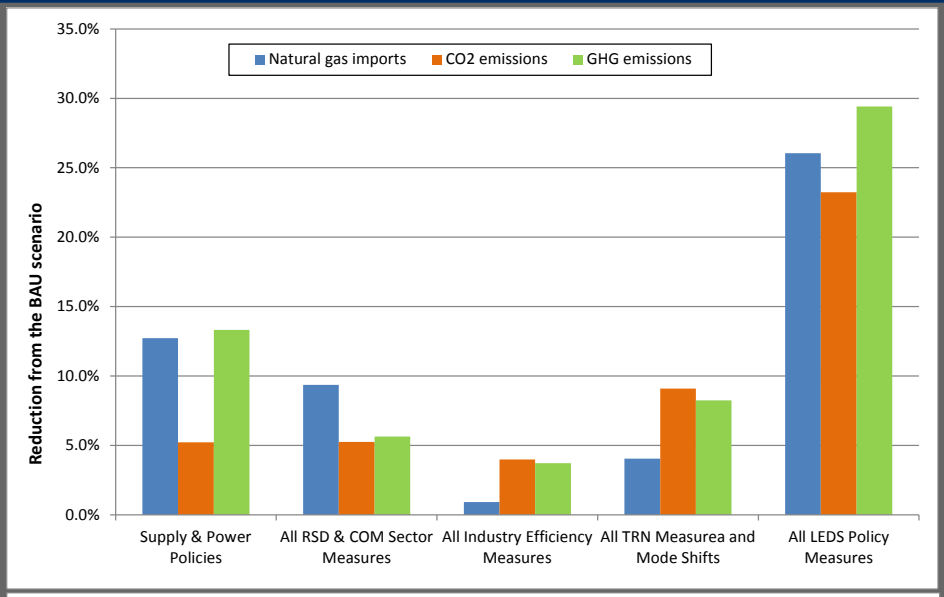
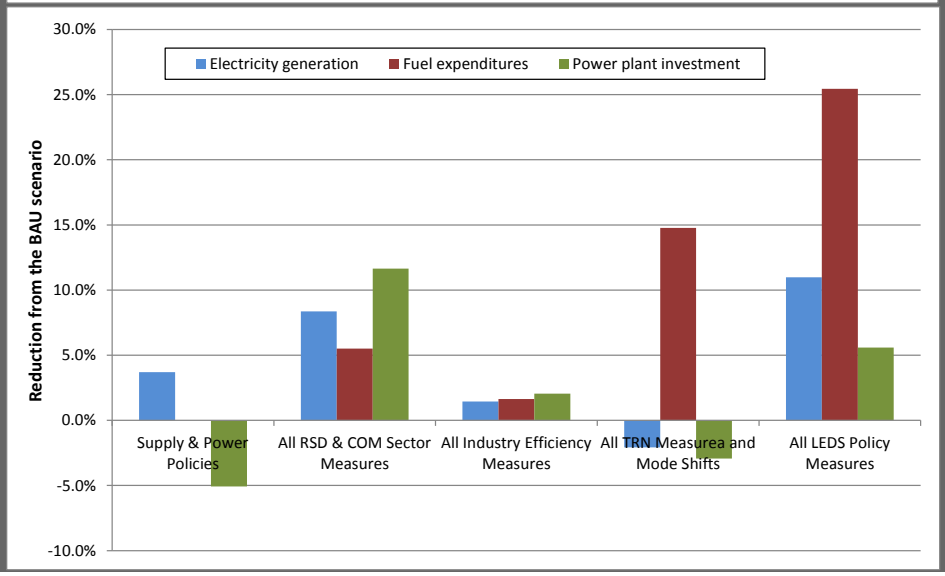
ENHANCING CAPACITY FOR LOW EMISSION DEVELOPMENT STRATEGIES (EC-LEDS) CLEAN ENERGY PROGRAM

COOPERATIVE AGREEMENT NO. 114-A-13-00008

MARKAL-Georgia Analysis of LEDS Mitigation Measures





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December 2016

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Acronyms

BAU	Business-as-Usual
BEUR	Billion Euro
CH4	Methane
CNG	Compressed Natural Gas
CO_2	Carbon Dioxide
COP	Conference of the Parties
EC-LEDS	Enhanced Capacity – Low Emissions Development Strategy
GfG	Governing for Growth
GDP	Gross Domestic Product
Gg	Gigagram
GOG	Government of Georgia
GWh	Gigawatt Hours
GWP	Global Warming Potential
GHG	Greenhouse Gas
HPEP	Hydro Power and Energy Planning
IEA-ETSAP	International Energy Agency's Energy Technology Systems Analysis Programme
INDC	Indicative National Determined Contribution
Kt	Thousand Tons
Ktoe	Thousand Tons Oil Equivalent
LDV	Light Duty Vehicle
MARKAL	MARKet Allocation
MEUR	Million Euro
MoE-AD	Ministry of Energy Analytical Department
MW	Megawatts
N_2O	Nitrous Oxide
NDC	National Determined Contribution
NMVOC	Non-methane volatile organic compounds
PJ	Petajoules
PJa	Petajoules per annum
REDP	Regional Energy Demand Planning
RES	Reference Energy System
RESMD	Regional Energy Security and Market Development
SC	Steering Committee (LEDS)
SEAP	Sustainable Energy Action Plan
UNFCCC	United Nations Framework Convention on Climate Change
USAID	US Agency for International Development
WG	Working Group (LEDS)

1 Executive Summary

This report was prepared under the US Agency for International Development (USAID) Enhancing Capacity for Low Emissions Development Strategy (EC-LEDS) Clean Energy Program for Georgia, which supports increased climate change mitigation by building capacity to stimulate private sector investment in energy efficiency and green buildings, raising public awareness, and strengthening Government of Georgia (GOG) capacity to develop and implement a national LEDS.

This report builds on the BAU scenario report that describes the energy and emissions aspects of the BAU scenario for Georgia as a whole, and for each supply and demand sector. This report summarizes analyses that were performed to determine the impact of possible LEDS measures, as well as determine the aggregated impact of groups of measures bundled together as sector policies.

The analyses presented in this report were performed using the MARKAL-Georgia model and the best available local data, augmented by international data for future technology characterizations. The sector-specific LEDS measures were identified by sector-based working groups as the most feasible and implementable options for Georgia, and the model calculated the quantitative metrics of the impacts of each option, as well as the aggregated impact when several potentially overlapping measures are combined.

The aggregated impacts of each sectoral combination and the combination of all LEDS measures are shown in the following three figures. Figure 1 shows that in the All LEDS policies scenario CO2 emissions are reduced by 23% with Transportation measures making the largest contribution followed by Buildings, Power, and Industry sector measures. The most significant methane (CH4) emission reductions occur in the Power sector due to the measure to reduce natural gas distribution system losses. GHG emissions, which include methane these emissions, are reduced more than 29%, with the Power sector producing the greatest contribution. It should be outlined that reduction of gas consumption by sectoral measures result in decrease of fugitive emissions as well, thus causing the reduction of methane emissions by sectoral measures.

In addition to the combined set of all LEDS policy measures, a set of the most feasible LEDS policy measures was developed that eliminates measures, which are more difficult to implement, require significant financial support or have large implementation barriers. The measures not included are building efficiency retrofits, and some of the transport mode-shift measures. Details of which specific measures are included in the preferred scenario are provided in Appendix A.6. The Feasible policies scenario produces a 21% reduction in GHG emissions.

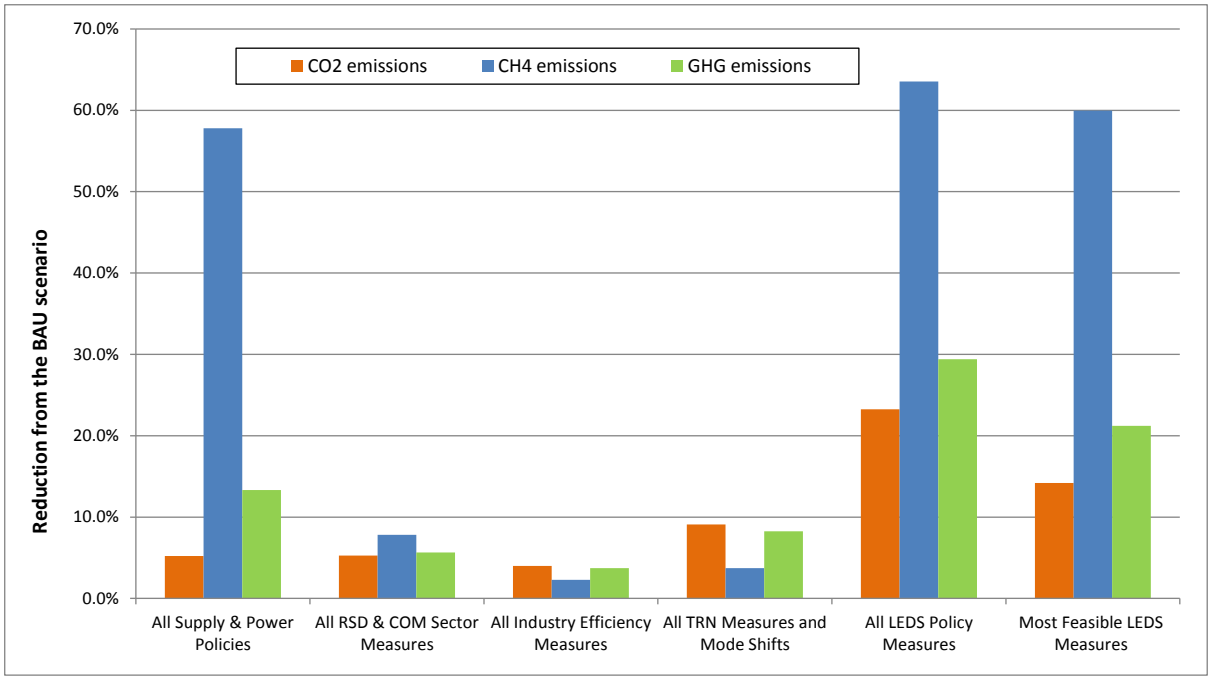

Figure 1: Impact of Combined Sectoral LEDS Measure – Emissions

Error! Not a valid bookmark self-reference. Figure 2 shows the changes in primary energy, final energy and natural gas imports. In the All LEDS policies scenario, primary energy use is reduced by 10% with approximately equivalent changes occurring in the buildings, power and transport sectors. Final energy is reduced by 15% with the biggest contributions coming from the transport and buildings sectors. Natural gas imports are reduced by 26% overall with most of the reductions coming from the power and buildings sectors. The Feasible policies case does not implement some of the buildings and transport measures, and reduces natural gas imports by less than 14%, with a 10% reduction in primary energy use and an 8% reduction in final energy use.

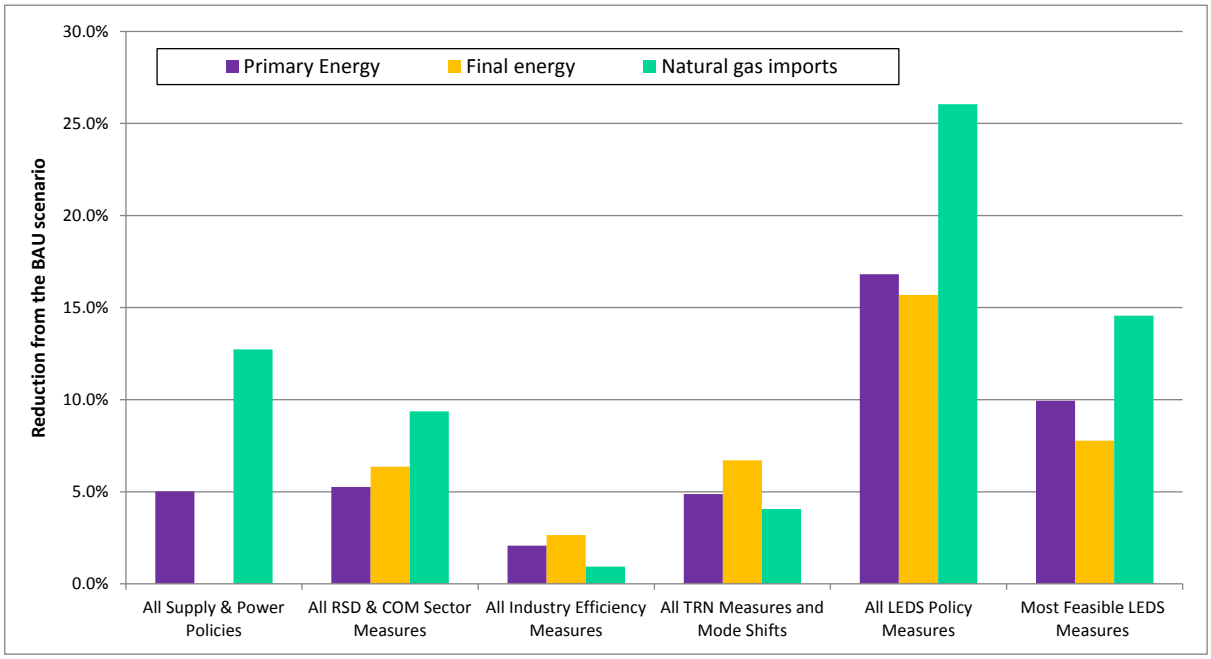

Figure 2: Impact of Combined Sectoral LEDS Measure – Energy

Figure 3 shows that in the electricity generation is reduced in all the sectors except Transportation, and that the All LEDS policies case achieves a net reduction of 11%. Fuel expenditures are reduced

by 25% with most of that coming from the Transportation sector, followed by Buildings and Industry. Power plant investment shows a 6% reduction, with increased investments from the Power and Transport sector measures offset by the savings from the Buildings and Industry sector measures. However, in the Feasible policies case, the elimination of specific buildings and transport sector measures results in a 5% reduction in electricity generation, almost 16% reduction in fuel expenditures, and a 1% increase in power plant investment.

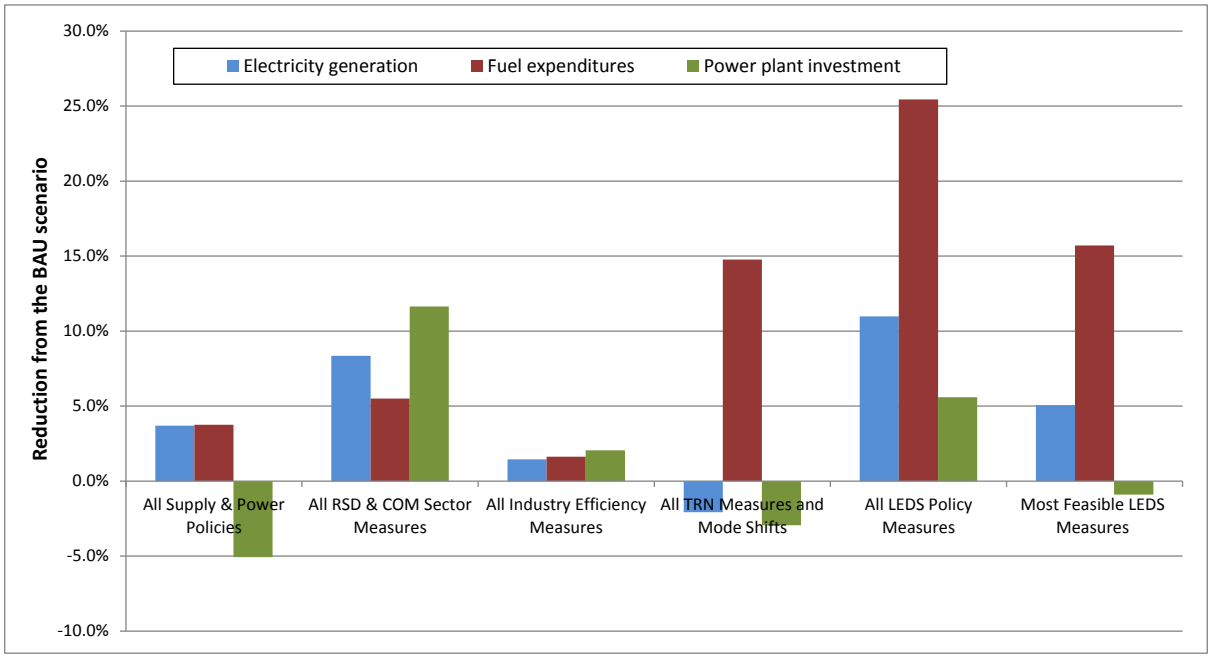

Figure 3: Impact of Combined Sectoral LEDS Measure – Generation and Costs

This report provides similar details on the individual measures from each sector, and is intended to provide the analytic underpinning of a LEDS roadmap for Georgia. It has been developed as part of advising the LEDS Steering Committee and working groups, and to continue the process of enhancing the local capacity to identify the most effective policies for LEDS implementation.

2 Introduction

The US Agency for International Development (USAID) Enhancing Capacity for Low Emissions Development Strategy (EC-LEDS) Clean Energy Program for Georgia supports increased climate change mitigation by building capacity to stimulate private sector investment in energy efficiency and green buildings, raising public awareness, and strengthening Government of Georgia (GOG) capacity to develop and implement a national LEDS. Under Component 3, the EC-LEDS Clean Energy Program is supporting the National EC-LEDS Steering Committee (SC) and associated technical working groups (WGs) by providing advisory assistance to the GOG to articulate concrete actions, policies, programs and implementation plans under the US-Georgia bilateral EC-LEDS initiative, including supporting Georgia's preparation of policy measures needed to achieve their Intended Nationally Determined Contribution (INDC) as submitted to the United Nations Framework Convention on Climate Change (UNFCCC) 21st Conference of Parties (COP-21) in Paris December 2015.

This report documents work performed by DecisionWare Group (DWG) and Sustainable Development Center Remissia in cooperation with Winrock International, leader of the EC-LEDS Clean Energy Program, and the Ministry of Energy Analytical Department (MoE-AD) to analyze a large number of policy measures using the updated MARKAL-Georgia energy system planning model to help identify those measures deemed most attractive for Georgia's LEDS pathway.

This report summarizes this analysis, both in terms of the impact of individual measures, as wells as the aggregated impact of groups of measures bundled together as sector policies. The report focuses on the change in energy consumption, investment requirements, and Greenhouse Gas Emissions (GHG) emissions relative to the Business-as-Usual (BAU) scenario. The analyses presented in this report were performed using the best available local data, augmented by international data for future technology characterizations. The sector-specific LEDS measures were identified by the WGs as the most feasible and implementable options for Georgia, and the model provides quantitative measures of the impacts of each options, as well as the aggregated impact when several potentially overlapping measures are combined.

This report builds on the BAU scenario report[1] that describes the energy and emissions aspects of the BAU scenario for Georgia as a whole, and for each supply and demand sector. Therefore, this report only summarizes the BAU scenario results, particularly those metrics that will be used to characterize the performance of the measures in each sector.

This report is intended to provide the analytic underpinning of a LEDS roadmap for Georgia. It has been developed as part of advising the LEDS SC and WGs, and to continue the process of enhancing the capacity of the MoE-AD towards ownership and responsibility for the stewardship of MARKAL-Georgia going forward.

3 MARKAL-Georgia Overview

The MARKAL-Georgia model has been developed over several years with the support of a series of USAID regional and national projects designed to better inform policy making and assess future energy investment options. It is built using the MARKAL integrated energy system modeling platform, developed under the auspices of the International Energy Agency's Energy Technology Systems Analysis Program (IEA-ETSAP, www.iea-etsap.org). The MARKAL-Georgia model has been used to examine the role of energy efficiency and renewable energy in meeting anticipated Energy Community commitments and European Union accession directives. The model was also used for energy strategy analysis as part of the USAID Hydro Power and Energy Planning (HPEP) project. Most recently under this EC-LEDS project, the model was used to develop the BAU trajectory for the energy sector for Georgia's submission to COP-21.

The key features of a MARKAL model are:

- Encompasses the ***entire energy system*** from resource extraction through to end-use demands as represented by a Reference Energy System (RES) network (see the example in Figure 4);
- Employs least-cost ***optimization;***
- Identifies the most ***cost-effective*** pattern of resource use and technology deployment over time;
- Provides a framework for the evaluation of mid-to-long-term ***policies and programs*** that can impact the evolution of the energy system;
- Quantifies the ***costs and technology choices***, and the associated emissions, that result from imposition of the policies and programs, and
- Fosters **stakeholder buy-in** and consensus building.

[1] USAID, Enhancing Capacity For Low Emission Development Strategies (EC-LEDS)
Clean Energy Program Georgia, MARKAL-Georgia LEDS BAU Scenario Report, November 2016.

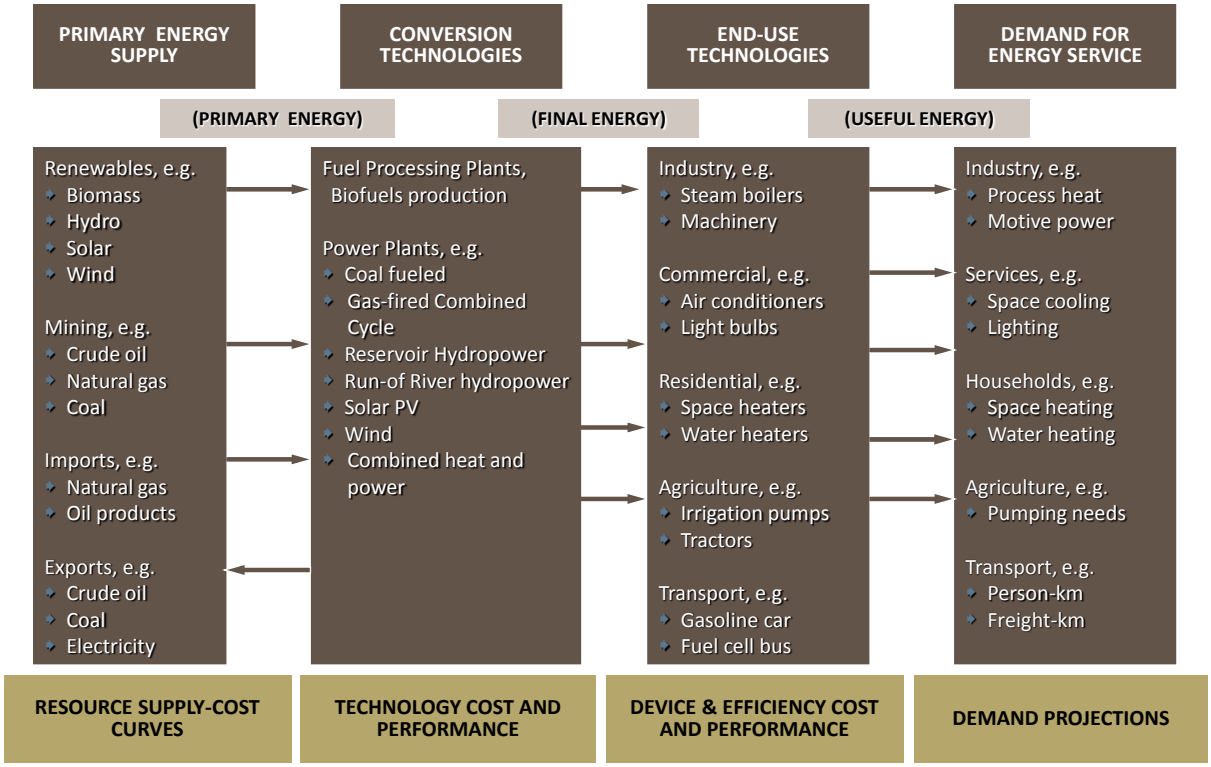

Figure 4: Simplified Reference Energy System

Under the current phase of EC-LEDS project the MARKAL-Georgia model has been substantially revised and updated. The major change involved moving the model's Base Year to 2014 and calibrating the model to the 2014 Geostat energy balance, which is an improvement over the 2012 and 2013 energy balances. In addition, the model was restructured into 2-year periods out to 2040, compared to 3-year periods out to 2036 in the previous version. Furthermore, all input data were reviewed and updated where appropriate. A summary of these changes may be found in Appendix A of the BAU Report[1].

Based on 2014 Geostat energy balance, there are 25 different forms of energy currently used in Georgia, each fully depicted in the model. These energy carriers are utilized in the following demand sectors:

- Residential
- Commercial
- Industry
- Transportation
- Agriculture
- Territory Electricity Demand (TED), representing the electricity consumption in Abkhazia.

In addition, there is a separate sector representing the non-energy demands to fully represent all the entries in the 2014 Geostat energy balance.

The power sector describes Georgia's existing and planned power plants, including the three thermal plants currently in operation, the Enguri and Vardnili regulating hydro plants, other regulating hydro plants, run of river hydropower plants, as well as potential renewable and new coal and natural gas-fired power plants.

4 LEDS Business as Usual (BAU) Scenario

The MARKAL-Georgia BAU scenario represents the expected evolution of the Georgia energy system under current policies and practices. The BAU scenario does not represent a forecast of evolution of energy system; rather it serves as the comparison scenario for quantifying the costs, benefits, technology changes, fuel switching, emissions and other impacts of potential measures that collectively will shape the LEDS strategy for Georgia. Table 1 presents the primary energy and emissions results for the BAU scenario showing the change between 2014 and 2030.

Table 1: BAU Scenario Parameters

Indicator	Units	2014	2030	Growth
GDP	2014M€	12,436	28,566	130%
Primary Energy Supply	PJ	192	409	113%
All Imports	PJ	135	267	98%
Natural gas Imports	PJ	76	152	99%
Net Electricity exports	GWh	-248	13,529	NA
Fuel Expenditure	2014M€	1225	2,773	126%
Power Plant Capacity	MW	3,431	8,780	156%
Hydro Power Plant Capacity	MW	2,751	7,684	179%
Thermal (gas and coal) Power Plant Capacity	MW	680	1,075	58%
Other renewable Power Plant Capacity	MW	0.00	0.02	NA
Electricity generation	GWh	10 135	31 380	210%
Power Plant New Capacity (2014-2030)	MW	NA	5,349	NA
Power Plant Investment Cost (2014-2030)	2014M€	NA	8,049	NA
Total Final Energy	PJ	160	302	89%
Transport Final Energy	PJ	56	114	106%
Buildings Sector Final Energy	PJ	68	118	73%
Industry Final Energy	PJ	30	61	106%
Total CO2 Emissions	Kt	7 907	15 994	102%
Transport sector CO2 Emissions	Kt	3 458	6 709	94%
Buildings sector CO2 Emissions	Kt	1 673	3 671	119%
Industry sector CO2 Emissions	Kt	1 630	3 461	112%
Power sector CO2 Emissions	Kt	1 121	2 111	88%
Total Methane Emissions	Kt	70	140	101%
Total N2O Emissions	Kt	0.19	0.33	69%
Total GHG emissions	Kt CO2 eq	9 421	19 025	102%

The following sections of the report present the mitigation measures for each sector and provide a summary of their impact. The model results selected to illustrate the impacts of the measures in each sector include energy-sector CO_2, methane (CH_4) and total GHG (CO_2 eq.) emissions, as well as primary energy, final energy and natural gas imports. A third group of metrics includes electricity generation, fuel expenditures and power plant investments. Appendix A provides detailed tables of the key model results by sector.

5 Supply and Power Sector

5.1 Description of Mitigation Measures

The measures for the supply and power sectors include reducing natural gas losses, improving power plant efficiency, promoting hydropower and as well as other renewables. In addition, one scenario looks at the combined effect of all the measures for this sector. Each is briefly described in Table 2.

Table 2: Supply and Power Sector Measures

Measure	Description
Reduce natural gas distribution losses	Assumes investment to reduce gas losses in the distribution system from 6% in 2014 to 2% by 2030.
More efficient thermal generation	Two existing inefficient gas-fired power plants are replaced with modern, efficient combined cycle power plants.
Promotion of hydropower	Improvements to the electric T&D system are made which allows an increase in the share of hydro generation serving the load.
Promote wind generation	Assumes 150MW of wind power plants are in place by 2025.
All supply and power sector measures	Combines all supply and power sector measures.

5.2 Mitigation Measures Impact Summary

The measure to reduce natural gas distribution losses reduces gas imports by 2.7%, and lowers total GHG emissions by 8.5%, due to the reduction in methane emissions. There was no change in fuel expenditures, power plant investment, or generation mix. The measure to implement more efficient gas power plants (replacing Mtkvari Unit 9 and Tblsrese Units 3+4) with 500 MW of new gas combined cycle power plants reduces gas imports by 4.5% and GHG emissions by 2.5%. Fuel costs are reduced by 58 million EUR (MEUR) in 2030, with power plant investment increasing by 258 MEUR relative to the BAU, where old plants continue to operate.

Strengthening the electric transmission grid to lower the gas power plant balancing requirement leads to greater generation from hydropower as arising from 130 MW of additional hydropower capacity. Natural gas imports are reduced by 3.5% and GHG emissions by 2.6%. Fuel costs are reduced by 30 MEUR in 2030, with power plant investment increasing by 224 MEUR.

The measure to require more non-hydropower renewables, in particular new wind plant, shows that these resources displace hydropower generation as well as some gas generation and lower exports. Natural gas imports are reduced by 1.8% and GHG emissions by 1%. Fuel costs are reduced by only 6 MEUR in 2030, with power plant investment increasing by 50 MEUR.

The combined supply and power sector measures reduce natural gas imports by 12.7% and lowers GHG emissions by 13.3% Fuel costs are reduced by 104 MEUR in 2030, and power plant investment increases by 408 MEUR. The GHG reduction in 2030 is 2.535 Mt CO2eg, which is comprised of 836 kt of CO_2 emission reductions and 81 kt of methane emission reductions. These results are summarized Table 3.

Table 3: Summary Results of Supply and Power Sector Measures

Measure	Impact in 2030
Reduce natural gas distribution losses	• Reduces gas imports by 2.7% and total GHG emissions by 8.5%, due to the reduction in fugitive methane emissions. • Reduces fuel expenditures by 36 MEUR. • No impact to power plant investments.
More efficient thermal generation	• Reduces gas imports by 4.5% and GHG emissions by 2.5%. • Reduces fuel expenditures by 58 MEUR. • Increases power plant investment by 358 MEUR.

Promotion of Hydropower	• Reduces gas imports by 3.5% and GHG emissions by 2.6%. • Reduces fuel expenditures by 30 MEUR. • Increases power plant investment by 244 MEUR.
Promote wind generation	• Reduces natural gas imports by 1.8% and GHG emissions by 1%. • Reduces fuel expenditures by 6 MEUR. • Increases power plant investment by 50 MEUR.
All supply and power sector measures	• Reduce natural gas imports by 12.7% and lowers GHG emissions by 13.3%. • Reduces fuel expenditures by 104 MEUR in 2030. • Increases power plant investment by 408 MEUR.

Figure 5 shows the reductions in emissions for the Supply and Power sector mitigation measures. The greatest GHG emission reductions come from the measure to reduce natural gas losses in the distribution system, which accounts for two-thirds of the GHG reductions in the combined Supply and power sector policies case.

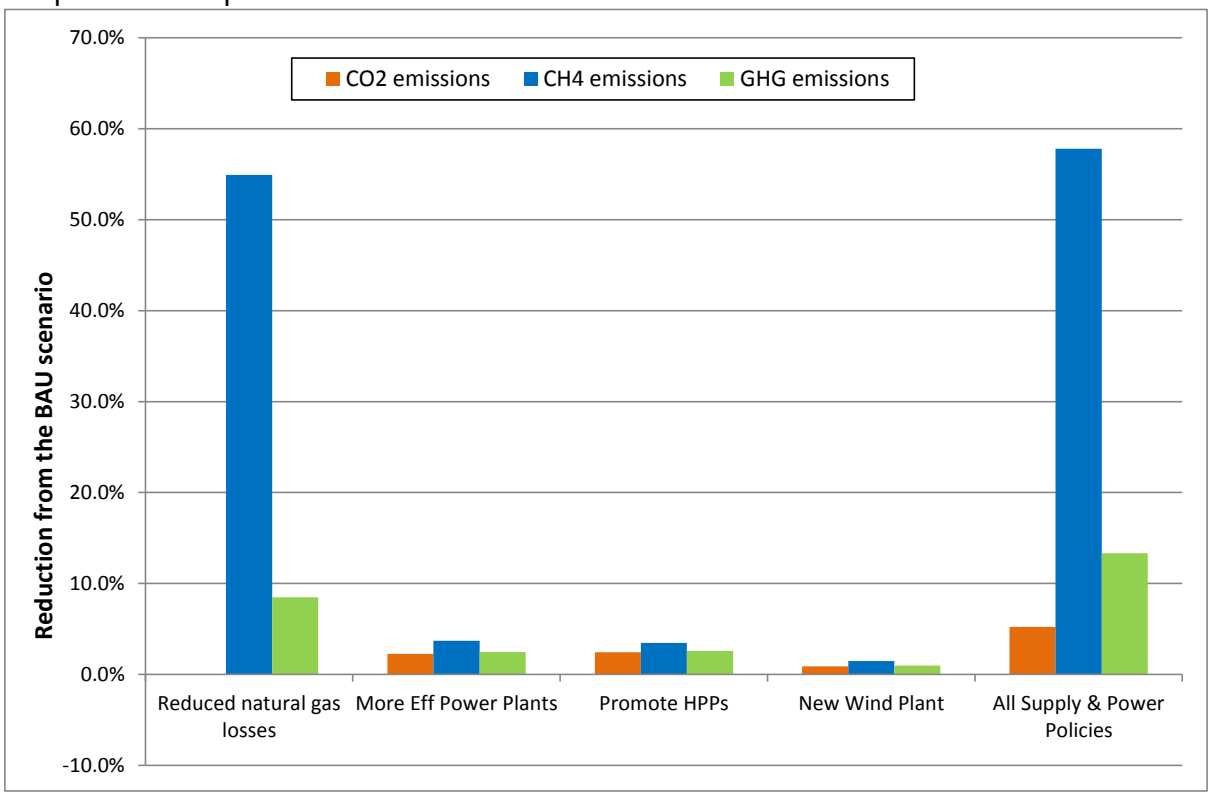

Figure 5: Impact of Supply and Power Sector Measure - Emissions

Figure 6 shows that these Power and Supply sector measures reduce primary energy use in proportion to the reduction in natural gas imports, and that there is no impact on final energy use, as would be expected.

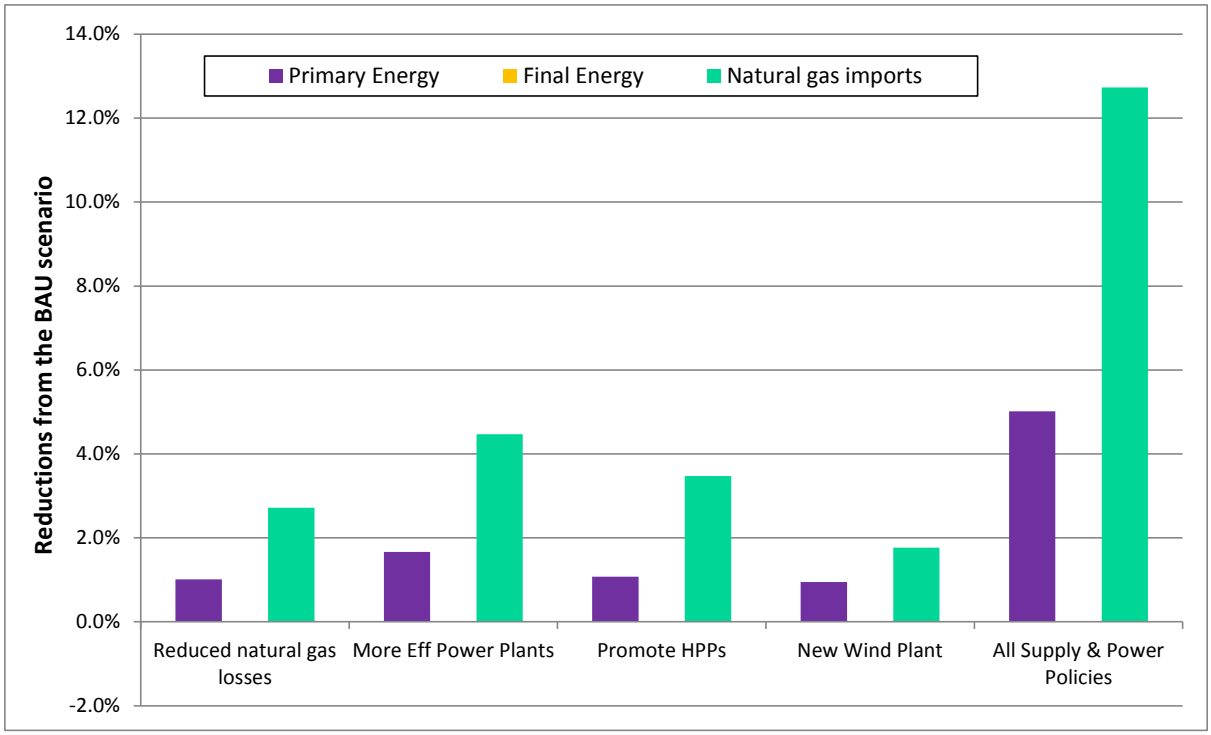

Figure 6: Impact of Supply and Power Sector Measure - Energy

Figure 7 shows that these measures reduce electricity generation and fuel expenditures but increase power plant investments compared to the BAU scenario.

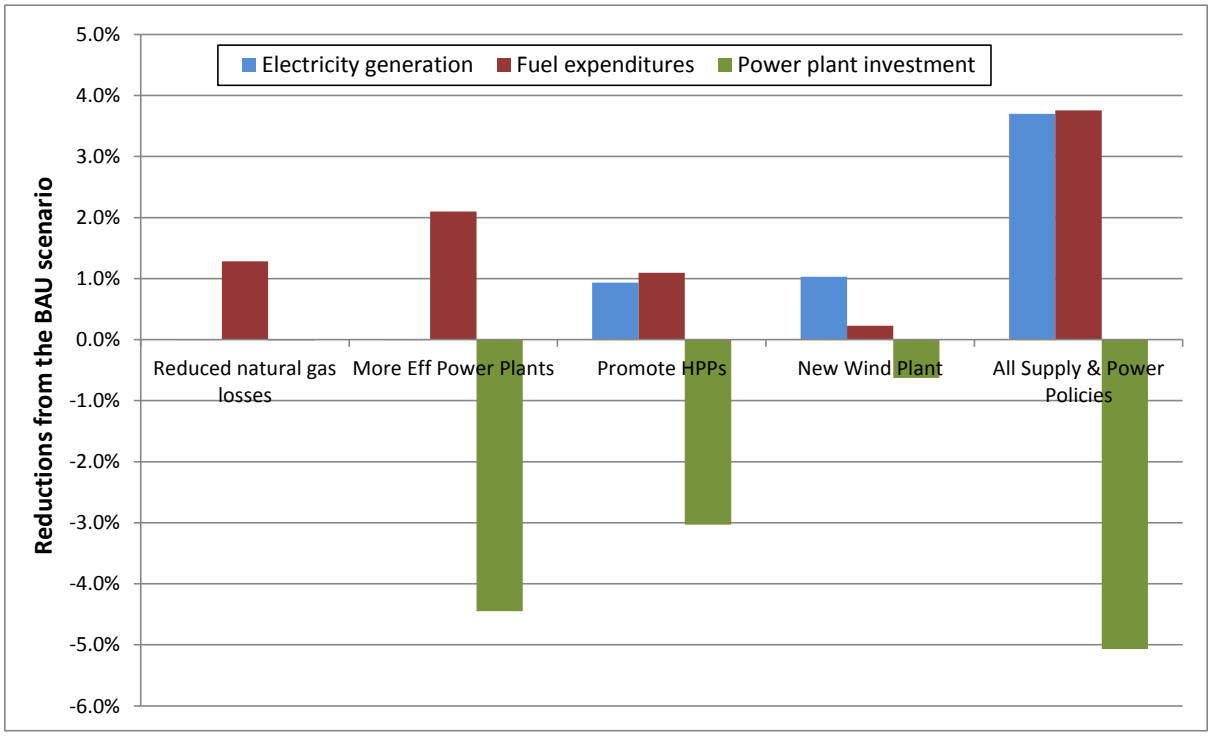

Figure 7: Impact of Supply and Power Sector Measure – Generation and Costs

The interplay between the power and supply sector components under the different mitigation measures can be readily seen in Figure 8, which shows the change in electricity generation by plant type for three of the power sector policies relative to the BAU scenario. Promoting wind power gas and hydropower generation, and promoting hydropower plants offsets gas-fired generation.

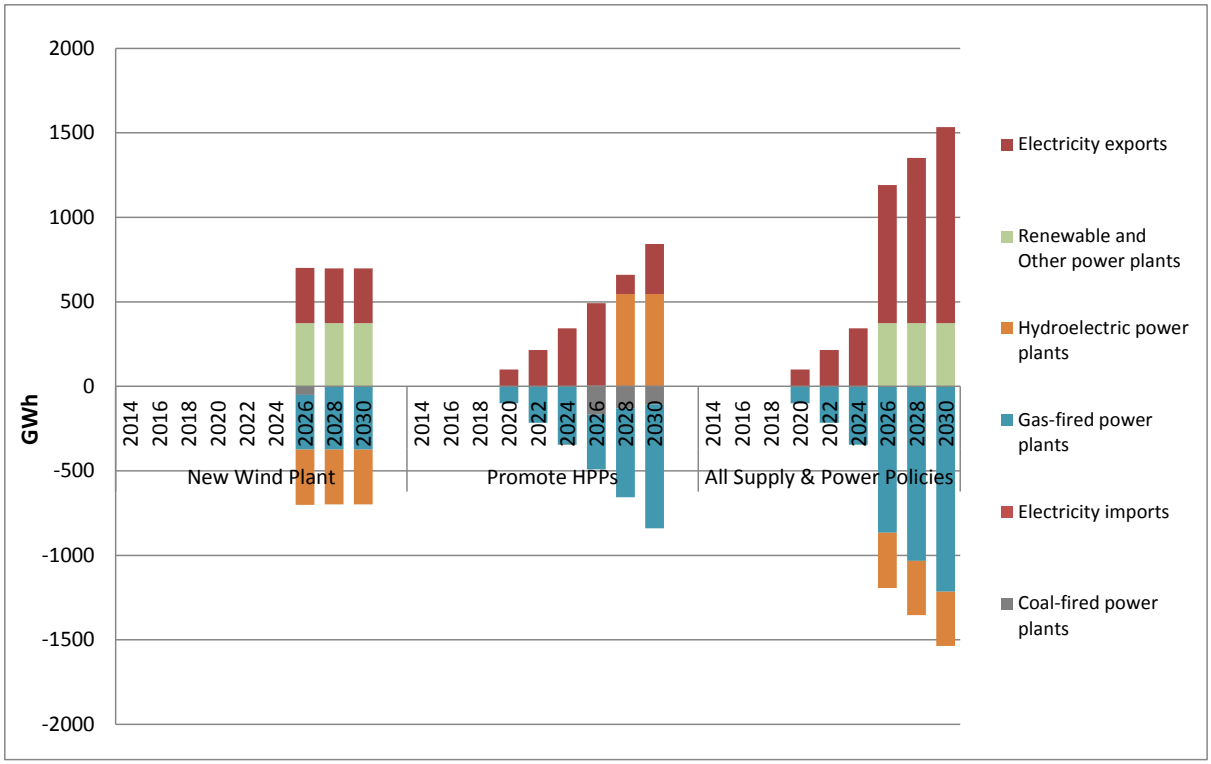

Figure 8: Electricity Generation Change from the BAU for select Power Sector Policies

6 Building Sectors Energy Use and GHG Emissions

6.1 Description of Mitigation Measures

In MARKAL-Georgia the buildings sector consists of commercial (state owned and private) and residential (households) buildings, as well as public lighting. There are ten individual measures and three combination runs. The individual measures include efficient lighting, appliance labeling, energy efficiency retrofits for existing buildings as well as new construction, and the promotion of solar water heaters and modern efficient biomass heating stoves. Of the three combination runs, one bundles the building shell measures, another the remaining appliance and device measures, and the third bundles all measures. These are described in more detail in Table 4.

Table 4: Buildings Sector Measures

Name	Description
Efficient lighting (phase out Incandescent bulbs)	Restrict the purchase of incandescence bulbs from 2022, thereby promoting the use of more efficient bulbs.
Labeling of appliances	Labeling of electric appliances to encourage increased penetration of more advanced technologies such that they comprise 50% of new purchases in 2030.
Public buildings retrofits	Use of energy service contracting for complete renovation of public buildings (9% of all commercial buildings) reaching 50% of such buildings in 2030.
Commercial building retrofits	Promote energy efficiency retrofit measures for private commercial buildings so that 50% of such buildings are retrofitted by 2030.
New building codes	New building codes with efficiency standards for both residential and commercial new buildings leading to a 20% improvement compared to existing buildings in all new buildings by 2030.

Residential buildings retrofits	Use of energy service contracting for complete renovation of existing residential buildings such that 40% are renovated by 2030.
NAMA for biomass heating stoves	Promote installation of efficient biomass heating stoves for rural households leading to an 80% share of new biomass heating stove by 2030.
NAMA for solar water heating	Promote installation of solar water heaters in residential houses leading to a 30% share of all new water heaters by 2030.
Commercial solar water heating	Promotion of solar water heaters in the commercial sector leading to a 50% share of all commercial water heaters by 2030.
LED lamps for public lighting	Requires that 90% of all public lighting fixtures are replaced with LED bulbs by 2030.
Renewables, appliance & lighting efficiency	Combines the NAMAs for solar and biomass, appliance labeling, and both lighting measures.
All Building Retrofits	Combines all commercial and residential building retrofit and insulation measures.
All RSD & COM Sector Measures	Combines all commercial and residential mitigation measures.

6.2 Mitigation Measures Impact Summary

Phasing out incandescent light bulbs saves the Georgian economy 706 MEUR between 2014 and 2030. Electricity generation is reduced by 5% in 2030, and power plant investment is reduced by 560 MEUR between now and 2030. Gas imports are reduced by 1.5%, and power sector CO_2 emissions drop by almost 6%, although overall GHG emissions drop only by 0.8% because electricity is relatively clean in Georgia.

Appliance labelling leads to a 2.3% reduction in electricity generation in 2030, a 0.6% decrease in gas imports, and an energy system cost savings of 85 MEUR, as the increased cost of the more efficient appliances is more than offset by the reductions in electricity expenditures. Power plant investment is reduced by 264 MEUR, while overall GHG emissions are reduced by 0.3%.

Public building retrofits impact a small percentage of all commercial buildings. Therefore, the measure has a small impact, reducing GHG emissions by 0.1% in 2030. There is a slight decrease in energy system costs as the increased cost of the building retrofits is offset by the reductions in energy system costs. Commercial building retrofits impact a larger percentage of commercial buildings, and reduce gas imports by 0.6%, fuel costs and GHG emissions by 0.3% in 2030, and the energy system cost is reduced by 33 MEUR.

Implementing new building codes and standards for commercial and residential buildings achieves a 0.5% reduction in total GHG emissions in 2030 (92 kt CO2 eq.). Gas imports are reduced by 0.7%, and the energy system cost is reduced by 22 MEUR.

Installing thermal insulation in existing residential buildings decreases final energy use by 8.7% and gas imports by 4.1%. Fuel expenditures are reduced by 3.0% in 2030, and total GHG emissions are reduced by 2.8%. The energy system cost increases by 37 MEUR as the cost of the insulation measures is not fully offset by the energy costs savings.

Advanced biomass heating stoves reduce energy use for rural heating by 0.6% (as saved biomass is used to replace mostly gas and LPG), which lowers gas imports and total fuel costs by 0.2% each. There is a small reduction in power plant investment, and GHG emissions are reduced by 0.2% (46 kt) in 2030. System cost increases by 76 MEUR due to the higher cost of the stoves.

Promoting solar water heaters for urban households reduces gas imports by 0.2% and fuel expenditures by 0.3% in 2030, but increases electricity generation by 0.1% as the solar water heaters displace gas and use electricity for back-up. Overall GHG emissions are reduced by 0.2%. System cost increases by 10 MEUR due to the higher cost of the solar water heaters.

Commercial solar water heating also reduces natural gas imports by 0.2% and fuel costs and GHG emissions by 0.1% in 2030. Electricity generation and power plant investments go up slightly in 2030.

Switching public lighting to LED bulbs saves almost 27 MEUR over the planning horizon. Electricity generation is reduced by 0.4% (120 GHW) in 2030, and power plant investments are reduced by 45 MEUR. GHG emissions reductions are very small as mostly hydropower generation is reduced.

Combining all the renewable energy, appliance, and lighting efficiency measures reduces final energy use in buildings by 4.2% and achieves a 1.8% reduction in GHG emissions (352 kt CO2eg) in 2030. System cost is reduced by 1.2% (721 MEUR), and electricity generation is reduced by 8.2% (2.25 TWh) in 2030. Power plant investment is reduced by 10% (811 MEUR). System cost decreases by 38 MEUR.

Combining all commercial and residential building retrofits (and insulation) measures, reduces natural gas imports by 5.8%, fuel expenditures by 3.9% in 2030, with a 0.1% reduction in electricity generation and power plant investment costs. GHG emissions are reduced by 3.8% (730 kt) in 2030.

All Building sector measures reduces natural gas imports by 9.4%, electricity generation by 8.4% and GHG emissions by 5.6% (1074 kt) in 2030. Fuel expenditures are reduced by 5.5% and power plant investment is reduced by 937 MEUR. System cost decreases by 682 MEUR as the investments in efficiency measures are offset by the savings in fuel expenditures and the reduction in power sector investments.

Table 5: Summary Results of Buildings Sector Measures

Name	Impact in 2030
Efficient lighting (phase out Incandescent bulbs)	• Saves over 700 MEUR in energy system costs. • Reduces electricity generation by 5% and power sector CO_2 emissions by almost 6%. • Reduces new power plant investment by 560 MEUR and reduces gas imports by 1.5%. • Decreases building sector energy use by 2.8%.
Labeling of appliances	• Saves over 85 MEUR in energy system costs. • Reduces electricity generation by 2.3% and gas imports by 0.6%. • Reduces power plant investment by 264 MEUR, and lowers GHG emissions by 0.3%.
Public buildings retrofits	• Reduces GHG emissions by 0.1%. • Energy system cost does not change significantly as the increased cost of the building retrofits is offset by the reductions in fuel expenditures.
Commercial building retrofits	• Saves 38 MEUR in energy system costs. • Reduces gas imports by 0.6% and fuel expenditures by 9MEUR • Reduces power plant investment by 4 MEUR and GHG emissions by 0.4%.
New building codes	• Saves 24 MEUR in energy system costs. • Reduces gas imports by 0.7% and fuel expenditures by 13 MEUR. • Reduces power plant investment by 4 MEUR and total GHG emissions by 0.5%.
Residential buildings retrofits	• Saves 157 MEUR in energy system costs. • Reduces building final energy use by 8.7% and gas imports by 4.1%. • Reduces fuel expenditures by 83 MEUR, power plant investment by 5 MEUR. • Lowers total GHG emissions by 2.8%.
NAMA for biomass heating stoves	• Saves 77 MEUR in energy system costs. • Reduces building final energy use by 0.6% (mostly gas and LPG), • Reduces gas imports by 0.2% and total fuel expenditures by 6 MEUR. • Reduces power plant investment by 4 MEUR and GHG emissions by 0.2%.
NAMA for solar water heating	• Saves 10 MEUR in energy system costs. • Reduces building final energy use by 0.1% and fuel expenditures by 7 MEUR. • Increases electricity generation by 0.3% as the solar water heaters displace gas and

	use electricity for back-up. • Increases power plant investment by 14 MEUR and reduces GHG emissions by 0.2%.
Commercial solar water heating	• Saves 32 MEUR in energy system costs. • Reduces natural gas imports by 0.2% and fuel expenditures by 3 MEUR. • Reduces electricity generation by 0.7% and power plant investments by 78 MEUR. • Reduces GHG emissions by 0.1%.
LED lamps for public lighting	• Saves 27 MEUR in energy system costs. • Reduces electricity generation by 0.4%, and power plant investments 45 MEUR. • Reduces GHG emissions by 9 kt.
Renewables, appliance & lighting efficiency	• Saves 761 MEUR in energy system costs. • Reduces final energy use in buildings by 4.2% and fuel expenditures by 51 MEUR. • Reduces electricity generation by 8.2% and power plant investment 925 MEUR. • Reduces GHG emissions by 1.8% (352 kt CO2eg).
All Building Retrofits	• Saves 83 MEUR in energy system costs. • Reduces Building sector energy use by 9.8% and fuel expenditures by 107 MEUR. • Reduces gas imports by 5.8% and electricity generation by 0.1%. • Reduces power plant investment costs by 12 MEUR and GHG emissions by 3.8% (730 kt CO2eg).
All RSD & COM Sector Measures	• Saves 671 MEUR in energy system costs. • Reduces Building sector energy use by 14.1% and fuel expenditures by 153 MEUR. • Reduces natural gas imports by 9.4%, electricity generation by 8.4% • Reduces power plant investment by 937 MEUR. • Reduces GHG emissions by 5.6% (1074 kt CO2eg).

The results metrics for this sector are divided into the renewables, appliance & lighting efficiency measures and the commercial and residential building shell measures. Figure 9 shows the reductions in CO_2, methane and GHG emissions for the renewables, appliance & lighting efficiency measures. The largest reductions occur for the measure to phase out incandescent bulbs, and the total for these measures achieves a 1.8% reduction in GHG emissions. Reductions of methane emissions are due to the reduction of natural gas losses related to less use of natural gas.

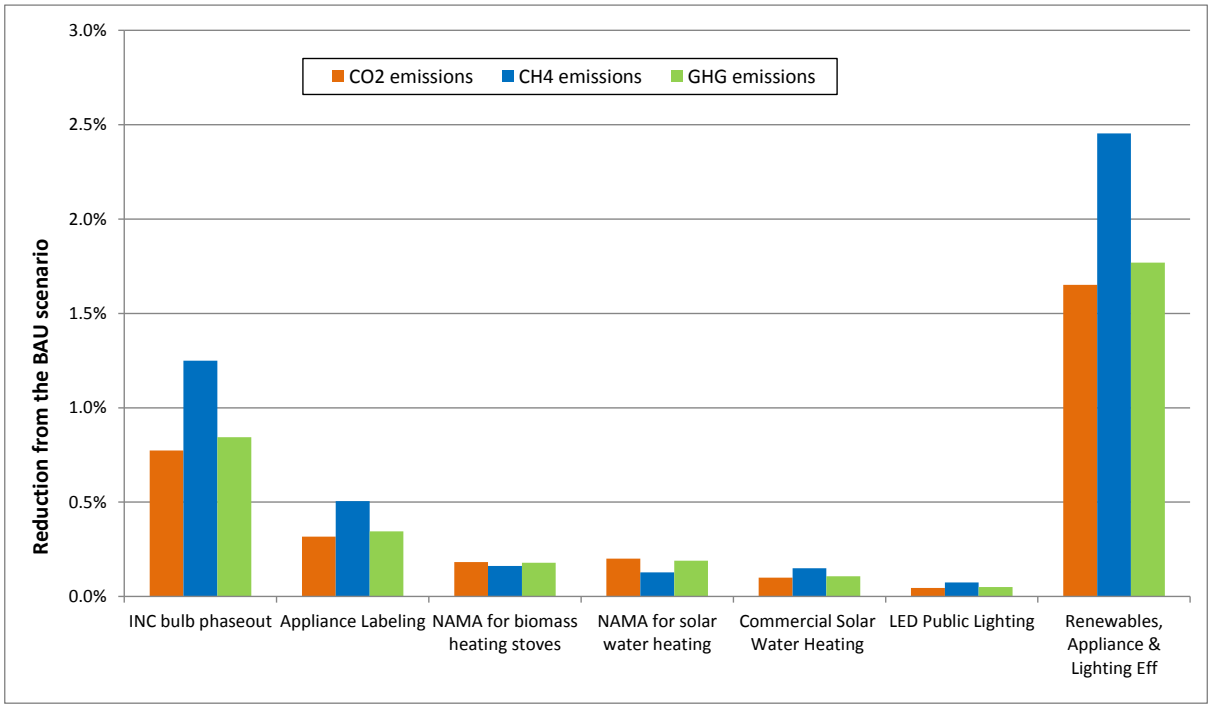

Figure 9: Impact of Lighting, Appliance & Renewables Measure – Emissions

Figure 10 shows that the reductions in primary energy, final energy and natural gas imports follow the reductions in final energy use and again the measure to phase out incandescent bulbs provides the greatest contribution of this set of measures.

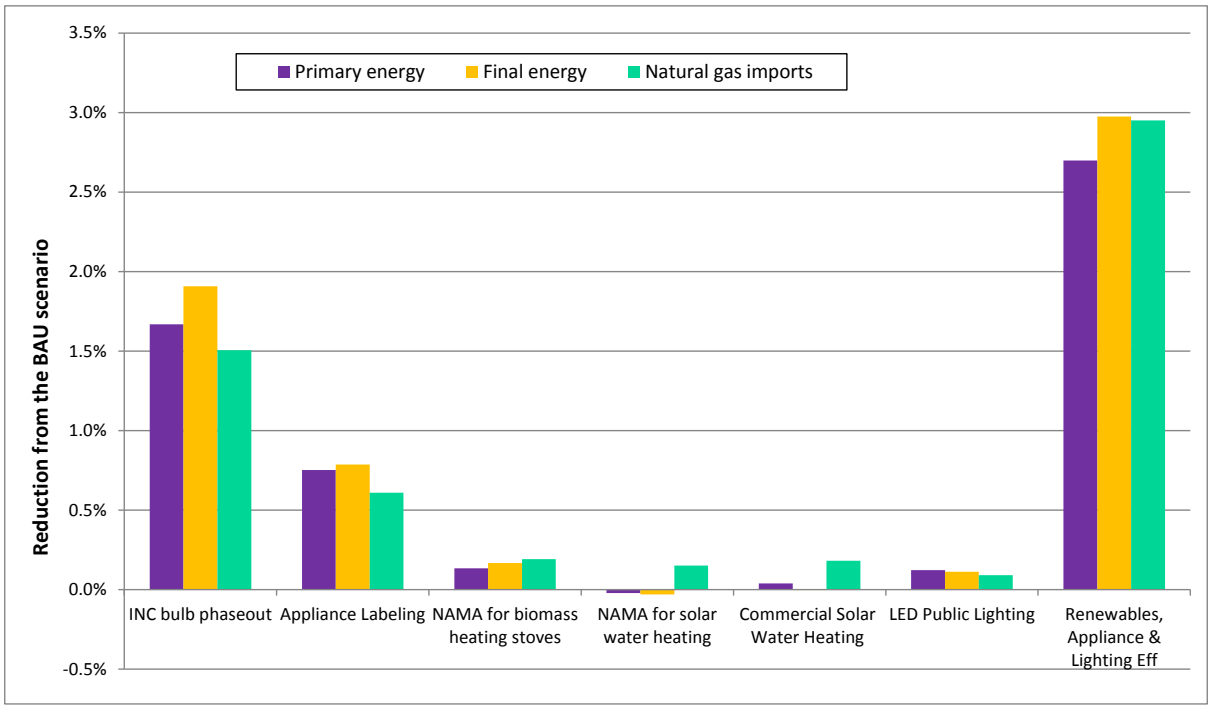

Figure 10: Impact of Lighting, Appliance & Renewables Measures – Energy

Figure 11 shows that almost all these measures reduce electricity generation, final energy consumption and power plant investments. The solar water heating measure shows a very slight increase in electricity generation due to the use of electricity as backup to the solar heating.

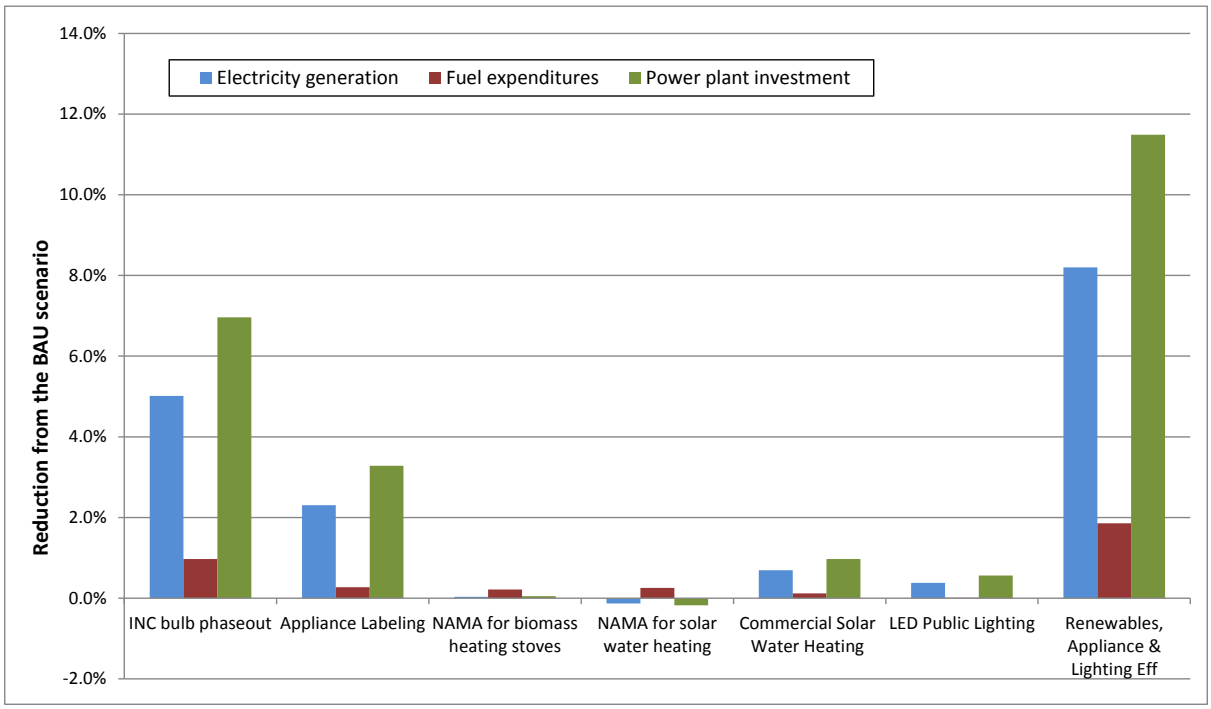

Figure 11: Impact of Lighting, Appliance & Renewables Measures – Generation and Costs

Shifting to the commercial and residential building shell measures, Figure 12 shows that the greatest reductions in CO_2, methane and GHG emissions occurs for the residential building shell measures. The figure also shows that the combined building shell measures achieve a 3.8% reduction in GHG emissions, and that the total reduction for all the sector measures combined is 5.6%.

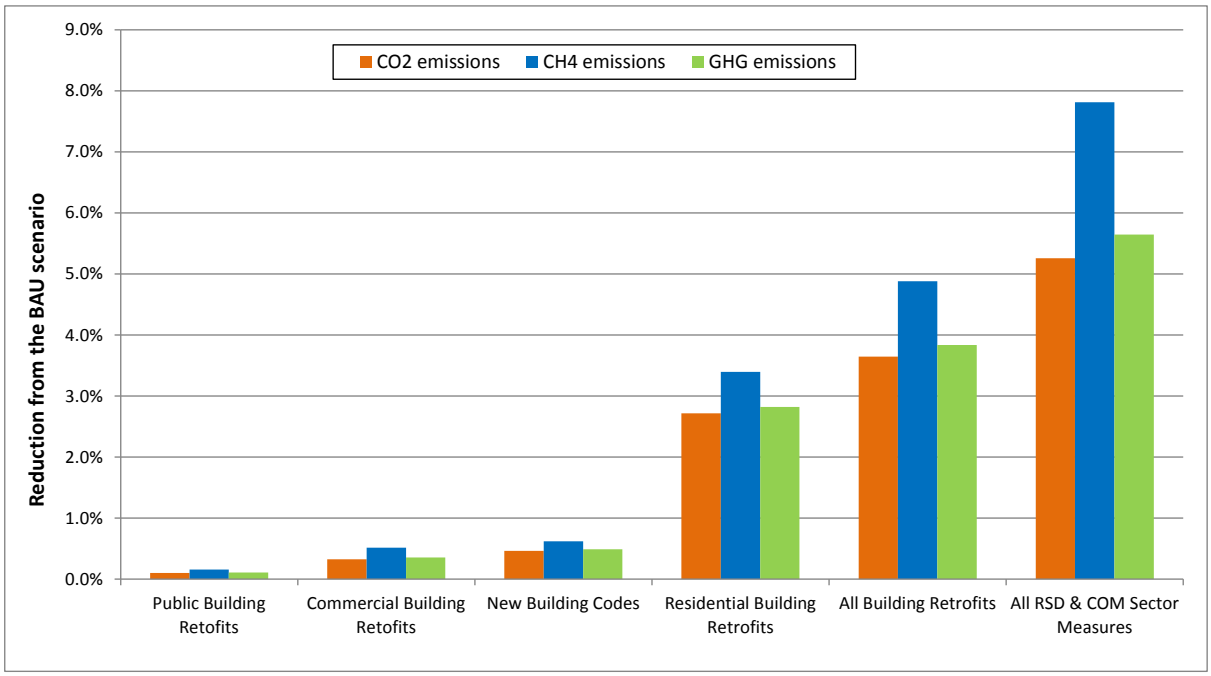

Figure 12: Impact of Commercial and Residential Building Shell Measures – Emissions

Figure 13 shows the reductions in primary energy, final energy and natural gas imports that results from these measures, along with the combination of all the measures, which achieve a 9.4% reduction in natural gas imports, or almost 380 million cubic meters in 2030.

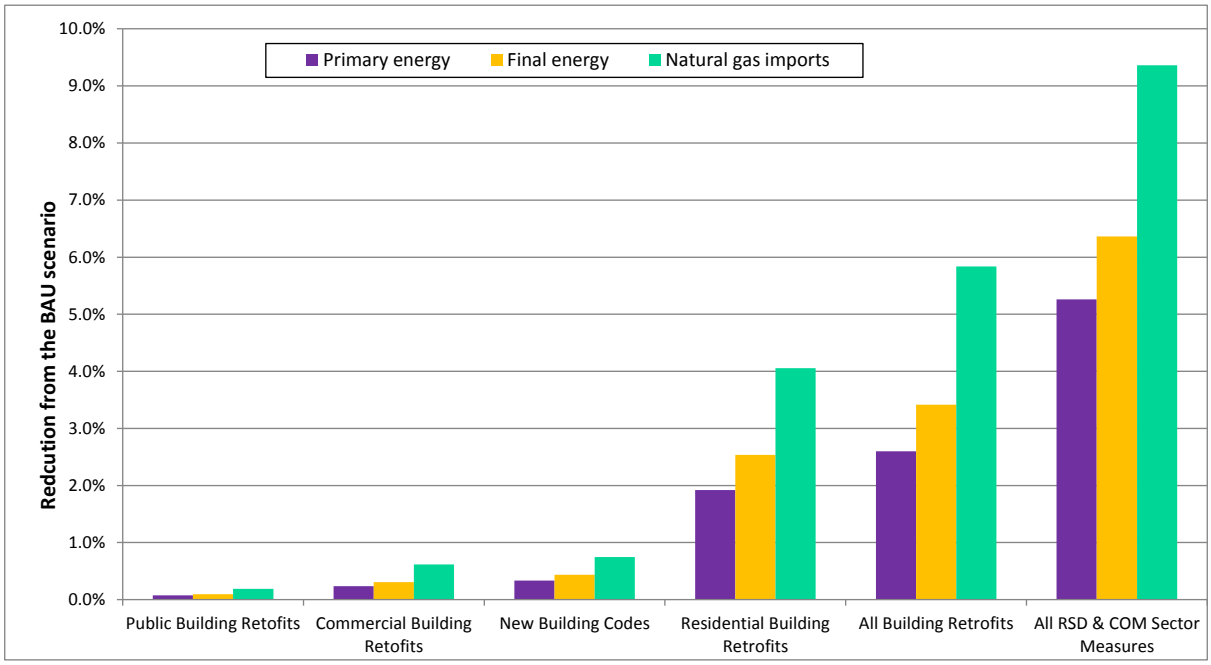

Figure 13: Impact of Commercial and Residential Building Shell Measures – Energy

Figure 14 the shows the reductions in electricity generation, fuel expenditures and power plant investments for the building retrofit measures and the combined sector measures. Note that the building sector measures show larger reductions in final energy use, while the renewable and appliance measures primarily showed reductions in electricity generation. The results from the combination of all sectoral measures show a savings of 8% in electricity generation, 153 MEUR in fuel expenditures and 937 MEUR in power plant investment.

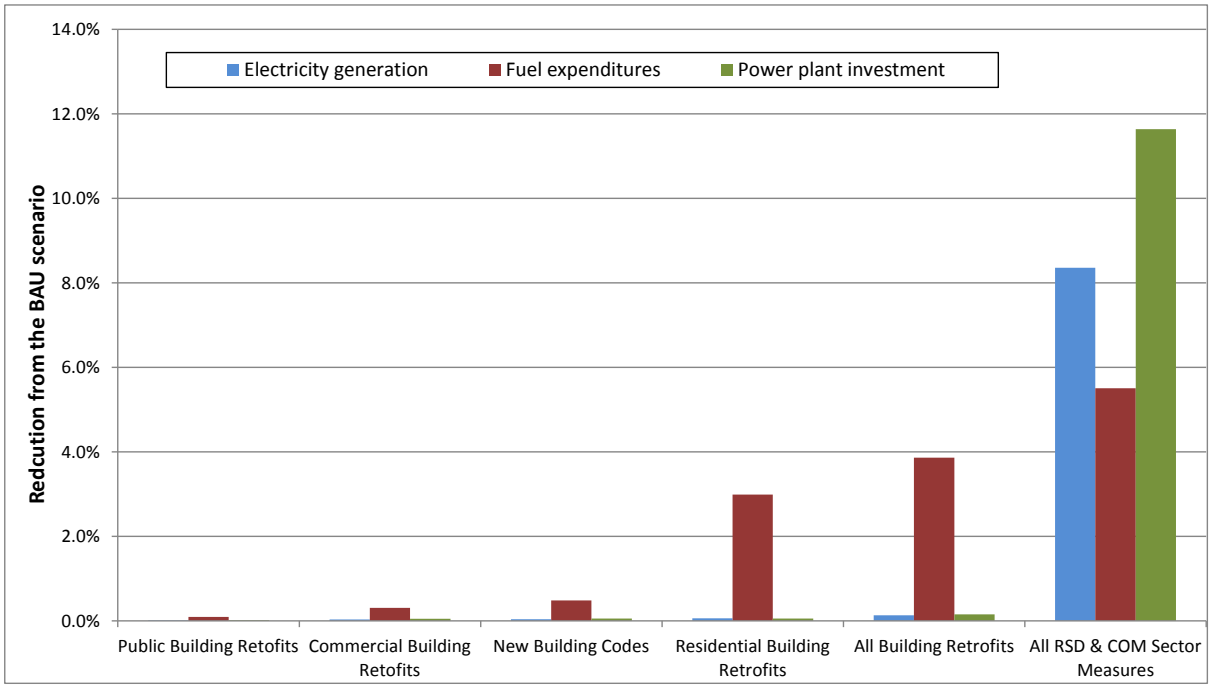

Figure 14: Impact of Commercial and Residential Building Shell Measures – Generation and Costs

7 Industry Sector Energy Use and GHG Emissions

7.1 Description of Mitigation Measures

The Industrial sector is comprised of six sub-sectors: Chemicals, Food, Iron & Steel, Non-metallic Minerals, Construction and Other. Each subsector requires process heat and mechanical drive services to produce their associated products. Mitigation measures were identified for Chemicals, Food, Iron & Steel and Cement, since these are the most energy intensive industries in Georgia[2]. The measures are based on Georgia-specific industrial plant measures and include various types of process heat efficiency improvements, motor drive efficiency measures, and one cogeneration measure. Impacts of some plant specific and process specific measures have been calculated by Industry expert and provided as inputs to a scenario in the MARKAL-Georgia model. In this way the model can determine the combined effect of these and other measures. There are also two combination runs, and one scenario introducing a Pig iron industry in 2020. These are described in more detail in Table 6.

[2] EC-LEDS Industry Overview Report.

Table 6: Industry Sector Measures

Name	Description
Chemicals - Efficiency measures in Rustavi Azoti	The measure includes several energy efficiency measures in Rustavi Azoti plant, such as energy efficient natural gas burners in ammonia production, rehabilitation of steam network, cogeneration in nitric acid production and other measures. Based on plant-specific calculations, these different measures can save up to 434TJ of natural gas from 2022 and 612TJ of electricity from 2020.
Food industry process heat improvement	Increase Food industry utilization of advanced process heat technologies to 30% by 2030. This is general measure for all food industry.
Iron & steel ferroalloy intensity improvements	It was assumed that by improving the technological base and processes in ferroalloy production the coke intensity can be improved by 20% and electricity intensity by 5%.
Iron & steel industry Automated Controls	The measure assumes the increase the use of automatic controls to reduce gas consumption in iron and Steel industry (reinforcement production). Based on plant-specific calculations for Rustavi Steel It was assumed that reductions can reach 15% in such plants.
Cement industry utilization of waste heat for clinker drying	Based on plant-specific calculations, the utilization of waste heat for clinker drying can save 5.1 TJ of natural gas at annually Heidelberg Cement Georgia. The measure is implemented in 2020.
Cement industry conversion from wet process to dry process	The measures assumes that Kaspi plant of Heidelberg cement Georgia will be converted from wet to dry process and expanded in 2020, and the Rustavi plant will be converted from wet to dry in 2028.
All Industry advanced motor drives	Increase the utilization of advanced and variable speed motors to 50% by 2030 in all industrial plants.
All Industry Efficiency Measures	Combines all the industry measures except the Pig Iron subsector development.
Development of a Pig iron production subsector	The scenario investigates the possibility of starting pig iron production at Rustavi Steel plant. A new Pig Iron industry is started in 2020 with an annual production of 750 kt and a specific consumption of 400 kg of coke per ton of pig iron (8.793PJ annually).

7.2 Mitigation Measures Impact Summary

The results from the Industry sector mitigation measures are organized according to sub-sector, with the Chemicals, Food and Iron & Steel showing smaller impacts than the Non-metallic Minerals industry, which is dominated by cement production. The model results used to illustrate the impacts of these measures include electricity generation, power plant investment, natural gas imports and industry sector emissions. The results are described below and summarized in Table 7. Appendix A provides a detailed table of results.

The advanced motor drive efficiency measures have a similar impact across all industry subsectors, reducing electricity generation by about 0.1% in 2030, with a corresponding 0.1% reduction in power plant investment. The energy system cost goes up by about 6 to 8 MEUR in 2030 because of the increased capital expenditures. There are minimal GHG reductions (0.1%) as most of the electricity saved comes from hydropower. Bundling all the Industry advanced motor drive measures results in a 0.5% reduction in electricity generation, and a 0.1% reduction in gas imports. Power plant investment is reduced by 40 MEUR and the GHG emissions are 0.1% (13 kt) lower in 2030.

Chemical industry measures at the Rustavi Azoti plant results in a 0.4% reduction in natural gas imports and a 0.5% reduction in electricity generation. Industry sector final energy use drops by 1.0%, and energy system costs are reduced by 24 MEUR, and GHG emissions are reduced by 0.3% (48 kt) in 2030.

Food industry process heat improvements save 0.3% of natural gas imports, reduce industry sector final energy use by 0.7%, and GHG emissions by 0.2%. Total energy system cost is reduced 5 MEUR.

Iron & Steel industry process heat improvements in ferroalloy production reduce electricity generation by 0.4% (122 GWh) and natural gas imports by 0.1% in 2030. Power plant investment is reduced by 43 MEUR over the planning horizon, and GHG emissions decrease by 0.8% (149 kt) in 2030.

Iron & Steel industry automated controls has a very small impact, reducing total industry sector final energy use by 0.2% and GHG emissions by 11 kt in 2030.

Cement industry conversion from wet process to dry process has a significant impact, reducing industry final energy use by 6.9% and total final energy by 1.4% in 2030. Fuel expenditures are reduced by 0.8% and the total energy system cost is reducing by 134 MEUR. Total GHG emissions are reduced by 2.4% (458 kt) in 2030.

Cement industry utilization of waste heat for clinker drying has very small effect, as the energy savings is modest. Natural gas consumption is reduced by 0.124 ktoe, and so are natural gas imports. As a result emission reductions are also very small – just 0.37ktons of CO2eq in 2030.

Combining all the Industry sector measures reduces CO_2 emissions by 4.0% and GHG emissions by 3.7%. Natural gas imports are reduced by 0.9% and electricity generation by 1.4% (454 GWh) in 2030. Fuel expenditures are reduced by 1.6%, power plant investment decreases by 165 MEUR, and total system cost decreases by 174 MEUR.

Development of a Pig Iron production subsector in 2020 leads to 2.9% increase in total final energy consumption and a 4.9% increase in GHG emissions (936 kt), which are primarily due to CO_2 emissions from coke used in the pig iron production process. Fuel expenditures increase by 2.8% in 2030, and the energy system cost increases by 551 MEUR. Electricity generation is not impacted.

In summary, all the industry measures have a beneficial impact, but the predominant measure is the cement industry wet-to-dry process upgrade, which accounts for 65% of industry sector GHG emission reductions. The addition of a new Pig Iron industry will more than fully offset any reductions, as the CO_2 emission additions are almost twice the reductions from all the sector mitigation measures.

Table 7: Summary Results of Industry Sector Measures

Name	Impact in 2030
Chemicals - Efficiency measures in Rustavi Azoti	• Reduces gas imports by 0.4% and industry sector final energy use by 1.7%. • Reduces electricity generation by 0.5% (172 GWh) and power plant investment by 62 MEUR. • Energy system cost is reduced 76 MEUR and GHG emission are reduced by 48 kt.
Food - Process heat improvement	• Reduces gas imports by 0.3% and industry sector final energy use by 0.7%. • Reduces GHG emissions by 0.2% (30 kt). • Decreases energy system cost by 5 MEUR.
Iron & steel – Ferroalloy Process heat improvements	• Reduces electricity generation by 0.4% (122 GWh) and gas imports by 0.1%. • Reduces power plant investment by 43 MEUR and total system cost by 74 MEUR. • Decreases GHG emissions by 0.8% (149 kt).

Iron & steel - Automated controls	• Reduces industry sector final energy use by 0.2%. • Minimal changes in power plant investment or energy system cost. • Reduces GHG emissions by 11 kt.
Cement - Utilization of waste heat for clinker drying	• Reduces natural gas imports and industry sector final energy use by 0.003% • Reduces GHG emissions by 0.002% (0.373 kt).
Cement - Conversion from wet process to dry process	• Reduces industry final energy use by 6.9% and fuel expenditures by 21MEUR. • Reduces total energy system cost by 134 MEUR. • Reduces GHG emissions by 2.4% (458 kt).
All Industry - Advanced motor drives	• Reduces electricity generation by 0.5% and power plant investment by 58 MEUR. • Increases energy system cost by 41 MEUR. • Reduces GHG emissions by 0.1% as most electricity come from hydropower.
All Industry - Efficiency measures	• Reduces gas imports by 0.9% and electricity generation by 1.4% (454 GWh). • Reduces fuel expenditures by 45 MEUR, power plant investment by 165 MEUR, and energy system cost by 244 MEUR. • Reduces CO_2 emissions by 4% and GHG emissions by 3.7% (710 kt).
Pig Iron – Development of new subsector	• Increases industry sector final energy use by 27% for the coke used in the pig iron production process. • Increases fuel expenditures by 78 MEUR and energy system cost by 551 MEUR. • Increases CO2 emissions by 5.8% and GHG emissions by 4.9% (936 kt).

The results for the industry sector are presented in two groups: the chemicals, food and iron & steel industry subsector measures, and the cement and pig iron subsector measures, along with the combined industry measures Figure 15 shows that the reductions in CO_2, methane and GHG emissions for the Chemicals, Food and Iron & Steel industry subsector measures, come primarily from the iron and steel subsector with important contributions from the chemicals subsector.

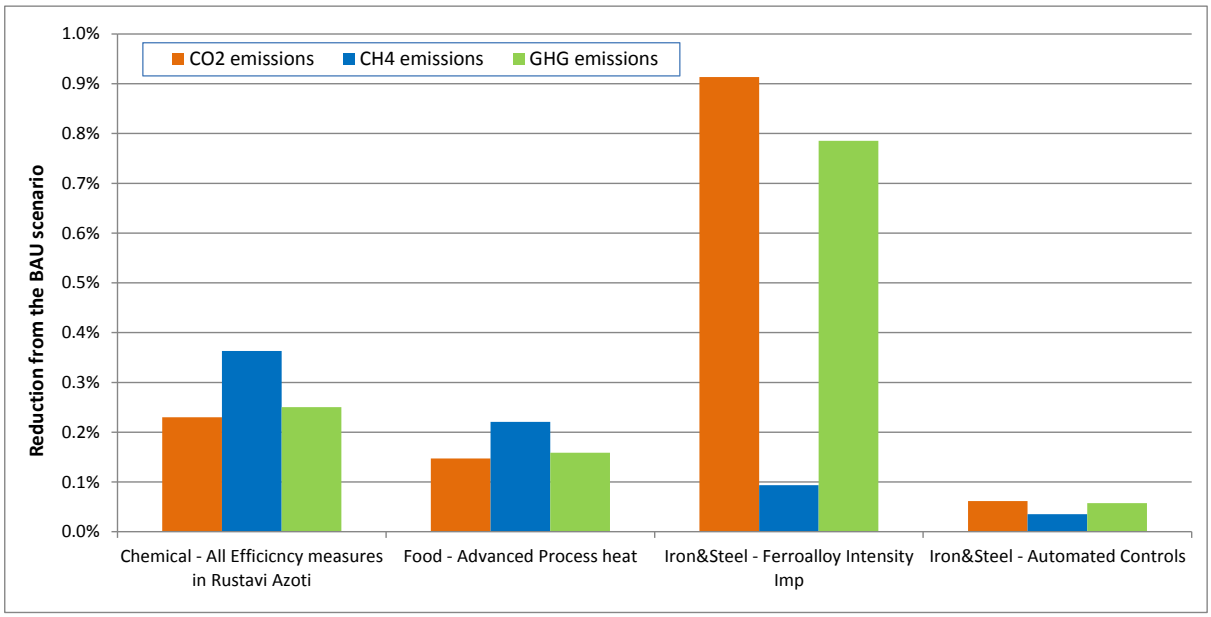

Figure 15: Impact of Chemicals, Food and Iron & Steel Industry Measures – Emissions

Figure 16 shows that the greatest reductions in natural gas imports come from the chemical subsector measure at Rustavi Azoti plant.

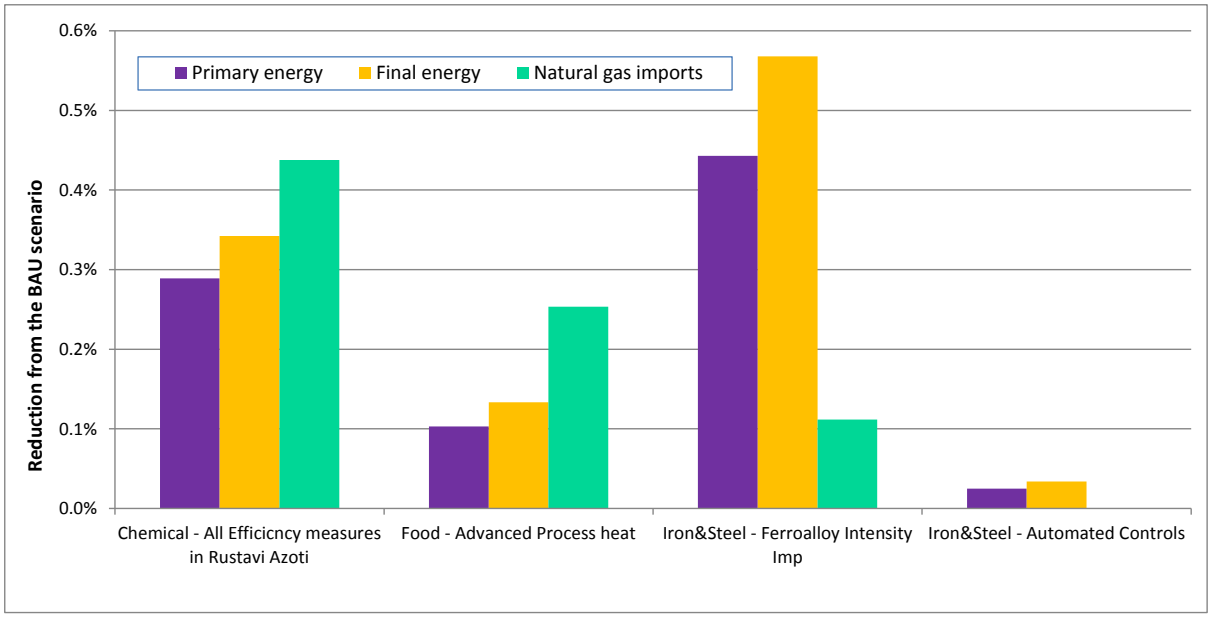

Figure 16: Impact of Chemicals, Food and Iron & Steel Industry Measures – Energy

Figure 17 shows that the reductions in electricity generation and power plant investments come primarily from the chemicals subsector followed by the iron and steel subsector.

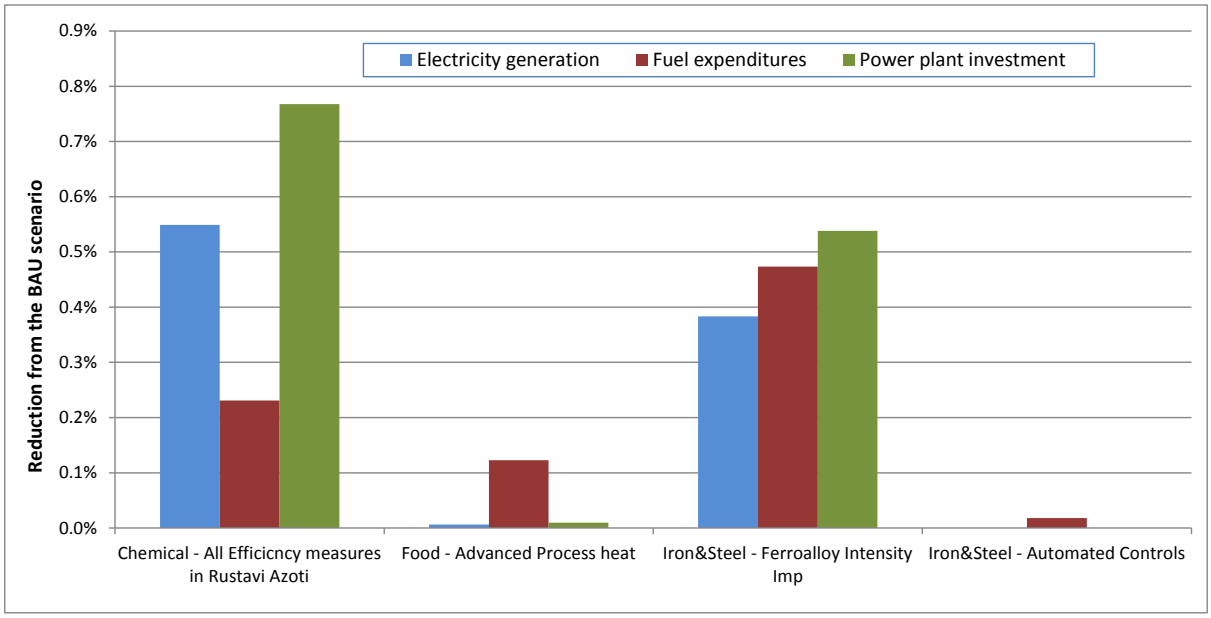

Figure 17: Impact of Chemicals, Food and Iron & Steel Industry Measures – Generation and Costs

Shifting to the cement, pig iron and combined sectoral measures, Figure 18 shows that the reductions in CO_2, methane and GHG emissions for this industry grouping are dominated by the cement sector wet-to-dry process improvement measure, which reduces GHG emissions by 2.4% and accounts for about two-thirds of the emission reduction potential from the entire industry sector (less the Pig iron measure.) The addition of a pig iron subsector in Georgia would increase GHG emissions by 4.9% (710 Kt).

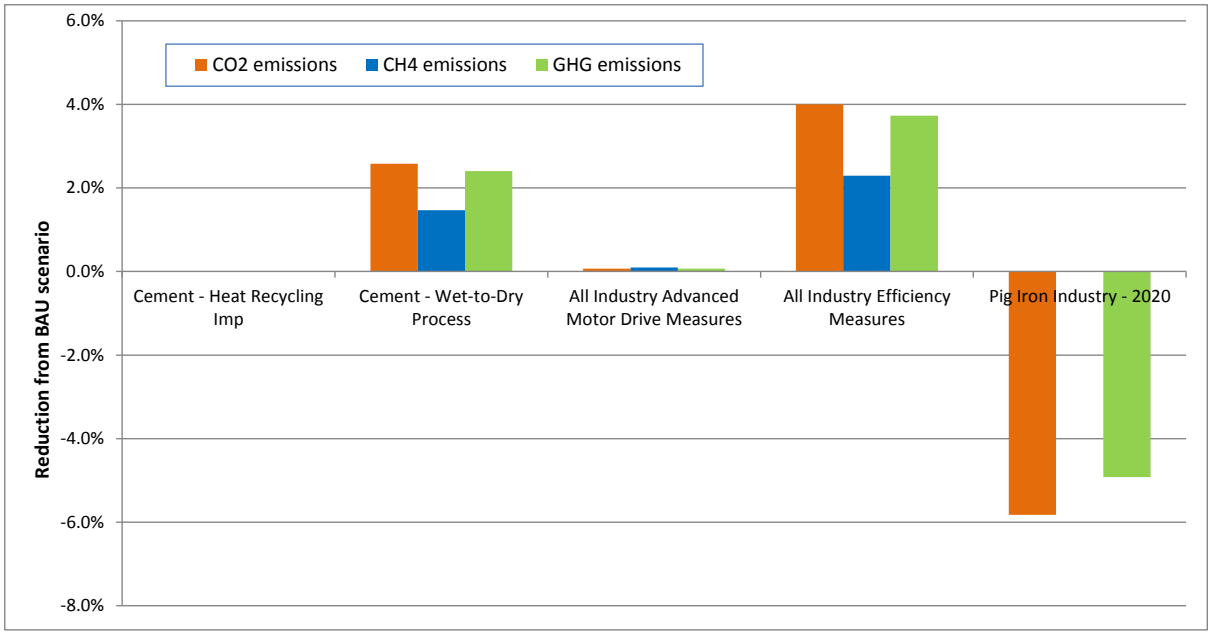

Figure 18: Impact of Cement, Combined and Pig Iron Industry Measure - Emissions

Figure 19 shows that about half the reductions in primary and final energy use for the entire sector come from the cement sector wet-to-dry process improvement measure. However, most of the reductions in natural gas imports come from the chemicals and iron and steel subsectors. The addition of a pig iron subsector final energy use by almost 3%.

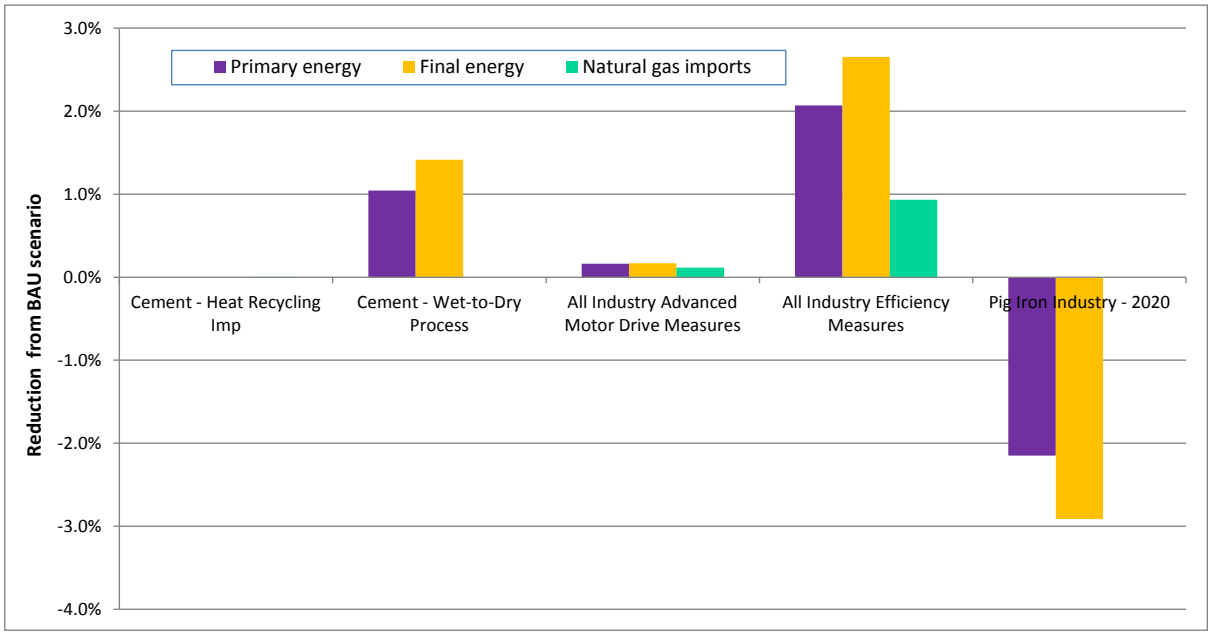

Figure 19: Impact of Cement, Combined and Pig Iron Industry Measures – Energy

Figure 20 shows that about one third of the reductions in electricity generation (and power plant investments) come from the advanced motor drive measure, with the chemicals and iron and steel subsector measures contributing similar reductions. The addition of a pig Iron subsector has no impact on electricity production, but increases fuel expenditures by almost 3%.

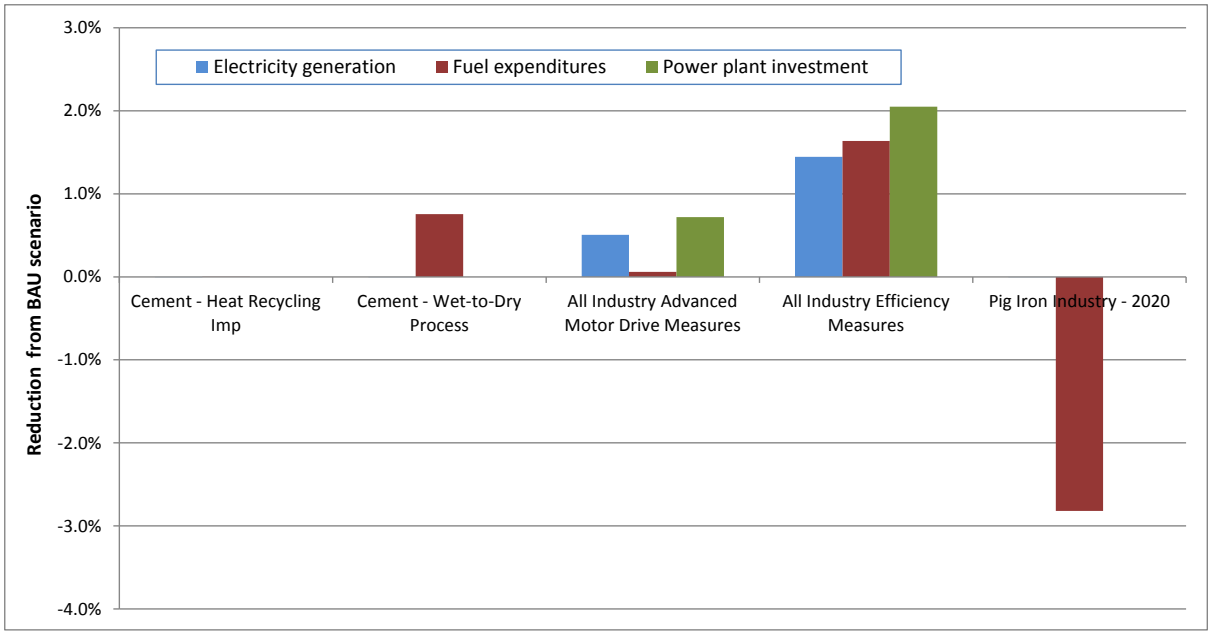

Figure 20: Impact of Cement, Combined and Pig Iron Industry Measure – Generation and Costs

8 Transportation Sector Energy Use and GHG Emissions

8.1 Description of Mitigation Measures

The transportation sector is sub-divided into passenger and freight transport modes. The mitigation measures fall into two categories: i) improving vehicle efficiency and switching to cleaner fuels, and ii) shifting transport activity from a less efficient to a more efficient mode (e.g. car to bus). Most measures deal with passenger transport, both urban and inter-city, and a few deal with freight transport

Table 8: Transportation Sector Measures

Description	Details
Promote Biofuels: 6% by 2030	A biofuels blending requirement is implemented in 2020 that grows to 6% of road transport fuels by 2030.
Improve road transport efficiency	Mandatory vehicle inspection and improved fuel standards for all road vehicles (LDVs, light and heavy trucks, buses and mini-buses), as well as new driving regulations are introduced so that vehicles are better maintained and drive more efficiently. The fiscal policy for new vehicles on the other hand promotes penetration of newer and better vehicles in the market. All measures result in a 15% improvement of average vehicle efficiency by 2030 compared to base year.
Promote hybrid and electric vehicles	Eliminating the tax on import of electric and hybrid vehicles is assumed to lead to a 5% market share for hybrids and 1% market share for electric vehicles by 2030.
Promote urban transport	Municipal public transport is improved and expanded to attract more ridership, resulting in a shift of 1.5% of total passenger transport demand to Bus and away from LDV and Minibus by 2020 and 3.8% by 2030. This represents the impact of existing Sustainable Energy Action Plans (SEAPs) by 2020 and the possibility of expanding the measures nationwide to other urban areas by 2030.

Promote Clean buses	Measures to promote cleaner buses lead by 2030 to 60% of total bus fleet used for passenger transportation to be run on clean energy (CNG or electric), while each vehicle's technology share was calculated by MARKAL-Georgia optimization model.
Taxi regulations	Increasing regulations of taxis raise the cost of using taxis, thus decreasing LDV transport demand by 3% in 2030.
Promote public parking systems	Increase cost for inner-city parking shifts 0.11% of LDV transport demand to BUS and Minibus demand by 2020 and 0.5% by 2030. This represents the impact of existing Sustainable Energy Action Plans (SEAPs) by 2020 and the possibility of expanding the measures nationwide to other urban areas by 2030.
Promote cycling and walking	Develop and maintain cycling & walking infrastructure that reduces LDV transport demand by 1.5% in 2020 and 3% by 2030. This represents the impact of existing Sustainable Energy Action Plans (SEAPs) by 2020 and the possibility of expanding the measures nationwide to other urban areas by 2030.
Promote two wheelers	Promoting 2-wheelers in cities with hills shifts 0.05% of total LDV transport demand to 2-wheelers by 2020 and 2.4% by 2030. This represents the impact of existing Sustainable Energy Action Plans (SEAPs) by 2020 and the possibility of expanding the measures nationwide to other urban areas by 2030.
Improve Intercity passenger rail	Assuming a new rail link to Turkey, as well as improvement of rail passenger service and infrastructure, so that 9% of all road passenger transport is shifted from LDVs and Buses to Rail using an 80%-20% split.
Improve intercity bus transport	Improved service and routes leads to a 10% increase in the passenger transport share for buses and minibus reducing LDV transport demand by 2% by 2030.
Promote freight transport shift from heavy truck to rail	New railway to Turkey, improved rail infrastructure and coherent freight transport policy will shift the freight from Heavy trucks to Rail such that Rail accounts for 50% of all freight transport by 2030.
All transport measures except passenger mode-shifts	Combines all transport measures except the passenger mode-shift measures and the biofuels target.
All mode shift measures	Combines all passenger transport mode-shift measures.
All transport sector measures	Combines all transport sector measures except the biofuels target.

8.2 Mitigation Measures Impact Summary

The model results used to illustrate the impacts from the Transportation Sector mitigation measures include final energy use, natural gas imports, electricity generation, power plant investments and transport sector emission reductions. The results are described below and summarized in Table 9. Appendix A provides a detailed table of results.

Promoting biofuels through a blending target of 6% in 2030 reduces transport sector CO2 emissions by 6.1% and overall GHG emissions by 2.2% (409 kt) in 2030. Fuel expenditures increase by 0.2% (5 MEUR) in 2030, and energy system cost increases by 32 MEUR. Import of oil products is reduces by 0.2%, and fuel expenditures are reduced by 5 MEUR in 2030.

Improving the efficiency of the entire road vehicle stock, through better fuel standards, mandatory inspections and other measures, results in a 2.8% reduction of transport fuel use, a 0.6% reduction in

natural gas imports, and a 58 MEUR reduction in fuel expenditures in 2030. Energy system costs decrease by 424 MEUR and GHG emissions are reduced by 1.2% (235 kt) in 2030.

Promoting hybrid and electric vehicles reduces transport energy use by 0.6%, natural gas imports by 0.3%, and increases electricity generation by 0.6% (largely from hydropower) in 2030. Energy system costs increase by 171 MEUR and power plant investments increase 73 MEU. GHG emissions decrease by 0.4% (76 kt) in 2030.

Promoting improved urban public transport systems reduces energy system costs by 136 MEUR and reduces GHG emissions by 0.2% (40 kt) in 2030. Natural gas imports drop by 0.3%, and fuel expenditures are reduced by 9 MEUR in 2030. Electricity generation is not impacted.

Promoting cleaner buses increases natural gas imports by 0.4%, but decreases fuel expenditures by 4 MEUR. Energy system cost decreases by 7 MEUR, and although transport sector emissions decrease by 0.108 kt, the total GHG emissions increase by 0.1% (10 kt) in 2030, due to an increase in fugitive methane emissions from gas use. The relative impact of these fugitive emissions will be greater when this measure is combined with the measure to reduce natural gas losses in the power sector.

Implementing new taxi regulations to lower LDV use reduces transport final energy by 1.5% and total fuel expenditures by 30 MEUR in 2030. Natural gas imports drop by 0.5%, and electricity generation is not impacted. GHG emissions decrease by 0.7% (124 kt) in 2030. Energy system costs decrease by 1.2 billion EUR (BEUR) due to reduced vehicle purchases.

Implement public parking systems to lower LDV use reduces transport final energy by 0.2% and total fuel expenditures by 4 MEUR in 2030. Natural gas imports drop by 0.1%, and electricity generation is not impacted. GHG emissions decrease by 0.1% (16 kt) in 2030. Energy system costs decrease by 50 MEUR.

Promoting walking and cycling to lower LDV use reduces transport final energy by 1.5% and total fuel expenditures by 29 MEUR in 2030. Natural gas imports drop by 0.5%, and electricity generation is not impacted. GHG emissions decrease by 0.6% (122 kt) in 2030. Energy system costs decrease by 376 MEUR due to reduced vehicle purchases.

Promote two wheelers to lower LDV use reduces transport final energy by 0.7% and total fuel expenditures by 9 MEUR in 2030. Natural gas imports drop by 0.5%, and electricity generation is not impacted. GHG emissions decrease by 0.3% (59 kt) in 2030. Energy system costs decrease by 106 MEUR.

Improving intercity passenger rail through the new link to Turkey and improved service reduces transport final energy use by 1.6% and total fuel expenditures by 47 MEUR in 2030. Natural gas imports drop by 0.6%, and electricity generation increases by 1.1% (340 GWh) in 2030. Power plant investment increases by 124 MEUR. Total imports are reduced by 0.9%, and GHG emissions decrease by 0.9% (178 kt) in 2030. Energy system costs decrease by 474 MEUR.

Promoting intercity bus transport through improved service reduces transport final energy use by 0.8% and total fuel expenditures by 14 MEUR in 2030. Natural gas imports drop by 0.3%, and electricity generation is not impacted. GHG emissions decrease by 0.3% (62 kt) in 2030. Energy system costs decrease by 143 MEUR.

Promoting a shift in freight transport from Heavy truck to Rail freight reduces transport final energy use by 8.2% and total fuel expenditures by 197 MEUR in 2030. Natural gas imports drop by 1.0%, and total imports by 3.7%. Electricity generation increases 0.6% in 2030, and power plant investment increases by 66 MEUR. GHG emissions decrease by 3.8% (715 kt) in 2030. Energy system costs decrease by 2.29 BEUR, but the cost of rail infrastructure improvements are not included.

All Transport sector measures except the passenger-mode-shift measures reduce transport final energy use by 11.2% and total fuel expenditures by 272 MEUR in 2030. Natural gas imports drop by 1.6%, and total imports drop by 5.1%. Electricity generation is increased 1.1% in 2030, and power

plant investment increases 126 MEUR. GHG emissions decrease by 5.2% (998 kt) in 2030. Energy system costs decrease by 2.5 BEUR.

Combining all the passenger transport mode shift measures reduces transport final energy use by 6.8% and total fuel expenditures by 141 MEUR in 2030. Natural gas imports drop by 2.7%, and total imports drop by 3.2%. Electricity generation is increased 1.1% in 2030, and power plant investment increases 123 MEUR. GHG emissions decrease by 3.2% (603 kt) in 2030. Energy system costs decrease by 2.1 BEUR, but the cost of rail infrastructure improvements are not included.

Combining all the Transport sector measures (not including the biofuels measure) reduces transport sector final energy use by 17.7% and total fuel expenditures by 409 MEUR in 2030. Natural gas imports drop by 4.1%, and total imports drop by 8.2%. Electricity generation is increased 2.1% in 2030, and power plant investment increases 236 MEUR. GHG emissions decrease by 8.3% (1570 kt) in 2030. Energy system costs decrease by 4.62 BEUR, but the cost of infrastructure improvements are not included.

Table 9: Summary Results of Transportation Sector Measures

Description	Impact in 2030
Promote Biofuels: 6% by 2030	• Reduces GHG emissions by 2.2% (409 kt) and import of oil products 0.2% (12 ktoe) in 2030. • Increases fuel expenditures by 5 MEUR. • Increases energy system cost 32 MEUR.
Improve road transport efficiency	• Reduces transport fuel use by 2.8%, fuel costs by 58 MEUR and natural gas imports by 0.7%. • Decreases energy system costs by 424 MEUR. • Reduces GHG emissions by 1.2% (235 kt).
Promote hybrid and electric vehicles	• Reduces transport fuel use by 0.6% and natural gas imports by 0.3%. • Increases electricity generation by 0.6% (largely from hydropower) and increases power plant investment 73 MEUR. • Increases energy system costs by 171 MEUR. • Decreases GHG emissions by 0.4% (76 kt).
Promote Urban Transport	• Reduces energy system costs by 136 MEUR. • Reduces natural gas imports by 0.3% and fuel expenditures by 9 MEUR. • Reduces GHG emissions by 0.2% (40 kt).
Promote Cleaner Buses	• Increases natural gas imports by 0.4%, but decreases fuel expenditures by 4 MEUR. • Decreases energy system cost by 7 MEUR. • Increases GHG emissions by 0.1% (10 kt) due to fugitive methane emissions.
Taxi regulations	• Reduces transport final energy use by 1.5%, total fuel expenditures by 30 MEUR and natural gas imports by 0.5%. • Decreases GHG emissions by 0.7% (124 kt) and energy system costs by 1.2 BEUR due to reduced vehicle purchases.
Implement public parking systems	• Reduces transport final energy by 0.2%, total fuel expenditures by 4 MEUR and natural gas imports by 0.1%. • Decreases GHG emissions by 0.1% (16 kt) in 2030. • Decreases energy system costs by 50 MEUR.
Promote cycling and walking	• Reduces transport final energy by 1.5%, total fuel expenditures by 29 MEUR and natural gas imports by 0.5%. • Decreases GHG emissions by 0.6% (122 kt). • Decreases energy system costs by 376 MEUR.
Promote two wheelers	• Reduces transport final energy by 0.7%, total fuel expenditures by9 MEUR and natural gas imports by 0.5%. • Decreases GHG emissions by 0.3% (59 kt). • Decreases energy system costs by 106 MEUR.

Improve Intercity passenger rail	• Reduces transport final energy use by 1.6%, total fuel expenditures by 47 MEUR and natural gas imports by 0.6%. • Increases electricity generation by 1.1% (340 GWh) and increases power plant investment by 124 MEUR. • Reduces total imports by 0.9%, and GHG emissions by 0.9% (178 kt). • Decreases energy system costs by 474 MEUR.
Improve intercity bus transport	• Reduces transport final energy use by 0.8%, total fuel expenditures by 14 MEUR, and natural gas imports by 0.3%. • Decreases GHG emissions by 0.3% (62 kt). • Decreases energy system costs by 143 MEUR.
Promote freight transport shift from Heavy truck to Rail	• Reduces transport final energy use by 8.2%, total fuel expenditures by 197 MEUR and natural gas imports by 1.0%. • Increases electricity generation 0.6% and power plant investment by 66 MEUR. • Decreases GHG emissions by 3.8% (715 kt) and energy system costs by 2.29 BEUR, but rail infrastructure costs are not included.
All transport measures except passenger mode-shifts	• Reduces transport final energy use by 11.2% and total fuel expenditures by 272 MEUR. • Decreases natural gas imports by 1.6% and total imports by 5.1%. • Increases electricity generation by 1.1% and increases power plant investment by 126 MEUR. • Decreases GHG emissions by 7.2% (998 kt). • Decreases energy system costs by 2.5 BEUR.
All passenger transport mode-shifts measures	• Reduces transport final energy use by 6.8% and total fuel expenditures by 9.8%. • Decreases natural gas imports by 2.7% and total imports by 5.1%. • Increases electricity generation by 1.1% and power plant investment by 123 MEUR. • Decreases GHG emissions by 3.2% (603 kt). • Decreases energy system costs by 2.1 BEUR, but not all infrastructure costs are included.
All Transport sector measures, except biofuels	• Reduces transport final energy use by 22.4% and total fuel expenditures by 409 MEUR. • Decreases natural gas imports by 4.1% and total imports by 8.2%. • Increases electricity generation by 2.1% and power plant investment by 236 MEUR. • Decreases GHG emissions by 8.3% (1570kt). • Decreases Energy system costs by 4.62 BEUR, but not all infrastructure costs are included.

The metric results for the transport sector are presented in two groups: passenger transport mode shift measures, and all measures except passenger mode shifts. Figure 21 shows the reductions in CO_2, methane and GHG emissions for the passenger transport mode-shift measures, including the combination of these measures. Although each of these measures reduces GHG emissions by less than 1%, the combination of these measures achieves a reduction of 3.2% (603 kt).

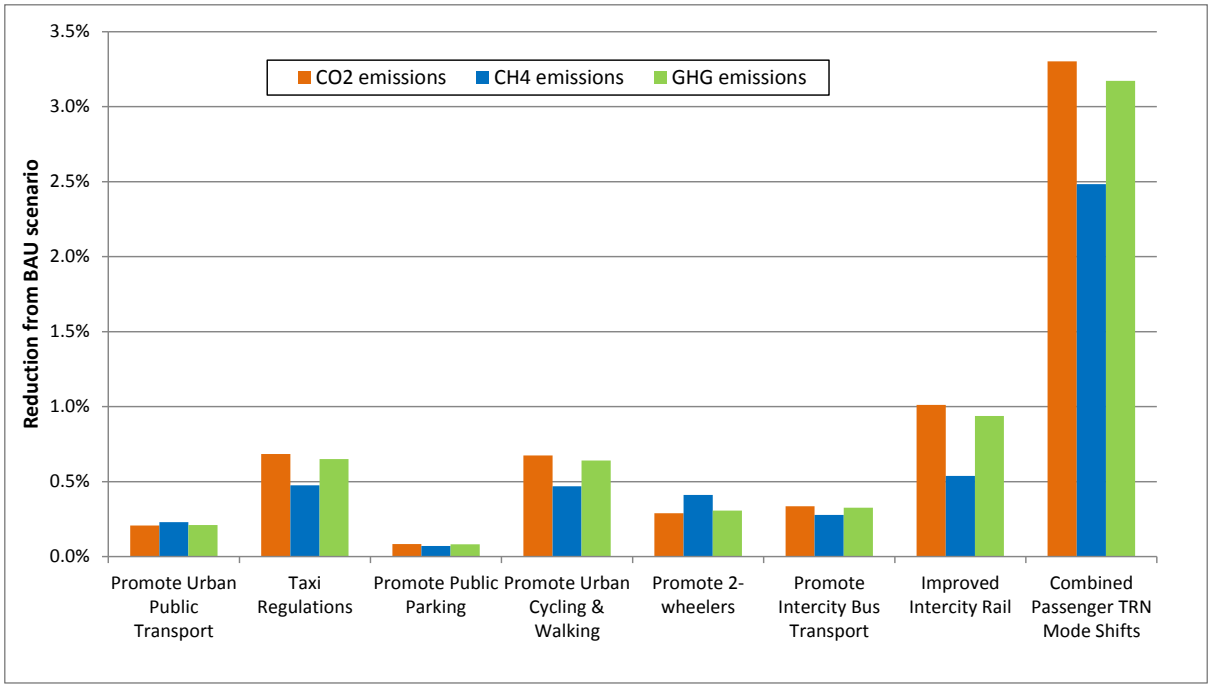

Figure 21: Impact of Passenger Transport mode-shift Measures - Emissions

Figure 22 shows the reductions in primary and final energy use as well as natural gas imports. Each of the measures has an incremental impact that results in a 2.7% reduction in natural gas imports.

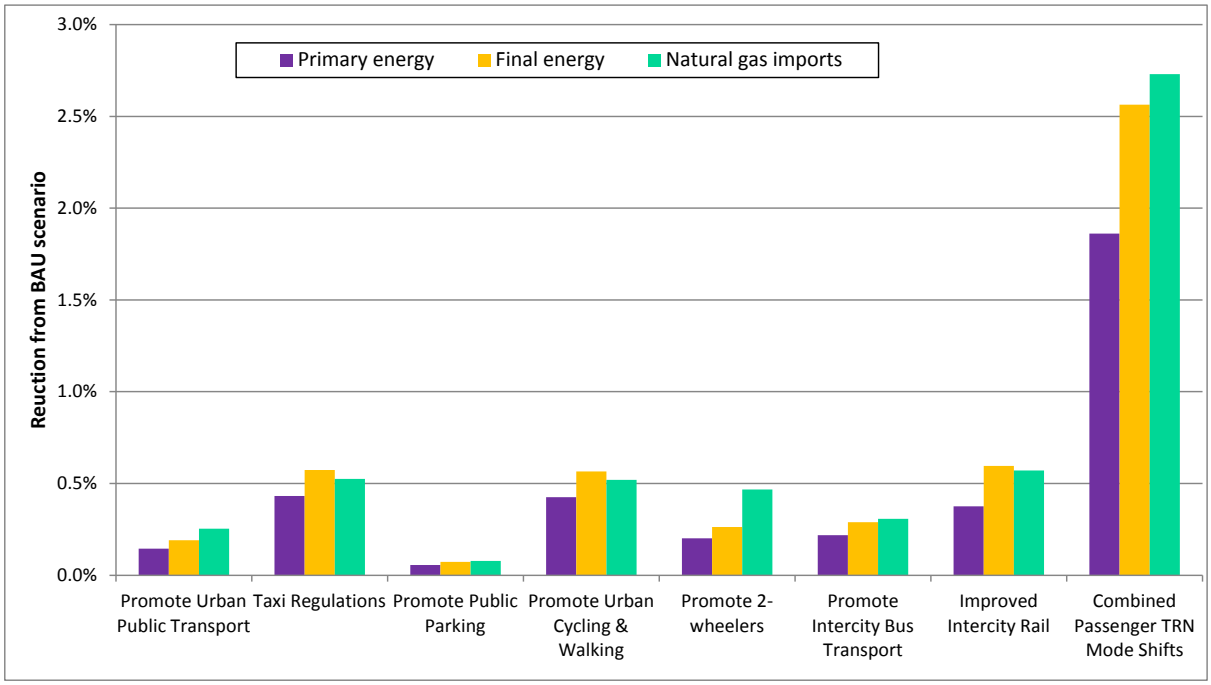

Figure 22: Impact of Passenger Transport mode-shift Measures – Energy

Figure 23 shows the reductions in electricity generation, fuel expenditures and power plant investments for the passenger transport mode-shift measures. All the measures achieve reductions in fuel expenditures, but for the intercity rail measure the fuel savings is offset by increases electricity consumption and power plant investment as intercity rail runs on electricity.

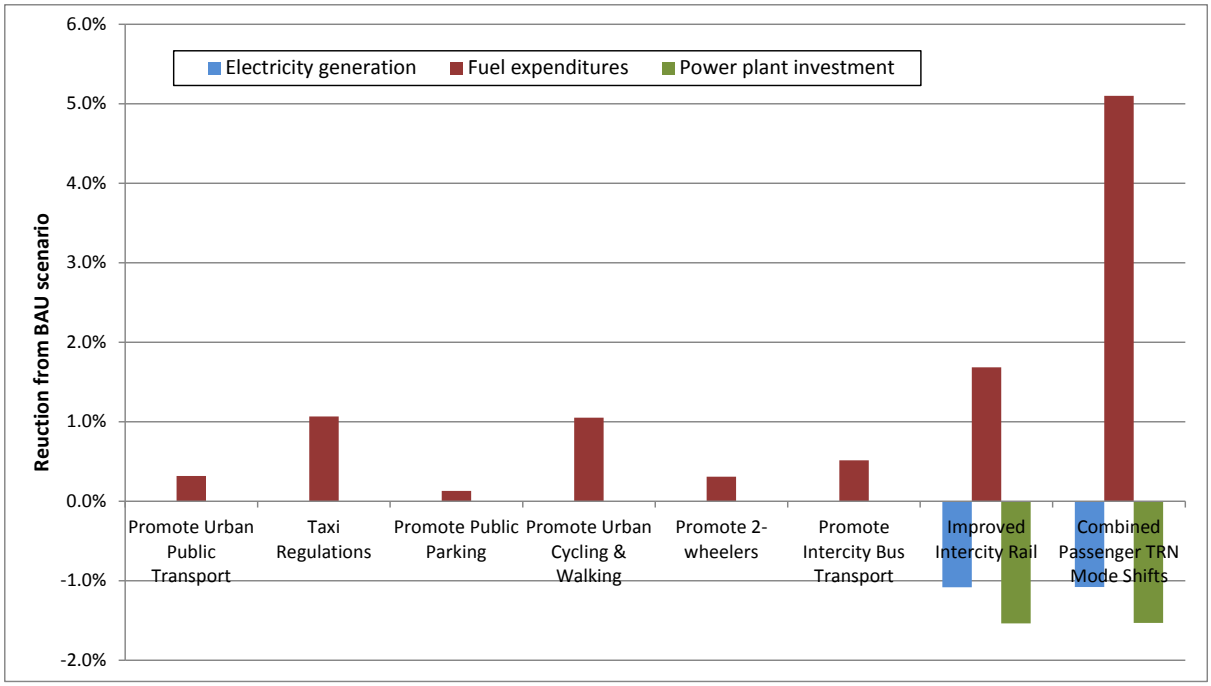

Figure 23: Impact of Passenger Transport mode-shift Measures – Generation and Costs

Shifting to the other transport sector measures (excluding passenger mode-shift measures), Figure 24 shows the reductions in CO2, methane and GHG emissions for these transport vehicle efficiency and freight mode-shift measures. The combination measure for this subset does not include the biofuels measure, and so the freight transport mode-shift and the road transport efficiency measure are the two largest contributors to the 5.2% reduction in GHG emissions (998 Kt). The figure also shows the impact of the combination of all transport sector measures, which achieves an 8.3% reduction in GHG emissions (1.57 Mt).

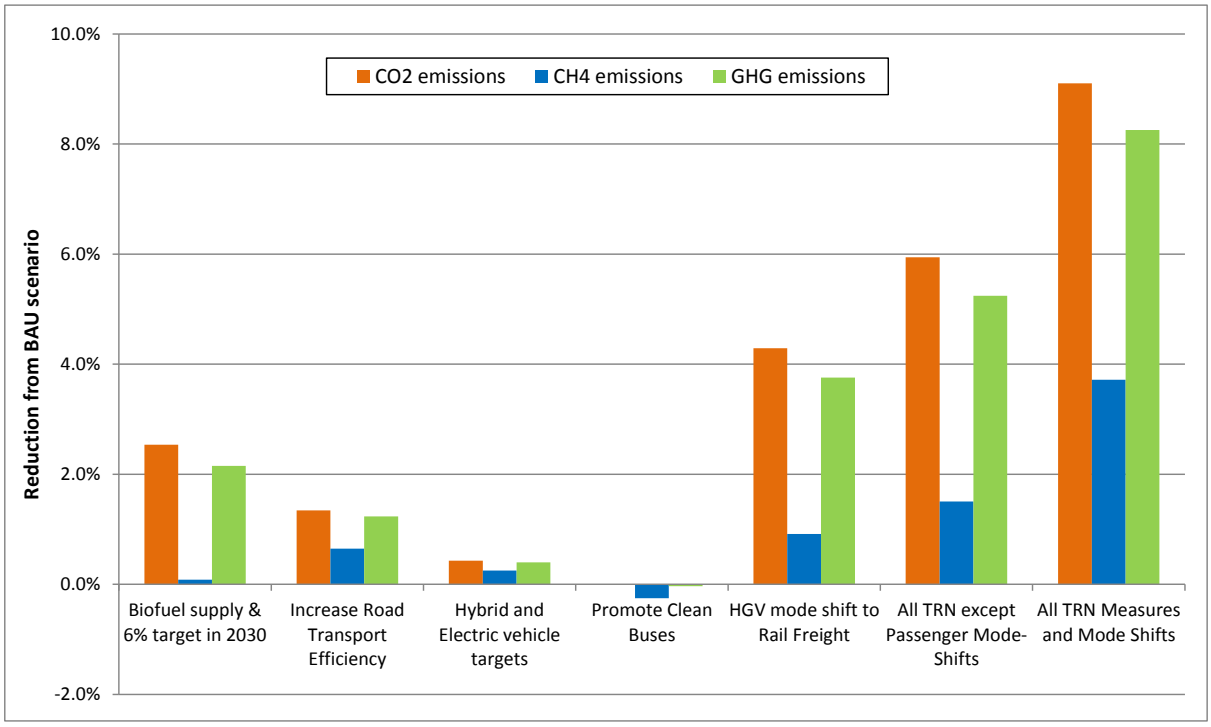

Figure 24: Impact of Other Transport Sector Measures - Emissions

Figure 25 shows the reductions in primary and final energy use and natural gas imports for the same measures. The measure to promote clean bus buses shows an increase in natural gas imports due the increased use of CNG buses. However, the other measures all reduce gas imports, and the combination of all transport measures achieves a 4.1% reduction overall.

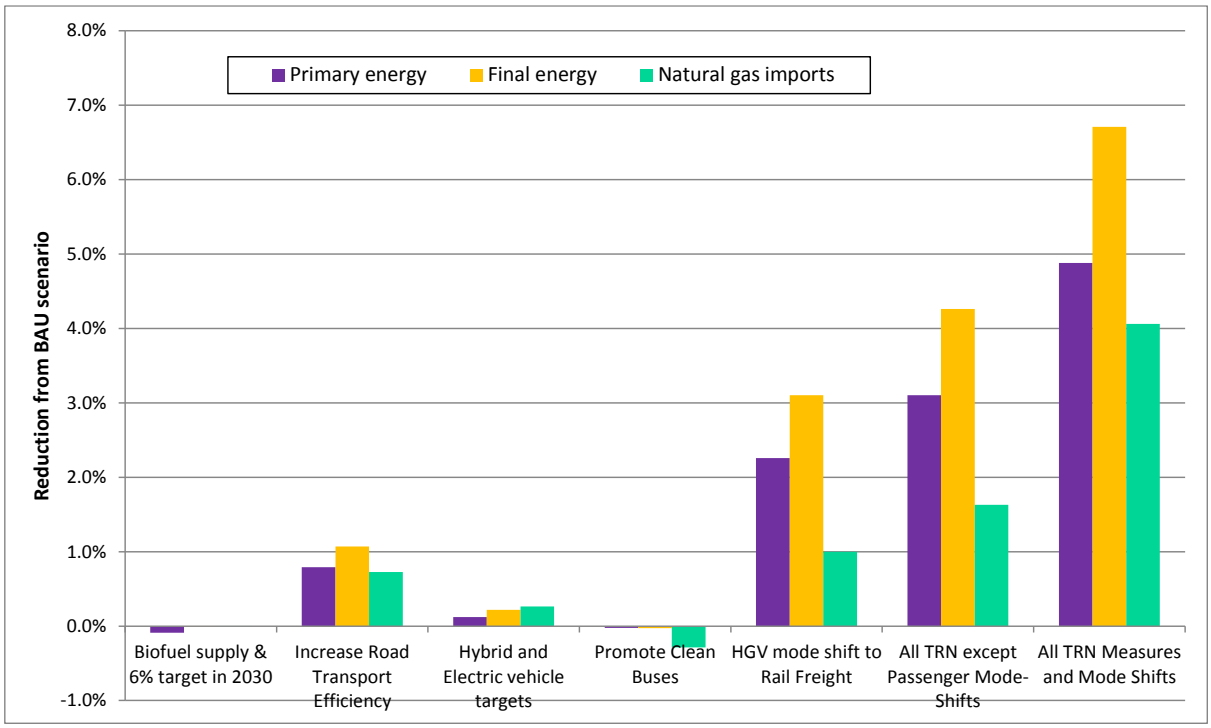

Figure 25: Impact of Other Transport Sector Measures – Energy

Figure 26 shows the reductions in electricity generation, fuel expenditures and power plant investments for the same measures. Many of these measures produce increases in electricity generation and power plant investment, due to shifting from fossil fuels to electricity for electric vehicles (cars and buses) and rail freight measures. This is also true of the two combination measures shown in the figure.

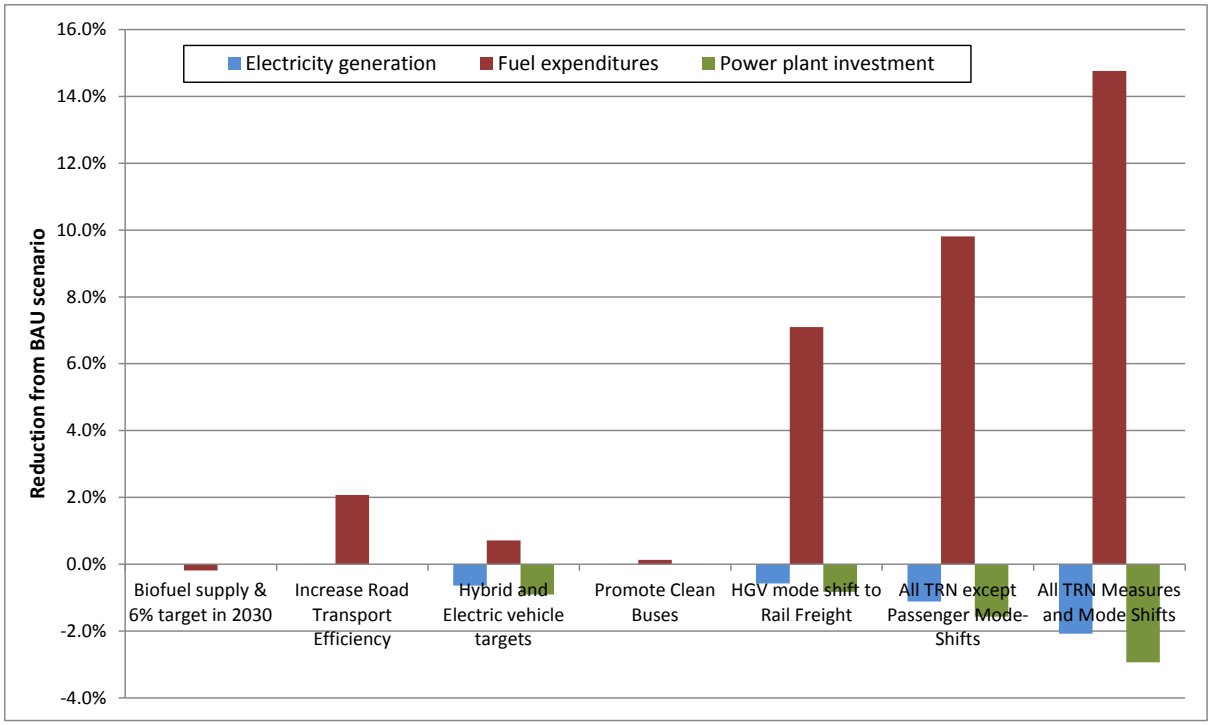

Figure 26: Impact of Other Transport Sector Measures – Generation and Costs

9 All Sectors Combined

Many of the individual LEDS measures have some overlapping or counteracting impacts that are not necessarily additive, and so the MARKAL-Georgia model was used to ensure that the combined impacts of the measures is properly integrated. This section looks at the combination scenarios for each sector and the full set of integrated measures for Georgia.

In addition to the combined set of all LEDS policy measures, a set of the most feasible LEDS policy measures was developed that eliminated measures, which are more difficult to implement, require significant financial support or have large implementation barriers. The measures not included are building efficiency retrofits, and some of the transport mode-shift measures. Details of which specific measures are included in the preferred scenario are provided in Appendix A.6.

Table 10: Summary of Results for Sectoral and All LEDS Measures

Description	Impact in 2030
All supply and power sector measures	• Reduce natural gas imports by 12.7% and lowers GHG emissions by 13.3% (2.54 Mt). • Reduces fuel costs by 104 MEUR and power plant investment increases by 408 MEUR. • Reduces energy system costs by 72 MEUR.
All Buildings (Commercial and Residential) Sector Measures	• Reduces natural gas imports by 9.4%, electricity generation by 8.4% and GHG emissions by 5.6% (1074 kt). • Reduces fuel expenditures by 153 MEUR and power plant investment by 937 MEUR. • Reduces energy system costs by 671 MEUR.
All Industry Sector Measures	• Reduces natural gas imports by 0.9% and electricity generation by1.4%. • Reduces fuel expenditures by 45 MEUR and power plant investment by 165 MEUR. • Reduces CO2 emissions by 4% and GHG emissions by 3.7% (710 kt). • Reduces energy system costs by 224 MEUR.

All Transport Sector Measures and Mode Shifts	• Reduces transport final energy use by 17.7% and total fuel expenditures by 409 MEUR. • Decreases natural gas imports by 4.1%, and total imports by 8.6%. • Increases electricity generation by 2.1% and power plant investment by 236 MEUR. • Decreases GHG emissions by 8.3% (1570 kt). • Decreases energy system costs by 4.62 BEUR, but not all infrastructure costs are included.
All LEDS Measures	• Reduces total final energy use by 15.7% and total fuel expenditures by 705 MEUR. • Decreases natural gas imports by 26%, and total imports by 22%. • Decreases electricity generation by 11% and power plant investment by 450 MEUR. • Decreases GHG emissions by 29.4% (5596 kt). • Decreases energy system costs by 5.6 BEUR, but not all infrastructure costs are included.
Most Feasible LEDS Measures	• Reduces total final energy use by 7.8% and total fuel expenditures by 435 MEUR in 2030. • Decreases natural gas imports by 14.6% and total imports by 13.4%. • Decreases electricity generation by 5.1% and power plant investment by 2.27 BEUR. • Decreases GHG emissions by 21.2% (4036 kt). • Decreases energy system costs by 3.2 BEUR, but not all infrastructure costs are included.

Figure 27 shows the reductions in CO_2, methane and GHG emissions for the set of all combined sector measures. The power sector contributes 45% of all GHG emission reductions in the All LEDS policies run due to the significant methane reduction measure in the gas distribution network. The Feasible LEDS policies case, which includes this measure, still achieves a 21% reduction.

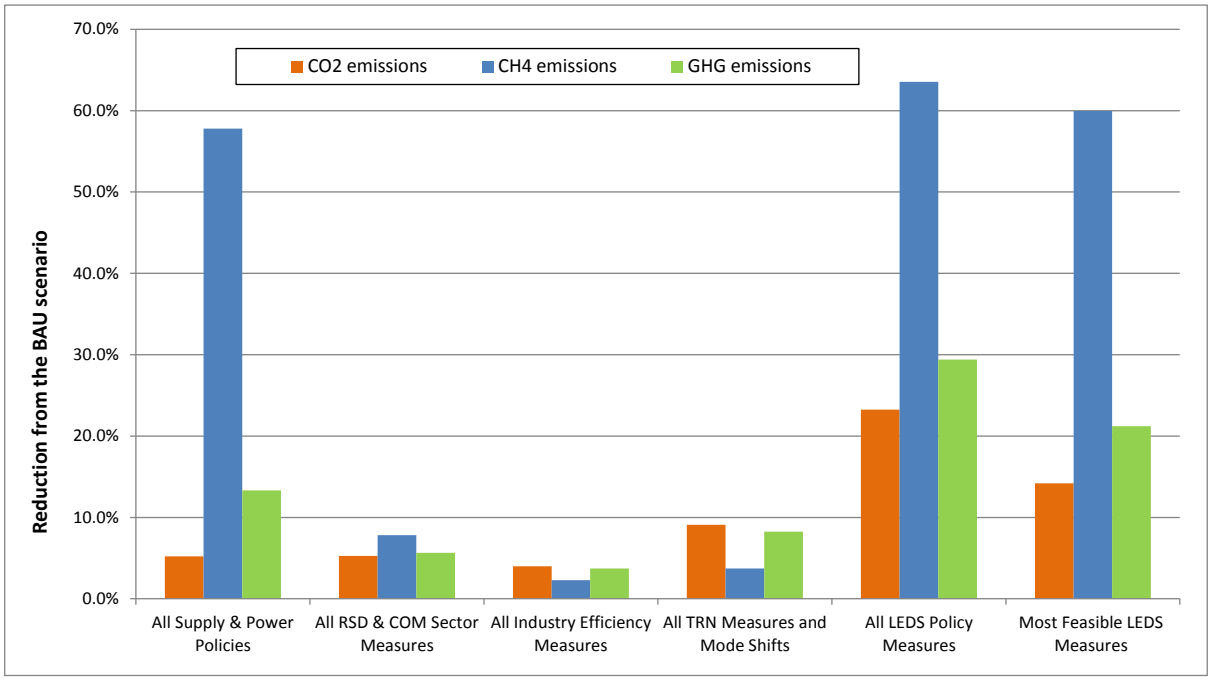

Figure 27: Impact of Sectoral and Combined LEDS Measures – Emissions

Figure 28 shows the changes in primary and final energy use and natural gas imports. The power sector is also the largest contributors to reductions in natural gas imports. The All LEDS policies

case achieves a 26% reduction on gas imports, while the Feasible policies case results in a 15% reduction.

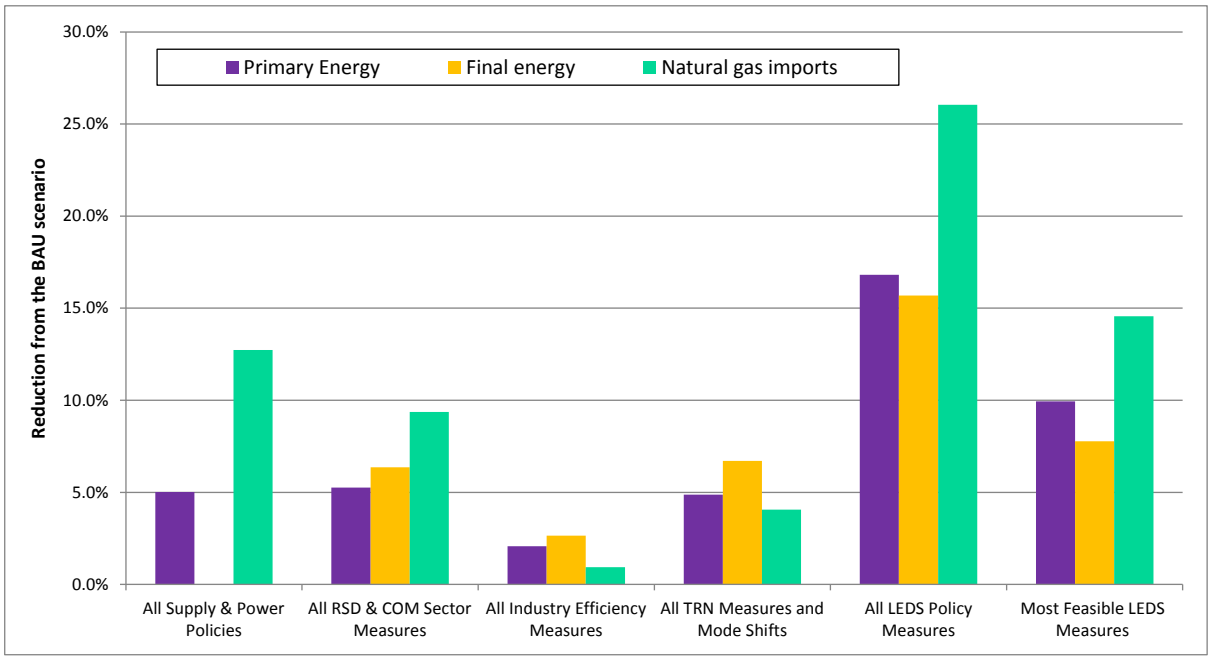

Figure 28: Impact of Sectoral and Combined LEDS Measures – Energy

Figure 29 shows the reductions in electricity generation, fuel expenditures and power plant investments for the combination measures. Note that the power sector and transport sectors have increases in power plant investments, and the transport sector has an increase in electricity generation. However, the All LEDS policies case has reductions in all three metrics. In contrast, the Feasible LEDS policies scenario eliminates several of the building sector measures that reduce electricity demand and counteract the increases in power plant investment. As a result, this scenario achieves only half the electricity generation reductions and results in a slight increase in power plant investment.

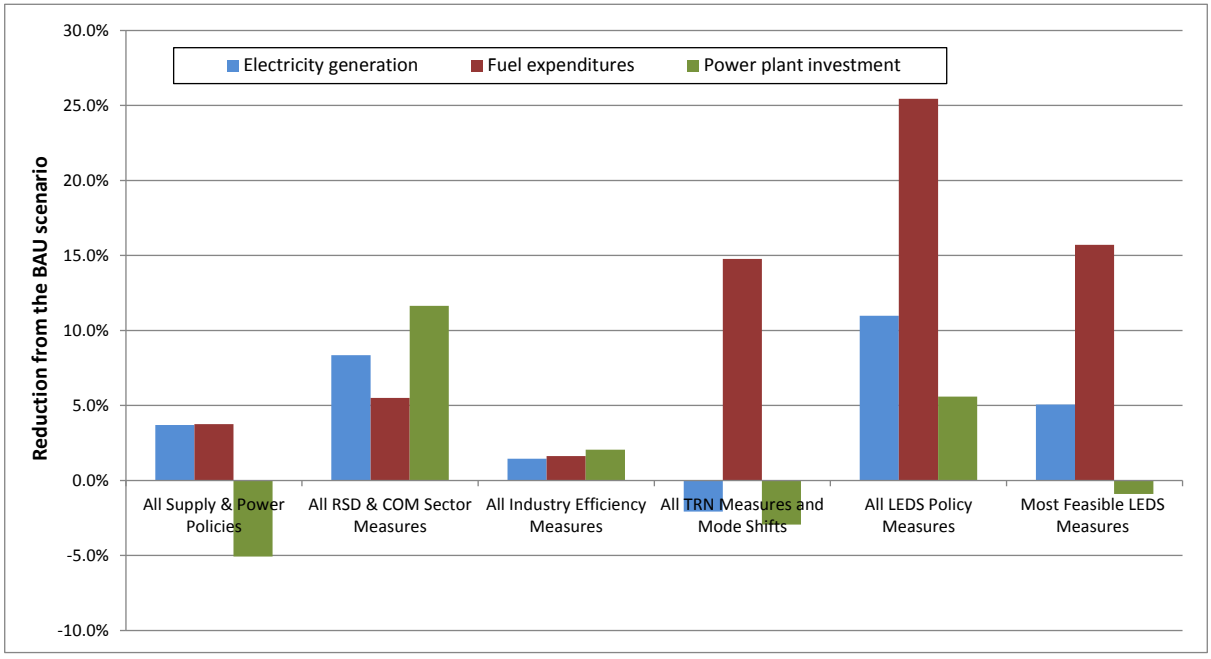

Figure 29: Impact of Sectoral and Combined LEDS Measures – Generation and Costs

Appendix A: Detailed Results of All LEDS Measures

A.1 Supply and Power Sector

Indicator	Units	Reference	Reduced natural gas losses			More Eff Power Plants			Promote HPPs			New Wind Plant			All Supply & Power Policies		
			Absolute value	Difference	Difference (%)	Absolute value	Difference	Difference (%)	Absolute value	Difference	Difference (%)	Absolute value	Difference	Difference (%)	Absolute value	Difference	Difference (%)
Total Discounted Energy System Cost (2014-2030)	2014M€	58,659	58,571	-88	-0.1%	58,649	-10	0.0%	58,661	2	0.0%	58,679	20	0.0%	58,587	-72	-0.1%
Primary Energy Supply -2030	PJ	409	405	-4	-1.0%	402	-7	-1.7%	405	-4	-1.1%	405	-4	-0.9%	389	-21	-5.0%
All Imports -2030	PJ	267	263	-4	-1.6%	260	-7	-2.5%	262	-5	-2.0%	265	-3	-1.0%	248	-19	-7.2%
Natural gas Imports	PJ	152	148	-4	-2.7%	145	-7	-4.5%	147	-5	-3.5%	149	-3	-1.8%	133	-19	-12.7%
Net Electricty Exports	Gwh	-13,529	-13,532	-3	0.0%	-13,532	-3	0.0%	-13,233	296	-2.2%	-13,206	323	-2.4%	-12,370	1,160	-8.6%
Electricity Generation	Gwh	31,380	31,382	2	0.0%	31,383	3	0.0%	31,086	-294	-0.9%	31,056	-324	-1.0%	30,218	-1,162	-3.7%
Fuel Expenditure - 2030	2014M€	2,773	2,737	-36	-1.3%	2,715	-58	-2.1%	2,742	-30	-1.1%	2,766	-6	-0.2%	2,669	-104	-3.8%
Power Plant Capacity -2030	GW	9	9	0	0.0%	9	0	-0.8%	9	0	1.5%	9	0	0.8%	9	0	0.0%
Hydro Power Plant Capacity -2030	GW	8	8	0	0.0%	8	0	0.0%	8	0	1.7%	8	0	-1.0%	8	0	-1.0%
Thermal (gas and coal) Power Plant Capacity-2030	GW	1.08	1.08	0	0.0%	1.01	0	-6.5%	1.08	0	0.0%	1.08	0	0.0%	1.01	0	-6.5%
Renewable Power Plant Capacity-2030	GW	0.02	0.02	0	0.0%	0.02	0	0.0%	0.02	0	0.0%	0.17	0	724.6%	0.17	0	724.6%
Power Plant New Capacity (2014-2030)	GW	5.35	5.35	0	0.0%	5.85	1	9.4%	5.48	0.13	2.5%	5.42	0	1.3%	5.92	1	10.7%
Power Plant Investment Cost (2014-2030)	2014M€	8,049	8,050	1	0.0%	8,407	358	4.4%	8,293	244	3.0%	8,100	50	0.6%	8,457	408	5.1%
Total Final Energy - 2030	PJ	302	302	0	0.0%	302	0	0.0%	302	0	0.0%	302	0	0.0%	302	0	0.0%
Transport Final Energy - 2030	PJ	114	114	0	0.0%	114	0	0.0%	114	0	0.0%	114	0	0.0%	114	0	0.0%
Buildings Sector Final Energy - 2030	PJ	88	88	0	0.0%	88	0	0.0%	88	0	0.0%	88	0	0.0%	88	0	0.0%
Industry Final Energy - 2030	PJ	61	61	0	0.0%	61	0	0.0%	61	0	0.0%	61	0	0.0%	61	0	0.0%
Total CO_2 Emissions - 2030	Kt	15,994	15,995	1	0.0%	15,629	-365	-2.3%	15,605	-389	-2.4%	15,849	-145	-0.9%	15,158	-836	-5.2%
Transport sector CO2 Emissions - 2030	Kt	6,709	6,709	0	0.0%	6,709	0	0.0%	6,709	0	0.0%	6,709	0	0.0%	6,709	0	0.0%
Buildings sector CO2 Emissions - 2030	Kt	2,816	2,817	1	0.0%	2,817	0	0.0%	2,817	0	0.0%	2,817	0	0.0%	2,816	0	0.0%
Industry sector CO2 Emissions - 2030	Kt	3,461	3,461	0	0.0%	3,461	0	0.0%	3,461	0	0.0%	3,461	0	0.0%	3,461	0	0.0%
Power sector CO2 Emissions - 2030	Kt	2,111	2,111	0	0.0%	1,746	-365	-17.3%	1,721	-390	-18.5%	1,965	-145	-6.9%	1,275	-836	-39.6%
Total Methane Emissions -2030	Kt	140	63	-77	-54.9%	135	-5	-3.7%	135	-5	-3.5%	138	-2	-1.5%	59	-81	-57.8%
Total N2O Emissions -2030	Kt	0.33	0.33	0	0.0%	0.32	0	-2.0%	0.32	0	-2.0%	0.33	0	-0.8%	0.31	0	-4.5%
Total GHG emissions	Kt CO2 eq	19,025	17,411	-1,613	-8.5%	18,551	-474	-2.5%	18,533	-492	-2.6%	18,837	-188	-1.0%	16,490	-2,535	-13.3%

A.2 Buildings Sector

Indicator	Units	Reference	INC bulb phase-out			Appliance Labeling			COM Public Building Retrofits			COM Building Retrofits			New RSD & COM Building Codes		
			Absolute value	Difference	Difference (%)	Absolute value	Difference	Difference (%)	Absolute value	Difference	Difference (%)	Absolute value	Difference	Difference (%)	Absolute value	Difference	Difference (%)
Total Discounted Energy System Cost (2014-2030)	2014M€	58 659	57 953	-706	-1.2%	58 573	-85	-0.1%	58 656	-3	0.0%	58 620	-38	-0.1%	58 635	-24	0.0%
Primary Energy Supply -2030	PJ	409	402	-7	-1.7%	406	-3	-0.8%	409	0	-0.1%	408	-1	-0.2%	408	-1	-0.3%
All Imports -2030	PJ	267	265	-2	-0.9%	266	-1	-0.4%	267	0	-0.1%	266	-1	-0.4%	266	-1	-0.5%
Natural gas Imports	PJ	152	150	-2	-1.5%	151	-1	-0.6%	152	0	-0.2%	151	-1	-0.6%	151	-1	-0.7%
Net Electricty Exports	Gwh	-13 529	-13 655	-125	0.9%	-13 509	21	-0.2%	-13 530	-1	0.0%	-13 531	-2	0.0%	-13 529	0	0.0%
Electricity Generation	Gwh	31 380	29 806	-1 574	-5.0%	30 656	-724	-2.3%	31 377	-3	0.0%	31 369	-11	0.0%	31 368	-12	0.0%
Fuel Expenditure - 2030	2014M€	2 773	2 746	-27	-1.0%	2 765	-8	-0.3%	2 770	-3	-0.1%	2 764	-9	-0.3%	2 759	-13	-0.5%
Power Plant Capacity -2030	GW	9	8	0	-3.4%	9	0	-1.6%	9	0	0.0%	9	0	0.0%	9	0	0.0%
Hydro Power Plant Capacity -2030	GW	8	7	0	-3.9%	8	0	-1.8%	8	0	0.0%	8	0	0.0%	8	0	0.0%
Thermal (gas and coal) Power Plant Capacity-2030	GW	1.08	1.08	0	0.0%	1.08	0	0.0%	1.08	0	0.0%	1.08	0	0.0%	1.08	0	0.0%
Renewable Power Plant Capacity-2030	GW	0.02	0.02	0	0.0%	0.02	0	0.0%	0.02	0	0.0%	0.02	0	0.0%	0.02	0	0.0%
Power Plant New Capacity (2014-2030)	GW	5.35	5.05	0	-5.6%	5.21	0	-2.7%	5.35	0	0.0%	5.35	0	0.0%	5.35	0	0.0%
Power Plant Investment Cost (2014-2030)	2014M€	8 049.24	7 488.87	-560	-7.0%	7 785.01	-264	-3.3%	8 048.06	-1	0.0%	8 045.41	Plot Area	0.0%	8 044.84	-4	-0.1%
Total Final Energy - 2030	PJ	302	296	-6	-1.9%	299	-2	-0.8%	301	0	-0.1%	301	-1	-0.3%	300	-1	-0.4%
Transport Final Energy - 2030	PJ	114	114	0	0.0%	114	0	0.0%	114	0	0.0%	114	0	0.0%	114	0	0.0%
Buildings Sector Final Energy - 2030	PJ	118	112	-6	-4.9%	115	-2	-2.0%	117	0	-0.2%	117	-1	-0.8%	116	-1	-1.1%
Industry Final Energy - 2030	PJ	61	61	0	0.0%	61	0	0.0%	61	0	0.0%	61	0	0.0%	61	0	0.0%
Total CO_2 Emissions - 2030	Kt	15 994	15 870	-124	-0.8%	15 943	-51	-0.3%	15 978	-16	-0.1%	15 942	-52	-0.3%	15 920	-74	-0.5%
Transport sector CO2 Emissions - 2030	Kt	6 709	6 709	0	0.0%	6 709	0	0.0%	6 709	0	0.0%	6 709	0	0.0%	6 709	0	0.0%
Buildings sector CO2 Emissions - 2030	Kt	3 671	3 671	0	0.0%	3 672	1	0.0%	3 655	-15.85	-0.4%	3 620	-51	-1.4%	3 597	-74	-2.0%
Industry sector CO2 Emissions - 2030	Kt	3 461	3 461	0	0.0%	3 461	0	0.0%	3 461	0	0.0%	3 461	0	0.0%	3 461	0	0.0%
Power sector CO2 Emissions - 2030	Kt	2 111	1 986	-124	-5.9%	2 059	-51	-2.4%	2 110	0	0.0%	2 110	-1	0.0%	2 110	-1	0.0%
Total Methane Emissions -2030	Kt	140	138	-2	-1.2%	139	-1	-0.5%	140	-0.22	-0.2%	139	-1	-0.5%	139	-1	-0.6%
Total N2O Emissions -2030	Kt	0.33	0.33	0	-0.7%	0.33	0	-0.3%	0.33	0	-0.1%	0.33	0	-0.3%	0.33	0	-0.4%
Total GHG emissions	Kt CO2 eq	19 025	18 864	-160	-0.8%	18 959	-66	-0.3%	19 004	-21	-0.1%	18 957	-68	-0.4%	18 932	-93	-0.5%

Indicator	Units	Reference	RSD Building NAMA			NAMA - ADV biomass heating stoves			NAMA - RSD solar water heating			COM Solar Water Heating			LED Public Lighting		
			Absolute value	Difference	Difference (%)	Absolute value	Difference	Difference (%)	Absolute value	Difference	Difference (%)	Absolute value	Difference	Difference (%)	Absolute value	Difference	Difference (%)
Total Discounted Energy System Cost (2014-2030)	2014M€	58 659	58 816	157	0.3%	58 736	77	0.1%	58 669	10	0.0%	58 627	-32	-0.1%	58 632	-27	0.0%
Primary Energy Supply -2030	PJ	409	401	-8	-1.9%	409	-1	-0.1%	409	0	0.0%	409	0	0.0%	409	-1	-0.1%
All Imports -2030	PJ	267	259	-8	-2.9%	267	-1	-0.2%	267	-1	-0.2%	267	0	-0.1%	267	0	-0.1%
Natural gas Imports	PJ	152	146	-6	-4.1%	152	0	-0.2%	152	0	-0.2%	152	0	-0.2%	152	0	-0.1%
Net Electricty Exports	Gwh	-13 529	-13 555	-26	0.2%	-13 522	8	-0.1%	-13 520	10	-0.1%	-13 538	-9	0.1%	-13 509	21	-0.2%
Electricity Generation	Gwh	31 380	31 361	-19	-0.1%	31 370	-10	0.0%	31 422	42	0.1%	31 162	-218	-0.7%	31 260	-120	-0.4%
Fuel Expenditure - 2030	2014M€	2 773	2 690	-83	-3.0%	2 767	-6	-0.2%	2 766	-7	-0.3%	2 769	-3	-0.1%	2 772	0	0.0%
Power Plant Capacity -2030	GW	9	9	0	0.0%	9	0	0.0%	9	0	0.1%	9	0	-0.5%	9	0	-0.3%
Hydro Power Plant Capacity -2030	GW	8	8	0	0.0%	8	0	0.0%	8	0	0.1%	8	0	-0.5%	8	0	-0.3%
Thermal (gas and coal) Power Plant Capacity-2030	GW	1.08	1.08	0	0.0%	1.08	0	0.0%	1.08	0	0.0%	1.08	0	0.0%	1.08	0	0.0%
Renewable Power Plant Capacity-2030	GW	0.02	0.02	0	0.0%	0.02	0	0.0%	0.02	0	0.0%	0.02	0	0.0%	0.02	0	0.0%
Power Plant New Capacity (2014-2030)	GW	5.35	5.35	0	0.0%	5.35	0	0.0%	5.36	0	0.1%	5.31	0	-0.8%	5.32	0	-0.5%
Power Plant Investment Cost (2014-2030)	2014M€	8 049.24	8 044.64	-5	-0.1%	8 044.93	-4	-0.1%	8 063.56	14	0.2%	7 971.03	-78	-1.0%	8 003.97	-45	-0.6%
Total Final Energy - 2030	PJ	302	294	-8	-2.5%	301	-1	-0.2%	302	0	0.0%	302	0	0.0%	301	0	-0.1%
Transport Final Energy - 2030	PJ	114	114	0	0.0%	114	0	0.0%	114	0	0.0%	114	0	0.0%	114	0	0.0%
Buildings Sector Final Energy - 2030	PJ	118	110	-8	-6.5%	117	-1	-0.4%	118	0	0.1%	118	0	0.0%	117	0	-0.3%
Industry Final Energy - 2030	PJ	61	61	0	0.0%	61	0	0.0%	61	0	0.0%	61	0	0.0%	61	0	0.0%
Total CO_2 Emissions - 2030	Kt	15 994	15 559	-435	-2.7%	15 965	-29	-0.2%	15 962	-32	-0.2%	15 978	-16	-0.1%	15 987	-7	0.0%
Transport sector CO2 Emissions - 2030	Kt	6 709	6 709	0	0.0%	6 709	0	0.0%	6 709	0	0.0%	6 709	0	0.0%	6 709	0	0.0%
Buildings sector CO2 Emissions - 2030	Kt	3 671	3 240	-431	-11.8%	3 642	-29	-0.8%	3 635	-36	-1.0%	3 672	1	0.0%	3 671	0	0.0%
Industry sector CO2 Emissions - 2030	Kt	3 461	3 461	0	0.0%	3 461	0	0.0%	3 461	0	0.0%	3 461	0	0.0%	3 461	0	0.0%
Power sector CO2 Emissions - 2030	Kt	2 111	2 107	-3	-0.2%	2 110	0	0.0%	2 114	4	0.2%	2 094	-17	-0.8%	2 103	-7	-0.3%
Total Methane Emissions -2030	Kt	140	135	-5	-3.4%	140	0	-0.2%	140	0	-0.1%	140	0	-0.2%	140	0	-0.1%
Total N2O Emissions -2030	Kt	0.33	0.32	0	-2.1%	0.33	0	-0.1%	0.33	0	-0.1%	0.33	0	-0.1%	0.33	0	0.0%
Total GHG emissions	Kt CO2 eq	19 025	18 488	-537	-2.8%	18 991	-34	-0.2%	18 989	-36	-0.2%	19 004	-20	-0.1%	19 015	-9	0.0%

Indicator	Units	Reference	Renewables, Appliance & Lighting Eff			All RSD & COM Building Retrofits			All RSD & COM Sector Measures		
			Absolute value	Difference	Difference (%)	Absolute value	Difference	Difference (%)	Absolute value	Difference	Difference (%)
Total Discounted Energy System Cost (2014-2030)	2014M€	58 659	57 898	-761	-1.3%	58 742	83	0.1%	57 988	-671	-1.1%
Primary Energy Supply -2030	PJ	409	398	-11	-2.7%	398	-11	-2.6%	388	-22	-5.3%
All Imports -2030	PJ	267	262	-5	-1.8%	257	-11	-4.0%	252	-15	-5.8%
Natural gas Imports	PJ	152	147	-4	-3.0%	143	-9	-5.8%	138	-14	-9.4%
Net Electricty Exports	Gwh	-13 529	-13 632	-103	0.8%	-13 560	-31	0.2%	-13 696	-167	1.2%
Electricity Generation	Gwh	31 380	28 807	-2 573	-8.2%	31 339	-41	-0.1%	28 758	-2 622	-8.4%
Fuel Expenditure - 2030	2014M€	2 773	2 721	-51	-1.9%	2 666	-107	-3.9%	2 620	-153	-5.5%
Power Plant Capacity -2030	GW	9	8	0	-5.7%	9	0	-0.1%	8	-1	-5.7%
Hydro Power Plant Capacity -2030	GW	8	7	0	-6.5%	8	0	-0.1%	7	-1	-6.6%
Thermal (gas and coal) Power Plant Capacity-2030	GW	1.08	1.08	0	0.0%	1.08	0	0.0%	1.08	0	0.0%
Renewable Power Plant Capacity-2030	GW	0.02	0.02	0	0.0%	0.02	0	0.0%	0.02	0	0.0%
Power Plant New Capacity (2014-2030)	GW	5.35	4.85	0	-9.3%	5.34	0	-0.1%	4.85	-0.50	-9.4%
Power Plant Investment Cost (2014-2030)	2014M€	8 049.24	7 124.68	-925	-11.5%	8 036.90	-12	-0.2%	7 112.31	-937	-11.6%
Total Final Energy - 2030	PJ	302	293	-9	-3.0%	291	-10	-3.4%	283	-19	-6.4%
Transport Final Energy - 2030	PJ	114	114	0	0.0%	114	0	0.0%	114	0	0.0%
Buildings Sector Final Energy - 2030	PJ	118	109	-9	-7.6%	107	-10	-8.8%	98	-19	-16.3%
Industry Final Energy - 2030	PJ	61	61	0	0.0%	61	0	0.0%	61	0	0.0%
Total CO_2 Emissions - 2030	Kt	15 994	15 730	-264	-1.7%	15 411	-583	-3.6%	15 153	-841	-5.3%
Transport sector CO2 Emissions - 2030	Kt	6 709	6 709	0	0.0%	6 709	0	0.0%	6 709	0	0.0%
Buildings sector CO2 Emissions - 2030	Kt	3 671	3 602	-69	-1.9%	3 093	-578	-15.7%	3 035	-636	-17.3%
Industry sector CO2 Emissions - 2030	Kt	3 461	3 461	0	0.0%	3 461	0	0.0%	3 460	-1	0.0%
Power sector CO2 Emissions - 2030	Kt	2 111	1 915	-196	-9.3%	2 105	-5	-0.3%	1 907	-204	-9.7%
Total Methane Emissions -2030	Kt	140	137	-3	-2.5%	133	-7	-4.9%	129	-11	-7.8%
Total N2O Emissions -2030	Kt	0.33	0.33	0	-1.4%	0.32	0	-2.9%	0.32	0	-4.3%
Total GHG emissions	Kt CO2 eq	19 025	18 688	-337	-1.8%	18 295	-730	-3.8%	17 951	-1 074	-5.6%

A.3 Industry Sector

Indicator	Units	Reference	Chemical - All Efficicncy measures in Rustavi Azoti			Cement - Heat Recycling Imp			Cement - Wet-to-Dry Process			Food - Advanced Process heat		
			Absolute value	Difference	Difference (%)	Absolute value	Difference	Difference (%)	Absolute value	Difference	Difference (%)	Absolute value	Difference	Difference (%)
Total Discounted Energy System Cost (2014-2030)	2014M€	58,659	58,583	-76	-0.1%	58,659	-0.325	0.00%	58,525	-134	-0.2%	58,654	-5	0.0%
Primary Energy Supply -2030	PJ	409	408	-1	-0.3%	409	-0.005	0.00%	405	-4	-1.0%	409	0	-0.1%
All Imports -2030	PJ	267	267	-1	-0.3%	267	-0.005	0.00%	266	-2	-0.6%	267	0	-0.1%
Natural gas Imports	PJ	152	151	-1	-0.4%	152	-0.005	-0.00349%	152	0	0.0%	151	0	-0.3%
Net Electricty Exports	Gwh	-13,529	-13,538	-8	0.1%	-13,529	0.000	0.0%	-13,530	0	0.0%	-13,529	0	0.0%
Electricity Generation	Gwh	31,380	31,208	-172	-0.5%	31,380	0.028	0.0%	31,380	0	0.0%	31,378	-2	0.0%
Fuel Expenditure - 2030	2014M€	2,773	2,766	-6	-0.2%	2,773	-0.045	0.0%	2,752	-21	-0.8%	2,769	-3	-0.1%
Power Plant Capacity -2030	GW	9	9	0	-0.4%	9	0.000	0.0%	9	0	0.0%	9	0	0.0%
Hydro Power Plant Capacity -2030	GW	8	8	0	-0.4%	8	0.000	0.0%	8	0	0.0%	8	0	0.0%
Thermal (gas and coal) Power Plant Capacity-2030	GW	1.08	1.08	0	0.0%	1.08	0.000	0.0%	1.08	0	0.0%	1.08	0	0.0%
Renewable Power Plant Capacity-2030	GW	0.02	0.02	0	0.0%	0.02	0.000	0.0%	0.02	0	0.0%	0.02	0	0.0%
Power Plant New Capacity (2014-2030)	GW	5.35	5.32	0	-0.6%	5.35	0.000	0.0%	5.35	0	0.0%	5.35	0	0.0%
Power Plant Investment Cost (2014-2030)	2014M€	8,049.24	7,987.45	-62	-0.8%	8,049.24	0.000	0.0%	8,049.24	0	0.0%	8,048.48	-1	0.0%
Total Final Energy - 2030	PJ	302	301	-1	-0.3%	302	-0.005	0.0%	297	-4	-1.4%	301	0	-0.1%
Transport Final Energy - 2030	PJ	114	114	0	0.0%	114	0.000	0.0%	114	0	0.0%	114	0	0.0%
Buildings Sector Final Energy - 2030	PJ	88	88	0	0.0%	88	0.000	0.0%	88	0	0.0%	88	0	0.0%
Industry Final Energy - 2030	PJ	61	60	-1	-1.7%	61	-0.005	-0.008%	57	-4	-6.9%	61	0	-0.7%
Total CO_2 Emissions - 2030	Kt	15,994	15,957	-37	-0.2%	15,994	-0.285	0.00%	15,581	-413	-2.6%	15,970	-24	-0.1%
Transport sector CO2 Emissions - 2030	Kt	6,709	6,709	0	0.0%	6,709	0.000	0.00%	6,709	0	0.0%	6,709	0	0.0%
Buildings sector CO2 Emissions - 2030	Kt	2,816	2,817	1	0.0%	2,816	0.000	0.00%	2,816	0	0.0%	2,816	0	0.0%
Industry sector CO2 Emissions - 2030	Kt	3,461	3,437	-24	-0.7%	3,461	-0.285	-0.01%	3,049	-413	-11.9%	3,438	-23	-0.7%
Power sector CO2 Emissions - 2030	Kt	2,111	2,097	-13	-0.6%	2,111	0.000	0.00%	2,111	0	0.0%	2,111	0	0.0%
Total Methane Emissions -2030	Kt	140	139	-1	-0.4%	140	-0.004	0.00%	138	-2	-1.5%	140	0	-0.2%
Total N2O Emissions -2030	Kt	0.33	0.33	0	-0.2%	0.33	0.000	0.00%	0.32	0	-1.8%	0.33	0	-0.1%
Total GHG emissions	Kt CO2 eq	19,025	18,977	-48	-0.3%	19,024	-0.373	-0.002%	18,567	-458	-2.4%	18,994	-30	-0.2%

Indicator	Units	Reference	Iron&Steel - Ferroalloy Intensity Imp			Iron&Steel - Automated Controls			Pig Iron Industry - 2020			All Industry Advanced Motor Drive Measures			All Industry Efficiency Measures		
			Absolute value	Difference	Difference (%)	Absolute value	Difference	Difference (%)	Absolute value	Difference	Difference (%)	Absolute value	Difference	Difference (%)	Absolute value	Difference	Difference (%)
Total Discounted Energy System Cost (2014-2030)	2014M€	58,659	58,585	-74	-0.1%	58,657	-2.1	0.00%	59,209	551	0.9%	58,700	41	0.1%	58,415	-244	-0.4%
Primary Energy Supply -2030	PJ	409	407	-2	-0.4%	409	-0.1	-0.02%	418	9	2.1%	408	-1	-0.2%	401	-8	-2.1%
All Imports -2030	PJ	267	266	-1	-0.5%	267	0.0	-0.01%	276	9	3.3%	267	0	-0.1%	263	-4	-1.7%
Natural gas Imports	PJ	152	152	0	-0.1%	152	0.0	0.00%	152	0	0.0%	152	0	-0.1%	150	-1	-0.9%
Net Electricty Exports	Gwh	-13,529	-13,533	-4	0.0%	-13,530	0.0	0.00%	-13,530	0	0.0%	-13,525	5	0.0%	-13,524	5	0.0%
Electricity Generation	Gwh	31,380	31,260	-120	-0.4%	31,380	0.0	0.00%	31,380	0	0.0%	31,221	-159	-0.5%	30,926	-454	-1.4%
Fuel Expenditure - 2030	2014M€	2,773	2,760	-13	-0.5%	2,772	-0.5	-0.02%	2,851	78	2.8%	2,771	-2	-0.1%	2,727	-45	-1.6%
Power Plant Capacity -2030	GW	9	9	0	-0.3%	9	0.0	0.00%	9	0	0.0%	9	0	-0.4%	9	0	-1.0%
Hydro Power Plant Capacity -2030	GW	8	8	0	-0.3%	8	0.0	0.00%	8	0	0.0%	8	0	-0.4%	8	0	-1.2%
Thermal (gas and coal) Power Plant Capacity-2030	GW	1.08	1.08	0	0.0%	1.08	0.0	0.00%	1.08	0	0.0%	1.08	0	0.0%	1.08	0	0.0%
Renewable Power Plant Capacity-2030	GW	0.02	0.02	0	0.0%	0.02	0.0	0.00%	0.02	0	0.0%	0.02	0	0.0%	0.02	0	0.0%
Power Plant New Capacity (2014-2030)	GW	5.35	5.33	0	-0.4%	5.35	0.0	0.00%	5.35	0	0.0%	5.32	0	-0.6%	5.26	0	-1.7%
Power Plant Investment Cost (2014-2030)	2014M€	8,049.24	8,005.92	-43	-0.5%	8,049.24	0.0	0.00%	8,049.24	0	0.0%	7,991.34	-58	-0.7%	7,884.28	-165	-2.0%
Total Final Energy - 2030	PJ	302	300	-2	-0.6%	302	-0.1	-0.03%	311	9	2.9%	301	-1	-0.2%	294	-8	-2.7%
Transport Final Energy - 2030	PJ	114	114	0	0.0%	114	0.0	0.00%	114	0	0.0%	114	0	0.0%	114	0	0.0%
Buildings Sector Final Energy - 2030	PJ	88	88	0	0.0%	88	0.0	0.00%	88	0	0.0%	88	0	0.0%	88	0	0.0%
Industry Final Energy - 2030	PJ	61	60	-2	-2.8%	61	-0.1	-0.17%	70	9	14.3%	61	-1	-0.8%	53	-8	-13.0%
Total CO_2 Emissions - 2030	Kt	15,994	15,848	-146	-0.9%	15,984	-9.9	-0.06%	16,926	932	5.8%	15,983	-11	-0.1%	15,354	-640	-4.0%
Transport sector CO2 Emissions - 2030	Kt	6,709	6,709	0	0.0%	6,709	0.0	0.00%	6,709	0	0.0%	6,709	0	0.0%	6,709	0	0.0%
Buildings sector CO2 Emissions - 2030	Kt	2,816	2,816	0	0.0%	2,816	0.0	0.00%	2,816	0	0.0%	2,817	1	0.0%	2,817	1	0.0%
Industry sector CO2 Emissions - 2030	Kt	3,461	3,324	-137	-4.0%	3,451	-9.9	-0.29%	4,393	932	26.9%	3,461	0	0.0%	2,854	-608	-17.6%
Power sector CO2 Emissions - 2030	Kt	2,111	2,102	-9	-0.4%	2,111	0.0	0.00%	2,111	0	0.0%	2,099	-11	-0.5%	2,078	-33	-1.6%
Total Methane Emissions -2030	Kt	140	140	0	-0.1%	140	0.0	-0.04%	140	0	0.0%	140	0	-0.1%	137	-3	-2.3%
Total N2O Emissions -2030	Kt	0.33	0.33	0	-0.6%	0.33	0.0	-0.03%	0.34	0	3.7%	0.33	0	-0.1%	0.32	0	-2.9%
Total GHG emissions	Kt CO2 eq	19,025	18,875	-149	-0.8%	19,014	-10.94	-0.06%	19,961	936	4.9%	19,011	-13	-0.1%	18,315	-710	-3.7%

A.4 Transport Sector

Indicator	Units	Reference	Biofuel supply & 6% target in 2030			Increase Road Transport Efficiency			Hybrid and Electric vehicle targets			Promote Clean Buses			HGV mode shift to Rail Freight		
			Absolute value	Difference	Difference (%)	Absolute value	Difference	Difference (%)	Absolute value	Difference	Difference (%)	Absolute value	Difference	Difference (%)	Absolute value	Difference	Difference (%)
Total Discounted Energy System Cost (2014-2030)	2014M€	58,659	58,691	32	0.1%	58,235	-424	-0.7%	58,830	171	0.3%	58,654	-4	0.0%	56,374	-2,285	-3.9%
Primary Energy Supply -2030	PJ	409	409	0	0.1%	406	-3	-0.8%	409	0	-0.1%	409	0	0.0%	400	-9	-2.3%
All Imports -2030	PJ	267	267	-1	-0.2%	264	-3	-1.2%	266	-1	-0.4%	267	0	0.0%	258	-10	-3.7%
Natural gas Imports	PJ	152	152	0	0.0%	151	-1	-0.7%	151	0	-0.3%	152	0	0.3%	150	-2	-1.0%
Net Electricty Exports	Gwh	-13,529	-13,530	0	0.0%	-13,545	-16	0.1%	-13,534	-4	0.0%	-13,530	0	0.0%	-13,546	-16	0.1%
Electricity Generation	Gwh	31,380	31,380	0	0.0%	31,376	-4	0.0%	31,581	201	0.6%	31,378	-2	0.0%	31,559	179	0.6%
Fuel Expenditure - 2030	2014M€	2,773	2,778	5	0.2%	2,715	-58	-2.1%	2,753	-20	-0.7%	2,769	-4	-0.1%	2,576	-197	-7.1%
Power Plant Capacity -2030	GW	9	9	0	0.0%	9	0	0.0%	9	0	0.4%	9	0	0.0%	9	0	0.4%
Hydro Power Plant Capacity -2030	GW	8	8	0	0.0%	8	0	0.0%	8	0	0.5%	8	0	0.0%	8	0	0.5%
Thermal (gas and coal) Power Plant Capacity-2030	GW	1.08	1.08	0	0.0%	1.08	0	0.0%	1.08	0	0.0%	1.08	0	0.0%	1.08	0	0.0%
Renewable Power Plant Capacity-2030	GW	0.02	0.02	0	0.0%	0.02	0	0.0%	0.02	0	0.0%	0.02	0	0.0%	0.02	0	0.0%
Power Plant New Capacity (2014-2030)	GW	5.35	5.35	0	0.0%	5.35	0	0.0%	5.39	0	0.7%	5.35	0	0.0%	5.39	0	0.7%
Power Plant Investment Cost (2014-2030)	2014M€	8,049	8,049	0	0.0%	8,049	0	0.0%	8,122	73	0.9%	8,048	-1	0.0%	8,116	66	0.8%
Total Final Energy - 2030	PJ	302	302	0	0.0%	299	-3	-1.1%	301	-1	-0.2%	302	0	0.0%	292	-9	-3.1%
Transport Final Energy - 2030	PJ	114	114	0	0.0%	111	-3	-2.8%	114	-1	-0.6%	114	0	0.1%	105	-9	-8.2%
Buildings Sector Final Energy - 2030	PJ	88	88	0	0.0%	88	0	0.0%	88	0	0.0%	88	0	0.0%	88	0	0.0%
Industry Final Energy - 2030	PJ	61	61	0	0.0%	61	0	0.0%	61	0	0.0%	61	0	0.0%	61	0	0.0%
Total CO_2 Emissions - 2030	Kt	15,994	15,588	-406	-2.5%	15,779	-215	-1.3%	15,925	-69	-0.4%	15,993	-1	0.0%	15,308	-686	-4.3%
Transport sector CO2 Emissions - 2030	Kt	6,709	6,303	-406	-6.1%	6,495	-214	-3.2%	6,626	-83	-1.2%	6,708	-0.692	0.0%	6,011	-698	-10.4%
Buildings sector CO2 Emissions - 2030	Kt	2,816	2,816	0	0.0%	2,816	0	0.0%	2,816	0	0.0%	2,816	0	0.0%	2,816	0	0.0%
Industry sector CO2 Emissions - 2030	Kt	3,461	3,461	0	0.0%	3,461	0	0.0%	3,461	0	0.0%	3,461	0	0.0%	3,461	0	0.0%
Power sector CO2 Emissions - 2030	Kt	2,111	2,111	0	0.0%	2,109	-1	-0.1%	2,125	14	0.7%	2,110	0	0.0%	2,123	12	0.6%
Total Methane Emissions -2030	Kt	140	140	0	-0.1%	139	-1	-0.6%	140	0	-0.3%	140	0	0.3%	139	-1	-0.9%
Total N2O Emissions -2030	Kt	0.33	0.33	0	-1.1%	0.33	0	-0.7%	0.33	0	-0.2%	0.33	0	0.1%	0.32	0	-2.0%
Total GHG emissions	Kt CO2 eq	19,025	18,615	-409	-2.2%	18,790	-235	-1.2%	18,948	-76	-0.4%	19,031	7	0.0%	18,310	-715	-3.8%

Indicator	Units	Reference	Promote Urban Public Transport			Taxi Regulations			Promote Public Parking			Promote Urban Cycling & Walking			Promote 2-wheelers		
			Absolute value	Difference	Difference (%)	Absolute value	Difference	Difference (%)	Absolute value	Difference	Difference (%)	Absolute value	Difference	Difference (%)	Absolute value	Difference	Difference (%)
Total Discounted Energy System Cost (2014-2030)	2014M€	58,659	58,523	-136	-0.2%	57,458	-1,201	-2.0%	58,609	-50	-0.1%	58,283	-376	-0.6%	58,764	106	0.2%
Primary Energy Supply -2030	PJ	409	408	-1	-0.1%	407	-2	-0.4%	409	0	-0.1%	407	-2	-0.4%	408	-1	-0.2%
All Imports -2030	PJ	267	267	-1	-0.2%	266	-2	-0.7%	267	0	-0.1%	266	-2	-0.7%	266	-1	-0.3%
Natural gas Imports	PJ	152	151	0	-0.3%	151	-1	-0.5%	152	0	-0.1%	151	-1	-0.5%	151	-1	-0.5%
Net Electricty Exports	Gwh	-13,529	-13,529	0	0.0%	-13,529	0	0.0%	-13,529	0	0.0%	-13,529	0	0.0%	-13,529	0	0.0%
Electricity Generation	Gwh	31,380	31,381	1	0.0%	31,379	-1	0.0%	31,380	0	0.0%	31,379	-1	0.0%	31,379	-1	0.0%
Fuel Expenditure - 2030	2014M€	2,773	2,764	-9	-0.3%	2,743	-30	-1.1%	2,769	-4	-0.1%	2,744	-29	-1.1%	2,764	-9	-0.3%
Power Plant Capacity -2030	GW	9	9	0	0.0%	9	0	0.0%	9	0	0.0%	9	0	0.0%	9	0	0.0%
Hydro Power Plant Capacity -2030	GW	8	8	0	0.0%	8	0	0.0%	8	0	0.0%	8	0	0.0%	8	0	0.0%
Thermal (gas and coal) Power Plant Capacity-2030	GW	1.08	1.08	0	0.0%	1.08	0	0.0%	1.08	0	0.0%	1.08	0	0.0%	1.08	0	0.0%
Renewable Power Plant Capacity-2030	GW	0.02	0.02	0	0.0%	0.02	0	0.0%	0.02	0	0.0%	0.02	0	0.0%	0.02	0	0.0%
Power Plant New Capacity (2014-2030)	GW	5.35	5.35	0	0.0%	5.35	0	0.0%	5.35	0	0.0%	5.35	0	0.0%	5.35	0	0.0%
Power Plant Investment Cost (2014-2030)	2014M€	8,049	8,050	0	0.0%	8,049	0	0.0%	8,049	0	0.0%	8,049	0	0.0%	8,049	0	0.0%
Total Final Energy - 2030	PJ	302	301	-1	-0.2%	300	-2	-0.6%	302	0	-0.1%	300	-2	-0.6%	301	-1	-0.3%
Transport Final Energy - 2030	PJ	114	114	-1	-0.5%	113	-2	-1.5%	114	0	-0.2%	113	-2	-1.5%	114	-1	-0.7%
Buildings Sector Final Energy - 2030	PJ	88	88	0	0.0%	88	0	0.0%	88	0	0.0%	88	0	0.0%	88	0	0.0%
Industry Final Energy - 2030	PJ	61	61	0	0.0%	61	0	0.0%	61	0	0.0%	61	0	0.0%	61	0	0.0%
Total CO_2 Emissions - 2030	Kt	15,994	15,961	-33	-0.2%	15,884	-109	-0.7%	15,980	-14	-0.1%	15,886	-108	-0.7%	15,948	-46	-0.3%
Transport sector CO2 Emissions - 2030	Kt	6,709	6,675	-33	-0.5%	6,599	-109	-1.6%	6,695	-14	-0.2%	6,601	-108	-1.6%	6,662	-46	-0.7%
Buildings sector CO2 Emissions - 2030	Kt	2,816	2,816	0	0.0%	2,816	0	0.0%	2,816	0	0.0%	2,816	0	0.0%	2,816	0	0.0%
Industry sector CO2 Emissions - 2030	Kt	3,461	3,461	0	0.0%	3,461	0	0.0%	3,461	0	0.0%	3,461	0	0.0%	3,461	0	0.0%
Power sector CO2 Emissions - 2030	Kt	2,111	2,111	0	0.0%	2,111	0	0.0%	2,111	0	0.0%	2,111	0	0.0%	2,111	0	0.0%
Total Methane Emissions -2030	Kt	140	140	0	-0.2%	139	-1	-0.5%	140	0	-0.1%	139	-1	-0.5%	139	-1	-0.4%
Total N2O Emissions -2030	Kt	0.33	0.33	0	-0.2%	0.33	0	-0.4%	0.33	0	-0.1%	0.33	0	-0.4%	0.33	0	-0.2%
Total GHG emissions	Kt CO2 eq	19,025	18,984	-40	-0.2%	18,901	-124	-0.7%	19,009	-16	-0.1%	18,903	-122	-0.6%	18,966	-59	-0.3%

Indicator	Units	Reference	Improved Intercity Rail			Promote Intercity Bus Transport			All TRN except Passenger Mode-Shifts			Combined Passenger TRN Mode Shifts			All TRN Measures and Mode Shifts		
			Absolute value	Difference	Difference (%)	Absolute value	Difference	Difference (%)	Absolute value	Difference	Difference (%)	Absolute value	Difference	Difference (%)	Absolute value	Difference	Difference (%)
Total Discounted Energy System Cost (2014-2030)	2014M€	58,659	58,185	-474	-0.8%	58,516	-143	-0.2%	56,161	-2,498	-4.3%	56,557	-2,101	-3.6%	54,035	-4,624	-7.9%
Primary Energy Supply -2030	PJ	409	408	-2	-0.4%	408	-1	-0.2%	396	-13	-3.1%	401	-8	-1.9%	389	-20	-4.9%
All Imports -2030	PJ	267	265	-3	-0.9%	266	-1	-0.3%	254	-14	-5.1%	259	-9	-3.2%	245	-22	-8.2%
Natural gas Imports	PJ	152	151	-1	-0.6%	151	0	-0.3%	149	-2	-1.6%	148	-4	-2.7%	146	-6	-4.1%
Net Electricty Exports	Gwh	-13,529	-13,534	-5	0.0%	-13,530	0	0.0%	-13,522	7	-0.1%	-13,534	-5	0.0%	-13,526	3	0.0%
Electricity Generation	Gwh	31,380	31,720	340	1.1%	31,380	0	0.0%	31,730	350	1.1%	31,719	339	1.1%	32,032	652	2.1%
Fuel Expenditure - 2030	2014M€	2,773	2,726	-47	-1.7%	2,758	-14	-0.5%	2,501	-272	-9.8%	2,631	-141	-5.1%	2,363	-409	-14.8%
Power Plant Capacity -2030	GW	9	9	0	0.8%	9	0	0.0%	9	0	0.8%	9	0	0.8%	9	0	1.4%
Hydro Power Plant Capacity -2030	GW	8	8	0	0.9%	8	0	0.0%	8	0	0.9%	8	0	0.9%	8	0	1.7%
Thermal (gas and coal) Power Plant Capacity-2030	GW	1.08	1.08	0	0.0%	1.08	0	0.0%	1.08	0	0.0%	1.08	0	0.0%	1.08	0	0.0%
Renewable Power Plant Capacity-2030	GW	0.02	0.02	0	0.0%	0.02	0	0.0%	0.02	0	0.0%	0.02	0	0.0%	0.02	0	0.0%
Power Plant New Capacity (2014-2030)	GW	5.35	5.42	0	1.2%	5.35	0	0.0%	5.42	0	1.3%	5.42	0	1.2%	5.48	0	2.4%
Power Plant Investment Cost (2014-2030)	2014M€	8,049	8,173	124	1.5%	8,049	0	0.0%	8,176	126	1.6%	8,173	123	1.5%	8,285	236	2.9%
Total Final Energy - 2030	PJ	302	300	-2	-0.6%	301	-1	-0.3%	289	-13	-4.3%	294	-8	-2.6%	282	-20	-6.7%
Transport Final Energy - 2030	PJ	114	113	-2	-1.6%	113	-1	-0.8%	101	-13	-11.2%	107	-8	-6.8%	94	-20	-17.7%
Buildings Sector Final Energy - 2030	PJ	88	88	0	0.0%	88	0	0.0%	88	0	0.0%	88	0	0.0%	88	0	0.0%
Industry Final Energy - 2030	PJ	61	61	0	0.0%	61	0	0.0%	61	0	0.0%	61	0	0.0%	61	0	0.0%
Total CO_2 Emissions - 2030	Kt	15,994	15,832	-162	-1.0%	15,940	-54	-0.3%	15,044	-950	-5.9%	15,466	-528	-3.3%	14,538	-1,456	-9.1%
Transport sector CO2 Emissions - 2030	Kt	6,709	6,522	-186	-2.8%	6,655	-54	-0.8%	5,732	-976	-14.6%	6,156	-553	-8.2%	5,205	-1,504	-22.4%
Buildings sector CO2 Emissions - 2030	Kt	2,816	2,816	0	0.0%	2,816	0	0.0%	2,816	0	0.0%	2,816	0	0.0%	2,816	0	0.0%
Industry sector CO2 Emissions - 2030	Kt	3,461	3,461	0	0.0%	3,461	0	0.0%	3,461	0	0.0%	3,461	0	0.0%	3,461	0	0.0%
Power sector CO2 Emissions - 2030	Kt	2,111	2,135	24	1.2%	2,111	0	0.0%	2,137	26	1.2%	2,135	24	1.2%	2,158	48	2.3%
Total Methane Emissions -2030	Kt	140	139	-1	-0.5%	140	0	-0.3%	138	-2	-1.5%	136	-3	-2.5%	135	-5	-3.7%
Total N2O Emissions -2030	Kt	0.33	0.33	0	-0.5%	0.33	0	-0.2%	0.32	0	-2.8%	0.32	0	-2.0%	0.31	0	-4.6%
Total GHG emissions	Kt CO2 eq	19,025	18,846	-178	-0.9%	18,962	-62	-0.3%	18,027	-998	-5.2%	18,421	-603	-3.2%	17,454	-1,570	-8.3%

A.5 Combined Sectoral Measures

Indicator	Units	Reference	All Supply & Power Policies			All RSD & COM Sector Measures			All Industry Efficiency Measures			All TRN Measures and Mode Shifts		
			Absolute value	Difference	Difference (%)	Absolute value	Difference	Difference (%)	Absolute value	Difference	Difference (%)	Absolute value	Difference	Difference (%)
Total Discounted Energy System Cost (2014-2030)	2014M€	58,659	58,587	-72	-0.1%	57,988	-671	-1.1%	58,415	-244	-0.4%	54,035	-4,624	-7.9%
Primary Energy Supply -2030	PJ	409	389	-21	-5.0%	388	-22	-5.3%	401	-8	-2.1%	389	-20	-4.9%
All Imports -2030	PJ	267	248	-19	-7.2%	252	-15	-5.8%	263	-4	-1.7%	245	-22	-8.2%
Natural gas Imports	PJ	152	133	-19	-12.7%	138	-14	-9.4%	150	-1	-0.9%	146	-6	-4.1%
Net Electricty Exports	Gwh	-13,529	-12,370	1,160	-8.6%	-13,696	-167	1.2%	-13,524	5	0.0%	-13,526	3	0.0%
Electricity Generation	Gwh	31,380	30,218	-1,162	-3.7%	28,758	-2,622	-8.4%	30,926	-454	-1.4%	32,032	652	2.1%
Fuel Expenditure - 2030	2014M€	2,773	2,669	-104	-3.8%	2,620	-153	-5.5%	2,727	-45	-1.6%	2,363	-409	-14.8%
Power Plant Capacity -2030	GW	9	9	0	0.0%	8	-1	-5.7%	9	0	-1.0%	9	0	1.4%
Hydro Power Plant Capacity -2030	GW	8	8	0	-1.0%	7	-1	-6.6%	8	0	-1.2%	8	0	1.7%
Thermal (gas and coal) Power Plant Capacity-2030	GW	1.08	1.01	0	-6.5%	1.08	0	0.0%	1.08	0	0.0%	1.08	0	0.0%
Renewable Power Plant Capacity-2030	GW	0.02	0.17	0	724.6%	0.02	0	0.0%	0.02	0	0.0%	0.02	0	0.0%
Power Plant New Capacity (2014-2030)	GW	5.35	5.92	1	10.7%	4.85	-1	-9.4%	5.26	-0.09	-1.7%	5.48	0	2.4%
Power Plant Investment Cost (2014-2030)	2014M€	8,049	8,457	408	5.1%	7,112	-937	-11.6%	7,884	-165	-2.0%	8,285	236	2.9%
Total Final Energy - 2030	PJ	302	302	0	0.0%	283	-19	-6.4%	294	-8	-2.7%	282	-20	-6.7%
Transport Final Energy - 2030	PJ	114	114	0	0.0%	114	0	0.0%	114	0	0.0%	94	-20	-17.7%
Buildings Sector Final Energy - 2030	PJ	88	88	0	0.0%	75	-12	-14.1%	88	0	0.0%	88	0	0.0%
Industry Final Energy - 2030	PJ	61	61	0	0.0%	61	0	0.0%	53	-8	-13.0%	61	0	0.0%
Total CO_2 Emissions - 2030	Kt	15,994	15,158	-836	-5.2%	15,153	-841	-5.3%	15,354	-640	-4.0%	14,538	-1,456	-9.1%
Transport sector CO2 Emissions - 2030	Kt	6,709	6,709	0	0.0%	6,709	0	0.0%	6,709	0	0.0%	5,205	-1,504	-22.4%
Buildings sector CO2 Emissions - 2030	Kt	2,816	2,816	0	0.0%	2,277	-539	-19.2%	2,817	1	0.0%	2,816	0	0.0%
Industry sector CO2 Emissions - 2030	Kt	3,461	3,461	0	0.0%	3,460	-1	0.0%	2,854	-608	-17.6%	3,461	0	0.0%
Power sector CO2 Emissions - 2030	Kt	2,111	1,275	-836	-39.6%	1,907	-204	-9.7%	2,078	-33	-1.6%	2,158	48	2.3%
Total Methane Emissions -2030	Kt	140	59	-81	-57.8%	129	-11	-7.8%	137	-3	-2.3%	135	-5	-3.7%
Total N2O Emissions -2030	Kt	0.33	0.31	0	-4.5%	0.32	0	-4.3%	0.32	0	-2.9%	0.31	0	-4.6%
Total GHG emissions	Kt CO2 eq	19,025	16,490	-2,535	-13.3%	17,951	-1,074	-5.6%	18,315	-710	-3.7%	17,454	-1,570	-8.3%

Indicator	Units	Reference	All LEDS measures			Feasable measures		
			Absolute value	Difference	Difference (%)	Absolute value	Difference	Difference (%)
Total Discounted Energy System Cost (2014-2030)	2014M€	58 659	53 084	-5 575	-9.5%	55 452	-3 207	-5.5%
Primary Energy Supply -2030	Ktoe	409	340	-69	-16.8%	368	-41	-9.9%
All Imports -2030	Ktoe	267	208	-60	-22.3%	232	-36	-13.4%
Natural gas Imports	Ktoe	152	112	-40	-26.0%	130	-22	-14.6%
Net Electricty Exports	Gwh	-13 529	-12 679	850	-6.3%	-12 727	802	-5.9%
Electricity Generation	Gwh	31 380	27 932	-3 448	-11.0%	29 793	-1 587	-5.1%
Fuel Expenditure - 2030	2014M€	2 773	2 067	-705	-25.4%	2 337	-435	-15.7%
Power Plant Capacity -2030	GW	9	8	-0.459	-5.2%	9	-0.223	-2.5%
Hydro Power Plant Capacity -2030	GW	8	7	-0.539	-7.0%	8	-0.153	-2.0%
Thermal (gas and coal) Power Plant Capacity-2030	GW	1.08	1.01	0	-6.5%	1.01	0	-6.5%
Renewable Power Plant Capacity-2030	GW	0.02	0.17	0	724.6%	0.02	0	0.0%
Power Plant New Capacity (2014-2030)	GW	5.35	5.46	0	2.1%	5.70	0	6.5%
Power Plant Investment Cost (2014-2030)	2014M€	8 049	7 600	-449.69	-5.6%	8 121	72.26	0.9%
Total Final Energy - 2030	Ktoe	302	254	-47	-15.7%	278	-23	-7.8%
Transport Final Energy - 2030	Ktoe	114	94	-20	-17.7%	101	-14	-11.9%
Buildings Sector Final Energy - 2030	Ktoe	118	99	-19	-16.2%	114	-4	-3.4%
Industry Final Energy - 2030	Ktoe	61	53	-8	-13.1%	56	-6	-9.4%
Total CO_2 Emissions - 2030	Kt	15 994	12 277	-3 717	-23.2%	13 726	-2 268	-14.2%
Transport sector CO2 Emissions - 2030	Kt	6 709	5 205	-1 504	-22.4%	5 685	-1 024	-15.3%
Buildings sector CO2 Emissions - 2030	Kt	3 671	3 045	-626	-17.0%	3 597	-74	-2.0%
Industry sector CO2 Emissions - 2030	Kt	3 461	2 852	-610	-17.6%	3 024	-437	-12.6%
Power sector CO2 Emissions - 2030	Kt	2 111	1 133	-978	-46.3%	1 377	-733	-34.7%
Total Methane Emissions -2030	Kt	139.97	51	-89	-63.6%	56	-84	-60.0%
Total N2O Emissions -2030	Kt	0.33	0.28	0	-16.1%	0.30	0	-9.4%
Total GHG emissions	Kt CO2 eq	19 035	13 434	-5 601	-29.4%	14 995	-4 040	-21.2%
GHG Emissions CO2eq								
Transport	Kt CO2 eq	6 789	5 270	-1 519	-22.4%	5 757	-1 032	-15.2%
Buildings	Kt CO2 eq	3 852	3 222	-630	-16.4%	3 778	-74	-1.9%
Industry	Kt CO2 eq	3 478	2 866	-612	-17.6%	3 039	-439	-12.6%
Agriculture	Kt CO2 eq	43	43	0	0%	43	0	0.0%
Power	Kt CO2 eq	2 122	1 139	-984	-46.4%	1 384	-738	-34.8%
Fugitives	Kt CO2 eq	2751	895	-1 856	-67.5%	993	-1 757	-63.9%
Total	Kt CO2 eq	19 036	13 434	-5 601	-29.4%	14 995	-4 040	-21.2%

A.6 Preferred LEDS Policy Measures

Sector	LEDS Measure	All LEDS Policy Measures	LEDS Policy Measures - Preferred
Power & Supply	Reduced natural gas losses	X	X
	More Eff Power Plants	X	X
	Promote HPPs	X	X
	New wind plant	X	
Buildings	INC bulb phase-out	X	
	Appliance Labeling	X	X
	COM Public Building retrofits	X	
	COM Building Retrofits	X	
	New RSD & COM Building codes	X	X
	RSD Building retrofits	X	
	NAMA - ADV biomass heating stoves	X	
	NAMA - RSD solar water heating	X	
	COM Solar Water Heating	X	
	LED Public Lighting	X	X
Industry	Chemicals - Nitric Acid Cogeneration	X	X
	Chemical - Advanced Motor Drives	X	X
	Chemical – Efficiency measures at Rustavi Azoti	X	X
	Food - Advanced Process heat	X	
	Food - Advanced Motor Drives	X	X
	Iron&Steel - Process heat Imp	X	
	Iron&Steel - Motor Drive Eff	X	X
	Iron&Steel - Automated Controls	X	
	Cement - Motor Drive Eff	X	X
	Cement - Heat Recycling Imp	X	

	Cement - Wet-to-Dry Process	X	X
	Pig Iron Industry - 2020		
Transport	Promote Biofuels: 6% by 2030		
	Improved LDV stock and fuel standards		
	Increase Road Transport Efficiency	X	X
	Hybrid and Electric vehicle targets	X	X
	Promote Urban Public Transport	X	
	Cleaner buses (CNG and electric)	X	X
	Taxi Regulations	X	
	Promote Public Parking	X	X
	Promote Urban Cycling & Walking	X	
	Promote 2-wheelers	X	
	Improved Intercity Rail	X	
	Improve intercity bus transport	X	
	Freight mode shift to truck to Rail	X	X
	All mode-shifting scenarios	X	
	Mode shifts with less measures		X