post-socialist transition, but has also faced the development of suburbanization.

3.4 Rail Transport

103. **Railways are a complex system with a number of actors, including rail infrastructure managers, operators, and regulatory agencies and a patchwork of networks and a variety of rolling stock.** Due to the long lifetime of rail infrastructure and rolling stock, there are limited opportunities to renew the asset base with more energy efficient stock over the short-term, but significant opportunities over the longer turn. However, given the fact that rail transport generates much less GHG emissions than road transport, even in the absence of upgrades to rolling stock and infrastructure, a modal shift from road towards rail will reduce GHG emissions, and generate additional co-benefits, such as reducing highway congestion and reducing air pollutants. To provide an illustration, to transport 100 tons of freight from Basel (Switzerland) to the port of Rotterdam (Netherlands) 4.7 tons of CO₂ emissions are generated by road, 2.4 tons by inland waterways, and 0.6 tons by rail.⁷¹ A recent independent study commissioned for the US Federal Railroad Administration found that on average rail was four times more fuel efficient than trucks, reducing GHG emissions by 75 percent.⁷² Emissions from the rail sector can be reduced through electrification and energy efficiency, but the largest reductions would come from the growth of intermodal transport, with a shift from road to rail, as detailed below.

104. **Electrification.** There is considerable evidence that electric trains are more energy efficiency than diesel-powered trains and have a smaller CO₂ footprint, as they are generally lighter, the electricity can be generated from energy sources which are more efficient than a diesel engine, and because regenerative braking can be used to return power to the system to be used elsewhere, for suitably equipped electric trains. According to a study that attempted to quantify the GHG emissions reduction potential of various technical options for the European rail sector, electrification is the most promising, capable of reducing emissions by 20 to 40 percent.⁷³ Rail electrification rates vary considerably within the EU-12, with a low of 7 percent in Lithuania to a high of 75 percent of the network in Bosnia and Herzegovina, considerably above the EU-27 average (Figure 14). However, more important than the size of the network which is electrified is the percentage of the traffic which is carried on electrified lines. About 80 percent of the European rail fleet runs on electric power, meaning most trains can switch to cleaner electricity when it becomes available.⁷⁴ In addition, modern trains within the EU are equipped with regenerative breaks that recover energy from power generation when braking.

105. **Increased electrification of Romania's rail network would be an expensive proposition.** Upgrading can result in significant costs, especially where tunnels and bridges have to be modified for clearance and due to the alterations required in the signalling system. Lines with low levels of traffic

⁷¹ Krohn, Olaf, Matthew Ledbury and Henning Schwarz (2009), *Railways and the Environment- Building of the Railways' Environmental Strengths*, January 2009. Brussels: Community of European Railway and Infrastructure Companies (CER). Available at:

http://www.cer.be/media/090120_railways_percent20and_percent20the_percent20environment.pdf

⁷² Association of American Railroads (2011), *Freight Railroads Help Reduce Greenhouse Gas Emissions*. April 2011. Available at www.aar.org/AAR/~media/aar/Background-Papers/Freight-RR-Help-Reduce-Emissions.ashx

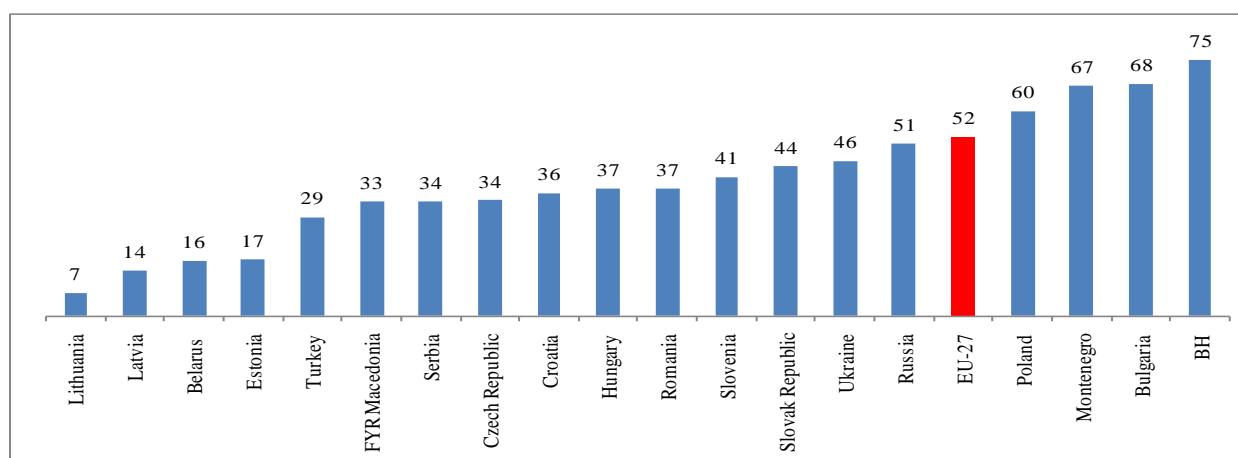
⁷³ Tom Hazeldine, Alison Pridmore, Dagmar Nelissen, and Jan Hulskotte (2009), *Technical Options to Reduce GHG for non-Road Transport Modes*. Paper 3 as part of contract ENV.C.3/SER/2008/0053 between the European Commission Directorate-General Environment and AEA Technology plc. See www.eutransportghg2050.eu

⁷⁴ Krohn, Olaf, Matthew Ledbury and Henning Schwarz (2009), *ibid*.

may not be feasible for electrification as the flip side of lower costs of running trains is higher maintenance costs. In addition, when converting rail lines to electric, connection to other lines have to be considered—through traffic from non-electrified lines, if significant, can be costly as it requires engine switches or dual mode engines to be used and is an issue for long distance trips.

106. Energy efficiency. Even though rail transport is more energy efficient than other transport modes, improving energy efficiency is an important mechanism to reduce contributions to climate change further as well as to save costs. The main opportunities for mitigating GHG emissions associated with rail transport, after electrification, are improving aerodynamics, reduction of train weight, introducing regenerative braking and on-board energy storage, mitigating the GHG emissions from electricity generation, and traffic management.⁷⁵ Of the various technical options available, the one with the highest impact is likely to be regenerative breaking, followed by energy efficient driving techniques.

Figure 14: Electrification Rate of Rail Network, 2010 (percentages)



Source: UIC.

107. Promoting intermodal transport and modal shift from road to rail. Increased usage of combined or intermodal transport, by for example taking a container off the road and putting it on a long-distance freight train and using trucks for short pre-and post-rail transport can cut energy consumption by almost half.⁷⁶ In the EU trucks account for around 75 percent of inland freight journeys, and while the figure is lower in EU-12, this represents a huge potential to integrate railways to modern, efficient, logistical chains, enhancing economic competitiveness while at the same time reducing road congestion and the negative environmental effects of road transport, particularly in relation to CO₂. For a

⁷⁵ Reduction of train weight includes usage of double deck trains, aluminium rail vehicle bodies, wide-body trains, articulated trains, and lightweight coach interior equipment. See Tom Hazeldine, Alison Pridmore, Dagmar Nelissen, and Jan Hulschotte (2009), *ibid*.

⁷⁶ Olaf Krohn, Matthew Ledbury and Henning Schwarz (2009), *Railways and the Environment- Building of the Railways' Environmental Strengths*, January 2009. Brussels: Community of European Railway and Infrastructure Companies (CER). Available at: http://www.cer.be/media/090120_railways_percent20and_percent20the_percent20environment.pdf

number of countries in EU-12, supporting modal shift from road to rail will require making the rail mode more attractive—pricing road externalities is part of the equation. However, it will also require (a) improving the operational performance of the rail undertakings; (b) investing in infrastructure rehabilitation and upgrades; and (c) particularly for countries with small network sizes and potentially large transit volumes, reducing delays in border crossing points. In this sense, policies encouraging modal shift to rail are the same set of policies required to sustain a competitive rail sector.

108. A 2011 rail report from the World Bank in South East Europe and Turkey highlights a number of problems faced by the sector in this sub-region and proposes a series of measures to strengthen it.⁷⁷ The report notes that despite recent transport demand trends towards increasing individuality and flexibility—which have tended to shift both passenger and freight traffic on to roads—there exists a large and growing market segment for rail transport, particularly along international freight corridors. The expansion of EU rail networks into new EU member states has created important opportunities in the long-run for rail freight, given the extra capacity on East-West axes and high growth rates of trade between EU-15 and EU-12 countries, as well as with candidate and potential candidate countries. However, this potential for a significant modal shift, particularly for freight, using international rail corridors connecting EU-15 and EU-12 countries and beyond, has not been realized in recent years.

109. The reasons for this are numerous, and include strong competition from other modes, not only roads, but also short-sea shipping and inland waterway navigation. This would include Pan-European Corridor VII through the Danube, multimodal corridors with RoRo ships between North Adriatic ports and Turkish Ports, and multi-modal corridors with short-sea shipping between North Sea ports and Turkish ports. At the same time, with the accession of Romania to the EU in 2007, the port of Constanta has become the gateway to the Black Sea, with new container train products being transported from central Europe to Constanta, which before would have been transported by rail via Bulgaria and from there to Turkey. There are already examples of road transport logistics providers using road, inland waterways, maritime, and road supply chains in South East Europe and Turkey, with prices that are about 15 to 30 percent lower than rail rates and significantly lower transit times.

110. One of the reasons for the higher rail transit times are processing times at rail border-crossing points in South East Europe. Creating incentives for the private sector to participate in developing intermodal (logistic) terminals to establish conditions for shifting more traffic from road to rail—by creating block trains for longer distances, for example—would require significantly higher commercial speeds along rail corridors and substantial reductions in border stopping times.

3.5 Regulation and Technology

111. **Vehicle emission standards.** Vehicle emissions are composed of the by-products that come out of the exhaust systems or other emissions such as gasoline evaporation. These emissions contribute to air

⁷⁷ Carolina Monsalve (2011), *Railway Reform in South East Europe and Turkey: On the Right Track?* Transport Unit, Sustainable Development, Europe and Central Asia Region, Report No. 60223-ECA, March 2011. Washington D.C.: The World Bank.

pollution and are a major ingredient in the creation of smog in some large cities. European emission standards define the acceptable limits for exhaust emissions of new vehicles sold in EU member states. These emission standards are defined in a series of EU directives staging the progressive introduction of increasingly stringent standards. Currently, emissions of nitrogen oxides, total hydrocarbon, non-methane hydrocarbons, carbon monoxide, and particulate matter are regulated for most vehicle types, including vehicles, lorries, trains, tractors and similar machinery, barges, but excluding seagoing ships and airplanes. On June 2013 an agreement was reached between the European Parliament, Council and European Commission on a further reduction in CO₂ emissions from cars. The agreement will reduce average CO₂ emissions from new cars to 95g per km from 2020, as proposed by the European Commission. This represents a 40 percent reduction from the mandatory 2015 target of 130g/km. The target is an average for each manufacturer's new car fleet; some models will emit less than the average and some will emit more.

112. Non-compliant vehicles cannot be sold in the EU but standards only apply to new vehicles.⁷⁸ CO₂ emissions generated by vehicles in the EU are subject to a voluntary agreement with vehicle manufacturers. For the EU-12, including Romania, where a significant share of the vehicle stock comes second hand from the EU, a policy that aimed to set standards exclusively for new vehicles would be much less effective than in the EU itself. As the European emission standards are made more stringent in the EU, this should eventually have a trickle-down effect in EU-12 countries, with cleaner vehicles being sold in the region.

113. Key factors when introducing or reforming vehicle emission standards is the availability of vehicle fleet data and import-export characteristics, as well as enforcement considerations. As highlighted by a recent report from Global Fuel Economy Initiative on emissions in Central and Eastern Europe, only countries who became EU member states are under the obligation to create national vehicle databases, but for most countries in the region there is a lack of information on fuel economy and amount of vehicles sold.⁷⁹ According to this report, current average fleet-wide fuel economy levels for light-duty vehicles is only available for the Russia Federation, with average fuel efficiency for domestically produced vehicles of around 9 liters/100km, and 10 liters/100km for imported vehicles, and for Serbia with an average fuel efficiency of 7-8 liters/100km. The OECD average figure in 2005 was around 8 liters per 100 km for new vehicles (including both gasoline and diesel vehicles). The lack of adequate data requires finding the financing, whether domestic or international, to fund projects which aim to collect fuel economy related data to create a baseline. A second issue in the region is that vehicle efficiency regulation, where available, is not always enforced.

⁷⁸ The EU's heavy-duty emission standards are applicable to new motor vehicles with a technically permissible maximum laden mass of over 3,500 kg, with engines that operate on diesel, natural gas or LPG. The first set of standards, Euro I, were introduced in 1992, and since then the EU has sought to tighten these standards. In October 2008 the Euro V standards came into force for new vehicle models issued during the year (the standards became applicable for all existing models a year later). In July 2009 the EU approved a set of stricter emission standards – Euro VI – which will come into force in January 2013 for new models (2014 for new registrations of existing models). To promote the early introduction of Euro VI-certified vehicles, EU member states may utilize tax incentives, subject to a number of conditions.

⁷⁹ Global Fuel Economy Initiative (2010), *Cleaner, More Efficient Vehicles: Reducing Emissions in Central and Eastern Europe*. Working Paper 3/10. Available at http://www.globalfueleconomy.org/Documents/Publications/wp3_cleaner_more_efficient_vehicles.pdf

114. **Biofuels.** Biofuel is a fuel derived from organic matter and is gaining increased public and scientific attention, driven by factors such as high oil prices, the need for increased energy security, concern over GHG emissions from fossil fuels, and government subsidies. In a recent report, the International Energy Agency found that by 2050 biofuels could provide 27 percent of total transport fuel and could replace diesel, kerosene and jet fuel.⁸⁰ However, an important factor when considering the GHG emission reduction potential of biofuels is considering the life-cycle assessment to evaluate the potential impact of a product or activity on human health and the environment over the entire cradle-to-grave life cycle of that product or activity.⁸¹ The possibility to use biomethane in order to meet biofuel targets and the usage of renewable biomethane produced from waste resources could be supported by EU policy—it results in lower net GHG emissions than any other type of vehicle fuel and also has the added benefit of providing an efficient method for biological waste treatment. For EU-12 countries which are EU member states, EU policy mandates that the share of energy from renewable sources in transport by 2020 be at least equal to 10 percent. This could provide some traction for biofuels to feature more prominently in EU-12 member states in the following decade. At the moment, biofuels remain very marginal in the region.

115. **Hybrid electric and plug-in electric vehicles.** A hybrid electric vehicle combines a conventional (usually fossil fuel-powered) engine with some form of electric propulsion. Common examples include hybrid electric vehicles such as the Toyota Prius, while a plug-in electric vehicle (PEV) is a vehicle that can be recharged from any external source of electricity, such as wall sockets, and the electricity stored in the rechargeable battery packs drives or contributes to drive the wheels. When considering the GHG impact of PEVs it is important to keep in mind that if electricity production depends heavily on high-carbon energy resources—as is the case in a number of EU-12 countries—then the net effect of PEVs will be modest. To date PEVs have made limited inroads in the US, with only three companies producing more than 10,000 vehicles annually, in contrast to projected new light duty sales in the US of 12 million in 2011—breaking into the mass market has yet to happen in any country.⁸² In contrast, 2 million hybrid automobiles and SUVs have been sold in the US through May 2011, with a new vehicle market share of 2.8 percent in 2009.

116. **Natural gas vehicles.** A natural gas vehicle (NGV) uses compressed natural gas (CNG) or liquefied natural gas (LNG). Worldwide there are 12 million NGV vehicles, with the highest share in the European region in Armenia, where 30 percent of vehicles run on CNG.⁸³ This reflects the fact that a large percentage of the fleet has been retro fitted for bi-fuel operation. CNG filling stations date from the time of the USSR and of the successor states, Armenia, Belarus, Moldova, the Russian Federation, Tajikistan, and Ukraine have kept their national programs running, although Armenia is the only country

⁸⁰ International Energy Agency (2011), *Technology Roadmap – Biofuels for Transport*. Paris: International Energy Agency.

⁸¹ T. E. McKone et al (2011), *Grand Challenges for Life-Cycle Assessment of Biofuels*, *Environ. Sci. Technol.*, 2011, 45 (5), pp 1751–1756

⁸² Report of an Expert Panel (2011), *Plug-in Electric Vehicles: A Practical Plan for Progress, The Report of an Expert Panel*, School of Public and Environmental Affairs, Indiana University, February 2011.

⁸³ Information on natural gas vehicles in the Europe region can be found in the website of the Natural and Bio Gas Vehicle Association: <http://www.ngaeurope.eu/european-ngv-statistics>

where the penetration rate exceeded 30 percent in 2008. The price of CNG in the Commonwealth of Independent State Countries is significantly lower than gasoline or diesel and has been a critical driver in the expansion of CNG penetration in Armenia. As with other alternative fuels, the use of NGV requires the development of fuel storage and infrastructure available at fueling stations. In the US CNG is popular with public transit agencies, including in Washington D.C, while the national fleet exceeds 100,000. Compared to other alternative fuels, NGV has taken a significant share of the vehicle market—exceeding 10 percent of the total—in Argentina, Bangladesh, Bolivia, Colombia, Iran, and Pakistan. In the latter case, the NGV share is 82 percent in 2010.

117. The US Environmental Protection Agency calculates the potential benefits of CNG versus gasoline for light-duty vehicles as reducing: (a) carbon monoxide emissions by 90 to 97 percent; (b) carbon dioxide emissions by 25 percent, (c) nitrogen oxide emissions by 35 to 60 percent; (d) potentially reducing non-methane hydrocarbon emissions by 50 to 75 percent; and (e) emitting little or no particulate matter. In 2007, the California Energy Commission found that CNG reduces GHG emissions by 30 percent in vehicles and 23 percent in buses compared to gasoline and diesel.⁸⁴

118. **For the alternative fuel options, a policy that focuses exclusively on public transport vehicles' fuel type or consumption would be relatively straightforward to monitor and implement.** Replacing buses with any of the alternative technologies discussed above, or with trolleys, is much more feasible than having a sizeable impact on the passenger vehicle market. However, because public transport represents a small share of a region's or country's emissions, the impact would not be as significant as the adoption of these new technologies by the passenger vehicle fleet or a modal shift from vehicles to public transit. Policies that seriously aim to reduce CO₂ emissions from the road sector must aim at controlling the growth of vehicle ownership and usage, while reducing emissions per km travelled.

119. **Lower emission freight vehicles.** Freight vehicles are also a potential target group for use of alternative fuels to reduce GHG emissions. This sits within a range of measures that may (with Government encouragement) be taken by freight operators, including: 85

- Vehicle aerodynamic modifications;
- Use of alternative fuels;
- Adoption of eco-driving practices;
- Improved load consolidation / organisation to minimise vehicle-km; and
- Scrappage/replacement of older vehicles.

120. There are a number of European examples where alternative fuels have been adopted by road freight operators. In some cases, these have been related to Government-backed incentives, schemes or

⁸⁴ See Fuels and Advanced Vehicles Data Center of the US Department of Energy website at http://www.afdc.energy.gov/afdc/vehicles/natural_gas_emissions.html?print

⁸⁵ Final Report on Research into GHG Mitigation Measures in the Small Carrier Freight Sector, prepared for GIZ and Mexican Government. TSTES SA and ITP Ltd, 2013.

trials. In France and the UK, vehicle tax for goods vehicles that meet required emission criteria have lower rates of tax, while in Germany there are a number of cities with Low Emission Zones, which require freight operators to invest in clean vehicle technology if they wish to service those cities. As an example, DHL Express in Germany operates 170 CNG fuelled delivery vehicles, which are used for deliveries in Stuttgart, Berlin, Munich, Bremen and Dusseldorf.⁸⁶

121. This brief survey on regulation and technology suggests that the most promising mechanism to reduce air pollutants and GHG emissions in Romania would be through the imposition of vehicle emission standards and vehicle import restrictions, with biofuels, electric, hybrid vehicles possible technological options only over the long-term. In a medium-term framework, making vehicle emission standards more stringent, by moving them in line with EU standards, could have a significant effect as far as the new vehicle fleet is concerned. For second hand vehicles, most of which come from abroad in a number of EU-12 countries, adopting vehicle import restriction regulations which set emission standards could be a powerful tool to control the growth of GHG emissions. In Romania, only new imported vehicles must satisfy EU requirements, while there are no national requirements on second hand vehicles. Closing this loophole will be critical going forward.

3.6 Air Transport

122. Reducing emissions from air transport poses significant challenges over the medium-term. As recognized by a recent report produced by International Civil Aviation Organization, while medium-term mitigation of CO₂ from the aviation sector could come from improved fuel efficiency, such improvements are expected to only partly offset the growth of aviation CO₂ emissions, with the amount of CO₂ emissions projected to grow by 3 to 4 percent annually at a global level.⁸⁷ A number of policy options are available to reduce the pace of GHG emissions growth, as detailed below.

123. EU Emissions Trading Scheme (EU ETS). For the EU-12, the EU has decided to impose a cap on CO₂ emissions from all domestic and international flights—from or anywhere in the world—that arrive or depart from an EU airport, by including air transport in the ETS starting from 2012. The EU ETS started on January 1, 2005 and covered in the past only energy intensive industrial installations and like any ETS the emission level to be achieved is set and the market determines the price of carbon. Airlines will receive tradable allowances covering a certain level of CO₂ emissions from their flight per year, and after each year operators must surrender a number of allowances equal to their actual emissions in that year. If the airlines anticipate that their emissions will exceed their allowances, they can buy additional emission allowances on the market or adopt measures to reduce emissions—for example, investing in more efficient technologies.

⁸⁶ BESTUFS II – Deliverable 2.4 III Best Practice Update 2008: Experiments and incentives in favour of environment-friendly vehicles and equipment. BESTUFS II Project Consortium, 2008. Available at <http://www.bestufs.net/download/>

⁸⁷ International Civil Aviation Organization (ICAO) 2010, *ICAO Environmental Report: Aviation and Climate and Climate Change*. Available at: http://www.icao.int/icao/en/env2010/Pubs/ENV_Report_2010.pdf

124. **Jet fuel taxation and other environmental charges.** When it comes to fuel taxation the position of the European Commission is that member states should eventually remove the exemption traditionally applied to aviation. At present, although it is possible for a fuel tax to be levied on domestic flights within EU member states, it is difficult to do so for international flights, even between member states due to legally binding commitments made in air service agreements between EU member states and third countries. Such agreements are expected to be renegotiated, but this will take time, making jet fuel taxation an option only in the long-term for the EU-12 countries.⁸⁸ A number of airports apply emissions or noise charges, which would need to be cost-effective and not duplicate emission trading.

Box 6: Reducing Emissions from Air Transport – The Case of the UK

In January 2009 the Government set a target that CO₂ emissions from UK aviation in 2050 should be at or below 2005 levels and this despite the support for a third runway at Heathrow Airport which would raise aircraft traffic movements from 480,000 to 605,000 per annum. The Governments asked the Committee on Climate Change to report on how this target could be met.

The Committee's starts with an assessment of the maximum increase in air transport demand compatible with the target that CO₂ emissions in 2050, from both domestic and international flights, do not exceed 2005 levels. Projections on growth of demand and emissions are made assuming no carbon price constraining demand, and if no limits were placed on airport capacity expansion, and then considers the scope of reducing emissions through (a) carbon prices; (b) modal shift from aviation to rail/high-speed rail; (c) substitution of communication strategies such as videoconferencing; (d) improvements in fleet fuel efficiency; and (e) use of biofuels. The work set out various scenarios and did not focus on non-CO₂ aviation effects on global warming.

Projected demand. Given real income growth of 150 percent to 2050, and without carbon pricing and capacity constraints, it is projected that demand would rise by 200 percent from 230 million passengers in 2005 to 695 million passengers by 2050. With a rising carbon price and capacity constraints the increase in demand would fall to 115 percent. In other words, demand would more than double.

Modal shift and videoconferencing. Rail/high-speed rail could reduce aviation demand by up to 8 percent, while videoconferencing could reduce business demand by 30 percent by 2050.

Fleet fuel efficiency. Fleet fuel efficiency improvements of 0.8 percent annually in the period to 2050 is likely, reducing carbon intensity of travel by about 30 percent by 2050.

Biofuels. Given issues regarding land availability and sustainability issues, the Committee assumed a 10 percent usage of biofuels as the most likely scenario.

Given these assumptions, demand growth of 60 percent compared to 2005 would be compatible with keeping CO₂ emissions in 2050 no higher than in 2005. This suggests that tax and capacity plans should be designed to limit total demand to around 60 percent, until technological developments suggest that any higher level of growth would be compatible with the 2050 target. This means demand must be constrained significantly compared to the business as usual case, pointing out the challenges in keeping the lid on CO₂ emissions from the transport sector. For faster growing economies, the challenge would be all the more daunting.

Source: International Civil Aviation Organization (ICAO) 2010, *ICAO Environmental Report: Aviation and Climate and Climate Change*. Available at: http://www.icao.int/icao/en/env2010/Pubs/ENV_Report_2010.pdf

125. **Modal shift towards high speed rail.** An important motivation for expanding high speed rail is to reduce travel time and to compete with air transport. For routes under 300 km, high speed rail tends to substitute air transport—the Eurostar from Brussels to Paris comes to mind as a successful example of modal shift—and can be important for relieving airport congestion, while for distances exceeding 1,000 km, air transport becomes more attractive. It is important that for each potential high-speed rail project there is a proper feasibility study and traffic demand forecast to see if there is sufficient demand for the services—most likely if it connects to high population urban centers—and to include in the economic assessment the potential benefits in terms of relieving rail congestion, road and air congestion, environmental benefits, location impacts, and to assess the benefits of 140-160km/h versus 200 to 250km/h and 300-350km/h services. The amount of fast and high speed rail should reflect the nature of potential traffic along those lines, composition of traffic, and cost recovery considerations.

126. **Other measures.** Other policies aimed at controlled emissions from air transport include (a) technological improvements (aircraft renewal and replacement and retrofitting aircraft); (b) improved air traffic management, airplane, and airport operations; and (c) usage of alternative fuels such as biofuels. One of the restrictions of renewals is the life cycle of planes, which is between 20 to 30 years, with fleet renewals having a much larger impact than retrofits—this measure is the one that is likely to have the largest impact compared to operational policies and usage of alternative fuels.

3.7 Conclusion

127. This chapter has reviewed different policy options to reduce GHG emissions in the transport sector within the context of an avoid-shift-innovate paradigm and a co-benefits framework. Without key changes to the way land development and transport investments are made, and projecting existing trends over the medium to long-term, GHG emissions from the transport sector are likely to continue rising rapidly in a number of countries, including Romania. Past experience in a number of countries suggest that these policies have rarely been introduced purely on climate change mitigation concerns. Instead, they have responded to smart transport planning and the need to reduce local externalities, such as air pollution, road congestion, or the desire to improve the quality of urban life. Improving the performance of rail companies will be critical to support a modal shift from road to rail—this does not require green policies, but policies aimed at making the railways competitive and profitable. This is a positive message, as trying to adopt “green” transport policies purely on a global externality argument is likely to be very difficult to sell politically and there may be scant interest or social acceptability for such measures, with limited prospects of implementation.

128. For EU member states and candidate member states, EU regulations can potentially act as powerful tools to control GHG emissions. An argument to illustrate this is the application of the EU air

quality directive to Belgium and Romania.⁸⁹ On April 6, 2011 the European Commission decided to take Belgium to court for failing to comply with EU air quality rules—Directive 2008/50/European Commission—concerning limit values for particulate matter known as PM₁₀. The PM₁₀ limit values were to be met by 2005 (or from the date of accession in the case of Romania), although EU member states may ask the Commission to extend the time for meeting the standards until June 2011. Such exemptions are subject to a number of conditions; member states must present an air quality plan setting out the relevant abatement actions during the extension period and demonstrate that they have taken all the necessary steps to achieve compliance by the extended deadline. On the same occasion, the European Commission warned Romania concerning six areas which exceed PM₁₀ limits, with a failure to respond likely to lead to a summons to the EU Court of Justice. While air pollution is not only the result of transport emissions, addressing air quality levels will often require reducing pollution generating by road transport in cities.

129. In terms of transport activities that can be financed through Operational Programmes, it must be borne in mind that in addition to infrastructure investments, there is an urgent need to adopt a comprehensive set of policies and investments aimed at reversing declining modal share of rail, for both freight and passenger, and to ensure there is increased use of public transport. Investing in track infrastructure is not enough to reduce declining traffic and modal share, and the set of policies and investments required to address this must be conducted in such a way as to refocus activities on reversing long-term declines.

⁸⁹ European Commission (2011), *Environment: Commission takes Belgium to Court and Warns Romania over Failure to Comply with EU Air Quality Rules*. Brussels, April 6, 2011. Press release IP/11/435. Available at: <http://europa.eu/rapid/pressReleasesAction.do?reference=IP/11/435&format=HTML>

4 ADAPTATION OPTIONS IN THE TRANSPORT SECTOR

4.1 Introduction

130. Infrastructure projects, characterized by a long life span and high costs, need to withstand current and future impacts of climate change. Adaptation consists of actions responding to current and future climate change impacts and vulnerabilities, and therefore is about protecting infrastructure and services against negative impacts, but also building resilience and taking advantage of any possible benefits from these changes. International activity to date has focused primarily on building adaptive capacity, rather than adapting to specific future projections of climate. Key areas of focus have been the following:

- Research to understand current and future vulnerability
- Development of guidance and tools
- Identification of adaptation measures
- Review of standards
- Adoption of resilience measures actions including weather prediction, monitoring and contingency planning
- Scheduling adaptation including to time with asset renewal

131. As noted in the EU Adaptation Strategy adopted by the European Commission in 2013, as of April 2013, only 15 EU Member States have adopted an adaptation strategy.⁹⁰ Adaptation is in most cases still at an early stage, with relatively few concrete measures on the ground—something that needs to be borne in mind when reviewing potential adaptation measures in Romania's Operational Programmes. This needs to be emphasized, as the adaptation agenda is less advanced than the mitigation agenda. Some Member States have developed sector-specific plans, such as plans to cope with heat waves and droughts, but only a third carried out a comprehensive vulnerability assessment to underpin policy. The Strategy suggests that the move to mainstream climate change adaptation into EU policies should be pursued in priority fields such as energy and transport. Key information gaps include (a) information on damage and adaptation costs and benefits; (b) regional and local-level analyses and risk assessments; (c) frameworks, models and tools to support decision-making and to assess how effective adaptation measures are; and (d) means of monitoring and evaluating past adaptation efforts.⁹¹

⁹⁰ European Commission (2013), Communication From the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions, An EU Strategy on Adaptation to Climate Change. Brussels, 16.4.2013. COM(2013) 216 final. Available at:

<http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2013:0216:FIN:EN:PDF>

⁹¹ A recent report published by the European Environment Agency has as its objective to provide policymakers across Europe, at different levels of governance and stages of policy formulation, with information that can be used to support adaptation planning and implementation. See European Environment Agency (2013), Adaptation in Europe - Addressing Risks and Opportunities from Climate Change in the Context of Socio-Economic Developments. EEA Report 3/2013. Available at:

<http://www.eea.europa.eu/publications/adaptation-in-europe>

132. This chapter presents a brief overview of the kinds of measures that are currently being considered to climate proof infrastructure, and are applicable to non-transport infrastructure. It does not attempt to present a list of potential adaptation measures for each transport sub-sector, but provides a broad categorization of policy options, keeping in mind the need for additional knowledge to bridge identified gaps. Building the information base on vulnerabilities is key to actually adopting concrete measures on the ground.

4.2 Adaptation Options

133. **Vulnerability assessment.** Developing an effective adaptation program relies on a robust understanding of vulnerability to current and future climate. Vulnerability is a function of a system's exposure and sensitivity to the impacts of climate change and its capacity to adapt. A climate change vulnerability assessment should be focused on those issues and assets which have been determined to be sensitive to weather and climate variables through the baseline assessment. It is often useful to provide information about the anticipated magnitude of the costs associated with the risks identified through a climate change vulnerability assessment. Depending on the nature and scale of the assessment and the availability of data, costs can be expressed quantitatively or qualitatively.

134. Understanding vulnerability is key to developing adaptation plans which minimizes risk and maximize opportunities associated with the impacts of climate change. Vulnerability is a function of a system's exposure and sensitivity to the impacts of climate change and its capacity to adapt, where:⁹²

- Sensitivity refers to the degree to which the system is affected by weather or climate variables (or change in variables).
- Exposure refers to the extent to which the system is subject to weather or climate variables (or changes in variables).
- Adaptive capacity refers to the ability of a system to adjust to weather or climate variables (or change in variables), to moderate potential damage or to take advantage of opportunities⁹³.

135. The aim of a vulnerability assessment is to highlight the relative vulnerability of assets or services to the impacts of weather or climate (change). It is important that current and future research and management is guided by a prioritization of relative vulnerability and a climate change vulnerability assessment can be used as a tool for directing adaptation efforts. The steps involved in an assessment of current vulnerability to weather and climate are:

- Define the boundary of the system to be assessed;

⁹² IPCC, 2007: *Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*, M.L. Parry, O.F. Canziani, J.P. Palutikof, P.J. van der Linden and C.E. Hanson, Eds., Cambridge University Press, Cambridge, UK, 976pp.

⁹³ Willows, R. and Connell, R. 2003. *Climate Adaptation; Risk, Uncertainty and Decision Making*. UKCIP, Oxford

- Identify weather and climate variables to be considered in the assessment;
- Review effects of recent weather events;
- Assess vulnerability (sensitivity, exposure and adaptive capacity) to current weather and climate variables; and
- Classify vulnerability and develop a mapping of vulnerability and a mapping of interventions
- Develop short-term and long-term adaptation measures that can be implemented throughout the investment program and project phase.

The steps involved in assessing vulnerability to climate change are similar, but involve reviewing climate change projections rather than recent weather events. In a climate change vulnerability assessment exposure to projected changes in climate variables affect vulnerability as sensitivity and adaptive capacity are fixed.

136. When preparing to undertake any vulnerability assessment, it is important to define the boundaries of the system to be assessed—national, regional, sectoral, sub-sectoral. Vulnerability assessment can be carried out at a range of scales, from individual assets or services to complex systems and sectors of the economy. The chosen level of scale may also relate to the assets or services in question; for example in areas of heterogeneous climate, exposure may be very different even if sensitivity (perhaps relating to uniform construction codes) or adaptive capacity is similar. A good example of a climate risk assessment is one completed by the UK Highways Agency in 2011—the table below provides a summary of the key risks identified through the risk assessment.⁹⁴ In a number of countries in the EU and OECD countries, transport agencies are developing vulnerability assessment as a first step to climate proofing their activities. The activities that are mentioned below are those that are likely to be identified by a vulnerability assessment as adaptation interventions, and include: (a) review of design and safety standards; (b) incorporation of adaptation considerations into infrastructure asset management systems; (d) emergency preparedness planning; and (e) revised planning and project development documentation. These activities prepare the ground for changes to be made as part of long-term measures, such as changes to infrastructure investments.

137. **Review of design and safety standards.** Efforts must be made to review and update, where necessary, infrastructure design standards to ensure that future infrastructure capital is more resilient to anticipated climate change and extreme events. The evidence from a number of countries suggests that this is likely to be cost effective for assets with a long life, such as bridges and ports. An assessment made by Transit New Zealand (now the New Zealand Transport Agency) found that assets with a design life of less than 25 years did not need significant changes in design, construction, or maintenance standards, with modifications to infrastructure being required only once the impacts of climate change are observed.⁹⁵ Instead it has modified its bridge manual to account for climate change as a design

⁹⁴ Highways Agency (2011) Highways Agency Climate Change Risk Assessment, August 2011. Available at: <http://archive.defra.gov.uk/environment/climate/documents/adapt-reports/06road-rail/highways-agency.pdf>

⁹⁵ Michael D. Meyer, Adjo Amekudzi, and John Patrick O’Har (2009), Transportation Asset Management Systems and Climate Change: An Adaptive Systems Management Approach. TRB Annual Meeting. Available at: <http://people.ce.gatech.edu/aa103/Asset%20Management-10-2734.pdf>

factor. There is a clear need for a similar kind of assessment to be conducted in Romania across all transport modes. For roads this would include, but not be limited, to: (a) reassess parameters used for design storm for drainage systems and structures; (b) investigate the need for river training and increased channel maintenance and bridge scour protection; (c) review culvert designs that cause limited damage to roads during flooding; (d) reassess methods for slope stabilization and protection; and (e) pavement specifications. The UK Highway Agency's Climate Change Risk Assessment Report also recommended amending road specifications so they are more resilient to the expected impacts of climate change.⁹⁶ After Hurricane Sandy, the Port Authority of New York and New Jersey is re-evaluating design criteria using latest storm surge, wind, and wave data and predictions. It is considering elevation of port facilities under development.⁹⁷ Review of technical specifications need to also review safety provisions for physical infrastructure and should be strengthened to cope with extreme events and other climate impacts.

Table 2: UK Highway Agency High Level Risks to Corporate Goals

Risk	Examples
Reduced asset condition and safety	Assets deteriorate more quickly due to changes in average climatic conditions; assets are more badly damaged as a result of more extreme climatic events.
Reduced network availability and/or functionality	Need for restrictions on the network to maintain safety; increased need for road works.
Increased costs to maintain a safe, serviceable network	Construction/maintenance/repairs/renewal required more often; more extensive construction /maintenance/repairs/renewal required; new (more expensive) solutions required e.g. designs and materials /components/ construction costs.
Increased safety risk to road workers	Increased risk to construction and maintenance workers and Traffic Officers as a result of climatic change e.g. if need to work on the network more often; if required to work on the network during extreme climatic events or if climate change requires them to perform more 'risky' activities.
Increased programme and quality risks due to required changes in construction activities	More onerous design requirements; new technical solutions required with higher uncertainty, affecting project programmes and/or quality.
Current Highways Agency internal operational procedures not appropriate	Effects of climate change require new ways of working - changed or new business processes, new skills/competences.
Increased business management costs	Need for more staff; more frequent (expensive) incidents to pay for; need for more research into ways of coping with climate change.

Source: UK Highway Agency.

⁹⁶ To date, the Highway Agency has already made some changes to technical standards have in order to increase resilience to climate changes including HD33 drainage standard and the Enrobé à Module Élevé 2 (EME2) revised pavement specification.

⁹⁷ http://oceancouncil.org/site/summit_2013/Presentation%20PDFs/8-SEALEVELRISE%20SECURED%20PDFS/8-SEALEVELRISE_Malione_2.pdf

Box 7: Improved Highway Drainage Design Standards in Denmark

Drainage design standards in Denmark were revised in 2009 in response to increased flood risk. Forecast return periods for critical events were shortened and a climate safety factor was introduced:

- For the design of pipes, culverts, and basins on the most important roads, the minimum return period for critical water levels—for example water levels exceeding road pavement level—is now 25 years.
- In addition, flood situations demanding full utilisation of the cross-sectional area of culverts should not occur more than once a year.

Dimensioning of infrastructure to cope with precipitation in Denmark is based on data series up to 2005. To compensate for increased precipitation in the future, a climate uncertainty factor has been introduced. Recommended values for the climate factor originate from guidelines published by the Danish Society of Engineers, Water Pollution Committee (and are the same as those that have been adopted in Norway). These are 1.3 when run-off calculations are based on a 10-year return period and 1.4 for a 100-year period. Independently of the climate factor, another factor is added, considering uncertainties arising from statistical methods. This model factor should normally be in the range 1.1–1.5 based on the quality of available data.

Source: Conference of European Directors of Roads (CEDR), Adaptation to Climate Change Report, January 2012. Available at: http://www.cedr.fr/home/fileadmin/user_upload/Publications/2013/T16_Climate_change.pdf

138. Incorporation of adaptation considerations in infrastructure asset management systems.⁹⁸

An asset management system can be used as a decision making framework for incorporating adaptation concerns into a transportation agency's management approach. Given that transportation agencies have some form of an asset management system, it is a convenient and targeted approach to incorporate climate-induced change into transportation decision making. How this could work is illustrated with the case of a road asset management system. Asset management relies on monitoring the performance of systems and analyzing the discounted costs of different investment and maintenance strategies. For existing infrastructure, the key issue is making efficient choices about maintenance and replacement. In constructing new infrastructure, asset management involves evaluating total life-cycle costs—both the initial capital costs and the subsequent costs for operation, maintenance, and disposal—to ensure not only that projects are prioritized appropriately, but also that they are built cost effectively. Examples from the road sector could include making a larger initial investment in thicker pavement to provide a greater than proportional increase in pavement life, or shortening the period between pavement overlays, which could reduce the fuel and maintenance costs of road users. There are a number of ways in which climate change monitoring techniques or adaptation strategies could be factored into an asset management system (Table 3). There is also international experience with this approach in both the United Kingdom and New Zealand.

⁹⁸ Michael D. Meyer, Adjo Amekudzi, and John Patrick O'Har (2009), Transportation Asset Management Systems and Climate Change: An Adaptive Systems Management Approach. TRB Annual Meeting. Available at: <http://people.ce.gatech.edu/aa103/Asset%20Management-10-2734.pdf>

Table 3: Climate Resilient Asset Management System

Asset Management System Component	Monitoring Technique(s)/Adaptation Strategy(s)
Goals and policies	Incorporate climate change considerations into asset management goals and policies; these could be general statements concerning adequate attention of potential issues, or targeted statements at specific types of vulnerabilities (e.g., sea level rise)
Asset inventory	Mapping, potentially using GIS, of infrastructure assets in vulnerable areas; Inventory critical assets that are susceptible to climate change impacts
Condition assessment and performance modeling	Monitor asset condition in conjunction with environmental conditions (e.g., temperature, precipitation, winds) to determine if climate change affects performance, Incorporating risk appraisal into performance modeling and assessment; Identification of high risk areas and highly vulnerable assets; Use of “smart” technologies to monitor the health of infrastructure assets
Alternatives evaluation and program optimization	Include alternatives that use probabilistic design procedures to account for the uncertainties of climate change; Possible application of climate change-related evaluation criteria, smart materials, mitigation strategies, and hazard avoidance approaches.
Short and long range plans	Incorporate climate change considerations into activities outlined in short and long range plans; Incorporate climate change into design guidelines; Establish appropriate mitigation strategies and agency responsibilities.
Program implementation	Include appropriate climate change strategies into program implementation; Determine if agency is actually achieving its climate change adaptation/monitoring goals
Performance monitoring	Monitor asset management system to ensure that it is effectively responding to climate change; Possible use of climate change-related performance measures; “Triggering” measures used to identify when an asset or asset category have reached some critical level.

Source: Meyer, Amekudzi, O’Har (2009).

139. **Emergency preparedness planning.** A number of actions can be done to prepare for emergencies—the two reviewed here are early warning weather information systems and contingency planning. Early warning weather information systems can be used in order to improve response to extreme weather events. These systems provide on demand weather forecasts by special infrastructure weather models for weather warning system, flash flood warning system, and fire risk warning system. They lead to better prevention of adverse impacts related to natural disasters and have significant cost reduction potential—for example for snow clearance on railway infrastructure since human and machinery resources can be managed more efficiently. Austria Federal Railways has adopted such a

system in order to enhance natural disaster management due to the increase in damages associated with extreme meteorological events in the past suggested the cost effectiveness of such an approach.⁹⁹ A second policy is to develop contingency management and planning of service delivery when disruptions occur due to weather related events is an important measure for ensuring resilience of infrastructure and transport services. The aim is to ensure that the transport industry are effectively prepared for, able to respond to and recover from, emergencies such as those resulting from extreme weather events.

140. Revised planning and project development documentation. Require climate adaptation to be addressed in the transportation planning and project development processes, by (a) making changes supporting longer planning timeframes; (b) providing guidance on the incorporation of quantitative and qualitative climate considerations and how to address uncertainty; (c) require climate change adaptation screening in Environmental Impact Assessments by reviewing and updating regulations and procedures where climate impacts and adaptation are relevant; and (d) require inclusion of adaptation considerations in project tender documentation. In addition, the planning process should require the maintenance of nationally standardized data sources and modelling techniques for transportation climate adaptation planning and for input to project development.¹⁰⁰

Box 8: Inclusion of Adaptation Considerations in Project Preparation

In its guidelines for incorporating adaptation considerations into project preparation, the EU recommends requiring climate change adaptation in key project preparation tools like Cost-benefit Assessment and Environmental Impact Assessment for all projects. At the project tendering stage, adaptation could be considered in a variety of ways. Two ways in which this has been proposed are the following:

- *Project eligibility criteria* that cover compliance with adaptation strategies, consideration of impacts and how to address them can effectively force project developers to consider adaptation – but may be difficult to put in place as they can be restrictive.
- *Project appraisal criteria* and scoring can effectively prioritize projects that consider climate impacts

The project appraisal process itself is important; evaluators need to understand how climate change impacts the project situation. Involving external experts directly in evaluation bodies and/or educational support for Managing Authorities is needed to address this issue. The production of appraisal guidelines for different project types can also be of use.

Source: European Commission (2013), Commission Staff Working Document, Technical Guidance on Integrating Climate Change Adaptation in Programmes and Investments of Cohesion Policy. Brussels, 16.4.2013, SWD(2013) 135 final. Available at: http://ec.europa.eu/clima/policies/adaptation/what/docs/swd_2013_135_en.pdf

⁹⁹ INFRA.wetter – Weather Warning and Information System for Railway Infrastructure. Presentation by C. Rachoy of Federal Austrian Railways at 11th July, 2008. Available at:

http://www.lakeside-conference.at/fileadmin/downloads/LC2008_Presentations/LC08-Session_VII_3-Rachoy_Christian.pdf

¹⁰⁰ This is one of the recommendations coming out of a recent White Paper on transportation adaptation by a US think tank. Bipartisan Policy Center (2009), Transportation Adaptation to Global Climate Change. Report prepared by Cambridge Systematics. Available at:

[http://bipartisanpolicy.org/sites/default/files/Transportation%20Adaptation%20\(3\).pdf](http://bipartisanpolicy.org/sites/default/files/Transportation%20Adaptation%20(3).pdf)

141. A paper recently produced by the European Commission lays out how adaptation can be integrated in the project development cycle focusing on seven modules¹⁰¹: (a) identify the climate sensitivities of the project; (b) evaluate exposure to climate hazards; (c) assess vulnerability; (d) assess risk; (e) identify adaptation options; (f) appraise adaptation options; and (g) integrate adaptation action plan into the project development cycle. This is an important aspect of adaptation work, as producing a vulnerability assessment at the sectoral level must then be translated into changed practice at the project development cycle level.

4.3 Conclusion

142. This chapter provides an overview of the kinds of policies being used by transportation agencies to deal with current and future climate change impacts. While there has been less progress on adaptation than mitigation, there is nevertheless starting to emerge a corpus of practices which can help guide Romania going forward. The EU has created the European Climate Adaptation Platform (Climate-ADAPT), which aims to support Europe in adapting to climate change. It is an initiative of the European Commission and helps users to access and share information on:¹⁰²

- Expected climate change in Europe
- Current and future vulnerability of regions and sectors
- National and transnational adaptation strategies
- Adaptation case studies and potential adaptation options
- Tools that support adaptation planning

Climate-ADAPT has begun to gather adaptation case studies of European relevance, providing an overview of this diversity of measures to all stakeholders with an interest in adaptation.

¹⁰¹ A useful source of information on how to incorporate adaptation issues for project management can be found in the document, European Commission (2013), Non-Paper Guidelines for Project Managers: Making Vulnerable Investment Climate Resilient, Directorate General Climate-Action. Available at:

http://ec.europa.eu/clima/policies/adaptation/what/docs/non_paper_guidelines_project_managers_en.pdf

¹⁰² <http://climate-adapt.eea.europa.eu/>

5 KEY INFLUENCES ON TRANSPORT INTERVENTIONS

5.1 Introduction

143. There are a number of key influences on the measures that the Government of Romania will want to include in proposals for the 2014-2020 Operational Programmes, which are discussed in this chapter. These include European Commission statements on the focus of future Operational Programmes, as well as the national work on creating over-arching plans for the transport and urban transport sector, and international agreements concerning inland waterways. The European Commission's views on Romania's Operational Programmes was presented in the introductory chapter. As a result, this chapter focuses on the other factors impacting on the formulation of the Operational Programmes for transport and urban transport.

5.2 General Transport Master Plan¹⁰³

144. The Ministry of Transport (MOT) is in the process of preparing a General Transport Master Plan (GTMP) for Romania. This has been a two year process, with completion due at the end of 2013. As well as guiding what goes into 2014-2020 Operational Programme, the GTMP will also inform priority-setting and planning of investments in transport from the state budget, from the IFIs (International Financial Institutions), through PPP (Public-Private Partnership) and through PFIs (Private Funding Initiatives). Following a tender process MOT appointed AECOM as consultants to support the development of the GTMP. The terms of reference for AECOM's work clearly sets out the objective of the project, which is "the development of transport policy instruments necessary to promote development of a national sustainable transport system, striking the right balance between the modes of transport and laying the foundation for preparation of the SOP Transport for the period 2014-2020, as well as for making other decisions concerning the best planning of the investments in the transport infrastructure."

145. The GTMP is intended to provide "an integrated strategy for the national transport system", including short, medium and long-term transport investment programs and policy measures. As a key part of the development process a National Transport Model (NTM) has been developed and validated by AECOM, which is intended to provide an appropriate tool for objective appraisal of options and give a solid basis for the GTMP. The NTM will be maintained and updated on an ongoing basis following completion of the GTMP; it is also recognized that the GTMP itself will need to be a "living document" with periodic updates to reflect changing circumstances and challenges.

¹⁰³ It should be noted that the World Bank has not received a new version of the GTMP. The version shared with the World Bank had a number of significant shortcomings, which are being addressed by AECOM.

146. A typical process for development of a national transport Master Plan would include the following stages:

- Consideration of national policy objectives.
- Definition of desired outcomes (or vision) and resultant objectives for transport interventions.
- Review of existing conditions and potential future conditions, and identification of key problems and challenges.
- Delineation of an overall transport strategy to address the key problems and challenges in a way that aligns with the objectives.
- Identification of potential solutions in terms of individual measures (investment and policy interventions) that fit within the strategy. Individual measures may include those previously identified by ministries and agencies, but may also include other interventions appropriate to the identified key problems.
- Sifting of potential solutions against defined criteria, to reach a short list of candidate interventions.
- Appraisal of shortlisted solutions.
- Development of a prioritized program of interventions, taking account of appraisal results and of funding constraints.

147. The Preliminary Report, dated August 19, 2013, states that the aim of the GTMP is to “provide a clear strategy for the development of Romania’s transport sector for the next 20 years”.¹⁰⁴ It also states that it will “identify the projects and policies which will best meet Romania's National transport needs over the next 5-15 years, for all modes of transport, and providing [sic] a sound, analytical basis for the choice of those policies and projects.” It goes on to present a set of proposed objectives for the Master Plan projects, including achieving transport economic efficiency; minimizing negative environmental impacts; giving priority to sustainable modes of transport which are more energy efficient and have lower emissions; and producing a safer transport system. It also sets out a funding objective which is partly about producing more efficient pricing for transport and partly about deliverability given likely constraints on transport funding from various national, EU, and private sector sources. From a climate change perspective, the sustainability objective relates to mitigation of climate change, although climate change is not specifically mentioned.

148. The Preliminary Report does not start with a coherent analysis of the problems and challenges that need to be addressed by the GTMP. It does, however, include some reference to problems and challenges in later chapters of the report, and refers to an earlier Existing Conditions Report, which has not been made available to the World Bank team. Neither does it present any over-arching strategy for addressing identified problems and challenges.

¹⁰⁴ Romania General Transport Master Plan. Preliminary Report on the Master Plan Short, Medium and Long Term. Prepared by AECOM for the Ministry of Transport, August 2013.

149. The Preliminary Report presents the results of a project sifting process, which aims to select a short list of projects. This starts from a long list of 403 projects, but it is not clear how these were derived and no detail is given on how they specifically address the priority problems and challenges that Romania faces. Out of these, 117 of these are allocated to the '2020 Reference Case' as projects that are already committed and will therefore (presumably) be delivered without further funding commitments. 86 projects are "selected for the 2020 Strategy", although it is not clear what criteria were used for selection. A "preliminary list of projects to be included in the 2020 to 2030 program" is also presented, although again it is not clear how these were selected. Two lists of "other projects" (up to 2020, and between 2020 and 2030) are also presented. These are excluded from the 2020 and 2030 strategy lists on the basis that for some "further study is required....while others should be financed as part of normal operations".

150. The World Bank's understanding of the Preliminary Report is that the 86 projects within the '2020 Strategy' were subject to an appraisal process en bloc rather than as individual projects or coherent packages of projects. This used the National Transport Model to compare the situation with the 86 projects within the '2020 Strategy' with the 2020 Reference Case projects. Notable outputs of this process are highlighted in the following paragraphs.

- The total estimated cost of the package of 86 projects was Euro 16.88 billion (at 2012 prices). Of this total, it was identified that Euro 11.39 billion would come from EU funding sources (CEF, CF and ERDF), with Euro 1.56 billion from the national budget, Euro 153 million from transport operators' own investments and Euro 3.77 billion from private sector (PPP and concessions) funding. This would suggest that the 2020 Strategy project list at this stage is unfettered by likely funding constraints.
- Of the total cost of the 86 projects, 48.8 percent (Euro 8.24 billion) would be attributable to rail projects, 43.0 percent (Euro 7.25 billion) to road projects, and 5.5 percent (Euro 935 million) to inland waterways, intermodal and ports projects combined.
- The transport modelling output on passenger transport forecasts a small increase in car trip mode share (0.6 percent) under the 2020 Strategy compared with the 2020 Reference Case, with the main abstraction being from bus and rail, whose trip mode share falls by 2.1 percent and 2.3 percent respectively. Air travel trip mode share is forecast to reduce by 0.2 percent. Under the 2020 Strategy, car passenger-km would be 15 percent higher than 2011 levels, while bus and rail passenger-km would be 1.3 percent and 1.4 percent higher respectively.
- In the area of freight transport, the transport modelling output forecasts that freight tonne-km travelling by road and rail would be 2.4 percent and 2.6 percent lower respectively under the 2020 Strategy than under the 2020 Reference Case. Waterborne freight tonne-km would be 9.3 percent higher and air freight tonne-km would be 1.5 percent higher.
- The forecast GHG emission impacts resulting from the 2020 Strategy were appraised (we understand from AECOM) using the outputs of the National Transport Model combined with

country-appropriate emission factors derived from the European Commission-sponsored TREMOVE project¹⁰⁵. These were then monetized using values that were developed in the European IMPACTS study¹⁰⁶ and which are widely accepted in Europe. The results of this process over the entire appraisal period are presented in the report as monetized values. These show a disbenefit (due to higher GHG emissions) in passenger transport of Euro 103.7 million (undiscounted), which is largely due to a forecast increase in car and light vehicle travel. A GHG emission benefit of Euro 649.4 million is forecast for freight transport – which is largely due to shift of freight transport from road and rail to inland waterways. The overall net GHG emission reduction benefit is forecast to be Euro 545.7 million (undiscounted) or Euro 87.9 million when discounted to 2010 values.

- In terms of overall costs versus benefits, the Preliminary Report forecasts a benefit/cost ratio (BCR) of 1.06 for the 2020 Strategy, which is quite low. It forecasts that 98 percent of the benefits will arise from travel time savings, with only 0.8 percent of benefits coming from climate change. Further, the report suggests that only 13 percent of the benefits would arise from the large scale rail investments, with the majority (primarily time savings) coming from road sector investments.

151. The World Bank team's view is that there is clearly significant work to do on the Master Plan before finalization. The marginal overall BCR suggests that the current collection of 86 projects does not constitute an economically viable program of transport interventions up to 2020 for Romania, nor is it likely to be affordable given previous levels of funding. Without further detail, it is also unclear how the individual projects mesh into an overall coherent strategy for addressing the problems and challenges facing the country.

152. From a climate change perspective, the forecast shifts in freight movements towards inland waterways is encouraging and accounts for all the predicted GHG emission benefits. However, in passenger transport the apparent ineffectiveness of the proposed large scale railway investment in achieving greater use of the railways rather than road travel is of concern and needs further investigation within the GTMP development process.

153. The European Commission target of having 20 percent of European Structural and Investment Funds allocated to climate change needs to be borne in mind – although we understand that this is likely to be applied at the national level rather than at an individual sectoral level. A current proposal under discussion includes a simplified method of calculating how much investments count towards the target, which applies coefficients to the investment cost. In the transport sector, investments in rail and waterborne transport have been allocated a 40 percent coefficient, while road and air transport have a 0 percent coefficient. Applying these to the EU-funded investment costs contained within AECOM's '2020 Strategy' suggests that the proportion of investment costs attributable to climate change would

¹⁰⁵ <http://ec.europa.eu/environment/air/pollutants/models/tremove.htm>, as at September 5, 2013.

¹⁰⁶ Handbook of Estimation of External Costs in the Transport Sector. European IMPACT study, 2008.

meet the 20 percent target. However, as noted above, the 2020 program may change significantly with further work on the GTMP.

154. The need for further work on the GTMP is recognized within section 2.1 of the Preliminary Report, which states that this includes (inter alia):

- Further analysis of need, and alignment of project definition with this analysis.
- Agreement of an estimated funding availability envelope.
- Appraisal of individual interventions, to inform refinement and selection for the 2020 program and the 2030 program.

155. The World Bank understands that the appraisal of individual interventions using the National Transport Model outputs will be undertaken using a two stage process. In the first stage the impacts of the individual options under consideration that can have a financial value attached to them will be appraised and monetized. These include impacts such as transport economic benefits, road safety benefits, local air pollution emissions and greenhouse gas emission impacts, as reported for the '2020 Strategy' as a whole in the Preliminary Report. As for the initial work reported in the Preliminary Report, these benefits / disbenefits, discounted to present values over the appraisal period, will then be compared with the similarly discounted costs over that period to get a benefit/cost ratio and a net present value.

156. For those options that appear promising from the monetized benefit/cost comparison, a multi-criteria analysis is then proposed. This brings in additional environmental, policy and funding appraisal criteria which cannot be easily monetized, alongside the monetized benefits and costs. Various weightings of the different criteria and sub-criteria will then be applied in order to reach an objective prioritization of options.

5.3 Sustainable Urban Mobility Plans

157. The GTMP will not cover urban transport investment and policy interventions. This is because responsibility for urban transport investment generally sits with the municipalities in Romania (with the exception of the Bucharest metro network), under the aegis of the Ministry for Regional Development and Public Administration (MRDPA). MRDPA is also responsible for regional, local and county roads that link the towns, cities and villages of Romania¹⁰⁷.

158. The need for Master Plans to guide urban transport strategies and investment has been identified by both the Government of Romania and by the European Commission. The terms of reference (TOR)

¹⁰⁷ <http://www.mdrt.ro/en/ministerul/prezentare>, as at August 8, 2013

have been drafted for studies to develop Sustainable Urban Mobility Plans (SUMP) for eight urban centers of Romania – the capital city area of Bucharest and Ilfov county, and seven larger cities that have been identified as regional urban growth poles (Constanta, Craiova, Ploiesti, Iasi, Brasov, Cluj-Napoca, and Timisoara). The designation of the seven cities as growth poles was confirmed by the government decision 1149/2008 in order to implement a national polycentric development policy. Bucharest municipality and the Bucharest-Ilfov region, according to the Europe 2020 strategy, must also (as an EU capital) develop an environmentally friendly transport system and promote sustainable urban mobility.

159. The European Bank for Reconstruction and Development (EBRD) will play a key role in procuring consultants to undertake the studies, in support of MRDPA. JASPERS (Joint Assistance to Support Projects in the Regions) will provide technical support as appropriate. In parallel with the studies, the World Bank will support spatial planning and integrated development planning for the growth poles and also continue to assist the Metropolitan Transportation Authority Bucharest.

160. The objectives of the SUMP, as stated in the draft TOR, include reference to climate change considerations, in that they should (among other objectives):

- Reduce air and noise pollution, greenhouse gas emissions and energy consumption;
- Improve resilience of transport networks to extreme weather and natural events in line with “adaptation to climate change” EU policies.

161. The appraisal process and criteria used in developing the eight SUMP are not defined at this stage, although they would be expected to include consideration of climate change issues in line with the above objectives. A challenge for the client and the consultants appointed to undertake the studies will be to ensure that the appraisal process and criteria used in each of the eight cities are comparable. It is not clear at this stage how this will be achieved. Equally, the appraisal process and criteria should ideally be compatible with those used in the development of the GTMP, in order that there is consistency between urban transport strategy and general transport strategy on the national networks. The outputs of the SUMP studies are likely to be available towards the end of 2014.

5.4 Inland Waterway Transport

162. Inland Waterway Transport interventions in Romania need to accord with a range of international agreements – particularly for the Danube, which flows through 11 countries.¹⁰⁸ These are designed to facilitate cross-border navigation and ensure that actions of one nation state do not adversely affect the river in another. The Belgrade Convention¹⁰⁹ (*Convention regarding the Regime of Navigation on the Danube*) is the international legal instrument governing navigation on the Danube. It provides for free

¹⁰⁸ The Lower Danube River Administration (AFDJ Galati) works within the framework of these conventions (as well as national laws and policies, EU policies and EU Directives) as the waterway authority on the whole of the Romanian sector of the Danube. This is done under the authority of the Ministry of Transport.

¹⁰⁹ <http://www.danubecom-intern.org>

navigation on the Danube in accordance with the interests and sovereign rights of the 11 member states party to the convention (including Romania). The member states undertake to maintain their sections of the Danube in a navigable condition for river-going and, on the appropriate sections, for sea-going vessels and to carry out the works necessary for the maintenance and improvement of navigation conditions and not to obstruct or hinder navigation on the navigable channels of the Danube. The Convention is coordinated by the Danube Commission, which includes representatives of all member states.

163. In addition, the International Commission for the Protection of the Danube River (ICPDR) is based on the *Danube River Protection Convention* (DRPC), which came into force in 1998 among the 11 member states. The main objective of the DRPC is to ensure that surface waters and groundwater within the Danube River Basin are managed and used sustainably and equitably. ICPDR promotes policy agreements and sets joint priorities and strategies for improving the state of the Danube and its tributaries.

164. In order to take the required steps on adaptation to climate change, the ICPDR was asked in a policy paper called “Danube Declaration” from 2010 to develop a Climate Adaptation Strategy for the Danube River Basin by the end of 2012. Possible adaptation measures for water management include: preparatory measures for adaptation (e.g. intensified monitoring activities to assess climate change impacts, forecasting and warning systems, further research to close knowledge gaps), ecosystem-based measures (e.g. implementation of a green infrastructure to connect bio-geographic regions and habitats, protection and restoration of water-retention areas), behavioral/managerial measures (including support for education, capacity-building and knowledge transfer or promotion of water-saving behavior), technological measures (e.g. improvement of infrastructure such as more efficient irrigation systems in agriculture or the construction and modification of dams and reservoirs for different purposes like drinking water supply), and policy approaches (e.g. support of an institutional framework to coordinate activities, for example on flood risk management). With this toolkit at hand, the countries will now decide which of these measures they will endorse for implementation through management plans which are being developed until 2015.

165. In December 2012 the countries of the Danube River Basin agreed on an adaptation strategy to climate change: for the future, changes in temperature and precipitation will affect water used in different sectors in all Danube Basin countries.¹¹⁰ The strategy is based on a thorough assessment of the possible impacts of climate change and suggests possible means to mitigate them. This sets the framework for adaptation measures for the Danube River in Romania.

166. The Ministry of Transport has finalized documentation for a Danube port study that could inform Romania’s investments in the sector, financed by EU funds. The study would cover the strategy for investments in infrastructure and the intermodal connections for the Danube ports over 2016-2030, as well as recommend public policies to support the development of these ports. Project proposals would

¹¹⁰ <http://www.icpdr.org/main/climate-adaptation-strategy-adopted>

take into account and prioritize all available financing - EU funds, national and local budgets, possible PPPs and possible private investments. The terms of reference connect the study with other on-going work of relevance, such as the preparation of the GTMP and the master plan for the Constanta Port which has been tendered.¹¹¹ The ports considered are both the larger ones under TEN-T, as well as secondary ports of lesser importance. The consultancy would have a modeling component to forecast freight traffic, using as variables demand (optimistic, baseline, pessimistic) and policy scenarios (e.g., tariffs). For each port, the consultant would prepare strategic development plans (including spatial optimization). At the time of finalizing this Report, there was uncertainty regarding the launching of the tender by the MOT, due to the potential devolution of ports and port administrations to local administration under a decentralization bill currently under discussion.

5.5 Conclusion

167. The GTMP should provide the basis from which to select non-urban transport projects to be financed from EU funds, in line with the ex-ante conditionality as specified in the Position Paper. However, the World Bank believes that in its current form the GTMP is unlikely to meet the standards and requirements of the European Commission, and therefore does not serve as a good basis for preparing the transport aspects of the Operational Programme and therefore cannot substantially inform this Report. Meanwhile, the SUMP's will be finalized toward the end of 2014, which suggests that the Operational Programme detailing Romania's use of EU funds for urban transport projects will not be able to benefit from the inputs of individual SUMP's. A Danube port study—with a tender which has not yet been launched—may also inform the selection of port projects under the ESIF, while the Constanza Port Master Plan has been launched.

¹¹¹ Constanta Port is administered by the National Company of the Port of Constanta, which is under the authority of the Ministry of Transport. In mid-2013 they had shortlisted 7 companies to do the Master Plan.

6 REVIEW AND PRIORITIZATION OF MEASURES

6.1 Introduction

168. This chapter presents the outcome of the World Bank's rapid assessment of transport-related measures for mitigation of climate change and measures within the transport sector for adaptation to climate change to be funded from the 2014-2020 EU funds. These take account of experience in other countries and of the particular issues and operating environment in Romania. We recognize that most transport interventions will not be primarily driven by concerns about climate change.¹¹² Instead, many will be driven by economic growth, connectivity, safety and security and other considerations. In this Report, the World Bank has focused on actions that have the potential to make a positive contribution to mitigation or adaptation and on how some of these may play a complementary role or be an integral part of interventions that may be important to Romania for other reasons.

169. The Transport Rapid Assessment exercise was necessarily qualitative in nature, given its wide-ranging scope and the large number of possible measures. However, it was based on use of the following broad selection criteria:

- Potential for cost-effective GHG reduction or adaptation to a changed climate – this was based on reported experience and studies from countries around the world.
- Appropriateness to the Romanian environment – prioritized measures needed to be able to fit within the developing cultural, administrative and social framework of Romania.
- Appropriate measures for Operational Programmes – in general, the focus was on investment projects, or on technical assistance (TA) actions that could guide further investment from both EU and national funds.
- The need for in-depth investigation in the Romanian local context – The World Bank has proposed feasibility and research studies through TA actions for some interventions that appear to have potential for GHG reduction and making infrastructure resilient but have not been considered fully in Romania.
- Implementation barriers / risks to benefit delivery – The World Bank considers the implementation barriers and risks to benefit delivery in Romania; where appropriate we have suggested further TA actions or pilot implementations that would address such barriers and risks prior to significant investment.

170. Within the recommended actions the World Bank has highlighted that, while certain infrastructure investment measures are potentially positive from a climate change mitigation perspective, the climate

¹¹² Monsalve, Carolina, Controlling Greenhouse Gas Emissions Generated by the Transport Sector in ECA: Policy Options, World Bank Transport Paper TP-40, February 2013.

change benefits—and indeed economic and other benefits—will only be realized if all aspects of transport service provision are addressed holistically to ensure that the transport mode is able to attract new users. This is particularly relevant to the rail sector, where rail travel is in decline, but also applies to urban public transport services and to Inland Waterway Transport. In all of these areas, maintenance, vehicles or rolling stock, customer service, operational efficiency and service prices need to be considered as part of an attractive package ‘offer’ to customers.

6.2 Mitigation Measures

171. A Technical Assistance project aimed at developing a methodology for measuring emission intensity per passenger-km and ton-km for different transport modes, using different technologies and under alternative operational conditions will be fundamental for developing a detailed baseline of transport related emissions and also for monitoring EU funded projects that claim to have a positive GHG emission impact. Thus, for example, the impact of investments financed through the Operational Programmes for rail and public transport could be monitored through changes in occupancy rates—low emission rail transport or public transport is not only failed investment but can be more emission intensive per passenger-km or ton-km than use of cars and trucks. In the following sub-sections, potential measures for consideration in each sub-sector reviewed are presented.

6.2.1 Rail Transport

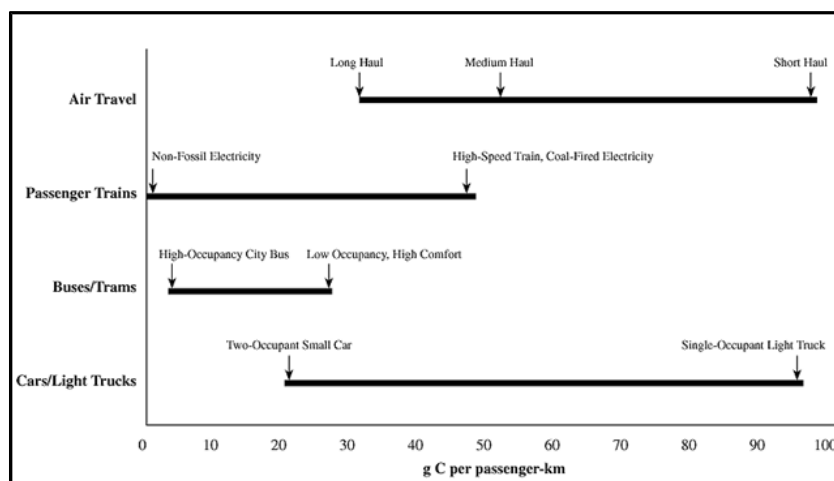
172. As noted in earlier sections of this Report, Romania has an extensive railway network. However, rail travel (both passenger and freight) is in steep decline. Parts of the network carry low levels of passenger and freight traffic, and the available funding for maintenance is not sufficient to adequately maintain the whole network. In general, investment in rail that will attract more passenger and freight travel to rail (rather than road or air) is good from a climate change perspective, since rail travel is generally a lower GHG emitter (per passenger-km or per freight ton-km) than road or air travel alternatives, as illustrated in

173.

174. Figure 15. This GHG advantage over other modes generally only holds true where trains are operated efficiently and with high load factors.

175. However, evidence from around the world shows that in order to attract passengers or freight customers (thereby giving GHG mitigation benefits) all aspects of the railway system need to be efficient and cost-effective. Improving the traditional infrastructure (track, signalling systems, stations, rail freight interchanges) alone is therefore unlikely to reverse the current trend of rapid decline in rail travel. A holistic approach is required in which parallel investment is needed in infrastructure, rolling stock and passenger and customer information systems. Areas such as customer service also need to be addressed, in order to ensure that an attractive and reliable offer can be made to customers. Crucially, development of a satisfactory solution to the over-riding problem of lack of maintenance of the railway infrastructure is required if Romanian railways are to attract more freight and passengers in the future.

Figure 15: Passenger transport typical CO2 intensity (from IPCC)¹¹³



176. From our rapid review of the situation in Romania and the available information, recommendations on rail transport related actions for inclusion within the 2014-2020 OPs from a climate change perspective are shown in Table 4. These sit under **Investment Priority IP 7.4 (Developing and rehabilitating comprehensive, high quality and interoperable railway systems)**, under **Thematic Objective 7 (Promoting sustainable transport and removing bottlenecks in key network infrastructures)**.

Table 4: Actions for Climate Change Mitigation in Rail Transport

Action	Specific objective	Type of action
<p>A comprehensive review of the rail network should be undertaken prior to further investment in any rail infrastructure outside the priority TEN-T network. This would include:</p> <ul style="list-style-type: none"> • Analysis of passenger / customer demand and potential demand • Analysis of customer / passenger needs and priorities • Rationalization of the network, including cutting down its size to a core network that can be maintained adequately with the available national budget and has the potential to attract sufficient passenger and freight traffic back to the railways to make them a cost-effective and low GHG emission mode of transport. • Review of infrastructure, and its adequacy to meet customer needs • Review of rolling stock, and its adequacy to meet customer needs • Review of efficiency of operations and maintenance • Review of customer / passenger service levels and 	Mode switch of freight and passenger travel from road to rail	Technical Assistance

¹¹³ Aviation and the Global Atmosphere. Special Report by the Intergovernmental Panel on Climate Change (IPCC), 1999.

<p>information systems</p> <ul style="list-style-type: none"> • Development of an action plan to cover all the issues above. 		
<p>The recommendations of the energy audit study previously undertaken on CFR Infrastructura¹¹⁴ should be implemented. In particular, these include equipping the railway network with equipment to allow regenerative braking to be used. This generates electricity which is fed back into the grid, thus reducing the electrical energy used to power trains by up to 20 percent. This would have a corresponding effect on GHG emissions from power stations arising from powering electric trains. To be effective, accelerated renewal of locomotives by the Romanian rail operating companies would be required since only 1 percent currently have regenerative capability.</p> <p>The infrastructure measures appear eligible for EU funding through the Large Infrastructure OP or Regional OP. Rolling stock renewal may require loans to operating companies or adoption of a different model of ownership (eg. state ownership of rolling stock, with franchised operation).</p>	Reduced GHG emissions per train-mile	Investment
<p>Individual railway infrastructure projects should be implemented in line with the results of the appraisal and prioritization process undertaken within development of the General Transport Master Plan, as part of an overall strategy of encouraging rail transport in preference to road transport. However, these need to be implemented as part of a holistic package to improve the attractiveness of rail travel (including rolling stock, maintenance, operational efficiency and customer service) on the relevant rail lines. Without such an approach, neither the economic nor the GHG mitigation benefits will be realized.</p>	Mode switch from road to rail transport.	Investment

6.2.2 Road Transport

177. In general, road infrastructure projects that encourage personal transport by private car or freight transport by truck, in preference to using railways, inland waterways or other public transport modes, will tend to generate rather than mitigate GHG emissions. This is largely because of induced traffic that results from many road projects, combined with modal shift of existing trips away from lower emission modes. However, there are some circumstances when improvement of road infrastructure can decrease GHG emissions. These include, for example:

- Road infrastructure that significantly shortens routes – for example, tunnels through mountains or bridges over rivers that eliminate the need for detours around the obstacles; and/or
- Road infrastructure that leads to relief of significant traffic congestion (where emissions per vehicle-km rise dramatically).

¹¹⁴ Review of CFR Infrastructura Electricity Efficiency Final Report. Arup for EBRD, February 2013.

178. In these circumstances, the increase in GHG emissions from induced traffic and undesirable modal shift may be counterbalanced by the savings from reduced vehicle-km or reduced emission rates. It must be recognized, however, that road transport infrastructure projects (in line with most transport projects) are usually targeted on improving connectivity and the economic benefits this brings, or on improving road safety. In appraising and prioritizing options, the balance between economic and safety benefits and GHG emission and other environmental and social disbenefits needs to be weighed. This is the approach that has been taken in developing the General Transport Master Plan, as described earlier. If the case for road transport infrastructure projects (taking account of all the benefits and disbenefits) is compelling, there are still possibilities for minimizing their negative impacts on GHG emissions in the detailed design stages by influencing how they are used.

179. Equally, there are also national policy measures that can be taken to influence road transport GHG emissions. These include use of fiscal measures to encourage reduction in GHG emissions from transport, initiatives to accelerate adoption of alternative fuels and funding and grant programs to improve the GHG emissions from road freight transport. While the implementation of such measures is likely to require national funding rather than EU funding, there are a number of areas where Technical Assistance studies within the OPs could explore the options and provide the basis for any future policy implementation by the Government of Romania.

180. Recommendations on road transport related actions for inclusion within the 2014-2020 OPs from a climate change perspective are shown in Table 5. These sit under the identified **Investment Priorities IP 7.1 (Supporting a multi-modal Single European Transport Area by investing in the Trans-European Transport Network), IP 7.2 (Enhancing regional mobility through connecting secondary and tertiary nodes to TEN-T infrastructure) and IP 7.3 (Developing environment-friendly and low-carbon transport systems and promoting sustainable urban mobility, including river and sea transport, ports and multimodal links), under Thematic Objective 7 (Promoting sustainable transport and removing bottlenecks in key network infrastructures).**

Table 5: Actions for Climate Change Mitigation in Road Transport

Action	Specific objective	Type of action
Study on fiscal measures to influence vehicle purchase and use choices: <ul style="list-style-type: none"> Fuel taxation Road user charge Vehicle registration fee Annual license fee Extension of the current Romanian ROLA vehicle scrappage scheme to include specific GHG emission criteria 	Increased low GHG emission vehicle purchase and use.	Technical Assistance
Study on which alternative fuels will best suit Romania and how best to encourage take-up of those alternative fuels and support roll-out of the associated fuelling / charging infrastructure:	Greater use of alternative (lower GHG) fuels and improved vehicle	Technical Assistance

<ul style="list-style-type: none"> • Natural gas • Electric • Electric hybrid • Biofuels <p>Such a study should look at the feasibility of introducing alternative fuels and assess costs and likely uptake, while also reviewing vehicle efficiency standards for vehicles using conventional fuels (gasoline and diesel), and the scope for introducing minimum standards for used vehicles.</p>	efficiency for vehicles using conventional fuels.	
<p>Study on measures to encourage freight hauliers to accelerate take-up of lower emission vehicle technology and behavior:</p> <ul style="list-style-type: none"> • Commercial vehicle scrappage schemes • Grant schemes for takeup of alternative fuel vehicles • Grant schemes for retrofitting of aerodynamic aids • Government-supported eco-driving schemes • Freight consolidation schemes • Provision of information sources on fuel consumption and GHG emission reduction for hauliers 	Increased take-up of low emission freight vehicles, fuels, driving behavior and operational procedures.	Technical Assistance
<p>National road infrastructure projects given a high national priority (by the results of the appraisal and prioritization process undertaken within development of the General Transport Master Plan) are likely to be implemented through the OPs. The number of road projects allocated a high national priority within the GTMP that can be included within OPs may, however, be constrained by the climate change funding priority criteria applied by the European Commission to EU funding programs.</p> <p>With road infrastructure projects, in the detailed design stage consideration should be given to inclusion of measures that will help minimize their negative GHG emission impacts. This may include, for example, consideration of high-occupancy vehicle (HOV) restrictions on road use where new capacity is created, and set-up of lift-sharing schemes in key areas served by the new facilities. Both of these measures would help limit the use of new road infrastructure by single-occupancy cars, which have high emissions per person-km. Other measures that are the subject of recommended Technical Assistance studies (as noted above) could also be implemented in parallel with road infrastructure projects to help ameliorate their negative GHG impacts.</p>	Reduction in GHG emissions per passenger-km	Investment

181. There are a number of examples where **fiscal measures** are being used to influence vehicle purchase and use decisions in other countries. Fuel taxation is used as a policy lever in a number of EU countries, encouraging purchase of fuel-efficient (and therefore low GHG emission) vehicles and discouraging unnecessary use of vehicles. In the UK, as an extreme example, an annual formula-based above-inflation ‘fuel duty escalator’ was applied to fuel tax to between 1993 and 2000. National road user charging has also been considered in a number of countries, and has been implemented in

different ways for heavy good vehicles in many EU countries (including Romania through the *Rovinieta* system). Structuring vehicle registration or annual vehicle licensing fees is another area that has potential to influence vehicle purchasing decisions. In Romania at present, the World Bank's understanding is that first vehicle registration fees are lower for older vehicles (which will tend to be greater emitters of GHG). By contrast, annual vehicle licensing fee tariffs in the UK are structured so that low GHG emitting vehicles pay less (or even nothing) than high emitters. Annual fees for private cars currently range from Euro 22 Euro for vehicles emitting just over 100g/km of CO₂ to Euro 540 for those emitting over 255g/km.

182. The recommended study on **alternative fuels** should look at the full range of issues associated with the alternatives, with a particular focus on how to facilitate take-up of the most promising options. In the Netherlands, for example, a national network of fast electric vehicle charging points is currently being implemented that will facilitate rapid take up of plug-in electric vehicles and plug-in hybrid vehicles. The aim is to bring a charging station within 50 km of all 16.7 million inhabitants.¹¹⁵

183. Measures to encourage **freight hauliers to accelerate take-up of lower emission vehicle technology and behavior** have been implemented in a number of countries around the world. Prominent examples include grants, subsidies and loans for investment in low carbon vehicle technology in California and Oregon, USA; truck scrappage schemes in Chile and Colombia; the EU EcoMove eco-driver training program; and provision of extensive information on “green freight” options by the UK government.

6.2.3 Inland Waterway Transport

184. Inland Waterway Transport is a low emission transport mode, particularly suited to movement of freight. As noted earlier in this Report, freight movement using IWT forms a significant proportion of all freight movement in Romania. The challenge being faced is to maintain and grow mode share in the light of competition from improved road connections that are likely to be put in place. As well as renewal and enhancement of port and freight interchange infrastructure, this will require improvement of operational and management systems. This needs to be done against a background of historic under-investment and at a time when IWT infrastructure bodies are also trying to cope with current climate change effects, which are increasingly leading to lower water levels and reduced navigability.

185. Recommendations on IWT related actions for inclusion within the 2014-2020 OPs from a climate change perspective are shown in Table 6. These sit under the identified **Investment Priorities IP 7.1 (Supporting a multi-modal Single European Transport Area by investing in the Trans-European Transport Network)**, **IP 7.2 (Enhancing regional mobility through connecting secondary and tertiary nodes to TEN-T infrastructure)** and **IP 7.3 (Developing environment-**

¹¹⁵ <http://www.roadtraffic-technology.com/news/newsabb-build-nationwide-ev-fast-charging-network-netherlands>.

friendly and low-carbon transport systems and promoting sustainable urban mobility, including river and sea transport, ports and multimodal links), under Thematic Objective 7 (Promoting sustainable transport and removing bottlenecks in key network infrastructures).

Table 6: Actions for Climate Change Mitigation in IWT

Action	Specific objective	Type of action
Study on measures to improve GHG emission from inland navigation on Romania's waterways: <ul style="list-style-type: none"> • Waterway information systems • Improved vessel traffic management systems • Measures to encourage improved vessel design and equipment • Measures to encourage use of alternative fuels • Measures to encourage low emission operational procedures 	Reduction in GHG per ton-km	Technical Assistance
Studies of river morphology and assessment of alternative river interventions to maximize river navigability while taking account of ecological considerations and sensitivities.	Mode switch from road to IWT	Technical Assistance
General port infrastructure improvements to improve operational efficiency, in line with GTMP priorities.	Mode switch from road to IWT	Investment
New and improved freight interchange facilities at river ports, including improved road and rail access, in line with GTMP priorities.	Mode switch from road to IWT	Investment
Improving navigability of waterways to link the Danube with Bucharest metro area, subject to the outputs of the GTMP prioritization process.	Mode switch from road to IWT	Investment

186. The recommended study on **how best to reduce GHG emissions** for Romanian waterborne transport can draw on studies that have been undertaken in different local or regional contexts by others. A good starting point would be the PIANC study on climate change and navigation¹¹⁶. The studies of **river morphology and assessment of alternative river interventions** may, we understand, have been partially undertaken for some waterway sections; however, these need to be made comprehensive across Romania's navigable inland waterways to provide an overall action plan.

6.2.4 Urban Transport

187. Urban transport climate change mitigation interventions are particularly important, given that a significant proportion of transport GHG emissions originate from such areas. Investment needs to be guided in each city area by a clearly defined sustainable urban mobility plan (SUMP) that has the

¹¹⁶ Waterborne transport, ports and waterways: A review of climate change drivers, impacts, responses and mitigation. PIANC EnviCom Task Group 3, undated.

backing of the key main local stakeholders. The SUMP, in turn, needs to be coordinated with an overall urban area plan taking account of other sectoral needs and activities. Useful European guidance on the process of developing sustainable urban mobility plans is available as a product of an EU-funded project.¹¹⁷

188. Recommendations on urban transport related actions for inclusion within the 2014-2020 OPs from a climate change perspective are shown in Table 7. These sit under the identified **Investment Priority IP 4.5 (Promoting low-carbon strategies for all types of territories, in particular urban areas, including the promotion of sustainable urban mobility and mitigation relevant adaptation measure)**, under **Thematic Objective 4 (Supporting the shift towards a low-carbon economy in all sectors)**. They also sit under **Investment Priority IP 7.3 (Developing environment-friendly and low-carbon transport systems and promoting sustainable urban mobility, including river and sea transport, ports and multimodal links)**, under **Thematic Objective 7 (Promoting sustainable transport and removing bottlenecks in key network infrastructures)**.

Table 7: Actions for Climate Change Mitigation in Urban Transport

Action	Specific objective	Type of action
Improvement of integrated urban planning. This should include coordinated consideration of land use and transport planning. Further discussion on integrated urban planning is provided in the Urban Sector Rapid Assessment Report	Long-term reduction of the need to travel, and facilitation of use of low emission modes.	Policy
Development of sustainable urban mobility plans (SUMP). Urban Transport Master Plan studies are in the process of being commissioned for eight cities (the seven growth poles plus Bucharest). These need to consider the full range of sustainable transport options, including behavioral change measures as well as infrastructure investment. However, there are 13 other ‘urban development poles’ with populations of over 100,000 which should also have SUMP. All SUMP studies should consider the role of intelligent transport systems inter alia.	Mode switch from car travel to lower emission modes	Technical Assistance
Study on the potential role of ‘harder’ demand management measures to address congestion and emissions in Romanian cities. The study scope should include use of parking restraint, congestion charging, and various forms of access control. The study should focus on the most congested cities – particularly Bucharest.	Mode switch from car travel to lower emission modes	Technical Assistance
Bus Rapid Transit (BRT) feasibility studies in cities where the SUMP indicates that this is likely to provide a cost-effective solution to urban mass transit.	Mode switch from car travel to BRT	Technical Assistance
Investment in urban public transport, in accordance with the	Mode switch from	Investment

¹¹⁷ Guidelines - Developing and Implementing a Sustainable Urban Mobility Plan. Available at www.mobilityplans.eu.

framework provided by the SUMPs. This investment could cover some or all of trams, trolleybuses, buses and suburban trains (depending on local circumstances and priorities. Investment in infrastructure needs to be implemented as part of a holistic package to improve the attractiveness of urban public transport (including vehicles, maintenance, operational efficiency and customer service). Without such an approach, neither the economic nor the GHG mitigation benefits will be fully realized.	car travel to lower emission modes; and reduction in GHG per passenger-km	
Investment in cycling and walking infrastructure, in accordance with the framework provided by the SUMPs. This could include cycle paths, tracks and cycle lanes; as well as secure public cycle parking. Better enforcement of cycle lane regulations (eg to prevent parking on them) as well as promotional campaigns centered on the financial and health benefits of cycling and walking would be required in order to maximize benefits.	Mode switch from car travel to zero emission modes	Investment
Establishment of a pilot project to demonstrate and test the feasibility, costs and benefits of urban freight consolidation centers. This would complement the more general study (see under 'Road') on measures to encourage freight hauliers to accelerate take-up of lower emission vehicle technology and behavior.	Reduction in GHG per ton-km	Investment
Establishment of pilot projects on alternative fuels for buses and other urban fleet vehicles – this would be linked to the Technical Assistance study on alternative fuels.	Greater use of alternative (lower GHG) fuels.	Investment
Extension of the metro system in Bucharest to provide a more complete network, with specific projects in line with the GTMP prioritization process.	Mode switch from car travel to metro.	Investment
Implementation of urban intelligent transport systems, in line with any priorities established in these areas by the SUMPs. These might include, for example, upgraded traffic signal control systems, parking guidance and information systems, and travel information systems.	Reduction in GHG emissions per-km and reduction in vehicle-km travelled.	Investment

189. The recommended **study on the potential role of 'harder' demand management measures** should focus on the most congested urban areas. Similar studies have been undertaken in many other European countries, and there are many examples of measures being implemented on a targeted basis to tackle congestion and emissions, such as congestion charging (eg. London and Milan), access control (eg. Lisbon and Mechelen), and parking restraint (eg. Zurich).

190. The recommended **feasibility studies on bus rapid transit (BRT)** should be undertaken:

- In cities where current mass transit options such as tram systems have degraded and require huge investment to refurbish them; or
- In cities where such systems no longer serve current travel demand patterns (which

are often very different from those that existed before Romania's transition to a market economy);

- In the context of a hierarchy of public transport services to meet different needs; and
- Taking account of the need for a holistic approach to all aspects of BRT delivery.

BRT has proven to be a highly cost-effective means of meeting public transport needs in a range of circumstances in Europe, North America, Australia, Asia and South America¹¹⁸. At least 24 European cities have BRT operations including cities in France, Germany, Switzerland, the Netherlands and the UK.

6.2.5 Air Transport

191. Air transport infrastructure projects given a high national priority (by the results of the appraisal and prioritization process undertaken within development of the General Transport Master Plan) could potentially be implemented through the Operational Programs, although this has not been identified as a priority by the European Commission in its Position Paper on Romania. These would primarily be centered on improvements to Romania's network of regional and local airports, as well as Henri Coanda Airport in Bucharest. As with road projects, however, the budget spent on such projects may be constrained by the climate change funding priority criteria applied by the European Commission to 2014-2020 EU funded programs.

192. A primary driver behind air transport infrastructure investment is improving connectivity and its importance to economic development, particularly in regions of the country that are poorly served at present by rail links. Another is ensuring the safety and security of passengers. In terms of mitigating GHG emissions from air transport, a number of international initiatives to find ways of reducing in-flight emissions are in progress. These include initiatives of ICAO and cooperative research programs under the 7th Framework RTD Program of the European Union. The Aviation Division of MOT is understood to be participating in some of these initiatives, as well as the national carrier, Tarom.

193. As far as international aviation is concerned, since the beginning of 2012 emissions are included in the EU Emissions Trading System (EU ETS). Like industrial installations covered by the EU ETS, airlines receive tradeable allowances covering a certain level of CO₂ emissions from their flights per year. The legislation, adopted in 2008, applies to EU and non-EU airlines alike. However, in November 2012 the European Commission made a proposal to exempt from enforcement flights into and out of Europe operated in 2010, 2011, and 2012 to provide time and space for negotiation with the 2013 ICAO General Assembly of a global agreement that would apply worldwide. The proposal was approved by the European Parliament and the Council on 24 April 2013 and the decision entered into force with immediate effect.

¹¹⁸ Bus Rapid Transit: Where Why and How? Presentation by C Brader at the COST BHLS workshop in Dublin 2008. Available at <http://www.uitp-bhls.eu/The-Bus-Rapid-Transit-BRT-wordly>.

194. Recommendations on domestic air transport related actions for inclusion within the 2014-2020 OPs from a climate change perspective are shown in Table 8. These focus primarily on minimizing the emissions from ground transportation to and from the airports by travelers and employees. These sit under the identified **Investment Priorities IP 7.1 (Supporting a multi-modal Single European Transport Area by investing in the Trans- European Transport Network) and IP 7.2 (Enhancing regional mobility through connecting secondary and tertiary nodes to TEN-T infrastructure)** under **Thematic Objective 7 (Promoting sustainable transport and removing bottlenecks in key network infrastructures)**.

Table 8: Actions for Climate Change Mitigation in Domestic Air Transport

Action	Specific objective	Type of action
<p>Studies to develop sustainable mobility plans for ground transportation connections to Romanian airports, including consideration of:</p> <ul style="list-style-type: none"> • Airport access charges for vehicles • Parking charges • Provision of improved public transport links for air travelers and airport employees • Provision of cycle paths and cycle parking facilities • Airport campus travel plans and behavioral change programs 	Mode switch from single occupancy vehicles to public transport or other low emission modes.	Technical Assistance

6.3 Adaptation Measures

195. Chapter 2 of this Report has set out the forecast likely future climate changes in Romania (including those that are already being seen) and outlined the general vulnerabilities of different transport subsectors to those changes. This section of the report sets out key recommended actions to address these vulnerabilities.

196. In response to the EU Green Paper ‘Adapting to climate change in Europe - options for EU action’, in 2008 the Government of Romania developed a ‘Guide on the adaptation to the climate change effects’¹¹⁹. This provides recommendations on measures which aimed to reduce the risk of the negative effects of climate change in 13 key sectors including infrastructure and transportation. The draft Adaptation Component of the Romanian National Climate Change Strategy (2011-2020)¹²⁰ builds on this to provide an action framework and guidelines to enable each sector to develop an individual action plan in line with national strategic principles. These documents have been taken into account (as well as experience and information from other countries) in developing the recommended

¹¹⁹ Guide on the adaptation to the climate change effects. Government of Romania 2008.

¹²⁰ Draft Adaptation Component of Romania’s National Climate Change Strategy 2011-2020, Government of Romania 2011.

adaptation actions.

197. Adaptation to climate change is a key requirement for the transport sector in Romania in future. It needs to become an integral part of all transport sector activities, and become embedded in the day-to-day thinking of people working in the sector. As well as use of new design norms (for example, increased drainage provision or heat-resilient materials) that take account of climate change, consideration of climate change adaptation needs to be built into tendering procedures across all parts of the transport sector, and into infrastructure asset management systems, emergency preparedness planning, and revised planning and project development cycle. The starting point for the adaptation work in the transport sector is to conduct sectoral or agency level Vulnerability Assessments in order to identify the relative vulnerability of assets and services to the impacts of climate change—through the development of vulnerability maps, among other things—in order to define short-term, medium-term, and long-term actions for implementation. Within this Report the World Bank has recommended adaptation actions for further consideration and investigation prior to their integration within Romania’s 2014-2020 Operational Programmes. Again, some of these involve Technical Assistance while others are Investment actions. A summary of the specific recommended adaptation actions in each transport sub-sector is provided in the following sections—with illustrations on the kind of factors that need to be considered for each mode—while the table below includes measures that apply to all modes, that are required, in order to have the information basis to make investments that factor in climate considerations.

Table 9: System Wide Technical Assistance for Climate Change

Action	Specific objective	Type of Action
All modes		
National study of vulnerability by sector/model which would involve conducting a comprehensive and detailed risk assessment should be undertaken, using the best available climate change forecasts from the National Meteorological Administration. Outputs include a mapping of risks, as well as an action plan of short-term, medium-term, and long-term actions.	Development of vulnerability assessments for each transport mode.	Technical Assistance
Revised planning and project development documentation. Require climate adaptation to be addressed in the transportation planning and project development processes, by (a) making changes supporting longer planning timeframes; (b) providing guidance on the incorporation of quantitative and qualitative climate considerations and how to address uncertainty; (c) require climate change adaptation screening in Environmental Impact Assessments by reviewing and updating regulations and procedures where climate impacts and adaptation are relevant; and (d) require inclusion of adaptation considerations in project tender documentation. In addition, the	Climate proof transport investment project through the project cycle and planning process	Technical Assistance

planning process should require the maintenance of nationally standardized data sources and modelling techniques for transportation climate adaptation planning and for input to project development.		
Review of design standards for transport mode to factor in expected climatic risks which emerge from the Vulnerability Assessment and the mapping of risks.	Review of design standards for each transport mode	Technical Assistance
Development of Emergency Preparedness Planning for each agency/sector, in line with projected climatic impacts	Updating emergency preparedness planning to projected climate changes	Technical Assistance
Inclusion of projected future climate impacts into infrastructure asset management systems. Given that transportation agencies have some form of an asset management system, it is a convenient and targeted approach to incorporate climate-induced change into transportation decision making, including project selection and implementation.	Inclusion of climate consideration in transport agency asset management systems.	Technical Assistance

6.3.1 Rail Transport

198. From the World Bank's rapid review of the situation in Romania and the available information, recommendations on rail transport related adaptation actions for inclusion within the 2014-2020 OPs from a climate change perspective are shown in Table 10. These sit under the identified **Investment Priority IP 7.4 (Developing and rehabilitating comprehensive, high quality and interoperable railway systems)**, under **Thematic Objective 7 (Promoting sustainable transport and removing bottlenecks in key network infrastructures)**. They also sit under **Investment Priority IP 5.1 (Supporting investment for adaptation to climate change)** under **Thematic Objective 5 (Promoting climate change adaptation, risk prevention and management)**.

Table 10: Actions for Climate Change Adaptation in Rail Transport

Action	Specific objective	Type of action
National study of vulnerability of existing rail infrastructure and rolling stock to changed climate conditions. A comprehensive and detailed risk assessment should be undertaken, using the best available climate change forecasts from the National Meteorological Administration and use of rainfall-runoff and hydraulic models. This should include consideration of the effects of prolonged periods of high temperatures and increased potential flood frequency due to increased rainfall intensity. Specific adaptation actions should be considered in cooperation with the infrastructure company and the train operating companies. Neighboring state rail authorities should	Development of an action plan for rail transport adaptation.	Technical Assistance

be consulted with respect to cross-border measures. A network-wide adaptation plan (including actions, timescales and budgets) should be drawn up, including prioritization based on the risk assessment. This should form the basis of future adaptation actions.		
Feasibility study on an improved weather warning system. This would allow the infrastructure owner to better prepare for extreme weather events in advance, reducing disruption and damage. This could include installation of additional weather stations, development of a regional meteorological model, and generation of a GIS database showing railway tracks, flood risks, and meteorological data. A weather warning system has recently been installed in Austria ¹²¹	Improvement of responses to weather events.	Technical Assistance
Implementation of heat and cold resilience infrastructure measures. Within the design and implementation of all new track infrastructure (permanent way) projects and in any refurbishment or upgrading, measures should be included to take account of the likelihood of increased temperatures. This could include, for example, consideration of bridge expansion joint design. Improved maintenance of existing track would also help minimize the impacts of track deformation during high temperature periods. Better management of trackside vegetation would also help minimize risk of disruption from fire damage during prolonged dry periods. For similar reasons, a gradual program of wooden sleeper replacement in high risk areas may also be appropriate.	Increasing resilience to high temperature episodes.	Investment
Improvement of rolling stock resilience to higher and lower service temperatures. Adaptation of rail rolling stock may be required in order to allow passengers to travel in reasonable comfort during high temperature periods, through more efficient ventilation/air conditioning in accordance with the network-wide adaptation plan.	Increasing resilience to high temperature episodes.	Investment
Implementation of flood resilience measures. Based on the vulnerability assessment study and resulting action plan, infrastructure measures should be taken to make the rail network more resilient to potential flooding in vulnerable areas. For new infrastructure, measures should be designed in that provide greater drainage capacity and flood protection. Depending on the network-wide adaptation plan, it may also be necessary to retro-fit flood protection measures on existing infrastructure, such as stabilization measures for embankments and cuttings, and reinforcement of bridge sub-structures. If the adaptation action plan identifies a need, this action could also include construction or improvement of flood defence banks and dykes in the vicinity of rail transport infrastructure.	Increasing resilience to flooding and consequent infrastructure damage and disruption.	Investment

¹²¹ INFRA.wetter – Weather Warning and Information System for Railway Infrastructure. Presentation by C. Rachoy of Federal Austrian Railways at 11th July, 2008.

6.3.2 Road Transport

199. Recommendations on road transport related adaptation actions for inclusion within the 2014-2020 OPs from a climate change perspective are shown in Table 11. These sit under the identified **Investment Priorities IP 7.1 (Supporting a multi-modal Single European Transport Area by investing in the Trans- European Transport Network), IP 7.2 (Enhancing regional mobility through connecting secondary and tertiary nodes to TEN-T infrastructure) and IP 7.3 (Developing environment-friendly and low-carbon transport systems and promoting sustainable urban mobility, including river and sea transport, ports and multimodal links), under Thematic Objective 7 (Promoting sustainable transport and removing bottlenecks in key network infrastructures).** They also sit under **Investment Priority IP 5.1 (Supporting investment for adaptation to climate change) under Thematic Objective 5 (Promoting climate change adaptation, risk prevention and management).**

Table 11: Actions for Climate Change Adaptation in Road Transport

Action	Specific objective	Type of action
National study of vulnerability of existing road infrastructure to changed climate conditions. A comprehensive and detailed risk assessment should be undertaken, using the best available climate change forecasts from the National Meteorological Administration and use of rainfall-runoff and hydraulic models. This should include consideration of the effects of prolonged periods of high temperatures and increased potential flood frequency due to increased rainfall intensity. Neighboring state road authorities should be consulted with respect to cross-border measures. A network-wide adaptation plan (including actions, timescales and budgets) should be drawn up, including prioritization based on the risk assessment. This should form the basis of future adaptation actions.	Development of an action plan for road transport adaptation.	Technical Assistance
Review of design standards to factor in expected climatic risks. As a result of higher precipitation intensity (a) reassess parameters used for design storm for drainage systems and structures; (b) investigate the need for river training and increased channel maintenance and bridge scour protection; (c) review culvert designs to ensure they cause limited damage to roads during flooding; (d) reassess methods for slope stabilization and protection; and (e) prepare new pavement specifications.	Development of revised road design and safety standards.	Technical Assistance.
Review of road asset management system to incorporate adaptation considerations during the planning of investments and operations and maintenance of roads.	Incorporate adaptation in road asset management systems	Technical Assistance
Implementation of resilience infrastructure measures (design and/or material specifications to address for instance lower cold service	Increasing resilience to high	Investment

temperatures and higher warmer service temperatures). Within the design and implementation of all new road infrastructure and in any refurbishment or upgrading, measures should be included to take account of the likelihood of increased temperatures. This could include, for example, use of revised pavement material specifications (such as the revised Romanian asphalt design norms) and consideration of bridge expansion joint design.	and low temperature episodes.	
Implementation of flood resilience measures. Based on the vulnerability assessment study and resulting action plan, infrastructure measures should be taken to make the road network more resilient to potential flooding in vulnerable areas. For new infrastructure, measures should be designed in that provide greater drainage capacity and flood protection. Depending on the network-wide adaptation plan, it may also be necessary to retro-fit flood protection measures on existing infrastructure, such as stabilization measures for embankments and cuttings, and reinforcement of bridge sub-structures. If the adaptation action plan identifies a need, this action could also include construction or improvement of flood defence banks and dykes in the vicinity of road transport infrastructure.	Increasing resilience to flooding and consequent infrastructure damage and disruption.	Investment

6.3.3 Inland Waterway Transport and Ports

200. The major adaptation consideration for inland waterways and ports is the likelihood of increased frequency of low water levels (particularly in the summer) due to reduced precipitation and increased evaporation due to higher temperatures. This is an effect that is already being seen on the Lower Danube, leading to navigation restrictions having to be implemented on an increasing number of days per year, according to the Lower Danube River Administration.

201. Any adaptation actions should be considered within the context of the international agreements highlighted in Chapter 5. They should also be developed in line with the Joint Statement on Development of Inland Navigation and Environmental Protection in the Danube River Basin¹²². This would involve an integrated planning approach involving key stakeholders and experts considering the ecological aspects of interventions alongside the navigational benefits.

202. Recommendations on IWT and ports related actions for inclusion within the 2014-2020 OPs from a climate change perspective are shown in Table 12. These sit under the identified **Investment Priorities IP 7.1 (Supporting a multi-modal Single European Transport Area by investing in the Trans- European Transport Network), IP 7.2 (Enhancing regional mobility through connecting**

¹²² Development of Inland Navigation and Environmental Protection in the Danube River Basin. Joint Statement on Guiding Principles of the International Commission for the Protection of the Danube River, the Danube Navigation Commission, and the International Sava River Basin Commission, 2008.

secondary and tertiary nodes to TEN-T infrastructure) and **IP 7.3 (Developing environment-friendly and low-carbon transport systems and promoting sustainable urban mobility, including river and sea transport, ports and multimodal links)**, under **Thematic Objective 7 (Promoting sustainable transport and removing bottlenecks in key network infrastructures)**. They also sit under **Investment Priority IP 5.1 (Supporting investment for adaptation to climate change)** under **Thematic Objective 5 (Promoting climate change adaptation, risk prevention and management)**.

Table 12: Actions for Climate Change Adaptation in IWT and Ports

Action	Specific objective	Type of action
National study of vulnerability of Inland Waterway Transport to changed climate conditions. A comprehensive and detailed risk assessment should be undertaken, using the best available climate change forecasts from the National Meteorological Administration and use of rainfall-runoff and hydraulic models. This should include consideration of the effects of prolonged periods of high temperatures and drought, as well as increased frequency of potential flood surges due to increased rainfall intensity. Neighboring river authorities should be consulted with respect to cross-border measures. A national IWT adaptation plan (including actions, timescales and budgets) should be drawn up, including prioritization based on the risk assessment and should include a mapping of risks. This should form the basis of future adaptation actions.	Development of an action plan for Inland Waterway Transport adaptation.	Technical Assistance
Review design of ports in low lying coastal areas to reflect new water levels arising from expected sea level changes and the dredging requirements of rivers in light of expected hydrological and morphological changes.	Making ports and IWT climate resilient	Technical Assistance
Implementation of improved river information systems. These could be based on better seasonal discharge predictions at waterway level; and improvements of methods in forecasting water levels.	To maximize river navigability through river traffic management under changed climatic conditions.	Investment
Develop port and IWT projects that have adapted designs to reflect new water levels due to sea level changes.	Making ports and IWT climate resilient	Investment
Implementation of carefully selected river-based measures, in line with the national IWT adaptation plan. Ecosystem-based measures might include measures such as increasing water retention properties of the landscape, e.g. by restoring bogs/swamps and wetlands. ¹²³ River engineering measures such as channel stabilization should be implemented only after detailed consideration of their ecological and	Maximization of river navigability under changed climatic conditions.	Investment

¹²³ Danube River Basin Climate Change Adaptation. Final Report to German Federal Ministry for the Environment, Nature Conservation and Nuclear Safety and ICPDR. Ludwig-Maximilians-Universität Munich, 2012.

biodiversity impacts in line with the Joint Statement on Guiding Principles of the ICPDR, the Danube Navigation Commission, and the International Sava River Basin Commission.		
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6.3.4 Urban Transport

203. Urban transport adaptation actions need to be considered in the context of the wider urban environment. It is recommended that adaptation planning work within cities and municipalities is undertaken on a cross-sectoral basis. Recommendations on urban transport related actions for inclusion within the 2014-2020 OPs from a climate change perspective are shown in Table 13. These sit under the identified **Investment Priority IP 4.5 (Promoting low-carbon strategies for all types of territories, in particular urban areas, including the promotion of sustainable urban mobility and mitigation relevant adaptation measure)**, under **Thematic Objective 4 (Supporting the shift towards a low-carbon economy in all sectors)**. They also sit under **Investment Priority IP 7.3 (Developing environment-friendly and low-carbon transport systems and promoting sustainable urban mobility, including river and sea transport, ports and multimodal links)**, under **Thematic Objective 7 (Promoting sustainable transport and removing bottlenecks in key network infrastructures)**. Finally, they also sit under **Investment Priority IP 5.1 (Supporting investment for adaptation to climate change)** under **Thematic Objective 5 (Promoting climate change adaptation, risk prevention and management)**.

Table 13: Actions for Climate Change Adaptation in Urban Transport

Action	Specific objective	Type of action
Studies of vulnerability of urban transport infrastructure and systems to changed climate conditions, for all Romanian cities. A comprehensive and detailed risk assessment should be undertaken, using the best available climate change forecasts from the National Meteorological Administration and use of rainfall-runoff and hydraulic models. This should include consideration of the effects of prolonged periods of high temperatures and increased potential flood frequency due to increased rainfall intensity. Stakeholders working in other urban sectors should be consulted with respect to cross-sectoral measures. City-wide adaptation plans (including actions, timescales and budgets) should be drawn up, including prioritization based on the risk assessment and a mapping of risks. This should form the basis of future adaptation actions.	Development of city action plans for urban transport adaptation.	Technical Assistance
Implementation of heat resilience infrastructure measures on local rail and tram tracks. Within the design and implementation of all new track infrastructure and in any refurbishment or upgrading, measures should be included to take account of the likelihood of	Increasing resilience to high and low temperature episodes.	Investment

increased temperatures. This could include, for example, consideration of bridge expansion joint design. Improved maintenance of existing track would also help minimize the impacts of track deformation during high temperature periods.		
Implementation of improved ventilation and/or air conditioning at metro or rail stations. In some places, improved ventilation or air conditioning may need to be implemented to allow passengers to travel in reasonable comfort during high temperature periods. This is likely to be most applicable to some metro stations and any subterranean suburban rail stations.	Increasing resilience to high temperature episodes.	Investment
Introduction of improved ventilation and/or air conditioning in public transport vehicles. Introduction of air conditioned buses, trolleybuses, trams and metro/rail rolling stock may be required in order to allow passengers to travel in reasonable comfort during high temperature periods. Air conditioned vehicles should be gradually introduced (particularly for use in the south and south east) in accordance with the city-wide adaptation plan.	Increasing resilience to high temperature episodes.	Investment
Implementation of flood resilience measures. Based on the vulnerability assessment study and resulting action plan, infrastructure measures should be taken to make the urban transport network more resilient to potential flooding in vulnerable areas. For new infrastructure, measures should be designed in that provide greater drainage capacity and flood protection. Depending on the network-wide adaptation plan, it may also be necessary to retro-fit flood protection measures on existing infrastructure, particularly where there are significant waterways running through the city. Measures might include stabilization measures for embankments and cuttings, and reinforcement of bridge sub-structures, as well as improvement of flood defence banks and dykes in the vicinity of urban transport infrastructure.	Increasing resilience to flooding and consequent infrastructure damage and disruption.	Investment

6.3.5 Domestic Air Transport

204. Recommendations on domestic air transport related adaptation actions are shown in Table 14. These sit under the identified **Investment Priorities IP 7.1 (Supporting a multi-modal Single European Transport Area by investing in the Trans- European Transport Network)** and **IP 7.2 (Enhancing regional mobility through connecting secondary and tertiary nodes to TEN-T infrastructure)** under **Thematic Objective 7 (Promoting sustainable transport and removing bottlenecks in key network infrastructures)**. They also sit under **Investment Priority IP 5.1 (Supporting investment for adaptation to climate change)** under **Thematic Objective 5 (Promoting climate change adaptation, risk prevention and management)**.

Table 14: Actions for Climate Change Adaptation in Domestic Air Transport

Action	Specific objective	Type of action
Studies of vulnerability of airport infrastructure and systems to changed climate conditions, for all Romanian airports. A comprehensive and detailed risk assessment should be undertaken, using the best available climate change forecasts from the National Meteorological Administration and use of rainfall-runoff and hydraulic models. This should include consideration of the effects of prolonged periods of high temperatures and increased potential flood frequency due to increased rainfall intensity. Airport-specific adaptation plans (including actions, timescales and budgets) should be drawn up, including prioritization based on the risk assessment. This should form the basis of future adaptation actions.	Development of airport-specific action plans for climate change adaptation.	Technical Assistance
Implementation of heat and cold resilience infrastructure measures. Within the design and implementation of all new airport infrastructure and in any refurbishment or upgrading, measures should be included to take account of the likelihood of changes in temperatures and more frequent extreme weather events. This could include, for example, use of revised pavement material specifications for runways, taxiways and aprons.	Increasing resilience to high and low temperature episodes.	Investment
Implementation of flood resilience measures. Based on the vulnerability assessment study and resulting action plan, infrastructure measures should be taken to make airport runways, taxiways and aprons more resilient to potential flooding in vulnerable areas. For new infrastructure, measures should be designed in that provide greater drainage capacity and flood protection.	Increasing resilience to flooding and consequent infrastructure damage and disruption.	Investment

6.4 Monitoring and Evaluation

205. In line with good practice, investment actions that are funded under the Operational Programs should be monitored and evaluated. This should include monitoring of outputs (the extent to which measures have been implemented) and outcomes (the impacts that result from the implemented measures). The World Bank recommends that a monitoring and evaluation plan is developed once the Operational Program contents are defined. This plan should then be refined, updated and (most importantly) followed, as implementation of the OP actions progresses. Appendix B contains a preliminary list of potential output and outcome indicators that may be appropriate to the different sorts of actions recommended above.

6.5 Conclusion

206. This chapter has presented potential mitigation and adaptation measures in the transport sector that could be considered by the Romanian authorities for inclusion in the Operational Programmes. It should be noted that this is a long-list, and has been unconstrained by total EU fund allocations for the

sector, presenting the authorities with different options that could be included in the Operational Programmes.

207. Given all the measures which are proposed, an important question is the sequencing or prioritization of such measures in terms of implementing the proposed Action Plan. The measures proposed are aimed at being implemented in the 2014-2020 period, in line with the time line of the Operational Programmes. With regard to adaptation the key immediate priority is to develop mode by mode national vulnerability studies which would form the basis of an adaptation plan, which would include a mapping of risks. This information base which identify key risks and vulnerability of transport infrastructure and transport services must be carried out before implementing other proposed measures, such as modifying planning and project preparation documentation, reviewing design standards, or implementing resilient infrastructure and rolling stock measures.

208. With regard to mitigation, the most pressing action is to develop a methodology for measuring emission intensity per passenger-km and ton-km for different transport modes, different technologies and under different operational conditions, in order to be able to monitor GHG emissions by mode, assessing the impact of measures that will be undertaken to reduce the growth of GHG emissions. Such an information base is at present absent. A second urgent priority is implementing policies to ensure improvement in the performance of the rail infrastructure manager and public rail operators—including allocating funding to maintain infrastructure investments—so that investments in rail infrastructure financed under the Operational Programme translate into higher ridership and higher ton-km of freight transported in the rail network, contributing to a modal shift.¹²⁴ A third priority is to launch a series of studies aimed at (a) reviewing fiscal measures to influence private car purchase and use; (b) assessing options in using alternative fuels; and (c) measures to encourage freight hauliers to accelerate take-up of lower emission vehicle technology; and (d) the potential role of ‘harder’ demand management measures to address congestion and emissions in Romanian cities. Reducing the growth rate of emissions from the road sector is critical for decelerating transport sector emission growth. This will require changes in pricing and other policies—but the critical step is launching the studies which will guide policy choices to be implemented over the 2014-2020 period and beyond.

209. In order to meet the target of spending 20 percent of ESIF funds on climate change—or whatever percentage as decided by the Romanian government—it will be essential to make large investments in railways, IWT, ports, multimodal transport, and urban transport. At the moment the coefficients for the calculation of activities supporting climate change activities for the sub-sectors listed above are 40 percent. This means that the modal composition of the investment program will need to allocate significant resources to non-road infrastructure projects. Road investments could be counted as supporting climate change activities if they are made climate resilient—this is why undertaking a vulnerability study for the road sector early in the 2014-2020 period will be important,

¹²⁴ The World Bank’s Advisory Services with the Ministry of Transport covers the issue of turning around the rail sector at great depth, focusing on among other issues on changes to corporate governance, turning around the financial performance of the infrastructure manager, and improving the contractual relations between the infrastructure manager and the state.

not only for helping to meet the spending target on climate actions, but to make the infrastructure resilient to projected climate change impacts.

7 CONCLUDING REMARKS

210. This Report has presented the results of the Transport Rapid Assessment focusing on climate risks, potential and opportunities for mitigation and adaptation, implementation barriers, and preliminary prioritization of climate actions, within the framework of preparation of the 2014-2020 Operational Programme. Based on these activities, the World Bank's overall conclusion is that there is significant potential for climate change mitigation through the reduction in the growth of transport sector GHG emissions in Romania. Within this Report the World Bank has recommended mitigation actions for further consideration and investigation prior to their integration within Romania's 2014-2020 Operational Programmes. Some of these involve Technical Assistance while others are Investment Actions. The World Bank believes that the recommended actions complement and reinforce transport measures that may be proposed for the Operational Programmes for other reasons—economic development, efficiency, connectivity, safety and security—with any GHG reductions a co-benefit.

211. Within the recommended actions the World Bank has highlighted that while certain infrastructure investment measures are potentially positive from a climate change mitigation perspective, the climate change benefits (and indeed economic and other benefits) will only be realized if all aspects of transport service provision are addressed holistically to ensure that the transport mode is able to attract new users. This would require not only infrastructure investments, but also interventions aimed at improving (a) the operation of transport services; and (b) efficiency in the management and organization of systems. This is particularly relevant to the rail sector, where rail travel is in steep decline, but also applies to urban public transport services and to Inland Waterway Transport. In all of these areas, maintenance, vehicles or rolling stock, customer service, operational efficiency and service prices need to be considered as part of an attractive package 'offer' to customers.

212. Adaptation to climate change is a key requirement for the transport sector in Romania in the future. It needs to become an integral part of all transport sector activities, and become embedded in the day-to-day thinking of those working in the sector. As well as use of new design norms (for example, increased drainage provision or heat-resilient materials) that take account of climate change, consideration of climate change adaptation needs to be built into tendering procedures across all parts of the transport sector. Within this Report the World Bank has recommended adaptation actions for further consideration and investigation prior to their integration within Romania's 2014-2020 Operational Programmes. Again, some of these involve Technical Assistance while others are Investment Actions.

213. Going forward, the key next step is finalization of the General Transport Master Plan (GTMP), as this is an ex-ante conditionality of the European Commission for the transport interventions to be financed from the Operational Programmes. It is also critical in terms of coming up with a list of prioritized projects and policies that could be financed from the Technical Assistance and Investment Action window available through the Operational Programmes. It is understood by the World Bank that there is considerable work required in order to finalize the GTMP, and that this will be a critical input for prioritizing investments to be financed out of EU funds. This provides a window of opportunity to

incorporate the recommendations of this Report into the finalization of the GTMP, thus ensuring adequate consideration of climate change interventions.

214. A second critical step is for Romania to decide on how it will implement the requirement that 20 percent of European Structural and Investment Funds be used for climate action. This is important, as it is not clear at the moment for the Large Infrastructure Operational Programme—which includes transport, energy and environment—what percentage of climate expenditure the transport sector will need to meet. This could have an impact on the modal composition of the transport programme. Likewise, the same applies for the Regional Operational Programme, which includes county roads and urban transport (excluding the metro of Bucharest).

215. Lastly, it will be important to coordinate the preparation of transport related aspects in the Large Infrastructure Operational Programme and the Regional Development Operational Programme, particularly with regard to roads. Motorways and national road projects will be financed through the Large Infrastructure Operational Programme while county roads will be financed through the Regional Development Operational Programme, and these need to be coordinated, to ensure that when a motorway section is built, access roads and roads in the surrounding area are also upgraded, in order to derive the full benefit of the investments. While this is not a climate related issue, it is nevertheless important in order to develop an integrated and optimized transport system. The General Transport Master Plan, which is based on a National Transport Model, could serve as the basis for the selection of road projects in both Operational Programmes.

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APPENDIX A – LAND TRANSPORT SUCCESS STORIES

While a number of specific policy instruments can be used to mitigate the impact on climate change of transport policies, the implementation of a package of policy measures is likely to have a larger impact in containing the growth of GHG emissions, while the adoption of a more “holistic approach” that employs a combination of instruments with significant co-benefits to society, other than GHG savings, are likely to be more politically feasible. A recent study by the European Environmental Agency (EEA) that modelled emissions in the EU reviewed various policy instruments and their impact on emissions by 2050 found that the greatest GHG savings potential arises from a combined package, in which technological improvements that reduce fuel consumption are used in parallel with measures to shift journeys to lower emission modes—modal shift away from roads—and which discourage the need to travel.¹²⁵ Particularly with regard to the latter point, high density, mixed-use land planning can have a large impact, but not in the short-to medium-term. This section presents some examples of smart transport policies with positive GHG co-benefits.

The Case of Singapore

One concrete example of a successful package of policies aimed at controlling the growth of motorization, vehicle trips, and congestion—with positive GHG emission spillovers—is the experience of Singapore. Constrained by limited space a comprehensive set of land development and public transport policies have been in place since the 1970s which have aimed to balance the growth in transport demand and enhance the effectiveness and efficiency of the land transportation system. The Singapore story is one of land transport policy development and sustainable transport planning, providing important lessons on how to control the number of vehicles and their usage, as well as increasing the availability of public transit.¹²⁶

- *Vehicle quota system (VQS).* Initially the policy included high import taxes, registration fees, and road taxes, but with time this moved to a combination of a vehicle quota system (VQS) and road pricing. Under the VQS scheme, the government plans for a rate of vehicle growth according to prevailing traffic and road capacity, taking into account the existing vehicle stock and projections of deregistering. This determines the vehicle quota and in turn all purchases of new vehicles are required to bid for a license in a twice a month public tender, with the willingness to pay determining the final cost of the license. Evidence suggests the VQS has been successful in reducing the annual growth rate of vehicles to 3 percent, down from 6.8 percent under earlier policies.

¹²⁵ European Environment Agency (2010), *Towards a Resource-Efficient Transport System. TERM 2009: Indicators Tracking Transport and Environment in the European Union*. EEA Report No. 2/2010.

¹²⁶ Sun Sheng Han (2010), *Managing Motorization in Sustainable Transport Planning: the Singapore Experience*. *Journal of Transport Geography* 18 (2010) 314-321.

- *Road pricing.* This began in 1975 with an Area Licensing Scheme (ALS), which required the purchase of a permit in the central area, with exemptions for ambulances, fire engines, police vehicles. In 1995 electronic road pricing (ERP) was introduced, using radio-frequency, optical-detection, imaging, and smart-vehicle technologies to implement its charges. One of the main advantages of the ERP over the ALS was the ability to vary the charges at different times of the day, and between weekdays and weekends, as well as along different routes. Evidence shows that drivers responded to vehicle pricing in terms of selecting routes, number of trips, and time of timing of trips, allowing greater vehicle ownership than otherwise as traffic can be successfully controlled. Traffic speed increased by 10 km/hr when compared to the ALS.
- *Promotion of public transit.* The Land Transport Authority (LTA) expanded the number of mass rapid transit (MRT) and light rapid transit (LRT) lines and planned extensions, with the aim of increasing coverage and frequency of service—the extensions will be integrated with land use as the MRT connects new town centers, while the new LRT increases the catchment area of MRT stations. High quality bus services are a critical aspect of public transit, and to make buses attractive, the bus operators must satisfy demanding performance standards.
- *Taxis.* These are an important component of public transport, with Singapore having the highest density of taxis of any major city, combined with low fares, and exacting performance standards for taxi services in terms of waiting times and traffic accidents.

The Singapore experience demonstrates that increasing vehicle ownership—an aspirational objective of developing country middle classes—can be combined with increased demand for public transit by controlling vehicle usage through targeted policies which impact on the price of a vehicle trip. Increase motorization in the absence of a multi-modal public transport strategy would have led to ever rising levels of traffic congestion, traffic fatalities and land use sprawl, as is the case in a number of cities worldwide—the case of Moscow comes to mind. Land transport policies in Singapore have focused on reducing congestion through a comprehensive strategy focusing on five key components: (a) integration of town and transport planning; (b) expansion of road network and improvement of road infrastructure; (c) network and traffic management through new technologies; (d) managing vehicle ownership and usage; and (e) improving and regulating public transport.¹²⁷ While this comprehensive approach was adopted with the aim of reducing congestion, it has reduced GHG emissions compared to what they would have been in the absence of such measures, as it encouraged a modal shift by reducing vehicle usage, while encouraging the development of public transport in parallel with land usage developments.

Transalpine Rail Transport in Switzerland

The number of transalpine trips through Switzerland by heavy goods vehicles more than quadrupled between the opening of the Gotthard tunnel in 1981 and the year 2000. Since 2001, a drop in trips has occurred, due to implementation of flanking transfer measures and the introduction of the distance-based

¹²⁷ Soi Hoi Lam and Trinh Dinh Toan, 2006, “Land Transport Policy and Public Transport in Singapore.” *Transportation* (2006) 33: 171-188.

heavy vehicle fee (HVF), replacing the flat-rate heavy vehicle charge that had been levied since 1985.¹²⁸ Overall responsibility for levying the new fee was allotted to the Federal Customs Administration. The aim of HVF is to internalize the external costs of trucks and therefore implement the polluter pay principle, with payment based on total weight, emissions levels, and kilometers driven—a 40 ton vehicle pays about Euro 200 (US\$284) for a 300 km journey. Annual revenues are about Euro 1 billion and go to the Swiss public transport fund. The quantity of goods transported over Swiss alpine passes by road and rail has more than doubled overall since 1981 to reach 34.6 million net tons in 2009. The share of goods transported by road increased during that period but is still low compared with neighboring countries, as in Switzerland about 60 percent are transported through the Alps by rail.

HVF must be paid on all Swiss and foreign vehicles used for freight transport whose total maximum permitted weight exceeds 3.5 tons and it is levied on all public highways in Switzerland. The amount charged is based on the mileage covered, the total maximum permitted weight, and the emission rating (Euro class) of the vehicle in question. The mileage covered within Switzerland is read off the tachograph that is fitted in almost all vehicles which are subject to the fee. The person who is liable for the fee has at the same time a duty to cooperate. Swiss transport companies regularly declare the mileage covered by their vehicles to the Directorate General of Customs. In the case of foreign vehicles, the mileage is automatically declared at the customs post upon leaving Switzerland. The fee is then either paid direct when the driver leaves the country or charged to an account in the transport company's name.

The system for levying HVF is implemented by the customs administration in conjunction with cantonal highways offices, transport companies and authorized assembly points. The Swiss authorities invested some CHF 290 million (US\$ 378 million) to set up the HVF system. This sum includes development—toll system, recording devices, among others—procuring and installing the necessary roadside infrastructure (beacons and associated equipment), and procuring the recording devices.¹²⁹ The annual cost of operation, maintenance and additional staff constitutes around 7-8 percent of the total, which is relatively low in comparison with other electronic toll systems. The HVF has led to fewer empty trucks, better capacity use, and a cleaner vehicle fleet, and has raised the competitiveness of rail transport. Funds from HVF have helped financed the Gotthard Base Tunnel, funded by the Swiss public transport fund which in turn is mainly fed by the HVF. The tunnel is an important part of the north-south rail axis through Switzerland, which is expected to open in 2016-2017.

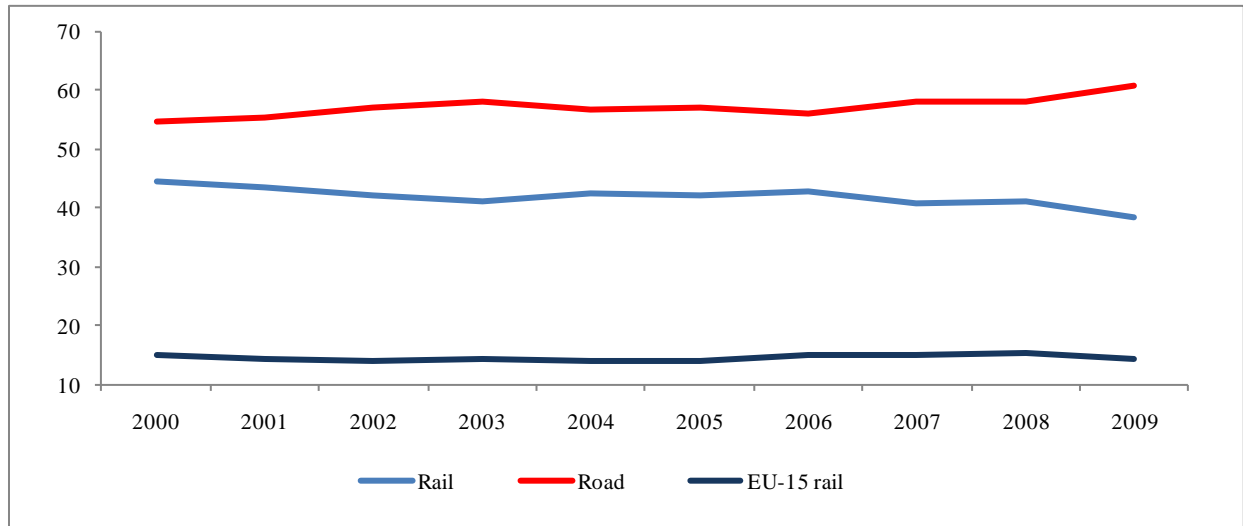
Looking at rail freight transport more broadly, and not limited to transalpine transport, the modal share of rail in Switzerland remains high compared to the EU-15 inland modal split. While Switzerland rail's modal share has not increased over 2000-09, but on the contrary has fallen from 44.5 percent to 38.4 percent, this remains considerably higher than for EU-15 countries, where rail's modal share was only 14.4 percent in 2009. Among new EU member states the share of rail in freight transport varies considerably, with declining, but exceptionally high shares for the Baltics—69.8 percent in Latvia, 52.7 percent in Estonia, and 40.1 percent in Lithuania—compared to the best performing EU-15 country,

¹²⁸ Federal Statistical Office (2010), *Mobility and Transport, Pocket Statistics 2010*, Neuchâtel 2010. Available at: <http://www.bfs.admin.ch/bfs/portal/en/index/news/publikationen.html?publicationID=3986>

¹²⁹ Swiss Federal Customs Administration. Further information available at: http://www.ezv.admin.ch/zollinfo_firmen/steuern_abgaben/00379/index.html?lang=en

Sweden (37.5 percent). To put this in perspective, the modal split in the US was 45.3 percent for rail in 2007, compared to 32.8 percent for roads.

Freight Modal Split in Switzerland (percentages)



Note: Based on Swiss data for rail, road, and pipelines.

Sources: Eurostat, Federal Statistics Office.

APPENDIX B – POTENTIAL MONITORING INDICATORS

Sector	Potential output indicators	Potential outcome indicators
Mitigation actions		
Rail	Length of new rail track implemented (km) Length of rail track reconstructed or upgraded (km) Length of rail track taken out of service (km) Number of stations upgraded Number of new locomotives / multiple units brought into service Number of new coaches / wagons brought into service Length of network equipped for regenerative braking (km) Number of locomotives equipped for regenerative braking	Rail patronage (number of passengers) Freight carried by rail (tonnes, tonne-km) Average journey times (hours) Journey time variability Customer satisfaction Estimated GHG emissions per passenger-km (tonnes CO _{2e}) Estimated GHG emissions per tonne-km (tonnes CO _{2e})
Road	Length of new road implemented (km) Length of road reconstructed or upgraded (km) Length of road lane with HOV restrictions (km) Number of people registered as participants in car share schemes Number of low GHG emission private vehicles in the national vehicle parc (number in different emission bands) Number of alternative fuel vehicles in operation Number of low GHG emission freight vehicles registered	Road vehicle-km travelled (by vehicle type) Road passenger-km travelled Road freight vehicle-km travelled Average journey times (hours) Journey time variability Road user satisfaction Estimated GHG emissions per passenger-km (tonnes CO _{2e}) Estimated GHG emissions per freight vehicle-km (tonnes CO _{2e})
Inland waterways	Number of improved vessel traffic management systems implemented Number of ports with upgraded infrastructure Number of improved freight interchange facilities Length of waterway with improved navigability (km)	Freight carried by IWT (tonnes, tonne-km) Average journey times (hours) Journey time variability Customer satisfaction Estimated GHG emissions per tonne-km (tonnes CO _{2e})
Urban	Number of 'hard' demand management	Local bus, tram, trolleybus, metro, BRT

Sector	Potential output indicators	Potential outcome indicators
	<p>schemes implemented</p> <p>Length of new tram or metro line implemented (km)</p> <p>Length of BRT route implemented (km)</p> <p>Number of stations and stops upgraded</p> <p>Number of new public transport vehicles brought into service</p> <p>Length of on- and off-road cycle lane implemented (km)</p> <p>Number of public cycle parking spaces created</p> <p>Number of urban freight interchange facilities implemented</p> <p>Number of buses and other public fleet vehicles running on alternative fuels</p> <p>Number of new or upgraded ITS systems implemented</p>	<p>patronage (number of passengers)</p> <p>Private urban vehicle-km</p> <p>Public transport urban vehicle-km</p> <p>Urban freight vehicle-km</p> <p>Average journey times (hours)</p> <p>Journey time variability</p> <p>Customer satisfaction</p> <p>Estimated GHG emissions per passenger-km (tonnes CO_{2e})</p> <p>Estimated GHG emissions per tonne-km (tonnes CO_{2e})</p> <p>Occupancy rates for public transport modes</p> <p>Occupancy rates for rail passenger transport</p>
Air	<p>Number of airport schemes implemented to encourage sustainable surface access</p>	<p>Local public transport patronage on airport services (number of passengers)</p> <p>Private vehicle-km for airport access</p> <p>Public transport vehicle-km for airport access</p> <p>Road freight vehicle-km to airport</p> <p>Customer satisfaction</p> <p>Estimated GHG emissions per passenger-km (tonnes CO_{2e})</p> <p>Estimated GHG emissions per tonne-km (tonnes CO_{2e})</p>
Adaptation actions		
Rail	<p>Length of track with uprated heat resilience measures</p> <p>Number of coaches fitted with improved ventilation or air conditioning</p> <p>Length of embankment / cutting with flood-resistant stabilization measures</p> <p>Length of flood defence banks / dykes to protect infrastructure</p> <p>Number of bridge structures with flood protection measures</p>	<p>Annual km-hours of track non-availability or restrictions due to extreme weather events</p>
Road	<p>Length of road with uprated heat resilience measures</p>	<p>Annual km-hours of road non-availability or restrictions due to extreme weather events</p>

Sector	Potential output indicators	Potential outcome indicators
	<p>Length of road with upgraded highway runoff drainage</p> <p>Length of embankment / cutting with flood-resistant stabilization measures</p> <p>Length of flood defence banks / dykes to protect infrastructure</p> <p>Number of bridge structures with flood protection measures</p>	
Inland Waterways	<p>Number of improved river information systems</p> <p>Number and size of river-based measures to maximise navigability</p>	Annual km-hours of waterway non-availability or restrictions due to low water levels
Urban	<p>Length of tram and urban rail track with uprated heat resilience measures</p> <p>Number of public transport vehicles / coaches fitted with improved ventilation or air conditioning</p> <p>Number of metro stations fitted with improved ventilation or air conditioning</p> <p>Length of road with upgraded highway runoff drainage</p> <p>Length of embankment / cutting with flood-resistant stabilization measures</p> <p>Length of flood defence banks / dykes to protect infrastructure</p> <p>Number of bridge structures with flood protection measures</p>	Annual km-hours of track and road non-availability or restrictions due to extreme weather events
Air	<p>Area of taxiway / runway / apron with uprated heat resilience measures</p> <p>Area of taxiway / runway / apron with upgraded runoff drainage</p> <p>Length of flood defence banks / dykes to protect infrastructure</p> <p>Number of bridge structures with flood protection measures</p>	Annual km-hours of airport non-availability or restrictions due to extreme weather events