**Report No. 70290-GE**

# A Policy Framework for Green Transportation in Georgia

Achieving Reforms and Building Infrastructure for Sustainability



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Sustainable Development Department
Europe and Central Asia Region
The World Bank

## Abbreviations and Acronyms

| | |
|---|---|
| BRT | Bus rapid transit |
| CHF | Swiss Franc |
| CO | Carbon monoxide |
| $CO_2$ | Carbon dioxide |
| EC | European Commission |
| EEV | Enhanced Environmentally-friendly Vehicles |
| EFFECT | Energy Forecasting Framework and Emissions Consensus |
| EPA | Environmental Protection Agency |
| ESMAP | Energy Sector Management Assistance Program |
| EU | European Union |
| EV | Electric vehicles |
| GDP | Gross Domestic Production |
| GEL | Georgian lari |
| GHG | Green house gas |
| GIZ | Deutsche Gesellschaft für Internationale Zusammenarbeit |
| HC | Hydro carbon |
| IEA | International Energy Agency |
| ITS | Intelligent transportation systems |
| LLC | Limited Liability Company |
| LRT | Light rail transit |
| LTA | Land Transport Agency |
| MoE | Ministry of Energy |
| MoEnv | Ministry of Environment |
| MoESD | Ministry of Economy and Sustainable Development |
| MoRDI | Ministry of Regional Development and Infrastructure |
| $NO_X$ | Mono-nitrogen oxide |
| NTA | National Tourism Agency |
| OECD | Organization for Economic Co-operation and Development |
| PM | Particulate matter |
| Ro-Mo | Rolling Motorway |
| Ro-Ro | Rolled-on and rolled-off |
| RUC | Road user charges |
| $SO_2$ | Sulfur dioxide |
| TPD | Transport Policy Department within the MoESD |
| TRACECA | Transport Corridor Europe-Caucasus-Asia |
| TWh | Terawatt-hour |
| UNFCCC | United Nations Framework Convention on Climate Change |
| VOC | Volatile organic compounds |
| WDI | World Development Indicators |

| | |
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# Acknowledgement

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# Executive Summary

## What is green transportation and why is it important for Georgia?

The Government of Georgia has long recognized that improving transport infrastructure and services is a critical prerequisite to enhance competitiveness and achieve long-term sustainable economic growth. In addition to investing in developing transport *infrastructure*, Government is also considering improving the efficiency and quality of transport *services*, and mitigating the negative environmental and health impacts of transportation by greening transportation.

The rationale for greening transportation in Georgia goes beyond the need to reduce greenhouse gas emissions, which is typically the primary objective of the emerging framework of green and low-carbon development. In fact, in Georgia the additional economic and development challenges are the growing fossil fuel imports that contribute to a large current account deficit and the increasing air pollution caused by road transport that add to healthcare costs. Despite these challenges, Georgia has opportunities to achieve the greening objective while at the same time reducing the economic impact of fossil fuel imports: the country has abundant indigenous energy sources, mainly hydropower, and although motorization rates are rising, it is still early enough to take actions—through policies and investments—to reshape longer-term patterns in the transport sector and in consumer choices.

Therefore, for the purpose of this study, *"green transportation" refers to reduced intensity of fossil fuel use and increased reliance on the country's indigenous energy sources (mainly hydropower), as well as minimized adverse impacts on the global and local environment through reduced emissions of greenhouse gases and local pollutants*. This paper argues that Government interventions are essential for green transportation because the current transport market lacks a mechanism to reduce the large negative externalities (emissions and congestion), and infrastructure and consumer patterns established now would take long to change. By pursuing a green transportation strategy, the Government of Georgia aims to achieve the following development objectives:

***Reducing reliance on energy imports***. Georgia relies entirely on imported energy to meet its transportation needs; the import bill for petroleum fuels comprises a significant share of the overall import bill, has substantial impacts on balance of trade, contributes to a large current account deficit and results in foreign currency shortages for other imports that Georgia requires for national development. Petroleum fuel imports, used almost entirely for transportation, increased about ten-fold during 1999-2008. During 2010, the total import bill for petroleum and hydrocarbon fuels was about US$832 million, or 16 percent of total imports and more than 7.0 percent of gross domestic product (GDP). During January-May 2011, the import bill for gasoline alone grew by 27 percent compared to the same period in 2010, primarily due to global price increases. Green transportation measures will help reduce fossil fuel consumption and increase the share of hydropower use for transportation, which supplies about 90 percent of total national electricity needs. Georgia has potential to expand current capacity: it is estimated that only 23 percent of the economically feasible potential of 32 TWh is now being used.

***Reversing the growing menace of air pollution***. In Georgia the main source of air pollution is road transport, which emits a major and growing share of pollutants, including carbon monoxide (CO), hydrocarbons—mostly volatile organic compounds (VOC) and methane, nitrogen oxides ($NO_x$), sulfur dioxide ($SO_2$), soot, benzopyrene and carbon dioxide ($CO_2$) These pollutants are present in areas with intensive traffic—large urban areas and along main road corridors—most acutely observed in Tbilisi. Georgia's cities have lower levels of individual vehicle use, but minibus fleets have high emission intensity, contribute to congestion and disrupt traffic; emissions are also rising from other vehicles.

***Strengthening Georgia's position as a regional trade hub and tourism destination by developing efficient and clean transport services***. Georgia's position along an important international transit corridor gives it an important role in international trade and transportation. Georgia's tourism sector has grown rapidly in recent years; its natural endowment and rich cultural heritage is expected to fuel further growth. Improved transport services are critical to these sectors. Better transport infrastructure and services would: (i) strengthen the competitiveness of Georgian goods; (ii) lower prices for Georgian consumers; (iii) strengthen Georgia's position as an international transshipment country for the region; (iv) improve access to tourism destinations; (v) improve regional integration; and (vi) enhance rural communities' access to markets and social services.

## Proposed Policy Framework for Greening Transportation

***Goal: Reduce transportation costs***. The primary goal of a green transport policy framework would be to reduce the total cost of transportation including all direct and indirect costs, while maintaining total social welfare benefits. Direct and indirect costs borne by private parties would be lowered through improved infrastructure, and fair competition among modes and operators. Indirect costs, borne by society, would be reduced by mechanisms that internalize quantifiable external costs.

***Principle: Influence and Improve consumer choices***. At the heart of green transportation is consumer choice about whether to move, when to move, which route to take, which mode and vehicle to use and so forth. In the aggregate, transport user decisions establish the degree of green transportation, which in turn affects levels of environmental impact and economic development, national dependence on petroleum products, air pollution, transport costs, and labor productivity. Therefore Government needs to adopt policies that provide incentives for greener transportation and improve options available to consumers. Georgia has made significant progress toward a market economy, and greening policy measures should not undermine the market economy.

***Instruments***. Various instruments, institutions and planning, regulations and enforcement, fiscal policy and pricing, and investments need to be balanced to achieve the following six policy objectives:

***A. Integrate environmental concerns into transport policy***. Although road transport is the major contributor to air pollution, Georgia's environmental objectives are not yet reflected in transport policies and the existing regulatory framework is not enforced. Government aspires to achieve green transportation but Georgia's existing transport policy fails to acknowledge the growing environmental damage inflicted by the transport sector. An integrated transport policy should specify air pollution reduction as an objective and set achievable target emission levels. Inter-ministerial collaboration is critical to share data, exchange knowledge, make and implement policies.

***B. Achieve and maintain a greener vehicle fleet***. A growing influx of older vehicles coupled with rising demand for private cars is causing rapid deterioration of air quality. As a time-bound policy, Government can consider various fiscal measures, including a vehicle scrapping-and-recycling program, vehicle retrofitting program, and other financial incentives for use of cleaner vehicles. Also importantly, current vehicle inspection that is limited to operators that provide international transport services needs to be expanded to other commercial operators. Enforcement capacity needs to be strengthened.

***C. Promote Low Emission Freight Transport Modes***. Georgia needs to develop a comprehensive transport policy to promote low emission freight transport modes, particularly rail transport, through improved intermodal connectivity and international collaboration with key trading partners and neighboring countries. This requires a national transport strategy, investment programs that coordinate all modes, and a strategic vision to improve intermodal connectivity and lower overall transportation costs and harmful effects on the environment. High priority investments include rail-road transshipment facilities, port development, and container handling facilities.

***D. Support commercial development of intercity passenger transport services***. The under-regulated and under-developed intercity passenger transport market is fragmented; transport services are irregular and unattractive to consumers, and because technical inspections are rare, vehicle condition is poor. Georgia should introduce measures to require operators of intercity bus services to renew and upgrade their vehicle fleet and consolidate all intercity bus services in an integrated passenger information service, participation in which can be made a tool to control market entry. Government through the National Tourism Agency and the Land Transport Agency could select strategic routes and control and monitor service quality on those routes.

***E. Transform minibuses and taxis into modern urban transport modes***. Minibuses are essential to the daily life of average Georgians but existing services are an inferior mode of transport lacking comfort, privacy and safety, hence are used by a captive clientele without other options. The taxi market is unregulated with respect to market entry, vehicle condition, service quality, and fares. Improving urban transport choices requires strategic planning toward a coherent multimodal public transport system, including legal and regulatory frameworks, competitive tendering, and gross-cost based contracting. To lower the costs of public transport services—including operating costs and externalities—while ensuring service quality, a legal framework should establish conditions for competition among service providers, including municipal companies and private sector participants.

***F. Support sustainable development of urban transport***. The Georgian urban transport sector, particularly in Tbilisi, consumes more energy per capita than many other cities in developed and developing countries. Building a sustainable urban transport system requires comprehensive planning in addition to balanced and multi-modal transport infrastructure development driven by a long-term vision with a mix of fiscal incentives, regulatory policies and investment in multi-modal urban transport systems. Although municipal authorities are responsible for urban transport, Government can establish a national policy framework, legal and regulatory framework, and national technical standards. Government can facilitate knowledge-sharing and technical capacity building, and allocate budgetary resources to promote technological innovations and generation of national public goods.

## Summary of the Proposed Green Transportation Policy Framework

| Institutions and Planning | Regulations and Enforcement | Fiscal Policy and Pricing | Investments |
|---|---|---|---|
| ***A. Integrate Environmental Concerns into Transport Policy*** | | | |
| • Integrate transport policy and environmental monitoring | • Reinstate fuel quality inspection | • Revise taxes on motor fuels to be differentiated by quality as incentives for cleaner fuel choices<br>• Maintain high fuel prices relative to income levels as a long-term policy | |
| ***B. Achieve and Maintain a Greener Vehicle Fleet*** | | | |
| • Strengthen institutions for effective enforcement | • Expand vehicle inspection requirements to include all commercial and non-commercial vehicles | • Scrap and recycle the old and polluting vehicle fleet<br>• Tax credits and other financial incentives for higher fuel-efficiency and technological improvements of vehicles | • Subsidize the scrapping and recycling of old and polluting vehicles |
| ***C. Promote Low Emission Freight Transport Modes*** | | | |
| • Develop a coherent transport policy that focuses on intermodality and international collaboration with key trading partners and neighboring countries | • Apply vehicle inspection regime to domestically registered trucks and to Georgian transport companies<br>• Introduce and enforce regulations on vehicle emissions and axle loads for foreign registered transit vehicles | • Differentiate charges on transit trucks according to vehicle emission class and axle loads<br>• Allocate revenues to the maintenance of road network assets and green transport investments | • Develop multimodal, green transit corridors by improving intermodal connectivity, eliminating bottlenecks and supporting containerization |
| ***D. Support Commercial Development of Intercity Passenger Transport Services*** | | | |
| • Improve the convenience of and access to intercity bus services through coordinated marketing strategy and passenger information services | • Control market entry through regulations and enforcement of vehicle and emission standards<br>• Introduce competitive tendering for strategic intercity routes and manage service quality | | • Improve quality of infrastructure and consumer amenities through public and private investments |
| ***E. Transform Minibuses and Taxis into Modern Urban Transport Modes*** | | | |
| • Develop a strategic vision and strengthen market competition for minibuses and taxis<br>• Develop a strategy for coherent multimodal public transport system | • Minibus market: introduce competitive tendering and gross-cost based contracting<br>• Taxi market: introduce partial regulations that control fare and quality but allow free market-entry | | • Refrain from direct budgetary support for vehicle improvement<br>• Oblige commercial entities to maintain their vehicle fleet quality |
| ***F. Support Sustainable Development of Urban Transport*** | | | |
| • Develop a national-level urban transport policy framework<br>• Institute integrated city development and transport planning | • Make private car use less convenient by introducing parking restrictions in urban centers | • Make private car use more expensive through appropriate forms of road user charges | • Invest in high-quality and competitive alternatives to private transport<br>• Introduce intelligent transportation systems for efficient traffic management and better user services in urban areas |

***Expected benefits: positive fiscal implications***. In addition to the environmental benefits estimated in the analysis below, the policy framework would help reduce fuel imports, and hence, the current account deficits. At the same time, the proposed fiscal and pricing measures would not be inconsistent with the current administrative philosophy that pursues small government. The proposed taxes and subsidies do not automatically lead to bigger government or increased tax burden on households and firms. Income (households) and cost (firms) effects of such fiscal measures can partly be compensated for by allocating revenues on developing green transport modes or reducing taxes that have negative effects on economic growth. Appropriate levels of taxes and other charges need to be identified through a follow-up research.

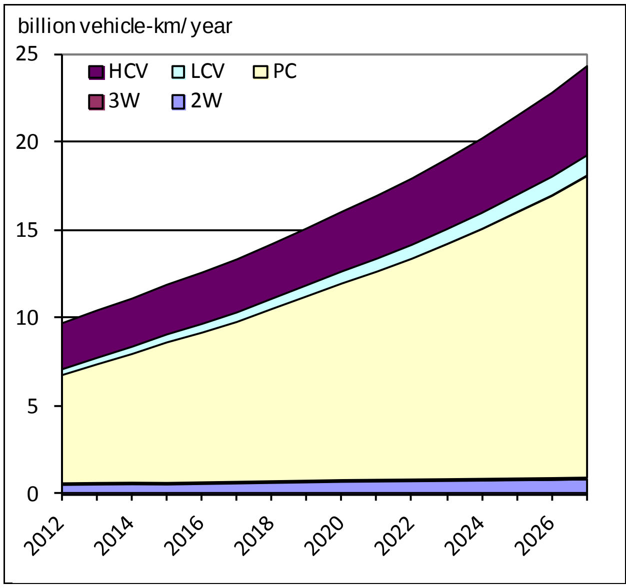
***Implementation: public outreach and phased approach***. Public outreach and phased approach would mitigate political risks and administrative difficulties during implementation of the framework. Public acceptance of fiscal and regulatory measures can be won through a public outreach strategy that highlights the service-fee nature of certain pricing measures and the social costs of environmental externalities. The proposed fiscal and pricing measures target the sources of pollution and inefficient use of motor fuels and can easily be formulated and communicated as “fees” that need to be paid for polluting the environment or for using transport infrastructure and services, instead of “taxes” on vehicles or fuels. In addition, to minimize the contact between public officials and the public, phased implementation of regulatory measures is recommended, starting with fuel quality inspection, which poses lowest governance risks, and expanding vehicle inspection to include all commercial operators.

## Economic and Environmental Benefits of Greening Transportation

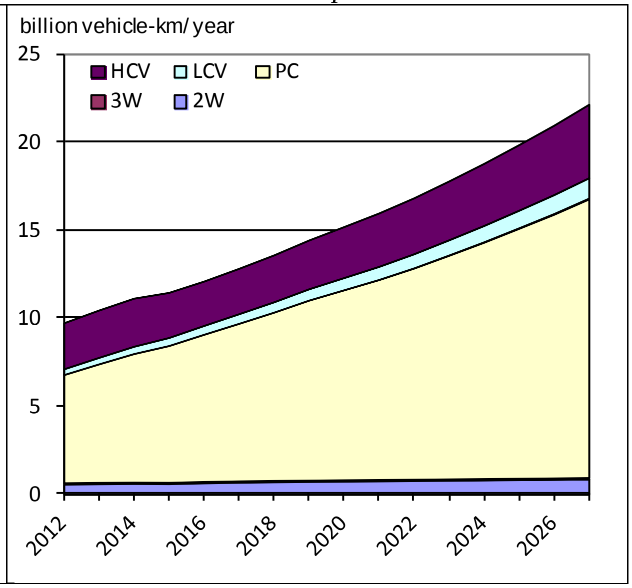
The economic and environmental benefits of the proposed framework for green transportation have been estimated for a 15-year period (2012-2027) using the EFFECT (Energy Forecasting Framework and Emissions Consensus Tool) framework by comparing two scenarios: business-as-usual or adopting the green transportation policy framework. The EFFECT framework predicts future vehicle ownership and transport demand on the basis of the baseline ownership and transport data, future economic and population growth, fuel prices, mode choice patterns, and anticipated improvements and changes in vehicle technologies. Under the green transportation scenario, it is estimated that Georgians will drive about 4.0-6.0 percent less than under the business-as-usual scenario, which would reduce motor fuel consumption by about 1,746 to 1,825 million tons over the 15 year period, equivalent to 9 billion GEL of fuel cost savings (discounted net present value). The CO2 emissions would drop by an estimated 2,797 to 5,338 million tons and most local pollutant emissions would be substantially reduced: a 22 to 67 percent drop in CO emissions, 26 to 54 percent drop in VOC emissions, and 11 to 23 percent drop in NOx emissions. Other indirect benefits, while not quantitatively measured, would include reduced traffic congestion, road traffic casualties, and healthcare costs.

**Vehicle-kilometers-traveled**

*Business-as-usual*

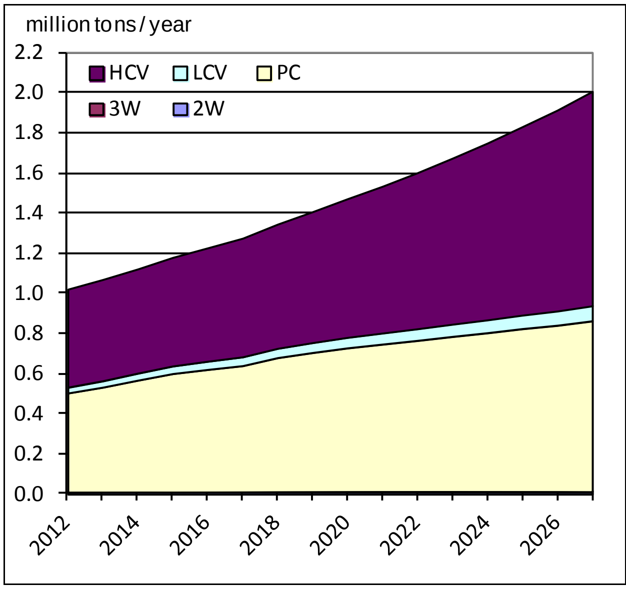



*Green transportation*

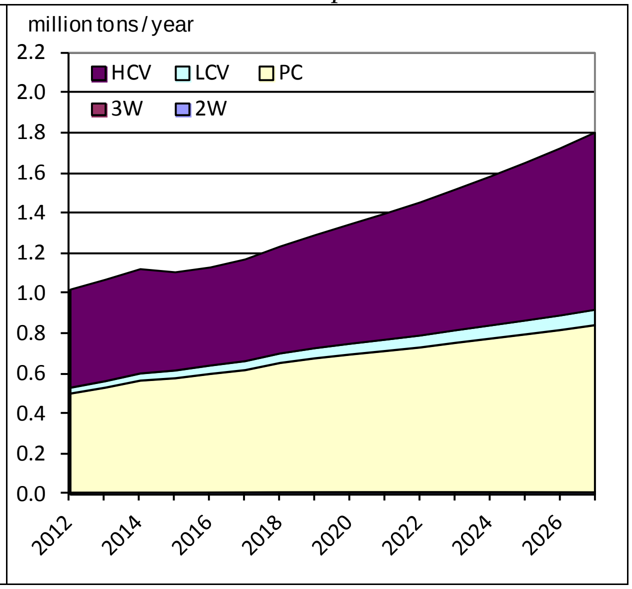



**Motor fuel consumptions**

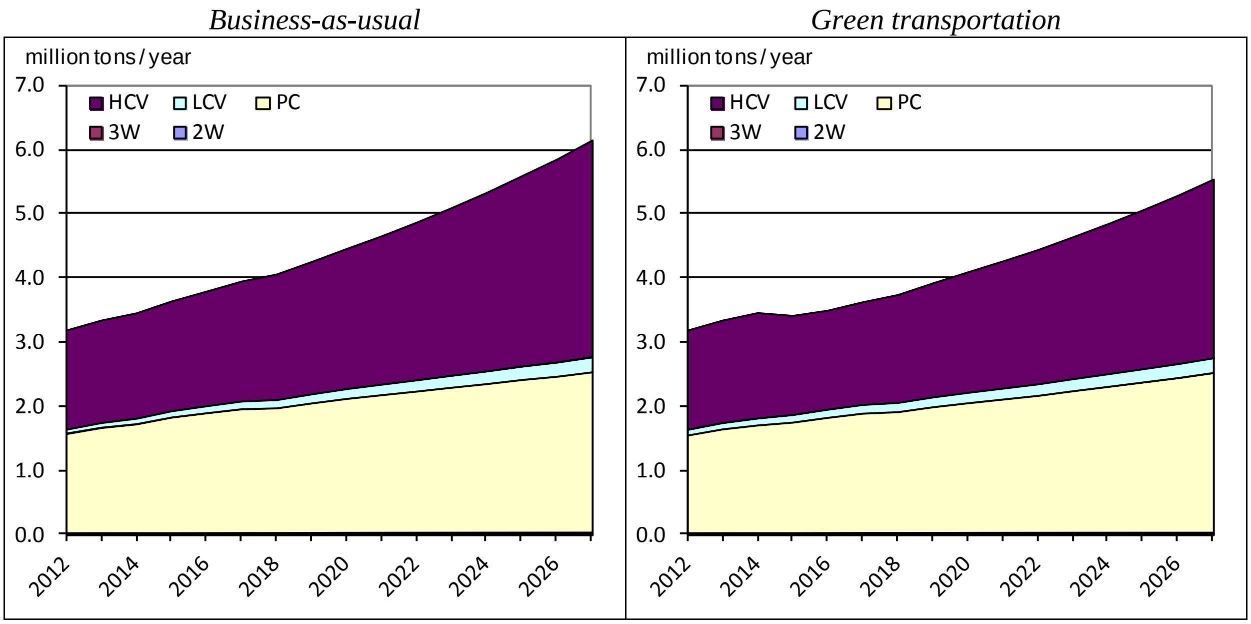
*Business-as-usual*




*Green transportation*



**$CO_2$ emissions from road transport**




**Comparison of business-as-usual and green transportation scenario for 2012-2027**

| Indicators | Business-as-usual | Green Transportation | |
|---|---|---|---|
| | | *Moderate* | *Aggressive* |
| Total vehicle-km on road (million) | 258,235 | 249,319 (-4%) | 244,075 (-6%) |
| Total fuel consumption (thousand tons) | 23,492 | 21,746 (-7%) | 21,667 (-8%) |
| Total fuel costs, excluding electricity (million GEL)[a] | 96,226 | 87,434 (-9%) | 87,331 (-9%) |
| Total electricity use (GWh) | 46,249 | 63,255 (+37%) | 75,992 (+64%) |
| Total passenger-km by road (million) | 730,502 | 664,955 (-9%) | 689,451 (-6%) |
| Total passenger-km by rail and electric public transport (million) | 30,490 | 62,600 (+105%) | 77,633 (+155%) |
| Total ton-km by road (million) | 524,924 | 489,010 (-7%) | 453,096 (-14%) |
| Total ton-km by rail (million) | 154,504 | 190,420 (+23%) | 226,335 (+47%) |
| Total $CO_2$ emissions (thousand tons) | 71,793 | 68,996 (-4%) | 66,455 (-7%) |
| Total CO emissions (thousand tons) | 1,200 | 392 (-67%) | 941 (-22%) |
| Total VOC emissions (thousand tons) | 178 | 82 (-54%) | 131 (-26%) |
| Total NOx emissions (thousand tons) | 458 | 351 (-23%) | 406 (-11%) |

*Note: All values are aggregate sums for the period 2012-2027*

[a] *Discounted*

## Roadmap of Priority Actions

Measures proposed in the above policy framework can be prioritized based on urgency and sequencing. The proposed roadmap below lays out priority actions for the short-term (2012-2014), medium-term (2015-2020), and longer-term (after 2020).

***Short-Term (2012-2014): Institutional Capacity and Preparatory Tasks***

| Objectives | Actions | Responsible Entities |
|---|---|---|
| *Strengthen the institutions and policies at national and municipal level* | 1.1) Include environmental objectives and targets in national and municipal transport policies | (Lead) MoEnv; (Support) TPD |
| | 1.2) Develop and implement an environmental monitoring framework, including ambient air quality measurement | (Lead) MoEnv; (Support) TPD |
| | 1.3) Update regulatory framework stipulated in Presidential Decree No. 302, introducing phased implementation plans with defined targets at each phase, streamline administrative procedures with a plan to outsource actual implementation. | (Lead) LTA; (Support) MoEnv, MoE, MoESD |
| | 1.4) Strengthen inter-agency collaboration among ministries, and between national government and municipal authorities | Council of Ministers |
| *Carry out preparatory work and studies for medium-term actions* | 1.5) Assess appropriate levels of transit truck charges by emission class and weight, and possibly by distance, devise an implementation plan, including an electronic toll collection system | (Lead) TPD, MoRDI; (Support) MoESD |
| | 1.6) Carry out green logistics study, assessing feasibility of containerization and transshipment facilities such as Ro-Mo and Ro-Ro and identify investment needs | (Lead) TPD; (Support) MoRDI, Georgian Railway |
| | 1.7) Develop strategy for intercity passenger transport based on ongoing market analysis | (Lead) TPD; (Support) NTA |
| | 1.8) Develop strategy for minibus reform, identifying steps to introduce competitive tendering and evaluating feasibility of gross-cost vs. net-cost contracting | (Lead) TPD; (Support) Municipalities |
| | 1.9) Research taxi regulations, investigating current market condition and identifying appropriate level of regulations | (Lead) LTA; (Support) Municipalities, TPD |
| | 1.10) Develop urban transport strategic plans in cities other than Tbilisi | (Lead) Municipalities; (Support) TPD |
| | 1.11) Carry out alternative analysis and/or feasibility studies for public transport modes in Georgian cities, including trams, ropeways, LRT, BRT | (Lead) Municipalities; (Support) TPD |

*Note: MoESD (Ministry of Economy and Sustainable Development), TPD (Transport Policy Department within the MoESD), MoEnv (Ministry of Environment), MoE (Ministry of Energy), MoRDI (Ministry of Regional Development and Infrastructure), LTA (Land Transport Agency) NTA (National Tourism Agency), Ro-Mo (rolling motorway), Ro-Ro (rolled-on and rolled-off)*

***Medium-Term (2015-2020): Enforcement, Market Reforms, and Infrastructure***

| Objectives | Actions | Responsible Entities |
|---|---|---|
| *Implement the improved regulatory framework* | 2.1) Based on updated regulatory framework developed under (1.3), enforce fuel quality standards | (Lead) LTA or a new designated agency; (Support) MoEnv, MoE |
| | 2.2) Expand vehicle inspections to all commercial vehicles, including those providing domestic services | (Lead) LTA, Police; (Support) MoEnv |
| | 2.3) Institute administrative procedures for periodic vehicle registration combined with compulsory safety and emissions inspection for all privately owned vehicles | (Lead) Police, LTA; (Support) TPD, MoEnv |
| | 2.4) Establish test facility for technical inspection and start pilot implementation in selected cities and regions | (Lead) LTA, Police; Support municipalities |
| *Promote market competition through key sub-sector reforms* | 2.5) Implement intercity passenger transport strategy developed under (1.8) | (Lead) NTA, TPD (Support) MoF |
| | 2.6) Implement in-city minibus market reform strategy developed under (1.9) | (Lead) Municipalities (Support) TPD |
| | 2.7) Based on the findings from (1.10), implement reforms of the urban taxi market, starting in a pilot city | (Lead) Municipalities (Support) LTA, TPD |
| *Develop infrastructure for lasting transformation* | 2.8) Implement revised transit truck charges based on the assessment and implementation plan prepared under (1.5) | (Lead) MoRDI or a designated entity; (Support) TPD |
| | 2.9) Based on study results from (1.6), prepare and implement infrastructure investment projects for new intermodal facilities, transshipment terminals, capacity expansion, etc. | (Lead) MoRDI, Georgian Railway, Port authorities, municipalities (Support) TPD, MoF |
| | 2.10) Based on study outcomes from (1.11), prepare and implement public transport capital investment projects: possible projects include fleet renewal, new investments in public transport trunk corridor development, infrastructure and facility for non-motorized transport, and ITS measures | (Lead) Municipalities (Support) TPD, MoF |

*Note: MoF (Ministry of Finance), MoESD (Ministry of Economy and Sustainable Development), TPD (Transport Policy Department within the MoESD), MoEnv (Ministry of Environment), MoE (Ministry of Energy), MoRDI (Ministry of Regional Development and Infrastructure), LTA (Land Transport Agency). NTA (National Tourism Agency)*

***Long-Term (2020 and after): Transformation***

| Objectives | Actions |
|---|---|
| *Transform mobility using advanced technologies* | 3.1) Institute financial incentives to adopt technologies to improve fuel efficiency |
| | 3.2) Evaluate alternative propulsion technology options including electric vehicles |
| | 3.3) Invest in infrastructure and facilities to support deployment of new technologies |
| *Shape green mobility patterns* | 3.4) Introduce appropriate road pricing measures, including congestion pricing |
| | 3.5) Incorporate environmental considerations in the existing taxation structure |

# I. Introduction: Framing the Policy Questions

## A. What is Green Transportation?

The Government of Georgia is considering options for reducing fossil fuel imports in favor of introducing large scale use of domestic energy sources for public and private transportation. However, this must be considered within the overall context of green transportation—which would generate benefits well beyond the substitution of fossil fuels with domestic energy sources.

The concept of green transportation has emerged in response to growing concerns about climate change; typically this refers to a transportation system characterized by low carbon emissions, i.e., green house gasses (GHG). In the context of Georgia, two other important development issues in green transportation in addition to GHG emissions are fossil fuel consumption and air pollution. For the purpose of this study, therefore, **green transportation in Georgia refers to reducing the intensity of fossil fuel use and increasing reliance on indigenous energy sources (mainly hydropower), as well as minimizing adverse impacts on the global and local environment through reduced emissions of GHG and local pollutants**.

Greening transportation would create "co-benefits": (i) reducing fossil fuel use would help **improve the balance of trade and energy security**; and (ii) employing measures to avoid unnecessary trips and using fewer vehicles for the same number of trips (i.e., public transportation) would **reduce traffic congestion on the road network**, particularly in urban areas.

## B. What is the Rationale for Green Transportation?

***Role of the Transport Sector in Georgia's Growth***

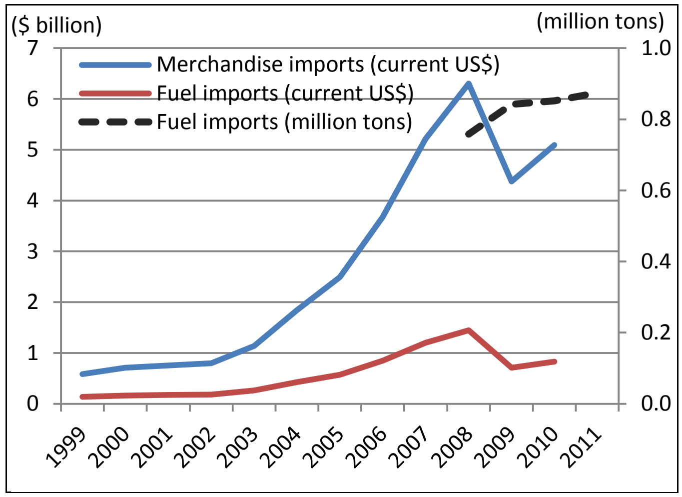
**Developing transport infrastructure and services is essential to realize Georgia's growth potential.** Improved transport and services would support development of sectors that are key to national economic growth—exports, tourism, and agriculture. Well-developed transport infrastructure and services would: (i) improve the competitiveness of Georgian goods; (ii) lower prices for Georgian consumers; (iii) strengthen Georgia's position as an international transshipment country for the region; (iv) improve access to tourism destinations; (v) improve regional integration; and (vi) enhance rural communities' access to markets and social services. Access to and affordability of transport services would foster transformational changes of the Georgian economy. Increasing transport sector efficiency helps create jobs and improve job quality, and generates productivity increases in agriculture, manufacturing and the services sector. This relates not only to market prices for transport services, but also to travel times, reliability and quality of transport services, and a connectivity between the different service providers. Low transport costs, which can be attained by well-developed infrastructure and competitive transport services, will help generate jobs and gradually improve productivity, first in agriculture and increasingly in manufacturing and in high-value services.

Government has long recognized the importance of upgrading national transport infrastructure to international standards of serviceability and has allocated substantial public resources for this. In 2011 more than 50 percent of Government's total planned capital investment was allocated for transport infrastructure or about 580 million GEL out of about 1.0 billion GEL (including donor funding). However, to achieve the goals of improving local industries' competitiveness and achieving long-term sustainable economic growth, Government must also invest in the modernization of transport services.

*Balance of Trade and Energy Security*

**By greening transportation, Georgia could reduce the total import bill for petroleum products, thereby improving the balance of trade and energy security.** Georgia relies entirely on imported energy to meet its transportation needs; the import bill for petroleum fuels comprises a significant share of the overall import bill, has substantial impacts on balance of trade, contributes to a large current account deficit (above -10 percent of gross domestic product (GDP) since 2003, except in 2004, peaking at -23 percent in 2008), and results in foreign currency shortages for other imports Georgia needs for national development. Petroleum fuel imports, used almost entirely for transportation, increased about ten-fold during 1999-2008; although during the same period the share in overall merchandise imports fell from 23 percent to around 18 percent. Fuel import volumes are also steadily increasing since the global financial crisis (Figure 1). During the financial crisis overall imports plummeted but have been recovering. In 2010, the total import bill for petroleum and hydrocarbon fuels—including about 810 million liters of gasoline and diesel—was about US$832 million, or about 16 percent of total imports and more than 7.0 percent of GDP. Also in 2010, the import bill increased by 17 percent from US$710 million in 2009; its share of GDP also increased from 6.6 to 7.2 percent; the import bill for gasoline alone grew by 27 percent between January and May 2011, compared to the same period in 2010, primarily due to global price increases.

**Figure 1**: Oil imports as a substantial share in overall merchandise imports




*Source: World Bank Development Indicators 2011, the Union of Oil Products Importers and Customers of Georgia*

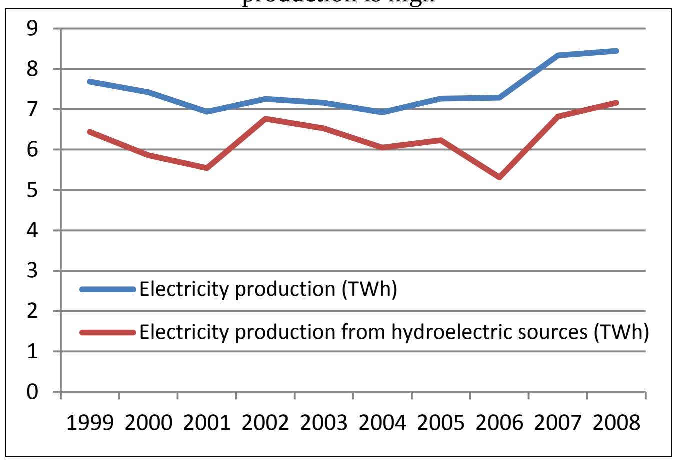
*Catalyst for Service Sector Development*

**Increasing international trade in the region provides opportunities for Georgia's transport sector to increase national foreign currency earnings.** According to the statistics for international trade in services, transport services, including deflated values of freight and passenger transport, account for more than 50 percent of Georgia's commercial services exports. The tourism sector, a key service industry in Georgia, critically depends on improving transport connectivity and developing efficient transport services. Recently, tourist numbers have expanded rapidly—up about 45 percent during January-June 2011 over the same period in 2010. Tourism sector annual export value reached almost US$500 million by end-2010, or about 4.0 percent of GDP. New developments for the sector are ongoing throughout Georgia, which calls for more transport infrastructure development to provide reliable and high-quality transport services at lower costs.

*Potential for Increasing Hydropower Generation*

**Greening transportation would provide an opportunity to utilize national hydropower potential more efficiently for economic growth.** Georgia exports hydro-generated electricity and has potential to expand existing capacity, which supplies about 90 percent of total national electricity needs (Figure 2) and is estimated to be only 23 percent of the economically feasible potential of 32 TWh. However hydro-generated electricity supply is seasonal; during summer—high season—generation is about 160 percent of domestic demand and part of the surplus—now about 1 TWh—is exported, mainly to Turkey. During the winter season, supply shortages are supplemented by thermal generation and an electricity-swap with Turkey. In the longer-term, Government aspires to meet Georgia's electricity demand solely from hydropower and to increase exports of excess supply. To achieve this, five hydropower plants are now under construction and contracts have been signed for another 16. An additional 20 new plants under consideration would increase electricity generation capacity by about 3000 MW. This increased capacity, plus the future completion of transmission grids, led to Government expectations of being able to increase electricity exports to Turkey by as much as 10 to 15 times current levels. Electricity production from hydropower sources has gradually increased and makes up about 86 percent of total production, but this has not led to reduced dependence on imported energy. Instead, the share of imported energy in overall energy use has increased and reached almost 70 percent of all energy use before the financial crisis.[1]

**Figure 2**: Georgia's hydropower share in overall energy production is high




*Source: World Bank Development Indicators 2011*

***Negative Impacts of Road Transport on the Global and Local Environmental***

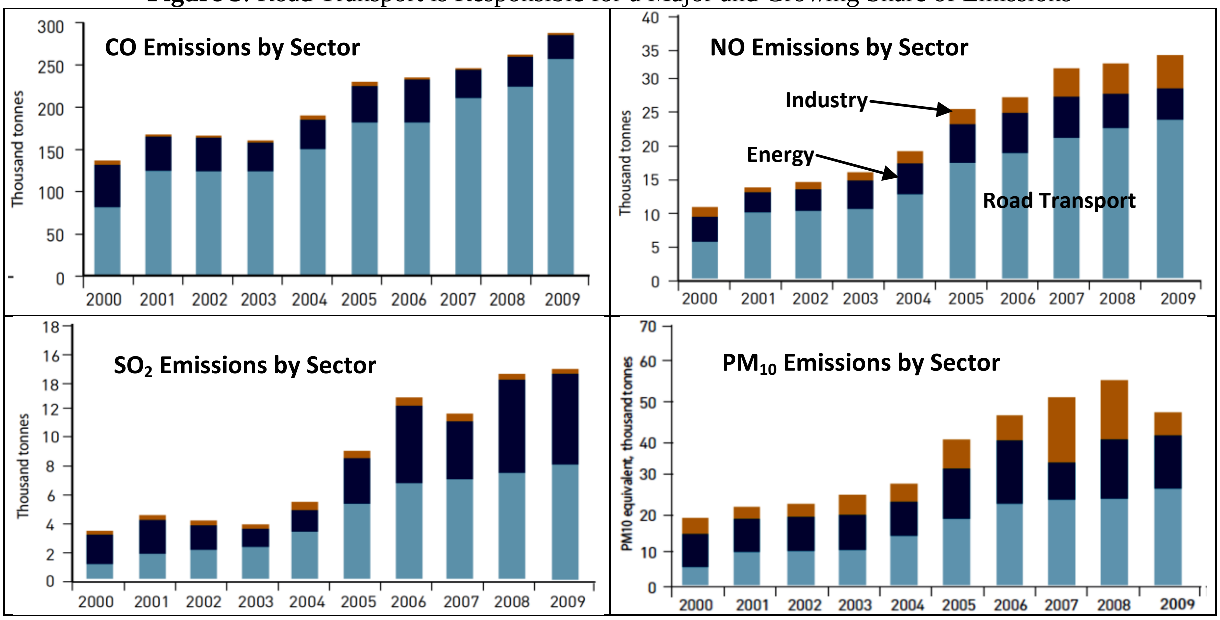
**Greening transportation would lower greenhouse gas emissions from road transport, contributing to the global public goods**. Transport sector accounts for about 40 percent of Georgia's $CO_2$ emissions. According to International Energy Agency (IEA), in 2009, CO2 emissions from road transport were 2 million tons and other transport sectors 0.2 million tons, of the total of 5.7 million tons. The share of transport sector is expected to grow as mitigation in other sectors, such as building and industry, is relatively easier.

**Also lowered would be vehicle emissions of major local air pollutants thereby reducing health costs and improving the quality of life for Georgians.** In Georgia the main source of air pollution is road transport, which emits a major and growing share of most pollutants, including carbon monoxide (CO), hydrocarbons (volatile organic compounds and methane), nitrogen oxides ($NO_x$), sulfur dioxide ($SO_2$), soot, benzopyrene and particulate matter (PM) (Figure 3). These pollutants are present in areas with intensive traffic—large urban areas and along main road corridors—most acutely observed in Tbilisi, where emissions of these pollutants incur substantial health costs. They contribute to eye irritation, respiratory diseases, cardio-pulmonary damage and premature death.[2] A comparative example is Mexico City; a World Bank study estimated that reducing local ozone concentrations and emissions of particulate matters by only 10 percent would save annual health costs up to US$1,607 million for Mexico City

[1] WDI (2011)
[2] ENVSEC (2011)

metropolitan area.[3] Although Georgia's cities have lower levels of individual vehicle use, minibus fleets have high emission intensity, contribute to congestion and disrupt traffic; emissions from other vehicles are also rising.

**Figure 3**: Road Transport is Responsible for a Major and Growing Share of Emissions




*Source: Ministry of Environment Protection (2009)*

### *Future Prices of Petroleum Fuels and Carbon Emissions*

**Policies for green transportation would prepare the Georgian economy for future changes in fuel prices and a potential international agreement on pricing carbon emissions.** Either scenario is likely for the global economy in the near future. First, continued economic growth and rising demands for private vehicles and energy in developing countries would continue to drive oil prices higher, which would raise the oil import bill for Georgia. Second, internationally coordinated climate change mitigation efforts would set a high price on carbon emissions, which could curtail oil price rises. To stabilize the GHG concentration in the atmosphere to a level that limits the global temperature increase to within 2ºC, the U.S. Department of Energy estimates that the global carbon price, implemented as a global carbon tax, would need to be US$50 per ton today and increased to US$700 by 2100. This lower bound of carbon prices assumes an immediate international agreement and global compliance. Delay in implementing a carbon pricing regime would lead to much more rapid increases of future carbon prices.[4] On the other hand, estimates from the International Energy Agency assumed that tightening private vehicle technical standards would achieve a 30 percent reduction in fossil fuel use by transport by 2050, although stricter private vehicle emission standards means higher capital costs for private vehicles, estimated at US$4,500 billion by 2050.[5] Such costs will affect lower-income households disproportionately, including Georgian consumers, compared to the effect on consumers in higher-income countries.

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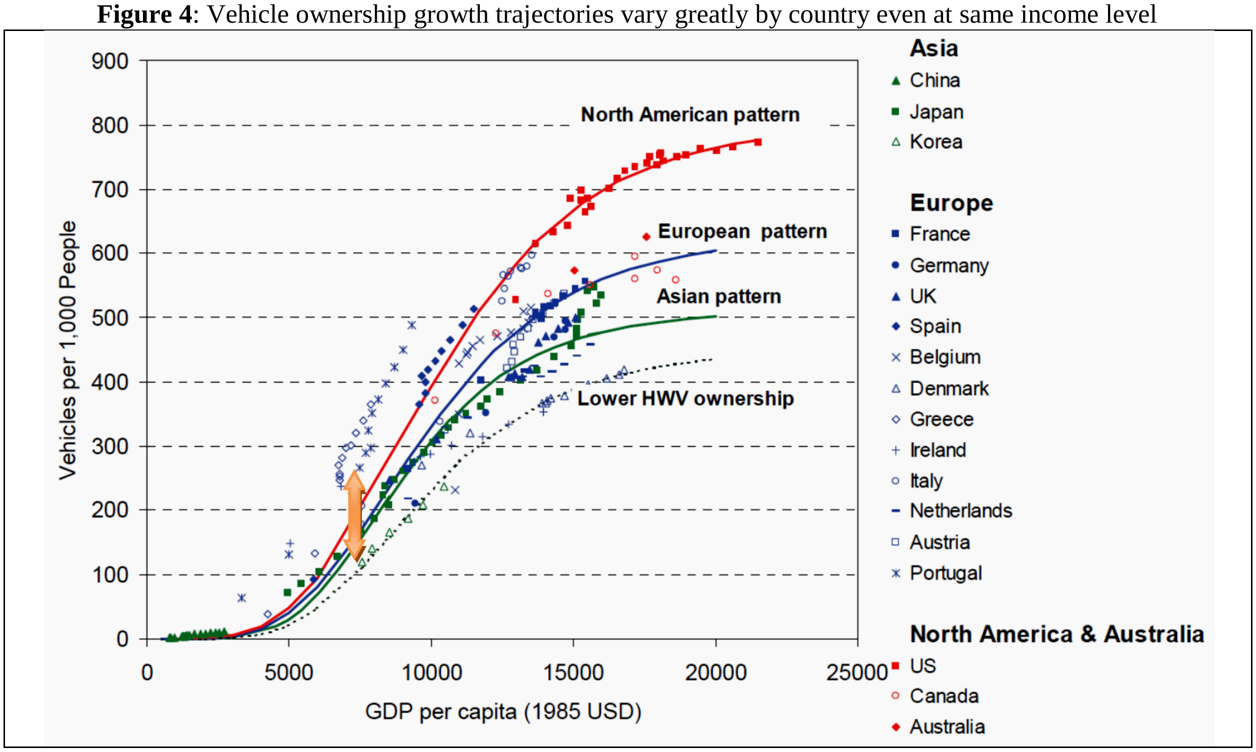
[3] Cropper et al. (2002)
[4] Edmonds, Clarke, Wise and Lurz (2007)
[5] IEA (2009)

In either case, Georgia and other non oil-producing countries are likely to face high costs for fossil fuel usage—paid at the pump, through high carbon prices or through higher vehicle prices due to stricter technical standards. Therefore, investing now in infrastructure for low-emission modes will help insulate Georgia from the almost inevitable rise in oil and carbon prices, reduce transportation costs, and improve national energy security.

## C. What is the Rationale for Government's Involvement in Greening Transportation?

**Because of its long life, investing in transport infrastructure will shape transport modal choices and hence potentially lock in the long-run trajectory of transportation costs.** Transportation planning and infrastructure development affects spatial development, generation of agglomeration economies, and consumer choices and behavior; the long lifespan of infrastructure would have a persistent effect on transport system emission intensity. Development of transport infrastructure, which lowers transportation cost, would ultimately encourage spatial concentration of production centers. International experience also suggests that this increases the economic weight of major cities, resulting in higher macroeconomic productivity.[6] Urban land-use policies in particular influence the choice of lower emission modes in a multi-modal transport system. Transport infrastructure has a long lifespan, thus its modal composition has a persistent effect on transport system emission intensity.

**Figure 4**: Vehicle ownership growth trajectories vary greatly by country even at same income level




*Source: Argonne National Laboratory (2006)*

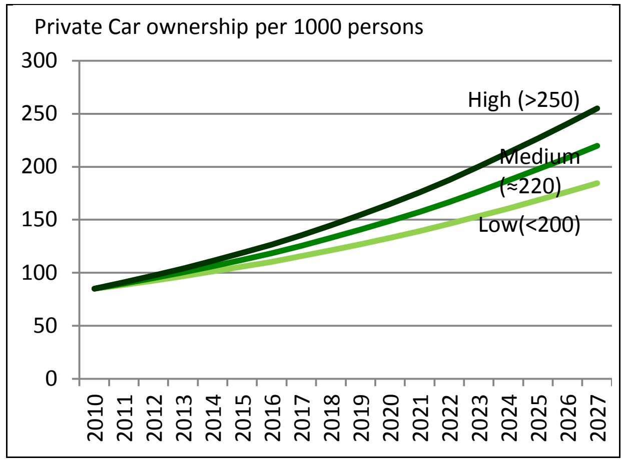
**High-income countries have ended up at very different levels of motorization rates, suggesting that economic growth and motorization can be decoupled to a certain extent.** Figure 4 shows that, for example at GDP of US$ 7,500 per capita, car ownership of high-income countries ranged between 100

[6] World Bank (2009); Ciccone and Hall (1996); Glaeser and Mare (2001)

and 300 cars per one thousand people. East Asian countries are at the lower bound, North American countries at the upper bound, and Western European countries in between. What sets them apart includes transport infrastructure development, spatial development plans, and fiscal policies on fuel use and transport (see Section II for description of instruments and impacts). This strongly implies that decisions made now in lower middle-income countries, such as Georgia, regarding planning, infrastructure development, and policies would establish the direction for development over the longer-term.

**When Georgia reaches US$ 7,500 per capita GDP, will there be low or high vehicle ownership, relative to income level?**[7] Assuming an average growth rate at 7.0 percent per year, Georgia's GDP per capita could be around US$7,500 in 2027. Figure 5 shows estimated motor fuel consumption over the next 15 years by motorization scenario. Under a low motorization scenario, whereby Georgians in 2027 own fewer than 200 vehicles per 1,000 inhabitants, the entire transport sector fuel consumption during 2012-2027 will be 22.6 million tons, and CO2 emissions will be 69.3 million tons. In comparison, under a high motorization scenario, whereby Georgians own more than 250 vehicles per 1,000 inhabitants, transport sector fuel consumption during the same period will be 24.4 million tons, and CO2 emissions 74.3 million tons, about 7-8 percent higher than the lower bound estimate.[8]

**Figure 5**: Possible trajectories of motorization rate growth in Georgia




*Source: World Bank staff estimation using Gompertz Function and data provided by the Ministry of Internal Affairs, assuming GDP growth at 7% per year*

**To improve transport sector efficiency, Government intervention is necessary to correct market failures.** Market failure occurs when there are large negative externalities. As in any other sector, efficiency in transport is determined by service providers reacting to costs and profit opportunities, and users reacting to prices and benefits. In Georgia, large external costs associated with the transport sector exist but are not reflected in market prices; these include local air pollution, GHG emissions and negative impacts of climate change, traffic congestion, and deterioration of transport infrastructure. Under the current market-based approach, transport service providers do not and will not the bear the cost of the negative externalities they generate—for instance, harmful gases emitted from minibuses—until government intervention forces them to reduce emissions or pay for the externalities.

**These distortions are likely to remain in transport services unless Government intervenes.** Transport sector service providers need to be guided to reduce these costs through modal structure choices. Measures to correct market failures will be felt more strongly in sub-sectors with higher emissions because their market share will decline. In Georgia's urban sector, this affects primarily the supply structure for passenger transport among light rail, buses, and old and new mini-buses. In freight transport,

[7] It should be noted that not only ownership but also use of vehicles shapes the energy/carbon intensity of transport sector. Many cities implement policies that aim to discourage the use, not ownership, of private cars. Nevertheless, there is long-term correlation between vehicle ownership and energy/carbon intensity.

[8] Estimation was done using the EFFECT framework based on data provided by Georgian entities. Detailed results are in Chapter IV; assumptions and methodology are described in Annex 1.

it affects the modal share between rail and road. Corrections of externalities need to be introduced as close as possible to their source. Regulating external costs requires establishing technical standards to implement technology substitution; local pollution should be reduced by charging for emissions of specific pollutants—for example, GHG emissions are addressed by fuel taxes and other fiscal measures. The ideal instruments are often proxied by other measures, which avoids high implementation costs. For instance, tailpipe pollutants are difficult to monitor, so charges for local emissions are usually approximated by charges per vehicle-km, differentiated by vehicle type.

# II. Defining the Goal, Principle, Instruments and Scope

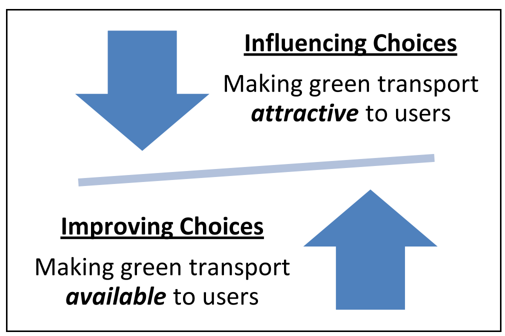
## A. Goal: Reduce Total Cost of Transportation

Rising demand for transport would increase local pollution from fuels, which would increase health costs and other environmental impacts for Georgian citizens. Rising levels of congestion would increase travel times and safety risks.[9] If fossil fuels remain the dominant source of energy for transport, Georgia will continue to be dependent on energy imports and economic growth will be constrained by current account deficits. Finally, rising GHG emissions would continue to concentrate in the atmosphere, contributing to global warming.

Therefore **the primary goal of the green transport policy framework is to reduce the total cost of transportation including all direct and indirect costs, while maintaining total social welfare benefits**. Direct and indirect costs borne by private parties would be lowered through fair competition among modes and operators. Indirect costs borne by society would be reduced by mechanisms that internalize quantifiable external costs.

## B. Principle: Influence and Improve Transport User Choices

**At the heart of green transportation is consumer choice—the choices each transport user faces—whether to move, when to move, which route to take, which mode and vehicle to use** and so forth. In the aggregate, transport user decisions determine how green transportation is, and affect environmental sustainability and economic development. In Georgia, these choices also affect the levels of national dependence on petroleum products, air pollution, transport costs, and labor productivity. Therefore the policy framework for green transportation must shape consumer choices by including factors that affect their decisions.




**This paper proposes a policy framework that will influence and improve transport user choices in ways that support environmental sustainability and economic development**. Georgia has progressed admirably toward a market economy, thus an important policy goal would be to minimize negative impacts on the environment and the economy from transport choices made by users, but *without undermining the market economy*. This requires Government to intervene to correct market failures and inefficiency by influencing choices—without imposing solutions.

**Influencing choices: Government needs to implement demand-side measures that include incentives for transport users to choose greener transportation, principally by strengthening the regulatory and fiscal framework**. Market inefficiencies are present in several subsectors, including urban transportation and freight transportation; these inefficiencies reward consumer choices that benefit individual transport users at the expense of overall society. For instance, a transport service provider that operates old vehicles is likely to incur low capital cost due to the low value of the vehicles. However,

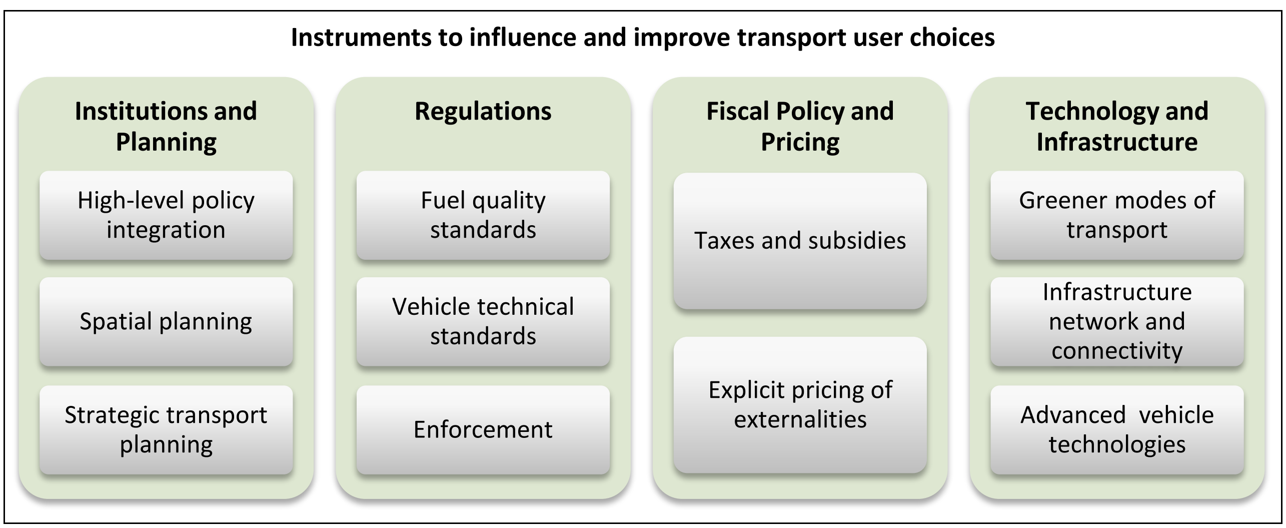
[9] During 2000-2005, vehicle ownership increased from 80 per 1000 inhabitants to 100 per 1000 inhabitants. (Department of the Patrol Police) Increase vehicle ownership per capita has outstripped road capacity increases.

services provided by such vehicles generate larger externalities, as they emit a greater amount of pollutants and have a higher likelihood of vehicle breakdown that could threaten road safety, compared to those by newer vehicles (hence cleaner and more fuel-efficient). While savings in capital costs are enjoyed by transport users who pay low fares, the cost of externalities is borne by society—affected individuals and tax-payers—in the form of health costs, discomfort, environmental deterioration, traffic collision injuries and casualties, and potentially declining land values. This discrepancy between the two marginal costs—one borne by the society and higher, and the other borne by users and lower—needs to be narrowed. This would in effect make users consider not only their benefits but also negative externalities to society that their choice of transport options may bring about.

**Improving choices: On the supply side, the Government role is critical to developing infrastructure, catalyzing innovation, and advancing technology that would provide more green transport options for users**. First, how the transport network infrastructure is built up and connected determines how each transport mode performs and how transport services are provided. Long-term plans for transport network development and investment priorities need to factor in how they create and impact green transport options. For instance, good intermodal connections combined with an appropriate pricing policy to influence consumer and provider choices could offer multi-modal transport options that are cheaper and greener than single-modal options; high-quality well-connected public transportation services could compete favorably with private vehicle use. Second, innovation and technology such as new vehicle technologies, alternative fuels, new transportation modes, new urban development approaches, and transport logistics innovations contribute to fostering green transportation. Government can initiate and implement innovative measures. Perhaps more importantly, Government can be a catalyst for innovation and adoption by creating an enabling environment for industry and rewarding high-impact solutions and good practices.

## C. Instruments: Tools to Influence and Improve Transport User Choices

Under the principle laid out above, this study proposes a policy framework for green transportation that blends various individual measures, each of which falls under one of the following instruments: (i) institutions and planning, (ii) regulations and enforcement, (iii) fiscal policy and pricing, and (iv) technology and infrastructure.



**Institutions and Planning**. Strong institutions and good planning are the first-order necessary condition for successful policies. Particularly relevant in the context of green transportation are the following areas.

- High-level policy integration. Greening agenda is highly inter-sectoral and interdisciplinary, encompassing policy issues of various sectors, including environment, energy, industry, trade, and transport. High-level policies that go beyond sectoral goals and interests would minimize redundancies and conflicts, while maximizing the collective benefits.
- Spatial planning. Spatial development—the location of agglomerations such as industries, tourism destinations, and human settlements and their interactions—affects travel patterns and intensity, and *vice versa*. In the context of intercity transport, the location of major industries and cities and how logistics chains develop collectively determine overall transport costs and affect productivity. In the context of inner-city transport, physical layouts, land-use allocations, and development densities are key parameters that shape travel patterns.

**Regulations**. Regulations are explicit legal instruments that public authorities can use to control supplier and consumer choices to achieve desired policy outcomes. While over-regulations are viewed to undermine market principle, when appropriately targeted and enforced, regulations are effective tools to correct excessive externalities. Examples of instruments specific to green transportation include the following:

- Fuel quality standards. In many countries, various chemical characteristics of motor fuels—lead, sulfur, oxygenates and aromatic content—are subject to government regulations. Each of these chemicals affects various aspects of pollutant emissions.
- Vehicle technical standards of vehicles. Many countries specify vehicle emission standards that define limits for exhaust emissions by pollutant type, and maximum fuel consumption rate by vehicle type (gasoline mileage), applied to all new vehicles sold nation-wide. Some countries rely on voluntary agreements with vehicle manufacturers (e.g., the European Union), other countries specify and enforce obligatory limits (e.g., the United States).[10]
- Enforcement. Strong and cost-effective enforcement of standards on fuels and vehicles is a critical element of any regulatory framework. Enforcement can be particularly challenging when the governance is weak, as the increased contact between public officials and citizens could spawn petty corruption.

**Fiscal policy and pricing**. Often substituting or complementing regulatory measures, fiscal incentives can affect transport user behaviors through market mechanism. Compared to regulatory measures, fiscal policies entail lower administrative costs and governance risk associated with enforcement. On the other hand, the outcomes of fiscal policies are less certain than those of regulatory measures, since they depend on how tax payers and users respond to monetary incentives.

- Internalizing externalities. Road users make a decision on trips based on the personal costs (e.g., depreciation of their vehicles, cost of fuel and parking, value of their time), but not based on the impact of their trips on air pollution, congestion, or any other negative impacts on society as a whole. Similarly, drivers that use fuels with a high content of pollutants are unaware of, and not held accountable for, the health costs due to transport emissions. As a result, road users tend to

[10] Monsalve (2012)

drive and pollute more than they would have if they were to bear the full cost of the transport services that includes the social costs of air pollution and congestion caused by them. This increases pollution and congestion, and consequently, social costs in form of health costs and productivity loss. Pricing and charges, if set at rates that reflect the monetary value of damage to infrastructure assets and health costs caused by transport emissions and safety risks, would give incentives to transport users to make greener and safer choices, contributing to green transportation. The pricing tool to correct externalities—internalization of external costs—is central to the European Commission strategy to achieve an efficient transport sector.[11]

- Taxes and subsidies. Taxes and subsidies on fuels and vehicles that are designed to vary on the basis of their impacts on the environment can be a cost-effective tool to incentivize green transport behaviors. Fiscal measures can be designed revenue-neutral and progressive. For instance, increased fuel tax revenues from lower quality fuels can be used to reward greening behavior, in form of subsidies or tax breaks on vehicle retrofitting.
- Explicit pricing of externalities. To explicitly charge for externalities, many countries implement various forms of road user charges, such as distance-based road user charges, road tolls, vignettes, congestion charges, and distance-based automobile insurance, among others (see Box 1).

**Box 1. A Typology of Road Use Charging Principles**

Road use charging (RUC) is a mechanism whereby charges are directly linked to the actual use of road infrastructure. RUC can be used solely to raise revenues, or it can be a more sophisticated mechanism to influence user behavior. It is useful to differentiate between the two situations in which RUC is applied: (i) Road segment based charges, for travelling on specific segments of the road network, such as tunnels or along motorways; and, (ii) Zone-based charges that are imposed over a specified area, for example portions of a city or even an entire country.

**Area Licensing**: License provision enables users to enter a defined area; the license can be paper or electronic and is linked to a registration number. It does not restrict the number of journeys 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**: A linear cordon is set up and charges occur at access points to the zone. The user pays a charge per crossing into the zone, or time-based charges for being in the zone. This road charge is versatile and can incorporate variables such as vehicle type, time of day, etc. However, one disadvantage is that road users can avoid paying the charges by traveling the perimeter of the zone, thereby increasing congestion *outside* the zone.

**Distance-based charging**: The fee levied is proportional to distance travelled, and in simple terms, fees more accurately reflect pollution costs. An urban cordon could be defined and charges levied according to distance travelled within the cordon.

**Time-based charging**: Drivers are charged based on time spent on specified roads, or in an urban area within a cordon. During periods of higher traffic congestion drivers would pay more so this would provide an incentive to enter the zone at less congested/costly times. Time-based charges can result in undesirable outcomes such as encouraging drivers to speed to reduce the time spent in charging zone.

**Congestion charging**: It is generally accepted that congestion is undesirable. Satellite positioning and roadside sensors make it possible to detect whether a particular vehicle is contributing to congestion and assign charges to the owner. Congestion charges are levied according to traffic conditions and defining what constitutes congestion is critical to scheme implementation and levying user charges.

*Sources*: Oh et al (2009); University of Nottingham (http://www.nottingham.ac.uk/transportissues/cong_roadcharging.shtml), re-quoted from Monsalve (2012)

**Technologies and infrastructure**. Globally, vehicle technologies, transport infrastructure and operating systems are rapidly advancing in response to rising demand for high-quality transport services and fewer harmful effects on quality of life.

[11] EC (2011)

- Greener modes of transport. Many cities have succeeded in developing and implementing modern, high-speed, high-capacity and high-quality public transportation systems.
- Infrastructure network and connectivity. Well-developed transport network and advanced transshipment technologies can improve overall throughput and intermodal connectivity at key transport hubs and junctions, both in terms of capacity, time and costs. Improved connectivity between modes can induce modal shift from highly flexible modes (such as road transport) to less-flexible but lower-cost modes (possibly railway), especially for long-distance trips.
- Advanced vehicle technologies. Mechanical improvements have contributed to better fuel efficiency of internal combustion engine vehicles: tires with low rolling resistance, improved aerodynamics, decreased vehicle weight, and energy-efficient electric components. Facing stricter standards, vehicle manufacturers are likely to continue improving fuel efficiency and emissions of internal combustion engine vehicles. In the future, wider introduction of hybrid engines coupled with electric technologies is expect to contribute to substantial improvements in fuel economy.[12]

## D. Scope: Transport Network and Key Sub-sectors in Georgia

This study covers the overall transport network development and demand, as well as specific issues of key sub-sectors, including international freight transport, interurban passenger transport, and urban transport. Overview of the transport sector is as follows:

**Georgia's transport network and modal share**. Roads and railway are the backbone of Georgia's transport network. The total length of road network in Georgia is over 20,000 km, of which about 1,500 km are international roads. The operational length of railway network is about 1,326 km, of which about 293 km is double-tracked and 1,251 km is electrified. There are four seaports in Poti, Batumi, Kulevi and Supsa, which together handled about 23 million tons of dry and liquid cargo and about 226,000 TEU of container cargo in 2010. Civil aviation carries marginal share of total transport but its volume is growing rapidly. Modal share of passenger and freight transport is shown in Table 1.

**Table 1:** Transport modal share in Georgia

| Transportation Mode | Cargo Transportation (million tons) | | | Passenger (million) | | |
|---|---|---|---|---|---|---|
| | 2009 | 2010 | Change (%) | 2009 | 2010 | Change (%) |
| **Railway** | 17.1 | 19.9 | 16% | 3.1 | 3.2 | 3% |
| ***o/w Liquid cargo*** | *9.7* | *11.5* | *19%* | | | |
| **Road** | 28.2 | 28.5 | 1% | 309.5 | 317.9 | 3% |
| **Civil Aviation** | 0.0122 | 0.0154 | 26% | 0.772 | 0.918 | 19% |
| **Total** | **45.3** | **48.4** | **7%** | **313.4** | **322.0** | **3%** |

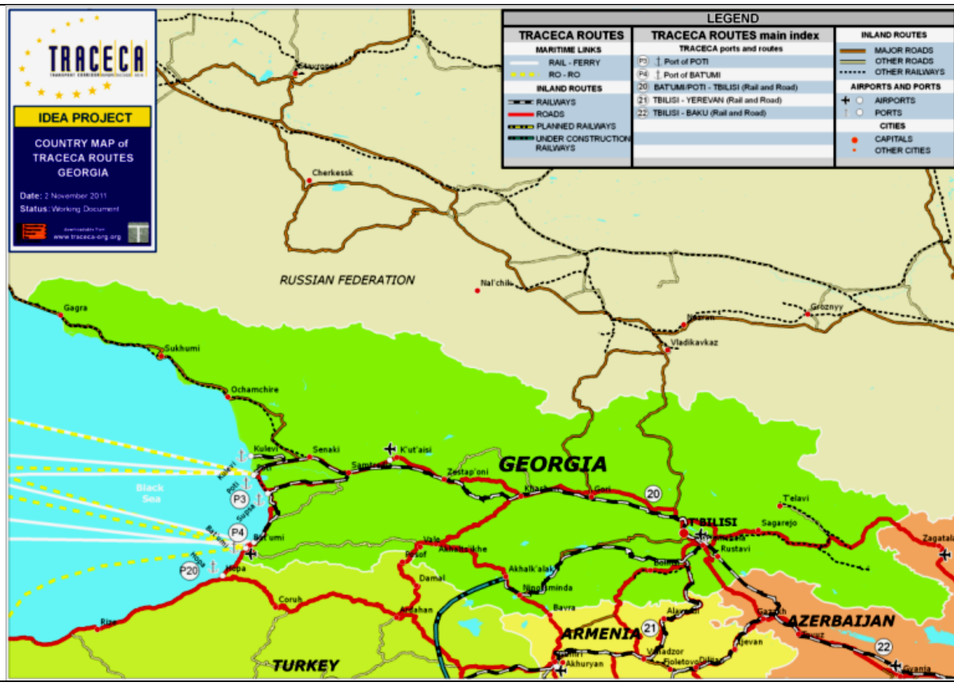
*Source: The Georgian Ministry of Economy and Sustainable Development (2011)*

**Transit corridor**. Georgia is located along an important international and regional corridor, Transport Corridor Europe – Caucasus – Asia (TRACECA), and well placed to absorb growing transport demands. TRACECA corridor through Georgia is the shortest route between Europe and Azerbaijan, Armenia and the Central Asian Republics through its Black Sea ports (Figure 6). The TRACECA corridor includes roads, railways, pipeline infrastructure and shipping routes, and connectivity and trading with its

[12] Global Fuel Economy Initiative (2010)

neighbors, both transit and bilateral, is important to Georgia's economy.[13] The Government recognizes that in order to realize this potential, significant investment is required to rehabilitate and modernize aging infrastructure, including rail, roads and port.[14] The Ministry of Economy and Sustainable Development through its Transport Policy Department formulates main directions of the transport sector policy.

**Figure 6**: International Transport Corridors and Major Intermodal Junctions in Georgia




*Source: TRACECA Website (www.traceca-org.org)*

[13] The most important trading partners of Georgia are mostly its neighboring countries, Turkey, Azerbaijan, Ukraine, Russia, and Kazakhstan, followed by Western European, East Asian and the United States.

[14] World Bank (2009)

# III. Policy Framework for Green Transportation in Georgia

This paper proposes a policy framework for green transportation comprising six major measures that would require legal/regulatory reforms, institutional changes and capital investments: (i) Integrate environmental concerns into transport policy; (ii) Achieve and maintain a greener vehicle fleet; (iii) Promote low emission freight transport modes through intermodal connectivity; (iv) Support commercial development of intercity passenger transport services; (v) Transform minibuses and taxis into modern urban transport modes; and (vi) Support sustainable development of urban transport.

## A. Integrate Environmental Concerns into Transport Policy

***Why this measure?***

**Current condition: no environmental objectives are reflected in transport policies and a regulatory framework exists only on paper without being enforced**. Government aspires to achieve green transportation, but the existing transport policy in Georgia is silent about the growing impact of the transport sector on the environment. The Ministry of Environment Protection assessment of national environmental status revealed the critical link between road transport and compromised air quality (Figure 3), but so far these findings have not influenced transport sector policies or regulations. During the reforms, mandatory inspections of motor vehicles and fuel quality and the entire agency responsible for vehicle inspections were all but eliminated to end petty corruption.[15] Now fuel quality inspection and certification is voluntary and about half of total motor fuel consumption consists of cheaper relatively lower-quality petroleum products from Azerbaijan. Because car owners have access to cheaper, low-grade petroleum, some disabled the catalytic converters in newer vehicle imported from Europe in order to run on lower-quality fuels.[16] Vehicle emission standards are now enforced only for vehicles operated by international transport service providers, which are a fraction of Georgia's entire vehicle fleet (see Section III.B for detail). Presidential Decree No. 302 issued in 2001 laid out a regulatory framework to reduce negative environmental impacts of motor transport;[17] however, it was never implemented and was later annulled in 2006.

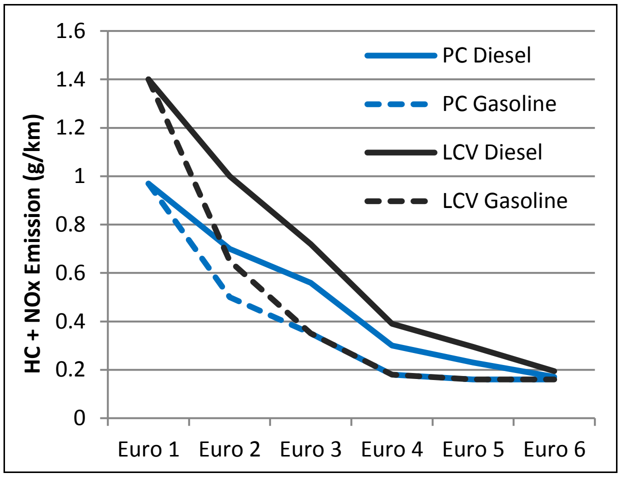
**Rationale for change: need for government intervention to change consumer choices**. Higher-income countries with greater motorization rates have learned that transport sector environmental issues cannot be addressed simply by retrofits or technological fixes, but only by influencing choices and behaviors of transport users.[18] Unlike other sectors, transport sector environmental impacts result from aggregated consumer choices, for instance, millions of urban dwellers who face the daily decision of whether to drive or use public transport and a number of freight forwarding companies that choose their routes among alternative corridors and modes.[19] The need to influence decisions of many constituencies on a massive scale requires a comprehensive framework for greening transportation that integrates environmental

[15] World Bank (2012); discussions with Georgia Union of Oil Products Enterprises Importers and Customers
[16] World Bank (2011)
[17] The Decree covered three main areas: (i) improving vehicle technical standards to align with European standards and establishing certification entities and inspection arrangements, (ii) vehicle retrofitting and improving fuel quality to comply with international standards, and (iii) utilizing transport waste.
[18] European Commission, Directorate-General Environment (2003)
[19] On the contrary, in the power sector, Government can reduce harmful environmental effects by improving a few point sources such as major power generators because end users do not differentiate among energy sources, such as coal or solar, unless they have different price tags.

concerns into transport policy. This framework then needs to be implemented and enforced, which cannot be left to the market. Appropriate government intervention is necessary.

**Rationale for change: local emissions vary greatly by fuel quality and vehicle standards; therefore, environmental policies should target them to effectively curtail emissions at source.** Recently, Georgia raised fuel standards [20] and enforcing them would greatly improve ambient air quality. The U.S. Environmental Protection Agency (EPA) tests showed that when the sulfur content of gasoline is increased from 30 to 330 ppm, emissions rise substantially, ranging 14-40 percent increase of HC and 8-134 percent increase of NOx[21]. Reducing sulfur levels in diesel fuel reduces PM emissions greatly. Tests on Japanese diesel trucks showed that by reducing sulfur content from 400 to 2 ppm, the PM emissions would be halved. Similarly in the US, a reduction of diesel sulfur content from 368 to 54 ppm resulted in a 14 percent reduction of PM emissions.[22] European Union standards on vehicle emissions have been cut drastically since early 1990 when Euro 1 standards were first defined. The Euro 4 standards that took effect in 2004 specified that the maximum allowed level of combined HC and NOx emissions is to be reduced by a third for diesel vehicles, and less than a quarter for gasoline vehicles (Figure 7).

**Figure 7**: European Union Vehicle Emission Standards for HC and NOx




*Source: Relevant EC Directives*
*Note: PC means passenger cars, LCV light-duty commercial vehicles weighing between 1305-1760 kg*

***How can this be done?***

**Institutional: integrating transport policy and environmental monitoring**. Georgia can foster policy integration by lowering institutional barriers among sectors and sub-sectors within government. The Ministry of Environment Protection is the logical choice to remain responsible for regular monitoring and assessment of national environmental status. Government should initiate a formal process to integrate environmental assessment results with transport sector policy-making at the level of central government and city administration[23]. An integrated transport policy should specify that air pollution reduction is an objective and set realistic target emission levels that can be achieved by a budget-constrained action plan against the baseline. Inter-ministerial collaboration is critical for data sharing, knowledge exchange, policy-making and implementation. Potential collaboration methods include consulting with the environment ministry or environmental experts to ensure that transport policy and action plans are technically feasibility and consistent with other elements of environment policies.

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[20] The Regional Environmental Center for the Caucasus (2008): Beginning in January, 2010, the allowable lead content of gasoline was adjusted from 0.013 to 0.005 g/L, and sulfur content of diesel from 350 to 50 ppm.
[21] Koupal (1999)
[22] Manufacturers of Emission Controls Association (1999)
[23] Government entities include the Transport Policy Department under the Ministry of Economy and Sustainable Development and the Ministry of Regional Development and Infrastructure.

**Regulations and enforcement: reinstating fuel quality inspection**. To control the quality of motor fuels, several other former Soviet Union countries have employed regulatory and fiscal measures that are more strict and comprehensive than those in Georgia, as summarized in Table 2. The Presidential Decree 302 (2001), which envisaged upgrading motor fuel quality in Georgia to European standards, needs to be revisited. Guidelines and regulations on quality norms on motor fuels should be strictly enforced, rather than relying on the current voluntary agreements.[24] It should be feasible to implement this policy at low transaction costs because only a few companies in Georgia import petroleum products. Tighter regulations are unlikely to result in supply shortages; in fact worldwide, most countries enforce strict standards on pollutants per unit of gasoline or diesel, including European countries from which Georgia imports about half of its petroleum demand.

**Table 2:** Measures that promote cleaner fuels in Eastern Europe, South Caucasus and Central Asia

| Country | Measures |
|---|---|
| Armenia | • Production and importation of leaded petrol banned from September 29, 2001<br>• Rates of environmental tax of vehicles depend on type of fuel used;<br>• Possibilities and potential of bio-fuel production being considered. |
| Azerbaijan | • Leaded gasoline production stopped since 1995;<br>• Harmonization with EU requirements of standards for diesel fuel;<br>• Imported fuel-lubrication materials planned for 2008-2012 |
| Moldova | • Use of leaded petrol banned from September 1, 1998<br>• Importation, storage and trade of leaded petrol prohibited in 2002<br>• Environment pollution tax for leaded petrol and diesel fuel double that of unleaded petrol<br>• Planned reduction of sulfur content in fuel<br>• State stimulation of bio-fuel indicated in law<br>• State energy strategy implies transposition of directive 2003/30/EC into national legislation by 2020 and increased use of cleaner fuels including gaseous motor fuel. |
| Russia | • Production and use of leaded gasoline is banned by federal law of 22.03.2003<br>• Stricter limits for sulfur, benzene, aromatic hydrocarbons contents set for fuels sold in Moscow<br>• Implementing Moscow government program to use alternative fuels (natural gas, synthetic, etc.)<br>• Draft technical regulations developed to introduce Euro-2, Euro-3 and Euro-4 standards for automobile fuel production and use. |
| Uzbekistan | • Elaborated national program of phasing out leaded petrol<br>• Fergana refinery eliminated use of lead additives for petrol in 2008 and is working to reduce sulfur content in diesel to 0.5<br>• Developing system of differentiated compensatory environmental payments for production and use of leaded petrol |

*Source: The Regional Environmental Center for the Caucasus (2008)*

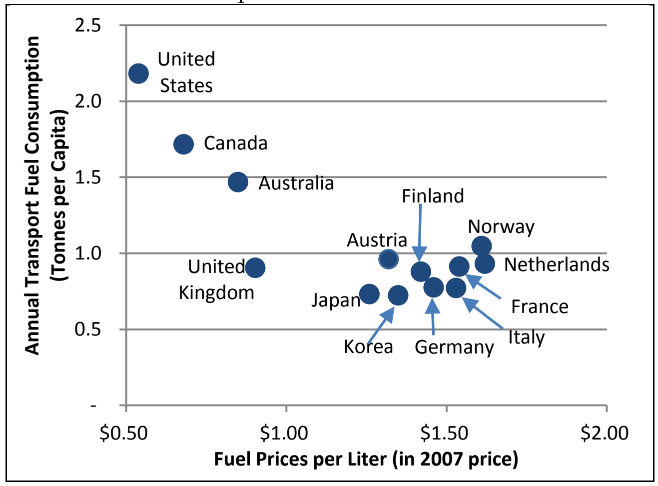
**Fiscal policy and pricing: tax on motor fuels according to quality to provide incentives to use cleaner fuels**. Another effective measure might be to institute a targeted fiscal/pricing measure to influence consumer choices on fuel type and quality; this could replace or complement regulatory measures. For instance, instead of banning motor fuels with high sulfur content, higher excise tax rates could be applied to certain classes of fuels. At the appropriate level, targeted taxes would internalize the externalities caused by road transport—pollutant emissions. The outcomes of such measures are less

[24] According to discussion with members of the Association of Oil Product Importers and Distributors in Georgia, mandatory inspections of fuel quality is said to have spawned rent-seeking activity by some officials and was abolished during the governance reform.

certain than regulatory measures, which control outcomes but offer no incentives, and would depend on fuel prices and how sensitive Georgian consumers are to price changes.

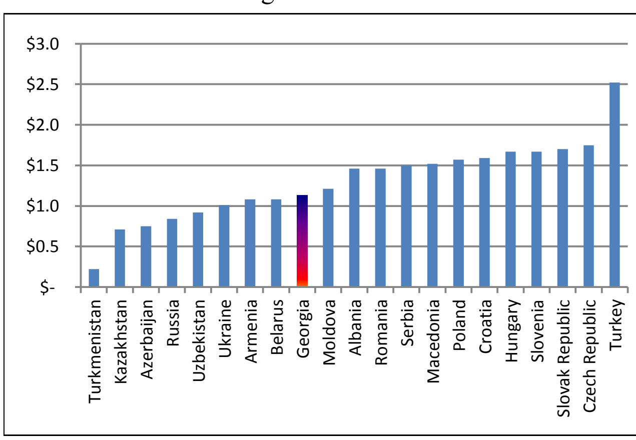
**Long-term policy on fuel pricing: maintain high fuel prices relative to income level as a long-term strategy to reduce dependence on fossil fuels**. Among high-income countries, there is strong negative correlation between prices and per capita consumptions of motor fuel (Figure 8). High fuel prices discourage vehicle usage in the short-term, and encourage structural changes in the longer term—e.g., switch to fuel-efficient vehicles, relocation of residents and businesses to public transport accessible areas, and rearrangement of logistics chains. [25] Currently, motor fuel prices in Georgia are relatively higher than prices in most other oil-producing countries, and lower than many European non oil-producing countries (Figure 9). As a share of monthly per capita income, Georgia's fuel price is higher than fuel prices in most countries with similar income levels, and lower than prices in a few countries with lower income levels (Figure 10). Given the scarcity of the fossil fuel (no domestic production) and the known long-term effect of cheap fuel prices on transport sector energy consumption trajectory, the long-term fiscal policy should aim to maintain this relatively high ratio of fuel price to income.

**Figure 8**: Correlation between fuel prices and transport fuel consumption in OECD countries



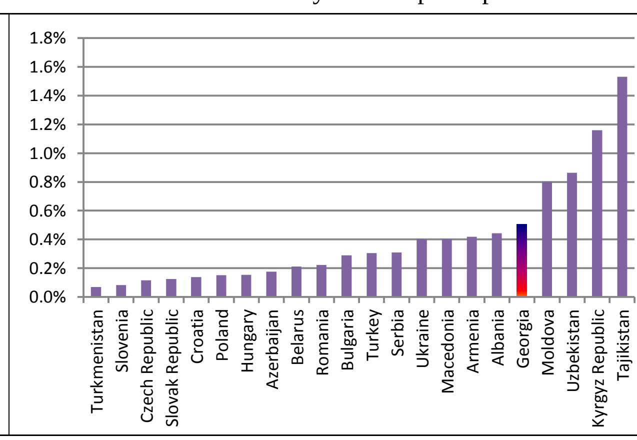

*Source: Victoria Transport Policy Institute, data from 2007*

**Figure 9**: Gasoline prices in Georgia lower than the Region's median




*Source: GIZ (2011)*

**Figure 10**: Relatively high gasoline prices in Georgia as a share of monthly income per capita




*Source: UN Stats; GIZ (2011)*

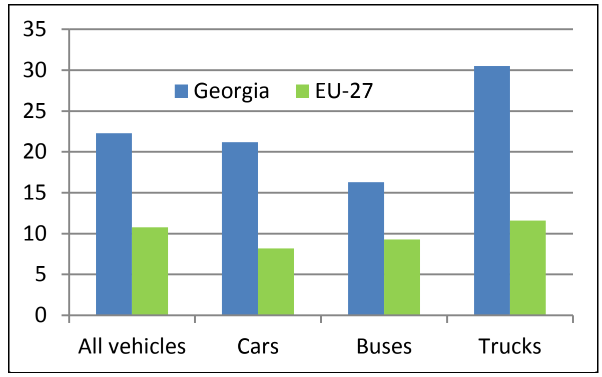
[25] Literature reveals a broad range of vehicle travel elasticity with respect to fuel price: as low as -0.1 in the short-term (i.e., 10 percent increase in fuel price resulting in 1.0 percent decrease in vehicle travel), and as high as -0.5 in the long-term (i.e., 10 percent increase in fuel price resulting in 5.0 percent decrease in vehicle travel) (Victoria Transport Policy Institute, 2011). Both short- and long-term elasticity depend on factors that affect transport choices. For example, availability of alternative transport modes, such as public transportation, enables transport users to shift away from private car use, resulting in higher elasticity.

## B. Achieve and Maintain a Greener Vehicle Fleet

***Why this measure?***

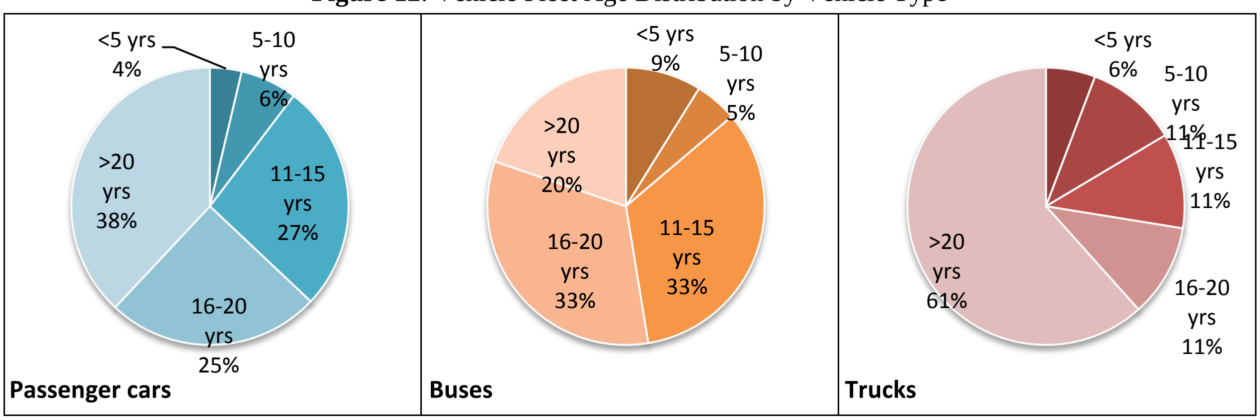
**Current condition: strong supply and demand for second-hand, older, polluting vehicles, which dominate the market**. On average, motor vehicles operated in Georgia are much older than those operated in Western European countries (Figure 11 and Figure 12), and about 98 percent of newly registered vehicles are second-hand.[26] This growing influx of old vehicles coupled with rising demand for private cars is the main cause of rapid deterioration in air quality. At present levels of economic development in Georgia, most vehicle buyers' incomes are too low to purchase newer cars, and lower customs fees for older vehicles distort the market in favor of older cars.[27] Moreover, as mentioned in Section III.A, the lack of fuel quality control leads to further degradation of vehicle condition and standards.[28]

**Figure 11**: Significantly higher average age of vehicle fleet in Georgia comparing to EU-27 countries




*Source: WB staff calculations based on data provided by Ministry of Internal Affairs; TREMOVE v.3.1, 2009*

**Figure 12**: Vehicle Fleet Age Distribution by Vehicle Type




*Source: WB staff calculations based on data provided by Georgian Ministry of Internal Affairs*

**Current condition: vehicle standards are enforced for only a small fraction of the vehicle fleet**. Georgia has adopted legislation to alight with EU standards for commercial vehicles, but regular inspection and enforcement applies only to operators of international cargo and passenger transport services.[29] Expanding the inspection scope to cover commercial vehicles operating domestic services and private vehicles appears to be a challenge, given the staffing levels at the Land Transport Agency (LTA).

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[26] Data from the Ministry of Internal Affairs

[27] According to the Ministry of Internal Affairs, Patrol Police, Custom clearing fees are three times higher for 1-2 year-old vehicles than for 7-12 year-old vehicles.

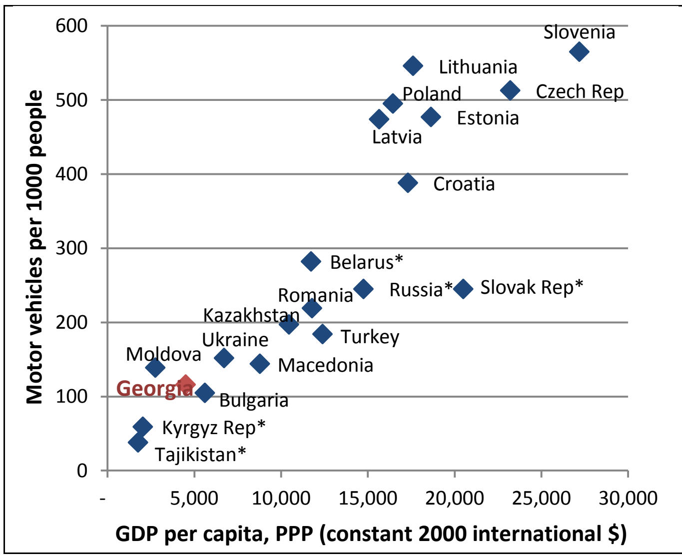
[28] World Bank (2011)

[29] This is done by the Land Transport Agency that checks stationary vehicles at depot and the petrol police that checks mobile vehicles at border crossing points and along motorways.

Only three staff in the monitoring unit now perform vehicle inspections for about 300 transport companies that own and operate about 2,000 vehicles.

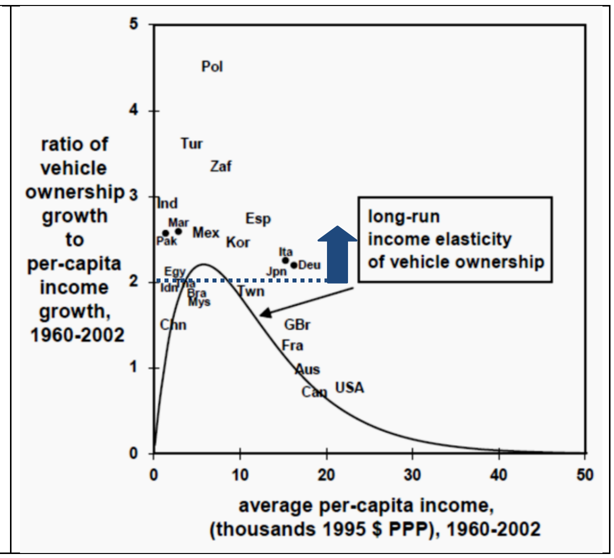
**Rationale for change: the need to influence long-term consumption patterns in the face of rapid motorization**. As incomes rise, motorization rates tend to surge (Figure 13). Typically, demand for individual car ownership and use has increased rapidly when per capita GDP reaches US$4,000–8,000 (Figure 14). If Georgia returns to the high growth rates enjoyed before the crises, these income levels could be reached in the next few years. Therefore developing a policy framework now that will provide incentives for consumers to opt for greener transport choices—such as purchasing fuel-efficient cars—will have long-term effects on the local and global public goods. This is borne out by international experience, which suggests that policies that shape consumer choices at Georgia's current income level will have enduring outcomes (Figure 4).

**Figure 13**: Strong positive correlation between GDP and motor vehicle ownership




*Source: World Development Indicators;*
*Note: Asterisks (*) indicate data from 2007, otherwise 2008*

**Figure 14**: Vehicle ownership growth much faster than GDP growth between $4,000-8,000 per capita




*Source: Dargay, Gately and Sommer (2007)*

### *How can this be done?*

**Fiscal policy and investments: scrapping-and-recycling the old and polluting vehicle fleet**. As a time-bound policy, Government can intervene in the market to remove some of the old fuel-inefficient vehicles from the road network (38 percent of passenger cars or almost 245,000 cars) that are 20 or more years old. Vehicle scrapping-and-recycling programs are fiscal policy measures that are often combined with moderate capital investments. Typically a government offers financial incentives such as tax exemptions and/or subsidies to owners of older vehicles to purchase newer and less-polluting models; sometimes a government provides financial assistance, such as cheaper financing for new vehicles or loan guarantee (see Box 2 on Cairo). Variations of vehicle scrapping-and-recycling programs have been implemented in several countries with a range of income levels; these have experienced varying degrees of success as measured by cost-effectiveness. However, the common benefit has been substantially reduced fuel consumption and emissions (Table 3).

A vehicle scrapping-and-recycling program must be carefully designed considering fiscal implications, income levels, potential revenue streams (from recycling scrapped metals), financial sustainability, and anticipated environmental and economic benefits. If not properly targeted, it could be a very regressive and expensive policy that benefits the wealthier population who can afford to purchase new vehicles and brings about little environmental benefits.[30] Moreover, in the case of Georgia, where domestic automobile industry is non-existent, vehicle scrapping-and-recycling programs could merely substitute fuel imports with vehicle imports, which is undesirable given that one of the key policy objectives is to balance the current account through reduction in fuel imports.

**Table 3**: Comparing Vehicle Scrapping Programs

| **Programs** | **US: CARS (2009)** | **France: Prime a la Casse (2009)** | **Germany: Umw-elpraemie (2009)** | **Egypt (2009-ongoing)** | **Romania (2009-10)** |
|---|---|---|---|---|---|
| Objective | Fuel economy | Reduction of GHG emissions | Fleet renewal | Air quality | Air quality; industry support |
| Eligibility of participating cars | 25+ years | 10+ years | 9+ years | 20+ years taxi | 12+ years and operational |
| Requirements for new cars | Fuel efficiency | Less than 160g CO2/km emissions | 1 year used cars allowed, minimum Euro 4 | ? | ? |
| Subsidies or tax credit per vehicle | $3,500-4,500 | €1,000 | €2,500 | $1,300-2,300 | |
| Number of vehicles replaced | 677,081 | 470,000 | 1,932,929 | 17,000 (in 2009) 49,000 (2010-18) | 221,650 |
| Government spending on subsidies/tax waivers | $2,850 million | €600 million | €5,000 million | Est. $620 million for 8 years | €216 million |
| Value of scrapped vehicles | €850 million | €555 million | €3,000 million | Unknown | Unknown |
| Fuel savings (€ million) | €20 million | €50 million | €40 million | Unknown | Unknown |
| Energy consumption reduction | | | | 2.1 MJ | |
| $CO_2$e reduction by 2025 (thousand tons) | 100 | 265 | 200 | 1,300 | |

*Source: Vigneault (2009), IHS Global Insight (2010), ACEA (2009), ESMAP (2010)*

**Box 2. Cairo's Taxi Scrapping-and-recycling Project**

**Project Overview**. In April 2009, the Egyptian Ministry of Finance, with support from the Prime Minister, initiated the Vehicle Scrapping-and-recycling Program for the Greater Cairo Region (GCR). Under this initial phase, a taxi replacement and recycling program was launched on a voluntary basis; private taxi owners receive financial and other incentives to surrender their old vehicles for new, more fuel-efficient models and the old vehicles are scrapped and recycled. The program was launched to support enforcement of Traffic Law 121, effective June 9, 2008, which targets improvements in air quality and reduction of greenhouse gases (GHG) associated with Egypt's aging fleet of taxis, microbuses, minibuses, and buses. Initially, the program focused on replacing taxis in the GCR; it was a collaborative effort between government and the private sector that offered an attractive financial package to taxi owners with vehicles that were more than 20 years old. The package includes a 25-30 percent price reduction for a new replacement vehicle, €2,500 in subsidies and tax waivers, discounted loan terms and insurance agreements, and other incentives. Total program cost was estimated at about US$620.24 million, depending on the number of

[30] For instance, the German program has been heavily criticized by environmentalists that its true objective was to support motor industry rather than to reduce emissions. Since the requirements for older vehicles that could be turned in for recycle were fairly loose (merely 9 years or older), emission reductions from vehicle replacement were marginal.

participants, share of each model, etc. The program will remain active for 28 years. During the first phase, it will replace about 45,000-50,000 taxis in the GCR. Then, in later phases, pending approvals, taxis and other mass transport vehicles in other regions would be replaced. The first phase will reduce emissions by an estimated 1.3-2.3 million tons $CO_2e$ over 10 years. Carbon financing will support the project, plus help underwrite development of a recycling facility for the scrapped vehicles. As of 2009, some 17,000 taxis had been replaced, reducing emissions by 57,233 tons $CO_2e$ and energy use by 29 percent.

***Distribution of Model Years of Registered Taxis in the Greater Cairo Region***

| Governorate | 1987+ | 1982-1987 | 1978-1982 | 1972-1977 | Before 1972 | Total | Total <=1987 |
|---|---|---|---|---|---|---|---|
| Cairo | 23,741 | 7,436 | 11,299 | 9,212 | 4,071 | 55,759 | 32,018 |
| Giza | 10,369 | 2,929 | 5,604 | 4,292 | 1,804 | 24,998 | 14,629 |
| Kalubea | 1,636 | 590 | 1,230 | 1,328 | 128 | 4,912 | 3,276 |
| **Total** | 35,746 | 10,955 | 18,133 | 14,832 | 6,003 | 85,669 | 49,923 |
| Percent of GCR Taxis >=22 years old: | | | 58% | | | | |
| Percent of GCR Taxis >=32 years old: | | | 24% | | | | |
| Percent of GCR Taxis >=37 years old: | | | 7% | | | | |

**Public-Private Partnership**. MOF's PPP scheme allows vehicle owners to receive several layers of financial incentives to participate in the vehicle scrapping-and-recycling program. MOF provides some public funding, including payments for surrendered vehicles, and exemptions from sales tax and custom fees for vehicle owners. Participating automobile dealers offer new vehicles at 25-30 percent below market rates. New vehicles are financed with a below-market-rate interest loan from participating banks, and MOF provides a loan guarantee in special cases. Owners are offered the option to participate in an advertising scheme—an advertising agency pays a portion of revenue to the lending bank to underwrite some of the vehicle owners' debt service payments. Owners pay a reduced fee for maintenance, spare parts, and insurance for all new taxis against all standard casualties (theft, fire, accidents, etc.). Under this program, 12 vehicle options are available as replacements. Incentive assistance helps vehicle owners to repay the car loan in fewer than six years, on average.

***Estimated project cost (2010-2018)***

| | No. Of Vehicles | Per Vehicle ($)* | Total (US$m) (2010-18) |
|---|---|---|---|
| | 49,000 | | |
| Max. Govt. Subsidy per vehicle** | | 911 | 44.64 |
| Tax and Custom Waivers+ | | 2,674 | 131.03 |
| Vehicle price after discounts | | 8,833 | 432.82 |
| Annual Program Coordination & Monitoring+ | | | 0.05 |
| Recycling Site Preparation** | | | 11.70 |
| **Total Estimated Project Cost** | | | $620.24 |

* Based on US$1=5.61 EGP (Egyptian pounds)
** World Bank (2010). Carbon Finance Assessment Memorandum (CFAM)
+ UNFCCC (2009). *Egypt Vehicle Scrapping and Recycling Program*. CDM SSC-POA-DD Ver. 01. Oct. 6 '09

***Estimated average benefit to vehicle owners***

| | EGP | USD |
|---|---|---|
| Vehicle Price after Scrapping and Discount | 49,554 | $8,833 |
| Total Monthly Loan Installment Including Insurance | 1,250 | $223 |
| Installment Paid by Advertising Company | 550 | $98 |
| Installment Left to be Paid by the Owner | 700 | $125 |
| Payback for Vehicle Owners (Years) | 5.9 | |

Source: World Bank, 2010

*Source: ESMAP (2010)*

**Fiscal policy: tax breaks and other financial incentives for higher fuel-efficiency and technological improvements of vehicles**. Government needs to gradually phase out the existing customs clearing fees structure, which distorts the market toward older vehicles by imposing lower fees. Instead, Government should create fiscal and financial incentives—perhaps customs clearing fees and other vehicle taxes that differentiate vehicles by fuel economy, types of fuel used, and emission standards. Some of these incentives have been implemented in other countries in the region (see Table 2). Technical retrofitting of older vehicles should be encouraged in cases where such investments are economically feasible taking into account environmental benefits (see Annex 3 for international review of vehicle retrofitting). These incentives may be combined with the taxes on motor fuels according to fuel quality (Section III.A).

**Fiscal policy: in the long-run, financial incentives for clean technology vehicles including hybrid and electric vehicles may be considered**. Currently, hybrid electric and plug-in electric vehicle production remains expensive, and even after significant subsidies to consumers, these vehicles remain unaffordable for most Georgian consumers (see Annex 2 for London's deployment program). Providing subsidies for such cutting-edge technologies would therefore be a very regressive measure that subsidizes the wealthy fraction of the population that can afford to buy very expensive vehicles. Moreover, under a policy objective to improve the balance of trade, wide introduction of electric vehicles would merely substitute fossil fuel imports with vehicle imports, unless Georgia starts manufacturing or assembling automobiles. Heavy subsidies for purchasing electric vehicles are therefore fiscally and socially unjustifiable. Nevertheless, this policy should have a place in the long-term as a measure to electrify private transportation, if and when the prices of technologies become affordable enough for the average income (Box 3), and provided that supply of electricity continues to comes mostly from hydropower.

**Box 3. Current and Future Price of Electric Vehicles**

Current prices of advanced engine technologies are substantial and would require high subsidy levels to make them affordable. Whether prices will decrease in the future depends on technological developments which are highly uncertain. Costs of alternative engines will decrease with the increasing scale of their global production and future technical change. To what extent electric vehicles will become affordable, or how much subsidy will be required for their adoption, depends mainly on progress in improving battery technologies and the reduction of battery costs. An increased battery performance will give more autonomy to electric vehicles and save time for reloading or replacing batteries. An increase in the energy intensity is particularly important for battery electric vehicles and power density for plug-in electric drive vehicles. According to the IEA, battery performance could double within the next decade or so, increasing the travel distance of a fully charged battery set to 200 km for pure electric vehicles. Battery costs depend very much on the lifetime of the batteries. Current batteries have a life cycle of roughly 1000 deep discharge cycles, with an average lifetime of 3 years. Optimistic estimates see the lifetime more than double in the near future (3 to 5 years) to a maximum of up to 10 years.

Current battery costs are in the range of US$ 700 to 1000 per kWh. Electric vehicles will need about 30 kWh for the travel capacity of 150 km. Estimates of cost reductions are based on expected innovations, learning and scale effects. They see a potential for a 50 percent reduction. An optimistic estimate would then see the battery costs come down to US$ 15,000 in 10 years. Under these scenarios electric vehicles and plug-in vehicles are expected to increase their market share to about 25 percent by 2030 on average, with higher levels in countries like Germany, France, Spain and Poland.

*Source: Nemry and Brons (2010); IEA (2011)*

**Regulations and enforcement: expanding vehicle inspection requirements to include all commercial and non-commercial vehicles to maintain a vehicle fleet that is clean, safe and fuel-efficient**. Similar to fuel quality control (Section III.A), Government needs to revisit the 2001 green transportation program, which proposed upgrading vehicle technical condition and quality in Georgia to European standards. While keeping the spirit of the said Decree, Government should establish simple administrative procedures to monitor and control the main sources of pollution, beginning with a low cut-off standard and raising it gradually over time, reinforced by strong incentives for compliance, and strong disincentives for non-compliance. International experience reveals that the most effective systems adopt standards that fail about 15-20 percent of vehicles. Standards that are too strict encourage fraudulent behaviors, and standards that are too loose are ineffective to achieve the objective of a clean, safe, and fuel-efficient fleet (Box 4). To increase compliance with inspection requirements, technical inspections must be a requirement for vehicle operation; therefore Government must require regular vehicle registration that coincides with an inspection schedule (Table 4).

**Implementing and enforcing a regulatory framework is likely to pose substantial governance and administrative challenges.** Two entities are now responsible for vehicle inspection: Land Transport Agency and Ministry of Internal Affairs, Petrol Police. Their roles are differentiated by location and methods of inspection. The LTA monitors transport companies—now limited to companies that provide international services—on a regular basis to inspect the parked vehicle fleet. The Ministry of Internal Affairs inspects individual vehicles and operators at various border crossing points and checkpoints along highways. The longer-term goal should be to inspect all vehicles registered and operating in Georgia. As Georgia's experience suggests, the challenge is that regulatory frameworks may not achieve desired outcomes; instead they may spawn rent-seeking behaviors, especially when public sector governance is weak. It is recommended that the LTA sets out guidelines and inspection methods, and then contract technical inspections to the private sector under a long-term contractual arrangement. The LTA would then manage the contract with the private concessionaire, based on their performance (e.g., adequate facilities and record keeping, number of vehicles inspected, etc.) and have minimal contact with vehicle owners and operators.[31] Administrative costs of vehicle licensing and inspection vary by the scope of the government functions and cost-sharing arrangements (e.g., how much each vehicle owner pays vs. the local authority). In the U.S., the State of Virginia requires safety and emissions inspection for all vehicles at the time of each registration updates, the State government spends about US$155 million per year, or about US$19 per capita for driver licensing, vehicle registration and inspection. In Texas, a similar program costs US$118 million a year, or about US$5 per capita.[32]

**Box 4. Essential Best Practices of Effective Vehicle Inspection and Maintenance Programs**

**Institutional Design**. A vehicle inspection/maintenance program should conduct inspections using "test-only" facilities. Policymakers must choose between relatively few centralized or "test-only" facilities, and relatively numerous decentralized or "test-and-repair" facilities. Having fewer facilities means better ability to spread costs over a high volume of inspections, thus achieving low cost per inspection and easier government oversight.

Government should set the policy framework and provide overall management of the inspection/maintenance program and private contractors perform actual inspections. This approach is contrary to a popular belief: that public services should be performed by government employees. However, experts agree that it is more efficient and effective for private firms to perform this role under government oversight. This is the same principle that drives the broader privatization movement affecting energy, water, transportation, and other sectors—*competition*. A state-owned entity with an unchallenged monopoly to provide a service often exhibits low technical competence and has few sanctions to improve poor performance or eliminate fraud among employees or the organization as a whole. A capital-starved public monopoly can be subject to budgetary pressures from external forces that threaten service quality and its ability to generate revenue, even if it is otherwise capable of providing the service in a financially viable manner.

Policymakers should exert strong oversight and institute a system to monitor quality assurance (QA) for the inspection/maintenance program to deliver on the emission reductions sought. Quality assurance also helps to maintain public confidence and support for the program. Oversight and QA involve a set of highly technical tasks that can be performed by government (if capacity exists) or contracted out in part.

Policymakers should implement inspection/maintenance programs using a phased approach that allows incremental learning, adaptation, and capacity building. Ideally, inspection/maintenance programs should begin with the vehicles that emit the most (due to their emission rates, high mileage, or both). Also, phasing in stricter emission standards is desirable to avoid failing an unacceptably high percentage of vehicles, or if the vehicle repair industry capacity is too low and needs more time to respond to the expanding market created by tighter standards.

**Test Procedures and Emission Standards**. Policymakers should set inspection/maintenance emission standards based on emission level distribution data, cost/benefit analysis for a range of maintenance levels, and an evaluation of the level of political support for various standards. Pollutants vary for gas and diesel engines (CO/HC/NOx versus PM/smoke/NOx). Standards that are either too strict or too lax are unlikely to gain support. Therefore it is recommended that during the phase-in, policymakers should set standards at levels that yield a 15-20 percent vehicles failure rate. However, this could be adjusted according to technical factors and costs. As emission standards for new vehicles are tightened, policymakers can raise standards to reflect newer technology and improved emissions performance.

**Enforcement and Compliance Promotion**. Inspection/maintenance compliance should be a requirement for vehicle operation linked to a system of mandatory periodic vehicle registration and safety inspections. Government records of vehicle ownership are a building block of a functioning society that aids in tracking vehicle status and assists governments with urban planning, tax collection, accident and crime investigation, air emission inventories and inspection/maintenance compliance. The multiple

[31] International experience suggests that handing over technical inspections to the private sector under a contract with a governmental entity is likely more effective and prevents corruption (U.S. Agency for International Development, 2004).

[32] These are actually fiscally responsible programs, as the state governments generate large revenues from various fees. In both states, revenues from licensing and registration fees are about 10-20 times greater than the cost of technical inspection and administration.

benefits should encourage policymakers to establish vehicle registration before,, or concurrent with efforts to launch or strengthen an inspection/maintenance program.

**Managing Resources**. Policymakers should set inspection fee levels to support inspection/maintenance program costs (i.e., privately operated test-only centers with strong oversight and quality assurance components). Typically, fees may appear high but are affordable to vehicle owners. Subsidies could be considered for initial capital costs for land or fixed facilities but inspection fees *must* be set at levels that cover ongoing operating costs.

Policymakers should ensure that all actors in an inspection/maintenance program have the capacity to carry out their roles, in particular the vehicle service sector. Few policymakers recognize how critical it is to build capacity to provide maintenance and repairs for vehicles that fail inspection/maintenance tests. Policymakers are encouraged to seek the support of donors and vehicle manufacturers to provide training and capacity building in the vehicle services sector.

*Source: U.S. Agency for International Development (2004)*

**Table 4**: Schedule of Compulsory Motor Vehicle Inspection in Singapore by Vehicle Age

| Type of vehicle | Vehicle age | | |
|---|---|---|---|
| | Fewer than 3 years | 3 to 10 years | More than 10 years |
| Motorcycles and scooters | Exempt | Annually | Annually |
| Cars and station wagons | Exempt | Every two years | Annually |
| Tuition cars | Annually | Annually | Annually |
| Private hire cars | Annually | Annually | n/a |
| Public service vehicles | | | |
| Taxis | Every six months | Every six months | Every six months |
| Public buses | Every six months | Every six months | Every six months |
| Other buses | Annually | Annually | Annually |
| Trucks and goods vehicles | Annually | Annually | Every six months |
| All other heavy vehicles | Annually | Annually | Every six months |

*Note: Life span of all private hire cars and taxis is seven years.*
*Source: Registry of Vehicles 1993*

## C. Promote Low Emission Freight Transport Modes

***Why this measure?***

**Current condition: international truck transit traffic is increasing, in absolute terms and relatively to total road freight transport (Figure 15) and total transit transport; the rail transport share is declining (Figure 16)**. Since 2006, total annual international freight transport by road has been growing at an average of 13 percent; annual transit cargo is growing at 21 percent per annum. In contrast, railway cargo throughput has fluctuated and declined during the recession. If these trends continue, road transit transport externalities will continue to rise within Georgian territory, including local emissions, GHG emissions, traffic congestion, and collisions and casualties.[33] In 2010, total fuel consumption by road freight transport (including both international and local goods movement) was an estimated 462 thousand tons (about 49 percent of total fuel consumption); NOx emissions 20 thousand tons (about 78 percent of total emissions), and PM emissions 900 tons (about 88 percent of total emissions), per year.[34]

**Figure 15**: The growing share of transit cargo of total international road transport

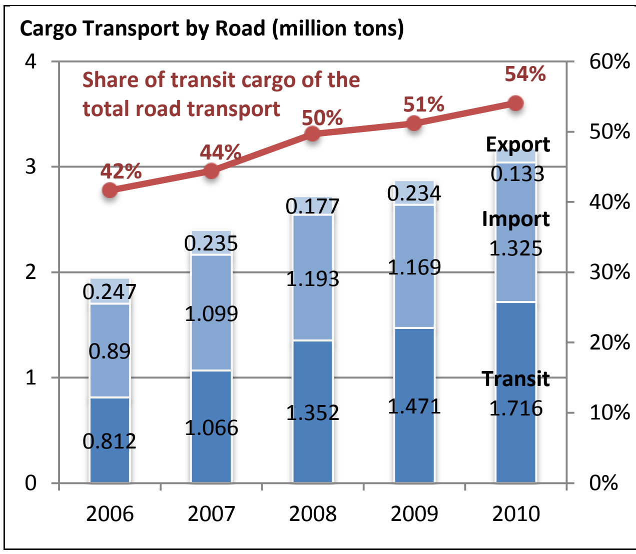
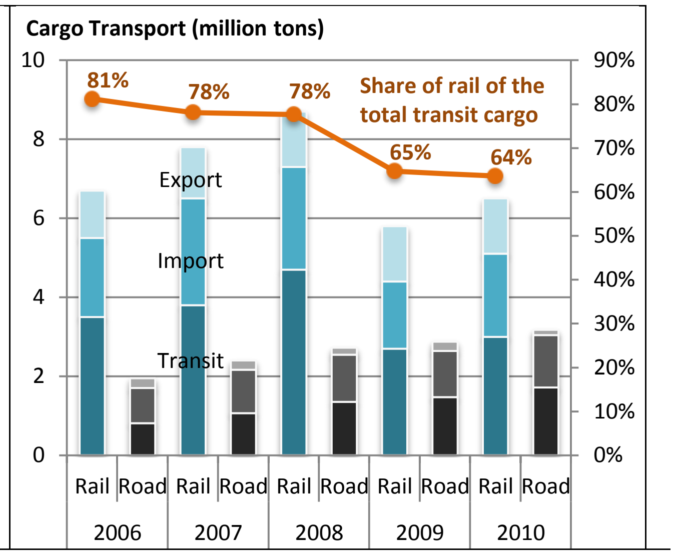



**Figure 16**: The decreasing share of railway transport† of total transit cargo




*Source: WB staff calculation based on the data from the Georgian Ministry of Economy and Sustainable Development*
*†Excluding liquid cargo*

**Rationale for change: all transit trucks are charged a flat fee (200 GEL) regardless of vehicle emission class or weight; this fails to capture marginal social costs incurred by truck transport**. Other European transit countries—Austria and Switzerland—charge more per vehicle or per ton-km than the current flat fee rate in Georgia, even though trucks operating in Georgia are of lower emission class than those in Western Europe, mostly Euro-3 or lower (Table 5). The EU transport policy aims to internalize external costs and is based on the principle of "users-pay-principle"—transport users (passengers and carriers) pay infrastructure and social costs that they incur. In fact, road use charges in

[33] On some road sections along the East-West Highway that are yet to be rehabilitated, trucks drive at low speeds, causing frequent over-passing, which is one of the main reasons for road traffic casualties. Overtaking accounted for about 18 percent of traffic violations in 2010 according to Transportation Policy Department of the Ministry of Economy and Sustainable Development.
[34] EFFECT model calibration by WB staff

European countries are often set to cover the average cost, higher than marginal costs, which include costs associated with road deterioration, emissions and congestion, plus fixed infrastructure costs. In Georgia, transit charges are based on a similar principle—transit trucks, which bring no direct benefits to the Georgian economy, pay for using the Georgian transport network—but existing transit charge levels fail to cover the average costs, nor do they provide incentives for truckers to be greener.

**Table 5**: Comparing transit charges for heavy vehicles

| ***Vehicle Emission Class*** | ***Truck charges per kilometer (in EURO)*** | | | | | | |
|---|---|---|---|---|---|---|---|
| | ***Austria*** | | | ***Switzerland*** [b] | | | ***Georgia*** |
| | *2-axle* | *3-axle* | *4+ axle* | *2-axle* | *3-axle* | *4+ axle* | *No classification* |
| Euro 0–2 | 0.187 | 0.262 | 0.393 | 0.460 | 0.767 | 1.022 | 0.188 [c] |
| Euro 3 | | | | 0.399 | 0.664 | 0.886 | |
| Euro 4–5 | 0.165 | 0.231 | 0.347 | 0.339 | 0.564 | 0.752 | |
| Euro EEV [a] | 0.150 | 0.210 | 0.315 | | | | |
| Euro VI | 0.145 | 0.203 | 0.305 | | | | |

*Sources: WB staff calculation based on data from Austrian Motorway Agency (ASFiNAG, www.asfinag.at); Swiss Federal Office for Spatial Development (2012); and Georgian Ministry of Economy and Sustainable Development*

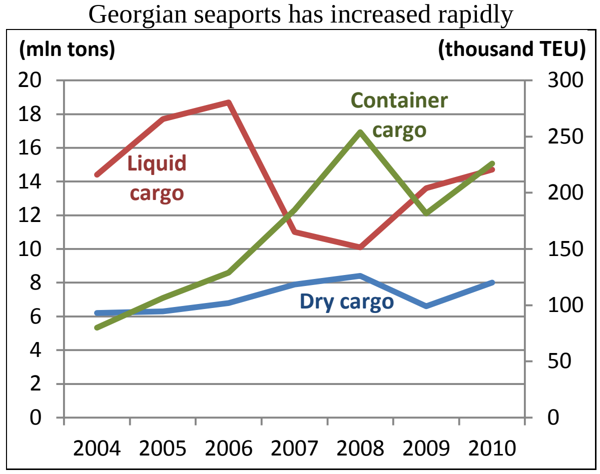
[a] *Enhanced Environmentally-friendly Vehicles*

[b] *These values are converted from Swiss Franc (CHF) rates set per ton-km, assuming on average weight of 18 tons for 2-axle trucks, 30 tons for 3-axle trucks, and 40 tons trucks/trailers with for four or more axle. The original fee schedule is 3.07 CHF cents per ton-km for Category 1 (Euro 0, 1 and 2), 2.66 for Category 2 (Euro 3), and 2.26 for Category 3 (Euro 4–5).*

[c] *This was calculated from the flat fee for all transit traffic: 200 GEL divided by the average transit distance between Sarpi and Red Bridge (approximately 500 km).*

**Rationale for change: existing weak physical and institutional intermodal connectivity cannot realize the potential for green, multimodal freight transportation and logistics**. Railway connections at major ports, including Batumi and Poti, are single-tracked and terminal capacity is limited. Container terminal capacity remains inadequate to meet growing containerization trends.[35] Since 2004, dry and liquid cargo volumes handled in Georgian seaports have increased only marginally, at 4.3 and 0.8 percent per annum respectively, although containerized cargo volumes have increased at an average rate of 18.9 percent annually (Figure 17). Georgia is located along an important international trade and transport corridor—the Transport Corridor Europe-Caucasus-Asia. But, development of key intermodal junctions is handled by mode-based agencies and companies, such as Ministry of Regional Development and Infrastructure (road sector development) Georgian Railway and private sector port operators, rather than a strategic objective of central Government. This mode-based transport sector capital investment planning creates silos, and inter-agency and inter-jurisdiction coordination is weak. Inadequate coordination among major transport

**Figure 17**: Containerized cargo volume handled in Georgian seaports has increased rapidly




*Source: WB staff calculation based on the data from the Ministry of Economy and Sustainable Development*

[35] Interview with the Georgian Railway

modes and a lack of a nationwide multimodal transport corridor development strategy preclude opportunities to create a better-connected network, lower transport costs, and greening transportation.

***How can this be done?***

**Institutional: develop coherent transport policy that aims at modal shift from roads to railway through strengthened inter-modality and international collaboration with key trading partners**. Transport services operated by private entities in railway and port sectors of Georgia have been reasonably efficient and competitive: they are financially self-sustaining and use profits to invest in new developments to remain competitive in the market. Nevertheless, their roles are limited in developing intermodal connectivity since these entities and their commercial decisions depend on national-level policy decisions and international relationships. Therefore strong national leadership is critical in the following areas:

- To develop a national transport strategy and investment programs that coordinate all modes and pursue further modal shift to railway, under a strategic vision to lower the overall costs for transportation and harmful environment effects through improved intermodal connectivity. The strategy should build on accurate baseline data, multimodal diagnostic analysis, future market forecasts, and risk assessments.
- To strengthen international collaboration for efficient custom processing and border-crossing, particularly at Azeri and Armenian borders, for railway and road connections.
- To explore potential for sea-railway connection: Potential exists for a further shift from truck traffic to seaway connections from Turkish ports, such as Istanbul, Samsun and Trabzon, directly to Georgian ports. This would serve green objectives, but it requires sophisticated logistical arrangements and international collaboration with public and private sector actors.

**Investments in infrastructure: develop multimodal, green transit corridors by improving intermodal connectivity, eliminating bottlenecks and supporting containerization**. The geographical and geopolitical position of key gateways in Georgia—along the TRACECA corridors (Figure 6)—lends itself to playing a bigger role as multimodal and intermodal junctions. At the national level, this would require coordinating an infrastructure investment strategy that goes beyond modal plans. From the perspective of green transportation, guiding principles of the strategy are: (i) to increase the share of rail transport particularly for international transit traffic; and (ii) to improve sea-railway and road-railway connections. Specific recommendations are as follows:

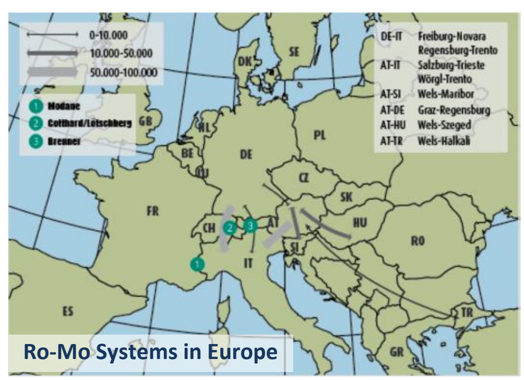
- Tbilisi as a regional logistics hub: The capital city is a primary junction of road and rail networks connecting to all neighboring countries. It is of strategic importance to strengthen Tbilisi's role as a multimodal hub for international and domestic cargo movements. Recently, the Georgian Railway has expanded railway container terminal capacity and coordination with other modes should be carefully planned.
- Batumi as an intermodal junction: The Port of Batumi has potential to expand its role as a container and Ro-Ro (roll-on roll-off) port. The berths have adequate depth, there is room for capacity expansion, and the port connects to the rail network. However, Batumi municipality's city development plans focus on attracting tourists and urban transport, while substantially reducing the role of its seaport, which appears to be at odds with goals for enhancing international transport connectivity. However, these two objectives can be reconciled. Transferring liquid cargo-handling (primarily petroleum products) capacity from Batumi to Kulevi ports seems to be

a rational choice to take full advantage of specialization at each port while improving the environment and attractiveness of the city. Meanwhile, transshipment of containers and Ro-Ro cargo at Batumi Port needs to be improved by providing a double-track railway connection and expanding terminal capacity.

- Poti as a container port with strong railway connection: Operators are most active here in infrastructure development. The Georgian Railway has recently expanded the port container terminal and improved the port rail connection. The container terminal operator, APM Terminals, has plans to invest in port capacity expansion; it will build new container and bulk cargo terminals and deepen the berths, which will increase the cargo handling capacity by 50 percent.[36]
- Exploring potential for Rolling Motorway (Ro-Mo): Ro-Mo, also known as "Contrailer", is a combined transport system in which the trucks are transported by rail (Box 5). The increasing truck traffic through Sarpi and Adjara Region has led Georgian Railway to consider a Ro-Mo terminal near Batumi, where the planned Batumi bypass motorway will pass by the railway line. The Ro-Mo system has clear environmental benefits over truck traffic, but the costs (high costs of wagons), patronage (estimated shift from roads), and the long-term competitiveness, especially against containerized transport, should be carefully examined.

**Box 5. Rolling Motorway (Ro-Mo) Systems**

**Definition and types of operation**. Rolling motorway is a combined transport system in which trucks are transported by rail. Combined transport can be unaccompanied or accompanied by drivers. In unaccompanied combined transport, goods travel in swap bodies, standardized containers, or semi-trailers. These are transferred at transshipment facilities, called terminals, which are links between transport methods. In accompanied combined transport, the road vehicle is transported by rail, including the traction cabin and drivers. Wagons consist of special close-coupled flatcars that provide a drivable track along the entire train. Wagon wheels are small, 380/360/335 mm in diameter. Both ends of the rail link have purpose-built terminals that allow the train to be easily loaded and unloaded. Road vehicle drivers carry out loading (called "horizontal loading"), accompany the railway shipment as a passenger in a couchette carriage, and deliver the shipment by road at the destination. Before and after rail wagon transport, the vehicle is driven on the road. Often, rail transport surmounts a geographical obstacle, or weight or access restrictions along the road route. The distance covered by rail depends on the length of road "obstacles" and on required statutory night rests. Combined transport allows the driver to rest during a section of the route or while crossing the Alps. On arrival drivers can resume the road trip completely rested.



Ro-Mo Systems in Europe

**Existing Systems in Europe**. Among Ro-Mo systems operational in Europe, the Austrian Federal Railways (ÖBB) carried 254,000 trucks, equivalent to 8.5 million tons of cargo in 1999; in Switzerland the capacity of the Ro-Mo crossing Alps is continually increasing, from 105,000 trucks in 2003 to 350,000 in 2007.

**Advantages and disadvantages**. Ro-Mo system advantages, relative to other transshipment technologies include high capacity, rapidity, low fixed terminal costs, and technical reliability. Its disadvantages include low detachability of individual units, and accessibility.

**Mode-choice decision criteria**. Reffet et al. (2008) tried to understand how and under which conditions a road carrier would select a Ro-Mo system instead of roads. They interviewed 22 road carriers, users of the alpine Ro-Mo between Toulon (France) and Civitavecchia (Italy). Most road carriers wanted more regular and planned freight flows. The choice between accompanied or unaccompanied transport depends on origins and destinations. Unaccompanied transport is used mainly with short pre- or post-transfers. Typically companies begin by operating accompanied transport, which is more flexible, to test service quality, while preparing

[36] Wall Street Journal (2012)

their organization for a later use of unaccompanied transport. Primarily larger companies use unaccompanied transport because they carry higher volumes of cargo on a regular basis, own enough trailers, and can partner with foreign companies or can even open subsidiaries in the other country. However, some smaller businesses managed to optimize their organization to switch to unaccompanied transport. Accompanied or not, carriers choose these alternative modes to reduce costs, improve driving time, and deliver on time with the same quality of service. Environmental issues did not seem to be a criterion for carriers to choose these new modes. Finally, researchers found that, although satisfied with existing offers, carriers would prefer higher frequencies for existing services.

*Source: Danielis, R., L. Rotaris, L. Buzzulini, E. Biktimirova (2010); Woxenius, J. (2007); Reffet et al. (2008)*

**Fiscal policy and pricing: differentiate charges on transit trucks by vehicle emission class and axle weight and allocate revenues for maintenance of road network assets and green transport investments**. Georgia's road user charges on transit trucks, when combined with major investments for intermodal connectivity discussed above, would contribute to green transportation by encouraging a modal shift from roads to railway. Existing transit fees rates are not excessively low relative to income levels, but to achieve greening objectives, fee rates should be based on emission standards. Moreover, rates should be reviewed regularly and adjusted to reflect social costs of transit traffic. As discussed above, European countries with intense transit traffic such as Switzerland, Austria, and Germany have imposed heavy-duty vehicle charges based on weight, distance driven, and vehicle emission standards (Box 6). In addition to encourage modal shift, charges should aim to cover infrastructure costs and reduce taxpayers' burdens. Pricing policies that aim to cover infrastructure costs enjoy strong political support from tax payers in European countries. In Georgia, average cost-based road user charges would improve the economic feasibility of some new investments in the railway and port sub-sectors described above. Road user charges should be viewed the cost of using Georgia's infrastructure, rather than impediments to transport. Considering the planned upgrading of East-West Highway, charging appropriately for using the road system would also improve road network sustainability.

**Box 6. Heavy Vehicle Charges in Transit Countries**[37]

***<u>Switzerland</u>***

A distance-related heavy vehicle fee (HVF) has been levied in Switzerland since 1 January 2001. It replaces the previous flat-rate heavy vehicle fee. Full details of the heavy vehicle fee are presented in the brochure "Fair and efficient" published by the Federal Office for Spatial Development. The switch to a distance-related fee system aimed to: (i) limit the increase in heavy vehicles on the road; (ii) encourage rail freight shipping (road-to-rail policy), and (iii) relieve environmental impacts. The HVF applies to heavy-goods vehicles with a permissible laden weight exceeding 3.5 tons and is calculated on the basis of three criteria: (i) number of kilometers covered on Swiss territory; (ii) permissible laden weight of vehicle; and (iii) vehicle emissions.

**Rate of charge**. The HVF introduced an initial rate of 1.68 centimes per ton-kilometer (tkm); this rose to 2.44 centimes per tkm in 2005, and 2.70 centimes per tkm on 1 January 2008. This rate reflects the uncovered costs imposed and total number of ton-kilometers driven by heavy road vehicles (calculated according to permissible laden weight).

**Use of revenue**. One-third of net revenue goes to the cantons and two-thirds of net revenue goes to the federal government. The cantons use most of their allocation to meet their share of uncovered road transport costs. The federal government share is used primarily to finance major public transport projects: (i) Rail 2000; (ii) new trans-alpine rail routes (NEAT); (iii) links to the European high-speed network; and (iv) rail noise control program.

**International context**. The HVF is supported by international law through the Overland Transport Agreement with the European Union. On January 1, 2004, Austria successfully introduced a distance-related heavy vehicle fee; one year later, Germany followed suit one year later. Both countries limit the fee to vehicles using motorways. The Czech Republic introduced a heavy-vehicle fee for motorways and clearways on 1 January 2007, and the Slovak Republic is planning a similar

[37] S Perkins (2008), ECMT Committee on Road Charges

solution.

**Legal basis and enforcement**. Key legislation for HVF enforcement comprises the Federal Heavy Vehicle Fee Act (Schwerverkehrsabgabegesetz) and the Federal Heavy Vehicle Fee Ordinance (Schwerverkehrsabgabeverordnung). Article 85 of the Swiss Constitution provides the constitutional basis. The HVF was introduced without any notable problems and its enforcement is delegated to the Swiss Federal Customs Administration.

**Monitoring**. The impact of HVF is monitored continuously and analyzed by the ARE. The principal result is a significant reduction in road use by heavy-goods vehicles. Prior to introducing the HVF, distances were steadily increasing; in the two subsequent years after, distances travelled fell sharply. By end-2005, distances were down by 6.5 percent from 2000. In addition, there was a noticeable surge vehicle fleet renewal and a trend to concentration in the road haulage sector.

***Austria***

In January 2004, Austria replaced a fixed annual road user charge for trucks with an electronic km charge for all vehicles over 3.5 tons maximum gross weight—trucks, buses and other heavy vehicles.

**Charges and revenues**. Charges are set at a level that will recover infrastructure investment and maintenance costs and provide for new investments in motorway infrastructure due to rising demand. Toll revenues are the sole source of financing for the Austrian roads corporation (ASFINAG), which receives no government subsidy for highway network development and management. Initially, charges did not differentiate among vehicle emission classes; instead, charges were based on vehicle weights, and consequently, impacts on road deterioration. For the new charging schedule, introduced in 2011, rates were based on vehicle emissions. In 2004, revenues were estimated at Euro 600 million; all revenues accrue to the company charged with managing and expanding the motorway system.

**Technology – microwave and transponders**. Toll collection is done using microwave technology, fully automated (multi-lane free-flow system). Like Switzerland, Austria uses roadside transponders and an on-board unit to levy charges. All vehicles over 3.5 tons that use the Austrian highways and expressway network must purchase and install a “GO-Box”, an on-board microwave communication unit.

**Payment**. Pre-pay or post-pay methods are available. Customers may pre-pay toll values up to a maximum allowable amount. Alternatively, registered customers can select weekly, bi-weekly, or monthly billing.

**Interoperability**. In accordance with the EETS (European Electronic Toll Services), the system is interoperable with most European countries, using 5.8 GHz DSRC microwave technology. Since 2004, ASFINAG and the Swiss Federal Customs Administration—operator of the Swiss toll system—collaborated for full interoperability between the two systems, including all in-vehicle equipment, communication, and back-office functions. These arrangements will be expanded to include other European countries, including Germany, and the Scandinavian Consortium.

***Germany - LKW-Maut***

Germany's LKW-Maut (Lastkraftwagen-Maut, literally 'truck-toll') applies to cargo vehicles based on kilometers driven, number of axles, and vehicle emissions category. Up to 35 percent of truck miles traveled on German motorways (Autobahnen) are generated by foreign trucks. Germany experienced increased pressure from transit freight traffic and needed an additional source of revenue for motorway maintenance and expansion. Thus, Government implemented a distance-based toll for all trucks over 12 tons gross weight and abolished the former Eurovignette charge in anticipation of the new toll in January 2005. Motorway freight tolling was authorized by the Motorway Toll Act for Heavy Commercial Trucks (in effect since April 12, 2002) and the Toll Regulation.

**Charges**. The charge is calculated based on estimated maintenance, upgrading, and renewal costs for the motorway system attributable to trucks. The charge is levied according to the number of axles (i.e., approximate truck weight) and based on exhaust emissions class. An average user is charged €0.15 per kilometer, or about $0.31 per mile. Emergency vehicles and buses are exempt. The charge aims to provide an appropriate financial environment for inter-modal competition for freight between road haulage and railways. The charge was designed to raise revenues to relieve public budgets of this expenditure, and charge all users equally, including foreign trucks. Revenues are dedicated to covering the costs of collection and investment in transport infrastructure, mainly federal highway construction. Replacing the time-based Eurovignette charge with a km charge, and increasing charge levels drove rationalization of the haulage industry and reduced km driven below what would have otherwise been the case. As with Austria, though, the impact can be expected to be much less than in Switzerland.

**Technology**. Toll Collect oversees toll collection on behalf of the Federal Republic of Germany. Toll Collect has developed an automatic log-on system for truckers, based on a combination of GSM and GPS. To use the automatic log-on, truck drivers must register their freight company and the individual truck. After registration, an on-board unit (OBU) can be installed by an authorized Toll Collect partner. The OBU automatically determines the distance traveled on the toll route, calculates the toll based on vehicle class and toll rate information entered, and transmits the information to the Toll Collect center for processing via GSM (cellular) communication. After toll information is submitted to the Toll Collect center, a bill is generated and e-mailed to the truck driver or owner. The German government paid for about 450,000 OBUs now in use, and truck drivers were responsible for installation.

**Enforcement**. System enforcement is based on 300 gantries equipped with infrared detection equipment and high-resolution cameras that can recognize truck license plates. In addition, Federal Officers of Freight in 300 mobile enforcement vehicles patrol the motorways and have authority to pull trucks over and check for payment records. If a fee has not been paid and the GPS data are unclear, a charge is levied for 500 km of travel. Estimated collection costs are 20 percent of gross revenues. During the first eight months of Truck Toll scheme operation some 11.6 million trucks were checked and the violation rate was less than 2.0 percent.

**Revenues and Impacts**. Toll revenues in excess of system operating costs provide funding for transportation infrastructure improvements. The truck tolling program has given freight companies incentive to purchase lower-emission vehicles. The UK Commission for Integrated Transport (2007) cites a 6.0 percent decrease in the number of empty-truck runs and a 6.0 percent modal shift to rail from road freight due to the truck toll system. Those decreases will likely reduce emissions of carbon dioxide and other pollutants on German roads. The only negative consequence of the freight toll system detected thus far has been that some trucks now use roads other than the autobahn, creating noise and congestion on these routes.

*Sources: Swiss Federal Office for Spatial Development (2012); ASFiNAG website (www.asfinag.at); Report CEMT/CM(2004)19 to ECMT Council of Ministers Charges for the Use of Infrastructure; and Wikipedia (en.wikipedia.org/wiki/LKW-Maut)*

## D. Support Commercial Development of Intercity Passenger Transport Services

***Why this measure?***

**Current condition: the under-regulated and underdeveloped intercity passenger transport market offers inferior service quality and inadequate safety to users and generates environmental damage**. Georgia's intercity passenger transport sector is not well developed commercially and most services are provided on an ad hoc basis by independent minibus "owner operators" from inner cities. As a result, the intercity bus market is very fragmented and transport services are irregular and unattractive for consumers. To make matters worse, intercity vehicles are rarely properly inspected for their technical conditions or emissions.[38] Operators are not required to obtain licenses or permits; they simply have to sign a contract with bus terminals in destination cities. Since most of the buses are 10-20 years old, they contribute disproportionately to air pollution and traffic problems, and compromise road safety. Some municipalities have already banned the buses from entering their cities. These minibuses cause urban traffic congestion due to limited infrastructure—there are few bus stops and stations for buses to pick up and drop off passengers.

**Current condition: lack of intercity transportation options may hinder future tourism potential, leaving foreign transport services companies to reap benefit from the increasing number of visitors**. National transportation for tourists is organized by foreign (mostly Turkish) and Georgian companies that provide transport services, thus individual tourists have limited options beyond private transport (Table 6). Also, time schedules and booking arrangements are cumbersome for tourists, and there consumers have no way to compare the market and choose the best level of service. Officials in the LTA observed that some passengers might be willing to pay higher prices for better vehicles and service quality, but few operators are entering the existing market offering better services at higher prices.

**Table 6: Comparing passenger transport modes between major destinations**

| Routes | Trip Characteristics | Transport Modes | | | | |
|---|---|---|---|---|---|---|
| | | Private cars | Air | Rail | Mini-bus | Tour bus |
| Tbilisi – Batumi | travel cost (GEL) | 60 or more | 90 | 24 | 18 | 18 |
| | travel time (hours) | 6 | 1 | 6 | 6 | 6 |
| Tbilisi – Akhmeta | travel cost (GEL) | 45 | n/a | n/a | 7 | n/a |
| | travel time (hours) | 2.5 | n/a | n/a | 3 | n/a |

*Source: Ministry of Economy and Sustainable Development, Transport Policy Department (2011)*

*Note: The Georgian Railway plans to invest about US$550 million to improve the Tbilisi-Batumi passenger services, the major domestic tourist route, which will reduce travel time to three hours from the current six to eight hours. Thus rail transport would be competitive with road transport, which now takes about five hour.*

**Rationale for change: developing clean and high-quality intercity bus services is now critical to enable competition with private road transport in the age of rapid motorization**. The relatively short distances between cities and the mountainous terrain of the country are more advantageous to road-based transport than rail; and as motorization rates increase among Georgians and citizens of neighboring countries (i.e., potential tourism clientele), travelers are likely to become more reliant on private transport. Lessons learned from countries such as the United States have shown that modern intercity buses are much greener, cheaper and safer than other modes of land transport such as private cars and rail (Box 7). Although potentially private car ownership will rise in Georgia, other countries have shown that there will

[38] From the discussion with the Land Transport Agency in July, 2011

always be demand for cheaper and easier long-distance transportation. Furthermore, intercity bus transportation, when properly regulated, is a statistically safe and energy-efficient form of land transport. American statistics show that intercity buses are the safest ground transport option, with three times as many passenger miles and 60 percent less energy use than rail transportation. Statistically, air is the safest transport mode, but the emissions level is higher than long-distance buses.[39]

**Rationale for change: a well-developed intercity passenger transport market would play a critical role in promoting tourism**. Availability of good in-country transportation could open up potential for some specialized tourism market segments, particularly individual tourists who do not rely on organized group tours and multiple-destination travels. Furthermore, to make national tourist attractions more easily accessible, it is critical to offer reliable bus services from airports and between cities.

**Box 7. History of Intercity Buses in USA**

Intercity bus services have played an important role in American transport since the early twentieth century, connecting thousands of people between cities via regular bus services accommodating rich and poor alike. Prior to U.S. road infrastructure improvements, railway dominated long-distance transportation. By 1930, roads had improved, allowing the intercity bus industry to grow and compete with the rail sector. This prompted Government to enforce strict regulations for bus and truck operators to shelter the important rail industry. Consequently, intercity bus traffic was strictly regulated for the next 47 years following the Motor Carrier Act of 1935. The Act granted power to individual states to control market entry for bus operators, and regulate routes and rates. Tight regulations reduced competition and encouraged bus mergers, which led to the formation of Greyhound Bus Lines, which acquired many small bus companies and became the market leader. At first Government supported this monopoly in the intercity bus sector because it made the industry financially stronger and reduced the need for more infrastructure (bus terminals) in inner cities. In 1947, the U.S. government decided to create competition within the sector by merging several bus companies to form Trailways Bus Lines, which had a 20 percent market share by 1970.

During the post-1960s, the intercity bus sector slumped due to (i) weakening consumer demand due to highway infrastructure improvements such as interstate highways; (ii) increased car ownership (by 1970, 80 percent of Americans owned car); (iii) deteriorating downtown business districts in major cities; (iv) affordability of air travel as a long-distance option due to discounted airline fares, which followed the airline sector boom. As a result, the intercity bus industry was deteriorating fast and tight regulations exacerbated its decline. In an attempt to resurrect the intercity bus sector, Government passed the Bus Regulatory Reform Act on September 22, 1982, which provided bus operators relief from federal pricing and route restrictions and offered a mechanism to appeal state-imposed regulations on intrastate routes. Unfortunately, this attempt to revive the industry through deregulation had limited success and failed to generate more traffic, unlike the effect of deregulation on other transportation sectors such as rail, trucking and air. Industry decline caused big players such as Greyhound Lines and Trailways, to undertake severe cutbacks and reorganization.

After 14 years of deregulation, the intercity bus industry had resurgence in 2006. Rising highway congestion made travel in private vehicles less appealing and the spike in oil prices made driving personal vehicle less economical. As a result, a new breed of innovative intercity bus operators emerged (such as *Megabus*) that offer cheap tickets available through the internet using a concept known as "yield management," and providing a level of service comparable to that available on express rail travel competitors such as Amtrak. Consumer demand has shifted towards low-cost good-quality service for intercity transportation, which is convenient, safe and less harmful to the environment. Modern intercity buses carry an estimated three times as many passenger miles and use 60 percent less energy than railway operators. In addition, data show that intercity bus transportation is now the safest land transportation available. Therefore, it is not surprising that the intercity bus sector is the fastest-growing passenger transport mode in America, reporting 22 percent growth during 2007-2010, compared to 12 percent for railway passenger transportation.

Intercity bus companies remain subject to federal and state regulations. Two main regulatory policies that affect competition relate to curbside parking and safety. Today, few intercity buses operate out of bus stations; instead, they pick up and drop off passengers at parking lots in strategic inner-city locations. This innovative practice has prompted state governments to regulate bus parking in urban areas. Operators must get permission to use curbside areas and may have to pay for the privilege. This regulation restricts the number of bus stops en route and may be a deterrent for potential bus passengers who live far away from the transit hub. In relation to safety, Government has regulatory policies for vehicle operating standards (regular bus inspections are carried out by a government agency), driver licensing (including training on safe driving) and passenger safety

[39] Average $CO_2$ emissions of short-haul air transport is 0.24 kg per passenger mile, while intercity bus trips (20 miles or longer) emit 0.08 kg per passenger mile (World Resource Institute, 2002).

per se. Recently, the National Highway Transportation Safety Administration (NHTSA) called for all buses to be equipped with seatbelts. Although seatbelts are proven to reduce fatalities by 77 percent, it is speculated that this regulation is not economically viable and should be considered carefully to ensure that competition in the industry is unaffected.

Government also subsidizes intercity bus companies by collecting lower federal fuel taxes (7.3 cents per gallon compared to 18.4 cents paid by other motorists) and through grants to help companies comply with the Americans with Disabilities Act and national security needs. Still, these grants are equal to just 1.0 percent of railway subsidies, which has created unfair competition in some states because rail can offer such low subsidized fares to its customers.

*Source: O'Toole, R. (2011)*

### *How can this be done?*

**Planning and regulatory framework: upgrading vehicle standards and service quality through regulations, and integrated passenger information services combined with market entry control**. First, as discussed in Sections III.A and III.B, enforcement of vehicle emission and safety standards should be extended to minibus intercity operators, and integrated passenger information services need to be provided to improve overall passenger travel experience, in particular, tourists. Information services could be developed and maintained by a private firm, selected through competition by a government entity such as the National Tourism Agency; the firm could consolidate service information from participating operators (i.e. routes, timetables, fares) so that passengers access schedules and book by telephone or on-line. Integrated information services—a coordinated marketing tool—can be also used to control market entry and/or enforce regulations. Operators that wish to be included in a consolidated timetable and booking system must comply with minimum standards for vehicle emissions, safety and service quality. In most high-income countries, intercity bus operators rely heavily on web-based booking systems to capture customers (such as Megabus in the U.S., Box 7). Often, a marketing organization represents several operators and provides a consolidated service (Box 8).

**Box 8. Norway Marketing Website**

Since long-distance coach service was almost completely deregulated in 2003, Norway has been commercializing its intercity bus sector by transferring responsibility to the private sector. Local authorities must still approve route authorizations before market entry, but restrictions are usually limited and apply only if other subsidized transport needs protection.

Today, most intercity bus services are organized via NOR-WAY BUSSEKPRESS, a marketing firm that represents 30 bus companies; the firm advertises bus services on behalf of company members—including timetables and prices for 25 national routes and four airport-to-city links. A website makes customer booking convenient and secure (refunds are available); it provides useful safety information and a hotline number for queries. The website advertises tourist attractions that include complimentary bus services.

*Source: NOR-WAY Bussekspress retrieved at http://www.nor-way.no*

**Planning and legal framework: introducing competitive tendering for strategic intercity routes and managing the service quality**. To provide good quality transportation connections for tourists, it might be necessary to secure reliable and high-quality intercity and long-distance bus services along some strategic routes, such as airport-to-city center connections. To secure service frequency and quality along such strategic routes, a central or local authority may select qualified operators through competitive tendering, under a concession agreement. Similar arrangements have been implemented in Sweden and Spain, where competitively selected private operators provide services under concession agreements for an 8-20 year period (Box 9). This requires careful planning and selection of routes, well-defined terms for service quality and operational and financial requirements, and a mechanism to monitor concessionaire performance. If such strategic routes fail to generate sufficient revenues to cover full costs or a central or local authority decides to keep fares low to benefit passengers, operating subsidies or revenue guarantees could be considered.

**Box 9. Concessions of long-distance bus transportation**

***Spain***. Spain is the only country that exclusively concessions long-distance bus services by public sector. Transport authorities select long-distance bus services to be competitively tendered to private operators under a concession agreement for 8-20 years. Although a restricted market, some private operators are growing and now account for a significant market share. This situation emerged because the rail sector is underdeveloped Spain so the long-distance bus market is critical for intercity passenger connectivity. As a result, Government ensures these services are subsidized and tendered on a competitive basis.

***Sweden***. In 1999, the intercity bus sector was almost fully deregulated; local authorities maintain control over bus stop locations. Since full deregulation, substantial privatization was carried out and now almost 90 percent of intercity buses operate on a commercial basis, the rest operate under contracts to local authorities. Local authorities concession strategic routes to the private sector and subsidize where necessary to ensure passengers are accommodated on important strategic routes such as to schools and health services, for example.

*Source: Van de Velde, D. (2010)*

**Investments: improving the quality of infrastructure and consumer amenities through public and private investments.** Currently, infrastructure in cities is limited for intercity buses, and coupled with a fragmented bus market, has contributed to traffic congestion and poor service levels for users. International experience suggest that appropriate infrastructure can be provided with little burden on the municipal budget. Options include the following:

- Option 1: Provide curbside parking. Local authorities can regulate parking locations and charge bus companies a fee for curbside parking spaces. This option should be considered only if it creates minimal disruption to traffic and poses no safety risks for waiting or disembarking passengers. Curbside parking may be inappropriate for high-frequency intercity bus services with multiple operators competing for the space.
- Option 2: Contract the private sector for Design, Build, Finance and Operation (DBFO) concessions for intercity transport terminals (possibly intermodal). An Intermodal Transportation Hub is a large multi-modal terminal that includes rail, commuter rail (metro) and bus services (Box 10). Public transportation connects passengers to each hub where they can select a mode of intercity transportation to other hubs. Municipalities can enter a time-bound concession agreement with a terminal developer. The concessionaire will generate revenues from operator usage fees and from consumer amenities such as shops and restaurants. Hubs facilitate easy connections and transfers, which can expand the passenger base for public transport. Existing bus terminals or railway stations can be rehabilitated or retrofitted to create hubs.

Furthermore, intercity bus terminals could also be used for regular vehicles inspections to ensure environmental and safety standards are met. A strong enforcement mechanism should be combined with meaningful penalties for non-compliance, such as a ban on using the terminal facility.

**Box 10. Intermodal Transportation Hub at South Station Train Terminal, Boston, USA**

Boston's historic South Station is legendary in USA transport history. The railway station was built in 1899 when it was one of the largest stations in the world, serving about 40 million passengers each year. Not only did it accommodate trains and passengers, but also provided consumer amenities such as shops, restaurants and hotel services. Over the years, the station has had numerous renovations and attracted multiple investors. In 1975, the station was suffering extensive deterioration and the owner was bankrupt so there were plans to demolish it. Instead, South Station was sold to the Massachusetts Bay

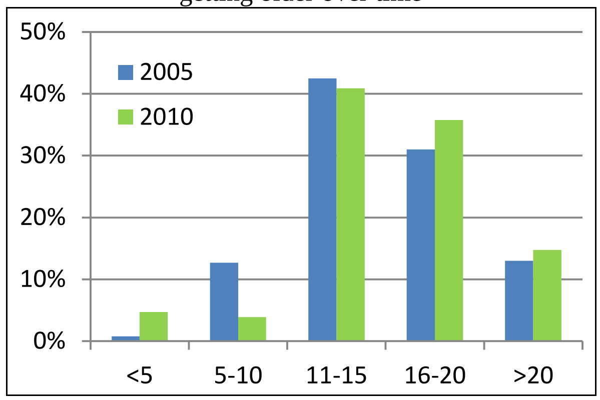
Transportation Authority (MBTA) in 1978 for US$6.1 million. The MBTA completed restoration in 1989 at a cost of US$195 million. Funding was provided by MBTA, Amtrak, Federal Railroad Administration, Urban Mass Transit Authority, Equity Office Properties, and private development corporations, and included reconstruction of 11 railway tracks, construction of a new bus terminal and parking garage. South Station now caters for passengers with multiple transportation modes—trains, metro and buses—and many consumer amenities that provide an excellent source of revenue for investors.

*Source: Amtrak (2011), Revitalizing America's Train Stations (www.greatamericanstations.com/Stations/BOS/)*

## E. Transform Minibuses and Taxis into Modern Urban Transport Modes

***Why this measure?***

**Figure 18**: Minibuses fleet in Georgia is old and getting older over time




*Source: WB staff calculations based on data provided by Georgian Ministry of Internal Affairs*

**Current condition: minibuses (locally called *Marshrutkas*) provide important urban transport services in Georgian cities, but generate harmful environmental impacts and other negative externalities such as congestion**. In all major Georgian cities, minibuses are used by a large share of urban residents that do not own private cars (e.g., low-income workers, students, and pensioners). For example in Tbilisi, minibuses carry about 430,000 passengers daily, compared to 260,000 passengers that use metro and 215,000 that use municipal buses.[40] The minibuses are essential to the daily life of average Georgians but they are 11-20 years old (Figure 18), highly polluting, and often unsafe, thus they generate substantial negative externalities that undermine environmental sustainability and incur considerable costs that must be borne by the entire society, including non-users.

**Current condition: the contractual arrangement for minibus operation is not conducive to competition and long-term sustainability**. Under the existing contractual arrangement minibus operators have little incentive to provide greener and safer services because newer vehicles would require large capital investments, which would require higher fares, which in turn would make their passenger business uncompetitive against other operators and other public transport services.

**Current condition: the taxi market is completely unregulated with respect to market entry, vehicle and service quality, and fares, and appears to contribute to air pollution and congestion problems**. There is no legal licensing for taxi service providers, either for firms or individual owner-operators; in fact, taxi signs that can be mounted on any cars are sold at about 20 GEL apiece at many retail shops without any restrictions on the purchaser. This system, in which anyone who owns/operates vehicles can pick up willing passengers in an instant on-street market (with or without the 20-GEL taxi sign), appears to fill some gaps of urban mobility demand. Rigorous analysis was not possible for this study because statistics on the taxi market are scarce in all Georgian cities. Nevertheless, the current arrangement is unlikely to be sustainable for a couple of reasons. First, the lack of quality control threatens safety and security. Second, unless policies are implemented to govern taxis and services from other privately hired vehicles, this unregulated market will simply add to growing congestion problems, as is the case in other developing cities such as Lima and Bangkok.

**Rationale for change: preparing for rising motorization rates, capitalizing on the unique features of minibus services**. Existing minibus services provides an inferior mode of transport that lacks comfort, privacy and safety and is used by a captive clientele without other options. In the future, as incomes rise and private car ownership increases, urban residents are likely to abandon minibuses for private vehicles. Some demand might be absorbed by modern high-capacity public transport, such as the light rail transit

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[40] Asian Development Bank (2011)

(LRT) being explored by the Tbilisi City Hall, but the almost door-to-door nature of minibus service is in more direct competition with private transport.[41] Unless a timely intervention is made to reform minibus service into a modern and greener mode, these services will eventually be limited to the urban poor and Georgian cities will remain unprepared for the age of private mobility by most urban residents. Instead, the current broad customer base offers potential to retain high modal share if services offered attractive pricing and improved service quality, and if municipalities enacted measures that make it more difficult and expensive to use private cars in city centers.

**Rationale for change: a case for an integrated and coherent public transport services**. Municipal bus services are regulated and run by municipal enterprises; minibus services are unregulated and run by private operators, which create a de facto two-tier system of public transportation[42] characterized by cost-inefficient service delivery and lack of user convenience. Well-planned public transport systems comprise sub-systems categorized by functional role (e.g., trunk and feeder services) and by service quality (e.g., premium and regular services), rather than types of operators (e.g., state-owned vs. private companies). Reform is necessary to assign minibus services a clearly defined functional role and to integrate them into an overall coherent public transportation system.

**Rationale for change: need for safe, clean and reliable taxi services that complement other modes**. Typically three types of regulations are applied to the taxi market: quantity (total number of taxi licenses or contracts that allow operation within a specified jurisdictional area), quality (vehicle standards, driver performance, availability of booking services, etc.), and fare. None of these regulations has been implemented in Georgia. By contrast, most high-income countries and some middle-income countries implement quality regulation; quantity and fare regulations vary by country and city (Table 7). International experience suggests that deregulation from quantity (market entry) control can lead to a market balance of supply and demand, as opposed to under-supply of taxi services observed in the cases of strict market entry, increasing the welfare of users. This is possible, however, only when it is supplemented with tight control over the quality and some regulations on fares.[43] To develop green and efficient tax markets, Georgian municipalities must intervene to implement balanced taxi regulations.

**Table 7**: Taxi regulations in high-income countries

| | | Fares | |
|---|---|---|---|
| | | Deregulated | Regulated |
| Entry | Deregulated | Sweden<br>New Zealand<br>Few US cities | Ireland<br>Netherlands<br>Some US cities<br>Some UK cities |
| | Regulated | Norway | Canada<br>Some US cities<br>Some UK cities |

*Source: Gwilliam (2005)*

***How can this be done?***

**The recent initiative by the Tbilisi City Hall suggests that reforming the fragmented minibus market is possible, albeit difficult**. Tbilisi City Hall began implementing a minibus reform program by introducing a zone-based competitive tender, under which bidders must form limited liability companies (LLCs) to purchase brand-new vehicles required for participating in the tender. Operators on routes already tendered under this scheme have introduced fare increases of more than 50 percent. Particularly at

41 Minibuses and high-capacity/high-speed public transport modes, such as LRT, are complementary not substitutes; hence, shift to private cars from minibuses is much more likely than shifting to other public transport modes.

42 Two-tier systems are commonly found in former Soviet Union countries, which experienced a sudden vacuum in public services due to rapid deterioration of public sector planning and fiscal capacity after the breakup of the union. The vacuum was filled by largely unregulated private operators.

43 OECD (2007)

the beginning, reforms faced resistance from bus operators and citizens, who were dissatisfied with the increased operating cost, and higher fares.[44] Despite these difficulties, reforms achieved reasonable success in transforming minibus services, which now offer cleaner more comfortable vehicles operating on fixed routes. However, it is even more important to introduce similar reforms in other Georgian cities and to sustain the clean vehicle fleet and high-quality services over the long-term. Long-term sustainability can be secured if minibus reforms contribute to an overall coherent public transport system, not just minibus services. A coherent system would require fundamental changes in how public transport services are procured and managed, which in turn requires institutional, legal and regulatory reforms, initial capital investments, and development and implementation of a long-term fiscal plan.

**Institutional: bringing in a strategic vision and strengthening market competition**. Achieving green transportation is more than just one-time replacement of minibus or taxi vehicle fleets; true greening requires the lasting impact of institutional reforms. First, the roles and responsibilities of involved entities must be clearly defined to improve the efficiency of minibus and taxi markets and eliminate the two-tier bus system. Municipal services delivery, including public transportation, typically requires three distinct functions: strategic planning, management, and service delivery. Institutional arrangements may vary but common to most successful cases are the following: (i) municipal government with strong leadership and long-term vision carries out strategic planning to develop a coherent public transport network design; (ii) management is carried out by a government department or a designated entity that ensures service quality aligns with contract specifications; the management function is clearly delineated from the service delivery function; (iii) a strong legal and regulatory basis exists for adequate market competition and equal treatment of commercial entities, which are selected through competitive tendering and provide services under contractual agreements, regardless of ownership forms (e.g., municipal enterprises or private sector suppliers) and for ensuring service quality and consumer welfare.

**Institutional: strategic planning toward a coherent multimodal public transport system**. From the planning stage, minibuses should be integrated into a coherent network of a good quality multi-modal public transport system to complement other modes. Municipal authorities and other public transport operators may view the minibus sector as undesirable competition to traditional bus services. However, the fact that minibuses attract passengers demonstrates that they provide a differentiated service with relative advantages that are valued by users.[45] Therefore municipal authorities need to take adequate control over routes and service quality under a broader public transport regulatory strategy. Crowding out the minibuses by increasing municipal buses is a costly decision that often fails to achieve its objectives. Similarly, the role of taxi services should be evaluated in the context of an urban transport strategy.

**Legal and regulatory framework for minibus market: introducing competitive tendering and gross-cost based contracting**. To lower public transport services costs—including operating costs and externalities—while ensuring service quality, a legal framework should establish conditions for sufficient competition among service providers, including municipal companies and private sector participants. Competition can be ensured on a gross-cost basis—the municipality collects all fare revenues and pays service providers; or on a net-cost basis—the operator keeps the fare revenues and the payment to the operator (or by the operator in the cases of profitable routes) is based on the best bid. When there are

[44] Based on the discussion with Tbilisi City Hall, Municipal Transport Department in July, 2011

[45] Gwilliam (2005)

multiple public transport modes, the gross-cost system[46] is more convenient for users because it facilitates a single, multi-modal fare and ticketing arrangement and the municipality handles all revenue collection. Required service quality standards should be specified in the invitation to tender and carefully monitored; the primary selection criterion is that of least cost to provide the service specified. Thus the city retains complete control over service quality, network structure, performance and fares, while obtaining the best value-for-money through tendering arrangements.[47]

**Legal and regulatory framework for taxi market: introducing partial regulations that control fare and quality but allow free market-entry**. Taxi services supply/demand in Georgian cities is not well understood. Since the optimal level of supply is unknown, a less risky way to regulate the taxi market is to focus on the quality and fares:

- Benefits of <u>controlling the number of taxis, or market entry</u> are dubious and the negative impacts have been amply demonstrated in many countries. During the 1970's, a strong argument was made for strictly controlling the number of taxis based on the notion that without control, taxi operation is a low barrier-to-entry job, which results in an over-supplied market during recessions when other employment opportunities are limited.[48] Therefore, it was argued that quantity control—accompanied by licensing and specified initial investment—would differentiate serious long-term operators from temporary job seekers. However, the downside of entry control is the difficulty of establishing an optimal level of taxi supply, because "optimal" changes over time. A barrier to entry, once created, is difficult to eliminate. In markets with a barrier to entry, a taxi license represents a certain market value (even if license trading is not formally allowed). As a result, in entry-controlled markets incumbents often form a strong union and political lobbying group to protect the value of their licenses (somewhat similar to the minibus associations in Georgia), which renders reforms attempts politically difficult.[49]
- By contrast, <u>strict quality control</u> can function as *de facto* quantity control, without creating market rigidity. Quality control regulations should cover vehicles—safety and emissions—and drivers—no criminal records, safe driving skills, good health and geographical knowledge.[50] Particularly in the context of green transportation, tight environmental controls should be introduced, consistent with vehicle emission standards and fuel quality standards required in the national and local regulations (Sections III.A and III.B). Authorities may decide to experiment with more progressive environmental standards in the taxi market, followed by private cars and other vehicles at later stages. However, quality regulation must be designed carefully to ensure that it does not prevent the development of innovative services and market structures. For example, vehicle standards should not be set in ways that would curtail provision of lower price/lower quality services for which there may be a demand.[51]

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[46] It is used in many larger Western European cities such as London and many smaller Scandinavian cities.
[47] The EU advocates this general arrangement. Costs per vehicle kilometer fell by between 20 and 40 percent when these systems were introduced in Western Europe.
[48] Gwilliam (2005): Over-supply of taxis might reduce passenger waiting time, but would subsequently increase congestion and negative environmental impacts.
[49] Many large cities that initially regulated the taxi market entry and controlled the total number of taxi licenses have gradually moved to deregulation or less regulation on the market entry, which in most cases has been a politically painful process due to the resistance of the incumbent operators (OECD, 2007).
[50] Gwilliam (2005)
[51] OECD (2007)

- Fare control is necessary to protect passengers from exploitation. Fare regulations typically take three forms: (i) obligatory tariffs that should be observed at all times; (ii) posted tariffs determined by the operator but to a maximum chargeable amount, once declared and displayed in the vehicle; and (iii) maximum tariffs that are declared and displayed but subject to downward negotiations.[52] Higher fares increase the supply of taxis, which lowers average waiting time for potential passengers.

**Fiscal policy and public expenditures: gross-cost contracting affects municipal spending on public transport**.

- Predictability of budget: If a municipal government adopted gross cost-based systems, retaining all revenues from tariffs, annual municipal expenditures on public transport services would become predictable and multi-year budget planning would become possible. In the short term, improved minibus services would increase costs due to capital costs for new vehicles and service improvements such as introducing passenger information systems and fare integration systems. However, under a fully commercialized system procured through competitive tendering (gross or net cost-based systems), additional costs would not be a one-time capital investment; instead, from a fiscal point of view, they would be annuitized expenditures because municipal governments would not keep vehicles on the books; it would make regular payments for services based on outputs (e.g., vehicle-kilometers) over the contract period (normally 5-10 years).
- Ability to control tariff and revenues: The gross-cost based system insulates tariff-setting decisions from contractual obligations with operators, allowing Government the opportunity to factor social considerations into tariff policy, such as fare concessions for specified groups, without risking breach of contract. Moreover, under such an arrangement, fare integration among public transportation modes can be applied easily (without creating contractual difficulties with operators), which would increase convenience and affordability for public transport users.
- Sustaining vehicle quality while avoiding budgetary capital investments: Under a competitive tendering and output-based contractual requirement, commercial operators, either municipal enterprises or private companies, would be obliged to make commercial decisions on vehicle maintenance and upgrades, considering costs over the contract duration and contractual obligations on vehicle and service quality standards, without requesting government budget.
- Potential to institute and control cross-subsidization of public transport users by private car users: Requiring higher vehicle and service quality standards is likely to increase government expenditure on minibus services, which must be paid by users and/or taxpayers. Municipal authorities may choose to cross-subsidize public transport upgrades (green transport measures) from private cars (polluting modes) on the ground that higher costs to provide better quality public transportation would be offset by lower externalities such as congestion and air pollution.

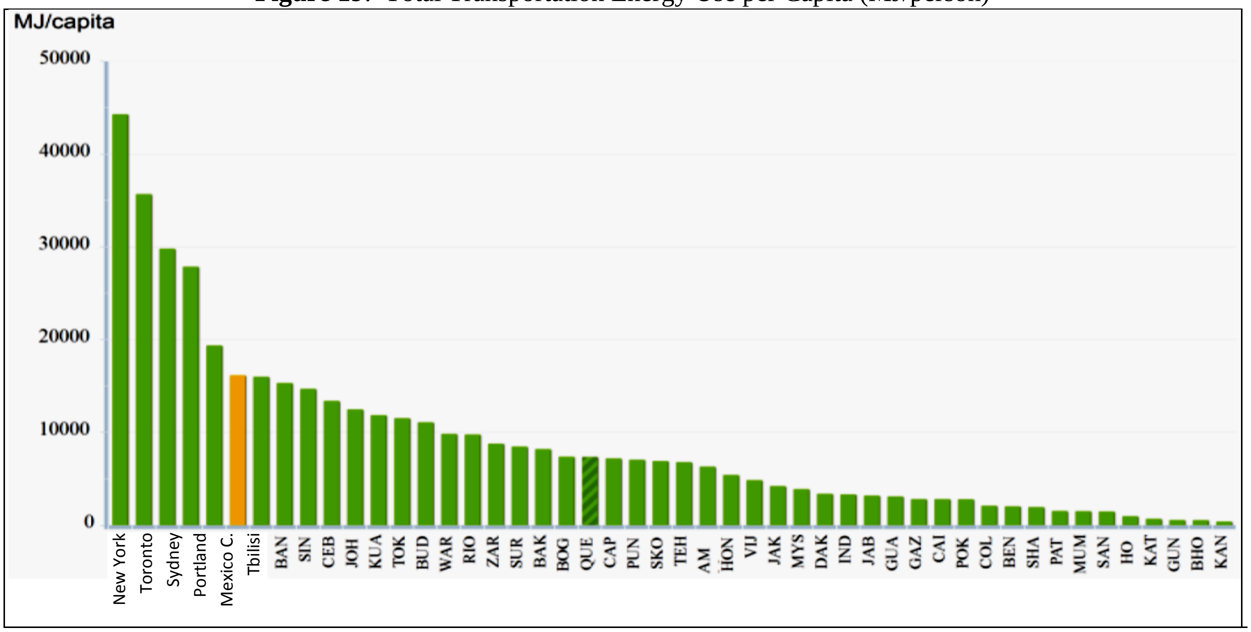
[52] Gwilliam (2005)

F. Support Sustainable Development of Urban Transport

***Why this measure?***

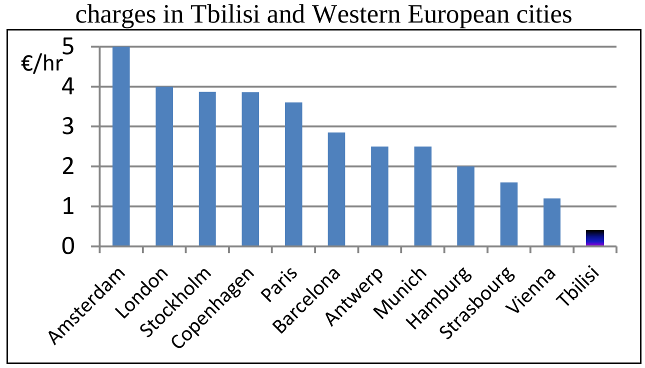
**Current condition: urban transport sector of Georgia, particularly Tbilisi, consumes more energy per capita than many other cities both in developed and developing countries**. In Tbilisi, the car ownership rate has more than doubles in only nine years, from 80 cars per 1000 people in 2000 to 205 cars in 2009. In addition, due to the city's hilly terrain and aging vehicle fleet, Tbilisi's energy consumption per capita is comparable to that of Paris or Mexico City, and significantly higher than several other cities, such as Tokyo, Budapest, Rio de Janeiro, Bogota, and Quebec (Figure 19).

**Figure 19**: Total Transportation Energy Use per Capita (MJ/person)




*Source: World Bank (2011), TRACE Study*

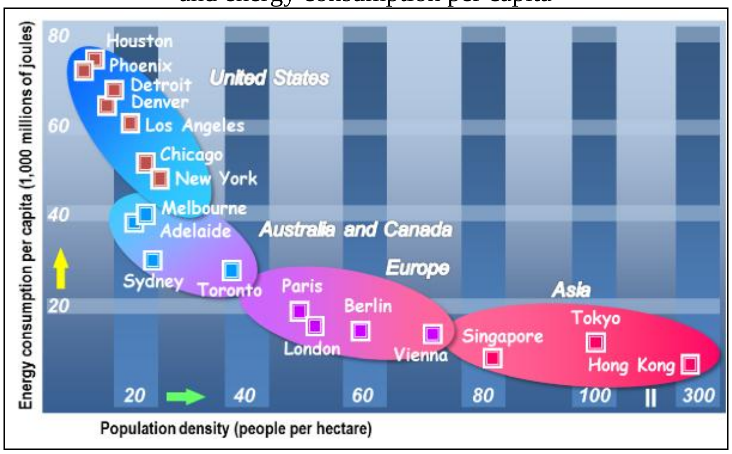
**Figure 20**: Comparison of first hour on-street parking charges in Tbilisi and Western European cities




*Source: Institute for Transportation and Development Policy (2011); Asian Development Bank (2011)*

**Current condition: private car use is cheap and unrestricted in most Georgian cities**. Private car users in Georgia's urban areas do not bear the full cost of externalities generated by their trips—traffic congestion and air pollution. As a result, the individual marginal cost of private car use is less than the social marginal costs incurred by it. At existing motorization rates, such externalities are contained, but this would no longer be the case if the expected economic growth materializes, driving up private car ownership. Parking restrictions and costs can also constrain private car use. However, in Georgia there are now few associated constraints or costs, even in congested city centers. For example, in central Tbilisi, short-term parking charges are as low as 0.2 to 1 GEL per parking, regardless of the duration of parking and the level of congestion.[53] By contrast, in most Western European cities, parking is strictly regulated and public spaces are priced according to demand levels (i.e., parking in city center is more expensive than parking in suburban areas). In fact, the hourly rate of parking charges in Tbilisi is lower than it appears in Figure 19, since most parking spaces have no time limits and one-time charges apply regardless of parking duration. Low charges and lack of parking enforcement encourages unregulated on-street parking, and ultimately creates an inefficient use of valuable road capacity that should be used to move traffic, not store vehicles. Low marginal costs and little restraint on private car use, combined with low public transport service quality (discussed above in Section III.D), would encourage a continuous modal shift to private cars.

**Figure 21**: Strong inverse correlation between population density and energy consumption per capita




*Source: Newman, P. and J. Kenworthy (1999)*

**Rationale for change: city development and transport planning will have a lasting impact on the city metabolism and sustainability**. Land-use policies and transport infrastructure development have long-term effects on shaping urban forms and travel patterns. Around the world, income growth, motorization levels, and car-oriented land-use and transport policies have resulted in urban sprawl, which has raised the monetary, time, and human costs of inner-city transport, along with energy consumption per capita in the transport sector. Figure 21 shows that higher population density results in lower energy consumption per capita. Increased fuel use is associated with high emissions of particulate matter, $NO_x$ and sulfur dioxides that raise the risks of respiratory and cardiovascular diseases among residents. Many cities have realized that reversing the trend is costly and time-consuming, if not impossible. Similar trends will eventually appear in Georgian cities, particularly in Tbilisi, due to rising motorization levels and concentrated car ownership in urban areas and rising incomes.[54] Early intervention and long-term strategic planning can prevent the long-term consequences, not to mention the future cost and difficulty of implementing corrective measures.

***How can this be done?***

Building a sustainable urban transport system requires holistic strategic planning and balanced and multi-modal development of transport infrastructure that is driven by a long-term vision. This approach requires a mix of fiscal incentives, regulatory policies and investment in multi-modal urban transport systems that

53 Asian Development Bank (2011)

54 Income growth and increasing private car use generally encourage households to move from inner-city quarters to suburban settlements. This expands the geographic size of urban areas, which dampens the land market and rents in inner cities but creates the expense of longer commutes and other trips. In Tbilisi, the increase of urban land areas would increase passenger travel demand and make it increasingly difficult to serve the demand by "yellow buses" and rail systems (including the metro and LRT system under consideration). Accommodating suburban expansion would incur high costs for road construction and high-value locations for businesses and residential housing would be lost to roads. Under a private car-dominated urban transport, the rent decreasing effect would be offset by high demand for urban land for roads and parking areas.

induce a high share of low-emission modes. The alternative is short-sighted short-term policies and investments that respond to the immediate demand to accommodate more private cars.

**Institutional: developing a national-level urban transport policy framework**. While urban transport planning and development is the responsibility of municipal authorities, the national government also plays an important role. International experience suggests that the central government role, similar in both federal and unitary government structures, is important in setting out a national policy framework, legal and regulatory framework, and technical standards that need to be applied on a national scale. Central government can also act as a facilitator in knowledge-sharing and technical capacity building, and allocate budgetary resources to promote technological innovations and generation of national public goods such as GHG emission reductions. In Georgia, planning and technical capacity is uneven across regions and municipalities: Tbilisi is most progressive in terms of greening agenda and reforms; a few other medium-sized cities have experimented with some public transport improvements and non-motorized transport measures but these have been opportunistically driven by external funding opportunities. To promulgate good practices in a greater number of cities, both international and Georgian, would require a national-level facilitator that is adequately staffed and funded. National government could take leadership in the following areas:

- Develop guidelines for urban transport planning and investment programs
- Establish technical and environmental standards for urban transport to be implemented at municipal level
- Create and maintain urban transport database and knowledge clearing house
- Provide grant funding to municipalities to adapt successful innovative approaches.

**Institutional: coordinating with spatial development and land-use policies**. At Georgia's current income level, many developing cities observe structural changes, which lead to substantial increases in transport demand.[55] In larger cities, housing prices increase substantially in central business districts, and in response, households and firms move out from the center. These choices occur when increased transport costs (longer commutes) are compensated by lower rents, and in aggregate, result in urban sprawl. Under these circumstances, land-use policies that encourage mixed-purpose development and high-density development around public transport corridors would contribute to energy-efficient and low-carbon development. This should be combined with urban transport system designs that influence citizens' choices of residential locations and travel patterns. By providing high-quality public transport options and imposing high charges for individual vehicle use (internalizing social external costs associated with as congestion and local emissions), transportation plans can contribute to restraining motorization rates and encouraging high shares of public transport use. Both favor higher-density urban settlements, and avoid the high intra-urban transport costs associated with low-density settlements at the outskirts of cities.

**Planning: instituting integrated city development and transport planning**. Major cities in Georgia need to adopt measures that restrict private car use. To accomplish this, urban land and city architecture development must be coordinated with transportation plans. Changes in land-use and geographical expansion of city boundaries have profound and lasting impacts on transport demands and travel patterns, which ultimately affects transport sector energy consumption. Long-term strategic and comprehensive transportation planning should be initiated as a good practice or even a mandate for city administration,

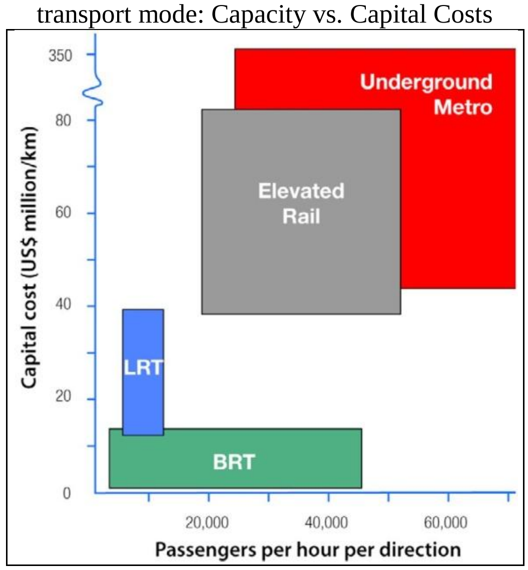
[55] Glaeser (2008)

and short- to medium-term transportation investment programs should derive from the strategic plan. Traffic impact assessments should be required for all new land developments above a specified size, and all changes in land use.

**Regulations and pricing: making private car use less convenient and more expensive**. A mix of regulations, physical restrictions and pricing tools can effectively restrain demand for private car use and parking in urban centers. Even at today's level of motorization and traffic congestion, some Georgian cities face parking scarcity. If cities charge for parking space according to land values, private vehicle use within cities is rationalized and demand for high-value land is reduced. These policies will mitigate congestion in the medium- to longer-term. In the longer-term, congestion charges could be introduced as an incentive to use public transport. Other cities' experiences show that revenues from charging policies cover operating expenses and are often used to develop and improve public transportation.

**Investments: invest in high-quality and competitive alternatives to private transport**. Policies for modal shift will encourage greater demand for public transport. The routes, frequency, speed, and convenience of public transport modes must be attractive to compete with private cars. Therefore, investment is justified in modern and green public transportation systems that are characterized by: (i) a physically segregated right-of-way that insulates the movement of public transport vehicles from other traffic and traffic congestion; (ii) modern, convenient, clean vehicles; (iii) integrated ticketing system; (iv) passenger information systems using advanced information and communication technologies; and (v) a service plan and scheduling that is well integrated with the overall transportation system and responsive to demand. Developing modern public transport systems typically requires large capital investments, coherent planning, technical capacity, and a stable budget for operation and maintenance. To ensure high-quality services and attractiveness of public transport modes, it is also necessary to provide operational integration of all public transport modes, such as fare integration and coordinated scheduling. Combining investments in public transport with restrictions and higher costs for private car use would provide compelling reasons for private vehicle users to adopt public transport. Options for Georgian cities, which are not too populous and typically located on hilly terrain, include the following:

**Figure 22**: International comparison of public transport mode: Capacity vs. Capital Costs




*Source: Wright, L. and W. Hook (2007)*

- Introduce relatively high-capacity and high-speed but cost-efficient modes, including light rail transit and bus rapid transit (BRT) systems, along major trunk corridors. International examples show that different modes offer varying ranges of capacity (Figure 22),[56] depending on vehicle capacities, scheduling, and the degree to which vehicles are segregated from other traffic flows. Investment decisions on public transport systems should therefore be based on an analysis of alternatives that explores all feasible opportunities.

[56] Capacity of a BRT system may vary greatly, from fewer than 10,000 to 50,000 passengers per hour, depending on the degree of physical separation from general traffic.

- Install modern ropeways and cable cars systems that connect residential areas and city centers, or rehabilitate existing systems in hilly areas. Systems that operated during the Soviet era as daily urban transport for residents and tourists[57] have all ceased to operate as the infrastructure has long since expired and the technical standards no longer comply with the standards of a newly adopted European Union Directive on Cableway Installations (2000/9/EC). Internationally, many cities on hilly terrain, or divided by rivers or valleys, have successfully introduced modern high-capacity and high-speed ropeway public transport. Examples include Portland Aerial Tram (U.S.A.), Medellin Metrocable (Colombia), and Caracas Metrocable (Venezuela).

**Investments: introduce intelligent transportation systems for efficient traffic management and better user services**. Intelligent transportation systems (ITS) refer to the application of information and communication technologies to transport. ITS applications improve urban transport efficiency and environmental sustainability by improving traffic flows, monitoring and enforcing parking and traffic rules, and facilitating operational integration of public transport services (e.g., single-ticket systems and schedule coordination). Such measures help create a quality public transport system that can compete favorably with private cars, thereby contributing to green transportation. These new technologies—including automated bus locating systems, advanced traffic management schemes (e.g., giving priority to public transport vehicles at key intersections), electronic ticketing systems, and passenger information systems—require careful planning and phased implementation due to the need for technical standards and the inter-sectoral and inter-agency nature of some applications.[58] Therefore it is recommended that municipalities develop an ITS strategic plan for at least five years, and begin implementation of service elements that mitigate congestion and improve public transport service quality.

[57] During Soviet era, there were 5 ropeway systems operating in Tbilisi and 12 systems in nine cities—Signakhi, Tsnori, Gurjaani, Tkibuli, Chiatura, Sachkhere, Kutaisi, Bakuriani, and Mitarbi. All systems were used primarily for regular urban transport, except the systems in the ski resorts (Bakuriani, and Mitarbi).

[58] For instance, it is desirable that all public transport operators adhere to same communication standards for their vehicle locating systems so they are compatible with one another. As another example, same communication network, once established for ITS application, may be shared among multiple services run by various entities (e.g., congestion monitoring by city's traffic management unit, and traffic rules enforcement by the police). Therefore a coordinated approach is critical in order to prevent wasteful or redundant investments, while maximizing the utilization of facilities and equipment.

# IV. Summary and Roadmap of Priority Actions

## A. Summary of the proposed Green Transportation Policy Framework

The proposed Green Transportation Policy Framework laid out in Chapter III includes various measures that falls under one of the four types of instruments discussed in Section II.C—(i) institutional and planning, (ii) regulation and enforcement, (iii) fiscal policy and pricing, and (iv) investments—under six policy objectives, and is summarized in Table 8.

**Table 8**: Summary of the Proposed Green Transportation Policy Framework

| Institutions and Planning | Regulations and Enforcement | Fiscal Policy and Pricing | Investments |
|---|---|---|---|
| ***A. Integrate Environmental Concerns into Transport Policy*** | | | |
| • Integrate transport policy and environmental monitoring | • Reinstate fuel quality inspection | • Revise taxes on motor fuels to be differentiated by the quality as incentives to use cleaner fuels<br>• Maintain the high fuel prices relative to income levels as a long-term policy | |
| ***B. Achieve and Maintain a Greener Vehicle Fleet*** | | | |
| • Strengthen institutions for effective enforcement | • Expand vehicle inspection requirements to include all commercial and non-commercial vehicles | • Scrap and recycle the old and polluting vehicle fleet<br>• Tax credits and other financial incentives for higher fuel-efficiency and technological improvements of vehicles | • Subsidize the scrapping and recycling of old and polluting vehicles |
| ***C. Promote Low Emission Freight Transport Modes*** | | | |
| • Develop a coherent transport policy that focuses on intermodality and international collaboration with key trading partners and neighboring countries | • Apply vehicle inspection regime to domestically registered trucks and to Georgian transport companies<br>• Introduce and enforce regulations on vehicle emissions and axle loads for foreign registered transit vehicles | • Differentiate charges on transit trucks according to vehicle emission class and axle loads<br>• Allocate the revenues to the maintenance of road network assets and green transport investments | • Develop multimodal, green transit corridors by improving intermodal connectivity, eliminating bottlenecks and supporting containerization |
| ***D. Support Commercial Development of Intercity Passenger Transport Services*** | | | |
| • Improve the convenience of and access to intercity bus services through coordinated marketing strategy and passenger information services | • Control market entry through regulations and enforcement of vehicle and emission standards<br>• Introduce competitive tendering for strategic intercity routes and manage the service quality | | • Improve the quality of infrastructure and consumer amenities through public and private investments |
| ***E. Transform Minibuses and Taxis into Modern Urban Transport Modes*** | | | |
| • Develop a strategic vision and strengthen market competition for minibuses and taxis<br>• Develop a strategy for coherent multimodal public transport system | • Minibus market: introduce competitive tendering and gross-cost based contracting<br>• Taxi market: introduce partial regulations that control fare and quality but allow free market-entry | | • Refrain from direct budgetary support for vehicle improvement<br>• Oblige commercial entities to maintain their vehicle fleet quality |

| *F. Support Sustainable Development of Urban Transport* | | | |
|---|---|---|---|
| • Develop a national-level urban transport policy framework<br>• Institute integrated city development and transport planning | • Make private car use less convenient by introducing parking restrictions in urban centers | • Make private car use more expensive through appropriate forms of road user charges | • Invest in high-quality and competitive alternatives to private transport<br>• Introduce intelligent transportation systems for efficient traffic management and better user services in urban areas |

***Assessment of the proposed policy framework through the objectives and constraints of Government***

This paper argues that the proposed policy framework would increase the likelihood for Georgia to achieve greener transportation without undermining mobility and accessibility. The policy framework would contribute to the various development objectives of Government discussed in Section I.B. From fiscal point of view **it would help reduce fuel imports, and hence, the current account deficits**. From environmental point of view, **it would help reduce emissions of GHG as well as of local pollutants**. The quantified benefits of the policy framework are discussed in the following section.

At the same time, the fiscal, political, and administrative constraints facing Government need to be recognized for successful implementation of the proposed framework. First, **the proposed fiscal and pricing measures would not be inconsistent with the current administrative philosophy that pursues small government**. The proposed taxes and subsidies do not automatically lead to bigger government or increased tax burden on households and firms. Taxes on low quality fuels, pollutants and high-emission vehicles would bring about net welfare benefits in terms of reduced health and environmental costs. Also, income (households) and cost (firms) effects of such fiscal measures can partly be compensated for by how the revenues are used. Government can choose (i) to allocate the revenues generated from the proposed "green" taxes for investment in green transport modes, (ii) to reduce taxes that have negative effects on economic growth, or (iii) to combine both approaches. For instance, if fuel tax revenues are used to improve public transport modes, increased fuel costs for households can be compensated by enhanced mobility through high-quality public transport services. If Government, now with the revenues from green taxes and to be revenue-neutral, reduces the labor or corporate taxes, that would help reduce the informal sector or increase domestic and foreign investments. More generally, introduction of green taxes could be planned as part of broader changes in the taxation.

Second, **public acceptance of fiscal and regulatory measures can be won through a public outreach strategy that highlights the "service fee" nature of certain pricing measures and the social costs of environmental externalities, and promote "polluters pay principle"**. The proposed fiscal and pricing measures are not blanket taxes, but those that target the sources of pollution and inefficient use of motor fuels (in other words, transport users have options to avoid these taxes, by opting for greener modes of transport). Therefore they can easily be formulated and communicated as "fees" that need to be paid for polluting the environment or for using transport infrastructure and services, instead of "taxes" on vehicles or fuels. This approach has also been advocated in the White Paper of the European Commission not only for the political reason but also for the economic rationale. Most congestion charging schemes in Western Europe and North America have gained much political support when they were viewed as fees associated with certain services and users were provided with alternative options.

Third, **implementation of the proposed regulatory measures can be designed in a way that minimizes administrative costs and sustains the achievement of governance reform**. To minimize the contact between public officials and the public, which was the principle of the recent governance reform in Georgia, phased implementation of regulatory measures is recommended. Fuel quality inspection poses lowest governance risks as it can be done by checking a limited number of motor fuel importers and distributors. Expanding the current vehicle inspection that is limited to firms that provide international transport services to include other commercial operators including domestic ones would be a sensible next step. Economic and financial feasibility of inspecting privately owned vehicles needs to be assessed, taking into consideration of governance risks and administrative costs.

## B. Business-As-Usual vs. Green Transportation Scenarios

This section presents the results of EFFECT analysis for two scenarios: business-as-usual and green transportation; the same socio-economic parameters were used for both. The following assumptions applied to both scenarios: (i) total output (GDP) grows at an annual rate of 7.0 percent, and the population at 1.0 percent; (ii) moderate motorization rate results in about 220 vehicles per 1,000 people by 2027; (iii) the vehicle fleet undergoes moderate technological improvements in terms of fuel efficiency and emissions.

The EFFECT framework predicts future vehicle ownership and transport demand (in terms of ton-km and passenger-km) by mode, vehicle type, and engine technology, on the basis of the baseline ownership and transport data, future economic and population growth, fuel prices, mode choice patterns, and anticipated improvements and changes in vehicle technologies. The current version of the EFFECT (v3.0) includes a railway module, allowing modal shift between road and rail transport. It allows users to determine level of disaggregation based on the data availability and objective of the analysis. Further details of the EFFECT framework, including input data, assumptions, and calibration methodologies are in Annex 1.

**Figure 23**: Vehicle-kilometers-traveled under the business-as-usual scenario

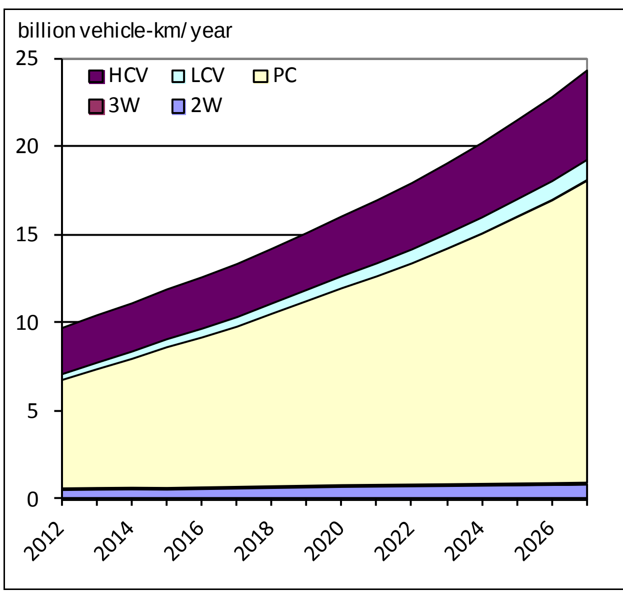



**Figure 24**: Vehicle-kilometers-traveled under the green transportation scenario

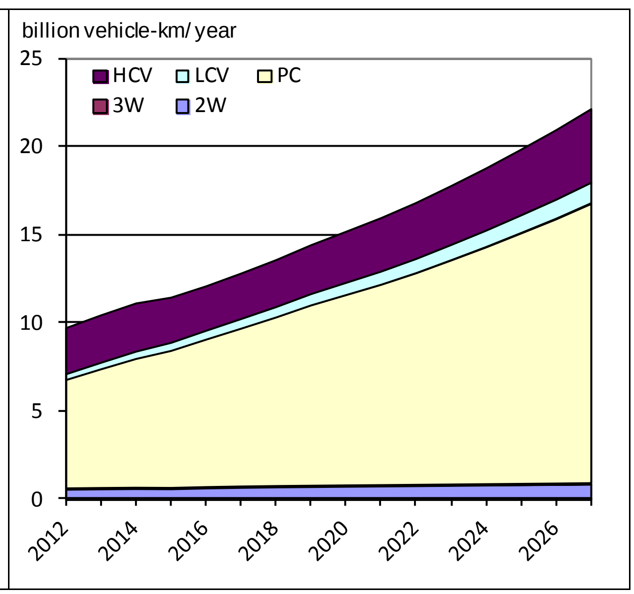


**Figure 25**: Motor fuel consumption under the business-as-usual scenario

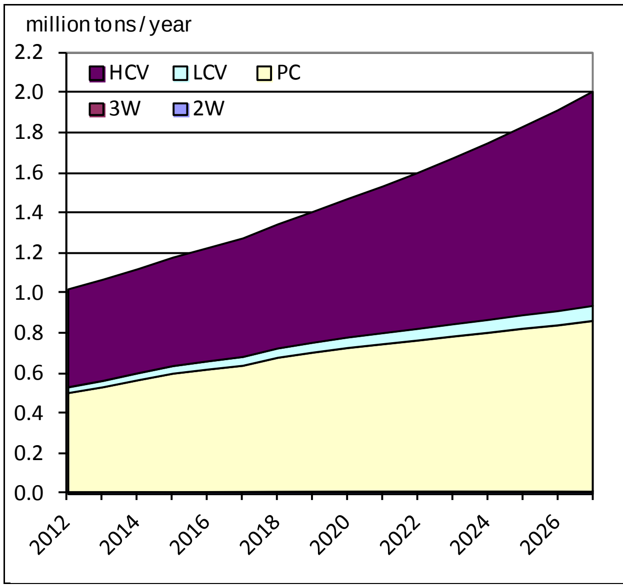



**Figure 26**: Motor fuel consumption under the green transportation scenario

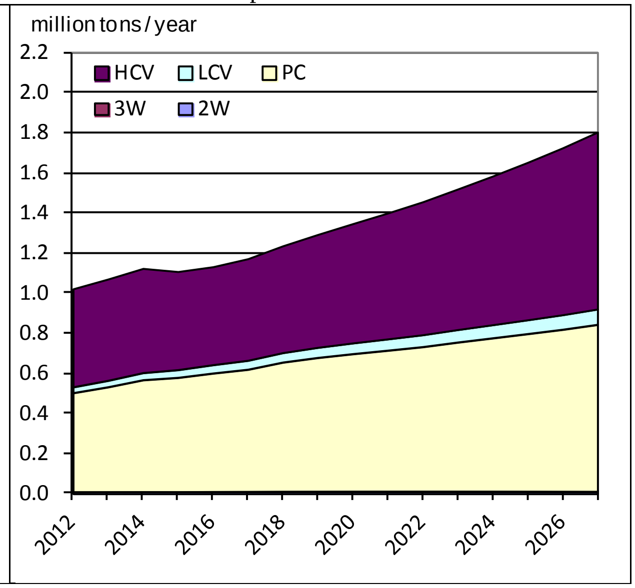



**Figure 27**: $CO_2$ emissions from road transport under the business-as-usual scenario

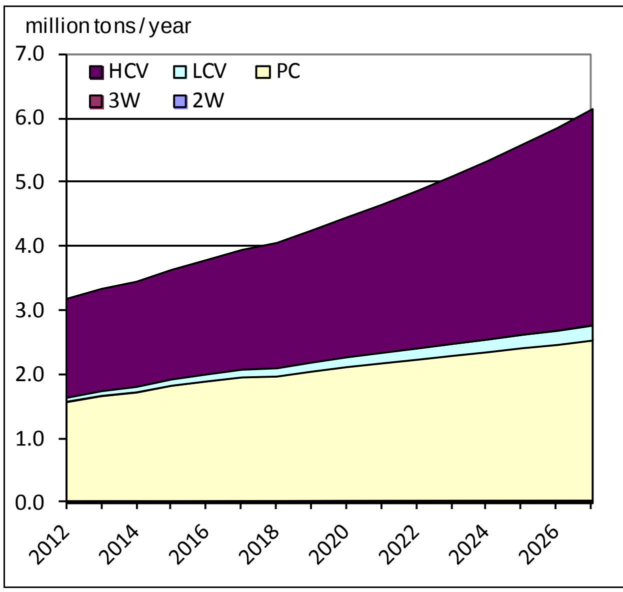
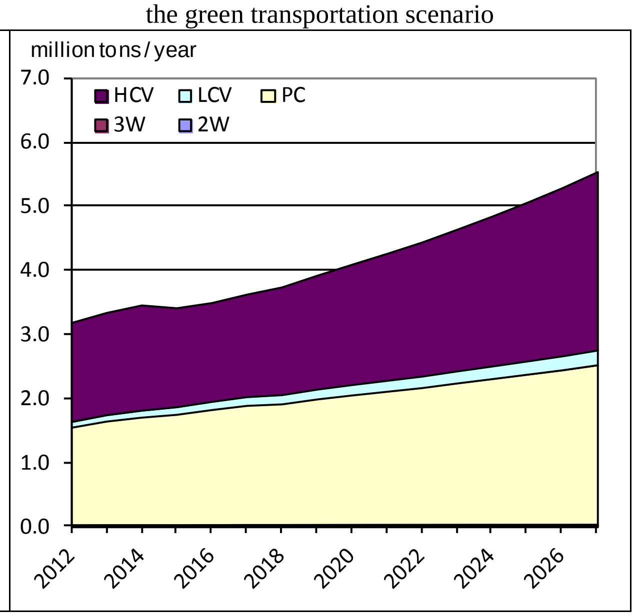



**Figure 28**: $CO_2$ emissions from road transport under the green transportation scenario




*Source: WB Staff analysis using the EFFECT Framework based on the data provided by Georgian entities*

Under the green transportation scenario, as shown in Figures 23-28 and Table 9, Georgians will drive about 4.0-6.0 percent less during 2012-2027 as measured by vehicle-kilometers, compared to the business-as-usual scenario. Subsequently during the same period, reduction in motor fuel consumption is estimated at 1,746 to 1,825 million tons (7-8 percent), equivalent to about 9 billion GEL in fuel cost savings (discounted net present value). The green transportation scenario would reduce CO2 emissions by an estimated 2,797 to 5,338 million tons (4-7 percent). Most local pollutant emissions are substantially reduced under the green transportation scenario (Table 9): CO emissions by 22-67 percent, VOC emissions by 26-54 percent, and NOx emissions by 11-23 percent.

Indirect benefits of green transportation scenario were not factored into the calculation but would include (i) reduced traffic congestion, thus time-savings and increased productivity; (ii) reduced road traffic accidents and fatalities; (ii) positive impacts on public health; and (iv) potentially lower transport costs that would enhance competitiveness of Georgia's exports and lower prices for consumer goods. The modal shift to rail-based transport and electric modes of public transport would increase electricity consumption substantially, requiring expansion of hydropower generation capacity.

**Table 9**: Comparison of business-as-usual and green transportation scenario for 2012-2027

| Indicators | Business-as-usual | Green Transportation | |
|---|---|---|---|
| | | *Moderate* | *Aggressive* |
| Total vehicle-km on road (million) | 258,235 | 249,319 (-4%) | 244,075 (-6%) |
| Total fuel consumption (thousand tons) | 23,492 | 21,746 (-7%) | 21,667 (-8%) |
| Total fuel costs, excluding electricity (million GEL)[a] | 96,226 | 87,434 (-9%) | 87,331 (-9%) |
| Total electricity use (GWh) | 46,249 | 63,255 (+37%) | 75,992 (+64%) |
| Total passenger-km by road (million) | 730,502 | 664,955 (-9%) | 689,451 (-6%) |
| Total passenger-km by rail and electric public transport (million) | 30,490 | 62,600 (+105%) | 77,633 (+155%) |
| Total ton-km by road (million) | 524,924 | 489,010 (-7%) | 453,096 (-14%) |
| Total ton-km by rail (million) | 154,504 | 190,420 (+23%) | 226,335 (+47%) |
| Total $CO_2$ emissions (thousand tons) | 71,793 | 68,996 (-4%) | 66,455 (-7%) |
| Total CO emissions (thousand tons) | 1,200 | 392 (-67%) | 941 (-22%) |
| Total VOC emissions (thousand tons) | 178 | 82 (-54%) | 131 (-26%) |
| Total NOx emissions (thousand tons) | 458 | 351 (-23%) | 406 (-11%) |

*Note: All values are aggregate sums for the period 2012-2027*
[a] *Discounted*

These reductions and savings are attributed to various factors, as described below and shown in Table 10.

**Cleaner vehicle fleet due to renewal and regular inspection (measures recommended in Sections III. A, B)**. In Georgia, the 50-percent vehicle retirement age, at which 50 percent of vehicle fleet of a certain vehicle cohort retires, is much higher than in the case of higher-income countries. As in other countries, it will go down naturally as the average income grows, and stricter vehicle emission standards and regular vehicle inspection will expedite this trend. The proposed vehicle scrapping and recycling program will likely result in large-scale vehicle renewal within a relatively short period of time. Participation rates for a vehicle scrapping-and-recycling program would be influenced by financial incentives such as tax breaks and subsidies, the price difference between eligible old and new vehicles, and the income level. Data were unavailable on Georgian consumer behavior on vehicle choices; therefore this study assumed that future vehicle choices in Georgia would resemble those of consumers in other developing countries (see Annex 1 for detailed assumptions). Under the green transportation scenario, vehicle-km travelled, fuel consumption, and subsequently CO2 emissions increase. This is due to the fact that typically newer cars are driven longer average distances than older vehicles. The main benefits of vehicle renewal and maintenance are substantial reductions in local emissions: CO emissions are estimated to decline by 196 thousand tons; VOC emissions by 40 thousand tons; and NOx emissions by 12 thousand tons.

**Modal shift of freight transport from road to railway (measures recommended in Section III. C)**. Improvement of intermodal connections and increased road user charges on freight transport will induce road-to-rail modal shift. Future modal shares of cargo transport between road and railway depend on multiple factors, such as charges on road use, fuel prices, quality and prices of rail and transshipment services, and differences in border-crossing efficiency of each mode. Based on past trends of rail and road modal share, it is assumed that between 6 and 12 percent of total road cargo (ton-km) would be shifted to rail. The benefits of such a modal shift are estimated as shown in Table 9: fuel consumption is estimated to reduce by 607 to 1,214 thousand tons; CO2 emissions by 1,904 to 3,809 thousand tons; and NOx emissions by 15 to 29 thousand tons.

**Modal shift of passenger transport from private cars to public transport (measures recommended in Sections III. D, E, F)**. Improvement of urban transport systems and introduction of restrictions and pricing for private transport in urban areas would induce modal shift from private to public transport, including regional rail, interurban buses, metro (Tbilisi), in-city buses, and other future in-city electric transport modes (such as LRT, ropeways, etc.). Well-developed intercity bus services would also be a good alternative to private transport. Future mode choice patterns of urban and interurban passenger transport would depend on the quality and prices of various modes, fuel prices, level of congestion, and other urban transport demand management measures, such as parking restrictions and congestion pricing. Benefits of green transport policy on passenger transport will vary: fuel consumption is estimated to reduce by 526 to 750 thousand tons; CO2 emissions by 1,577 to 2,240 thousand tons; and NOx emissions by 9 to 11 thousand tons.

**Table 10**: Green transportation scenario: fuel consumption and emissions reductions by contributing factors

| Reductions attributed to | Freight modal shift | | Passenger modal shift | | Vehicle renewal and inspection |
|---|---|---|---|---|---|
| | *Lower bound* | *Upper bound* | *Lower bound* | *Upper bound* | |
| Fuel consumption reduction (thousand tons) | 607 | 1,214 | 526 | 750 | -154 |
| Fuel costs savings (million GEL)[a] | 2,369 | 4,738 | 2,370 | 3,463 | 722 |
| $CO_2$ emissions reduction (thousand tons) | 1,904 | 3,809 | 1,577 | 2,240 | -777 |
| CO emissions reduction (thousand tons) | 3 | 6 | 38 | 57 | 196 |
| VOC emissions reduction (thousand tons) | 1 | 1 | 5 | 7 | 40 |
| NOx emissions reduction (thousand tons) | 15 | 29 | 9 | 11 | 12 |

*Note: All values are aggregate sum during the period of 2012-2027*

[a] *Discounted*

## C. How to Implement the Policy Framework: Roadmap for Green Transportation

Measures proposed in the above policy framework can be prioritized based on urgency and sequencing. The proposed roadmap below lays out priority actions for the short-term (2012-2014), medium-term (2015-2020), and longer-term (after 2020).

In the short-term, it is critical to focus on building institutional capacity and carrying out preparatory tasks including key studies and strategy development. High priority activities include (i) reinstating fuel and vehicle emissions standards, (ii) carrying out green logistics study, identifying investment needs, (iii) developing strategies for intercity passenger transport and minibus reforms, and (iv) carrying out alternative analysis or feasibility study for modern and green public transport modes in Georgian cities, including LRT, BRT and ropeway transport.

***Short-Term (2012-2014): Institutional Capacity and Preparatory Tasks***

| Objectives | Actions | Responsible Entities |
|---|---|---|
| *Strengthen the institutions and policies at national and municipal level* | 1.1) Include environmental objectives and targets in national and municipal transport policies | (Lead) MoEnv; (Support) TPD |
| | 1.2) Develop and implement an environmental monitoring framework, including ambient air quality measurement | (Lead) MoEnv; (Support) TPD |
| | 1.3) Update regulatory framework stipulated in Presidential Decree No. 302, introducing phased implementation plans with defined targets at each phase, streamline administrative procedures with a plan to outsource actual implementation. | (Lead) LTA; (Support) MoEnv, MoE, MoESD |
| | 1.4) Strengthen inter-agency collaboration among ministries, and between national government and municipal authorities | Council of Ministers |
| *Carry out preparatory work and studies for medium-term actions* | 1.5) Assess appropriate levels of transit truck charges by emission class and weight, and possibly by distance, devise a plan for implementation, including electronic toll collection system | (Lead) TPD, MoRDI; (Support) MoESD |
| | 1.6) Carry out green logistics study, assessing feasibility of containerization and transshipment facilities such as Ro-Mo and Ro-Ro and identifying investment needs | (Lead) TPD; (Support) MoRDI, Georgian Railway |
| | 1.7) Develop strategy for intercity passenger transport based on ongoing market analysis | (Lead) TPD; (Support) NTA |
| | 1.8) Develop strategy for minibus reform, identifying steps to introduce competitive tendering and evaluating feasibility of gross-cost vs. net-cost contracting | (Lead) TPD; (Support) Municipalities |
| | 1.9) Research taxi regulations, investigating current market condition and identifying appropriate level of regulations | (Lead) LTA; (Support) Municipalities, TPD |
| | 1.10) Develop urban transport strategic plans in cities other than Tbilisi | (Lead) Municipalities; (Support) TPD |
| | 1.11) Carry out alternative analysis and/or feasibility studies for public transport modes in Georgian cities, including trams, ropeways, LRT, BRT | (Lead) Municipalities; (Support) TPD |

*Note: MoESD (Ministry of Economy and Sustainable Development), TPD (Transport Policy Department within the MoESD), MoEnv (Ministry of Environment), MoE (Ministry of Energy), MoRDI (Ministry of Regional Development and Infrastructure), LTA (Land Transport Agency) NTA (National Tourism Agency), Ro-Mo (rolling motorway), Ro-Ro (rolled-on and rolled-off)*

In the medium-term, enforcement of various regulatory measures needs to be strengthened, and based on the knowledge gathered through preparatory studies, market reforms need to be implemented. Investment projects for infrastructure development would also start during this period.

***Medium-Term (2015-2020): Enforcement, Market Reforms, and Infrastructure***

| Objectives | Actions | Responsible Entities |
|---|---|---|
| *Implement the improved regulatory framework* | 2.1) Based on updated regulatory framework developed under (1.3), enforce fuel quality standards | (Lead) LTA or a new designated agency; (Support) MoEnv, MoE |
| | 2.2) Expand vehicle inspections to all commercial vehicles, including those providing domestic services | (Lead) LTA, Police; (Support) MoEnv |
| | 2.3) Institute administrative procedures for periodic vehicle registration combined with compulsory safety and emissions inspection for all privately owned vehicles | (Lead) Police, LTA; (Support) TPD, MoEnv |
| | 2.4) Establish test facility for technical inspection and start pilot implementation in selected cities and regions | (Lead) LTA, Police; Support municipalities |
| *Promote market competition through key sub-sector reforms* | 2.5) Implement intercity passenger transport strategy developed under (1.8) | (Lead) NTA, TPD (Support) MoF |
| | 2.6) Implement in-city minibus market reform strategy developed under (1.9) | (Lead) Municipalities (Support) TPD |
| | 2.7) Based on the findings from (1.10), implement reforms of the urban taxi market, starting in a pilot city | (Lead) Municipalities (Support) LTA, TPD |
| *Develop infrastructure for lasting transformation* | 2.8) Implement the revised transit truck charges based on the assessment and implementation plan prepared under (1.5) | (Lead) MoRDI or a designated entity; (Support) TPD |
| | 2.9) Based on study results from (1.6), prepare and implement infrastructure investment projects for new intermodal facilities, transshipment terminals, capacity expansion, etc. | (Lead) MoRDI, Georgian Railway, Port authorities, municipalities (Support) TPD, MoF |
| | 2.10) Based on study outcomes from (1.11), prepare and implement public transport capital investment projects: possible projects include fleet renewal, new investments in public transport trunk corridor development, infrastructure and facility for non-motorized transport, and ITS measures | (Lead) Municipalities (Support) TPD, MoF |

*Note: MoF (Ministry of Finance), MoESD (Ministry of Economy and Sustainable Development), TPD (Transport Policy Department within the MoESD), MoEnv (Ministry of Environment), MoE (Ministry of Energy), MoRDI (Ministry of Regional Development and Infrastructure), LTA (Land Transport Agency). NTA (National Tourism Agency)*

In the long-term, more innovative measures will be examined and introduced where feasible. Given the current trends of vehicle technology development and battery prices, this would be appropriate time frame for Georgia to consider electric vehicles and other technologies for wider deployment.

***Long-Term (2020 and after): Transformation***

| Objectives | Actions |
|---|---|
| *Transform mobility using advanced technologies* | 3.1) Institute financial incentives for adoption of technologies to improve fuel efficiency |
| | 3.2) Evaluate alternative propulsion technology options including electric vehicles |
| | 3.3) Invest in infrastructure and facility to support deployment of new technologies |
| *Shape green mobility patterns* | 3.4) Introduce appropriate road pricing measures, including congestion pricing |
| | 3.5) Incorporate environmental considerations in the existing taxation structure |

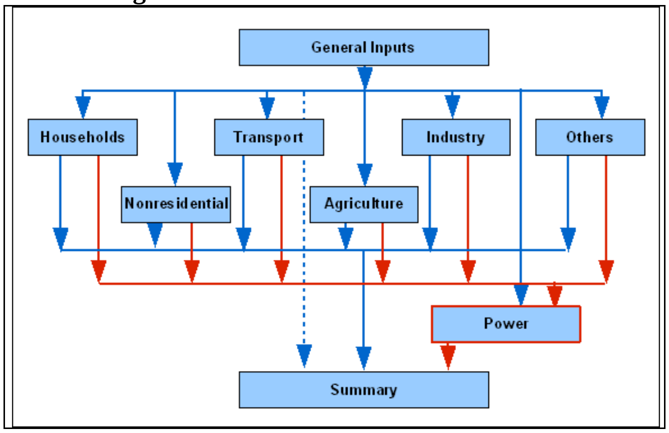
## ANNEX 1: EFFECT Analysis Methodology

### A. EFFECT: Energy Forecasting Framework and Emissions Consensus Tool

***The EFFECT framework***

EFFECT is an Excel-based bottom-up modeling tool designed to estimate energy consumption and forecast emissions in a given country over a long-term period.[59] The tool comprises one general module summarizing the basic socio-economic assumptions and six sector-specific modules for industry, transport, agriculture, power, households, and non-residential segments (Figure 29). The modular structure of EFFECT allows aggregating energy use estimates to project total emissions on a country level or, alternatively, simulating developments in an individual sector under various policy scenarios.

**Figure 29**: Modular Structure of EFFECT




*Source: ESMAP*

For purposes of this study, the analysis focuses on environmental and economic effects of policy choices suggested under the Green Transportation Framework as applied to the transport sector in Georgia. More specifically, the tools offered by EFFECT are employed to model and assess the reduction in fuel consumption and associated improvement of air quality under a number of vehicle use and technology considerations.

In its simplified form, the basic equation underlying the EFFECT framework expresses transport sector energy use as a function of three elements: (i) total number of vehicles (vehicle ownership), (ii) vehicle use (annual distance traveled = number of trips × average length of a trip), and (iii) vehicle technical parameters (e.g. fuel consumption per km for cars or energy consumption index for metro trains). For road transport, the equation takes the following form:

$$\textit{Fuel consumption} = \textit{number of motor vehicles} \times \textit{annual distance travelled} \times \textit{fuel consumption per km travelled}$$

Of critical importance to understanding the overall modeling framework is a brief description of the three concepts mentioned above and their underlying dependencies and relationships.

1) **Vehicle ownership.** Total vehicle population of a given country consists of a private vehicle fleet (passenger cars and motorcycles) and vehicles owned by public and private entities, which are used for commercial purposes (freight and passenger transportation). While a number of exogenous macroeconomic parameters (GDP, population growth and urbanization) affect the total vehicle stock, different approaches should be used to project private and commercial vehicle ownership.

[59] EFFECT was developed by the Energy Sector Management Assistance Program (ESMAP) administered by the World Bank. ESMAP is a global knowledge and technical assistance program that assists low- and middle-income countries to increase institutional capacity to achieve environmentally sustainable energy solutions for poverty reduction and economic growth.

Private vehicle ownership is a function of an extensive array of factors, including but not limited to household income, vehicle purchase price and operating (in-use) costs, demographic characteristics (driver's age, lifestyle, etc) and other – all of these parameters can be best accounted for using bottom-up forecasting approach based on household survey data.

Conversely, top-down modeling is considered to be more appropriate when projecting commercial vehicle fleet. The size of the latter can be estimated based on the forecasted demand for freight and passenger transportation services, for which GDP growth (used as a proxy for increase in economic activity, e.g. transportation of goods) and urbanization rate are key determinants. Both approaches are employed in EFFECT.

2) **Vehicle use.** Depending on the average age of the fleet and fuel price fluctuations, the number of vehicle-kilometers driven will vary thus affecting vehicle use. The net effect of change in the fuel price is the sum of two effects: the decline in the share of trips made by private motor vehicles (the in-use price elasticity effect) and the effect of an increase in the price of gasoline on shifts to other modes, e.g., shift to rail or bus (elasticity of substation effect).

   As evidenced by ample empirical data, vehicle use is inversely correlated with vehicle use: the older the vehicle, the less it is driven. However, a rebound effect may be observed when the reduction of vehicle operating costs due to improved fuel-efficiency of new cars encourages an increase in annual distance travelled.

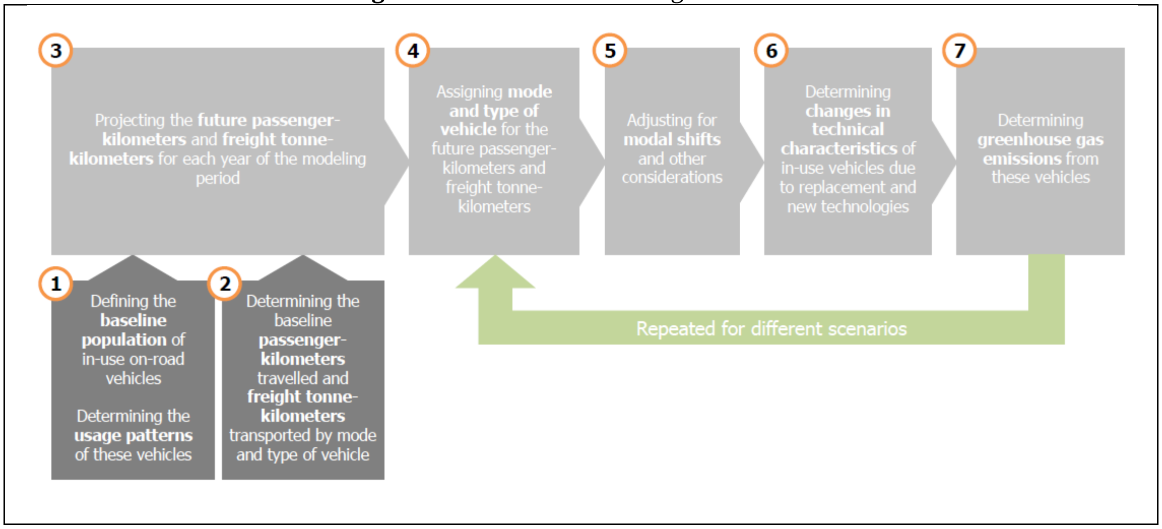
3) **Vehicle fleet composition** (vehicle fleet mix by class and technology). Future vehicle sales mix—and, ultimately, the composition of future vehicle population—depends on a complex set of consumer preferences. Most published studies of vehicle type choice attempt measuring these preferences by focusing on such explanatory variables as vehicle attributes, household characteristics, brand loyalty, travel attitude, personality, and lifestyle factors.

   Originally conceived as an engineering type modeling tool, EFFECT was not designed to reflect the complicated nature of user choices and their effects on vehicle fleet composition. Noting this caveat, a number of essential assumptions on consumer behavior were introduced in the model exogenously. The behavioral assumptions applied are described in more detail in *Section C: Assumptions Used in the Analysis*.

An important factor influencing aggregate transport sector emissions is the modal shift, i.e. relative change in the market share of three transport modes analyzed under EFFECT framework – road transport, railway and metro. Other things being equal, a shift from road to railway vehicles or from passenger cars to public transport will result in reduced emissions and improved air quality.

By analogy to vehicle type choice, travel mode choice by individual users depends on several quality variables (e.g., price, travel time, comfort, convenience, safety, etc.), which cannot be accounted for in EFFECT. To compensate for dearth of such dependencies in EFFECT, benchmarking data was used to model various model shift scenarios, as referred to in various places of the report. Introducing these exogenous assumptions in EFFECT allows filling out the existing gaps and calibrating a simple but accurate policy simulation. Structure of EFFECT analysis is depicted in Figure 30.

**Figure 30**: EFFECT  Modeling Framework




*Source:  ESMAP*

## B. Data used in the analysis

The transport module encompasses road, railway, and metro transport. A detailed micro-level dataset is used to forecast vehicle population for each mode over a long-term horizon, (the scenarios developed for Georgia span over 25 years, i.e. till 2036). The quantitative and qualitative characteristics of the projected vehicle stock determine the demand for energy in transport sector and the associated greenhouse gas and air pollutant emissions; therefore, high level of disaggregation of input data and projected vehicle stock is crucial to ensure the accuracy and quality of endogenous calculations.

The required inputs for the transport module can be broadly categorized as follows: (i) Baseline vehicle stock data; (ii) Household survey data; (iii) Baseline vehicle use data; (iv) Data on operating conditions; and (v) Data on vehicle capital and operating costs.

**Table 11: EFFECT input data and sources**

| Category | Data | Source |
|---|---|---|
| Socio-economic | Inflation | Geostat.ge |
| | Gross Domestic Product (GDP) | Geostat.ge |
| | GDP growth rate | World Bank projections based on IMF data |
| | GDP by Sector | Geostat.ge |
| | Exchange rate (GEO/USD) | Annual Report of the Ministry of Transport |
| | Discount rate | Geostat.ge |
| | Mean monthly per capita expenditure | Household survey 2007 |
| | Urban | Household survey 2007 |
| | Rural | Household survey 2007 |
| Population | Urbanization | WDI |
| | Urban/rural population | Household survey 2007 |
| Land | Total land area | Geostat.ge |
| | Land are by use | Geostat.ge |
| Fuel | Gasoline price | Ministry of Finance of Georgia |
| | Diesel price – Service and Transport | Ministry of Finance of Georgia |

| | | |
|---|---|---|
| | Tax rate for fuels | Ministry of Finance of Georgia |
| | Income and price elasticities | ESMAP empirical research data |
| | Fuel imports | Ministry of Energy of Georgia |

**Baseline vehicle stock data.** The baseline vehicle stock data are used as a starting point for vehicle ownership projections in EFFECT. There are three approaches to defining active vehicle population in the baseline year: (i) by running a mortality calculation on historic vehicle sales figures; (ii) by conducting a statistically significant survey of in-use vehicles; (iii) by obtaining active vehicle registration data.

In the first case, the data should be procured for at least 15 consecutive years. The mortality rates determined by Winfrey curve are then applied to the sales data to estimate the fraction of vehicles retiring each year over the analyzed period. The surviving vehicle stock is calibrated by adjusting the average life of each vehicle type to yield the active vehicle population numbers consistent with the exogenous data for the baseline year (e.g. from vehicle registration database).

When historic sales data for such an extended period is not available, the model is populated with in-use survey or vehicle registration data for the baseline year. In this case, the vehicles of each type are grouped by year of manufacturing, and zero mortality rate is applied (no vehicles are retired, since the input data reflect the actual fleet composition in the baseline year; the vehicles are grouped by the year of manufacturing to ensure accurate calculation of the average age).

The vehicle stock data requirements vary for each transport mode (road transport, metro and railway); however, the input data for all modes should be disaggregated by type (car class for private motor vehicles and rolling stock categories for railway transport), age, and technology (emissions standards, fuel type and consumption intensity).

The baseline vehicle stock data used in the analysis were provided by the Ministry of Internal Affairs of Georgia. The dataset comprising 749, 232 vehicles registered in Georgia as of 2011 specifies the year of manufacturing and the year of registration, vehicle model, make, type and engine displacement of each vehicle. The data were further refined and grouped to match the input requirements of the EFFECT model.[60] EFFECT distinguishes 13 vehicle types and 9 subtypes, classified according to vehicle size and engine displacement. The vehicle classification used in EFFECT as well as the grouping criteria applied to the vehicles listed in the registry are summarized in Table 12.

**Table 12: Vehicle classification used in EFFECT**

| Type | Sub-type | Classification criteria (engine size) |
|---|---|---|
| | ***Private vehicles*** | |
| Two-wheelers (2W) | Mopeds | <50 cc |
| | Scooters | <250 cc |
| | Motorcycles | 50 - 250 cc or vehicle type "motorcycle" in the original database |
| Passenger Cars | Mini cars | 600-1,400 cc |

[60] Approximately 30% of all original entries were incomplete, i.e. either missing information on engine size or fuel technology used. The gaps were filled in by making assumptions on lacking vehicle characteristics based on the vehicle make, model and year of manufacturing.

| | | |
|---|---|---|
| (PC) | Small cars | 1400-2000 |
| | Lower medium cars | N/A[61] (EFFECT criterion <=2000 cc) |
| | Upper medium cars | 2,000-3,500 cc |
| | Large and luxury cars | N/A (EFFECT criterion >2000 cc ) |
| | Sport utility vehicles | 3,500-4,250 cc |
| ***Commercial vehicles*** | | |
| Light commercial vehicles (LVC) | Passenger | N/A |
| | Goods | N/A |
| Heavy commercial vehicles (HCV – Bus) | Light urban bus | Buses with engine displacement under 3,600 or carrying 16 passengers or less |
| | Medium urban bus | Buses with engine displacement over 3,600 or carrying 16 passengers or more |
| | Coach | Buses with engine displacement over 16,000 |
| Heavy commercial vehicles (HCV – Truck) | Light truck | <7000 cc |
| | Medium truck | <7000-10000 |
| | Heavy truck | >16200 |
| | Prime mover | N/A |
| Two-wheelers | | N/A |

On-road transport fuel consumption is determined based on a range of intrinsic vehicle characteristics including vehicle type, subtype, engine displacement, technology, GVW, accumulated mileage, and fuel used. Thus, to obtain reliable estimates of fuel consumption and emissions, the baseline population needs to be further disaggregated into these categories. In order to determine the vehicle emission standards for the baseline (2010) vehicle population in Georgia, the following assumptions were used Table 13.

**Table 13**: Assumptions on vehicle standards

| Emission standards | Years of manufacturing |
|---|---|
| Euro 0 | Prior to 1991 |
| Euro 1 | 1993-1995 |
| Euro 2 | 1996-1999 |
| Euro 3 | 2000-2004 |
| Euro 4 | 2005-2008 |
| Euro 5 | 2009-2011 |

**Household survey data.** Household survey data is needed to make bottom-up projections of private vehicle ownership. The information on the average per capita income obtained from the survey is used to group rural and urban population into percentiles and derive mean monthly expenditure of each household. Applying assumptions on income elasticities to the mean monthly expenditure data allows forecasting vehicle ownership on the household level. Finally, car ownership forecast for each household is multiplied by the projected number of households (a function of population growth rate) to determine private vehicle ownership on the country level.

**Baseline vehicle use data.** Due to its direct influence on fuel consumption and emissions intensity, the baseline vehicle use data is factored in the EFFECT calculations. The key variables used to determine the vehicle use are the number of trips and average trip length for passenger transport and vehicle load and average trip length for freight transport.

[61] N/A marks vehicle types and/or subtypes which could not be identified for Georgia due to scarcity of available data. For instance, an overlap of engine size range of small cars and lower medium cars (1,400-2,000 cc) made it impossible to distinguish the two types based on the only criterion available (engine displacement).

For road vehicles, the annual age-sensitive vehicle use data by vehicle type, subtype and usage pattern applied in simulations for Georgia are based on expert-determined estimates used in previous ESMAP studies. For railway and metro transport, the model allows entering the actual country-specific number (annual distance traveled, number of passengers, and loading factor) to compute the aggregate vehicle use data endogenously.

The explanatory variables employed in projecting vehicle use are closely linked to the operating conditions dataset. Thus, the average trip length determines the number of starts per day, which, in its turn, causes aggregate cold start over-emissions.

For heavy-duty vehicles, both passenger and freight, vehicle loading has a significant impact on fuel consumption and emissions. Usually, a 50% load condition is used to determine average fuel consumption to account for deadheading (the truck running empty on the return journey or to pick up a load) and to cover the frequent occurrence for lighter weight loads where the volumetric capacity of the truck is reached before its maximum weight limitation. These assumptions have been applied for the scenarios modeled for this study.

The definition of the yearly in-use vehicle population, the annual kilometers driven by each vehicle and the mix of private and business usage patterns allow the vehicle-kilometers-travelled (VKT) to be calculated for each vehicle type and sub-type. The average number of passengers per vehicle is then projected to determine the passenger-kilometers per year (PKT) from these segments. In these calculations an average of 1.5 riders per moped, scooter, and motorcycle is assumed and an average of 1.85 passengers in passenger cars (not counting professional drivers) is used. The annual per-vehicle age-sensitive usage (km/year) by vehicle type and subtype and by usage pattern are estimated using the data collected for a previous ESMAP study.

**Data on operating conditions.** A number of operating conditions directly affect vehicle energy use and emissions generated by the transport sector. The data need to be defined for each year of the modeling period to calculate and apply emissions factors to each vehicle in the active population. The following factors are taken into account in EFFECT: (i) ambient temperature; (ii) driving conditions; (iii) bio-fuel mix; (iv) inspection and maintenance programs; and (v) total vehicle expenditures.

- *Ambient temperature.* Low ambient temperatures may cause over-emissions due to cold starts and evaporative emissions. While determining emission-factors, it is necessary to include monthly mean high and low temperatures based on a vehicle-population-weighted average rather than on a national geographical average. In scenarios analyzed under the present study, the monthly mean high and low temperatures for Georgia are taken from historical airport records.
- *Driving conditions.* Different urban, rural and highway road speed conditions result in varying fuel consumption and emissions levels. Whenever possible, the percentage of vehicle-kilometers travelled for each type of vehicle under different road conditions should be determined by using a traditional four-step transport model for each year of the modeling period. Given the data availability limitations, the travel mixes for the present analysis were obtained from previous ESMAP research and are based on expert judgment.
- *Bio-fuel mix.* The incorporation of bio-fuels into the petrol and diesel fuel mix changes the emissions characteristics of each vehicle. Additionally, under UNFCCC rules, the emissions from the combustion of biofuels are counted as agricultural emissions, not transport emissions, to avoid

double-counting. Given the scarcity of data on vehicle fleet composition in Georgia by type of fuel used, bio-diesel blend share is considered in the current scenarios.

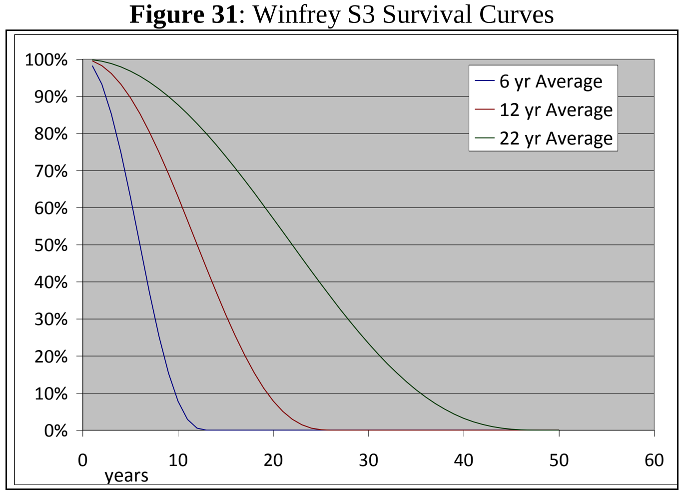
- *Inspection and maintenance.* Effective vehicle inspection programs reduce fuel consumption and emissions, particularly from older vehicles, because of the improved maintenance. Therefore, it is necessary to take into account the average accumulated mileage of the vehicles in the population. For Georgia, the effects of improved inspection and maintenance programs have not been analyzed.

**Data on vehicle expenditures (capital and operating costs).** Vehicle capital and operating costs have a direct influence on vehicle ownership and use. In EFFECT, the data on vehicle purchase prices and operating costs are used for the benefit-cost analysis, which juxtaposes annual vehicle costs (net of co-benefits) to annual $CO_2$ emissions. The stream of annual net costs is discounted to derive the present value of net costs using a Ramsey annual discount rate with Delta ($\delta$) equal to 0.001 and Eta ($\eta$) equal to 2 to arrive at the present value of the net cost. Annual tons of $CO_2$ emissions are added up without discounting to estimate the total $CO_2$ emissions mitigated by the option. The cost effectiveness ratio (cost per ton of $CO_2$ reduction) is calculated by dividing the former by the latter. The following operating costs are considered in the analysis: (i) Fuel costs; (ii) Insurance costs; and (iii) Maintenance (repairs, periodic service, oil consumption and tires wear and tear) and other costs (registration and other charges).

The data on new and used vehicle fixed costs (purchase prices) are based on publicly available market reference prices (www.autopapa.ge). The information on vehicle fuel prices (petrol and diesel) was provided by the Ministry of Energy of Georgia. The other operating costs are estimated using the empirical data from previous research conducted by ESMAP.

**Projection of future vehicle stock.** The EFFECT transport module projects annual in-use vehicle fleet by mode using the scrap-and-sales methodology. The projected total vehicle stock is disaggregated by vehicle type, technology and age to calculate energy use and emissions. This requires detailed modeling and forecasting of the vehicle fleet structures. For each transport mode, the projection follows the same basic steps.

**Figure 31**: Winfrey S3 Survival Curves




*Source: ESMAP*

1) The model is populated with baseline vehicle stock data obtained from official statistical sources (e.g. vehicle registration database of the Ministry of Transport) or historical sales data. The input data is disaggregated by vehicle type, engine displacement, technology, gross vehicle weight, and age.

2) Mortality rates are applied to the baseline vehicle fleet to estimate the number of retiring (scrapped) vehicles. Vehicle mortality is calculated using a Winfrey S3 survival curve as shown in Figure 31.

3) Total future vehicle sales by mode and type are derived by comparing surviving vehicle stock to the stock needed to fulfill transport demands. The annual sales volume is thus projected taking into account the number of vehicles in the active population that must be replaced annually and the expected growth of the active population.

4) Future transport demand is determined separately for private and commercial vehicles and for passenger and freight vehicles within the commercial fleet group. While private vehicle ownership is assumed to be affected by forecasted changes in income per capita and population numbers (bottom-up approach), demand for commercial freight transport services is determined by GDP growth only (top-down approach). The volume of transported goods (freight-tons-kms transported) is projected to grow in line with the increase in economic activity measured by GDP growth rate. Urbanization rate is used as a proxy for increase in passenger services demand. The assumption is based on the empirical evidence suggesting that urban population growth puts pressure on the average distance travelled per person per year. The yearly increase in total on-road passenger-kilometers travelled is thus assumed to grow at the same rate as the urban population. GDP growth, urbanization, and population growth rates are exogenous parameters taken from government and other sources.

5) Total future sales by mode are disaggregated by vehicle type and technology by applying the historic sales mix. Such disaggregation allows estimating fuel consumption and emissions taking into account expected improvements in technology.

In order to separate private vehicles (passenger cars and two wheelers) from other on-road vehicles, additional calculations are performed prior to step one, i.e. while estimating the baseline vehicle population. As mentioned above, EFFECT employs two distinct sets of baseline vehicle stock data: (i) private ownership projections based on household survey results and (ii) exogenous active vehicle population data. The size of the commercial vehicle fleet is thus determined by subtracting the number of private vehicles derived from bottom-up household ownership calculations from exogenous baseline vehicle stock data, which covers both private and commercial vehicles.

The definition of the yearly in-use vehicle population, the annual kilometers driven by each vehicle and the mix of private and business usage patterns allow the vehicle-kilometers-travelled (VKT) to be calculated for each vehicle type and sub-type.

Special consideration should be given to private vehicle ownership modeling methodology employed in EFFECT. The country-level demand for private transport is assumed to be a sum of individual household demands, i.e. it is estimated based on a bottom-up approach. In its turn, the individual household demand is a function of average household income, for which household expenditures are used as a proxy.

The annual kilometers driven by each vehicle vary according to the vehicle type and sub-type, its style of usage (private or business), and the age of the vehicle.

In the absence of country-specific data for Georgia, the annual age-sensitive vehicle use data by vehicle type, subtype and usage pattern were derived from expert estimates performed by Segment Y for ESMAP.

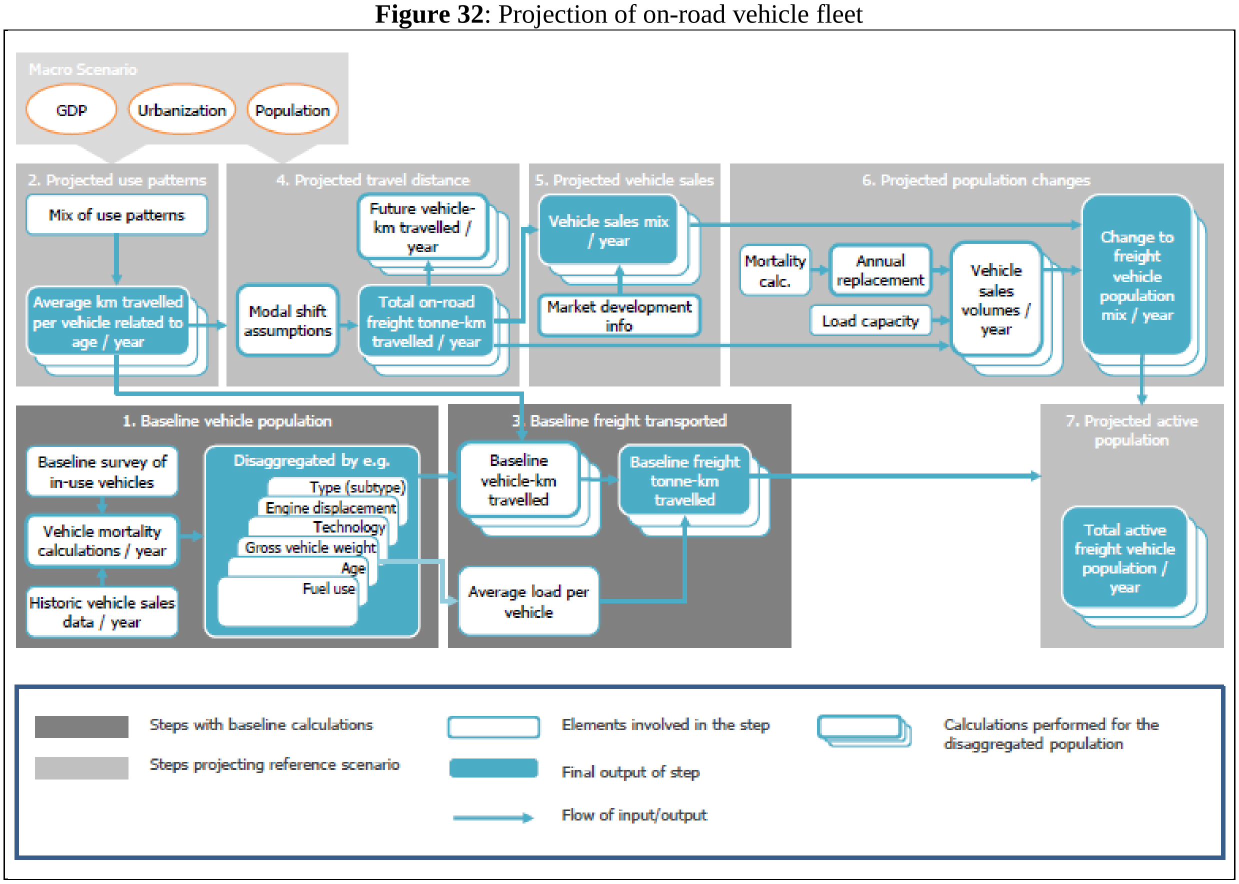
For passenger cars and two-wheelers, the total number of passenger-kilometers per each modeled year (PKT) is calculated by assuming an average of 1.5 riders per moped, scooter, and motorcycle and 1.85 passengers per care (not counting professional drivers).

For light-duty vans, multi-use vehicles, buses and coaches, the average number of passengers per vehicle is evaluated based on the GVW of these vehicles. For instance, the capacity of the light-duty AUV/MUV is considered as 9 passengers plus driver.

Similarly, the average load per vehicle for freight transport is assessed based on the GVW of these vehicles to determine the baseline on-road freight-ton-kilometers transported per year (FTKT). The capacity of the light-duty minivan, mini truck and pickups is considered as 0.6 tons per vehicle. The load capacity of vans is taken as one ton per vehicle. As in previous sections an average loading of 50% of the vehicle capacity is considered.

The assumptions on the annual distance traveled, number of passengers, and loading factor used in the railway and metro modules are based on the data from the Annual Report of the Ministry of Transport of Georgia. The process of forecasting the on-road vehicle stock is shown in Figure 32.

**Figure 32**: Projection of on-road vehicle fleet




*Source: ESMAP*

**Technological advancement**. Given the long-range projections under the EFFECT framework (15-year period in all scenarios modeled for Georgia), it is assumed that certain technological advancements can be made in the forecasted period that will enable the manufacturers to improve the fuel economy of their vehicles. The technical measures evaluated in EFFECT to project improvements in fuel efficiency are based on the report “Review and analysis of the reduction potential and costs of technological and other measures to reduce $CO_2$-emissions from passenger cars" which has was carried out by TNO, IEEP and LAT on behalf of the European Commission.[62]

**Table 14: Technological advancements considered in EFFECT**

| Technology | Gasoline cars | Diesel cars |
|---|---|---|
| Engine | Reduced engine friction losses | Reduced engine friction losses |
| | DI / homogeneous charge (stoichiometric) | |
| | DI / Stratified charge (lean burn / complex strategies) | |
| | | Mild downsizing |
| | Medium downsizing with turbocharging | Medium downsizing |
| | Strong downsizing with turbocharging | Strong downsizing |
| | Variable Valve Timing | |
| | Variable valve control | |
| | Optimized cooling circuit | Optimized cooling circuit |
| | Advanced cooling circuit+ electric water pump | Advanced cooling circuit+ electric water pump |
| | | Exhaust heat recovery |
| Transmission | Optimized gearbox ratios | |
| | Piloted gearbox | Piloted gearbox |
| | Dual-Clutch | Dual-Clutch |
| Hybrid | Start-stop function | Start-stop function |
| | Start-stop + regenerative braking | Start-stop + regenerative braking |
| | Mild hybrid (motor assist) | Mild hybrid (motor assist) |
| | Full hybrid (electric drive capability) | Full hybrid (electric drive capability) |
| Body | Improved aerodynamic efficiency | Improved aerodynamic efficiency |
| | Mild weight reduction (5% BIW = 1.5% veh. weight) | Mild weight reduction (5% BIW = 1.5% veh. weight) |
| | Medium weight reduction (12% BIW = 3.6% veh. weight) | Medium weight reduction (12% BIW = 3.6% veh. weight) |
| | Strong weight reduction (30% BIW = 9.0% veh. weight) | Strong weight reduction (30% BIW = 9.0% veh. weight) |
| Other | Low rolling resistance tires | Low rolling resistance tires |
| | Electrically assisted steering (EPS, EPHS) | Electrically assisted steering (EPS, EPHS) |
| | Advanced after-treatment | DeNOx catalyst |
| | | Particulate trap / filter |
| | Gear shift indicator | Gear shift indicator |

*Note: Mild weight reduction: ≈ 5% reduction of weight on Body-In-White; Medium weight reduction: ≈ 15% reduction of weight on Body-In-White; Strong weight reduction: ≈ 30% reduction of weight on Body-In-White; Advanced after treatment: e.g. NOx-storage catalyst for DI petrol engines; Reduced engine friction losses: includes low friction engine and gearbox lubricants; Mild downsizing with turbocharging: ≈ 10% cylinder content reduction; Medium downsizing with turbocharging: ≈ 20% cylinder content reduction; Strong downsizing with turbocharging: ≈ 30% cylinder content reduction*

Based on the technological measures outlined in the table above, marginal abatement curves were constructed to assess the additional costs incurred by manufacturers and consumers (retail price) against the potential emissions reductions for 6 vehicle type combinations (petrol / diesel, and small / medium / large).

[62] TNO (2006), CEER (2006), CEER (2006b)

The baseline of these cost curves are the EU 2002 Type Approval limits as further adjusted by ESMAP experts. The scenarios developed for Georgia assume a fuel consumption improvement for light duty commercial vehicles of approximately half that of cars reaching 175 g/km in 2022/3, and 160 g/km in 2028/9, ten and thirteen years later than the EU, respectively.

**Calibration of fuel consumption and emission**. The baseline vehicle emission factors used to estimate total transport sector emissions are obtained by applying COPERT 4 methodology. COPERT 4 is a software program developed under the aegis of European Environment Agency. The tool is used to calculate major air pollutants and GHG emissions from different vehicle categories. It is widely used by the EU countries to report their annual mobile source emissions in accordance with the requirements of international conventions and protocols and EU legislation. The speed-sensitive emissions factors calculated by COPERT 4 are derived from empirical data derived from numerous tests performed on real-world vehicles. In order to suit the requirements of EFFECT, a number of adjustments were made to COPERT 4:

- the methodology was replicated in a separate Excel module within EFFECT and linked to the transport module using Visual Basic;
- the scope was extended to include data on emissions from electric vehicles obtained from a survey of plug-in cars;
- the calculation of emissions from three-wheelers was enhanced by updating emission factors on the basis of a survey conducted in India;
- the COPERT 4 methodology generates emissions factors that are representative for average vehicles operating in the EU and these require adjustment to best represent average vehicles operating in India.

The enhanced emission calculation module based on COPERT 4 methodology generates some 3,500 emission factors for 253 specific vehicle types and technologies. The preliminary calculations are based on average emission factors obtained from studies conducted in European Union and India. Therefore, the initial fuel consumption and emission estimates need to be adjusted to better represent local vehicle fleet characteristics and operating conditions of each analyzed country. For instance, it can be expected that the speed sensitive fuel economy will change due to different country-specific road conditions thus affecting road transport fuel consumption.

To account for these differences, EFFFECT uses country-specific input data on vehicle fleet composition and operating conditions. Whenever this information is not available, assumptions generated by previous studies are used to populate the model.

Further adjustment is performed by calibrating the endogenous preliminary fuel consumption estimates to match the actual fuel consumption data obtained from official sources. Such data can be procured from independent road tests performed by vehicle owners, companies and magazines under local driving conditions. Alternatively, the results can be calibrated against total gasoline sales or fuel consumption furnished by a national statistical office or other official database. The calibration is performed by amending the annual age-sensitive vehicle usage data, which triggers changes in fuel consumption estimates in the reference scenario.

For purposes of this analysis, the fuel consumption results generated for Georgia were calibrated to match the transport sector fuel consumption data from World Development Indicators database maintained by the World Bank and the fuel import data supplied by the Ministry of Energy of Georgia. The resulting 5% deviation fits within the acceptable margin of error.

## C. Assumptions used in the analysis

**Relationship between Income growth and vehicle ownership**. Empirical evidence suggests that private vehicle ownership, like ownership of any appliances, is a function of income and vehicle price elasticity. The household car and motorcycle ownership can thus be derived from the average household income data, for which per capita expenditures can be used as a proxy.

Car and motorcycle ownership patterns and the distribution of household expenditures are derived from Georgia household survey data 2007. The data on average monthly per capita expenditure (MPCE) obtained from the household survey is used to range the population by average per capita income and group the resulting array into percentiles with equal number of individuals in each.

In order to determine the number of households, the average household size is projected using the United Nations methodology. In line with this methodology, the household size is estimated by multiplying the total population by the historic ratio of the number of households to population between 15–64 years of age. Previous research performed by ESMAP reveals evidence of significant variation in household size across expenditure groups. To capture the distribution of household sizes across income groups in Georgia, a linear regression is applied. The dependent variable is the logarithm of the household size, and explanatory variables are the logarithm of MPCE and a dummy that is 1 for the first percentile and 0 otherwise.

The number of individuals in each income percentile is divided by the estimated average household size to calculate the number of household percentile by location (urban and rural).

Eventually, a Gompertz function using monthly household expenditure (MMHE) as the independent variable is employed to estimate private vehicle ownership. The function contains three parameters (saturation level of vehicle penetration, rate of penetration and the level above which the rate of penetration increases faster) that can be either derived from historic household survey data, provided that the latter contain information on vehicle ownership, or estimated based on the results of surveys conducted in other countries with similar parameters (e.g. income per capita).

The following factors are taken into account when projecting future private vehicle ownership:

- Population is expected to grow at exogenously estimated rates;
- Household expenditures are assumed to grow at the same rate as GDP. However, because of increasing urbanization, per capita expenditure grows more slowly than GDP;
- The average household size grows as the ratio of the number of households to population between 15–64 years of age increases every year by 0.0011 (average annual rate of increase in the previous periods);
- The fraction of households in urban areas grows by the same rate as urbanization.

**Consumer choices on vehicles**. The wide variety of factors underlying the decision to purchase large, durable goods such as automobiles makes estimating consumer choices of a specific vehicle type or technology a particularly complex task. Understanding these factors, however, is critical in designing successful policy measures aimed at promoting cleaner vehicles.

One of the tools which can be used to encourage fleet renewal in Georgia is introduction of a vehicle scrapping program. Such programs offer a financial incentive (tax breaks and/or subsidies) for an owner of an old vehicle to retire (scrap) the old and thus heavily polluting car. Under an alternative but similar intervention, the incentive takes the form of contribution towards purchase of a new, greener vehicle to replace the scrapped one (replacement program).

Choosing a particular vehicle group for a scrapping program is a critical design parameter, since it affects the program size, its economic performance and the resulting environmental benefits. Programs targeted at older vehicles typically will retire fewer cars, cost less and reduce fewer emissions than will programs that cover more vehicles.

In case of Georgia, due to the large fraction of old vehicles in use (65% of vehicles are 20 years and older), the environmental benefits could be quite substantial. Empirical data shows that the share of cars retired under a vehicle fleet renewal program largely depends on the amount of incentive offered. Alberini et al. finds that a scrapping payment of US$1,500 would lead to 50% participation in the program; while a US$3,000 incentive would encourage 90% of old car owners scrap their vehicles. When applied to Georgia, these assumptions would translate into the retirement of 125,000 and 225,000 vehicles of the targeted group of 20+ old vehicles. Another important assumption concerns the choice of a replacement vehicle. The purchase of new and cleaner vehicle yields significant gains. According to Figliozzi et al, in case a new vehicle is used as replacement, emission reductions and benefits nearly double and cost-effectiveness improves by roughly a factor of two.

To estimate consumer choices induced by a scrapping program, the methodology suggested by BenDor and Ford is applied to EFFECT calculations[63]. The new car sales mix over three years of scrapping program implementation (2013-2015) is assumed to reflect the same shift in consumer preferences of cleaner vehicle technologies as revealed by a study conducted by BenDor and Ford. In estimating consumer choices the following factors are taken into account: vehicle purchase price, fuel cost, fuel availability, horse power, and range

[63] BenDor and Ford estimate market shares for new car sales under a feebate (a combination of fees and rebates) program to promote the sale of cleaner new vehicles. The simulation of user choices is based on a discrete-choice model estimated from a stated preference survey in California. The analysis assumes that buyers of new cars may choose between vehicles fueled by gasoline, alcohol, electricity, and compressed natural gas. In the reference scenario, a US$3,000 fee on the most polluting vehicle technology (conventional vehicle fueled by gasoline or diesel) and a US$7,000 rebate on the most environmentally friendly one (electric vehicle) result in a 15% reduction of the market share of conventional vehicles and an 11% increase in the share of electric vehicles in the new sales mix.

## ANNEX 2: London's Electric Vehicle Deployment Program

### A. Policy Drivers

The main driver of the Electric Vehicle (EV) Program in London is the set of air quality standards imposed by the EU, which require the UK to reduce emissions to 80 percent below 1990 levels. Failure to meet these standards could result in the UK facing up to £200 million in fines. EVs would also reduce $CO_2$ emissions in London. The program enjoys such tremendous political support from the mayor, government, and environmental and motoring lobbies that it was not cut during the current austerity budget.

Lifecycle analysis indicates that EVs reduce emissions by 30 to 40 percent in the context of current sources of energy in the UK when compared with regular combustion engines. This percentage is projected to increase as the UK continues to green its energy mix, as planned.

The second main driver of the EV program is a desire to develop a local electric vehicle industry. The low-carbon economy has potential to contribute to estimated 10,000-15,000 jobs, and an annual £600million to the London economy. Nissan is building a battery factory in Sunderland, which will produce batteries for the Leaf by 2013. However, it is generally accepted that the UK can lead only in parts or module manufacturing for electric cars, given the strength of German and French automobile manufacturers—Daimler-Benz, Peugot/Citroen and Renault/Nissan have electric vehicles entering the market in 2012.

### B. Charging Infrastructure

Primarily, Transport for London (TfL) is creating an environment in which EVs can be quickly adopted and thrive. Hence, the organization is supporting development of private and public charging points. TfL expects most EV drivers to recharge their cars at home, thus TfL has partnered with private sector companies to assist Londoners in installing household charging points. The partnership includes electricity suppliers (e.g., British Gas), vehicle manufactures (e.g., Nissan/Renault) and charging infrastructure providers (e.g., Charge Master). When a Londoner purchases an electric vehicle, the vehicle manufacturer coordinates with British Gas and Charge Master, thus, users get a charging point installed without running back and forth among the suppliers. Also, TfL has done most of the background work that government agencies would need to do to install a charging point. Procurement guidelines for goods valued at £150,000 or more take over nine months to complete but TfL established a framework in which procurement is completed in less than three months.

TfL is also partnering with the private sector to develop public charging points. Private sector companies such as such as Sainsburys, Tesco, ASDA, IKEA, Nissan, Siemens, BAA, Hertz, among many others, are installing charging points at their facilities. So far, NCP, a car-parking company, has installed about 120 charging points and there are plans to legislate that 25 percent of new parking spots should be fitted with electric charging points. The private company installing charging points contributes 50 percent of the cost of constructing a charge point, and the UK government provides the remaining 50 percent through a £9.3million grant. Siemens is underwriting the cost of background IT infrastructure and call center support.

Drivers pay £100 per year for access to any charging point in London; the cost of electricity at public charging stations is covered by the private sector partner.

## C. Vehicle Technology

Some 90 percent of trips made in London are about five miles in length. In the city, electric vehicles have a real-world range of 90 to 100 miles, thus are very suitable for city driving. Several EV models on the market include the Renault Influence Z.E. (midsize); Renault's Zoey (compact); Peugeot iOn (compact), Citroen C-Zero (compact), Mercedes-Benz E-Cell (van); Smith's Newton (van) Renault Kangoo Express (small van); Renault's Twizy (2-person); Mahindra's REVA (2-person); Tata's Indicar (2-person); and many others. Many other models are expected to enter the market during 2012.

There are fewer mini-buses on the market. Smith converts Ford Transit mini-buses into 18-20 seater minivans with an 80-mile range. There are no electric buses in London because the technology is not mature. However, there are 8,500 hybrid buses throughout London. Bus fares are the same for hybrid and regular buses since fares are regulated.

Electric vehicles are expensive. The cheapest European midsize EV costs £20,000. Thus manufactures are devising innovative purchase plans for customers to acquire EVs. For instance, Renault customers pay the equivalent of a regular gasoline engine and then a monthly fee to cover the cost of the battery. Nissan customers can rent the battery package and Nissan handles battery maintenance and battery risk.

## D. Implementation

The EV program was launched in May in 2009 with the goal of increasing the number of electric vehicles in London to 100,000 or 3.5 percent of the total London fleet. As of May 2011, there were 2,200 pure electric vehicles in London (0.07 percent of the entire fleet), and 16,000 hybrids and Plug-in Hybrid Electric Vehicles, or 0.56 percent of the total fleet.

As of May 2011, there were 400 public charging points in the 33 boroughs of London. The goal is to have 1300 public charging points by 2013 - which exceeds the number of petrol stations in London.

**Costs**. Floor-mounted charging points cost £4,000 plus installation, which averages an additional £3,000 in London since the street must be excavated, the charging stations equipped with RFID, and charging points must be networked. Three companies provide floor-mounted charging points: Electromotive, Charge Master, and Podpoint. Wall-mounted charging points cost £2,500 plus installation, which costs £1,000. These chargers require six to eight hours to fully charge a car; faster chargers take only 30 minutes but are more expensive. Battery-switching stations are even more expensive.

**The implementing organization**. The electric vehicle program has seven full-time staff, and another 25 people provide regular support. Other TfL departments provide support as needed, e.g., the legal department. The program manager estimates that 50 people would be needed if the EV program were to function as a separate organization.

Of seven full-time staff, two are dedicated to signing up program partners, which takes three to six months on average per partner. From first contact to having a charge point takes about nine months. The TfL plans to spin off the organization once EV adoption can support a commercial entity.

**Financing**. TfL has allocated £20 million for accelerated adoption of EVs, and the UK government has provided £9.3million in grants through the Plugged in Places program. The private sector is providing significant resources through the partnerships mentioned above. Other organizations such as the Clinton Foundation and Centre of Excellence for Low Carbon and Fuel Cell Technologies (CENEX) are involved. Additionally, TfL plans to review the congestion charge incentive as the number of electric vehicles increases.

**Other facts**

- There are no plans to develop a program for full-length electric buses or electric taxis. Full-length electric bus technology is in the early stages of development. London black taxis are highly regulated; a single company supplies the entire fleet of 22,000 taxis, 2,000 of which are purchased each year. Thus the market is too small for other vehicle manufacturers to participate.
- There is no modal shift from public transportation to electric vehicles. The EV incentives can be as high as £7,500 depending on location within London. Incentives are insufficient to persuade public transport passengers to purchase electric vehicles, but data indicate that people who must commute by car are shifting from combustion engine vehicles to electric or plug-in hybrid vehicles.
- The adequacy of charging infrastructure depends on the borough; workplaces are expected to contribute 22,500 charging points. The initial goal of 2,500 public charging points was reduced to 1,300 due to financial constraints.
- Creating partnerships is the most difficult part of the program since all participation is voluntary. With 33 boroughs, the politics to implement the same standards across the boroughs is challenging. Moreover, private sector participants receive a bulky legal agreement to participate in the program and that is intimidating to many.
- Public information and communications are critical for the program to succeed since misconceptions abound regarding electric vehicles.

## ANNEX 3: Review of Vehicle Replacement and Retrofit Programs[64]

Although new vehicle emission standards can help cap the growth in vehicle emissions and inspection/maintenance programs can reduce emissions from in-use vehicles, air pollution levels are likely to remain unacceptably high in many cities in the developing world because many uncontrolled vehicles are in operation. Vehicle retrofit and replacement programs may be warranted if air quality problems are severe. Such measures are likely to be most cost-effective when applied to intensively used vehicles such as taxis, minibuses, buses, and trucks, which have high emission levels in proportion to their numbers in the vehicle fleet. Retrofitting existing vehicles with new engines or emission control systems or replacing them with new, low-emitting vehicles can often reduce emissions from these vehicles by 70 percent or more. Even if vehicle retrofit and replacement programs are not warranted, care should be taken to ensure that the vehicle tax structure does not encourage owners to retain old vehicles, and that the tax structure encourages the purchase of new, emission-controlled vehicles.

### A. Scrapping and Relocation Programs

Vehicle fleets in many developing countries are characterized by many old, poorly maintained, and high-emitting vehicles. Although these vehicles may not be high-value, low labor costs for repairs make it feasible to keep older vehicles in operation. The value of such marginal vehicles can be affected by tax policies, sometimes in unexpected ways. For example, many developing countries impose high luxury taxes on new vehicle purchases, which increases the value of vehicles already in the fleet. Similarly, high taxes on new vehicle ownership that decline as the vehicle ages also raises the value of older vehicles and reduces their scrappage rate. From an emissions perspective, flat or even rising taxes on vehicle ownership as a function of age would be preferable, and even better would be a tax based on vehicle emissions levels.

Other policies can affect vehicle scrappage rates. Perhaps the most effective incentive to induce scrappage of older vehicles is to institute a strict inspection and maintenance program, possibly covering both emissions and safety requirements. Flat limits on the age of vehicles permitted to circulate are possible but inadvisable as this also discriminates against older vehicles that are properly maintained (Beaton and others 1995). A possible exception might be if new vehicles have significantly stricter emission standards than older vehicles in the fleet. In this case, it may be permissible to allow older vehicles to continue to circulate provided they are retrofitted to meet the same emissions standards as new vehicles.

The Union Oil Company of California (UNOCAL) created a successful program in Southern California to retire 1970 and earlier vintage automobiles by buying them from their owners for US$700 each and scrapping them. Nearly 8400 old automobiles were removed from the vehicle fleet in 1990 (U.S. Congress/OTA 1992).

UNOCAL’s latest program (SCRAP IV) initiated in January 1995, specifically targets pre-1975 model year vehicles, which can emit 50–100 times more pollutants per mile than new vehicles and account for a disproportionately high volume of all mobile emission sources in the Los Angeles Basin. Vehicles acquired through the program are scrapped and made available for self-service parts dismantling. Vehicles with special collector value are sold to the public. To qualify for the program, vehicles must be

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[64] This entire annex is from Faiz, Weaver, and Walsh (1996).

fully functional, not partially dismantled, and driven under their own power. They must have been registered in the local area for at least two years.

UNOCAL will use most of the emission credits earned from scrapping older vehicles under SCRAP IV to offset some emissions from its Los Angeles marine terminal (Oil and Gas Journal 1995). Removing all high emitting cars through this approach offers a cost-effective approach to reducing emissions as a substitute for controls on stationary sources or increasingly stringent emissions standards for new cars.

If the existing vehicle fleet retains significant economic value, relocating vehicles to smaller towns and villages outside major urban areas may be a useful approach that retains the vehicle economic value to society while removing it from cities, where air pollution is worst. Total emissions remain the same, but lower vehicle ownership and use in the countryside results in lower pollutant concentrations, and the lower population density means that fewer people are exposed to pollutants. Measures to encourage such a shift include differential vehicle taxes between urban and rural areas, age limits on vehicle registration in urban areas, and the application of differential taxes based on vehicle emissions in urban areas.

## B. Vehicle Replacement

Vehicle replacement is generally the most practical solution where the existing vehicle fleet is old, in poor condition, or difficult to retrofit. Such replacements not only reduce emissions but also improve traffic safety. Replacing buses and minibuses can improve the quality and comfort of public transport, which may encourage a mode shift from private cars. A key concern in evaluating the cost-effectiveness of a vehicle replacement program is the disposition of the vehicles replaced. If the old vehicle is allowed to continue operating as before (with a different owner), emissions will not decrease. Instead, it must be a requirement that the old vehicle be scrapped to capture the full potential for emission reductions, although this may greatly increase program costs, depending on the value of the old vehicle. A less costly alternative is to require that the old vehicle be sold and re-registered outside the urban area, thus increasing the supply of transport in rural areas and ensuring that vehicle emissions do not add to urban pollution. In the case of taxis, it may be sufficient to allow the old vehicles to be used as private cars, which are used much less intensively than taxis.

An example of an emissions-related vehicle replacement program is the Taxi Modernization Program undertaken in Mexico City. Based on an agreement signed in March 1991 between the Mexican authorities, the taxi associations, and the automotive manufacturers, this program is providing some US$700 million, through commercial banks, as a line of credit to fund the taxi program. Automobile manufacturers have agreed to make available specified numbers of vehicles per month, at agreed prices. The aim is to replace all pre-1985 taxis with new vehicles meeting Mexican 1991 or 1993 emission standards. Up to 63,000 taxis (93 percent of the fleet) could be replaced under the program. This program includes a combination of regulatory measures (taxicab licenses are denied for pre-1985 vehicles) and economic incentives (special prices have been negotiated with manufacturers and financing will be provided on favorable terms but at a positive real rate of interest).

Hungary has taken a step toward eliminating the two-stroke engines often found in the heavily polluting Trabant and Wartburg automobiles, East German vehicles common to many countries in the former Soviet bloc. In 1994, businesses that owned two-stroke engine vehicles were required to scrap them. Individual owners were encouraged to replace two-stroke vehicles with four-stroke engines or to install catalytic converters for the two-stroke engines.

## C. Retrofit Programs

If a vehicle was originally manufactured without emission controls but remains in reasonable condition, retrofitting emission controls may be a cost-effective option to reduce emissions. The retrofit may be accomplished by installing components such as air pumps or catalytic converters; replacing the engine with an engine designed for low emissions; or retrofitting a separate system, such as a liquefied petroleum gas or natural gas conversion kit. Retrofitting is most practical if the control measure in question can be implemented without changing the basic engine design, as in the case of a catalytic converter. A catalytic converter retrofit program that existed for several years in Germany, driven by tax incentives for vehicle modification, was considered a modest success. A similar program has been implemented in Sweden, and programs are being considered in Chile and Taiwan (China). In Hungary, Government has initiated a five-year program to persuade owners of older cars to install catalytic converters by offering financial assistance for up to 60 percent of the cost of retrofitting with catalytic converters (Walsh 1995). However, during the 1960s in California, an engine control retrofit program intended to reduce nitrogen oxide emissions suffered implementation difficulties and was abandoned after a few years.

Retrofit strategies are especially appropriate for heavy-duty vehicles such as trucks, buses, and minibuses because these vehicles have high levels of emissions, long lives, and high usage levels and thus produce large amounts of pollution, particularly visible smoke and particulate matter, per vehicle. Retrofitting these vehicles can be reasonably cost-effective. Also, heavy-duty vehicles are normally designed so that extra space is available and major components such as engines are interchangeable, thus simplifying the retrofit process. In contrast, passenger cars tend to be designed as an integrated system, making retrofitting more difficult.

Since strict emissions standards for new heavy-duty engines have been adopted only recently (and not at all in most countries), most engines in service are effectively uncontrolled. To improve air quality in the short term, it may be desirable in some cases to retrofit these engines for lower nitrogen oxide emissions. By retarding diesel fuel injection timing, a simple procedure with most engine designs, nitrogen oxide emissions can be reduced significantly. While retarding injection timing does increase fuel consumption and particulate matter emissions, it is often possible to achieve reductions of 20 to 30 percent in NOx emissions without marked effects on particulate emissions and fuel consumption. In many cases, further reductions can be achieved in nitrogen oxide and particulate emissions by upgrading engine technology at the time of major overhauls, either by rebuilding the engine with more advanced components or by replacing it with an engine designed for low emissions.

Since an engine overhaul will be required at some point in the life of the vehicle, the incremental cost of upgrading technology is relatively small and emission reductions can be significant. For medium- and heavy-duty gasoline vehicles, one practical and effective means of reducing emissions is to convert them to burn liquefied petroleum gas (LPG) or compressed natural gas (CNG). This can realize substantial emissions reductions (especially if high-technology LPG or CNG systems incorporating feedback control and three-way catalysts are used). These fuels also offer substantial cost savings. Domestic sources of LPG and CNG are usually less costly than gasoline; natural gas is usually cheaper than LPG and has superior characteristics as an engine fuel. Although natural gas vehicle conversions are more expensive than those for LPG, costs can normally be recovered through lower fuel and maintenance costs.

A successful retrofit requires considerable care and engineering development work. Proper design, prototype testing (including emissions testing), and manufacturing are required. Because of the expense involved in development, retrofitting will generally be most cost-effective if a large number of vehicles of similar type and design are available for retrofit. Examples include transit bus fleets, garbage collection fleets, and urban delivery fleets. The highest priority for retrofit programs should be transit buses and other vehicles operating in congested urban areas, particularly those with high-emission, stop-and-go driving cycles. Such programs could be undertaken, at least initially, on a voluntary or quasi-voluntary basis. Government-owned vehicle fleets are especially suitable for such programs.

A large-scale emissions retrofit program is planned in Mexico City. The Environmental Commission for the Mexico City Region has developed a plan to retrofit more than 100,000 gasoline-fueled minibuses and gasoline trucks with LPG and CNG systems. Vehicles to be retrofitted are those built between 1977 (1982 in the case of minibuses) and 1991 (when catalyst-forcing emissions standards for gasoline vehicles came into effect). Older vehicles will be forcibly retired; younger vehicles are already equipped with catalytic converters, and have much lower emissions. A highly successful program to retrofit taxis with LPG and CNG systems has been implemented in Buenos Aires. Retrofit programs are popular in Asian countries and have been used to convert motorized three-wheelers with two-stroke engines to run on LPG (variously referred to as helicopters, rickshaws, tempos, and tuk-tuks, in Bangladesh, Indonesia, Nepal, and the Philippines respectively).

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