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

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

CLEAN ENERGY PROGRAM

Sustainable Energy Action Plan for Kutaisi

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Submitted to: Nick Okreshidze, AOR

US Agency for International Development

USAID/Georgia

Submitted by: Dana Kenney, COP

Winrock International - Georgia

EC-LEDS Program

7, I. Chavchavadze Avenue

Tbilisi, 0179, Georgia

+995 32 250 63 43

www.winrock.org

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CONTENTS

List of Tables vii
List of Figures ix
List of Pictures ix
Glossary of Terms x
Acronyms xi
Introduction 13
Zugdidi City - Overview 14
General Characteristics 14
History 15
Population 15
Employment and Economy 16
Governing Body 18
Strategic Plans and Trends 18
The Sustainable Energy Action Plan 19
Strategic Planning and Increasing Local Opportunities 20
Sectoral Development 20
Transport Sector 20
Buildings Sector 21
Municipal Infrastructure Sectors 22
SEAP development methodology and summary 22
Transport & Road Infrastructures 25
Sector Overview 25
Methodology 29
Base Year Inventory and Baseline Scenario of the GHG Emissions (2013 – 2020) 32
Emissions Reduction Action Plan from Zugdidi Transport Sector 34
Description of Activities 37
Activity UP1. Construction of a Bridge Connecting Tsaghveri and Javakhishvili Streets 37
Activity UP2.4 Construction of Additional Bridges 37
Activity UP3.Creation of Foot and Bike Paths 38
Activity PBT1. Public Transport Service Improvement & Popularization 39
Activity PBT2. Renewal of Municipal Public Transort Vehicles 39
Activity PBT3: Municipal Transport Conversion to Biodiesel 39
Activity PRT1. Developing Parking Policy 40

Activity PRT2. Creating Technical Inspections & Fuel Quality Standards 40
Activity PRT3. Encouraging Low-emission Private Vehicles 40
Buildings 41
Sector Overview 41
Total Energy Consumption in Zugdidi 45
Methodology 49
Carbon Dioxide Emissions Assessment 52
Base Year Intervention & GHG Emissions Baseline Scenario (2013 – 2020) 52
GHG Emissions Reduction Action Plan from Zugdidi Buildings Sector 54
Detailed Description of Measures 68
Measure MB 1.1. Use bio-waste pellets in municipal buildings (pilot project) 68
Measure MB 1.2 Heat Pump- Based Heating/Cooling Supply to Zugdidi City Hall Administrative Building (Pilot Project) 68
Measure MB 2.1.- Energy-efficient Lighting Systems in Kindergartens 69
Measure MB 3.1. - Thermal Insulation of Roofs in Kindergartens 70
Measure MB 4.1. Solar Collectors for Kindergartens 71
Measure RB 1.1. – Installing Energy-efficient Bulbs in Common Areas of 9-Storey Residential Buildings 71
Measure RB 2.1.- Heat conservation in Common Spaces of 9-storey Residential Buildings 72
Measure RB 2.2 Thermal Insulation of Roofs in 2-storey Private Houses 73
Measure RB 2.3. – Replacement of Existing Windows by Metaloplastic Ones in Two-Storey Private Houses 73
Measure RB 2.4. – Thermal Insulation of Ceilings and Walls in New IDP Settlements 73
Measure RB 3.1. Bio-waste Pellet Heating in Private Houses 74
Measure RB 3.2. Heat Supply for IDP Settlements with Biomass Central Heating Systems 75
Measure RB 3.3. – Energy-Efficiency Public Awareness Training for Target Groups and Public Information Campaign 76
Street Lighting 77
Sector Overview 77
Methodology 85
Base Year Inventory & GHG Emissions Baseline Scenario (2012 – 2020) 85
Emissions Reduction Action Plan from Zugdidi Street Lighting Sector 85
Waste 87
Sector Overview 87
Solid Waste Disposal 88

Methodology 91
Activity Data 92
Population numbers producing waste deposed in the landfill 92
Characteristics of Waste Production and Disposal Processes 94
Waste Composition 95
Emission Factors 96
Base Year Inventory and GHG Emissions Baseline Scenario (2012 – 2020) 99
Closed Landfill 99
Active Landfill 100
Emissions Reduction Action Plan for the Zugdidi Solid Waste Sector 101
Greening/Landscaping 103
The Existing Situation 103
Methodology 107
Calculation Outcomes 109
Measures planned within the framework of the Action Plan 114
Measure 1: Restoration of Zugdidi Botanical Garden 115
Measure 2 - Reforestation of promising development zones of the city, 5 ha. 117
Awareness Raising and Staff Training Strategies 121
Barriers 121
Target Groups and Objectives 123
Short-term Strategy (2015-2017) 124
Long-term Strategy (2017 – 2020) 124
Monitoring, Verification and Reporting 133
The Zugdidi Unit Responsible for Monitoring 135
General and Sector-Related Driving Parameters 137
Activity Data Necessary for Monitoring the Zugdidi Transport Sector 141
Data to be Collected for Municipal Buses 141
Data to be Collected for Municipal Minibuses 143
Private Cars (Motor Cars) 145
Municipality- Owned Fleet 147
Commercial Transport (Taxi) 149
Commercial Transport Small Trucks (up to 2 tons) 151
Commercial Transport (Large Trucks) 153
Street Lighting Sector 157

Buildings Sector 161
Sustainable Development Criteria 164

LIST OF TABLES

Table 1. Zugdidi City Population 16
Table 2. Employment Dynamics in Zugdidi Municipality (2006-2013) 16
Table 3. GHG Emissions in Zugdidi in 2012 and 2020 BAU scenario (tons CO_2 eq.) 23
Table 4. Emissions Savings in different sectors according to Zugdidi SEAP 23
Table 5. Zugdidi Local Municipal Transport passengers and kilometers covered 26
Table 6.Transport registered in Zugdidi and its characteristics 28
Table 7. Transfer Coefficients and Carbon Emissions Factors for Different Types of Fuel 30
Table 8. Portion of Oxidized Carbon for Different Fuels 30
Table 9. Methane and Nitrous Oxide Emission Factors for Transport Sectors (kg/MWh) 30
Table 10. Global Warming Potential of Methane and Nitrous Oxide 30
Table 11. Final Energy Consumption of Zugdidi Transport Sector (MWh) - 2012 33
Table 12. GHG Emissions from Zugdidi Transport Sector in CO_2Equivalent - 2012 33
Table 13. Total Pollutants (t) and Percentage Difference between 2010 - 2013 33
Table 14. Fuel consumption growth rates for types of transport according to the BAU scenario 34
Table 15. Zugdidi Transport Sector Action Plan 36
Table 16. Area of Residential Buildings in Zugdidi 41
Table 17. Number of buildings and their area in m2. 42
Table 18. List of buildings owned by the Municipality 43
Table 19. Under - construction buildings in the city planned to enter into operation in the nearest months 45
Table 20. Consumed energy resources in Zugdidi 2012-2013 46
Table 21. Annual Energy Consumption in Zugdidi Buildings Sector 47
Table 22. Methane and Nitrous Oxide Emission Factors for Buildings (kg/MW/h) 49
Table 23. Final Energy Consumption in Zugdidi Buildings Sector - 2012 52
Table 24. GHG Emissions from Zugdidi Buildings Sector CO_2 –eq. (t) - 2012 53
Table 25. Fuel Consumption Growth Rates for Different Building Types under the BAU Scenario 53
Table 26. Existing Emissions from Residential Buildings and Possible Savings in Zugdidi 62
Table 27. Emissions from Non-residential Buildings and Possible Savings in Zugdidi 63
Table 28. Emissions Reduction Action Plan from Buildings 67
Table 29. Profitability Parameters of MB 1.1 Measure 68
Table 30. Measure MB 1.2. Profitability Parameters 69
Table 31. Profitability Parameters of MB 2.1 Measure 70
Table 32. Profitability Parameters of Measure MB 3.1 70
Table 33. Profitability Parameters of Measure MB 4.1Measure 71
Table 34. Profitability Parameter of Measure RB 1.1 71
Table 35. Profitability Parameters of Measure RB 2.1 72
Table 36. Profitability Parameters of Measure RB 2.2 73
Table 37. Profitability Parameters of Measure RB 2.3 73

Table 38. Profitability Parameters of Measure RB 2.4 74
Table 39. Profitability Parameters of Measure RB 3.1 75
Table 40. Project's Profitability Parameters for Measure RB 3.2 76
Table 41. Street Lighting Fixtures, Layout and Parameters 78
Table 42. Actual values of Zugdidi population, interpolated(*) for 1972–2001 and forecast for 2014-2020 93
Table 43. Actual (2010-2013) and Interpolated (*) Amount of the Waste Disposed in Old (a) and New (b) Landfills 94
Table 44. Composition of Municipal Waste in Batumi 96
Table 45. Methane Correction Factor (MCF) Values for Different Types of Landfills 97
Table 46. Default Values of the DOC_i by Waste Composition 98
Table 47. Methane Emissions from Zugdidi Closed Landfill for 2012 - 2036 99
Table 48. Methane Emissions from Active Landfill of Zugdidi - 2012 - 2036 100
Table 49. Amounts of CO_2 Saved with SEAP scenario 101
Table 50. Amounts of CO_2Saved in the SEAP implementation scenario 102
Table 51. Summary Table 102
Table 52. Green Cover of Zugdidi 103
Table 53. High and large-volume (m3) trees/plants in Botanical Garden (26 ha) 105
Table 54. Trees and plants set out in squares and boulevards in 2010 - 2013 106
Table 55. Coefficients used in calculations and their sources 109
Table 56. Accumulated Carbon and Annually Absorbed Carbon Dioxide 110
Table 57. Biomass Model Parameters 111
Table 58. Soil Module Parameters 112
Table 59. Carbon Accumulation and Carbon Dioxide Sequestration Indexes after Landscaping Activities (1ha) 114
Table 60. Estimation of Scheduled Activities 115
Table 61. Annual Accumulation Rates 117
Table 62. Estimation of Scheduled Activities for Greening 5 ha Zone 118
Table 63. Annual Accumulation Rates 120
Table 64. Carbon Accumulation Potential after Scheduled Landscaping 120
Table 65. Accumulated Carbon in Zugdidi Recreation Zones and Carbon Accumulation Potential As a Result of Scheduled Landscaping 120
Table66. Action Plan of Zugdidi Municipality in the Field of Staff Training and Awareness Raising to Ensure Successful Implementation of SEAP 126

LIST OF FIGURES

Figure 1. Sectoral Structure of Zugdidi Municipality Economy. Source: Zugdidi Municipality, 2009 17
Figure 2. Distribution of Economic Subjects Registered in Georgia by Regions (According to the situation by September 1, 2009) 17
Figure 3. Distribution of emissions by sectors between years 2012 and 2020 23
Figure 4. Increase of emissions according to the BAU and the SEAP scenarios in transport sector 24
Figure 5. Increase of emissions according to the BAU and the SEAP scenarios in the buildings sector 24
Figure 6. Increase of emissions according to the BAU and the SEAP scenarios in the lighting sector 25
Figure 7. Increase of emissions according to the BAU and the SEAP scenarios in waste sector 25
Figure 8. Zugdidi Street Plan 26
Figure 9. Increases of vehicles registered in Zugdidi Municipality 2003-2013 27
Figure 10. Trend of emissions from the transport sector according to the BAU scenario 34
Figure 11. ENSI Software format for Energy Budget Article "Heating" 51
Figure 12. Energy Budget 51
Figure 13. Trends of Emissions from Buildings Sector According to the BAU 53
Figure 14. Expenses for Street Lighting 2009 - 2013 77
Figure 15. Emissions from Street Lighting Sector in 2012 - 2020 85
Figure 16. Comparative Energy Consumption by Street Lighting Sector according to the BAU Scenario and the SEAP 86
Figure 17. Model Structure 108
Figure 18. Carbon accumulation and carbon dioxide sequestration indexes after planned greening activities (1ha) 113
Figure 19. Accumulated carbon dynamics after reforestation 114
Figure 20. Carbon Accumulation and Sequestrated Carbon Dioxide Rates after Landscaping Activities 116
Figure 21. Accumulated Carbon Dynamics after Renovation 117
Figure 22. Carbon Accumulation and Sequestrated Carbon Dioxide Rates after Landscaping Activities 119
Figure 23. Accumulated Carbon Dynamics after Plantings 119
Figure 24. Monitoring Process Management 136

LIST OF PICTURES

Picture 1. Zugdidi Municipality Map 14
Picture 2. Photos of the Dadiani Palace and Vlachernoe Virgin Mother Zugdidi Cathedral and former Hotel Odishi, now housing internally displaced persons. Photos taken in the1940s. 15
Picture 3. Dadiani Palace in Zugdidi 41
Picture 4. #16 Kindergarten of Zugdidi (15 Dekabristebi St.) 56
Picture 5. #3 Zugdidi Public School (186 Rustaveli St.) 56
Picture 6. Zugdidi Children's Polyclinic (5 Kostava St.) 57
Picture 7. Private Residential House (13 Antelava St.) 57
Picture 8. Private Residential House (30 Dekabristebi St.) 58
Picture 9. Private Hotel (14 Antelava St.) 58
Picture 10. Commercial Building (Diaroni Restaurant) 59
Picture 11. Three-storey Residential Building (6 Tabukashvili St.) 59
Picture 12. Five-storey Residential Building (36 S. Chikovani St.) 60
Picture 13. Nine-storey Residential Building (6 Tsotne Dadiani St.) 60
Picture 14. Storey-Residential Building (3 Tsotne Dadiani St.) 61
Picture 15. IDP Settlement Residential Buildings 61
Picture 16. Zugdidi City Active Landfill 89
Picture 17. Zugdidi Active Landfill 91
Picture 18. Center of Zugdidi City. Botanical Garden 104
Picture 19. Orthophotograph of Botanical Garden 105

GLOSSARY OF TERMS

Global Warming Potential (GWP) – dimensionless quantity characterizing for the particular GHG efficiency in terms of greenhouse effect production. Carbon dioxide GWP has been taken as a conventional unit of the quantity. Its value varies widely for other GHGs equaling to e.g. methane – 21, nitrous oxide – 310. GWP is applied to convert various GHGs to CO_2 equivalent. For example, 1 ton of methane reduction corresponds to 21 tons of CO_2 emission reduction (21 t CO_2eq.). Similarly, 1 ton of N_2O reduction equals to 310 CO_2 reduction in terms of efficiency (310 t CO_2eq.).

Pilot Project – the first test project within the framework of the program aiming at appraisal and perfection of selected methodology and technology along with preliminary results analysis and efficiency estimation of the project. Pilot project outcomes determine follow-up ways and means of the project implementation.

Conservative Assessment – the lowest/ most modest results oriented assessment

GHG – Greenhouse gas. Natural (or artificial) gas being a part of the atmosphere having the ability to contain the earth's heat radiation. There are naturally occurring gases – known as direct GHGs – water vapor (H2O), carbon dioxide (CO2), nitrous oxide (N2O), methane (CH4), and ozone (O3), and indirect GHGs e.g. sulfur dioxide (SO2) and ammonia (NH3). These gases, while interacting with water vapor and other elements, form various particles (aerosols) of sulfur and nitrogen salts that also play a significant role in the greenhouse effect.

Level 1 – selected source from the category of the simplest approach applied for the GHG gas emissions calculation in which typical values of countries with similar geographic and climatic conditions are considered as emission rates/factors.

Level 2 – includes more detailed emissions applying emission coefficients set/measured within the particular country. It increases reliability and accuracy of outcomes. Results obtained through mathematical or physical modeling are being used as well for emission calculation at higher – the third level, along with locally measured emission coefficients.

ACRONYMS

BAU	Business As Usual
BDD	Basic Data and Directions of the country
BRT	Bus Rapid Transit system
C	Carbon
Cd	Cadmium
CDM	Clean Development Mechanism
CH_4	Methane
ClimaEast	European Union funded project package assisting the Eastern Neighbourhood Partnership Countries and Russia in approaches to climate change mitigation and adaptation
CO	Carbon monoxide
CO_2	Carbon dioxide
$CO_{2\,eq}$	Carbon dioxide equivalent ($CO_{2\,eq}$)
CoM	Covenant of Mayors
Cr	Chrome
Cu	Copper
EC -LEDS	Enhancing capacity for low emission development strategies
EU	European Union
EU –COM	European Union Covenant of Mayors
FOD	First Order Decay model
FIZ	Free Industrial Zone
GDP	Gross Domestic Product
GEF	Global Environment Fund
Gg	Gigagram (109g= 103t)
GIZ	Die Deutsche Gesellschaft für Internationale Zusammenarbeit) German Society for International Cooperation
GWP	Global Warming Potential
HSW	Household Solid Waste
IPCC	Intergovernmental Panel on Climate Change
JRC	Joint Research Centre of the EU
LLC	Limited Liability Company
MCF	Methane Correction Factor
MDF	Municipal Development Fund
Mg	Megagram (10^6g = 1t)
MJ	Megajoule (106 Joule)
MSW	Municipal Solid Waste
Muni- EIPMP	Municipal emissions inventory, projection and mitigation measures planning
MW	Megawatt (106 watts)
N_2O	Nitrous Oxide
NCV	Net Calorific Value

NG	Natural Gas
NH_3	Ammonia
Ni	Nickel
NMVOC	Non-Methane Volatile Organic Compounds
N(N)LE	(Non-entrepreneurial(non-commercial) legal entity)
NO	Nitrogen Oxide
NO_2	Nitrogen Dioxide
NO_X	Nitrogen Oxides
Pb	Lead
PM	Particulate Matters
QA/QC	Quality Assurance/Quality Control
RDF	Regional Development Fund
Se	Selenium
SEAP	Sustainable Energy Action Plan
TJ	Terajoule (1012 Joule)
UNFCCC	United Nations Framework Convention on Climate Change
USAID	US Agency for International Development
VOC	Volatile Organic Compounds
Zn	Zinc

INTRODUCTION

In October, 2010 Georgia hosted a conference on the Covenant of Mayors (CoM) program of the European Union, emphasizing the importance of cities as complex systems in the process of greenhouse gas (GHG) emissions. The "city" is considered the main guiding unit in the development of Sustainable Energy Action Plans within the framework of EU energy efficiency priorities.

By signing on to the CoM, the Zugdidi City Municipality joined an initiative aiming at GHG emissions reductions by at least 20% by 2020 – a goal that has to be reached while while simultaneously improving social and economic development. Zugdidi developed the SEAP with the assistance of the USAID-funded "Enhancing Capacity for Low Emissions Development Strategies (EC-LEDS) Clean Energy Program". The strategic plan includes:

- Baseline emission inventories of GHG in Transport, Buildings, Street Lighting, Waste and Greening sectors;
- A GHG emissions baseline, the so-called "Business as Usual" or BAU scenario for each sector;
- Identifying GHG mitigation measures and the efficiency assessment of each sector before 2020;
- Monitoring, Reporting and Evaluation plan;
- Local potential development possibilities and awareness-raising strategy;

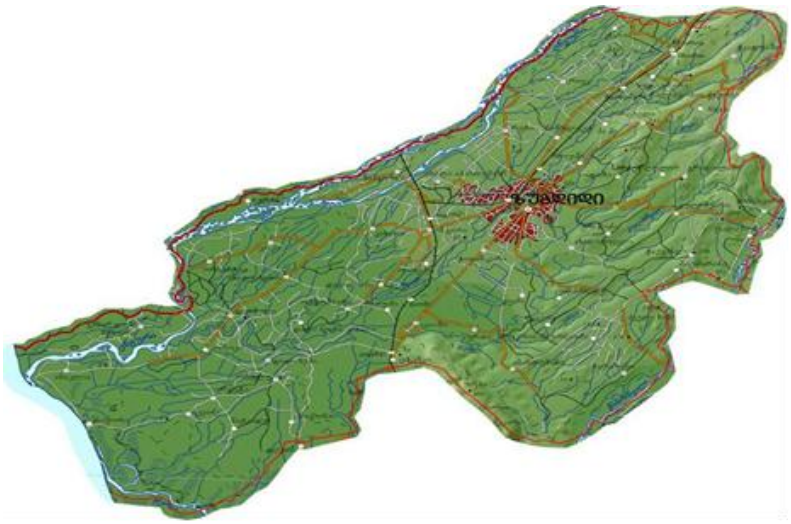
Economic growth rate, population growth and per capita GDP growth trends of Zugdidi served as bases for the BAU scenario and for planning specific measures for consumption and CO_2 emissions reduction by 2020. Carrying out these measures before 2020 will ensure a CO_2 emissions reduction for these Zugdidi sectors of at least 24% compared to the BAU of 2020.

ZUGDIDI CITY - OVERVIEW

General Characteristics

Zugdidi is one of the oldest cities in Georgia, situated in the Odishi Plains, on the Chkhoushi River, 110 m above sea level.[1] It is the administrative center of the Zugdidi Municipality and Samegrelo-Zemo (Upper) Svaneti regions, and is one of 12 Georgian "self-governing" cities.[2],[3]

The climate zone where Zugdidi is located[4] is humid-subtropical with hot summers (+27,7°C) and warm winters (+4,9°C), and an average temperature of 23.8°c. Annual precipitation is 1650 mm; average air humidity is 72%; and the total number of sunny days is about 210. Subtropical and contintental plant species as well as indigenous and imported crops are well adapted to its climate and soil conditions, which are suited to ecological farming.



Picture 1. **Zugdidi Municipality Map**[5]

The Municipal territory covers a total area of 2143.5 hectares near the Black Sea coast and includes Ganmukhuri and Anaklia, and borders on the Abkhazia Administrative Line (Gali Region) to the northwest, the Tsalenjikha Municiplaity to the northeast and the Chkhorotsku Municipality to the southeast. Zugdidi is 28-30 km from the Black Sea. The Municipality's shoreline villages of Anaklia and Ganmukhuri are attractive resort areas. The distance between the administrative center and Tbilisi is 339 km to the east, and the nearest port is Poti, approximately 70 km to the south, and the

[1]http://en.wikipedia.org/wiki/Zugdidi

[2] https://matsne.gov.ge/index.php?option=com_ldmssearch&view=docView&id=2244429&lang=ge

[3]Tbilisi, Batumi, Kutaisi, Rustavi, Poti, Telavi, Ozurgeti, Zugdidi, Gori, Ambrolauri, Mtkheta & Akhaltsikhe

[5]Source: Official website of Zugdidi Municipality. www.zugdidi-sakrebulo.ge

Kutaisi Airport is situated 90 km to the east. Rivers near Zugdidi are strategic hydropower resources: the Chkhoushia, Kuchkhoboni, Sintsa and Enguri.

History

Zugdidi began to develop into a city in the 1830s. The last ruler was David Dadiani (1846-1853)[6] who actively developed the culture and industry of the city. Zugdidi became a commercial center with advanced crafts and household industries in textiles, and a distillery was built in 1850. A library was founded in 1844 where ancient manuscripts and printed books were conserved. The city grew from 2000 residents in 1851 to 4000 by 1917. The status of "city" was officially granted in 1918. By 1925, there were 4525 residents and it was 19th of 33 cities and towns of Georgia at the time.[7] David Dadiani's and Ekaterine Chavchavadze's palace gardens became famous for their rich collection of exotic vegetation, and later became the Botanical Garden of Zugdidi.[8]

The Georgian poet and public figure, Raphael Eristavi, headed the Zugdidi administrative unit in 1957-1967 and contributed to the further development of the City, with a central walkway or promenade, still distinguished by its beauty.

Picture 2. **Photos of the Dadiani Palace and Vlachernoe Virgin Mother Zugdidi Cathedral and former Hotel Odishi, now housing internally displaced persons. Photos taken in the1940s.**

Contemporary Zugdidi

Zugdidi is the biggest unit of the Municipality and is the Administrative Center for the Region of Samegrelo-Zemo Svaneti. Most available data (including statistics) cover the entire Zugdidi Municipality rather than Zugdidi city alone.

Population

Today the total area of Zugdidi Municipality covers 2143.5 hectares and numbers approximately 74,792 persons. The population increased significantly after the war in Abkhazia in the 1990s, and make up 41,6% of the Municipality's residents.[9] Inhabitants

[6]Land use plan of the city. 2009
[7]General land use plan of the city. 2009
[8]http://en.wikipedia.org/wiki/Zugdidi_Botanical_Garden
[9]Different official data sources that the estimated population range of Zugdidi Municipality is between 69 000 and 75 000 people. The difference presumably is due to movements of displaced populations to Abkhazia and other territories.

are distributed according to the conditions and opportunities for agricultural development, and tend to concentrate more and more in the center of the city itself. The Zugdidi Municipality is the second biggest settlement of internally displaced people in Georgia, after Tbilisi.

The Zugdidi Municipality shows the highest rate of population density in the western region of Samegrelo. January 2010 data show that there are 239 persons/m^2. The 2002 census revealed that ethnically, the region is 98.2% Georgian; .9%-Russian; .1% Abkhazian; .1%-Ukrainian and 0.1% other groups. The Municipality includes 31 territorial bodies and 58 villages. The city population is shown in Table 1.[10]

Table 1. **Zugdidi City Population**

Number of Residents	2011	2012	2013	2014
Residents (in thousands)	75.19	76.70	75.10	74.80

Employment and Economy

Unfortunately employment numbers are not available, however the employment trends in Zugdidi Municipality from 2006 to 2013 are available and presented in Table 2.[11]

Table 2. **Employment Dynamics in Zugdidi Municipality (2006-2013)**

Different Sectors	2006	2007	2008	2009	2010	2011	2012	2013
Agriculture						3150	3200	3250
Industry	2986	3084	1953	2225	2274	3014	2940	2850
Service Sector	2800	3362	3393	3681	3330	4148	4020	4080
Total	5786	6446	5346	5906	5604	10312	10160	10180

The economy of the municipality is divided into Agriculture, Industry, Construction, Transport, Trade, Hotels & Restaurants, with the largest portion at 25%, represented by the construction sector in 2009, followed by Agriculture 23% and Hotels & Restaurants 7% (Pic. 2).[12]

[10]Regional Statistics Office

[11]Figures have been processed according to Regional Statistics Office data. Self-employed are considered all those owning 2 ha or more in private plots of land.

[12]Data covers the whole Municipality

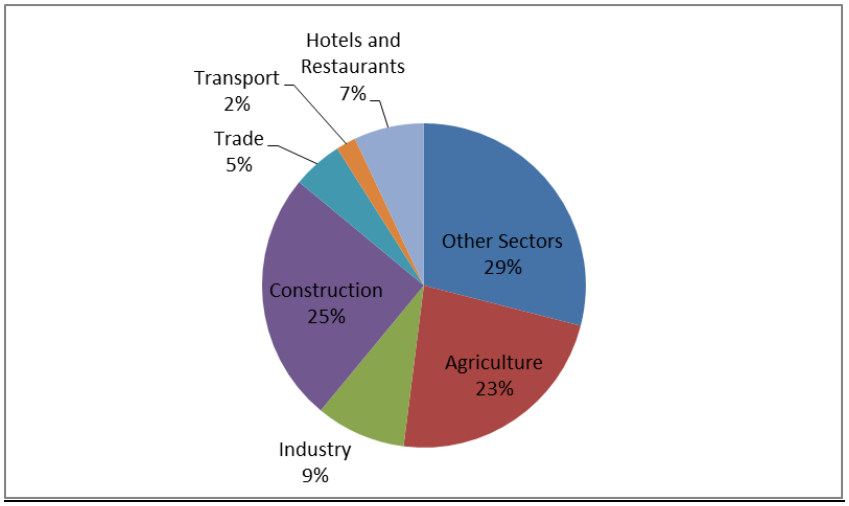


Figure 1. Sectoral Structure of Zugdidi Municipality Economy. Source: Zugdidi Municipality, 2009

Two large enterprises - a paper factory (4500 employees) and a ceramics factory (2000 employees) operated until the 1990s, along with other large and small manufacturing businesses. By January 1, 2010, the industrial enterprises numbered 17, with a production value of about 26.6 million GEL and employing 527 persons. Some enterprises are seasonally or temporarily closed, mainly due to a lack of investments and outdated equipment. Today most products include hazelnuts, wheat flour, inert materials, tea and bread. Per capita GDP is 1845 GEL.

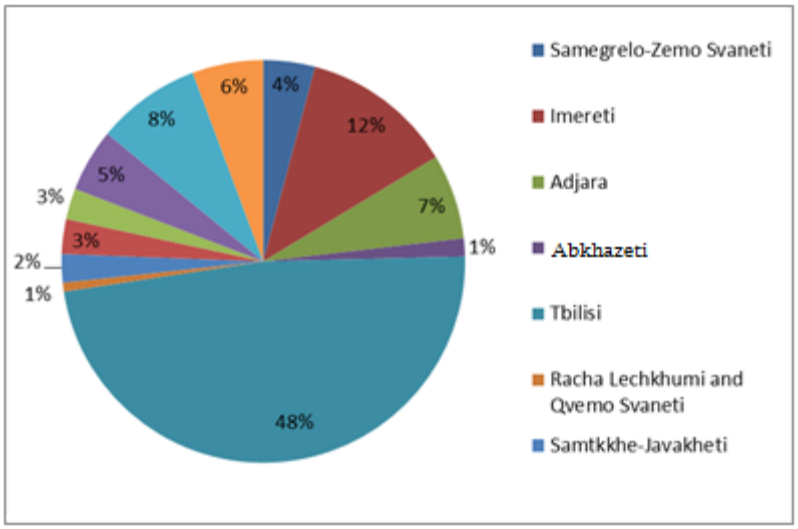


Figure 2. Distribution of Economic Subjects Registered in Georgia by Regions (According to the situation by September 1, 2009)

The Regional Chamber of Commerce represents the business society of the region, with 130 registered companies and firms. The most important tasks of the Chamber are to represent and protect the interests of its members in Georgia and abroad, promote market principles, assist regional businessmen to create their own products and explore new markets, as well as help the region to attract investments.

Zugdidi is rich in geothermal resources. The first initiatives to develop the field were carried out in the 1960s when two pumping stations were built – the first near the thermal sources and the second in the centre of the city. The second pumping station

supplied geothermal water to the existing central heating system. During the winter the system supplied 3000m^3/day of geothermal water for 4500–5000 m^2 in residential houses and public buildings. However, the efficiency of the system was much lower than expected, due to technical reasons and circumstances. Another attempt to develop geothermal heating was carried out with a 4-T borehole at the Zugdidi paper factory, for heating and technological purposes. After three years of successful exploitation, the source stopped because of new wells drilled in Tsaishi not far away.

Thus, the conclusions made regarding the practical use of geothermal waters from the Zugdidi-Tsaishi fields are that fields were developed without prior study-- drilling new wells was not studied in connection to existing heating systems and sometimes even hindered the functioning of the existing system; environmental problems were completely ignored; the developments were frequently marred by examples of violations of the basic rules of the system plans and construction.[13]

Under the SEAP an efficient management of geothermal resources in Zugdidi is considered one of the activities with great potential economic possibilities, but needs additional discussions and decisions. A study must be carried out to evaluate the possibility of restoring the old geothermal wells.

Governing Body

Zugdidi City obtained the status of "self-government" in 2014 which means it can elect local municipal and legislative representatives to the City Council. According to Paragraph 2 of Article 16 of the "Organic Law on Self-Governance", local authorities can promote investments, approve employment programs, and approve infrastructure and other programs. Zugdidi City Hall and Zugdidi the City Council are responsible for cooperation and consultation with donors and other stakeholders.

Strategic Plans and Trends

According to the medium-term development program[14] of Zugdidi Municipality for 2013-2017, the city plans an eco-friendly administrative unit by 2017 with "well-organized infrastructure, growing infrastructure, strong civil society, a variety of medical and social services, improved cultural, educational and sport programs, a tourist infrastructure, effective water supply and sewerage systems, effective treatment facilities and guaranteed uninterruptable power supply". In order to achieve these objectives Zugdidi will develop the following priority areas:

- Create an attractive, supportive business environment for SME development and employment;
- Implement infrastructure projects to provide high-quality and diversified services to the population;
- Provide appropriate services to the population in social and healthcare fields;
- Improve the cultural, educational and sport organizations material resources;
- Create a tourism-friendly environment.

[13]USAID. Zugdidi-Tsaishi field's geothermal waters practical use attempt overview

[14]Zugdidi Municipality Medium-term Development Program 2013-2017

These trends are consistent with the State Strategy[15] for the Regional Development of Georgia 2010-2017. According to the third chapter of the resolution "Development of Municipal Service and Infrastructure", the priority tasks of the country's regional development are as follows:

- Water Supply Sector Development;
- Municipal Waste Management;
- Transport System Development.

According to the Zugdidi City General Land Use Plan of 2009[16], possible trends of Zugdidi Economic Development include transport and engineering infrastructures, availability of well-qualified, experienced workforce in large enterprises, developing housing in Zugdidi and its surroundings and developing a road network which offers favorable conditions for large-scale processing enterprises. Among high-priority issues[17] the 2014 budget envisages the street lighting sector development, building repairs, repair of drainage network and other projects related to equipping the City with necessary facilities.

THE SUSTAINABLE ENERGY ACTION PLAN

After the status of self-government was granted to Zugdidi in February 2014 by the central Georgian government, the powers of the City government changed and expanded. This includes both its commitments toward the City and the whole region's development and raises new challenges for the government to drive a process of sustainable development over all the Municipality and the Samegrelo-Zemo Svaneti Region in the next five years. This creates an urgent need to develop the city's resources, including human, technological and financial.

The Samegrelo-Zemo Svaneti Regional Development Strategy Document for 2014-2021 points out: "Samegrelo-Zemo Svaneti will become one of the fastest growing regions in Georgia by 2021, with a stable economy and social well-being. The region will be distinguished by strong transport and communications sectors, dynamically developing industry, tourism and agriculture, processing and small business sectors, innovative entrepreneurial and research processes, an attractive investment climate and infrastructure, significantly increasing revenues, existing industrial powers and new markets to promote a higher standard of living and the well-being of the population."[18] The SEAP will help transform Zugdidi into a Sustainable Development Center to support these processes.

[15]State Strategy of Regional Development of Georgia 2010-2017

[16]Zugdidi City General Land Use Plan. 2009

[17]Explanatory note–on Zugdidi Municipality Budget Project and Priority Document

[18]Decree of the Government №1372 on approval of Samegrelo-Zemo Svaneti strategy of 2014 – 2021.

Strategic Planning and Increasing Local Opportunities

Since Zugdidi has had little experience in self-government there is no general plan for the city developing its strategies and priorities. Therefore creating a city development plan is a priority, and the SEAP will be contribute to sustainable economic development of the city. These two plans (City Development and the SEAP) have to be interconnected and coordinated. In addition, the city should be involved in projects of regional and national significance to ensure its sustainable development and socioeconomic growth while reducing CO2 emissions.

The SEAP was created using expert opinions discussed with managing structures of the city. It has to be integrated into the City Development Plan as soon as possible. The latter will cover Zugdidi City, Zugdidi Municipality and Samegrelo-Zemo Svaneti Regions' different sectors' plans and strategic trends. To determine the city's functional position and to determine the main priorities and work on them, it is necessary to include the SEAP priorities-- and these sectors can provide the basis for the Zugdidi SEAP, including Transport, Buildings and Infrastructure (waste, street lighting, and green areas).

Before discussing strategic views and priorities, however, particular attention should be paid to increasing the opportunities for the governing body of Zugdidi and other sectoral representatives to implement the sectoral measures necessary. This includes a need for specialized training, as well as technological and financial assistance to increase the potential of the city and region.

Sectoral Development

The Zugdidi City SEAP was developed in 2014 and includes six years including 2020. To do this the emissions reduction strategy for all sectors discussed in the SEAP has been divided into two periods: short-term (2014 – 2017) and long-term (2018 – 2020). Measures planned under the short-term period are more specific and detailed while long-term period measures are discussed in more strategic terms requiring further research, planning and feasibility study. This approach is fully consistent with the SEAP guiding methodology.

The sectoral strategy of GHG emissions reduction has been developed for all sectors in the Zugdidi SEAP, considering the CO_2 emissions growth rates of 2012 as a baseline year emissions inventory, until 2020. The following areas have been identified.

Transport Sector

Short-term:

1. Urban planning strategy development;
2. Successful completion of initiated and implementing projects for GHG emissions reduction for tbe transport infrastructure development:
   a. Construction of a bridge connecting Tsaghveri and Javakhishvili streets;
   b. Construction of additional bridges over the Chkhoushia River;
   c. Asphalting the city bypass road - Sh. Khubulava St.
   d. Paving other internal central streets.

Long-term:

1. Implementating measures formulated and agreed under the urban strategy;
2. Identify measures requiring feasibility studies, including four bridges:
   a. A bridge in the southern part of the city to connect Gori St and Constitution St;
   b. A bridge in the center connecting Kedia St. and Saint Petersburg St.;
   c. A bridge in center connecting Dadiani and Gulua Streets;
   d. A bridge in the northeastern part of the city connecting Tsereteli and Demuria Streets.
3. Creation of paths for pedestrians and cyclists.

Public Transport short-term strategy:

Prepare a detailed strategy of public transport development that will increase comfort and attractiveness, and take public transport services improvement measures, including:

a. Create a service park for the city municipal transport;
b. Construct Bus Stops for pedestrians;
c. Install smart e-schedule traffic boards;
d. Renew city municipal vehicles;
e. Determine and optimize internal transport routes;
f. Take measures to reduce traffic congestion;

Public Transport Long-term Strategy:

1. Increase the percentage of renewable fuel consumed by the Municipal Transport Fleet (biodiesel from used cooking oil collected from Zugdidi and Anaklia restaurants; biogas from landfills and from wastewater treatment facilities; electric transport, etc.).

Private Transport Short-term Strategy:

1. Develop an efficient parking policy with realistic fees are collected and parking spaces designated in the city center.

Private Transport Long-term Strategy:

1. Create technical vehicle inspection and fuel quality standards.
2. Create policies that motivate vehicle owners to reduce emissions.

Buildings Sector

Due to a high potential for renewable resources in Zugdidi Municipality (geothermal waters, biomass, including hazelnut shells) an assessment of these resources and action plan for the buildings sector are priorities. After this, renewable energy in the private and municipal sectors will be expanded.

Buildings Sector Short-term Strategy:

1. Prepare a renewable energy strategy and action plan for residential buildings (for heating);
2. Take simple energy efficiency measures in residential areas, especially in more densely populated neighborhoods with internally displaced persons.
    a. Install energy-efficient bulbs (as well as LED bulbs with motion sensor detector) in common areas of residential buildings;
    b. Insulate common areas of residential building entrances;
    c. Insulate attics and walls of IDP settlement buildings;
    d. Insulate roofs of private houses;
    e. Replace old windows with double-glazed ones.

The long-term SEAP envisages measures for residential buildings such as increasing the amount of renewable energy for heating (geothermics, biomass, sun).

Municipal buildings short-term measures include:

1. Thermal insulation for kindergarten roofs;
2. Replacing lighting with energy-efficient bulbs (energy-efficient bulbs with central control system).

Long-term measures for municipal buildings include:

1. Use of waste biomass pellets in municipal buildings (pilot projects);
2. Heating/cooling supply of Zugdidi City Municipality administrative buildings with heat pump and heating and cooling system and modern energy efficient technologies in other areas of the Municipality.
3. Use of solar collectors in kindergartens.

Municipal Infrastructure Sectors

The Municipal Infrastructure Development Strategy for 2016 includes three subsectors.

1) capture and burn methane (CH_4) from old and new landfills of the municipality. It is possible use the gas in the transport sector.

2) improve the energy efficiency in street lighting (by stages).

3) expand green zones of the city. Landscaping measures involve the Zugdidi Botanical Garden and a new city park (5ha).

SEAP development methodology and summary

The Zugdidi SEAP development methodology did not use a fixed baseline year since it must take associated risks with the city development processes into account. The methodology takes the future development of the city and the inevitable increase in emissions into account until 2020. This increase is reflected in the BAU scenario which is presented in detail in the Transport chapter.

A summary of inventory results of 2012 – 2020 and the assessment of emission rates saved by implementation of SEAP measures are given below:

Table 3. **GHG Emissions in Zugdidi in 2012 and 2020 BAU scenario (tons CO_2 eq.)**

Sector	2012	2020 (BAU)
Transport	30122	39583
Buildings	12740	18507
Street Lighting	225	282
Waste	3578	6892
Total	**46666**	**65264**

Table 4. **Emissions Savings in different sectors according to Zugdidi SEAP**

Sector	Saving (tons CO2eq)
Transport	6 980
Buildings	3410
Street Lighting	226
Waste	4 792
Landscaping	315
Total	**15 723**

Figure 3 shows emissions distribution by sectors in accordance with the BAU scenario between the baseline year of 2012 and 2020.

Figures 4 - 7 show increases in emissions in different sectors for the BAU and the SEAP scenarios.

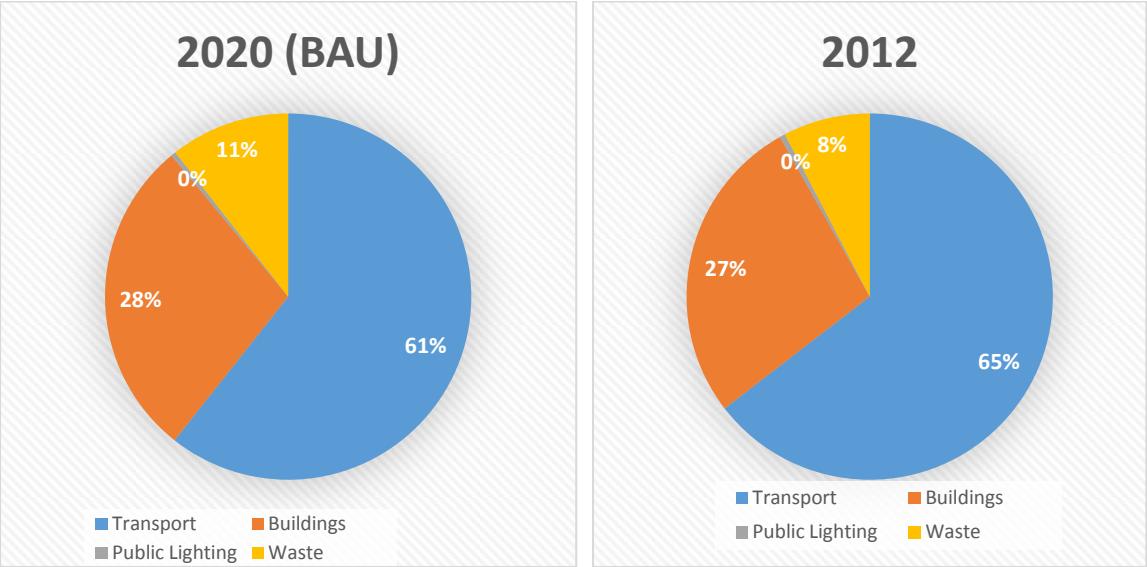


Figure 3. Distribution of emissions by sectors between years 2012 and 2020

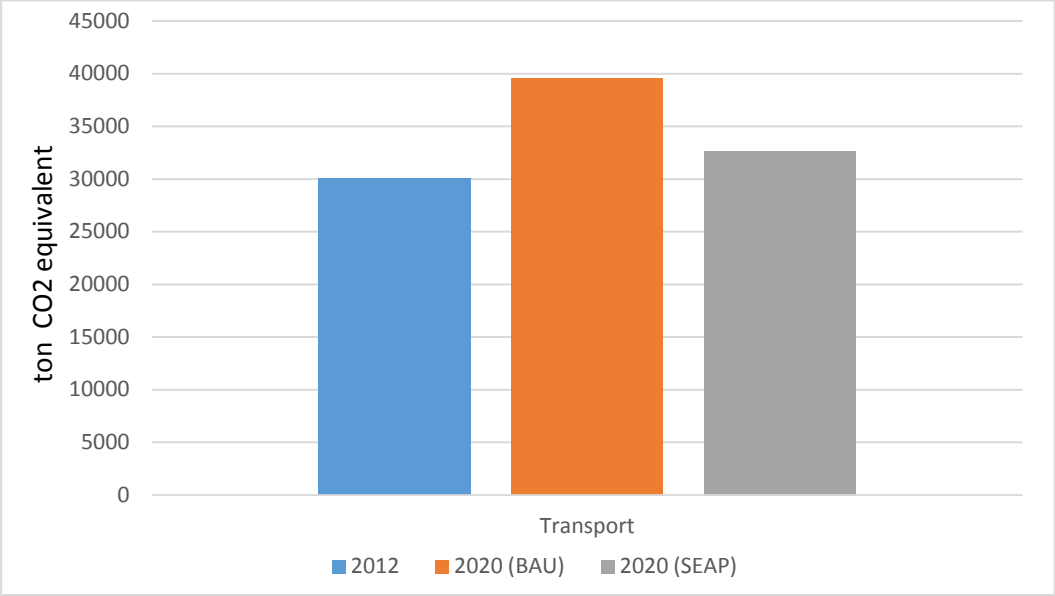


Figure 4. Increase of emissions according to the BAU and the SEAP scenarios in transport sector

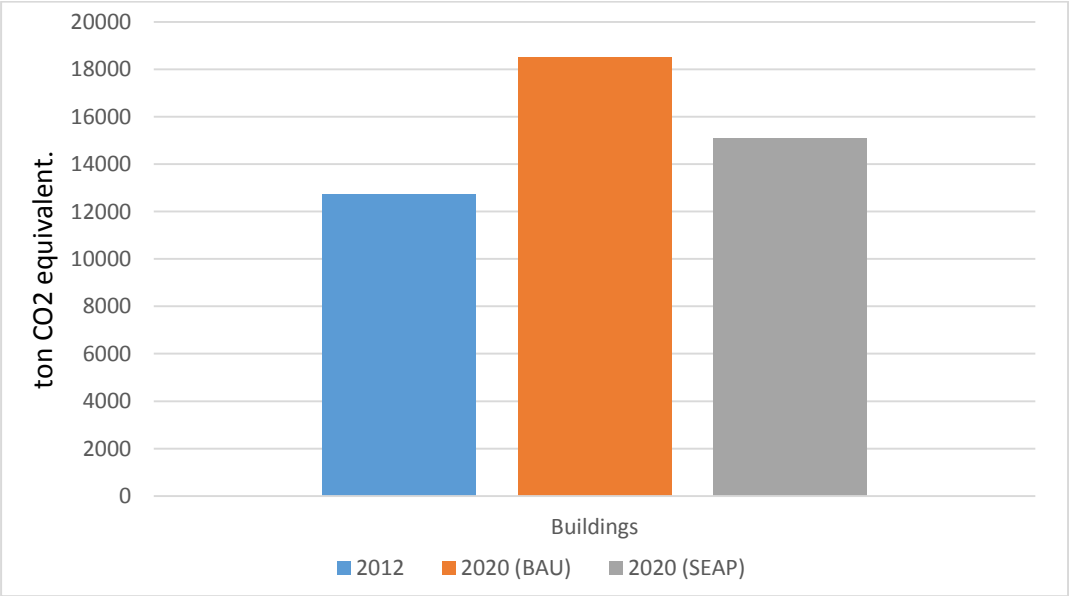


Figure 5. Increase of emissions according to the BAU and the SEAP scenarios in the buildings sector

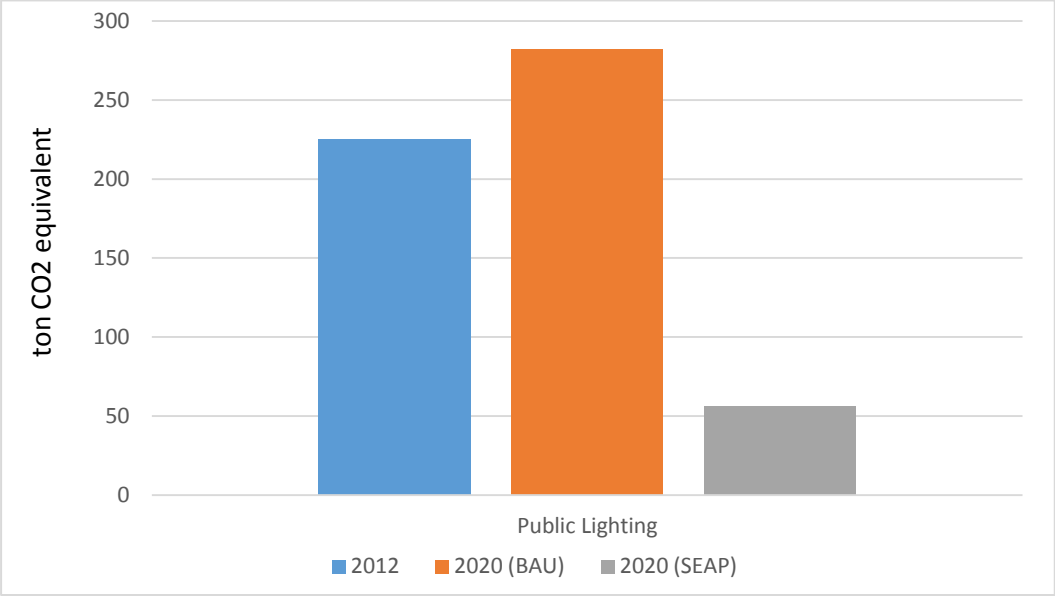


Figure 6. Increase of emissions according to the BAU and the SEAP scenarios in the lighting sector

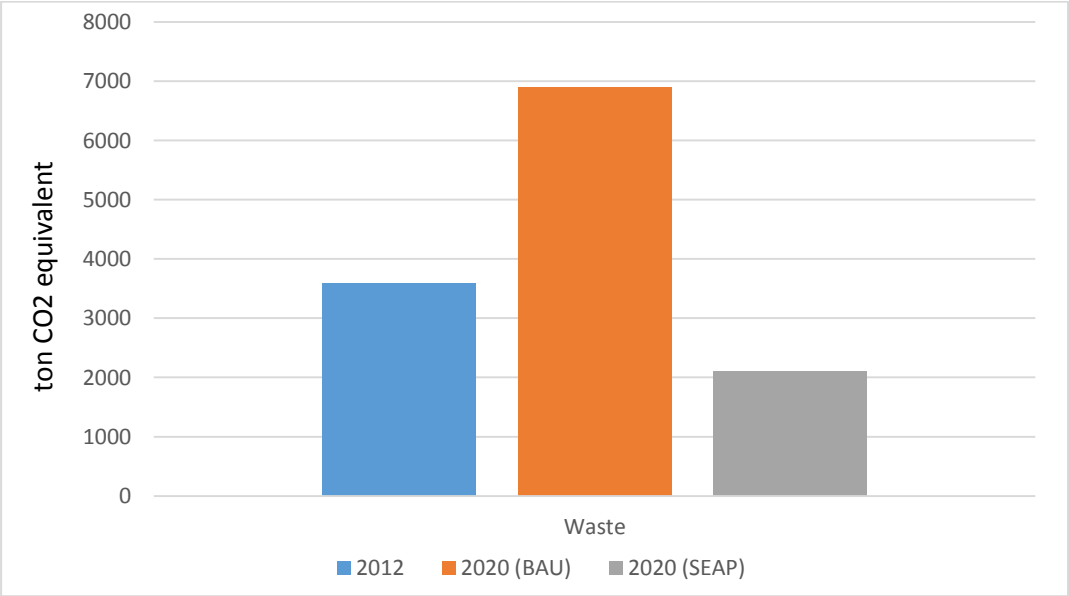


Figure 7. Increase of emissions according to the BAU and the SEAP scenarios in waste sector

TRANSPORT & ROAD INFRASTRUCTURES

Sector Overview

Main Georgian highways pass through Zugdidi's territory, from Tbilisi to Sokhumi and to Mestia and Anaklia, however after the Abkhazian-Georgian conflict the Tbilisi-Sokhumi road was closed near the village of Rukhi. There is a total of 591 km of motorways covering the Municipality of which 351 are asphalted and 240 dirt or gravel. In Zugdidi itself the total length of streets is 170 km, including 91 km asphalted, 79 km gravel or stone.[19]

Road conditions have significantly improved compared to previous years. Internal rural roads have been repaired through sources allocated by central and local budgets, asphalting of Ingiri – Octomberi-Kakhati and Kakhati – Orsantia motorways along with city roads has been funded by the Municipal Development Fund, and the process continues. A total of 15,686,472 GEL was spent on roadworks in 2010-2013.[20]

Error! Reference source not found. is a map of Zugdidi showing a well-organized semi-radial street network in the center, but where the interconnection of territories in southern Zugdidi divided by the railway is complicated, and isolates parts of the City since there is no passage from one side to the other.

[19]Zugdidi City Hall.

[20]Zugdidi City Hall.

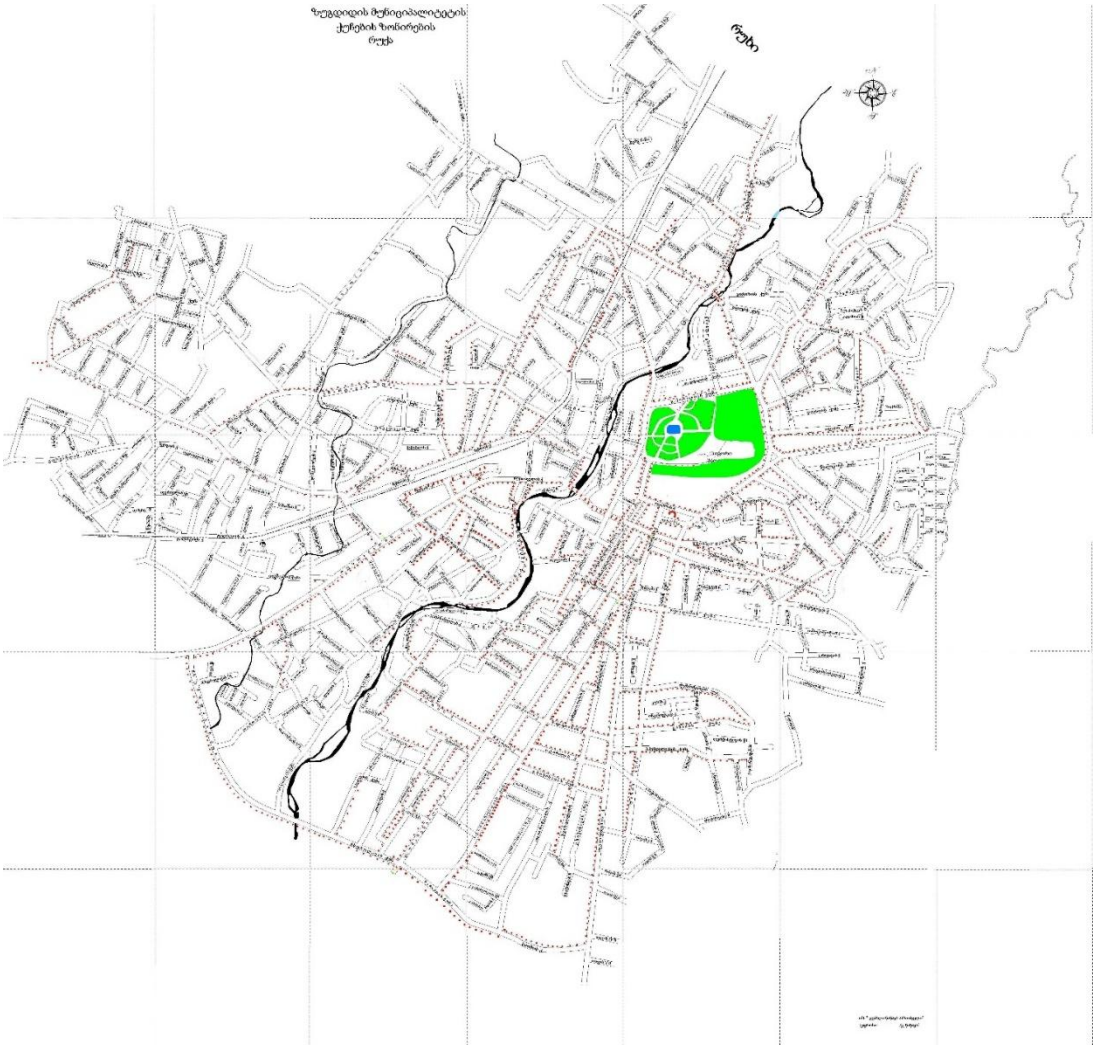


Figure 8. Zugdidi Street Plan

Buses ensure regular transportation by 32 local and 56 suburban passenger routes. The LLC "Municipal Transport" carries passengers witih "Bodgan" type buses and low fees on local and suburban routes. Three bus stations and a ticket office connect the buses according to routes, from where passengers travel between all main cities of Georgia. Out of 21 buses, 14 serve the city and 7 serve surrounding villages. Two mini-bus companies—Era LLC and Daka-Georgia LLC—also serve the city. Information on passengers and vehicles is presented in Table 5.

Table 5. Zugdidi Local Municipal Transport passengers and kilometers covered

Transport Companies	Type	Carried Passengers (thousands)		Trans. Quantity (unit.)	Covered distance km		Fuel Type		
		Daily	Annualy		Daily	Annualy	Gasoline	Diesel	Natural gas
"Zugdidi Municipal Transport» LLC	Shuttle bus	4116	1481760	14	2058	740880		14	
Daka Georgia LLC	Shuttle mini-bus City	3120	1123200	26	1230	442800		26	

"Era" LLC	Shuttle mini-bus City	952	342720	7	1050	378000		5	2
	Shuttle mini-bus intercity	8188	2947680	47	4338	1561680	0	41	2

The number of motor vehicles registered in the Municipality by the Service Agency tripled between 2003 and 2013. Zugdidi residents own about 80% of the vehicles.

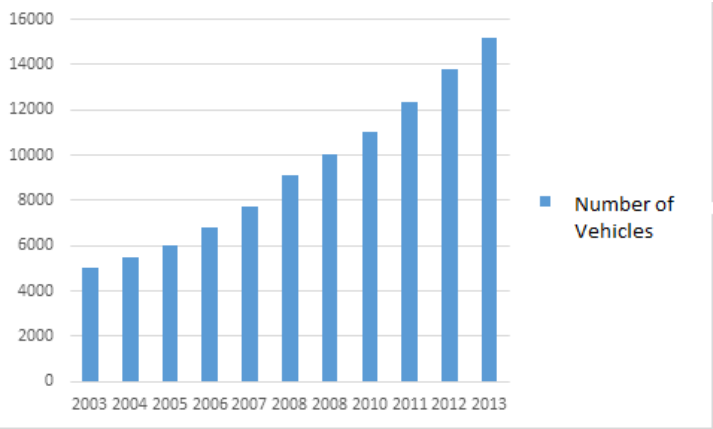


Figure 9. Increases of vehicles registered in Zugdidi Municipality 2003-2013

The increase in vehicle numbers is expected to continue, resulting in increase of GHG emissions. Thus energy efficiency in the transport sector is one of the most important SEAP objectives. Monitoring and surveys have been conducted to determine taxi and private/commercial truck traffic. Drivers were polled and vehicles counted during different periods and in 19 different parts of the city. It is estimated that 22% of buses use gasoline, 12% use diesel and 65% use natural gas. This is illustrated in Table 6.

Table 6.Transport registered in Zugdidi and its characteristics

Vehicles	Motor vehicles (except for taxis and municipal vehicles)	Vehicles serving Zugdidi Municipality and other transport facilities	Motorcycles	Buses	Mini-buses	Taxis	Small Trucks (up to 2 tons carrying capacity)	Heavy Trucks
By fuel type								
Gasoline powered	8 700	12	41			95		
Diesel powered	2 150	15		14	33	15	12	25
Natural gas powered	268					110		
Total	**11 118**	**27**	**41**	**14**	**33**	**220**	**12**	**30**
Annual kilometrage (km/car)	12 000	18 000	1 800	52 920	24 873	15 600	8 400	7 200
Average fuel consumption on gasoline (l/100 km)	9	18	3			9		
Average fuel consumption on diesel (l/100 km)	8	12		21	13	7	12	35
Average fuel consumption on natural gas (m^3/100 km)	7.00					11.00		
Total gasoline consumption (litre)	9 302 040	38 880	2 214	0	0	133 380	0	0
Total diesel consumption (litre)	2 043 360	32 400		155 585	106 704	16 380	12 096	63 000
Total natural gas consumption (m^3)	222 869	0		0	0	188 760		0

Fuel stations, including one 3 km away, were also surveyed for the SEAP. Fifteen gasoline/diesel and 3 natural gas stations serve Zugdidi. Brands are Gulf (3), Socar (2)(Gas+liquid), Wissol (3), Rompetrol (3), Lukoil (1), Crystal (1), and private (4) non-branded. The survey showed that 90-95 tons of fuel and 7 m^3 natural gas, are sold daily, or 2775 t. of fuel a month (30 days). Including:

- Gasoline - 1 942 t.
- Diesel - 833 t.
- Natural gas – 21m^3.
- Liquid gas- 1 m3 (transit vehicles generally)

According to Table 6, annual total fuel consumption in Zugdidi amounted to 9.5 million liters of gasoline, 25 million liters of diesel and 412 000 m^3 of natural gas. The fuel station survey showed a total of 33,300 t/y. The GHG inventory was based on the data from the table, however, it includes fuel consumption by vehicles coming from outside, e.g. on inter-city routes.Fuel consumption by cars transiting the territory should be added for accurate record keeping however due to the lack of information on transit traffic and incoming flows, only data on registered vehicles have been used.

Methodology

The baseline year for the transport sector, like other sectors, is 2012. GHG emissions are calculated with a formula adapted for the intergovernmental council's (IPCC) methodology level 1 sector approach for the local level, which is based on actual fuel consumption data.

Carbon Dioxide emissions$_j$(GgCO2) =
□□$_i$ {Actual fuel consumption ji (unit) x caloric value of fuel i(MW.h21/per unit)
x carbon emissions factor (TC/MW.h)/1000 x oxidized carbon portion i} x 44/12,
Where lower index refers to sector and lower index i - type of fuel.

Emissions for other gases with sector approach were calculated via following formula:
GHG emissionsj(GgGas)=
□□i {Actual fuel consumption ji (unit)
x caloric value of fueli(MW.h/per unit)
x Gas emissions factor ji(TGas/MW.h)/1000].

The IPCC typical values of carbon emission factors (carbon emission per energy unit) and transfer coefficient (fuel's heat of combustion, i.e. caloricity) have been considered for calculations since 1996.

[21] Basic energy unit in IPCC methodology is Terajoule, while in the SEAP methodology it is MW/h, that is why MW/h is used in the text

Table 7. Transfer Coefficients and Carbon Emissions Factors for Different Types of Fuel

Type of Fuel	Unit	Transfer Coefficient (MW/h unit)	Carbon Emission Factor (Ton C/ MW.h)
Gasoline	1000 liters	0.01	0.247
Diesel	1000 tons	0.011	0.267
Liquid Gas	1000 tons	0.013	0.227
Natural Gas	1 million m^3	0.009	0.202
Firewood	1000 m^3	0.002	--

The average emissions factor from the electricity grid was applied in 2012, which was 0.136 kg CO_2/kWh. A small portion of carbon in fuel is not oxidized during combustion but most is oxidized later in the atmosphere. It is calculated that non-oxidized carbon is stored indefinitely. Typical values of oxidized carbon recommended by the IPCC and used for 2006-2011 inventory are given in Table 8.

Table 8. Portion of Oxidized Carbon for Different Fuels

Fuel	Portion of Oxidized Carbon
Oil and Oil Products	0.990
Natural Gas	0.995

Different gas emissions factors for the transport sector are given below in Table 9.

Table 9. Methane and Nitrous Oxide Emission Factors for Transport Sectors (kg/MWh)

GHG	Gasoline	Diesel	Natural Gas
CH_4	0.072	0.018	0.18
N_2O	0.002	0.002	0.0004

Global warming potential values (GWP) of these gases for converting methane and nitrous oxide into carbon dioxide equivalent are presented in Table 10.

Table 10. Global Warming Potential of Methane and Nitrous Oxide

Gas	Life Expectancy, Years	100-year GWP
CH_4	12±3	21
N_2O	120	310

A guidance document[22] has been developed by the Joint Research Centre (JRC) for the MGCe Eastern Partnership member cities, according to which these cities are given a choice to determine mandatory reductions of emissions through three alternative approaches:

1. Reduction for full emissions of fixed base year;
2. Per capita emissions reduction for fixed year emissions;
3. Reduction by Business As Usual (BAU) scenario for prospective emissions of 2020.

The Zugdidi SEAP uses emissions reduction calculations for the BAU scenario. There are two options of scenario construction described by the guidance document:

1. The city can develop its own methodology, which will be evaluated by the JRC later;
2. The city may use national ratios indicated in the guidance document, developed for the Global Atmosphere Research (EDGAR) project CIRCE[23] employing an emissions database. The POLES (Prospective Outlook for the Long-term Energy Systems)[24] method has been used, and considers growth of energy consumption due to population and economic growth. According to the baseline year, the BAU scenario calculates the level of emissions for 2020 assuming that current trends of population, economy, technologies and human behavior will continue, and that no national measures will be taken towards a reduction of emissions[25].

The first approach has been applied in case of Zugdidi, i.e. its own methodology developed similar to the second approach. As in the second alternative, national growth ratios are being taken but there are differences:

1. The ratios have not been obtained from research conducted outside the country, as JRC ratios, but in accordance with the BAU scenario results based on the MARKAL-Georgia model created at the national level and used for creating low-emissions and energy strategies for Georgia. Therefore, these ratios better reflect the current situation and future plans of the country.
2. The ratios are available at the level of total emissions and at different fuel consumption levels in various sectors, allowing for better mitigation measures planning.
3. If there are population and Gross Domestic Product (GDP) growth projections at the municipal level, projections may be used to modify MARKAL-Georgia national ratios.

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[22]"HOW TO DEVELOP A SUSTAINABLE ENERGY ACTION PLAN (SEAP) IN THE EASTERN PARTNERSHIP AND CENTRAL ASIAN CITIES" — GUIDEBOOK, European Commission Joint Research Centre, Institute for Energy and Transport, Luxembourg: Publications Office of the European Union © European Union, 2013

[23] U.M. Doering, G. Janssens-Maenhout, J.A. van Aardenne, V. Pagliari (2010), CIRCE report D.3.3.1, Climate Change and Impact Research in the Mediterranean Environment: Scenarios of Future Climate Change IES report 62957.

- A. Pozzer, P. Zimmermann, U.M. Doering, J. van Aardenne, H. Tost, F. Dentener, G. Janssens- Maenhout, and J. Lelieveld, Effects of business-as-usual anthropogenic emissions on air quality, Atmos. Chem. Phys. Discuss., 12, 8617-8676, 2012, doi:10.5194/acpd-12-8617-2012

[24]Russ, P., Wiesenthal, T., van Regenmorter, D., Ciscar, J. C., 2007. Global Climate Policy Scenarios for 2030 and beyond. Analysis of GHG Emission Reduction Pathway Scenarios with the POLES and GEM-E3 models, JRC Reference report EUR 23032 EN. http://ipts.jrc.ec.europa.eu/publications/pub.cfm?id=1510

[25]JRC Report, "An approach with a Business-as- Usual scenario projection to 2020 for the Covenant of Mayors from the Eastern Partnership", 2012. http://edgar.jrc.ec.europa.eu/com/JRC-IES_CoM-East_report_BAUprojections2.pdf

Applying this method, an Excel-based software program, muni-EIPMP (municipal emissions' inventory, projection and mitigation measures planning), has been developed by the USAID funded "Enhancing Capacity for Low-Emission Development Strategies Clean Energy Program". It is the basis for BAU scenario projections based on the MARKAL-Georgia model and can be adapted to specific municipality inventories. The BAU scenario has been developed for Zugdidi using this software. Applied ratios are shown below (Table 14).

In addition to GHGs other local transport-related pollutants have been evaluated. Special software COPERT IV (Computer Programme to Calculate Emissions from Road Transport) from the European Agency has been applied and is widely used in Europe. Information in Georgia and its regions need to be adapted to the COPERT IV model, since very much information is lacking. COPERT IV allows the approximate evaluation of emissions on the basis of standard values of properly selected initial data. Due to the fact that technical inspections of vehicles are not carried out, and the information on fuel quality is lacking, the true values of pollutant emissions are likely much higher than the values shown here. As for the number of vehicles and fuel consumption, they are tailored to specific locations. Using COPERT makes it possible to regulate the database and create preconditions to calculate emissions from the transport sector, so certain data categories will be added. The results can only be applied to see emission trends and determine which are most likely to increase or decrease as a result of measures taken.

The following additional pollutants have been assessed with the COPERT software:

- Heavy metals: Lead (Pb), Cadmium, Copper, Chromium, Nickel, Selenium, Zinc;
- Volatiles: Volatile Organic Compounds (VOC), Non-methane Volatile Organic Compounds (NMVOC); Non-volatile: Carbon Monoxide (CO), Nitrogen Oxides (NOX, NO, NO2, NH3), PM, OM, EC, FC;

Direct GHG emissions have been assessed (C02, N2O and CH4) for all vehicles registered in Zugdidi (according to Table 1), and compared with the results of the inventory.

Base Year Inventory and Baseline Scenario of the GHG Emissions (2013 – 2020)

The structure and the baseline year inventory of 2012 data regarding fuel consumption by Zugdidi Transport include the following types of transportation:

- Municipal service vehicles;
- Public transport (buses, mini-buses and taxis);
- Private and commercial transport.

According to the SEAP development methodology, fuel consumption by navigation, air traffic and railway is not considered since travelling by abovementioned facilities is not within the city's territorial limits.

Fuel consumption in Zugdidi transport sector reached about 120 thousand MWh in 2012.

Table 11. Final Energy Consumption of Zugdidi Transport Sector (MWh) - 2012

Subsector	Natural Gas	Diesel	Gasoline	Total
Municipal Vehicle Fleet	0	347	369	717
Public Transport	1 761	2 988	1 267	6 017
Private & Commercial Transport	2 080	22 716	88 397	113 194
Total	**3 841**	**26 052**	**90 034**	**119 927**

Emissions of GHGes from the transport sector reached about 30.6 thousand tons of CO_2 equivalent in 2012.

Table 12. GHG Emissions from Zugdidi Transport Sector in CO_2Equivalent - 2012

Subsector	Natural Gas	Diesel	Gasoline	Total
Municipal Vehicle Fleet	0	92	92	184
Public Transport	361	792	316	1 468
Private & Commercial Transport	426	6 020	22 024	28 470
Total	**787**	**6 904**	**22 432**	**30 122**

Emissions of other local pollutants of 2010-2012 are presented below (Table 11).

Table 13. Total Pollutants (t) and Percentage Difference between 2010 - 2013

#	Title	Year				2010 -2012 difference
		2010	2011	2012	2013	
1	PB (kg)	4,11	4,24	4,42	4,55	**11%**
2	Cadmium (kg)	0,12	0,13	0,13	0,14	**17%**
3	Copper (kg)	52,37	53,46	55,84	57,42	**10%**
4	Chromium (kg)	2,08	2,12	2,22	2,29	**10%**
5	Nickel (kg)	1,02	1,04	1,08	1,10	**8%**
6	Selenium (kg)	0,14	0,15	0,15	0,15	**7%**
7	Zinc (kg)	22,99	23,37	24,33	25,01	**9%**
8	VOC	415,11	417,60	425,35	439,16	**6%**
9	NMVOC	401,33	403,02	410,31	423,63	**6%**
10	CO	3 755,34	3 826,80	3 951,54	3 951,54	**5%**
11	CH4	13,75	14,53	15,02	15,53	**13%**
12	NOX	262,49	270,47	281,14	289,61	**10%**
13	NO	249,73	257,11	267,07	275,16	**10%**
14	NO2	12,59	13,26	13,87	14,21	**13%**
15	N2O	0,94	1,00	1,04	1,07	**14%**
16	NH3	0,31	0,32	0,33	0,34	**10%**
17	PM	8,32	8,70	9,37	9,42	**13%**

Total GHG emission increases according to the MARKAL-Georgia National Model are presented below:

Table 14. Fuel consumption growth rates for types of transport according to the BAU scenario

Sector	2012	2013	2014	2015	2016	2017	2018	2019	2020
Transport	1	1.05	1.10	1.1	1.19	1.23	1.3	1.29	1.31

Due to the absence of local projections for gross domestic product and population growth, the national projections without modifications are used for Zugdidi. According to the baseline scenario, GHG emissions from the transport sector are 40,000 tons of CO_2 eq. for 2020.

Increases in GHG emissions in transport sector are given below:

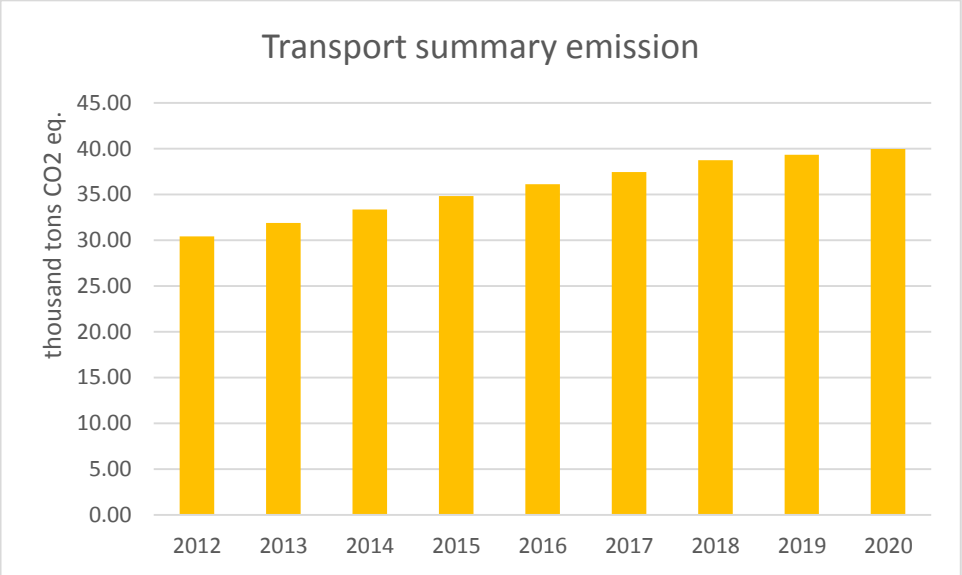

Figure 10. Trend of emissions from the transport sector according to the BAU scenario

Emissions Reduction Action Plan from Zugdidi Transport Sector

Transport plays a key role in today's society, taking them to workplaces and schools, shops and medical facilities. Transport helps get agricultural products to markets, raw materials to factories, office inventories to organizations and finished products to shops. It unites families and friends to communicate and help each other. It allows politicians and businesspersons to establish direct contacts and promote problem-solving and business relations.

Transport consumes significant amounts of energy and fossil fuels are mainly used today, but these are increasingly associated with GHG emissions into the atmosphere. The world's environmental, social and economic challenges require switching over to public transport, electric or other less polluting private vehicles, going on foot, using bikes and better city planning. In highly developed countries overcoming dependence on cars is already taking place. Developing countries are reaching towards a greater use of public transport and making it more sustainable. Although overcongestion is not as acute a problem in developed countries today, the fast pace of economic growth in developing

countries has meant unregulated use of private vehicles and a lack of public transport policies, all of which requires urgent measures. Traffic, noise, security, air pollution and GHG emissions are making such cities less attractive for investors, and causing them to invest elsewhere.

Zugdidi, like other cities, finds itself between these two realities. There are 160 privately owned cars per 1000 residents, approximately two and a half times fewer than in Western European cities, however Zugdidi residents prefer large, inefficient vehicles, as elsewhere in Georgia. Air pollution and traffic congestion caused by lacks of mandatory technical inspection and fuel quality are raising the rate of GHG emissions. Therefore, an action plan on reducing GHG emissions in the transport sector primarily include measures improving traffic flow, transport infrastructure and public transport services, as well as other ways to use vehicles and efficient technologies.

The necessity to implement measures to resolve transport issues was identified by assessing former general plans and their successes and failures at solving traffic regulation and improving public transport comfort and services. The new measures are divided into the following groups:

- Road infrastructure and urban planning (activity UP1 – UP3);
- Public transport (activity PBT1 – PBT3);
- Private transport (activity PRT1 – PRT3);

Developing strategies and detailed action plans is key for all three directions. At the three following strategies are necessary to fulfil measures and reduce emissions:

- Urban Planning Strategy and the Action Plan;
- Municipal Public Transport Development Strategy and the Action Plan;
- Parking Strategy and the Action Plan.

Implementing the Zugdidi SEAP measures will reduce CO_2 emissions from the Transport Sector by 6980 t. $CO_{2\ eq}$ by 2020.

Table 15. Zugdidi Transport Sector Action Plan

Subsectors and fields of activity	Main Measures (by subsectors)	Department/Person or Company in Charge/ if the third party is involved	Start/End Date	Cost	Expected Energy Savings (MW/h) from an Activity	Expected Renewable Energy (MW/h)	Expected CO2 Emission Reduction from an Activity (T)
Transport total					**14 951**	**0.35**	**6 980**
Public Transport	**PT1. Public Transport Service Improvement & Promotion:** Service Fleet Development for the City Municipal Transport; Construct bus stops for pedestrians; Install electronic display board; Optimize and improve internal transport routes ; Take measures to reduce overcrowding .	Zugdidi City Hall Transport Department	2015-2017	Estimation required	7 570		1 900
	Activity PT2. Renew Zugdidi City Municipal Vehicles	Zugdidi City Hall Transport Department	2015-2017	Estimation required	222		58
	Activity T3: Municipal Transport Conversion to Biodiesel	Zugdidi City Hall Transport Department	2017-2020	70 000 GEL		0.35	29
Private & Commercial Transport	**Activity PRT1. Parking Policy Development**	Zugdidi City Hall Transport Department	2015-2017	Estimation required	1 514		375
	Activity PRT2. Elaborating Technical Inspection and Fuel Quality Standards Activity PRT2. Encourage Low-emission Private Transport	Zugdidi City Hall Transport Department	2015-2017	Estimation required	10 670		2 755
Road Infrastructure and Urban Planning	UP1. Construction of Tsagveri and Javakhishvili connecting bridge	Zugdidi City Hall	2015-2018	3500000 GEL	733		242
	UP2. 4 Construction of Additional Bridges	Zugdidi City Hall	2018-2024	14000000 GEL	3 210		1 059
	UP3. Develop Walking and Cycling Routes	Zugdidi City Hall	2018-2020	Estimation required	1 702		562

Description of Activities

Up to 400 existing street networks have reserved areas that can be used by simple arrangements under the road infrastructure and urban planning measures:

Activity UP1. Construction of a Bridge Connecting Tsaghveri and Javakhishvili Streets

Internal city roads are diagonally divided by the Chkhoshua River, however only four transport and three foot bridges have been constructed. Today this is not enough to connect the network and ensure uninterrupted traffic movement. The construction of a bridge connecting Tsaghveri and Javakhishvili Streets is planned in the short-term strategy (for 2015) with a budget of 3.5 million GEL. It will have an important impact on infrastructure in Zugdidi, by connecting traffic from factory regions and seven lower villages with the city.

Many issues will be resolved, including the fact that 20 dangerous crossroads and 30 pedestrian crossings must now pass through the existing central route. Until the new bridge opens, cars have to go through the city center resulting in time and financial loss, causing drivers physical and mental stress, and therefore reducing their reaction in critical situations. After construction of the bridge, the shorter way will reduce traffic accidents and related damages; access to locations on the other side of the river will be shortened. It will be easier for Emergency Services (Medical, Fire, Police) to access all residential areas.

Total driving time for the shortened route will be 1-2 minutes for 0.5 km, while at present the central road takes nearly 10-15 minutes to cover three km. Assuming that 50% of all registered vehicles drive through this route at least once a week, the total amount of distance saved a year will be 725 thousand kilometers-- reducing emissions by about 242 thousand tons.

Activity UP2.4 Construction of Additional Bridges

Four more bridges are planned in the long-term strategy. These include:

- A bridge in the southern part of the city connecting Gori and Constitution Streets;
- A bridge in the city center, linking Kedia and St. Petersburg Streets;
- A bridge in the city center connecting Dadiani and Gulua Streets;
- A bridge in the north-eastern part of the city linking Tsereteli and Demuria Streets.

These four bridges will connect city streets along the Chkhoushia River. Most traffic will pass through these streets (about 80% of overall traffic will cross these bridges), but transit traffic will not. They will link city districts and mainly the low coastal zone, eastern and southern villages. Construction is planned before 2021 and along with bridge construction new roads are planned on the tea plantation and in new residential areas, to include them in the transport network.

Assuming that approximately 80% of registered transport will benefit from the bridges, reducing the 1.5 km distance by four, the total amount of distance saved by private vehicles will equal 3.65 million km, resulting in a 1059 t emissions reduction.

Activity UP3.Creation of Foot and Bike Paths

Bikes are one of the most popular forms of transportation in the world In 2007, 130 million bikes were produced worldwide, while only 69 million cars were manufactured in the same year. Due to energy crises and air pollution problems in the 1970s, many European countries decide to promote more sustainable transportation forms – public transport, walking and cycling.

Barriers to wider use of cycling can be overcome via following measures:

- Ensuring safe walking roads for bikes;
- Integrating this issue into other urban planning activities;
- Increasing the availability of bicycles;
- Providing technical services and spare parts;
- Increasing the level of bicycle protection;
- Increasing public awareness and cycling status.

Developing pedestrian areas is equally important, and both will enable the city to become future-oriented and sustainable. This implies: better functionality, safety, sustainable development, enhanced contacts between people, a healthier and more attractive environment. Pedestrian areas have a well-planned, well-connected network to make it easier for residents to reach their destinations safely, comfortably and on time. This measure also includes "environmental islands" in which private cars are prohibited.

Creating underpasses and clearing the sidewalks of commercial stands will help reduce impediments. At least two underpasses, as well as sidewalk repairs are needed as soon as possible to ensure easier passage and safety for pedestrians.

Urban planning and infrastructure development for the long-term strategy must take careful consideration of sidewalks and bike lanes. Although no policies have yet been defined the NGO Atinati is working on the popularization of cycling and walking. A pedestrian street could be located in the city center on the banks of the Chkhoushi River and connect the adjacent territories of Kostava, Sokhumi & Rustaveli Streets by bridge, with recreational spaces. Though street development is planned for 2017, traffic restrictions have not yet been considered. This will be possible after 2017, thus feasibility studies will determine where the bike and pedestrian routes will be located, as well as the sites of "environmental islands".

According to the Mitigation Measures Manual for Transport Sector[26], a 2-kilometer walk or bike ride can reduce emissions by 417 grams. Today Germany has taken appropriate measures, for example: only 15% of 1-3 km distances are covered by cars; 55% on foot; 30% by bike. Although the number of private vehicles is high people prefer more environmentally friendly forms of transportation when possible. According to a conservative estimate, at least 30% of 1-3 km distances will be covered on foot or by bike by 2020 in Zugdidi or about 5% of total transportation. Private vehicles covered about 133.4 million km in 2012; this figure will reach 175.3 million by 2020. Therefore, about 2.63 million km. of the total amount of distance traveled by private vehicles and public transport can be saved, resulting in a 562 tons of $CO_{2\ eq.}$ reduction compared to the BAU.

[26]Technologies for Climate Change Mitigation – Transport Sector, UNEP Risoe Center, 2011. http://tech-action.org/

Activity PBT1. Public Transport Service Improvement & Popularization

The demand for public transport is increasing as the population increases. Activities to be undertaken in the short term include:

- Renewal and development of the Service Fleet for City Municipal Transport;
- Creating busstops;
- Installating electronic display boards for transportation;
- Creating and developing better city transport routes;
- Reduce overcrowding in public transport.

Public transport emissions are much lower than for private cars. Therefore, helping the public decide to take public transport is important, but it has to be safe, comfortable, fast and available. Service improvement and popularization may not reduce private car use, but its growth will slow down emissions, compared to the BAU. Taking measures to restrict the use of private cars is also significant. All of these must be parts of a wider transport strategy.

Measures that improve public transport services and public awareness campaigns do not have a direct influence on energy consumption and CO_2 emissions, but they are effective weapons for other activities. Awareness and behavior change programs reduce the use of private cars by 10% in developed countries. The return for $1 is $30. [27] Since the percentage of public transport use is relatively high in Georgia, after taking adequate measures in all five directions, the rate of private cars will probably be reduced by 10% before 2020—and the transition from private cars to public transport will reduce emissions by half.[28] According to the baseline scenario, emissions by a private vehicle (with one passenger) in Zugdidi will reach 159,361 tons by 2020 according to the BAU. If 10% of the public take public transport, the emissions of this 10% will be reduced by half. In other words total emissions will be reduced by 5%, which is a 1900-ton reduction in CO_2 equivalent compared to the BAU.

Activity PBT2. Renewal of Municipal Public Transort Vehicles

This measure will implement the replacement of old buses by new, spacious and economical vehicles. Acquiring 17 new municipal buses is planned at first, resulting in approximately a 10% efficiency improvement and the reduction of emissions by 58,000 tons.

Activity PBT3: Municipal Transport Conversion to Biodiesel

The conversion of part of the municipal transport fleet to biodiesel will involve used comestible oils collected and delivered by Zugdidi and Anaklia restaurants and hotels. In return advertising for these businesses will be placed on buses. The Ilia State University and the organization Altera have launched a pilot project to create a biodiesel-producing machine to make fuel from waste cooking oil. It is being tested and a project proposal is prepared, which envisages ½-ton capacity biodiesel equipment that can provide 15-20 buses with enough biodiesel to save about 29,000 tons of fuel per year, or nearly 70,000 GEL. To carry out the measure properly, the assessment of oil storage and of their storage/collection systems will be required, needing additional funding.

[27] I Ker, Preliminary Evaluation of the Financial Impacts and Outcomes of the TravelSmart Individualised Marketing Program, ARRB for Department for Planning and Infrastructure, Perth, Western Australia, 2002.

[28] Technologies for Climate Change Mitigation – Transport Sector, UNEP Risoe Center, 2011. http://tech-action.org/

Activity PRT1. Developing Parking Policy

Parking policy is important for reducing emissions. Paid parking increases expenses and parking limits make it a less attractive option to use a car. Reducing congestion in central areas improves traffic safety at the same time. Relevant legislation is needed to establish municipal parking companies that collect fees to finance public transport, purchase/install meters; an urban planning review must designate areas for parking. According to the Mitigation Measures Manual for the Transport Sector[9], a 10% increase in the cost of cars leads to a 3% ownership decrease thus better parking policies can save about 375 tons CO_2-equivelent emissions.

Activity PRT2. Creating Technical Inspections & Fuel Quality Standards

The technical inspection of vehicles should become mandatory in Georgia in 2015, however this is still unclear. Zugdidi City Hall will align with the national policies to develop vehicle and fuel standards in line with European ones, as this will improve living conditions and health. Technical inspections will promote better vehicle maintenance. According to the Mitigation Measures Manual for Transport Sector[9] [a] well-maintained car's fuel consumption can be reduced by 3-7%. Since most vehicles in Georgia are old the emissions of private cars will be reduced at least by 7% which will cause a 2755 ton equivalent emissions reduction of CO_2. This assessment also includes PRT3 Activity results, as it has not been evaluated separately.

Activity PRT3. Encouraging Low-emission Private Vehicles

The former Activity PRT2 addresses the technical inspections of vehicles and fuel quality but implementing measures to replace air polluting gasoline- and diesel-powered cars with new, environmentally-friendly vehicles are also important. Measures can include the promotion of energy efficient cars, low- or zero-cost parking fees for eco-friendly vehicles, low rates for their technical inspections, reduced tariffs for low-emission taxis, etc. Since this measure will be implemented in the long term and the types of vehicles that will be promoted are not known, reduced emissions have not been assessed for this category.

BUILDINGS

Sector Overview

The buildings sector of Zugdidi is key for SEAP. This includes municipal and commercial buildings (offices, shops, hotels etc.). A significant prerequisite for reducing GHG emissions is to reduce energy consumption in existing buildings.

Picture 3. Dadiani Palace in Zugdidi

According to Zugdidi City Hall, there are 13,902 buildings in the city with a total area of 2,174,898 m^2. See Table below. (Table 14). There are generally two types of houses in Zugdidi – apartment buildings and one-family houses. Most are up to 50 years old, and some even older.

Table 16. Area of Residential Buildings in Zugdidi

№	Number of Storeys	Quantity	Total area (m^2)
1	1-2 ind.	13 806	2 095 923
2	1 – 3	39	4 290
3	4 – 5	41	49 991
4	10-Aug	16	24 694
	Total	**13 902**	**2 174 898**

Out of 96 multi-family buildings, 21% are about 30 years old, 54.1% - up to 50 and 23.9% over 50 years old. Out of the 78,975m^2 of floor space in the apartments, 92.3% are equipped with water, gas and electricity, while 7.6% are still without amenities. Most apartments are privately owned. There are 2,390 families (6,110 individuals) living in apartments in Zugdidi. Table 16 shows areas and numbers of constructions in Zugdidi. A list of buildings owned by the Municipality is presented in Table 17.

Table 17. **Number of buildings and their area in m2.**

№	Building title	Quantity	Area m²	Note
1	Residential Buildings	96	78 975	10, 9, 5, and three-storey
2	Residential Private Houses	13 803	2 095 923	Inner space
3	Municipal Buildings	12	22 781.5	City Council – Guberniya, Administrative building of the City Hall 2. Election District, Gym, Art Gallery, Choral Music School, Youth Palace, Plant's Recreation Center, Plant's Gym, Mechanical Plant, Fire Service
4	Schools	12	27 818	Data from the Resource Center
5	Kindergartens	16	8 241	Data from NNLE – preschool facilities
6	Medical Centers	13	17 722	Monitoring – by visual inspection
7	Pharmacies (4big, 20 small)	24	1 487	Monitoring – by visual inspection
8	Dental Offices	14	350	Monitoring – by visual inspection
9	Hotels	2	440	Monitoring – by visual inspection
10	IDP Compact Settlements	170	54 810	According to "Energo Pro Georgia" – on 170 incomplete subscribers – 1218 household*45m²=54810
11	Catering facilities (cafes, canteens)	32	1 150	Monitoring – by visual inspection
12	Restaurants (banquet, ritual rooms)	11	4 400	Monitoring – by visual inspection
13	Banks & Microfinance Organizations	21	6 440	Monitoring – by visual inspection
14	Large & Small Enterprises - Factories	47	8 460	Monitoring – by visual inspection
15	Shops	520	26 022	Monitoring – by visual inspection
16	Cinemas	3	13 200	1 fact. In municipal buildings 5000 m2
17	Gyms	2	3 200	1 in NNLE "Odishi" 2000 m2

18	Police stations and law enforcement	9	5 400	Military, Police, Prosecution, Courts,
19	Public Service Hall	1	1 200	Monitoring – by visual inspection
20	Churches	6	980	Monitoring – by visual inspection
21	Post Office	1	1 800	Monitoring – by visual inspection
29	Slums	4	1005	Monitoring – by visual inspection
30	Filling Stations	15	375	Monitoring – by visual inspection
31	Other buildings			
		14,834	**2,382,179**	

Table 18. List of buildings owned by the Municipality

№	Address	Building Ares	Land Areas	Property name	Condition
1	90, Rustaveli ave.	2 544.50	1 100	Administrative Building of the City Hall	Rehabilitated
2	79 Rustaveli Ave.	2 303.00	788	Administrative Building of the City Hall	To be rehabilitated
3	45 Zviad Gamsakhurdia Ave.	3 176.70	5 263	Governor	Rehabilitated
4	58/1 M. Kostava St.	232.9	2 366	Election District	Rehabilitated
5	222 D. Aghmashenebeli st.	1 952.60	10 550	Gym	Rehabilitated
6	28/1 D. Aghmashenebeli st.	153.3	1 059.3	Art Gallery	Rehabilitated
7	7 Tsotne Dadiani St.	97.8	194.7	Music School	Rehabilitated
8	2 Meunargia St.	538.8	2 069	Youth Palace	Rehabilitated
9	12 Janashia St.	2 314.70	26 133	Factory Recreation Center	To be rehabilitated
10	2 Janashia St.	2 078.00	5 000	Factory Gym	To be rehabilitated
11	19 (Mtskheta) Gori St.	4 925.00	26 153	Mechanical Factory	To be rehabilitated

12	13 Tsotne Dadiani St.	977	9 672	Fire Station	To be rehabilitated
13	Sokhumi St.	1 487.20	13 161	Fire Station	New construction in progress
	Total:	**22 781.50**	**103 509.0**		

Since most buildings were constructed in the 1950s-80s some are in need of repairs: up to 15 buildings are under threat of collapse adn 40 are in semi-ruinous state, yet no decisions have been made on renovations. Materials are usually lightweight concrete panels, silicate and clay bricks, building blocks and wooden planks. Individual houses are sometimes made of wood (8-9%) and the walls were covered with tin, tarpaper or boards. Most traditional wooden homes have now closed in the first floor (formerly built with open space) by cement blocks. These are not reinforced with a concrete 'belt' and are dangerous. Sloping roofs are covered by corrugated asbestos or asbestos tiles, tin or aluminum sheeting. Large building roofs are generally sloping while others are flat, for example on most apartment buildings.

Up to 10 residential basements are flooded by water and waste, while 94% of buildings have previously been renovated and are comfortable, however 88% of windows and doors are single-glazed with wooden frames. Other windows are double-glazed of metaloplastic or aluminum at European standards. Many homes—flats or individual houses--have cracks in the walls, ancient Soviet-era tar paper insulation, or asbestos roofing.

Zugdidi and its citizens are taking measures to improve building conditions. Some are carried out with support from the City while some are funded by private owners. In the last 15 years:

- Up to 90% of sloping roofs of slates or tin, have been replaced with galvanized tin and enamel tiles;
- Flat roofs of residential buildings (that were roofed by Soviet-era tarpaper) have been replaced with European standard 3-4 mm tar paper;
- 14-45% of private homes roofed by slates and galvanized tin have substituted various types of modern, galvanized and enamel tiles;
- 5-7% of private houses have been equipped with water, gas and electricity;
- 20-22% of flats and private houses have been repaired fully or partially;
- The central sewage system of the city is being repaired to serve more homes; the sewage system has been repaired for more than 15 residential buildings, so that flooding of entries has been controlled;
- Up to 300 large and small trade and residential facilities have been built and renovated;
- Two 7- and 8- storey residential blocks have been constructed;
- Up to 900 solar water heating systems have been installed;
- Ceilings and roofs of more than 150 private houses have been insulated by fiberglass and 40mm styrofoam;
- Up to 500 individual houses have been built by owners;
- The international organization Danish Refugee Council (DRC) built 200 private homes of 55-75m^2 for IDPs in the City and its surroundings. Six hundred houses and facilities in the IDP areas have been rehabilitated;

- Up to 30 large and small industrial facilities have been built;
- 10-12% of old wooden windows and doors of residential and private houses have been replaced by modern (double glazed) windows;

The construction of new buildings in progress is shown in the Table below.

Table 19. Under - construction buildings in the city planned to enter into operation in the nearest months

№	Building Name	Address
1	Public Service Hall	Sh. Dadiani st.
2	Refrigeration Building	Sh. Dadiani st.
3	Fire Service	Sokhumi st.
4	Water Supplies (Rehab. annex)	Left Bank
5	Hotel (with commercial area)	2 Zv. Gamsakhurdia ave.
6	Hotel	35 Zv. Gamsakhurdia ave.
7	Hotel (with commercial area)	Tabukashvili st.
8	Commercial Area (House of Technics OK)	Sokhumi st.
9	IDP Settlements block 8, flat - 300 b.	Vazha-Pshavela st.
10	Residential building (Commercial area)	K. Gamsakhurdia st.
11	Residential building (Commercial area)	K. Gamsakhurdia st.

Despite these measures the residential and municipal buildings sector of Zugdidi is an important source of energy consumption, loss and therefore savings. Many were built almost 50 years ago according to low standards, for quick and cheap construction. Most do not meet energy requirements: open entrances, thin walls, and damaged frameworks, single glazed windows, low thermal resistance, etc. These buildings have a very low potential for saving energy.

Total Energy Consumption in Zugdidi

The building sector of Zugdidi City uses electricity, natural gas, firewood, hazelnut shells and petroleum products (diesel, liquefied petroleum gas). The following table shows the sources of energy consumption values in Zugdidi buildings for 2012 – 2013. table 19 shows consumption of these resources by different types of buildings.

Table 20. Consumed energy resources in Zugdidi 2012-2013

№	Year	Electricity kW*h	Natural Gas M^3	Firewood M^3	Nut Shell T	Liquid Gas Kg
1	2012	62 082 837	1 875 450	10 510	18 750	36 750
2	2013	62 982 818	3 788 780	8 107	17 100	28 763

Table 21. **Annual Energy Consumption in Zugdidi Buildings Sector**

N	Facility	Quantity	Area	Electricity		Natural Gas		Firewood		Nut Shell		Liquid Gas	
			M²	kW*h/y		1000 m³/year		m³/y		t/y		kg/y	
												*[diesel (t/y)]	
				2012	2013	2012	2013	2012	2013	2012	2013	2012	2013
1	Residential buildings	96	78 975										
	(10; 9;8;5;4;3 and 2-storey buildings)			32 013 041	32 982 597	1 110.72	2 835.17	8 500	6 200	12 250	11 000	36 750	28 763
2	Private houses	13 803	2 095 923										
	(inner area)												
3	Municipal Buildings	12	22 781.5	5 068 750	5 652 500	29.176	28.12	0	0	0	0	0	0
4	Settlements of the IDPs	170	54 810	7 032 657	7 879 918	0	0	1 600	1 500	2 500	2 450	0	0
	(1 218 households *45 ∂²=54 810 ∂²)												
5	Schools	12	27 818	166 855	183 349	38.9	42.9	9	6	0	0	*19.4	*19.4
	*(Diesel, T/y)												

6	Kindergartens	16	8 241	15 770	20 575	0	0	401	401	0	0	0	0
7	Music School #1	1	447.3	17,06	1 840	0	0	0	0	0	0	0	0
8	Medical Facility St. Lukes's Medical Center	1	10 000	1 129 411	1 128 340	120	112	0	0	0	0	0	0
9	Large & Medium –sized Commercial Enterprises	47	8 460	2 925 574	3 002 454	576.664	770.58	0	0	4 000	3 650	0	0
10	Other buildings	-	-	13 730 762	13 131 245	-	-	-	-	-	-	-	-
	Totals		**2 307 456**	**62 082 837**	**62 982 818**	**1 875.46**	**3 788.77**	**10 510**	**8 107**	**18 750**	**17 100**	**36 750** ***19.4**	**28 763** ***19.4**

* The Socar Georgia Zugdidi office provided natural gas consumption data of 2012-2013 for the commercial sector. The division for different constructions (municipal buildings, schools, kindergartens, medical facilities) was carried out on the basis of energy audit information. The remaining amounts of natural gas are noted in the large- and medium-sized enterprises column.

Methodology

The methodology for calculating CO_2 baseline (2012) emissions and future trends (up to 2020) for the Buildings Sector was the same as in the Transport Sector, which includes carbon dioxide emission factors and transfer coefficients as well as methane and nitrous oxide emissions factors resulting from incomplete combustion of fuel. They were taken from IPCC 1996 and shown below.

Table 22. Methane and Nitrous Oxide Emission Factors for Buildings (kg/MW/h)

N	GHG	Natural Gas	Oil Products	Firewood, hazelnut Shell
1	CH_4	0.018	0.036	1.08
2	N_2O	0.00036	0.002	0.014

Emissions reduction potential after energy saving measures has been calculated by selecting typical buildings, carrying out energy audits and evaluating energy efficiency measures, then transposing these results to other buildings. Residential houses, schools, hospitals, kindergartens, hotels, educational institutions, shops, offices etc. have significant potential for energy conservation. An energy audit must be conducted by trained specialists to understand how to improve building insulation and energy saving measures.

It is impossible to assess the energy-saving potential of a building through simple accounting/fixing annually consumed energy quantities (e.g. 700,000 kWh/y) as the figure doesn't include size of the building. A clearer picture can be obtained by calculating the energy used per m2 annually. Other factors must be taken into consideration too, such as building type (administrative, hospital, school etc.), climatic conditions, building insulation,etc, then compared with national standards. Significant reductions on energy expenses in buildings are possible by carrying out measures such as repairing cracks, automatic hydraulic regulation of heating systems, and thermostatic valves on radiators. Additional insulation greatly reduces emissions along with reducing energy consumption.

An energy audit should include key issues such as insulation (walls, windows, roofs, and floors), heating systems, ventilation systems, hot water supply systems, automated electricity systems, lighting, as well as appliances and air-conditioning systems. The process of an energy audit is divided into six steps: project identification, scanning, energy audit, business plan, implementation (realization) and exploitation.

To create an overall document on energy consumption in buildings, energy and power consumption budget standards have been established based on eight articles: heating, ventilation, hot water supply, fans/pumps, lighting, miscellaneous applliances, air conditioning and outdoor equipment.

Dividing the budget into eight sections makes it easier to analyse energy and power consumption modifications annually. Annual energy consumption (kWh/y) must be determined as well as specific

annual energy consumption values (energy consumption for 1 m^2 space heating. kWh/m^2y). The budget for residential and household buildings may be simplified to include three articles: heating (including natural ventilation), the hot water supply and household (lighting, farm equipment, etc.).

An energy audit of typical buildings in Zugdidi was conducted using "Key Numbers" of the ENSI software. A Norwegian Consulting Company—ENSI--founded in 1992, developed simple software called "Key Number" for a quick calculation of energy characteristics that can be applied both for projecting rates for new buildings and reconstruction activities and for assessing energy-saving measures for existing buildings. Key figures reflect model values of specific types of energy consumption, taking into account all factors. Comparing measured and calculated values of energy consumption with key numbers permits a rapid assessment of energy efficiency and energy saving potential.

ENSI software provides a database for each energy budget article and reflects data obtained after carrying out energy-saving measures. For example, the ENSI software energy budget article "Heating" includes a first column with the most important "parameters" affecting energy consumption required for heating. The second column shows "model values" of each parameter based partly on construction standards, rules and regulations and partly on experience gained from various projects (**Error! Reference source not found.**). The third column, "condition", includes the real technical conditions of a given building selected for an energy audit, and its "measured energy consumption" required for heating (kWh/m2 y).

Today the actual exploitation conditions of buildings in Georgia differ substantially from project/normative conditions. Thus, measured energy consumption may be higher than the one calculated e.g. due to water leakage or improper operation of a heating system; or lower, e.g. due to heating or ventilation system shutoffs. Additionally, along with energy-saving measures, an owner might need to improve the microclimate in the building by installing a forced air ventilation system or improving the existing system. All these will lead to an increase in energy consumption.

Due to the fact that in most cases "measured energy consumption" does not coincide with "estimated energy consumption", calculated values of energy consumption provided in the fourth column of ENSI software have to be used as a "basic line", to get accurate values of energy economy. The "ENCON measure" contains alternative energy saving solutions and energy-saving measures and "after ENCON" column (saving by each parameter/measure) lists the savings.

Parameter	Reference		Condition	Baseline	Sensitivity	kWh/m²y	ENCON measure	After ENCON
1. Heating	46,4	kWh/m²y						
U - wall	0,30	W/m²K	0,45	0,45	+ 0,1 W/m²K	= 8,78	0,30	-9,51
U - window	2,40	W/m²K	3,00	3,00	+ 0,1 W/m²K	= 1,56	1,30	-24,77
U - roof	0,20	W/m²K	0,20	0,20	+ 0,1 W/m²K	= 1,71	0,20	
U - floor	0,30	W/m²K	0,30	0,30	+ 0,1 W/m²K	= 1,71	0,30	
Form - factor	0,31	-	0,31	0,31			0,31	
Window area	15,1	%	15,1	15,1			15,1	
Total solar gain	0,55	-	0,55	0,55			0,55	
Infiltration	0,25	1/h	0,40	0,40	+ 0,1 1/ h	= 11,23	0,25	-15,76
Indoor temperature	21,0	°C	21,0	21,0	+ 1 °C	= 5,92	21,0	
Setback temperature	18,0	°C	18,0	18,0	+ 1 °C	= 4,49	17,5	-2,11
Contribution from								
Ventilation		kWh/m²y	-2,01	-2,01			-1,41	
Lighting		kWh/m²y	21,32	21,32			19,98	
Various equipment		kWh/m²y	12,71	12,71			11,91	
Sum 1		kWh/m²y	73,5	73,5			24,6	
Distribution losses	2,0	%	2,0	2,0			2,0	
Automatic control	98,0	%	Modern	Modern	Poor +3 %, Manual +5 %		Modern	
Sum 2		kWh/m²y	76,5	76,5			25,6	
O & M / EM	98,0	%	95,0	95,0			98,0	-2,32
Sum 3		kWh/m²y	80,6	80,6			26,1	
Energy supply efficiency	100,0	%	100,0	100,0			100,0	
1. Heating corrected		kWh/m²y	80,6	80,6			26,1	

Figure 11. **ENSI Software format for Energy Budget Article "Heating"**

A similar structure is used for other sectors as well (ventilation, hot water supply, fans and pumps, lighting, other equipment, cooling and outdoor equipment). Results are collected in the "energy budget" table (Figure12).

Energy Budget | Power Budget | ENCON Measures | ET curve | Annual consumption

Project
test714

Reference building: Office
Reference condition: 1987
Climatic zone: Oslo
Heating season: 15.9 - 15.5

Budget item	Reference	Condition		Baseline before ENCON		After ENCON	
	kWh/m²	kWh/m²	kWh/y	kWh/m²	kWh/y	kWh/m²	kWh/y
1. Heating	46,4	80,6	191 755,4	80,6	191 755	26,1	62 149
2. Ventilation	33,5	44,2	105 148,1	44,2	105 148	42,0	99 901
3. DHW	9,9	19,8	47 012,5	19,8	47 013	10,4	24 784
4. Fans and pumps	20,2	23,0	54 676,0	23,0	54 676	17,3	41 071
5. Lighting	31,5	31,5	75 072,0	31,5	75 072	31,5	75 072
6. Various	24,0	24,0	57 066,4	24,0	57 066	24,0	57 066
7. Cooling	0,0	0,0	0,0	0,0	0	0,0	0
Total	165,5	223,0	530 730,6	223,0	530 731	151,3	360 043
8. Outdoor			0		0		0

Figure 12. **Energy Budget**

Carbon Dioxide Emissions Assessment

In order to assess emissions reduction potential, an energy audit of typical buildings was conducted and data applied to other buildings. To determine whether to apply this data to other buildings, the energy consumption was compared with three scenarios. The first was based on the annual energy data, second on data about buildings and the third on population data.

According to the first scenario, it is possible to estimate an annual energy consumption on the basis of annual statistical data of consumed natural gas, electricity and firewood (E1, kW*h/y). The second scenario needs a detailed energy audit of different type of pre-selected "typical" buildings and an estimation of specific energy expenditures (energy consumption per m^2, kW*h/m^2y) on heating, cooking and electricity use. An energy audit carried out with appropriate methods and the software format would allow us to determine the actual potential of energy-savings, involves a situational analysis and other measures to reduce energy consumption and CO2 emissions. Following this, specific energy consumption, the estimation of annually consumed energy on heating, hot water, cooking and electricity becomes possible (E2, kW*h/y) for various types of buildings. The third scenario is based on statistical data on the number of people living in the area. Determination of per capita energy consumption (kWh/y per capita) allows us to calculate the approximate annual energy consumption of the entire population (E3, kW*h/y) in the area. Finally, cross comparison of these three scenarios makes it possible to determine the accuracy of calculation for each scenario under the condition that (E1 = E2 = E3).

Base Year Intervention & GHG Emissions Baseline Scenario (2013 – 2020)

The Buildings' Sector structure of Zugdidi includes three sub-sectors according to the sustainable energy development manual: municipal buildings, residential buildings and other (commercial buildings). The data are based on the energy consumed in the buildings in 2012.

Energy consumption of the buildings sector in 2012 is given below.

Table 23. Final Energy Consumption in Zugdidi Buildings Sector - 2012

N	Subsector	Electricity	Natural Gas	Liquid Gas	Diesel	Firewood	Total
1	**Municipal Buildings**	5 085	272	0	250	835	6 442
2	**Other (commercial) buildings**	17 954	6 864	0	0	0	24 818
3	**Residential buildings**	39 049	10 364	483	0	21 062	70 959
	Total	**62 088**	**17 500**	**483**	**250**	**21 898**	**102 219**

GHG emissions from the Buildings sector amounted to 12,740 t. $CO_{2\ eq.}$ in 2012.

Table 24. GHG Emissions from Zugdidi Buildings Sector CO_2 –eq. (t) - 2012

N	Subsector	Electricity	Natural Gas	Liquid Gas	Diesel	Firewood[1]	Total
1	**Municipal Buildings**	692	55	0	66	23	835
2	**Other (Commercial buildings)**	2 442	1 383	0	0	0	3 824
3	**Residential buildings**	5 311	2 088	110	0	572	8 080
	Total	**8 444**	**3 526**	**110**	**66**	**594**	**12 740**

The parameters of the building sector's energy demand and consumption are driven by the increase in fuel consumption in various sectors projected by the MARKAL-Georgia national model. This, in turn, is based on population growth, GDP growth and GDP per capita growth of the city. Methodological details are described in the "Transport" chapter. According to the MARKAL-Georgia national model, GHG emissions growth rates are the following:

Table 25. Fuel Consumption Growth Rates for Different Building Types under the BAU Scenario

N	Sector	2012	2013	2014	2015	2016	2017	2018	2019	2020
1	Municipal & Commercial Buildings	1	1.1	1.21	1.3	1.37	1.44	1.5	1.55	1.6
2	Residential Buildings	1.04	1.08	1.12	1.17	1.21	1.26	1.31	1.37	1.42

In the absence of local projections of gross domestic product and population growth, national projections without modifications have been applied for Zugdidi. According to the baseline scenario of growth, GHG emissions from Buildings Sector reached 18.5 thousand tons of $CO_{2\ eq.}$ for 2020. The increase of emissions in the Buildings Sector is given below.

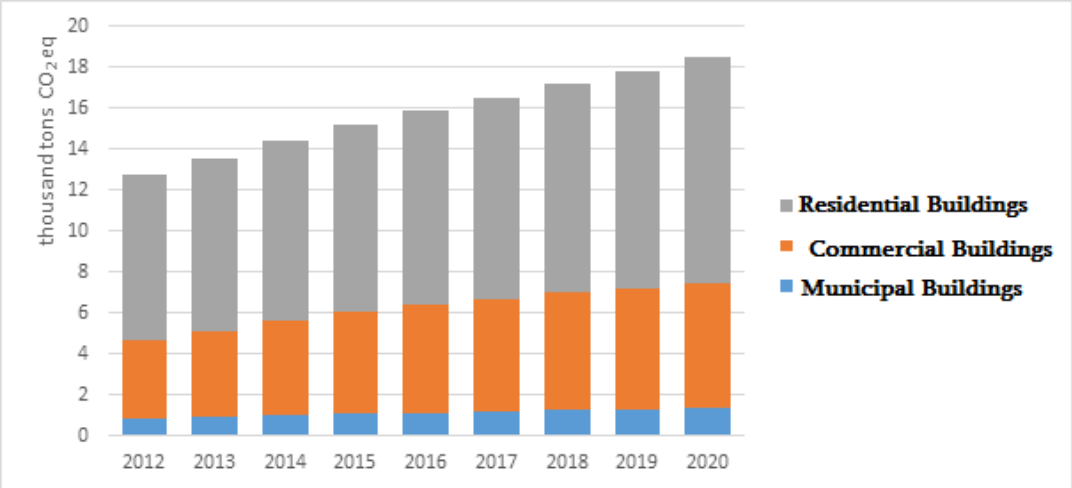

Figure 13. Trends of Emissions from Buildings Sector According to the BAU

GHG Emissions Reduction Action Plan from Zugdidi Buildings Sector

A promising way to reduce carbon dioxide emissions is the use of renewable energy sources. Most energy resources are used for heating and hot water supply. Therefore, biomass, heat pump and solar energy will significantly reduce the natural gas and carbon dioxide emissions as well. Biomass heat from combustion (wood waste, sawdust, hazel hazelnutshells, etc.) or calorific capacity depends on the moisture – the lower the moisture content the greater the heat of combustion. Dry biomass moisture content (including hazelnutshells) is not more than 8-12% and is distinguished by a high calorific value, or 16,200-18,000 kJ/Kg. Therefore, energy potential is high as well, from 4.5 to 5.0 kwh/kg.

Hazelnut cultivation is a successful business sector in Georgia. Hazelnuts are exported to many countries and the market demand has encouraged farmers and entrepreneurs to increase the harvests and processing factories. Today 42.1% of arable land is used for hazelnuts in the Zugdidi region and Georgia is ranked fourth hazelnut producer in the world, after Turkey, Italy and Azerbaijan. Almost all regions of Western Georgia reception centers for private cultivators, from where the hazelnuts are sent to processing plants. The hazelnuts are dried, calibrated and shelled then exported. Hazelnut shells are sold in local markets and used by locals to heat their homes.

Nut shells cost approximately 10-18 tetri per kilo in local markets of Zugdidi. A family uses an average of three tons of the product per season. Zugdidi residents used 35,859 tons of hazelnutshells in 2012-2013. Therefore, residual biomass (including hazelnutshells) for heating municipal and residential buildings can be considered a key sector for GHG reductions in Zugdidi's long-term strategy. Another promising energy is solar collectors in municipal buildings and heating/cooling energy through heat pumping. Carrying out these measures will not only reduce GHGs from the buildings sector but support non-conventional renewable energy in the region.

A short-term strategy of GHG emissions from municipal and residential buildings in Zugdidi will reduce energy consumption by insulating buildings and using energy efficient bulbs. Improved insulation of roofs, entrances and common areas, repairing cracks in the structures and replacing doors and windows saves considerable thermal energy, and is relatively affordable. At the same time appropriate training and public awareness campaigns will be carried out.

The Short-term Strategy of Zugdidi's SEAP includes:

Municipal Buildings:

1. Thermal insulation of roofs in kindergartens;
2. Replacement of the lighting system with energy-efficient bulbs.

Residential Buildings:

1. Installing energy-efficient bulbs in common areas of residential buildings;
2. Heat insulation of common areas of residential building entrances;
3. Thermal insulation of roofs in private houses;
4. Replacement of existing windows with double glazed ones in private homes;

5. Thermal insulation of attics and walls in residential buildings of IDP settlements.

The Long-term Strategy of Zugdidi SEAP Buildings sector considers:

For Municipal Buildings:

1. Use of residual biomass pellets in municipal buildings (pilot project);
2. Heat pump heating/cooling supply for the Zugdidi City Hall administrative building;
3. Use of solar collectors in kindergartens.

For Residential Buildings:

1. Development of biomass-operated high-efficiency ovens for private houses;
2. Heat supply of IDP settlements through biomass heating systems.

A detailed energy audit was conducted in the buildings sector of Zugdidi on May 29-31, 2014 to determine emissions reduction potential through the above-mentioned strategy. Twelve constructions were selected according to the type of their energy consumption.

Picture 4. #16 Kindergarten of Zugdidi (15 Dekabristebi St.)

Picture 5. #3 Zugdidi Public School (186 Rustaveli St.)

Picture 6. Zugdidi Children's Polyclinic (5 Kostava St.)

Picture 7. Private Residential House (13 Antelava St.)

Picture 8. Private Residential House (30 Dekabristebi St.)

Picture 9. Private Hotel (14 Antelava St.)

Picture 10. Commercial Building (Diaroni Restaurant)

Picture 11. Three-storey Residential Building (6 Tabukashvili St.)

Picture 12. **Five-storey Residential Building (36 S. Chikovani St.)**

Picture 13. **Nine-storey Residential Building (6 Tsotne Dadiani St.)**

Picture 14. **Storey-Residential Building (3 Tsotne Dadiani St.)**

Picture 15. **IDP Settlement Residential Buildings**

Table 26. Existing Emissions from Residential Buildings and Possible Savings in Zugdidi

Energy Expenses	Energy		Emissions		
	Potential	Savings	Standard	Potential	Savings
	kW*h/y	kW*h/y	Kg/kW*h	T/Y	T/Y
Energy expenses of 3-storey houses					
1. on heating	323 895	156 585	0.2	65.43	31.63
2. on hot water					
By natural gas	13 943	-	0.2	2.82	-
By electricity	19 520	-	0.14	2.65	-
3. on electrical equipment	47 619	42 900	0.14	6.48	5.83
Total	**404 976**	**199 485**		**77.37**	**37.46**
Energy expenses of 5-storey houses					
1. on heating	4 199 244	1 654 702	0.2	848.25	334.25
2. on hot water					
By natural gas	406 177	-	0.2	82.05	-
By electricity	568 648	-	0.14	77.34	-
3. on electrical equipment	1 509 728	259 953	0.14	205.32	35.35
Total	**6 683 797**	**1 914 655**		**1 212.95**	**36 960.00**
Energy expenses of 9-10-storey houses					
1. on heating	2 126 153	849 474	0.2	429.48	171.59
2. on hot water					
By natural gas	207 841	-	0.2	41.98	-
By electricity	290 978	-	0.14	39.57	-
3. on electrical equipment	686 493	128 409	0.14	93.36	17.46
Total	**3 311 465**	**977 882**		**604.4**	**189.06**
Energy expenses of private houses					
1. on heating	112 236 677		0.2	22 671.81	
Energy source - gas	112 236 677	56 904 309	0.2		11 494.67
Energy source - biomass	-	-	0.2		-
2. on hot water					
By natural gas	8 558 352	-	0.2	1 728.79	-
By electricity	11 981 693	-	0.14	1 629.51	-
3. on electrical equipment	32 696 399	5 449 400	0.14	4 446.71	741.12
Total	**165 473 121**	**62 353 709**		**30 476.82**	**12 235.79**

Table 27. Emissions from Non-residential Buildings and Possible Savings in Zugdidi

Energy Expenses	Energy		Emissions		
	Potential	Savings	Standard	Potential	Savings
	kW*h/y	kW*h/y	Kg/kW*h	kW*h/y	kW*h/y
Energy Expenses of kindergartens					
1. on heating	277 722	160 700	0.2	56.1	32.46
2. on hot water					
By natural gas	66 958	-	0.2	13.53	-
By electricity	93 741	-	0.14	12.75	-
3. on electrical equipment	67 576	14 834	0.14	9.19	2.02
Total	**505 997**	**175 533**		**91.56**	**34.48**
Energy Expenses of Schools					
1. on heating	1 007 012	364 416	0.2	203.42	73.61
2.electric equipment	100 145	22 254	0.14	13.62	3.03
Total	**1 107 156**	**386 670**		**217.04**	**76.64**
Energy Expenses of Medical Facilities					
1. on heating	3 735 798	590 143	0.2	754.63	119.21
2. on hot water					
By natural gas	172 790	-	0.2	34.9	-
By electricity	241 905	-	0.14	32.9	-
3. on electrical equipment	754 957	186 081	0.14	102.67	25.31
Total	**4 905 450**	**776 224**		**925.11**	**144.52**
Energy Expenses of Commercial Establishments					
1. on heating	883 005	222 000	0.2	178.37	44.84
2. on hot water					
By natural gas	270 563	-	0.2	54.65	-
By electricity	378 788	-	0.14	51.52	-
3. on electrical equipment	1 079 475	144 855	0.14	146.81	19.7
Total	**2 611 830**	**366 855**		**431.34**	**64.54**
Energy Expenses of IDP Settlements					
1. on heating	4 642 407	2 833 677	0.2	937.77	572.4
2. on hot water					
By natural gas	356 265		0.2	71.97	

		-			-
By electricity	498 771	-	0.14	67.83	-
3. on electrical equipment	1 151 010	224 721	0.14	156.54	30.56
Total	6 648 453	3 058 398		1 234.10	602.96
Energy Expenses of Hotels					
1. on heating	33 616	22 220	0.2	6.79	4.49
2. on hot water					
By natural gas	2 860	-	0.2	0.58	-
By electricity	4 004	-	0.14	0.54	-
3. on electrical equipment	6 292	924	0.14	0.86	0.13
Total	**46 772**	**23 144**		**8.77**	**4.61**

The tables above reflect the full potential of energy-saving under these measures involving all buildings. The plan of action for the next six years includes the following measures:

Sectors and Activities	Key Measures in Activities	Responsible Department, Person or a Company (If a third party is involved)	Implementation Period (Start and End Date)	Expected Energy Saving from each Measure (MWh/y)	Expected CO2 (T/y) Reduction from each Measure	Cost of Measures (GEL)
Buildings						
Municipal Buildings (MB)						
Activity MB1	Install space heating systems in municipal buildings					
MB 1.1	Use bio-waste pellets (Pilot Project in kindergarten)	Economic Policy Agency of Zugdidi City Hall	2015	67	13.6	15 000
MB 1.2	Heat pump based heating/cooling in Zugdidi City Hall Administrative Building (Pilot Project)	Economic Policy Agency of Zugdidi City Hall	2015-2016	373. 8	51	450 000
Activity MB 2	**Install Efficient Lighting Systems in Municipal Buildings**					
MB 2.1	Install Energy-efficient bulbs in kindergartens	Economic Policy Agency of Zugdidi City Hall	2015	1.4	0.19	300
Activity MB 3	**Municipal Builidngs Repairs**					
MB 3.1	Thermal insulation of roofs in kindergartens	Economic Policy Agency of Zugdidi City Hall	2015-2018	25.7	104	54 230

Activity MB 4	**Use renewable energy resources for hot water supply**					
MB 4.1	Use solar collectors in kindergartens	Economic Policy Agency of Zugdidi City Hall	2015-2020	25.2	25.45	78 000
Activity MB 5	**Education/Public Awareness-Raising Campaigns**	Economic Policy Agency of Zugdidi City Hall	2012-2020			
Activity MB 6	**Implement Energy Management & Monitoring Program in Municipal Buildings**		2012-2020			
MB 6.1	Control of Energy Consumption, Behavior Standards Development	Economic Policy Agency of Zugdidi City Hall				
MB 6.2	Energy Database Development of Municipal Buildings	Economic Policy Agency of Zugdidi City Hall				
Residential Buildings (RB)						
Activity RB 1	**Install Efficient Lighting Systems**					
RB 1.1	Install Energy-efficient Bulbs in Common Areas of Residential Buildings	Economic Policy Agency of Zugdidi City Hall	2015-2017	20	1.84	1600
Activity RB 2	**Residential Buildings Renewal**					
RB 2.1	Add Thermal Insulation to Common Areas of Residential Buildings Entrances	Economic Policy Agency of Zugdidi City Hall	2014	250	50.5	116 150
RB 2.2	Thermal Insulation of Roofs in Two-Storey Typical Private Houses	Investor	2014-2020	9.3	1.89	1824

RB 2.3	Replace Existing Windows in Two-Storey Private Houses with double-glaze Windows	Investor	2015-2020	6.5	1.3	2 475
RB 2.4	Ceiling and Walls insulation in IDP Settlement's New Buildings. Installation of Solar Collectors	Investor	2017-2018	1 135	229.5	541 260
Activity RB 3	**Use Renewable Sources for Hot Water and Heating Purposes**					
RB 3.1	Develop Bio Waste Operating Highly-Efficient Generators for Typical Two-Storey Private Houses	Economic Policy Agency of Zugdidi City Hall	2015	88 500	17 880	1 800 000
RB 3.2	Heat Supply to IDP Residential Buildings through Biomass Central Heating System (Pilot Project)	Economic Policy Agency of Zugdidi City Hall	2015-2016	0	306	350 000
Activity RB 4	**Public awareness raising/ information campaigns**					
RB 4.1	Trainings on energy efficiency in buildings for various target groups & mass media and energy efficiency information campaign	Economic Policy Agency of Zugdidi City Hall				
Total				**90 413.8**	**18 665**	**3 410 839**

Table 28. Emissions Reduction Action Plan from Buildings

DETAILED DESCRIPTION OF MEASURES

Measure MB 1.1. Use bio-waste pellets in municipal buildings (pilot project)

Bio-waste pellets can be used as fuel instead of natural gas in buildings. The bio-waste pellet is carbon-free fuel enabling a 20% emission reduction and scheduled for 2020. In order to determine all aspects of this measure a pilot project is recommended. The market price of one ton of organic waste pellets was 450 GEL due to the high cost of transporting sawdust used to make the pellets. Now, private companies selling sawdust will reduce their price to 250 GEL. Pellets heating capacity is 16,000 kJ/kg., which means that during 1 kg pellet combustion process 4.44 kWh energy is being released. The price for one kWh such energy is 250 / (1000 * 4.44) = 0.06 GEL/kWh. In comparison, the average price of 1000 m3 of natural gas is 750 GEL for different consumer groups and state buildings. Its thermal capacity is 33 868 kJ/Nm3.8.00 kWh of energy released during 1m3 of natural gas combustion. Thus, the cost of 1 kWh energy produced by burning natural gas will be 0.09 GEL/ kWh.

The total amount of energy required for heating the pilot building (#27 kindergarten) will be about 126 MWh/y, for natural gas. However for burning biomass the additional expense would be 15,000 GEL for purchasing and installing a pyrolysis (induction) furnace. Biowaste is a carbon-free fuel so conversion to this fuel reduces CO_2 emissions by 67 458 x 0.202=13.60 tons per year.

The pilot project results could be expanded to at least one municipal building. Profitability parameters of MB 1.1 measure are given below (Table 27).

Table 29. **Profitability Parameters of MB 1.1 Measure**

Measure	Investment Cost	Payback	Internal Rate of Return	Net Present Value Quotient*NPVQ	CO_2 Reduction
	Gel	*PB	*IRR,%		T/Y
Central Heating System	15 000	5.9	16%	0.62	13.6

*PB – Payback; *IRR – Internal Rate of Return; *NPVQ – Net Present Value of Quotient*

Measure MB 1.2 Heat Pump- Based Heating/Cooling Supply to Zugdidi City Hall Administrative Building (Pilot Project)

Heat pumps are the most energy-efficient systems for heating and air-conditioning. Their particular attractiveness lies in ability to transfer existing environmental (in land, air, water) thermal energy to buildings and use it for hot water and heating, or else expel excessive amounts of heat into the environment, as in the case of air conditioning.

Heat pumps offer a number of advantages compared to ordinary heating and airconditioning systems: efficiency, economy, ecological safety, simple servicing, low cost to use, system autonomy, high reliability, fire safety, and noiseless operation and fast/effective temperature regulation.

Heat pump efficiency is determined by a transformation coefficient showing heat volume (kW) per kW energy. These range from 2.5 to 7.8, i.e. a consumer is able to obtain up to 7.8 kW heat energy per kW of electricity. The heating system of the Zugdidi City Hall Administrative Building requires 468,530 kWh of electricity annually. Annual GHG emissions amount to 468 530*0.136/1000=63.7 t/y and the annual cost of 468,530*0.16=74,965 GEL. If heat pumps are used, the "conversion ratio" (that can be equal to 5 here) will mean only a fifth of the amount of electricity will be necessary to heat using a heat pump compressor or -468 530/5=93 706 kW/h. This means an annual savings for heating and airconditioning can be calculated at 468,530-93 706=374 824 kWh energy. Annual GHG emissions will be 93 706*0.136/1000=12.7 tons reducing initial emissions by 63.7-12.7=51.0 tons. The cost will be estimated at 93,706*0.16=14 993 GEL which makes a savings of 59,972 GEL annually. Thus overall using a heat pump for Zugdidi City Hall can save about 374,824 kWh energy, 51.0t GHG emissions and 59 972 GEL per year.

According to preliminary estimations, the total project cost is 450,000 GEL, including:

- Drilling biomass borehole – preparation – 130 000 GEL;
- Pipes from boreholes to buildings – 20 000 GEL;
- Heat pump and system installation - 220 000 GEL;
- Installation of heating and cooling equipment – 80 000 GEL.

Table 30. Measure MB 1.2. Profitability Parameters

Measure	Investment Cost	Payback	Internal Rate of Return	Net Present Value Quotient*NPVQ	CO_2-reduction
	GEL	*PB	*IRR,%		T/Y
Heat pump based Central Heating and Conditioning System	450 000	7.5	11.90%	0.28	51

Measure MB 2.1.- Energy-efficient Lighting Systems in Kindergartens

In order to assess potential energy savings for this measure, the same data are applied for a pilot kindergarten. Energy-saving potential has been determined by comparing an incandescent lighting system with energy-efficient bulbs. The basic energy consumption of incandescent bulbs is around 5614 kWh/Y, in contrast to 3369 kWh/y for energy-efficient bulbs. The pilot indergarten's energy savings will be 1409 kWh/y or 1409 x 0.16=225 GEL.

Energy-efficient bulbs will cost 300 GEL (1 bulb – 8 GEL). An economic profitability analysis is given below. CO_2 emissions reduction is 1409 x 0.136= 0.19t/y. Profitability parameters of the measure MB2.1 is presented in Table 31.

Table 31. Profitability Parameters of MB 2.1 Measure

Measure	Investment Cost	Payback	Internal Rate of Return	Net Present Value Quotient*NPVQ	CO_2-reduction
	GEL	*PB	*IRR,%		T/Y
Energy-efficient Lighting System	300	1.3	73.90%	2.51	0.19

Measure MB 3.1. - Thermal Insulation of Roofs in Kindergartens

It is well known that a building and its heating system make up one unit. Thermally insulating roofs reduces the load on the heating system. The following value has been used to calculate the ceiling heat resistance coefficient: R=0.53 m^2deg/W, and with insulation it would be R=2.50 m^2deg/W. Resulting energy savings in #15 Kindergarten at Dekabristi St. would be 25 733 kWh/y according to ENSI. The savings on natural gas use would be 25,733/8.00 =3 216 m^3 or 3216 x 0.75 = 2412 GEL. This measure considers the insulation of a 68 m^2 ceiling and investment costs of about 10,846 GEL; CO_2 reductions are 25 733 x 0.202= 5.20 t/per year. Profitability parameters of the measure are given below (Table 32). Thermal roof insulation is planned for at least 5 kindergartens.

Table 32. Profitability Parameters of Measure MB 3.1

Measure	Investment Cost	Payback	Internal Rate of Return	Net Present Value Quotient*NPVQ	CO_2-reduction
	GEL	*PB	*IRR,%		T/Y
Roof Insulation in Buildings	10 846	4.5	21.90%	1.14	5.2
5 Kindergartens with total ceiling Area of 600 m^2	54 230	4.5	21.90%	1.14	104

Measure MB 4.1. Solar Collectors for Kindergartens

Solar collectors convert radiation into energy for heating and hot water. This measure aims to install solar collectors for hot water to Kindergartens. About 4000 liters of hot water a day is consumed by kindergartens, requiring 24 907 kWh energy per year.

It is known that solar energy received on the horizontal surface in Zugdidi is approximately 1 200 kWh per year. The solar energy collector surface can be oriented at 90-degree angle leading to 25% increase of solar radiation amounting to 1 500 kWh/m^2/y. Taking into account the fact that solar energy collector efficiency is 70%, 1 050 kWh/m^2 energy would be available.

If the same amount of energy (25,200 kWh/y) is created with natural gas it would require 25,200 /8.00 =3150 m^3, or 3150 x 0.75=2362 GEL. The reduction of CO_2 emissions if natural gas use is changed to solar energy will be 5.09 per year. The profitability parameters of this measure are given below. Solar water heating is being considered for five kindergartens.

Table 33. Profitability Parameters of Measure MB 4.1Measure

	Investment Cost	Payback	Internal Rate of Return	Net Present Value Quotient*NPVQ	CO_2-reduction
	GEL	*PB	*IRR,%		T/Y
Hot water supply though solar energy	15 600	6.6	14	0.45	5.09
5 Kindergartens	78 000	6.6	14	0.45	25.45

Measure RB 1.1. – Installing Energy-efficient Bulbs in Common Areas of 9-Storey Residential Buildings

This measure includes replacement of incandescent bulbs with energy efficient ones for buildings with common areas. For example, a common space of F=389 m^2 in a nine-storey building with stairs has a minimum energy consumption for incandescent lighting of 3.5 W/m^2. This corresponds to a total consumption of 1.36 kW. Assuming that annual consumption of incandescent bulbs is about 1022 kWh ,their replacement with energy-efficient bulbs will save 680 kWh energy (680 x 0.16 = 109 GEL). A total number of nine bulbs will be replaced in each of 20 buildings, at a cost of 80 Gel/building. CO_2 emissions reduction from a building will be 0.092 t/y. The profitability parameters of the measure are given below (Table 34).

Table 34. Profitability Parameter of Measure RB 1.1

Measure	Investment Cost	Payback	Internal Rate of Return	Net Present Value Quotient*NPVQ	CO_2- reduction
	GEL	*PB	*IRR,%		T/Y
Lighting with energy-efficient bulbs	80	0.7	136%	5.3	0.092
In 20 buildings	1600	0.7	136%	5.3	1.84

Measure RB 2.1.- Heat conservation in Common Spaces of 9-storey Residential Buildings

This measure will address heating losses in common spaces within residential buildings by installing double-glaze windows on each floor. Heating buildings and minimizing heat losses will save up to 250 MWh energy in each case. Natural gas savings will be about 250 000/8.00=31,250 m^3 and emissions reductions will equal 50.50 t/y i.e. 31 250 x 0.45 = 14,062 GEL per year.

Approxiamately 1010 m^2 of new windows will be installed in 20 buildings at a total investment of 115 USD / m^2*1010m^2 = 116,150 GEL. The profitability parameters of this measure are presented below (Table 35).

Table 35. Profitability Parameters of Measure RB 2.1

Measure	Investment Cost	Payback	Internal Rate of Return	Net Present Value Quotient*NPVQ	CO_2- reduction
	GEL	*PB	*IRR,%		T/Y
Heat conservation in Common Areas of Residential Buildings	116 150	8.3	11.80%	0.36	50.5

Measure RB 2.2 Thermal Insulation of Roofs in 2-storey Private Houses

Additional thermal insulation for the roofs of private homes will raise the roofs' thermal resistance coefficient from R=0.51 m^2deg/W to R=2.30 m^2deg/W and will save up to 9,362 kWh energy. This will result in CO_2 emissions reductions of 1.89 t/y or 9 362 x 0.056 = 524 GEL per year each. Investment and installation costs are 15 GEL and the total investment will be 152 m^2 x 12.00 GEL / m 2 = 1 824 GEL. Profitability parameters of the measure are given below (Table 36).

Table 36. Profitability Parameters of Measure RB 2.2

Measure	Investment Cost GEL	Payback *PB Payback	Internal Rate of Return *IRR,%	Net Present Value Quotient*NPVQ	CO_2-reduction T/Y
Roofs Thermal Insulation in1 50 m^2 Typical Private House	1 824	3.5	28%	1.96	1.89

Measure RB 2.3. – Replacement of Existing Windows by Metaloplastic Ones in Two-Storey Private Houses

This measure will raise the thermal resistance coefficient from R=0.17 m^2deg/W to R=0.30 m^2deg/W saving up to 6 524 kWh energy in a typical house resulting CO_2 emissions reductions of 1.31 t/y or 6 524 x 0.056 = 365 GEL per year. About 33 m^2 of metaloplastic windows will be replaced with an investment of 75 GEL/m^2 x 33 m^2 = 2475 GEL. Profitability parameters of the measure are given below (Table 37).

Table 37. Profitability Parameters of Measure RB 2.3

Measure	Investment Cost GEL	Payback *PB	Internal Rate of Return *IRR,%	Net Present Value Quotient*NPVQ	CO_2-reduction T/Y
Replacement of Windows	2 475	6.7	14.90%	0.76	1.31

Measure RB 2.4. – Thermal Insulation of Ceilings and Walls in New IDP Settlements

Expected energy savings under this measure equals to 751,861 kWh for external walls, 128,340 kWh and 256,093 for ceilings. CO_2 emissions reductions from residential buildings will be 151.8, 25.9 & 51. 7 t/y respectively. Improving insulation for outer walls and ceilings and installing solar

collectors for hot water are planned for IDP settlement buildings. Profitability parameters are presented below (Table 38).

Table 38. Profitability Parameters of Measure RB 2.4

N	Measure	Investment Cost	Payback	Internal Rate of Return	Net Present Value Quotient*NPVQ	CO_2- reduction
		GEL	*PB	*IRR,%		T/Y
1	Thermal Insulation of Outer Walls	329 560	7.8	4.7	0.4	151.8
2	Ceiling Insulation	49 200	6.8	14.40%	0.6	25.9
3	Solar Collectors	162 500	11.3	8%	0.02	51.7
	Total	**541 260**				**229.5**

Measure RB 3.1. Bio-waste Pellet Heating in Private Houses

In order to use biomass for heating purposes, several optimal biofuel combustion technologies for burning have been considered and the pyrolysis burner, or induction stove was selected.

Pyrolysis boilers ensure complete combustion of fuel and the ability to control the combustion process, which saves energy. The two-tier fuel combustion and high-temperature combustion chamber significantly reduce the release of harmful substances into the atmosphere. The automatic control of the burners is similar to natural gas, or liquid fuel powered boilers, and considerably simplifies its maintenance.

An average annual demand for heating in a typical two-storey house is about 29,507 kWh/y. CO_2 emissions reduction. Its conversion to biomass will be 29,507 x 0.202=5.96 t a year. This measure corresponds to a 600 GEL investment to buy an efficient furnace, and annual savings in monetary terms will be 29,507 x 0.06 = 1770 GEL (0.09-0.03=0.06 GEL/kWh is the difference between hazel hazelnutshell and natural gas prices).

The pilot project results should be extended to 3000 two-storey residential houses. This will significantly increase Zugdidi's portion of renewable energy. Profitability parameters of the measure are given below (Table 37).

Table 39. **Profitability Parameters of Measure RB 3.1**

Measure	Investment Cost GEL	Payback	Internal Rate of Return	Net Present Value Quotient*NPVQ	CO_2- reduction
		*PB	*IRR,%		T/Y
Per house	600	0.3	295%	18.51	5.96
Per 3000 houses	1 800 000	0.3	295%	18.51	17 880

Measure RB 3.2. Heat Supply for IDP Settlements with Biomass Central Heating Systems

"Biomass" refers to organic matter made of vegetable and animal origin, including firewood, forestry exploitation residues, wood industry waste, agricultural harvest residuals, agro-processing industry residues, animal waste, purification equipment waste and food and municipal waste. Biomass is an alternative form of organic fuel, and an annually renewable energy source. The portion of biomass reached 9% of overall consumption of primary energy in the EU member countries by 2010. The World Energy Agency predicts that the amount of biomass will reach 42-46% of non-conventional renewable sources throughout the world by 2020.

Biomass has the following advantages: it is a renewable resource, and found in almost all inhabited areas, and is cheaper than fossil fuels. It is available and accessible, and can be formed into bricks, bales and pellets. It reduces GHG emissions significantly and can make a major contribution to energy supply and create additional jobs.

The heating systems of the IDP settlement residential buildings in Zugdidi require 1,515,178 kWh energy a year, while another 256,093 kWh of energy is needed for hot water supply. Natural gas-powered "Karma"- type stoves are used now for heating, and electric water heaters supply hot water. Annual expenses for natural gas in case of its continued use will be 1,515,178/(8*0.9)=210 441 m3/y.

As 8kWh/m3 is the energy potential of 1m^3 natural gas and 0,9 heat generator's CP coefficient, natural gas rates annually reach 210 441*0.45=96,698 GEL, with annual CO_2 emissions of 1,515,178*0.202/1000= 306 t/y.

Biomass would replace natural gas at the annual expense of: 1,515,178/(4.7 * 0.9)=358,198 kg/y, where 4.7 kWh/kg is biomass energy potential and 0,9 heat generator' CP coefficient, at a total annual expense for biofuel of 358 198 * 0.15=53,729 GEL.

Thus, annual savings would be 96,698 Gel – 53,729 Gel= 42,969 GEL. Annual emissions savings would be 1,515,178*0.202/1000= 306 t/y.

The estimated total outlay costs of the project will be 350,000 GEL, including:

- Heat generator with installation – 85,000 GEL;
- Boiler, with auxiliary equipment – 15,000 GEL;
- Thermal network – 25,000 GEL;
- Installation of heating appliances in the buildings – 225,000 GEL;

The project's profitability parameters are given below (Table 40)

Table 40. **Project's Profitability Parameters for Measure RB 3.2**

Measure	Investment Cost	Payback	Internal Rate of Return	Net Present Value Quotient*NPVQ	CO_2- reduction
	GEL	*PB	*IRR,%		T/Y
Central Heating System	350 000	8.2	10.70%	0.18	306

Measure RB 3.3. – Energy-Efficiency Public Awareness Training for Target Groups and Public Information Campaign[29]

Public awareness-raising measures will include:

- Information for residents on how to reduce energy consumption by investing in energy-efficient equipment. This component to be implemented by a local NGO.
- Awareness-raising activities such as exhibitions of children's drawings on environmental protection, cleaning and planting activities, lectures and seminars on climate change and its consequences, discussions with residents on planned measures and the savings importance of energy-efficient bulbs and energy/water conservation.
- Training in energy conservation for all relevant individuals, especially for Municipality staff – to improve the quality of implementation, monitoring and data collection/processing.

Awareness-raising measures are important for achieving the SEAP long-term outcomes. The Action Plan Working Group coordinates the timetable and its implementation, while the control is under the responsibility of Municipality Governance.

[29]These measures are in line with the general strategy in terms of education and awareness raising activities. (Chapter 10)

STREET LIGHTING

Sector Overview

The total length of internal roads and streets in Zugdidi (422 streets and turns) is 170 km, of which 60% have street lighting. Up to 10 squares remain without lighting and buildings, except for a few, do not have façade lighting. Zugdidi is continuing to add outdoor lights, which is leading to increased expenses. By the end of 2013 there were almost twice as many lights as in 2009.

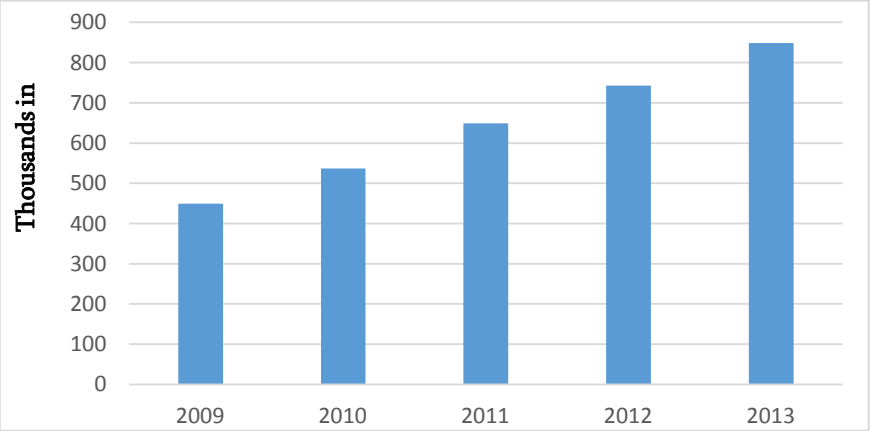

Figure 14. Expenses for Street Lighting 2009 - 2013

Total energy consumption in Zugdidi amounted to 1.655 million kWh in 2012.[30] Street lighting has been based on three-type of fixtures-- AMBAR-3, Onyx -3 & Opal – 1. The total number of fixtures (3006) by types and energy consumption are given below:

[30]Source: Zugdidi Municipality

Table 41. Street Lighting Fixtures, Layout and Parameters[31]

№	Parameter / Street, Avenue, Village name	Lighting Fixture	Lighting Source Type	Fixture Wattage	Towers Layout	Total amount of operating fixtures (pieces)
	1	2	3	4	6	8
1	Antelava St (Ilia)	opal-1	Sodium	70	Line	8
2	Aghmashenebeli 1st turn	ambar-3	Sodium	150	Line	6
3	Aghmashenebeli 2st turn	ambar-3	Sodium	150	Line	6
4	Aghmashenebeli St. (David)	onyx-3	Sodium	400	Line	56
5	Baramia St,	ambar-3	Sodium	250	Line	34
6	Baratashvili St.	opal-1	Sodium	70	Line	8
7	Bendeliani St. (Chichiko)	opal-1	Sodium	70	Line	27
8	Beria St.	ambar-3	Sodium	150	Line	34
9	Bashauri St.	opal-1	Sodium	70	Line	18
10	Belinski St.	opal-1	Sodium	70	Line	13
11	Borjomi St.	opal-1	Sodium	70	Line	15
12	Bukia St.	ambar-3	Sodium	150	Line	24
13	Gamsakhurdia St. (Konstantine)	ambar-3	Sodium	250	Line	62
14	Gamsakhurdia St. (Zviad)	onyx-3	Sodium	400	Double Line	80
15	Gamsakhurdia St. (Zviad)	opal-1	Sodium	70	Line	76
16	Griboedovi 1st turn	opal-1	Sodium	70	Line	7

[31] Zugdidi Amenities – Street Lighting Department

17	Briboedovi St.	opal-1	Sodium	70	Line	24
18	Gori St.	opal-1	Sodium	70	Line	20
19	King Gubaz St.	opal-1	Sodium	70	Line	22
20	Gulua and Mosia Segment	ambar-3	Sodium	150	Line	7
21	Gogebashvili St.	ambar-3	Sodium	150	Line	12
22	Gorki St.	ambar-3	Sodium	150	Line	20
23	Dadiani St. (Tsotne)	ambar-3	Sodium	150	Double Line	42
24	Dadiani St. (Shalva)	ambar-3	Sodium	150	Line	17
25	Dgebuadze St.	opal-1	Sodium	70	Line	2
26	Dochia St. (Mamia)	ambar-3	Sodium	150	Line	5
27	Egrisi St.	opal-1	Sodium	70	Line	13
28	Eristavi St segment	opal-1	Sodium	70	Line	22
29	Egrisi 1st turn	opal-1	Sodium	70	Line	4
30	Vakhtang VI St.	ambar-3	Sodium	150	Line	8
31	Zarkua St.	ambar-3	Sodium	150	Line	7
32	Tabukashvili St.	ambar-3	Sodium	150	Line	8
33	King Tamar St.	ambar-3	Sodium	250	Line	67
34	Theatre Flat	opal-1	Sodium	70	Line	27
35	Tamar Kupunia St.	opal-1	Sodium	70	Line	32
36	Tavisufleba St.	ambar-3	Sodium	250	Line	69

37	Tbilisi St.	ambar-3	Sodium	250	Line	21
38	Teatri St.	ambar-3	Sodium	250	Line	12
39	Tetri Giorgi St.	opal-1	Sodium	70	Line	10
40	Konstitutsia St.	ambar-3	Sodium	150	Line	15
41	Kedia St. (Sergo)	opal-1	Sodium	70	Line	16
42	Kitia St. (Shota)	opal-1	Sodium	70	Line	9
43	Kolkhida St.	opal-1	Sodium	70	Line	14
44	Krubskaya St.	ambar-3	Sodium	150	Line	17
45	Krilovi St.	ambar-3	Sodium	150	Line	8
46	Kostava St. (Merab)	ambar-3	Sodium	250	Double Line	20
47	Lomouri St. (Segment)	ambar-3	Sodium	150	Line	16
48	Laghidze St. (Revaz)	ambar-3	Sodium	150	Line	5
49	Lasha-Giorgi St.	opal-1	Sodium	70	Line	13
50	Lazi St.	opal-1	Sodium	70	Line	58
51	Lermontov St.	opal-1	Sodium	70	Line	29
52	Leselidze St.	ambar-3	Sodium	150	Line	14
53	Levan Dadiati St.	ambar-3	Sodium	150	Line	13
54	Lomonisov St.	opal-1	Sodium	70	Line	7
55	Left Bank St.	opal-1	Sodium	70	Line	6
56	Matskhovari Kari St.	opal-1	Sodium	70	Line	20

57	Mtkheta St.	ambar-3	Sodium	150	Line	9
58	Melikishvili St.	opal-1	Sodium	70	Line	7
59	Measkhia St.	ambar-3	Sodium	250	Line	25
60	Meunargia St.	ambar-3	Sodium	150	Line	14
61	Mirtskhulava St.	ambar-3	Sodium	150	Line	6
62	Mosashvili St.	opal-1	Sodium	70	Line	19
63	March 8 St.	ambar-3	Sodium	150	Line	8
64	Nikoladze St.	ambar-3	Sodium	250	Line	17
65	Ninoshvili St.	ambar-3	Sodium	150	Line	25
66	Ninoshvili 1st turn	ambar-3	Sodium	150	Line	4
67	Orbeliani Turn	ambar-3	Sodium	150	Line	12
68	Odishi St.	ambar-3	Sodium	150	Line	24
69	Orbeliani St.	opal-1	Sodium	70	Line	11
70	Paichadze St. (Boris)	opal-1	Sodium	70	Line	13
71	Kuttsua St. (Paata)	ambar-3	Sodium	250	Line	6
72	Petriashvili St.	opal-1	Sodium	70	Line	13
73	Pushkini St.	ambar-3	Sodium	250	Line	88
74	Rapava St. (Jano)	opal-1	Sodium	70	Line	21
75	Rustaveli St.	ambar-3	Sodium	250	Double Line	67
76	Rustaveli 1st turn	ambar-3	Sodium	150	Line	5

77	Sairme St.	opal-1	Sodium	70	Line	5
78	Sajaia St.	opal-1	Sodium	70	Line	5
79	Samgori St.	ambar-3	Sodium	150	Line	10
80	Samegrelo Lane	opal-1	Sodium	70	Line	3
81	Samegrelo St.	ambar-3	Sodium	150	Line	10
82	Saint-Petersburg St.	opal-1	Sodium	70	Line	33
83	Sarajishvili St.	opal-1	Sodium	70	Line	9
84	Sichinava ST. (Vazha)	opal-1	Sodium	70	Line	15
85	Sokhumi St.	ambar-3	Sodium	250	Double Line	99
86	Gamarjveba St.	ambar-3	Sodium	150	Line	54
87	Turgenev St.	ambar-3	Sodium	150	Line	10
88	Tabidze St.	ambar-3	Sodium	150	Line	12
89	Petre Uberi St.	ambar-3	Sodium	150	Line	6
90	Paliashvili St.	opal-1	Sodium	70	Line	16
91	Pazisi St.	ambar-3	Sodium	150	Line	8
92	Poti St.	ambar-3	Sodium	150	Line	9
93	Kiria St (Shalva)	ambar-3	Sodium	150	Line	5
94	Kobalia St. (Grigol)	ambar-3	Sodium	150	Line	19
95	Kortua St. (Isaak)	opal-1	Sodium	70	Separating Line	14
96	Kuji St.	ambar-3	Sodium	250	Double Line	34

97	Kutaisi St.	ambar-3	Sodium	150	Line	16
98	Ghurtskaya St. (Gela)	ambar-3	Sodium	150	Line	21
99	Kazbegi St.	ambar-3	Sodium	150	Line	5
100	Khubulava turn. (Riot Police)	ambar-3	Sodium	250	Line	8
101	Shartava St. (Zhiuli)	ambar-3	Sodium	150	Line	64
102	Chekhov St.	opal-1	Sodium	70	Line	7
103	Chitadze St.	ambar-3	Sodium	150	Line	36
104	Chikava St.	opal-1	Sodium	70	Line	8
105	Chaikovski & Javakhishvili Turns	opal-1	Sodium	70	Line	21
106	Chilachava St.	ambar-3	Sodium	150	Line	25
107	Chikovani St.	opal-1	Sodium	70	Line	7
108	Tsabadze St.	ambar-3	Sodium	150	Line	27
109	Tsaishvili St.	ambar-3	Sodium	150	Line	21
110	Tsiskarishvili St.	ambar-3	Sodium	150	Line	8
111	Tsereteli End (Zugdidi- Tsalenjikha road)	ambar-3	Sodium	250	Line	100
112	Tsereteli St.	ambar-3	Sodium	150	Line	53
113	St Giorgi Lane	opal-1	Sodium	70	Line	15
114	St Nino St.	ambar-3	Sodium	150	Line	21
115	Tskneteli St. (Maya)	ambar-3	Sodium	150	Line	17
116	Chavchavadze St. (Aleksandre)	opal-1	Sodium	70	Line	7

117	Chavchavadze St. (Ilia)	ambar-3	Sodium	150	Double Line	60
118	Chavchavadze 2nd turn	opal-1	Sodium	70	Line	9
119	Chonkadze St.	ambar-3	Sodium	150	Line	8
120	Chkondideli St.	ambar-3	Sodium	150	Line	39
121	Khelaia St. (Ambrosi)	ambar-3	Sodium	150	Line	25
122	Janashia St. (Besarion)	ambar-3	Sodium	250	Line	21
123	Janashia 1st turn	ambar-3	Sodium	150	Line	16
124	Janashia St. (Sasha)	ambar-3	Sodium	150	Line	5
125	Javakhishvili St. (Mikheil)	opal-1	Sodium	70	Line	32
126	Jikia St. (David)	opal-1	Sodium	70	Line	27
127	Jikia St. (Gocha)	opal-1	Sodium	70	Line	17
128	Jorjiashvili St.	opal-1	Sodium	70	Line	11
129	Rustaveli St.	opal-1	Sodium	25	Double Line	26
130	Rustaveli St.	ambar-3	Sodium	250	Separating Line	78
131	Kostava St.	ambar-3	Sodium	250	Line	60
132	Sokhumi St.	onyx-3	Sodium	400	Line	14
133	Paris St.	ambar-3	Sodium	150	Line	55
134	Sverdlov St.	opal-1	Sodium	70	Line	11
135	TV Tower	ambar-3	Sodium	150	Line	10
	Total					**3006**

Methodology

The methodology for calculating the CO_2 baseline (2012) emissions inventory and future trends (up to 2020) for the Buildings Sector was the same as described in the Transport Sector. According to the MARKAL-Georgia baseline scenario projection, energy consumption in the street lighting sector will increase by 25% for 2020. (With approximately 760 new non-efficient sodium bulbs).

Base Year Inventory & GHG Emissions Baseline Scenario (2012 – 2020)

Total energy consumption from the street lighting sector amounted to 1,655,213 kWh in 2012. Emissions reached 225 t CO_2 eq. The electrical grid average emissions factor -- 0.136 t CO_2/MWh-- was considered as the emissions factor in 2012 assuming it would not change during the period covered. According to the baseline scenario, street lighting energy consumption will increase up to 2.07 thousand MWh by 2020 equaling 0.282 thousand tons of CO_2 emissions a year.

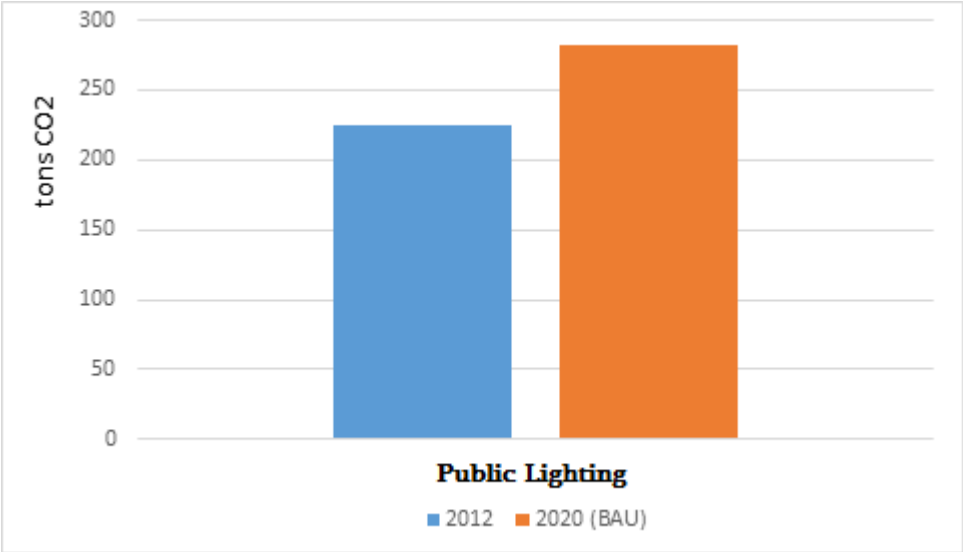

Figure 15. Emissions from Street Lighting Sector in 2012 - 2020

Emissions Reduction Action Plan from Zugdidi Street Lighting Sector

The street lighting sector action plan includes:

- Outdoor lighting poles fully equipped by energy-efficient bulbs (installation of 3767 energy-efficient bulbs by 2020);
- Automated Outdoor Lighting Management System (AOLMS).

Replacng inefficient bulbs with energy-efficient LED bulbs will have the most significant effect of these measures. LEDs are one of the most efficient light sources on the market, with many advantages, including:

- High levels of brightness and colors;
- Waterproof and dust resistant;
- Rational use of energy;
- Long life.

LED bulbs have a lifetime of up to 50,000 hours, while halogen and luminescent bulbs only four hours. In spite of the fact that initial investments to purchase LED bulbs is higher, long term expenses are significantly lower. Taking this measure will mean 100% of street lightbulbs will be replaced by 3767 LED bulbs by 2020. This measure will save up to 1.66 GWh energy and 0.226,000 tons of GHG emissions. Purchasing and installing these lights amounts to 270 Gel each, or 1,017,000 GEL to be carried out in phases over 8 years, at an annual cost of about 127,000 GEL. The following chart shows GHG emissions according to the BAU and the SEAP comparative analysis.

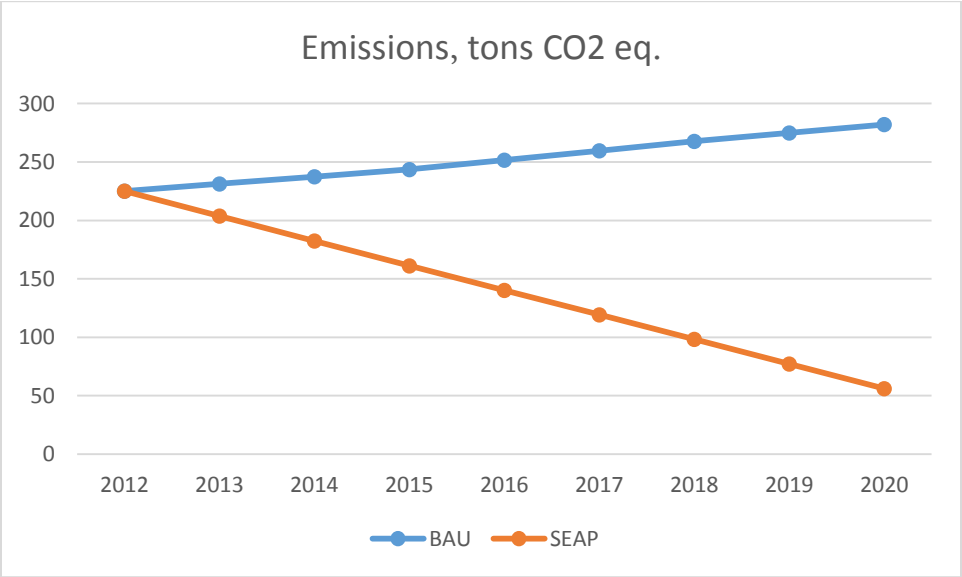

Figure 16. Comparative Energy Consumption by Street Lighting Sector according to the BAU Scenario and the SEAP

In addition to reduced emissions, the measure will have other advantages:

- Significant reductions in electricity expenses. Savings will reach about 265,000 thousand Gel/year by 2020 and will continue for years;
- Reduced maintenance costs;
- Outdoor lighting engineers and workers can be employed to solve existing issues in household and municipal services without additional human resources and budgetary expenses.
- Increased traffic safety and increased security for bikes and pedestrians by better, uniform lighting of road surface and the surroundings.

The development of an Automated Outdoor Lighting Management System (AOLMS) aiming at reducing energy consumption and emissions has been recommended but not yet evaluated.
The Automated Outdoor Lighting Management System (AOLMS) has the following advantages:

- Remote, automated and automatic turning on/off the lighting line (annual schedule with possibility to modify);
- Energy savings based on evening, night and morning mode management;
- Receiving information on electrical grid parameters under each phase;
- Can store information about energy consumption and breakdowns;
- Promptly informs dispatchers on breakdowns with possibility to duplicate message via e-mail and SMS;
- Automated processing of information received and sent;
- Automated formation of consolidated and detailed reports;
- Lighting control (GSM (GPRS) channel;
- Cable integrity control and elimination of its infringement;
- Control of high and low voltage threshold by each phase;
- Possibility to receive meter readings on monitors anywhere;
- Instantaneous receipt about unauthorized connections and electricity thefts;
- Control of out-of-service lighting equipment;
- Integration with other automated systems;
- Reduced expenses.

WASTE

Sector Overview

Improving the city's infrastructure and the construction of residential and commercial buildings and road repair have increased in recent years. However developing the city infrastructure causes an increase in waste by the population. Without sufficient management, waste in the region negatively impacts the environment (GHG) and local areas (air & surface/groundwater pollution). Both threaten human health. The United Nations Framework Convention on Climate Change (UNFCCC) and Intergovernmental Panel on Climate Change (IPCC) developed a methodology and handbook to calculate GHG emissions from the Zugdidi Waste Sector based on the following source – categories:

- Solid Waste Disposal (6A)
- Waste Water Treatment (6B1 , 6B2)
- Waste Incineration (6C)
- Other Waste (6D) – Industrial, Medical and Radioactive

A Waste Sector inventory was conducted for one subsector only. However, "Disposal of Solid Waste"(6A) "Waste incineration" and "Other Waste" have not been considered since no waste is burned and Other Waste (Industrial, Medical and Radioactive) is not recorded or controlled. In addition to this, construction and household waste are dumped in the same areas. The total amount of household and construction waste in landfills amounts to 45,000 m3 a year, with only 5000 m^3 of this made up by construction waste according to local experts. The old landfill figures were not taken into account because building materials contain practically no organic carbons to emit methane.

The "Household and Commercial Waste Water Treatment" as well as "Industrial Waste Water" (6B2) subsectors have not been considered as the region is limited to several small tea factories, hazelnut processing, construction and refrigeration enterprises, and technologies that do not use water circulation. Therefore, industries developed in Zugdidi Municipality are not sources of methane emissions within the "Industrial Waste Water" Subsector.

Solid Waste Disposal

In the village of Chitatskari, 10 km distance from Zugdid and 2 km away from the nearest dwellings, a six hectare landfill with a depth of three meters operated from 1972 to 2010. The landfill served Zugdidi City and some neighboring villages. According to 2009-2010 data, about 40-45,000 m^3 solid and construction waste was delivered there annually. Most of the waste has been compacted, and some (40 m^3) was taken to new landfill opened in 2010. The old landfill is surrounded by private lands yet environmental conditions are satisfactory. The city's old landfill is owned by the Municipality.[32] The new landfill, bordered by two villages – Tsaishi and Didinedzi[33] started operating in 2010.

It is currently the only active landfill area in the Samegrelo-Zemo Svaneti region[34] (except for Poti). According to N(N)LE "Zugdidi Cleaning" management, the landfill is environmentally safe and meets modern standards and requirements. There is a concrete road, parking, laundry, spare parts warehouse and administrative building.[35] The polygon waste thickness is about 2m. Waste is pressed and covered with earth from time to time, but does not have a site for animal burials. No cases of spontaneous combustion have been recorded.[36] Technical and inert waste are not being dumped here. Only 500 meters away from the landfill, the Utora River flows, but is isolated from the landfill. (See Pic. 16).

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[32]Local expert

[33]http://www.livepress.ge/ka/site/politics/2788/

[34]There is a temporary landfill in Mestia now – a hole being filled with waste. A mobile dump is being planned which will transport the waste to nearest site.

[35]http://www.zugdidicity.ge/index.php?css=purple.css&id=1144

[36] Spontaneous combustion cases are frequent, according to population

The Samegrelo-Zemo Svaneti Region has one active landfill per each municipal unit (except Mestia) and the only body having an environmental influence permit is the Khobi Municipality landfill. The total area of all eight landfills is about 43,4 hectares. The volume of waste generated throughout the year exceeds 139,500 m^3. The waste is not sorted or separated nor is there any organic waste composting.[37]

Picture 16. Zugdidi City Active Landfill

Since 2013, Zugdidi's new landfill maintenance (waste collection and disposal) has been the responsibility of the LTD Solid Waste Company of Georgia, which is part of the Ministry of Regional Development and Infrastructure of Georgia. Due to a lack of resources, the Company has not been collecting household waste from all of the villages: Narazeni, Octomberi and Ganmukhuri village residents claim that they have to dispose of their garbage independently (digging holes to dump trash in or throwing it in local public lands, etc).[38]

An average of 110-120 m^3 waste per day-- 45,000 m3 a year--is collected over the Municipality territory. The composition of the waste is mixed, so there is no accurate/measured data on the contents--scrap metal, glass containers, household appliances, construction solid waste, etc.[39] The amounts have increased 10-fold[40] over the last 10 years, according to the local government.

37 https://matsne.gov.ge/index.php?option=com_ldmssearch&view=docView&id=2024548

38 http://www.radiotavisupleba.ge/content/zugdidi/25229861.html

39 Local expert

40 Local expert

The Zugdidi Cleaning company cleans 75% of the City streets and empties 800 Municipal and 205 commercial garbage bins. Each municipal bin is intended for only 15- 20 consumers, however the Regional Office reports that 80-90% of the population benefit from these bins, especially nearby area residents who do not have trashcans in their streets.[41] The landfill also serves other regions of Samegrelo Zemo Svaneti: Tsalenjikha, Jvari, Khobi, Chkhorotsku and Senaki with approximately 15,000 m^3 per annum. Municipal waste is not brought from neighboring regions on a daily basis. According to Georgian Solid Waste Management Company LLC, the total amount of waste carried to the landfill amounted to 28,800 m^3 as of June 10, 2014.

There is one illegal landfill in the Municipality but no quantitative data are available. A waste processing office specializing in scrap metal collection operates as well.[42] At present, a Waste Management Improvement Project is being carried out to provide necessary equipment and garbage bins to the area,[43] however, based on information received from Tsaishi and Didinedzi villages, people enter the grounds to collect food, scrap metal and other items despite a metal mesh enclosure and entry restrictions.[44] There are recorded cases from both villages, of methane gas ignition and heavy odors from the landfill. Insects and rodents have increased significantly, and there have been some cases of poisoning. Waste is generally dumped on the surface, even though arable lands are located only a few meters away from the area.[45] Leakage from the landfill even pollutes the ground waters of the town used by a large proportion of the urban population. Most residents access the ground water directly, but no water safety monitoring is conducted.[46](See Picture 17)

[41]Local expert
[42]http://nala.ge/uploads/zugdidi.pdf
[43]http://nala.ge/uploads/zugdidi.pdf
[44]http://www.livepress.ge/ka/site/politics/2788/
[45]http://boqlomi.blogspot.de/2012/07/video_08.html
[46]http://nala.ge/uploads/zugdidi.pdf

Picture 17. Zugdidi Active Landfill

The Ministry of Regional Development and Infrastructure, with financial support from the German Development Bank (KFW) will construct a modern landfill facility in Samegrelo-Zemo Svaneti to replace the existing dump and address these challenges, although the date and site are still unknown. According to the Ministry, a study to select the site will be conducted soon, taking into account environmental and other factors.[47]

Methodology

There are two ways to calculate methane emissions from landfills suggested by the IPCC guidelines: Default (level 1), and FOD (First Order Decay) (level 2). The main difference between these two is that FOD gives a time-dependent profile of emissions production, and better reflects waste degradation processes, while the typical default method is based on the assumption that waste production potential, as well as emissions, occur in the year of disposal. The default method can be successfully applied if there is a constant amount and composition of waste disposed to a landfill, or if the variations are insignificant over several decades. However, if there are important changes in the amount and composition of waste, the use of the default method is not recommended.

[47]Local Expert

To calculate methane emissions from both landfills (closed 6 ha and active 15 ha) the FOD method (level 2) has been applied. Relevant formulas and parameters are given below:

Level 2: First Order Decay (FOD) Method

$$M^{G}_{CH4}(t) = \sum_{x=1}^{x=t} [(A \bullet k \bullet MSW_T(x) \bullet MSW_F(x) \bullet MCF(x) \bullet DOC(x) \bullet DOC_F(x) \bullet F \bullet 16/12)] \bullet e^{-k(t-x)},$$

$$M^{E}_{CH4}(t) = [M^{G}_{CH4}(t) - R(t)] \bullet (1 - OX)$$

where:

$M^{G}_{CH4}(t)$ = methane amount produced in a year, while $M^{E}_{CH4}(t)$ - is finally emitted methane amount

MSW_T =Pop • GR.

MSW_T - total Municipal Solid Waste (MSW)

Pop - population producing waste disposed to landfill

GR - municipal solid waste production norm

MSW_F - portion of the Municipal Solid Waste in total waste disposed at landfill

MCF - methane correction factor

DOC - degradable organic carbon

DOC_F - fraction DOC dissimilated

F-fraction of CH4 in landfill gas

R -recovered CH4

OX-oxidation factor

t – year of inventory

x– previous year (with respect to)

$k=\ln(2)/t_{1/2}$ - methane generation speed constant; $t_{1/2}$ - half-life

$A=(1-e^{-k})/k$ - normalization coefficient correcting the Total calculation

Activity Data

Population numbers producing waste deposed in the landfill

According to the data of 2012, Zugdidi City population was estimated at approximately 74,042 people, or 42% of the entire Municipality. Moreover, the city population has increased 50% since 1989, mainly resulting from the influx of displaced persons to the urban area (Table 40). Population density is 1 8001 persons per km^2.[48]

[48]http://www.droa.ge/ckfinder/userfiles/files/ადმინისტრაციულ-ტერიტორიული%20ოპტიმიზაციის%20წინადადებები.pdf

Table 42. Actual values of Zugdidi population, interpolated(*) for 1972–2001[49] and forecast[50] for 2014-2020

Year	Population, person		Year	Population, person		Year	Population, person	
	Zugdidi	Zugdidi Municipality		Zugdidi	Zugdidi Municipality		Zugdidi	Zugdidi Municipality
1972*	45 568	109 363	1992*	54 054	129 729	2012	74 042	177 700
1973*	45 796	109 910	1993*	55 538	133 292	2013	73 792	177 100
1974*	46 025	110 459	1994*	57 023	136 855	2014	74 161	177 986
1975*	46 255	111 012	1995*	58 508	140 418	2015	74 531	178 875
1976*	46 486	111 567	1996*	59 992	143 982	2016	74 904	179 770
1977*	46 719	112 124	1997*	61 477	147 545	2017	75 279	180 669
1978*	46 952	112 685	1998*	62 962	151 108	2018	75 655	181 572
1979*	47 187	113 248	1999*	64 446	154 671	2019	76 033	182 480
1980*	47 423	113 815	2000*	65 931	158 234	2020	76 413	183 392
1981*	47 660	114 384	2001*	67 415	161 797	2021	76 796	184 309
1982*	47 898	114 956	2002	68 900	167 800	2022	77 179	185 231
1983*	48 138	115 530	2003	69 250	166 200	2023	77 565	186 157
1984*	48 378	116 108	2004	69 125	165 900	2024	77 953	187 088
1985*	48 620	116 689	2005	70 458	169 100	2025	78 343	188 023
1986*	48 863	117 272	2006	71 750	172 200	2026	78 735	188 963
1987*	49 108	117 858	2007	71 542	171 700	2027	79 128	189 908
1988*	49 353	118 448	2008	72 100	171 500	2028	79 524	190 858
1989	49 600	119 040	2009	72 300	173 300	2029	79 922	191 812
1990*	51 085	122 603	2010	73 250	175 800	2030	80 321	192 771
1991*	52 569	126 166	2011	74 200	177 400	2031	80 723	193 735

Since 80-90% of the population and 205 commercial customers[51] are currently using the Zugdidi City landfill and registered in the local cleaning department database, it is assumed that 90% of waste generated by the city population and commercial customers is disposed of in landfills. In addition to the waste from Zugdidi, garbage generated by the Samegrelo Zemo-Svaneti regions are delivered there as well. Unfortunately no information is available on the towns or populations who are disposing of waste to the landfill, however the annual average disposal rate is known.

[49] Population was interpolated in 1972 – 2001. For the population of 1989 and 2002-2013 Statistical data were applied

[50] Population projections for the years 2014-2020 were made with the assumptions that annual growth will be 0.5% as applied in the MARKAL-Georgia model.

[51] Commercial customer is considered as an ordinary resident under these assessments

Characteristics of Waste Production and Disposal Processes

There are two landfills – one closed and one active-- on Zugdidi Municipal territory. The closed landfill served Zugdidi City and neighboring villages from 1972 to 2010, with about 40,000m^3 of household dumped per year. Just after the new landfill opened in 2010, waste generated from other Municipalities of Samegrelo- Zemo Svaneti (15,000 m^3/y) has also been disposed of in the area. To assess emission trends from landfills, annually generated waste has been calculated on a per capita basis applying the existing data of Zugdidi City (2012).

45 000 m^3/(74 042*90/100+205)=0.675 m^3= 135 kg, (1m^3-0.2 t) where,
45 000m^3- Average annual waste generated by Zugdidi Population in 2011 – 2013;
74,042 – The population of Zugdidi in 2012 disposing 90% of waste in the landfill;
205 Commercial customers each of which were considered as one resident;
1m^3-0.2 t waste, volume to mass transferring coefficient

Calculations revealed that annually generated per capita waste (135 kg) in Zugdidi is quite close to results of research carried out in Batumi (151/kg/per capita/year waste). The per capita waste of Batumi, assessed without differentiation, is higher, due to large numbers of tourists, while a considerable proportion of organic waste (47%) is used for cattle feed in Zugdidi. There is no precise information about the number of residents whose waste is being disposed of in the landfill, but since the total annual amount of trash delivered in 2010 – 2012 is known, methane emissions have been calculated in terms of total numbers rather than on a per capita basis.

The amount of waste in the old landfill in 1972 was half of that of 2010, and increased incrementally until that date. This growth has been reflected via interpolaton, as illustrated by Table 43. The fact that waste has increased by 10 times[52] over the last 10 years has also been considered, thus waste will probably increase by 2% after 2014, based on growth rates for the future.

The future scenario means that methane will not be collected and recycled from closed and active landfills. Moreover, the active dump continues operating at least before 2020.

Table 43. Actual (2010-2013) and Interpolated (*) Amount of the Waste Disposed in Old (a) and New (b) Landfills

Year	Kg/Year	Year	Kg/Year	Year	Kg/Year
1972*	600 000	1985*	860 005	1998*	1 120 010
1973*	620 000	1986*	880 006	1999*	1 140 011

[52]http://nala.ge/uploads/zugdidi.pdf

1974*	640 001	1987*	900 006	2000*	1 160 011
1975*	660 001	1988*	920 006	2001*	1 180 012
1976*	680 002	1989*	940 007	2002*	1 200 000
1977*	700 002	1990*	960 007	2003*	2 050 000
1978*	720 002	1991*	980 008	2004*	2 900 000
1979*	740 003	1992*	1 000 008	2005*	3 750 000
1980*	760 003	1993*	1 020 008	2006*	4 600 000
1981*	780 004	1994*	1 040 009	2007*	5 450 000
1982*	800 004	1995*	1 060 009	2008*	6 300 000
1983*	820 004	1996*	1 080 010	2009*	7 150 000
1984*	840 005	1997*	1 100 010	2010	7 992 000

Year	Kg/Year	Year	Kg/Year	Year	Kg/Year
2010	8 000	2019*	15 206 400	2028*	17 694 720
2011	12 000 000	2020*	15 482 880	2029*	17 971 200
2012	12 000 000	2021*	15 759 360	2030*	18 247 680
2013	12 000 000	2022*	16 035 840	2031*	12 000 000
2014*	13 824 000	2023*	16 312 320	2032*	18 800 640
2015*	14 100 480	2024*	16 588 800	2033*	19 077 120
2016*	14 376 960	2025*	16 865 280	2034*	19 353 600
2017*	14 653 440	2026*	17 141 760	2035*	19 630 080
2018*	14 929 920	2027*	17 418 240	2036*	19 906 560

Waste Composition

Waste management in Georgia is at the initial stages, thus there is no reliable information on waste composition, especially data for separate cities. Hence, GHG calculations from household waste disposal areas have been made using data obtained through the Third National Communications inventory process on waste composition. The data existing in Georgia about municipal waste compounds are not complete or accurate. There are only percentage rates measured by different donors within the framework of a single study. For example, the compositions of municipal waste were estimated in 2003 for Tbilisi (GIZ) and in 2010 for Batumi (by the Environmental and Natural Resources Agency of Adjara[53]). There are some differences between the results since Tbilisi is much bigger in territory and population. Zugdidi differs from bigger cities in terms of lifestyle and living conditions. Therefore, data from the

[53] http://www.greenalt.org/webmill/data/file/EIA_Adjara_%20SWM1.pdf

most similar city (Batumi) have been applied for Zugdidi calculations. The percentages of generated waste (measures in 2007, EU[54]) are shown in Table 41. There are other sources describing the composition of wastes but data are more evaluative in nature.[55]

Table 44. Composition of Municipal Waste in Batumi

Fraction	Mass %
Paper	7.6
Plastic	10.15
Inert	3.54
Metal	1.19
Textile/Leather	11.79
Organic	62.76
Mixed	2.36
Green	0.61
Total	**100**

The data from Batumi was gathered only once (2007) so there is no information about multi-year dynamics. However the Batumi 2010 data have been applied to all years for the inventory of methane emitted from closed and active landfills (Table 44).

Emission Factors

There are factors applied to calculate methane emissions from solid waste:

Methane Correction Factor – MCF depends on the landfill type - Unmanaged landfills produce less methane than managed ones because decomposition of most waste in the upper layers is aerobic and releases carbon dioxide. The IPCC 2006[56] gives the default values of the correction factor, presented below in Table 45.

[54] http://www.greenalt.org/webmill/data/file/EIA_Adjara_%20SWM1.pdf

[55] 2003 - "2003, GIZ" ; 1990 and 2010 - "*GEO*- cities Tbilisi: Integrated environmental assessment of trends and conditions of the Capital http://geocities-tbilisi.ge/failebi/2388-Introduction.pdf;

561996 IPCC Guidelines for National GHG Inventories, http://www.ipcc-nggip.iges.or.jp/public/gl/pdfiles/rusch6-1.pdf(p. 6.8)

Table 45. Methane Correction Factor (MCF) Values for Different Types of Landfills

Type of Landfill/Landfill	Average thickness of waste m	MCF
Managed[57]		1
Managed– thin[58]	Waste thickness<5	0.5
Unmanaged – deep	Waste thickness>5	0.8
Unmanaged – thin	Waste thickness<5	0.4
Uncategorized Landfill		0.6
Zugdidi (closed)	**3**	**0.6**
Zugdidi (active)	**2**	**0.5**

Since the Zugdidi landfill is not managed, its depth is only 3m (Table 45) so 0.6 has been used to calculate MKF. Despite the fact that active landfill of Zugdidi is new, its management does not conform to European Standards. It is covered with earth and compacted as far as possible, which causes anaerobic processes to take place. The Zugdidi landfill is not deep (thin) and it is managed. Waste thickness is much less than 5 m, so 0.5 is applied as methane correction factor (Table 45).

Degradable organic carbon - DOC. **–** Waste component, decomposing biochemically and measured in GgC/gg per waste.

DOC depends on waste composition and country/regional climatic conditions. In case of conducting necessary researches, (testing samples from different city landfills), usage of the DOC national data is recommended. If the latter are not available in a country, default values of the IPCC 2006 depending on the waste composition only[59], are applied to calculate DOC for the waste components. Default values of the DOC are given in Table 46, and the formula assesses the DOC by waste composition.

571996 IPCC Guidelines for National GHG Inventories, http://www.ipcc-nggip.iges.or.jp/public/gl/pdfiles/rusch6-1.pdf (ᲒᲐ. 6.8)

58 A managed landfill implies the disposal area is kept secure. Wastes are covered, pressed and layered. Good Practice Guidance and Uncertainty Management in National GHG Inventories, 2000, ᲒᲐ. 59

[59] 2006 IPCC Guidelines for National GHG Inventorieshttp://www.ipcc-nggip.iges.or.jp/public/2006gl (ᲒᲐ. 2.16)

Table 46. Default Values of the DOC_i by Waste Composition

Waste Composition	DOC_i
Food waste	0.15
Garden	0.2
Paper	0.4
Wood and Straw	0.43
Textiles	0.24
Disposable Diapers	0.24

$$DOC=\sum(DOC_i \cdot W_i), \ (1)$$

Where, DOC –Degradable Organic Carbon;
DOC_i –Degradable Organic Carbon by Waste Type/Fraction (i);
W_i - Portion of waste by type/fraction (i)

Fraction of degradable organic carbon dissimilated-DOC_F).

DOD_F is actually a dissimilated component of organic carbon. A certain amount of organic carbon is not decomposed at all or decomposes very slowly. IPCC GPG-recommended values for DOC_F vary between 0.5-0.6 (It is assumed that the landfill is in an anaerobic conditions and lignin[60] carbon is included in the DOC value). DOD_F depends on a number of factors such as temperature, moisture, pH, waste composition, etc. The IPCC GPG recommends using national values, though they should be based on well-documented surveys.

Methane Content of Landfill Gas (F).

Methane concentration in landfill gas is up to 50% according to the IPCC 2006. Only oil and fat containing materials generate bio gas with more than 50% of methane.

Oxidation Factor (OX)

Oxidation factors reflect the amount of methane generated in waste cover materials (soil, etc.). OX value in case of managed landfill (where waste are covered by oxidizing materials – soil, compost) is equal to 0.1, amounting to 0[61] for unmanaged dumps. This volume (OX=0) has thus been taken for the Zugdidi landfill.

The IPCC 2006 level 2 software has been applied for automated calculation of all necessary parameters.

[60]Plant cell consist of three important components: cellulose, lignin and hemicellulose. Lignin strengthens cell walls, binging the latters as well. Dissimilation of lignin is anaerobic process. Lignin becomes durable under anaerobic conditions

[61] Good Practice Guidance and Uncertainty Management in National GHG Inventories, 2000, ȣ3. 5.10. http://www.ipcc-nggip.iges.or.jp/public/gp/english/index.html (ȣ3.5.10)

Base Year Inventory and GHG Emissions Baseline Scenario (2012 – 2020)

Closed Landfill

The old landfill of Zugdidi closed in 2010 and emissions reduction started in 2012. Table 47 shows Zugdidi methane emissions forecasts from old landfills after closure, relative to total annual amount of waste disposed during its operation (Table 43 a). Calculations have been based on the assumption that existing waste had been left in the landfill (only a very small amount of waste was relocated to the new dump– 40m3) and methane will not be utilized.

Table 47. Methane Emissions from Zugdidi Closed Landfill for 2012 - 2036

Year	GG/year	Kg/Year	m³/Year	m³/day
2012	0.12	123 800.00	171 944.44	471.08
2013	0.11	106 800.00	148 333.33	406.39
2014	0.09	92 400.00	128 333.33	351.6
2015	0.08	80 200.00	111 388.89	305.18
2016	0.07	69 900.00	97 083.33	265.98
2017	0.06	61 200.00	85 000.00	232.88
2018	0.05	53 700.00	74 583.33	204.34
2019	0.05	47 400.00	65 833.33	180.37
2020	0.04	41 900.00	58 194.44	159.44
2021	0.04	37 300.00	51 805.56	141.93
2022	0.03	33 200.00	46 111.11	126.33
2023	0.03	29 800.00	41 388.89	113.39
2024	0.03	26 800.00	37 222.22	101.98
2025	0.02	24 200.00	33 611.11	92.09
2026	0.02	21 900.00	30 416.67	83.33
2027	0.02	19 900.00	27 638.89	75.72
2028	0.02	18 100.00	25 138.89	68.87
2029	0.02	16 600.00	23 055.56	63.17
2030	0.02	15 200.00	21 111.11	57.84
2031	0.01	14 000.00	19 444.44	53.27
2032	0.01	12 900.00	17 916.67	49.09
2033	0.01	11 900.00	16 527.78	45.28
2034	0.01	11 000.00	15 277.78	41.86
2035	0.01	10 200.00	14 166.67	38.81
2036	0.01	9 500.00	13 194.44	36.15

The outcomes show (Table 47) that methane emissions from the closed landfill were equal to 0.12 Gg in 2012. This will be significantly lower by 2020 (0.04 Gg), though it will start entering the atmosphere at that time.

Active Landfill

Since the Solid Waste Management Company does not have a project for the active landfill's closure, it will continue operating under the existing conditions. Therefore, the upward trend of methane emissions will continue: Table 43 (b). Table 48 shows Zugdidi methane emissions forecasts from active landfills relative to the total annual amount of waste disposed of throughout their operation (Table 43 b). Calculations have been based on the assumption that existing waste methane will not be utilized.

Table 48. **Methane Emissions from Active Landfill of Zugdidi - 2012 - 2036**

year	Gg/year	Kg/year	m³/year	m³/day
2012	0.05	46 600.00	64 722.22	177.32
2013	0.09	86 200.00	119 722.22	328.01
2014	0.12	120 000.00	166 666.67	456.62
2015	0.16	156 000.00	216 666.67	593.61
2016	0.19	187 900.00	260 972.22	714.99
2017	0.22	216 400.00	300 555.56	823.44
2018	0.24	242 000.00	336 111.11	920.85
2019	0.27	265 100.00	368 194.44	1 008.75
2020	0.29	286 300.00	397 638.89	1 089.42
2021	0.31	305 700.00	424 583.33	1 163.24
2022	0.32	323 700.00	449 583.33	1 231.74
2023	0.34	340 500.00	472 916.67	1 295.66
2024	0.36	356 200.00	494 722.22	1 355.40
2025	0.37	371 000.00	515 277.78	1 411.72
2026	0.39	385 100.00	534 861.11	1 465.37
2027	0.4	398 500.00	553 472.22	1 516.36
2028	0.41	411 400.00	571 388.89	1 565.45
2029	0.42	423 800.00	588 611.11	1 612.63
2030	0.44	435 800.00	605 277.78	1 658.30
2031	0.45	447 500.00	621 527.78	1 702.82
2032	0.46	458 800.00	637 222.22	1 745.81
2033	0.47	469 900.00	652 638.89	1 788.05
2034	0.48	480 700.00	667 638.89	1 829.15

2035	0.49	491 400.00	682 500.00	1 869.86
2036	0.5	501 800.00	696 944.44	1 909.44

These figures indicate that if the Landfill continues operating under the old terms, methane emissions from the active landfill will be 0.29 Gg by 2020 (Table 48).

Emissions Reduction Action Plan for the Zugdidi Solid Waste Sector

Within the framework of the SEAP the only measure planned for the closed landfill is methane collection and on-site incineration, which will result in a much smaller portion of GHGs being released into the atmosphere, like the present emissions of methane gas (CH_4). Amounts of reduced emissions are also calculated for the old landfill, which remains unchanged. Methane collection and on-site incineration will be implemented (2016) (Table 46).

Table 49. Amounts of CO_2 Saved with SEAP scenario

Year	Gg/y		t /y	
	CH_4	CO_2-eq	Total Emissions CO_2 t	Saved CO_2 t
2012	0.12	2.6	2 599.80	0
2013	0.11	2.24	2 242.80	0
2014	0.09	1.94	1 940.40	0
2015	0.08	1.68	1 684.20	0
2016	0.07	1.47	1 467.90	0
2017	0.06	1.29	391.68	893.52
2018	0.05	1.13	343.68	784.02
2019	0.05	1	303.36	692.04
2020	0.04	0.88	268.16	611.74
2017-2020 total	**0.2**	**4.29**	**1 306.88**	**2 981.32**

CO_2 emissions will be reduced by 0.62 in 2020, according to the SEAP scenario. The calculations assume that only 80% of methane gas can be actually collected and the amount of CO_2 released per ton of methane incineration is 2.75 tons. The toal amount of CO2 saved with this scenario will be 2.98 Gg over four years.

Methane collection and on-site incineration measures are being considered for the active landfill as well, which will mean a much smaller portion of GHGs entering the atmosphere instead of the methane gas (CH_4) emitted now. Reduced emissions have been calculated for the new landfill but exiting conditions remain the same. It has been assumed that methane collection and an on-site burning system will be deployed in 2016. (Table 47).

Table 50. Amounts of CO_2Saved in the SEAP implementation scenario

year	Gg/year		t/y	
	CH_4	CO_2-eq	total emissions CO_2 t	saved CO_2 t
2012	0.05	0.98	978.6	0
2013	0.09	1.81	1 810.20	0
2014	0.12	2.52	2 520.00	0
2015	0.16	3.28	3 276.00	0
2016	0.19	3.95	3 945.90	0
2017	0.22	4.54	1 384.96	3 159.44
2018	0.24	5.08	1 548.80	3 533.20
2019	0.27	5.57	1 696.64	3 870.46
2020	0.29	6.01	1 832.32	4 179.98
2017-2020 total	1.01	21.21	6 462.72	14 743.10

CO_2 emissions will be reduced by 4.18 Gg in 2020, according to this scenario. The calculations assume that only 80% of methane gas can be actually collected and amounts of CO_2 released from 1 ton of methane incineration are 2.75 tons. The total CO2 saved in case of project implementation will be 14.74 Gg over four years (Table 48).

Table 51. Summary Table

Landfill	**Methane release in CO_2 eq (tons) 2012**	**Methane release in CO_2 eq(tons) 2020**	**Saving in 2010 in CO_2 eq (tons)**
Old	2 600	880	620
New	980	6 000	4 180
Total	**3 580**	**6 880**	**4 800**

GREENING/LANDSCAPING

The Existing Situation

Total area of Zugdidi City is approximately 2.1 thousand hectares, of which 97 ha[62] are landscaped, including the recreation areas that occupy 29 hectares (Table 52).

Table 52. Green Cover of Zugdidi

№	Landscaped Areas	Total Area	Covered by Plants	Planted %
		Recreation Zones		
1	Botanical Garden	259 700	233 730	90
2	Central Boulevard of the City	13 050	11 745	90
3	Laws Across So. Gamsakhurdia Ave.	2 900	1 740	60
4	Adjacent Territory of State Historical-Ethnographic Museum	5 500	4 950	90
5	Railway Station Territory lawns	250	150	60
6	"Sichabuke" Square	1 200	600	50
7	Square of the Regional Admininistration territory	1 200	720	60
8	Square at Shalva Dadiani Theatre territory	2 500	1 250	50
9	Chavchavadze Square	600	300	50
10	"Samaya" Square	600	300	50
11	April 9 Square	320	128	40
12	Gulua Square	880	352	40
13	Square on Akaki Tsereteli St.	750	525	70
14	"Sichabuke" Square	770	385	50

[62] http://www.zugdidi-sakrebulo.ge/index.php?css=red.css&id=1261&slave=1219&lang=geo#read_position

15	Meunargia Square	280	112	40
Landscaped Areas				
1	Cemeteries	270 000	189 000	70
2	Green areas near organizations and residential buildings	350 000	157 500	55
3	Fragmented landscaped areas in different parts of the city	59 500	35 700	60
Total		**970 000**	**639 187**	**66**

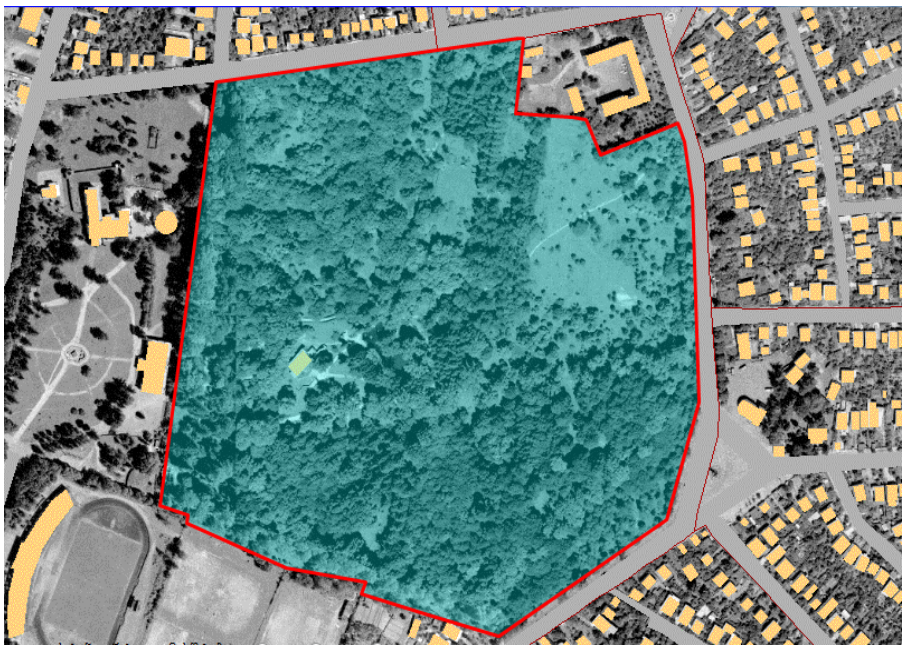
The Botanical Garden (Pic. 18) is located in the center of Zugdidi and is the biggest recreation zone as well as one of the largest absorbers of Co2, thus the main carbon reservoir of the city. Its influence on the local ecological environment is significant, and it serves as Zugdidi's central park. Plants are organized by origin or geographic location, however as the gardens are in poor condition the population can not fully enjoy them. Another important park is the Boulevard at Central Street, one of the most popular holiday areas for the local population. The Boulevard was created in the 18th century and is unique with its 150- 200 year-old trees, perennials and annual plantings.

Since the Botanical Garden is in a poorly maintained, including its infrastructure and unweeded plant areas—for example annual alder sprouting that is out of control--greater attention must be paid to the care and cultivation of all the plants. The landscape of the Botanical Garden is a grove and thus its carbon accumulation potential is greater than other vegetation in the city where trees are less densely planted.

Picture 18. Center of Zugdidi City. Botanical Garden

A complete inventory of green plants has not been made in Zugdidi, therefore no accurate data are available, nor is there information on other green plants in other recreation areas, compared to ligneous or woody plants. Consequently, percentage rates usually reflect a high distribution of ligneous plants where a significant portion of biomass is accumulated. The percentages of trees that are most common in recreation areas of Zugdidi City (except the Botanical Garden) are:

- Platanus orientalis - 40%, 70ha;
- Cedrus deodara- 15%, 27ha;
- Tilia caucasuca- 10%, 39ha;
- Pinus pinaster- 5%, 21ha;
- Cupressus sempervirens- 5%, 18ha;
- Other trees- 25%, 31ha.



Picture 19. Orthophotograph of Botanical Garden

There are 147 exotic and up to 20 endemic plant species in the Botanical Garden. Approximately 700 different trees/plants were planted between 1958 and1987. The most common trees and bushes are:

Table 53. High and large-volume (m3) trees/plants in Botanical Garden (26 ha)

N	Species	QTY	Age	Area.%	Note
1	Alder	5000	15-Oct	20	Requires Thinning
2	Hornbeam	350	40-50	8	Mixed development
3	Ligustrum	2000	Oct-40	15	Mixed development

4	Platanus	250	100	6	Mixed development
5	Acacia	50	40-50	2	Mixed development
6	Lime	50	60-80	3	Mixed development
7	Critomeria	160	50	5	Mixed development
8	Sequoia	33	50-300	2	one 200-year-old. Other 50-60 year-old.
9	Canoewood	5	200	1	Mixed development
10	Maple	150	Mar-40	5	Mixed development
11	Cedar	50	40-50	2	Mixed development
12	Beech	15	60	1	Mixed development
13	Yew	1	250		
14	Ginko biloba	2	120		
15	Georgian Oak	1	120		
	Other Species	120-125		20	Mixed development

No landscaping works are planned for Zugdidi at present but different species have been planted in the city's main streets, squares and boulevards between 2010 and 2013. (Table 51)

Table 54. Trees and plants set out in squares and boulevards in 2010 - 2013

N	Plant Species	QTY pieces	Note
1	Oak	21	Planted in various locations
2	Pine	420	
3	Hick	420	
4	Quercus suber	18	
5	Photinia	450	
6	Catalpa	350	
7	Ligustrum Jonandrum	150	
8	Leyland Cypress	1000	
9	Thuja Orientalis	45	
10	Thuja Occidentalis	60	
11	Robinia	500	
12	Buxus	250	

	Total	3684	

A total of 3400 maples, acacias and platanes were set out in the framework of a project by the Municipality in March, 2014, when approximately 1 hectare was landscaped.

Methodology

The carbon accumulation and absorption potential of Zugdid's green cover was assessed by the IPCC – 2003 methodology. An evaluation based on the CO2FIX model was used to measure the accumulation potential after landscaping works conducted throughout the city in spring and the subsequent period. The IPCC calculations were conducted for "live biomass" only (including underground biomass), namely, a calculation of collected carbon and its subsequent increase in biomass, calculated by the following equation:

Equation calculating carbon savings in live biomass (underground and above ground):

$\Delta C_{F_{LB}} = [V \bullet D \bullet BEF_2] \bullet (1+R) \bullet CF$

Where

V_Wood volume, m^3/ha;

D_ Absolutely dry wood volume weight, tons of dry mass/ m^3;

BEF_2- Coefficient of converting commercial wood stock into the total stock of above-ground woody plants to get above-ground live biomass.

R_ Ratio of the trunk of a tree to its root mass;

CF_ Carbon content in dry substance/ ton C/ton dry mass.

Equation calculating annual increment in carbon stocks of the biomass:

$\Delta C_{F_G} = (A \cdot G_{TOTAL}) \cdot CF$

Where:

ΔC_{F_G} annual increment of carbon savings resulting from biomass growth, t C/year

A_Area, covered by woods/plants;

G_{TOTAL} average annual rates of total biomass increment, tone of dry mass/ha/year;

$G_{TOTAL} = G_W \cdot (1+ R)$,

Where:

R Ratio of the trunk of a tree to its root mass;

G_W - aboveground biomass increment, t/dry mass;

If G_W data are not available, so the followng equation is applied:

$G_W = I_V \cdot D\ BEF_1$,

Where:

I_V biomass average annual increment, m^3/ha/year;

D_ Absolutely dry wood volume weight, tons of dry mass/ m^3;

BEF_1 - coefficient for converting average annual increment into the total aboveground biomass.

The CO2FIX V 3.1 model determines carbon accumulation volumes in the carbon turnover's natural cycle, applying a simple accounting methodology. This model calculates changes in all

carbon "reservoirs" in the forest over a specific period (carbon "reservoirs" are carbon-accumulating ecosystems existing inside/outside the forests, including live biomass, dead cover, organic soils and processed woody resources). Calculations carried out on a one-year and one-hectare scale include six general modules: biomass module, soil module, production module from woody resources, bio-energy module, financial module, and carbon credits counting module (for the CDM). According to the model methodology, the carbon accumulation volume (CTt) in each (t) period is calculated as follows:

CTt = Cbt +Cst + Cpt (Mg C/ha), where

Cb_t - Total amount of carbon in underground and above-ground biomass of a plant (Mg C/ha);

Cs_t - carbon stocks in organic soils (Mg C/ha);

Cp_t -Carbon stocks of woody products obtained from forestry works (Mg C/ha).

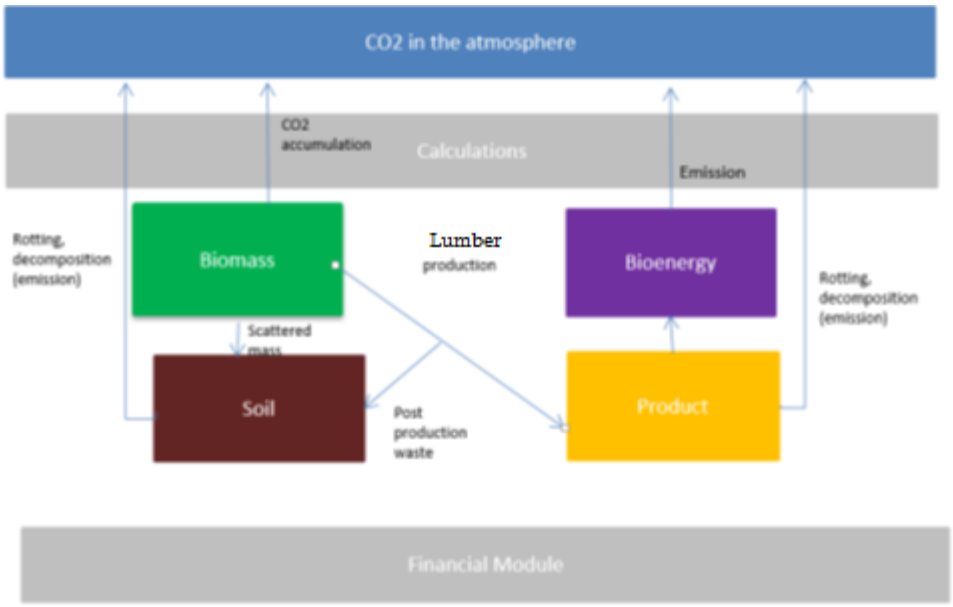


Figure 17. Model Structure

Two counting modules – biomass and soil modules have been applied to calculate accumulation potential as a result of landscaping activities.

Biomass module: The biomass module uses a "Cohort System" for calculations. Cohorts comprise one or various groups of woody plants. Growth, drying and other features separately characterize each cohort species.

Soil module: The Yasso model is applied to determine carbon dynamics in soil. (http://www.efi.fi/projects/yasso/). The model (included into CO2fix system) describes carbon decomposition and its dynamics in dry soil. It is calibrated for detection of total carbon stock in any soil layers. This model is suitable for coniferous, as well as for deciduous forests, and was

tested in different countries with different climate zones to describe the influence of specific climate conditions on the decomposition processes of the fallen leaves and branches.

Calculation Outcomes

The calculation of carbon reserves and annual increments have been carried out for green zones of Zugdidi (including recreation areas and botanical garden separately) on the basis of these methodologies. The annual carbon absorption potential of plantings of 2014 have also been computed with the CO2FIX V 3 Model. Some coefficients necessary for calculations in recreation areas of Zugdidi City have been taken from inventory based forest-use planning of the Samegrelo-Zemo Svaneti Regional Forestry Department[63].

For the 97 ha of fragmented planting areas within the city recreation zone, data corresponding to 50-60 year old sparse forest stands has been used. However for closed canopy stands in the recreation zones—especially the 26 ha Botanical Garden—data corresponding to 120-150 year-old forest stands have been applied. The average annual incremental and tree (woody plants) stock data have been calculated (Table 55). To calculate weight values of of the wood volume weight (D), main tree stock has been used. Other coefficients (BEF_1, BEF_2, R, CF) were taken from IPCC methodology, specifically, from the standard index list, corresponding to the region's climate.

Table 55. Coefficients used in calculations and their sources

Indexes suitable for calculations	Zugdidi green cover (fragmented and closed canopy stands)	
	Fragmented	Closed canopy
A - Green cover area , h[64]	40.6	23.3
V- Tree stock m3/ha[65]	110	200
D - volume weight of totally dry wood, tone totally dry mass[66]	0.430	0.570
I_V- Woody plants (trees) mean annual increment, m^3 [67]	2.0	2.8

[63]. Forest-use planning of Samegrelo-Zemo Svaneti Regional Forestry Department

[64]Zugdidi, local expert ,http://www.zugdidi-sakrebulo.ge.

[65] "Land Use Planning"of Samegrelo Zemo-Svaneti Regional Department, 2008;

[66]"Global Wood Database" http:/datadryad.org; მახვილაძე ე. მერქანმცოდნეობა, თბილისი 1962; Боровников А.М., Уголев Б. Н., Справочник по древесине. «ЛеснаяПромышленность», Москва, 1989;

[67]Average taxation rates of Batumi wood and plants; Adjara Forest Inventory, 2004

BEF_1- Coefficient for conversion of wood mean increment into total aboveground (including crown) mean increment [68]	1.15	1.15
BEF_2- Coefficient for conversion of commercial wood stock into the total stock of aboveground stock (including crown), for calculating aboveground living biomass.[69]	1.3	1.3
R - Ratio of root mass to trunk[70]	0.24	0.24
CF- carbon content in dry wood[71]	0.5	0.5

Calculated rates for Zugdidi City green areas are given below (Table 56)

Table 56. Accumulated Carbon and Annually Absorbed Carbon Dioxide

Green zones types	Areas covered with plantings (ha)	Accumulated carbon per 1 ha TC	Carbon accumulated in green plantings TC	Annual deposit of Carbon/Carbon Dioxide		
				ha carbon stock increments, tC	Carbon stock annual increments within discussed territory tC	Annually absorbed carbon dioxide $GgCO_2$
Green zones of Zugdidi	40.6	38.2	1550.9	0.6	24.4	89.5
Botanical Garden	23.3	91.8	2138.9	0.91	21.2	77.7
Average (Weighted) summarized rate		**57.7**		**0.71**		
Total	**63.9**		**3689.8**		**45.6**	**167.2**

Calculation process with results:

[68]Good Practice Guidance for Land Use, Land Use Change and Forestry, (IPCC 2003),Table 3A1.10,http://www.ipcc-nggip.iges.or.jp/public/gpglulucf/gpglulucf_files/GPG_LULUCF_FULL.pdf;

[69]Good Practice Guidance for Land Use, Land Use Change and Forestry, (IPCC 2003),Table 3A1.10;

[70]Good Practice Guidance for Land Use, Land Use Change and Forestry, (IPCC 2003),Table 3A1.8http://www.ipcc-nggip.iges.or.jp/public/gpglulucf/gpglulucf_files/GPG_LULUCF_FULL.pdf;

[71]Good Practice Guidance for Land Use, Land Use Change and Forestry, (IPCC 2003).http://www.ipcc-nggip.iges.or.jp/public/gpglulucf/gpglulucf.html

Carbon savings accumulated in Zugdidi green cover (40.6 ha):

$\Delta C_{F_{LB}}$ = [V●D●BEF_2] ●(1+R) ●CF=[110●0.43●1.3] ●(1+0.24) ●0.5= 61.5●1.24●0.5=38.2/ha

Hence, the following is accumulated in Zugdidi green zones:

40.6×38.2=1550.9tC

Annually deposited carbon in Zugdidi green cover (40.6 ha):

ΔC_{F_G}=(A · G_{TOTAL}) · CF= 40.6· 1.2· 0.5=24.4tC

G_{TOTAL} = G_W · (1+ R)=0.97·1.24=1.2

G_W = I_V· D · BEF_1=2.0·0.43·1.15=0.97

Per ha, plantings accumulate 0.6tC /ha a year, so annual absorption of carbon dioxide is 2.2tCO_2/ha.

<u>Carbon accumulation in closed canopy plantings of 23.3 ha in Botanical Garden:</u>

$\Delta C_{F_{LB}}$ = [V●D●BEF_2] ●(1+R) ●CF =[200●0.57●1.3] ●(1+0.24) ●0.5= 148.2●1.24●0.5= 91.8tC/ha

Hence, 2138.9 t C is accumulated in the Botanical Garden (23.3 ha) plantings. Annually deposited carbon in the Botanical Garden:

ΔC_{F_G}=(A · G_{TOTAL}) · CF= 23.3·2.2· 0.5= 25.6tC

G_{TOTAL} = G_W · (1+ R)=1.8·1.24=2.2

G_W = I_V· D · BEF_1=2.8·0.57·1.15=1.8

Each hectare of the Botanical Garden (23.3 ha) collects 0.91 t/C/ha a year, so the CO_2 annual absorption rate is 3.3 tCO_2/ha. The estimated carbon accumulation potential of the green zones of Zugdidi (including recreation areas) can be calculated: 3689.8 tC have been accumulated until the base year in the city's green areas. Landscaping and recreation zones were created from the beginning of the 19th century and each hectare's increment is 0.71 tC/y.

Since carbon accumulation potential after landscaping in 2014 was evaluated by the CO_2FIX model, parameters and coefficients were defined specifically for Zugdidi's conditions to ensure accurate calculations (See Tables 57 & 58).

Table 57. Biomass Model Parameters

Characteristics applied for biomass module	Characteristic Rates
Carbon content of biomass	**0,5 t.C /t.dry mass**
wood density, t.dry.mass	
Platanus	0.55
Cypress	0.542

Maple	0.48
Acacia	0.77
Thuya	0.39
Magnolia	0.46
Crepe Myrtle	0.62
Oleander	0.255
Initial carbon	0tC/ha
Growth correction factor	1
Annual rate of phytomass (branches, roots) natural death	
Coniferous:	
Needles	0.3
Branches	0.04
Roots	0.03
Deciduous:	
Leaves	1
Branches	0.05
Roots	0.08

Table 58. Soil Module Parameters

Characteristics used for Soil Module	Characteristic Indexes
Total of temperature throughout a year (below zero) (C°d)	5160.4
Evapotraspiration (PET,mm)	605
Precipitation volume in vegetation period (mm);	1510
Average monthly temperatures in periods of vegetation	
March	8.2
April	12
May	15.3
June	19.2
July	21.6
August	22
September	18.7
October	14.1

Carbon accumulation potential forecasts have been calculated using the 2014 data above for one ha of landscaping in Zugdidi. Annual carbon accumulation rates after landscaping are

presented below (Figure 18). While accumulation dynamics for the subsequent 70 years is shown in Figure 19.

Figure 18. Carbon accumulation and carbon dioxide sequestration indexes after planned greening activities (1ha)

	Sequestered Carbon reforestatio...	Sequestered Carbon reforestatio...		Sequestered Carbon reforestatio...	Sequestered Carbon reforestatio...		Sequestered Carbon reforestatio...	Sequestered Carbon reforestatio...
year [yr]	carbon [MgC/ha]	CO2 equiv. [MgCO2eq...	year [yr]	carbon [MgC/ha]	CO2 equiv. [MgCO2eq...	year [yr]	carbon [MgC/ha]	CO2 equiv. [MgCO2eq...
0	0.00	0.00	21	71.26	261.29	43	141.81	519.99
1	1.95	7.14	22	75.24	275.87	44	144.69	530.51
2	4.48	16.44	23	79.17	290.27	45	147.53	540.95
3	7.58	27.78	24	82.92	304.02	46	150.35	551.29
4	10.61	38.89	25	86.50	317.15	47	153.15	561.56
5	13.47	49.39	26	89.91	329.68	48	155.93	571.75
6	16.24	59.53	27	93.19	341.70	49	158.65	581.73
7	18.97	69.57	28	96.35	353.27	50	161.32	591.51
8	21.72	79.66	29	99.47	364.71	51	163.94	601.10
9	24.67	90.46	30	102.56	376.05	52	166.50	610.52
10	27.85	102.13	31	105.64	387.33	53	169.03	619.78
11	31.24	114.55	32	108.70	398.56	54	171.52	628.91
12	34.80	127.62	33	111.75	409.74	55	173.98	637.91
13	38.53	141.29	34	114.79	420.91	56	176.40	646.80
14	42.40	155.46	35	117.84	432.10	57	178.79	655.57
15	46.40	170.13	36	120.90	443.29	58	181.16	664.25
16	50.49	185.14	37	123.95	454.50	59	183.48	672.75
17	54.67	200.44	38	127.01	465.70	60	185.75	681.07
18	58.91	216.02	39	130.03	476.79	61	187.97	689.24
19	63.10	231.37	40	133.03	487.76	62	190.16	697.24
20	67.22	246.47	41	135.99	498.62	63	192.30	705.11

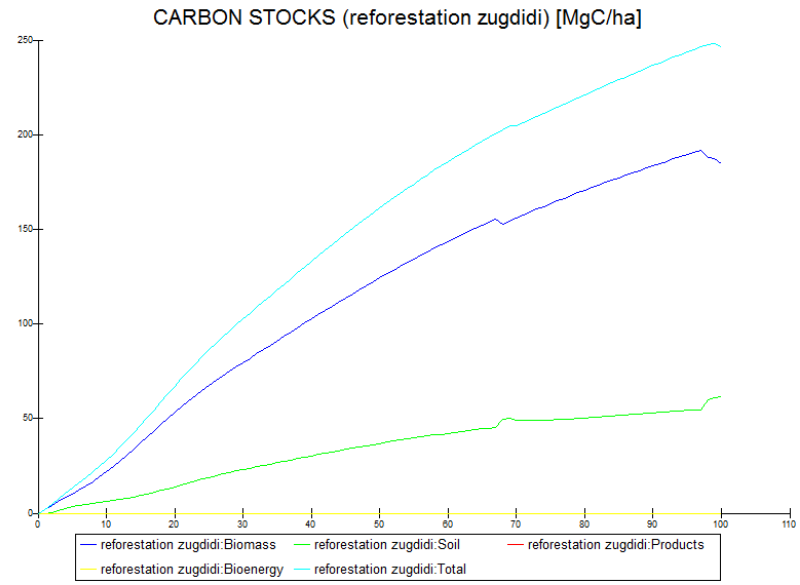


Figure 19. **Accumulated carbon dynamics after reforestation**

Summarized data obtained according to the model shows that 19 t C will be accumulated in each hectare after the planting planned for 2020. Annual sequestration indexes are presented in Table 56.

Table 59. **Carbon Accumulation and Carbon Dioxide Sequestration Indexes after Landscaping Activities (1ha)**

	2014	2015	2016	2017	2018	2019	2020
Accumulated Carbon, tC	1.95	4.48	7.58	10.61	13.47	16.97	18.97
Sequestrated Carbon , tCO_2	7.14	16.44	27.78	38.89	49.39	59.53	69.57

Measures planned within the framework of the Action Plan

Two types of measures are planned to increase annual carbon accumulation potential of Zugdidi's green cover. The first measure includes the restoration/reconstruction of the Botanical Garden's green zones, possibly planting introduced and endemic species on a 1 ha area to enrich the dendrological flora. Several departments of the Bottanical Garden will participate to contribute according to origin and systemic and geographical bases of the plants (e.g. Caucasus, Colchis, etc.). Walking paths and plant description boards will be created.

The second measure will develop a 5- ha recreation area in an attractive development zone of the City, along the central (Tbilisi-Zugdidi) highway at the village of Chitatskaro (Onaria) on adjacent territory. The measure also includes reforestation at entrance to the city.

Measure 1: Restoration of Zugdidi Botanical Garden

Principle activities will involve planting in the main area of the Botanical Garden to unify different-sized territories, and will generally make up one hectare. The trees and bushes will be planted at distances of 5m (between the largest trees); 4 m (for medium trees) and 3 m (for smaller trees). The largest trees, which need the most light, will be planted on 20% of the total area (0.2 ha), the medium trees that require shade will cover 35% (0.35ha) and smaller trees and bushes will be planted on 45% (0.45 ha) of the territory. The average age of the trees will be no less than 7-10 years old, with fully developed crown and healthy root systems. The roots of coniferous trees must be especially securely planted.

The following number of saplings are required: Large – 47 pieces; Medium – 240 pieces; Smallest – 604 pieces. The total for the planned hectare is 891 saplings. Costs for infrastructure-related activities are taken from the City budget allocations for recreational areas.[72] A Renovation Project must be created that includes renovation and infrastructure schemes, the list of selected plants and estimation of planned works. Estimated costs of the activities for the projected territory are given in Table 57.

Table 60. Estimation of Scheduled Activities

№	Description of Expenditures	Size Unit	Price per unit (US $)	Total Amount	Total Price (US $)
Core Expense					
1	**Planting Material**				
1.1	Largest trees (saplings)	piece	95	47	4465
1.2	Medium tree saplings	piece	35	240	8400
1.3	Small trees and bushes	piece	25	604	15,100
	Total 1:			**891**	**27,965.00**
2	**Activities**				
2.1.	Cleaning and weeding	ha	150	1	150

[72]https://matsne.gov.ge/index.php?option=com_ldmssearch&view=docView&id=1770736&lang=ge

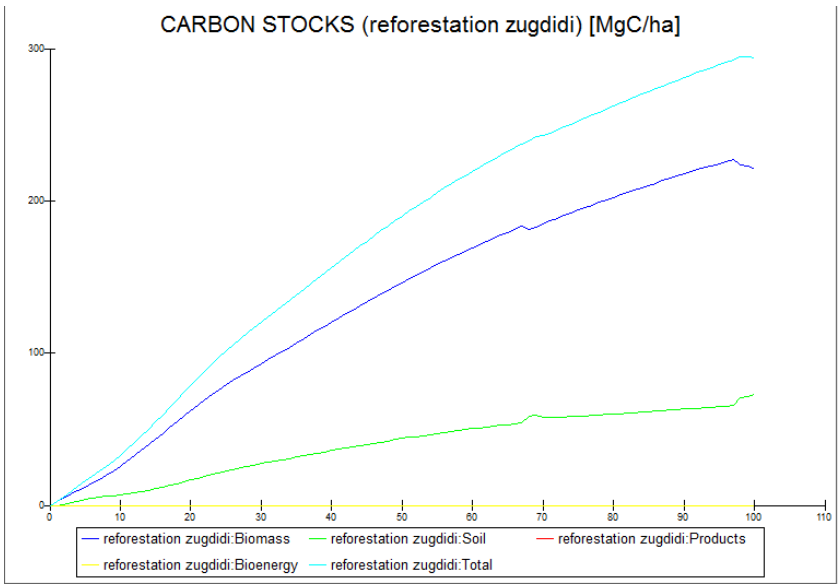
2.2.	Planning and marking the area for planting	Sapling	0.5	891	445.5
2.3.	Planting Saplings	Sapling	0.2	891	591
2.4.	Watering saplings	Sapling	0.1	891	296
2.5	Infrastructure development	M^2	1 700	45	76 500.00
	Total 2:				**77 982.50**
	Total (USD)				**105 947.50**

As shown in Table 60, total cost is 105,947.5 USD, or 182,230.0 GEL (1GEL – 1.72 USD). Carbon accumulation rates after renovation are presented in (Figure 20) and accumulation dynamics are shown in (Figure 21).

Figure 20. Carbon Accumulation and Sequestrated Carbon Dioxide Rates after Landscaping Activities

	Sequestered Carbon reforestatio...	Sequestered Carbon reforestatio...		Sequestered Carbon reforestatio...	Sequestered Carbon reforestatio...		Sequestered Carbon reforestatio...	Sequestered Carbon reforestatio...
year [yr]	carbon [MgC/ha]	CO2 equiv. [MgCO2eq...	year [yr]	carbon [MgC/ha]	CO2 equiv. [MgCO2eq...	year [yr]	carbon [MgC/ha]	CO2 equiv. [MgCO2eq...
0	0.00	0.00	20	78.86	289.16	40	156.31	573.13
1	2.29	8.38	21	83.57	306.44	41	159.83	586.05
2	5.26	19.29	22	88.22	323.46	42	163.32	598.85
3	8.89	32.59	23	92.80	340.28	43	166.78	611.52
4	12.45	45.64	24	97.18	356.34	44	170.20	624.08
5	15.82	58.00	25	101.37	371.69	45	173.60	636.53
6	19.08	69.95	26	105.37	386.35	46	176.97	648.88
7	22.31	81.80	27	109.21	400.42	47	180.31	661.14
8	25.57	93.75	28	112.91	413.99	48	183.63	673.32
9	29.05	106.52	29	116.57	427.41	49	186.89	685.26
10	32.81	120.31	30	120.20	440.75	50	190.08	696.98
11	36.81	134.96	31	123.83	454.04	51	193.22	708.46
12	41.00	150.34	32	127.44	467.30	52	196.30	719.75
13	45.38	166.40	33	131.05	480.50	53	199.33	730.86
14	49.91	183.00	34	134.65	493.73	54	202.31	741.82
15	54.58	200.14	35	138.27	506.98	55	205.26	752.64
16	59.36	217.65	36	141.89	520.26	56	208.18	763.32
17	64.23	235.50	37	145.52	533.56	57	211.06	773.88
18	69.18	253.65	38	149.15	546.89	58	213.90	784.32
19	74.06	271.55	39	152.75	560.07	59	216.69	794.54

Figure 21. Accumulated Carbon Dynamics after Renovation



According to the summary tables, the accumulation of 2.3 tC is expected for the scheduled plantings on the 1 ha area, and accumulation rates up to 2020 are presented below (Table 61).

Table 61. Annual Accumulation Rates

	2015	2016	2017	2018	2019	2020
Accumulated Carbon, tC	2.3	5.3	8.9	12.4	15.8	19.1
Carbon Sequestration, tCO_2	8.4	19.3	32.6	45.6	58	70

Measure 2 - Reforestation of promising development zones of the city, 5 ha.

Reforestation (including squares and lawns) of a 5ha project area is planned as part of the city's development. The landscaping works will be preceded by the creation of a Renovation Project with the following components: topographical maps for renovation and park infrastructure development, a list of selected plants and a cost appraisal of all works. At this stage the report includes an initial plan of activities with relevant estimations to begin the project. Approximately 80% (4 ha) of the total area will be planted and the rest will be a green park with paths, roads and squares.

The trees will be planted at distances similar to those in the Botanical Garden: 5m (between the largest trees) 4 m (medium trees) and 3m (for bushes and smaller trees). The trees will

cover, respectively, 20% of total area (0.8 ha), 35% (1.4 ha) and 45% (1.8 ha). The average age of the trees must be at least 7-10 years so that they are developed and will have formed a crown and healthy root systems.

Considering the distances between plantings, the following numbers of saplings are required: largest – 97 pieces; medium – 880 pieces; smallest (and bushes) – 1980 pieces; The total number required is 2957. The approximate costs are shown in Table 62.

Table 62. Estimation of Scheduled Activities for Greening 5 ha Zone

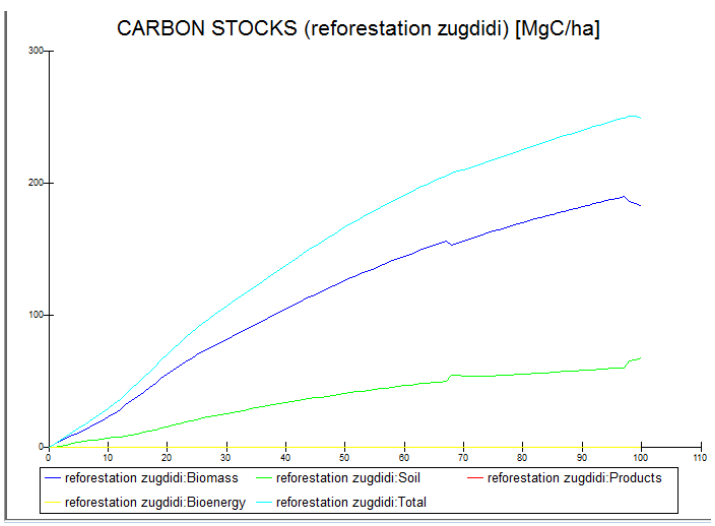
№	Description of Expenditures	Size Unit	Price per unit (US $)	Total Amount	Total Price (US $)
	1. Core Expenses				
1	**Plant Materials**				
1.1	Largest trees	piece	95	97	9 215.0
1.2	Second largest trees/saplings	piece	35	880	30 800.0
1.3	Smallest trees/bushes	piece	25	1 980.0	49 500.0
	Total 1:			2 957.0	**89 515.0**
2	**Fieldwork**				
2.1.	Cleaning and weeding	ha	110	5	550
2.2.	Planning and marking the area for planting	Sapling	0.5	2 957.0	1 479.0
2.3.	Planting Saplings	Sapling	0.2	2 957.0	591
2.4.	Watering saplings	Sapling	0.1	2 957.0	296
2.5	Infrastructure development	M^2	10 000	45	450 000
	Total 2:				**452, 916.00**
	Total (USD)				**542 431.00**

As shown in Table 62, the total cost of measures is 542,431.0 USD, equivalent to 932 982.0 GEL (1GEL – 1.72 USD). Carbon accumulation rates after renovation are presented below (Figure 22) and accumulation dynamics are given graphically (Figure 23).

Figure 22. Carbon Accumulation and Sequestrated Carbon Dioxide Rates after Landscaping Activities

	Sequestered Carbon reforestatio...	Sequestered Carbon reforestatio...		Sequestered Carbon reforestatio...	Sequestered Carbon reforestatio...		Sequestered Carbon reforestatio...	Sequestered Carbon reforestatio...
year [yr]	carbon [MgC/ha]	CO2 equiv. [MgCO2eq...	year [yr]	carbon [MgC/ha]	CO2 equiv. [MgCO2eq...	year [yr]	carbon [MgC/ha]	CO2 equiv. [MgCO2eq...
0	0.00	0.00	20	69.95	256.50	40	137.53	504.26
1	2.01	7.37	21	74.17	271.95	41	140.53	515.28
2	4.63	16.97	22	78.31	287.14	42	143.50	526.18
3	7.82	28.67	23	82.40	302.13	43	146.44	536.96
4	10.95	40.16	24	86.29	316.39	44	149.35	547.63
5	13.92	51.03	25	89.99	329.97	45	152.23	558.19
6	16.78	61.52	26	93.52	342.89	46	155.09	568.66
7	19.60	71.88	27	96.89	355.25	47	157.92	579.04
8	22.44	82.29	28	100.12	367.12	48	160.73	589.33
9	25.49	93.47	29	103.31	378.82	49	163.47	599.40
10	28.80	105.59	30	106.48	390.42	50	166.16	609.25
11	32.33	118.53	31	109.62	401.95	51	168.79	618.89
12	36.05	132.17	32	112.75	413.41	52	171.37	628.34
13	39.94	146.46	33	115.86	424.81	53	173.90	637.62
14	43.98	161.28	34	118.96	436.20	54	176.39	646.76
15	48.17	176.63	35	122.07	447.60	55	178.84	655.76
16	52.45	192.33	36	125.18	459.01	56	181.26	664.64
17	56.82	208.35	37	128.30	470.42	57	183.65	673.40
18	61.27	224.67	38	131.41	481.83	58	186.01	682.05
19	65.65	240.73	39	134.48	493.11	59	188.32	690.51

Figure 23. Accumulated Carbon Dynamics after Plantings



According to the summary tables, the accumulation of 8 tC is expected during the scheduled planting of the four hectares, and accumulation rates up to 2020 are presented in Table 60.

Table 63. **Annual Accumulation Rates**

	2015	2016	2017	2018	2019	2020
Accumulated Carbon, tC	8	18.4	31.2	43.6	55.6	66.8
Carbon Sequestration, tCO2	29.2	67.6	114.4	160.4	206	246

Outcomes

Table 64. **Carbon Accumulation Potential after Scheduled Landscaping**

Scheduled Measures	Annual Carbon Accumulation , tC					
	2015	2016	2017	2018	2019	2020
Zugdidi Botanical Garden Renovation/Reconstruction (total of 1 ha), Project Budget: 105 947.5 GEL	2.3	5.3	8.9	12.4	15.8	19.1
Reforestation of Promising Development Area of Zugdidi (5ha) Budget: 932 982.0 GEL	8	18.4	31.2	43.6	55.6	66.8
Total	10.3	23.7	40.1	56	71.4	85.9
Sequestrated tCO_2	37.8	86.9	147	205.3	261.8	315

Table 65. **Accumulated Carbon in Zugdidi Recreation Zones and Carbon Accumulation Potential As a Result of Scheduled Landscaping**

	Annual Carbon Accumulation , tC								
	2012	2013	2014	2015	2016	2017	2018	2019	2020
In recreation zones of the City Carbon Accumulation (without taking measures)	3 689.80	3 690.50	3 691.20	3 691.90	3 692.60	3 693.30	3 694.00	3 695.00	3 695.50
Annual Carbon Accumulation After Landscaping Activities in the City (2014)	-	-	1.95	4.48	7.58	10.61	13.47	16.97	18.97
Planned	-	-	-	10.3	23.7	40.1	56	71.4	85.9

Annual Carbon Accumulation After Landscaping Activities in the Botanical Garden and Urban Forests (2014)									
Total	3 689.80	3 690.50	3 693.10	3 706.70	3 724.60	3 744.00	3 763.50	3 783.40	3 800.40
Sequestrated tCO_2	13 529.20	13 531.80	13 541.40	13 591.20	13 656.80	13 728.00	13 799.50	13 872.50	13 934.80

AWARENESS RAISING AND STAFF TRAINING STRATEGIES

The sustainable development of the energy sector in a country, region or municipality is a field the national and local levels play equally important roles. All parties should be committed to achieving the best outcomes. Raising public awareness for renewable energy development and energy efficiency requires a complex and multilateral approach, and a relevant communications strategy. This is one of the most important components of Zugdidi's Sustainable Energy Action Plan (SEAP).

Barriers

The SEAP preparation process clearly revealed potential barriers to the effective implementation of strategies. Therefore, an evaluation of all identified barriers and overcoming ways are necessary. A preliminary assessment defined three types of barriers that have to be dealt with:

- Country level barriers linked to bad past practices (especially for public awareness); current economic and social difficulties; a lack of technical know-how
- Barriers specific to Zugdidi's context
- Specific project proposal and technology-related barriers.

Barriers for Sustainable Energy Development Process in Georgia

1. **Wasteful energy consumption.** During Soviet times wen energy was cheap, consumption was almost unlimited. Even the energy crisis of the 1990s did not change these attitudes.
2. **Lack of awareness or knowledge about sustainable development.** Only a few people are aware of sustainable development concepts and are directly engaged.
3. **Absence of a clear national policies for short-, mid- and long-term measures for the energy sector, for energy efficiency or renewable energy**. Clear information is not available. Energy demands increase annually at an average of 10%, yet alternative resources, except for hydro power, are not defined and there is no legislative framework

such as there are for gasification and hydroelectricity.

4. **Imperfect and high-risk technology market. O**perational failures by new technology or a pilot projects could impact further development perspectives. The availability of technology is not taken into account for long term plans in the energy sector.
5. **Uncoordinated and sometimes inappropriate approaches by NGOs regarding energy efficiency and renewable energy (except for hydro) activities**. The growth of energy efficiency is chaotic with the arrival of new technologies (mostly household appliances) and international energy standards into the country, yet without clear government standards or guidelines.

Although there are barriers, it is important that the the Zugdidi Municipal Government becomes aware of sustainable energy development perspectives and interested in implementing modern, clean, energy renewable technologies.

Barriers against Realizing Sustainable Energy Plans in Zugdidi

1. **Zugdidi faces almost the same obstacles to sustainable energy development as other municipalities cities**. Since Zugdidi has only recently become self-governing and is encountering the challenges of its first stage of "independence" from central government, there is a lack of knowledge and experience as well as a lack of human, technical and material resources. Data and statistics are needed as well as experience in long-term planning. These lacunae cause the new self-governing cities to remain dependent on centralized energy supplies and on private sector energy providers.
2. **The Zugdidi Municipality does not collect statistics or data on geo-thermal resource savings and utilization**. The Municipality is rich in geothermal resources and is under a long-term (49 years) lease operated by the private sector. Most geothermal deposits aren't developed and this leads to financial losses. There is a lack of information for long-term strategy development to use these resources in agriculture, spa and fitness fields, hot water supply and household services sectors.
3. **Absence of funds.** Most of the budget resources are used for infrastructure growth and social projects, which hampers the development of long-term energy policies.
4. **Zugdidi is the second largest area of emergency IDP settlements.** The promotion of energy efficient and renewable energy needs specific approaches and technologies.

In addition to technology development, import and distribution, there are specific barriers to be taken into account when assessing technologies to apply for the SEAP.

Barriers Related to Technology

1. **Lack of knowledge about modern energy-efficient and renewable technologies on the international market.**
2. **Lack of knowledge about the local environment.** New technology has to be introduced effectively. For example, energy-efficient bulbs cannot be used within old and improperly functioning electricity networks. Studies must ascertain how technology can be transferred.
3. **Lack of knowledge and awareness on environmental and social counter-indications.** The public must be educated on how to use new technologies in order to assess technical risks, avoid and minimize them.
4. **Lack of trained human resources.** Local know-how is needed to select appropriate technologies adaptable to local conditions, and to install them. This is lacking in municipalities and cities.
5. **Much renewable technology is not sufficiently flexible and easily adaptable to existing urban environments.** Additional funds and training are needed to adapt them.

Target Groups and Objectives

An analysis of the groups within which awareness must be raised by targeted campaigns identified the following:

- Zugdidi City Municipal Staff and Members of Zugdidi City Assembly;
- The Zugdidi city population, including displaced persons (IDPs);
- Non-governmental organizations in the surrounding region and Zugdidi City;
- Private sector within the renewable energy field (e.g. owners of geothermal water resources, hazelnut manufacturers, sawmill owners);
- Education and research centers.

Information campaigns to raise awareness in all these sectors are crucial for the successful implementation of the Action Plan. The public should fully understand the aims of sustainable energy development and how to implement the SEAP. They should be aware of its positive social and economic consequences. When it becomes necessary to change habits and behavior to obtain maximum support from the population, they should be involved in the processes of developing action plans. Global practice has shown that the higher the involvement of the population in the earlier stages the easier the management of the process is, and the stronger the support of the project.

Consultations are necessary to gather new ideas and project proposals. Today, the most important target groups for the Zugdidi Municipality are a) internally displaced persons (IDPs)

who make up 50% of the total population and b) the private sector operating in the renewable energy sector—both producers and consumers. The significant geothermal deposits with temperatures up to 100°C are found almost everywhere; hazelnut plantations are numerous; the shells have a high calorific value and release large amounts of thermal energy with efficient combustion. The Zugdidi Municipality is rich in forest resources, thus sawmills offer waste biomass (sawdust and other).

In the initial stages of the SEAP, meetings and consultations with Zugdidi's main target groups should be organized,-for instance residential building owners' associations, transport organizations, the water supply sector, waste management sector, etc. The advantages and benefits for the city and its population should be clearly explained at these meetings.

The strategy on awareness raising and training for specialists and future experts to carry out Zugdidi's SEAP include the following steps:

Short-term Strategy (2015-2017)

1. Study of attitudes of the city's residents, including IDPs, towards energy efficiency and renewable energy issues to reveal barriers (situation analysis) and prepare recommendations to carry out appropriate measures;
2. Develop targeted programs for energy efficiency and renewable energy issues aimed at IDPs, who have partial subsidies for energy consumption. The energy savings by this group of the population will enable the Municipality to conserve funds for other types of social assistance programs;
3. Involve renewable energy manufacturers and consumers (geothermics, hazelnut shells, sawdust, etc.) in the activities of the SEAP through information campaigns on energy efficient and economically profitable technologies, offering cooperation strategies to public and private sectors;
4. Raise local authorities' awareness on sustainable energy development advantages as well as the social and economic benefits;
5. Train the Municipality staff and bring in external human resources to ensure successful implementation and monitoring of the SEAP;
6. Create an information-education campaign to raise public awareness. Prepare information/education/illustration materials about successful experiences and modern technologies that are recommended for the green development of cities;
7. Demonstrate the advantages of energy efficient and renewable energy measures for the population through pilot projects, etc.

Long-term Strategy (2017 – 2020)

1. The long-term strategy should be updated and adjusted to the barriers and successes achieved during the shorter term activities;

2. Initiate consultations with stakeholders (city population, the IDPs, private sector, non-governmental sector) on regulations and standards to be adopted by the municipality in different sectors (buildings, construction, transportation, municipal waste, sewage) to identify potential barriers to their introduction.
3. Developand implement awareness raising and incentive programs for different target groups to ensure the smooth introduction of standards and regulations (e.g. energy efficiency and renewable energy).

Table66. Action Plan of Zugdidi Municipality in the Field of Staff Training and Awareness Raising to Ensure Successful Implementation of SEAP

Main strategic goals	Main target groups	Measures to be implemented	Potential leading organization(s)	Outcome	Potential donors
Short-term strategic Goals (2015-17)	• Zugdidi Municipality & the City Assembly • Zugdidi City Residents including IDPs settled in Zugdidi City	Main goal of short term strategy to support information awareness of city authorities on perspectives of sustainable energy consumption and its social and economic benefits; to provide maximum information and awareness to the population; to provide assistance to the population for receiving benefits from this initiative; to provide specialists / future experts with relevant training to ensure optimal implementation and monitoring of the action plan.	• Zugdidi City Hall • Coordinators of the Covenant of Mayors in Georgia (Ministry of Energy and Ministry of Environment and Natural Resources Protection) • Local and international ongoing programs within the framework of Covenant of Mayors and the initiatives on preparation of low emissions development strategies	• Zugdidi SEAP is successfully implemented • Zugdidi City Hall continues the same activity after 2020 • Zugdidi population including the IDPs are informed on initiatives launched by the city authorities	• Zugdidi City Hall • Coordinators of the Covenant of Mayors in Georgia (Ministry of Energy and Ministry of Environment and Natural Resources Protection) • Local and international programs within the framework of Covenant of Mayors and the initiatives on preparation of low emissions development strategies • International donors supporting climate change mitigation, renewable energy, energy efficiency and sustainable development

					processes.
1. Staff Training					
Training for technical staff to make recommendations and perform their work in a qualified way to ensure successful technical implementation of the Covenant of Mayors Process	• Zugdidi City Hall technical team • Special service established by the City Hall (e.g. an energy efficiency center) to serve the City Hall, Zugdidi population and especially the IDPs as well as the private sector working in the renewable energy field	• Establish special technical support group/service within or outside Zugdidi City Hall to work for the City Hall on SEAP implementation and monitoring and on promoting modern technologies for the public and private sectors. • Develop the technical support team training program including sustainable energy, climate change mitigation measures, the EU directives, and the Covenant of Mayors requirements and analysis of barriers to implementing modern technologies. • Prepare manuals for technical support team • Include support team in exchange programs and international information networks. • Involve potential candidates for the team early in the SEAP preparation process.	• Zugdidi City Hall • Ministry of Energy • Ministry of Environment and Natural Resources Protection of Georgia • Representative of the Covenant of Mayors Process in Georgia (Energy Efficiency Center)	• Program and manual on preparation of specialists for the City Hall technical support group • Staff selected on a competitive basis • Clearly defined responsibilities and working program for selected specialists for City Hall, the public and private sectors • Actively involved technical support team for exchange programs and international networks to obtain the latest information on technologies and approaches in the energy sector • A technical team ready to prepare necessary specialists for the private sector	• **Zugdidi City Hall** • **EC-LEDS Project** • **USAID** • **GIZ** • **EU**
2. Public information and awareness raising					

Awareness raising on energy efficient measures. In this process, the public should be informed about the social and economic advantages of sustainable energy development. The first phase will be focused on consulting the city population including IDPs on energy efficient measures in buildings, and on providing the information on modern technologies and the best practices for implementation	• Domestic Partnership • Tenants'Associations in IDP settlements • NGOs • Other public associations	• Prepare information materials for the public on measures and technologies to improve living conditions and reduce energy consumption expenses • Prepare information materials for residents about Zugdidi. (e.g. potential of the city in terms of energy efficiency and landscaping and the population's role in promoting these processes). • Prepare information materials for residents on on energy efficient measures arried out by signatory cities of the Covenant of Mayors and subsequent outcomes • Hold regular meetings with the public and train PR workers within residential associations • Involve the public in the preparation and implementation of pilot projects	• Zugdidi City Hall • NGOs	• TV ads and leaflets for Zugdidi residents on effective technologies on the market and their advantages. • Pilot projects (2 per year) with maximum involvement of local population are implemented	• **Zudidi City Hall** • **USAID** • **GIZ** • **EU**
3. Raised Awareness of Zugdidi Municipality and Assembly Representatives					
Raise local officials' awareness on the advantages of the city's energy consumption sustainability and social and economic benefits of the measures	• Zugdidi City Hall • Zugdidi City Assembly	• Carry out seminars for the representatives of Zugdidi City Hall and City Assembly on the advantages and perspectives of sustainable energy consumption in the city. • Support participation of representatives of City Hall and City Assembly in meetings and conferences connected to the Covenant of Mayors process at local and international levels.	• Zugdidi City Hall • Zugdidi City Assembly • Regional Energy Efficiency Center	• Illustration materials prepared for information-education meetings • Information meetings conducted (at least twice a year) • Experts from the EU and other donor countries are invited to conduct seminars on modern technologies and approaches • Decisions, considered projects and measures are covered by mass media • Representatives from City Hall and City Assembly are fully involved into the current processes at local and international level	• **EC-LEDS** • **USAID** • **EU-COM** • **GIZ** • **Partnership for mitigation** • **GHG reduction**

		• Involve mass media representatives in high level meetings to be held by the Covenant of Mayors to achieve positive publicity on ongoing processes • Ensure the participation of stakeholders in CoM decision making processes		• Regularly updated information at the City Hall web site on current processes and projects	**projects** • **National Communications of Georgia on Climate Change**
Long-term goals (2017-2020)	• **Zugdidi City Hall** • **Zugdidi City Assembly** • **Zugdidi City Population** • **IDPs settled in Zugdidi City** • **Private sector operating in renewable energy field** • **NGOs**	• **Main goal of long term strategy is to involve the private sector in achieving the SEAP objectives, overcome revealed barriers, carry out information campaign, raise target groups' awareness in prohibitive and restriction measures and the role of standards in ensuring energy consumption sustainability**	• **Zugdidi City Hall** • **Zugdidi City Assembly** • **Energy Efficiency Center** • **Private Sector Initiative Group** • **CoM's Programs and Projects**	• **Zugdidi City officials are ready to meet new standards and implement certain regulations in terms of approaching the EU directives and supporting the Mayors initiatives** • **City population, especially the IDPs and private sector working for the renewable energy sector are aware of the necessity to implement mentioned measures**	
1. Involve the IDPs settled in Zugdidi in achieving the SEAP objectives					
Raising the IDPs awareness regarding energy efficient technologies; Preparation of informative and illustration materials about successful practices of changing behavioral norms and modern technologies recommended for the city landscaping activities	• Zugdidi City Municipality • Tenants associations of IDP settlements • Different type of energy consumers & their associations • NGOs • Private sector	• Development/implementation of the targeted group, namely IDP-oriented communication plan based on priority fields and directions of the SEAP • Development of incentive mechanisms for mentioned targeted groups	• Zugdidi City Municipality • Tenants associations of IDP settlements	• Information and illustration materials on best practices are prepared for the targeted groups • Special programs for densely populated IDP settlements are developed	**EU-COM and its other programs** **Zugdidi City Hall** **EC-LEDS -Process** **Green Economy programs**
2. Behavioral Changes by Zugdidi Population					
Implement behavioral changes in lifestyles and increase involvement	• Apartment Owners Associations	• Separation of specific targeted groups (e.g. kindergartens, private	• Zugdidi City Municipality	• Targeted groups identified • Information/illustration materials about best	**EU-COM and its**

of residents by introducing new technologies (building energy efficiency, private vehicles, waste recycling etc.). Prepare and illustrate successful practices of changing behavioral norms and modern technologies for landscaping activities	• Owners of Private Vehicles • Energy consumers and their associations • NGOs • Private sector	vehicle owners, private sector, municipal buildings, IDPs, etc.) in accordance with high- priority areas and directions of the SEAP and development/implementation of the group-oriented communication plan • Considering the lack of experience in self-governance in communication processes TI experts will be necessary in the beginning • Develop incentive mechanisms for targeted groups (e.g. for apartment owners associations saving the largest amount of energy);	• NGOs • Media	practices • TV ads to effect behavioral change and success are developed • Incentive mechanisms, projects and programs to make behavioral changes for the benefit of reduced energy consumption and clean technologies	**other programs** **Zugdidi City Hall** **EC-LEDS -Process** **Green Economy programs**
3. Involving the private sector in reaching SEAP goals					
Enhance involvement of the private sector in Sustainable Energy Action Plan by providing them with information about energy efficient and economically beneficial technologies and offering programs on cooperation between public and private sectors	• Private sector operating in the field of renewable energy • A private sector initiative group • Biomass (Hazelnut shell, sawdust, agricultural waste, forest biomass residue)	• Establish an energy forum to unite stakeholders to work towards energy saving measures • Raise private sector interest in renewable energy for using innovative technologies by levying local tax and tariff concessions for companies implementing energy efficient and innovative technologies, etc • Create incentives for the private sector of educational and renewable energy field to carry out research-development activities; • Provide risk-reduction consulting services for the private sector in the fields of renewable energy; • Create funds that support new technologies to reduce technological adaptation-related risks;	• Zugdidi City Municipality • Energy Efficiency Center • Private sector working for renewable energy • NGOs	• Energoforum is conducted twice a year • Incentive mechanisms are created to ensure involvement of the private sector, including renewable energy in processes to develop technologies. • Energy Efficiency and Technologies Center established to provide consulting services on new technologies • Risk insurance fund(s) established for private sector to manage risk-related technologies • Initiative groups established in different sectors acting as main links between the government and the private sector • Representatives of the private sector operating in the field of renewable energy are involved into international processes, associations and professional networks	**Zugdidi City Hall** **Private sector operating in the field of renewable energy** **EU COM** **GEF** **UNFCCC-programs**

		• Encourage the creation of an initiative group from the private sector working to include the renewable energy field in the CoM process.			
4. Intensifying consultations with stakeholders in the introduction of regulations and standards					
• Intensify consultations with stakeholders (city population, the IDPs private sector operating in the field of renewable energy, non-governmental sector) on the regulations and standards to be introduced by municipality in different sectors (construction, transport, waste management)	• Zugdidi City Hall • Zugdidi City Assembly • Zugdidi city residents/the IDPs • Private sector operating in the field of renewable energy • NGOs	• Ensure maximum information on standards and regulations elaborated for the sectors considered in the city sustainable energy plan to the public and private sectors and other target groups • Prepare information points and TV programs explaining social and environmental benefits of these measures • Prepare and train activists who will conduct work with target groups	• Zugdidi City Hall • Regional center of energy efficiency and Innovative Technologies • Initiative groups operating in the field of renewable energy sector • NGOs	• Specialists who will work with target groups are prepared • Explanatory work and consultation on regulations and necessary standards for implementation of SEAP are conducted regulary for public and private sectors by non-governmental sector • Mass media is actively involved in explanatory work on social and environmental benefits of the mentioned measures (clips, discussions, etc.)	Zugdidi City Hall Zugdidi City Assembly
5. Identifying barriers through consultations with stakeholders					
Identify barriers encountered during the implementation of regulations and standards through consultations with stakeholders	• Zugdidi City Hall • Zugdidi City Assembly • Zugdidi residents • Private sector operating in the field of renewable energy • NGOs	• Identify barriers found during consultations with residents regarding standards and regulations being considered for SEAP sectors • Develop measures aimed at overcoming identified barriers by consulting with target groups	• Zugdidi City Hall • Zugdidi City Assembly	• Groups (private sector initiative groups, non-governmental sector, mass media) are prepared to conduct consultations • Barriers in each SEAP sector identified • Measures to address barriers are developed with the target groups	Zugdidi City Hall

6. Raise awareness of government, public and private sectors about the need for regulations and standards for sustainable energy					
Develop and implement awareness raising and incentive programs for target groups to ensure a smooth introduction of regulations and standards (for instance, energy efficiency). Effective for decision makers and implementators.	• Zugdidi City Hall • Zugdidi City Assembly • Zugdidi city residents including IDPs • Private sector operating in renewable energy field	• Inform decision implementers on successful and unsuccessful international practices • Decision makers participate in processes related to the Covenant of Mayors and international low emissions • Special attention paid to sustainable consumption of energy in Georgia to ensure the independence of energy supplies • While highlighting the decisions made on regulations and new standards mass media should pay special attention to social, environmental and tourism issues as well as long term economic effects	• Zugdidi City Hall • Programs and projects of the CoM	• Decision makers and implementators are involved and well informed about current international processes, about the obligations of Georgia related to climate change and energy efficiency • Information packets containing clear analyses of compliance in the process of CoM with EU Directives are prepared • Good practices manuals are developed • Involvement of foreign consultants is necessary	Government of Georgia EC-LEDS EU-CoM GIZ Clima East And other programs to be proposed in future

Implementation Process and Stages : This process should be facilitated by the CoM coordinating Ministries along with local and international programs in the CoM framework.

1. The implementation strategy, as an integral part of the city SEAP, is approved and monitored by the Zugdidi City Assembly;
2. Updating and implementing the strategy is under the responsibility of Zugdidi City Hall;
3. Training local staff to implement and monitor the strategy may become the responsibility of the "Regional Center for Energy Efficiency and Innovative Technologies", which is currently being discussed.

MONITORING, VERIFICATION AND REPORTING

To plan and carry out the monitoring measures for SEAP and to reduce GHG emissions the way local government reforms are carried out is of significant importance. This is also true of the internal organizational structure of its executive body (compliance to legislative amendments). The effectiveness of local financial and human resource development and growth are of great importance to self-governing units. If these resources are lacking and appropriate technical skills and knowledge are not present, the successful implementation of SEAP is compromised.

That is why, in this transitional phase, the monitoring plan can include several options, however a distribution of functions and clear separation of rights and responsibilities between internal structural units of municipalities and external resources will be most effective. An effective approach uses both internal and external resources for monitoring. Creating the action plan showed that one of the most important problems of Zugdidi and other cities in Georgia is obtaining data on energy consumption from the necessary sectors for the base year emissions inventory. In many cases, no data accounting system existed since they were not previously used to evalute economic parameters. Sometimes the database needs additional processing, which can only be done by the owners of the source data because there is always additional commercial information that could be confidential. Generally, the collection of necessary data requires significant time and human resources, but municipalities do not have well organized statistical/analytical tools or analytical departments.

With the exception of some larger municipalities, there are no municipal-level statistics offices in Georgia, and this impedes SEAP implementation and monitoring. To reduce the risks from a lack of data, the "Monitoring" section of the Zugdidi SEAP offers a performance methodology

that seeks to compensate for these lacunae. One measure is to create a data register for monitoring baseline scenarios that is updated regularly with systematic information from the Zugdidi SEAP monitoring group.[73]Thus monitoring, verification and reporting will take a minimum of time as they can use regular updates from available data.

For internal monitoring and analysis, the responsible department/divisions within Zugdidi City Hall should have software that is easy to use for non-specialists that calculates baseline scenario emissions and quantities of reduced emissions for different measures or combined data from the BAU scenario. Local staff will undergo software training to ensure effective use of the program.

When periodic monitoring reports on the SEAP implementation are being created, based on conditions from the CoM, the involvement of invited experts should be considered especially for the first mandatory reporting process.

Main activities included in the Monitoring and Reporting process of Zugdidi:

1. Regular update of the Baseline Scenario (BAU);
2. Assessment of emissions reduced after taken measures and implemented projects;
3. Development of final report;
4. Determine how to simplify the monitoring system in future.

Under the current action plan the parties responsible for these activities are:

1. The Zugdidi Municipality: responsible for obtaining statistical information about main KPIs (GDP, population, per capita income, portion of economic activities/economic sectors in GDP, etc.), and describing city development processes. To calculate the the baseline scenario, external technical assistance could be approved by the municipality for carry out this work. The calculation of the baseline scenario and a renewal methodology plan will be sent to the City Hall under the LEDS by the Georgian Government and coordinated with the CoM. Emissions factors will also be aligned with the responsible authority of the UN Framework Convention on Climate Change in Georgia.
2. Implementing Unit/Project owners who will collect information needed to calculate reduced emissions. The Municipality will provide them with the data collection methodology and will ensure periodic verification. The Municipality is responsible for calculating and verifying final emissions, although the work can be done either by the Municipality, or by external expertise accredited by the CoM. Periodic verification of

[73] Employees of appropriate City Hall offices or Energy Manager specially appointed by the City Hall.

activity data provided by the project executor is the responsibility of the Municipality as well.

3. The City Hall, which is responsible for a final report, which must be approved by the City Council, after which it will be submitted to the EU. The Report will include monitoring results, general parameters that have to be monitored during the SEAP implementation, quality control and quality assurance (QA/QC) procedures and emissions factors. Based on this, a specific year baseline scenario will be updated and reduced emissions calculated.

The Zugdidi Unit Responsible for Monitoring

The overall responsibility for preparing and implementing the CoM and SEAP, and for updating them fall to the Strategic Planning, Investment and Economic Development Department (SPIED). This department is responsible for carrying out, monitoring and analyzing results, then integrating the results into the revised action plan. They must verify and monitor data then prepare and submit the Final Report for approval to the City Council before it is submitted to the EU. The SPIED Department is also responsible for organizing data collection, supporting data quality improvement, updating them and finding new data sources. The Department can make use of other divisions and LLCs in the Municipality or certified external personnel. Resources from the nearest Regional Center of Energy Efficiency could be used initially.

There are five main sectors considered within the Sustainable Energy Action Plan of Zugdidi: energy consumption in building sector, energy consumption in transport sector, street lighting energy consumption, methane emissions from waste sector and increasing emission absorption source by green area development. In order to evaluate each sector's baseline scenario, information on activity data is necessary, and is presented in Figure 25. Each implemented project and measure must be monitored for its quantitative emissions reduction value and its total emissions savings compared with the baseline scenario. The amount of final emissions reductions can then be analyzed. At this stage, Zugdidi City Hall is considering two options for monitoring and collecting sector-related data: a) collect and provide statistical data according to each City Hall department; b) archive data and carry out primary processing at the nearest regional energy efficiency center. The first option is more convenient at this stage, but it is not yet clear whether a common data archive of all sectors will be created, or whether the data will be archived in the departments that are responsible for managing the sector. **Error! Reference source not found.** shows City Hall offices and LCCs responsible for data collection

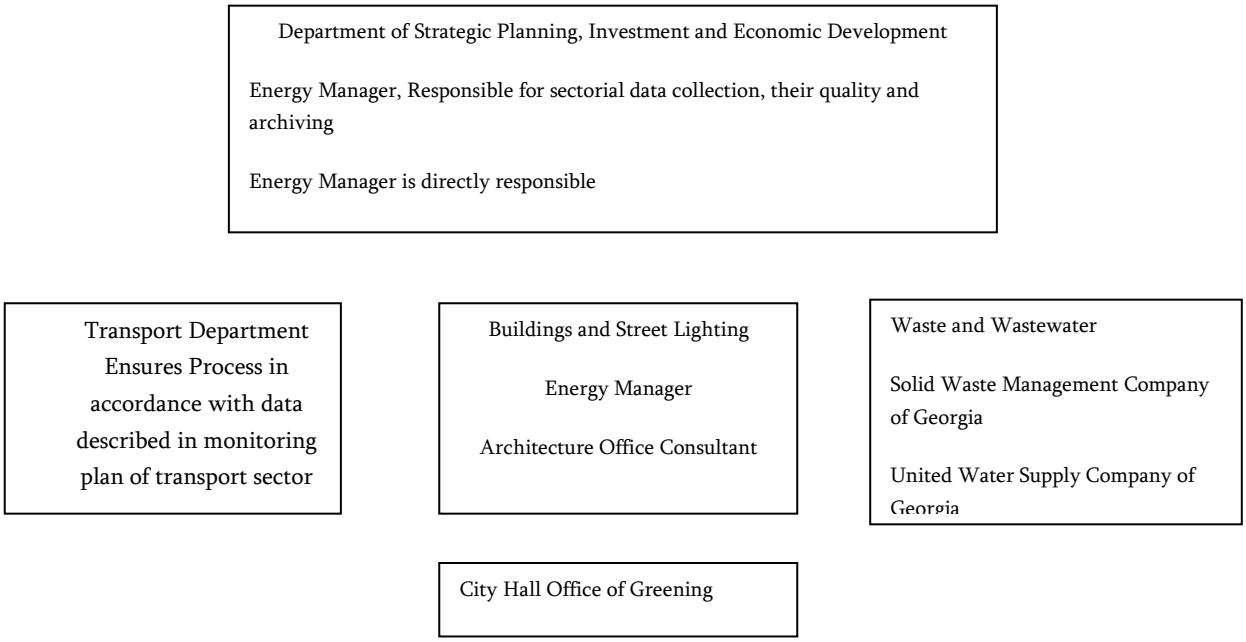


Figure 24. Monitoring Process Management

Four types of data will be collected and evaluated to prepare monitoring reports for each sector:

- Annual emissions in CO_2equivalent;
- Measures and project implementation status and emissions savings for a given period;
- Driving parameters (KPIs) of the baseline scenario (for example, in the transport sector: population, GDP, income growth and passenger-kilometers according to transport types;
- Economic and social effects of the measures taken.

In addition to these types of data other primary parameters can be considered for the monitoring process, taken from different sources and secondary data, then automatically calculated with muni_EIPMP software. An approved monitoring group from the Zugdidi Municipality will be responsible for annual reporting. These will be compiled every two years and submitted to an independent third party—likely provided by the CoM--for verification.[74] The reporting structure will be created by the monitoring group in alignment with a common format developed and proposed by the Covenant of Mayors.

[74] The CoM Office determines the frequency of Monitoring reports.

General and Sector-Related Driving Parameters

The purpose of this parameter is to update the baseline scenario taking into account current significant social and economic changes in Zugdidi.

Data/Parameter # 2.1	**Population through the monitoring year**
Data unit:	
Description:	Primary data[75]; Annual monitoring .
Source of data used:	Annual statistics (www.Geostat.ge) and local statistics
Value applied:	**76,700 (2012)**
Any comments	The Zugdidi population of the monitoring year is used to make BAU scenario calculations in terms of new circumstances, test additional values, ensure data control and monitoring of per capita emissions trends.

Data/Parameter # 2.2	**Population Increase Rate (percentage)**
Data unit:	%
Description:	Calculated data; Annual monitoring. This parameter is mainly used for the Business as Usual (BAU) scenario to assess emissions increases based on electricity, fuel, waste, waste water, industry and other fields.
Source of data used:	This is evaluated at a national level by the Ministry of Energy of Georgia. The National Trend value is used for the MARKAL model
Value applied:	0.5
Any comments	To make SEAP forecasts the same annual percentage of 0.5% is used as the Ministry of Energy, to plan the energy sector based on the MARKAL model. This parameter will be redefined during the low-emissions strategy development process. The Forecast is annual, until 2020 inclusive. The size of the population during the monitoring year is enough and the parameter is necessary only for updating the BAU.

Data/Parameter # 2.3	**Gross Domestic Product (GDP) in the monitoring year**
Data unit:	Million GEL
Description:	Calculated data; Annual monitoring

[75]Data is considered primary if it is not calculated in the monitoring process and is taken from different sources. Primary sources may be calculated, but has to be drawn from a specific source and implementers should get the finished data.

Source of data used:	Statistical annual (www.Geostat.ge) and local statistics. This SEAP source was Zugdidi Municipality.
Value applied:	This value has not been used in SEAP, because it did not exist, but must be evaluated for future monitoring .
Any comments	The National Statistics Office provides information about the region's annual GDP. In this case, Samegrelo-Zemo Svaneti Region's GDP and total amount of the same region's population make it possible to determine per capita GDP in the Samegrelo- Zemo Svaneti region and then, during the monitoring year, to estimate the GDP of Zugdidi by multiplying this by the city's population. Another method of assessment may be more accurate using the GDP from the monitoring year for additional testing and studying different values: To control data and to monitor emissions trends per GDP unit in order to estimate emissions intensity during economic development .

Data/Parameter # 2.4	**Gross Domestic Product (GDP) Growth Rate Forecast (%)**
Data unit:	%
Description:	Calculated data; This is done by the Analytical Department of the Ministry of Economy and Sustainable Development of Georgia and the Ministry of Energy and other international monetary structures (World Bank, IMF, etc.)
Source of data used:	A parameter evaluated at the national level and made on behalf of the Ministry of Energy of Georgia. National level data has been taken as used in the MARKAL model due to the non-existence of local data.
Value applied:	5% up to 2018 , 6% 2018-2020.
Any comments	These data are needed to estimate future emissions trends and are used to update the BAU scenario only.

Data/Parameter # 2.4	**Grid emission factors CO2 t/MWh**
Data unit:	T **CO2**/MWh
Description:	Primary data. Calculated at the national level and provided to municipalities
Source of data used:	Calculated especially for SEAP, but there is also a value calculated for the Kyoto Protocol's Clean Development Mechanism projects (Ministry of Environment and Natural Resources Protection of Georgia)
Value applied:	0.136
Any comments	The emissions factor is calculated by dividing annual emissions from the power sector by annual electricity generation. This emissions factor will be calculated centrally in order to monitor low emissions and will be delivered to municipalities for their SEAPs. During SEAP preparation the used grid emissions factor has been calculated by averaging since Zugdidi does not produce electricity independently but receives it from the centralized energy system of Georgia.

Data/Parameter # 2.5	**Natural Gas (NG) emission factors**
Data unit:	T/TJ, or Kg/TJ
Description:	Primary data
Source of data used:	At this stage, the IPCC calculated typical value is being used (exploited for level 1 calculations)
Value applied:	55.78 CO2 T/TJ; 5 CH4 Kg/TJ; 0.1 N2O Kg/Tj.
Any comments	It is recommended to use the national calculated value that depends on the natural gas calorific value (NCV). This should be updated constantly during the monitoring process using information about gas caloricity consumption.

Data/Parameter # 2.6	**Gasoline**
Data unit:	T/TJ, Kg/TJ
Description:	Primary data
Source of data used:	At this stage, the IPCC calculated typical value is being used (exploited for level 1 calculations)
Value applied:	68.6 TCO2/Tj; 20 Kg CH4/Tj; 0.6 Kg N2O /Tj.
Any comments	It is recommended to use the national calculated value that depends on the carbon content of gasoline, and should be updated constantly during the monitoring process according to information on imported gasoline caloricity.

Data/Parameter # 2.7	**Diesel**
Data unit:	T/TJ, Kg/TJ
Description:	Primary data
Source of data used:	At this stage, the IPCC calculated typical value is being used (exploited for level 1 calculations)
Value applied:	73.3 TCO2/Tj; 5 Kg CH4/Tj; 0.6 Kg N2O /Tj.
Any comments	It is recommended to use the national calculated value that depends on the carbon content of diesel, and should be updated constantly during the monitoring process according to information on imported diesel caloricity.

Data/Parameter # 2.8	**Net Calorific Value of Different Fuels (NCV for NG, Gasoline, Diesel)**
Data unit:	

Description:	Primary data. These data will be collected at the national level from fuel importers.
Source of data used:	These data should be collected for each type of fuel used in the country. The information sources are mainly fuel importers and distributors.
Value applied:	At this stage, typical values are used in the SEAP provided by the IPCC
Any comments	Systematic update is recommended taking into account fuel parameters. It would be better to use these typical data if local data are unavailable.

Activity Data Necessary for Monitoring the Zugdidi Transport Sector

Data to be Collected for Municipal Buses

Data/Parameter # 3.1.1	**Quantity of municipal buses**
Data unit:	Quantity of buses during the monitoring period (annual value)
Description:	Primary data
Source of data used:	City bus service company, " Zugdidi Municipal Transport" LTD. Provided by Zugdidi Municipality
Value applied:	14 (diesel)
Any comments	

Data/Parameter # 3.1.2	**Average distance traveled by one bus per year by fuel type (gasoline, diesel, gas)**
Data unit:	Km/year
Description:	Primary data
Source of data used:	City bus service company, Zugdidi Municipal Transport LTD. Provided by Zugdidi Municipality
Value applied:	52,920 (diesel)
Any comments	It is recommended that this data be taken directly from private shipping companies by the monitoring group, and that it shows daily kilometrage of buses in order to calculated annual data. Data validation and verification is the responsibility of the Zugdidi Municipality Transport Service. The municipality should verify data against used fuel expenses. (Possible if fuel expenses are covered by the Municipality, otherwise different verification method must be applied).

Data/Parameter # 3.1.3	**Total distance traveled by all buses annually (by fuel type)**
Data unit:	Trans.Km
Description:	Secondary data, calculated by the MUNI_EIPMP. Quantity of buses multiplied by annual kilometrage of each bus
Source of data used:	
Value applied:	740,880 (on diesel)
Any comments	This data will be verified by the amount of fuel used by buses annually

Data/Parameter # 3.1.4	**Average cost of diesel for1 bus per 100 km**
Data unit:	L/100 km
Description:	Primary data
Source of data used:	Bus Service Company –Zugdidi Municipal Transport. Provided to the SEAP by Zugdidi Municipality, that also could be an alternative source.
Value applied:	21 L/100 Km
Any comments	This data should be checked with bus registration certificates and analyzed in case of significant discrepencies.

Data/Parameter # 3.1.5	**Annual consumption of fuel by all buses (by fuel type – gasoline, diesel)**
Data unit:	L/year
Description:	Secondary data. Calculated by the MUNI_EIPMP
Source of data used:	Quantity of diesel powered buses multiplied by fuel expense (100 km) multiplied by one bus' annual kilometrage and divided by 100.
Value applied:	155,585 L (Diesel)
Any comments	The data is calculated by the monitoring group and checked against fuel issued. (Possible if fuel expenses are covered by the Municipality, otherwise different verification method has to be applied). In the case of Zugdidi, only diesel is used by buses.

Data/Parameter # 3.1.6	**City bus load factor[76]**
Data unit:	Passenger.km/trans.km
Description:	This parameter should be evaluated by statistical methods and surveys. It could be calculated by Parameter 3.1.7. or estimated by another method
Source of data used:	Observations for the SEAP are made by Zugdidi City Hall
Value applied:	16
Any comments	This parameter is used only to assess GHG emissions reductions after measures are taken in the sector. The GHG annual inventory from the transport sector is not dependent on it. These data can be assessed through surveys, bus tickets sold at public transport stops, etc. If Parameter 3.1.7 (mobility) is known, it can be calculated as #3.1.7/3.1.1/3.1.2

[76]Passenger load factor measures the capacity of utilization for public transport services.

Data/Parameter # 3.1.7	**Annual passenger turnover per bus**
Data unit:	Passenger.km
Description:	Secondary data is usually calculated through the load factor
Source of data used:	Total distances traveled by buses per year is multiplied by one bus load factor
Value applied:	11,854,080
Any comments	

Data to be Collected for Municipal Minibuses

Data/Parameter # 3.2.1	**Quantity of municipal minibuses**
Data unit:	Quantity of buses during the monitoring period (annual value)
Description:	Primary data
Source of data used:	City Bus Services Era LTD and Daka Georgia LTD Provided to the SEAP by Zugdidi Municipality
Value applied:	33 (26 Daka Georgia LTD and 7 Era LTD) 31 (Diesel) 2 (natural gas)
Any comments	

Data/Parameter # 3.2.2	**Average distances traveled by one minibus a year according to consumed fuel type (gasoline, diesel, gas, electricity)**
Data unit:	Km/y
Description:	Primary data
Source of data used:	City Bus Services Era LTD and Daka Georgia LTD Provided to the SEAP by Zugdidi Municipality
Value applied:	24,872 (diesel and gas)
Any comments	It is recommended that this data be taken directly from minibus companies by the monitoring group and that information shows daily kilometrage of buses based on which annual data is calculated. Data validation and verification are the responsibility of the Zugdidi Municipality Transport Service. The municipality should verify data against used fuel expenses.

Data/Parameter # 3.2.3	**Average distance per year traveled by all minibuses according to consumed fuel type (gasoline, diesel, gas)**
Data unit:	km/y
Description:	Estimated data. Is calculated by the MUNI_EIPMP
Source of data used:	1 minibus annual kilometrage is multiplied by total number of mini-buses
Value applied:	820,800
Any comments	The Municipality should verify the data relative to consumed fuel expenses provided by the Finance Department

Data/Parameter # 3.2.4	**Average diesel expenses of one minibus per 100 km**
Data unit:	L/100 km m3 or l/100 ml
Description:	Primary data.
Source of data used:	Provided to the SEAP by the Zugdidi Municipality
Value applied:	13 l/100 km
Any comments	This data should be checked with each minibus registration certificate and analysed in case of significant discrepencies.

Data/Parameter # 3.2.5	**Average fuel consumption by all minibuses according to fuel types (gasoline, diesel, gas)**
Data unit:	L/year
Description:	Secondary data. Will be calculated by the monitoring group.
Source of data used:	Calculated by the MUNI_EIPMP Quantity of diesel powered mini buses multiplied by fuel expense (100 km) multiplied by one bus' annual kilometrage and divided by 100: 3.2.5.= 3.2.1. * 3.2.2. * 3.2.4/100.
Value applied:	106 704 (Diesel)
Any comments	This data is calculated by the monitoring group and it should be compared to provided fuel by the Transport Service in the Finance Department.

Data/Parameter # 3. 2.6	**Transport's (minibus) Passenger Load Factor**
Data unit:	Passenger.km/Trans.km

Description:	This parameter should be evaluated by statistical methods and surveys. It could be calculated from Parameter 3.2.7. if it is assessed, or else using another method
Source of data used:	Observations for the SEAP are made by Zugdidi Municipality.
Value applied:	12
Any comments	This parameter is used only for assessment of GHG emission reductions after measures taken in the sector. The GHG annual inventory from transport sector is not dependent on it. These data can be assessed through surveys, bus tickets sold at public transport stops, etc. If parameter 3.2.7 (mobility) is known, this parameter can be calculated.

Data/Parameter # 3.2.7	**Annual passenger turnover for mini-buses (mobility)**
Data unit:	Passenger.km
Description:	Secondary data usually calculated through load factor
Source of data used:	Total distance traveled by buses a year is multiplied by one bus load factor
Value applied:	9,849,600
Any comments	The data is calculated by Transport Department, shipping companies or the National Statistics Office of Georgia.

Private Cars (Motor Cars)

Data/Parameter # 3.3.1	**Number of private cars registered in Zugdidi (by fuel types)**
Data unit:	Quantity of transport
Description:	Primary data
Source of data used:	Ministry of Internal Affairs – Patrol Police Department. Provided to the SEAP by Zugdidi Municipality
Value applied:	11,118 (total): 8700 (on gasoline); 2150 (on diesel); 268 (on gas).
Any comments	

Data/Parameter # 3.3.2	**Average annual distance traveled by one vehicle (by fuel type is recommended)**
Data unit:	Km/year
Description:	Primary data.
Source of data used:	Provided by Zugdidi Municipality. Assessed through surveys

Value applied:	12,000 Km/Year
Any comments	The National Statistics Office and interviews with drivers to learn average daily kilometrage, then to make yearly calculation. Surveys should meet reliability criteria. Interviews and surveys to determine daily kilometrage and the SEAP implementation will be conducted simultaneously.

Data/Parameter # 3.3.3	**Average distance traveled by all motor cars per year (by fuel types)**
Data unit:	Trans.km/year
Description:	Calculated data
Source of data used:	Calculated by the MUNI_EIPMP Data # 3.3.1 and 3.3.2
Value applied:	**133,416,000**
Any comments	Annual kilometrage of one car multiplied by total number of motor vehicles

Data/Parameter # 3.3.4	**Fuel consumption per 100 km (by fuel type)**
Data unit:	L/100 km m3/100 km kW.h/100 km
Description:	Primary data
Source of data used:	Taken from the registration certificate of a motor vehicle. Provided by Zugdidi Municipality
Values applied:	Gasoline -9 l/100 km Diesel-8 l/100 km Natural gas-7 m3/100 km
Any comments	This data is rechecked via registration certificate and surveys.

Data/Parameter # 3.3.5	**Fuel consumption of all motor cars by fuel types (gasoline, diesel, gas)**
Data unit:	L/year
Description:	Secondary data. Will be calculated by the monitoring group.
Source of data used:	Calculated by the MUNI_EIPMP: 3.3.5 = 3.3.1. * 3.3.2. * 3.3.4/100 Quantity of gasoline powered motor vehicles multiplied by fuel expense (100 km) multiplied by one car annual kilometrage and divided by 100.

Value applied:	9,396,000 L (Gasoline) 2,064,000 L (Diesel) 225,120 m^3 (Natural gas)
Any comments	This data is calculated by the monitoring group and is compared to the spent fuel in the city. Significant error is expected, however.

Data/Parameter # 3.3.6	**Transport Load Factor**
Data unit:	Passenger.km/ trans.km
Description:	This parameter should be evaluated by statistical methods and surveys. It could be calculated from Parameter 3.3.7. if it is assessed, or estimated by another method
Source of data used:	Calculated for the SEAP by the Zugdidi Municipality
Value applied:	**1.85**
Any comments	This parameter is used only to assess GHG emissions reductions after measures taken in the sector. The GHG annual inventory from transport sector is not dependent on it. This data can be assessed as a result of a survey if Parameter 3.3.7 is known (mobility of private motor cars) and calculated : #3.3.7/3.3.1/3.3.2

Data/Parameter # 3. 3.7	**Total number of passengers transported by all motor vehicles a year (annual mobility of private cars)**
Data unit:	Passenger.km/year
Description:	Secondary data calculated through the load factor
Source of data used:	Calculated
Value applied:	**246,819,600**
Any comments	Quantity of vehicles is multiplied by one car's annual kilometrage and multiplied by the average load factor of a car.

Municipality- Owned Fleet

Data/Parameter # 3.4.1	**Zugdidi municipality service vehicles (by fuel type)**
Data unit:	Amount of transport
Description:	Primary data
Source of data used:	Provided to the SEAP by Zugdidi Municipality
Value applied:	**Total 27**

	On gasoline -12; diesel- 15.
Any comments	Zugdidi Municipality transport department is responsible for this data

Data/Parameter # 3. 4.2	**Average distance traveled by one vehicle a year (by fuel and transport types)**
Data unit:	km/ year
Description:	Primary data
Source of data used:	Provided to the SEAP by Zugdidi Municipality
Value applied:	**18 000 km/year**
Any comments	Zugdidi Municipality transport department is responsible for this data

Data/Parameter # 3.4.3	**Average distance traveled by the municipality service vehicles annually**
Data unit:	Trans.km/year
Description:	Calculated data.
Source of data used:	Calculated by the MUNI_EIPMP Data # 3.4.1 and 3.4.2
Value applied:	**486,000**
Any comments	Verification will be done according to consumed fuel.

Data/Parameter # 3. 4.4	**Fuel consumption per 100 km (by fuel and transport types)**
Data unit:	L/100 km
Description:	Primary data.
Source of data used:	Provided to the SEAP by Zugdidi Municipality
Value applied:	**Gasoline -18** **Diesel - 12**
Any comments	Zugdidi Municipality Transport Department is responsible for these data

Data/Parameter # 3.4.5	**Annual fuel consumption of the entire municipal fleet (by fuel type)**
Data unit:	L/Y
Description:	Secondary data.Calculated by the monitoring group
Source of data used:	Calculated by the MUNI_EIPMP: 3.4.5 = 3.4.1. * 3.4.2. * 3.4.4/100
Value applied:	38 880 (Gasoline) 32 400 (Diesel)
Any comments	Verification will be done in accordance with consumed fuel

Commercial Transport (Taxi)

Data/Parameter # 3. 5.1	**Taxi cabs of Kutaisi by fuel type**
Data unit:	Number of taxis by fuel type
Description:	Primary data
Source of data used:	Ministry of Internal Affairs. Patrol Police Department. Provided by Zugdidi Municipality
Value applied:	220 (total) 95 (on gasoline); 15 (on diesel); 110 (on natural gas)
Any comments	Zugdidi Municipality Transport Service is responsible for the data. Primary verification of these data is the responsibility of the City Hall Transport Department, but they can control officially registered taxis only, thus the reliability of the data is very low. More likely this is to be reflected by total amounts of fuel sold.

Data/Parameter # 3. 5.2	**Average distance traveled by one taxi annually (by fuel types)**
Data unit:	km/year
Description:	Primary data.
Source of data used:	Provided for the SEAP by Zugdidi Municipality
Value applied:	**15,600**
Any comments	The Zugdidi Municipality Transport Department is responsible for the data. These data for officially registered taxis can be obtained from the Revenue Service or taxi unions. Estimations should be made by questioning drivers and observations.

Data/Parameter # 3.5.3	**Average distance covered by all taxis annually (by fuel type is recommended)**
Data unit:	Trans.km/year
Description:	Calculated data.
Source of data used:	Calculated by the MUNI_EIPMP data # 3.5.1 and 3.5.2
Value applied:	3,432,000 total kilometrage 1,482,000 (on gasoline); 234,000 (on diesel; 1,716,000 (on natural gas m3)
Any comments	

Data/Parameter # 3. 5.4	**Fuel consumption by transport type**
Data unit:	l/100 km m3/100 km
Description:	Primary data
Source of data used:	Registration certificate of each vehicle. Provided for the SEAP by Zugdidi Municipality.
Value applied:	Gasoline 9 l L Diesel 15 L Gas 11 m3
Any comments	

Data/Parameter # 3. 5.5	**Annual fuel consumption by taxis (by fuel types)**
Data unit:	L/year
Description:	Secondary data
Source of data used:	Calculated by the MUNI_EIPMP: 3.5.5 = 3.5.1. * 3.5.2. * 3.5.4/100
Value applied:	133 380 (Gasoline) 16 389 (Diesel) 188 760 (Natural Gas)
Any comments	Quantity of gasoline-, diesel- or gas-fueled taxis multiplied by fuel expenses (100 km) multiplied by one taxi's annual kilometrage and divided by 100.

Data/Parameter # 3.5.6	**Passenger load factor of taxi cabs (load factor)**
Data unit:	Passenger.km/ trans.km
Description:	This parameter should be evaluated by statistical methods and surveys. It could be calculated from Parameter 3.5.7. if it is assessed or other method.
Source of data used:	Assessed by Zugdidi Municipality through observations and surveys
Value applied:	**2.5**
Any comments	

Data/Parameter # 3. 5.7	**Total amount of passengers carried by all cabs a year (annual mobility of cabs)**
Data unit:	Passenger.km/year
Description:	Secondary parameter
Source of data used:	Calculated by the SEAP Development Group
Value applied:	**38,115,000**
Any comments	3.5.7. = 3.5.1. * 3.5.2. * 3.5.6.

Commercial Transport Small Trucks (up to 2 tons)

Data/Parameter # 3. 6.1	**Small trucks driving inside Zugdidi**
Data unit:	Small trucks by fuel type
Description:	Primary data
Source of data used:	Provided for the SEAP by Zugdidi Municipality
Value applied:	**12 (diesel)**
Any comments	Primary verification of these data is the responsibility of Zugdidi City Hall Transport Service

Data/Parameter # 3. 6.2	**Average distance traveled by one small truck a year (by fuel type is recommended**)
Data unit:	km/year
Description:	Primary data
Source of data used:	Provided for the SEAP by Zugdidi Municipality. A result of surveys and monitoring

Value applied:	8400
Any comments	Primary verification of these data is the responsibility of City Hall Transport Department

Data/Parameter # 3.6.3	**Average distance traveled by small trucks a year (by fuel type is recommended)**
Data unit:	Trans.km/year
Description:	Secondary data
Source of data used:	Calculated by the MUNI_EIPMP Data# 3.6.1 and 3.6.2
Value applied:	100 800 (on diesel)
Any comments	

Data/Parameter # 3. 6.4	**Fuel consumption by transport types**
Data unit:	L/100 km
Description:	Primary data
Source of data used:	Provided for the SEAP by Zugdidi Municipality. A result of surveys
Value applied:	Diesel 12 L
Any comments	This data should be checked with registration certificate of each motor vehicle and analyzed in case of significant discrepencies.

Data/Parameter # 3. 6.5	**Annual fuel consumption by vehicle and fuel types**
Data unit:	L/year
Description:	Secondary data
Source of data used:	Calculated by the MUNI_EIPMP : 3.6.5. = 3.6.1. * 3.6.2. * 3.6.4/100
Value applied:	Diesel 12 096 L
Any comments	

Data/Parameter # 3.6.6	**Small trucks load factor (load factor)**
Data unit:	Ton.km/ Trans.km

Description:	This parameter should be evaluated by statistical methods and surveys. It could be calculated from Parameter 3.6.7. if it is assessed or estimated by another method
Source of data used:	Provided for the SEAP by Zugdidi Municipality. A result of surveys
Value applied:	2
Any comments	Quantity of diesel powered small trucks multiplied by fuel expense (100 km) multiplied by one truck's annual kilometrage and divided by 100.

Data/Parameter # 3. 6.7	**Transported freight by all small trucks in a year (annual freight turnover)**
Data unit:	Ton.km/year
Description:	Secondary data
Source of data used:	Calculated via MUNI_EIPMP: Data #3.6.1*3.6.2*3.6.6.
Value applied:	
Any comments	Quantity of small trucks multiplied by annual kilometrage and multiplied by transported freight for one vehicle. These parameters can be verified through freight actually transported and kilometrage.

Commercial Transport (Large Trucks)

Data/Parameter # 3. 7.1	**Number of large trucks in Zugdidi (diesel)**
Data unit:	Number of large trucks by fuel type
Description:	Primary data
Source of data used:	Provided to the SEAP by Zugdidi Municipality
Value applied:	30 (total) 25 Diesel 5 Gas
Any comments	Primary verification of these data is the responsibility of the City Hall Transport Department.

Data/Parameter # 3. 7.2	**Average distance covered by one large truck a year (by duel type is recommended)**
Data unit:	Km/year
Description:	Primary data

Source of data used:	Provided to the SEAP by Kutaisi Municipality. Survey results
Value applied:	7200
Any comments	Primary verification of these data is the responsibility of the City Hall Transport Department

Data/Parameter # 3.7.3	**Average distance covered by all large trucks a year (by fuel type is recommended)**
Data unit:	Trans.km/year
Description:	Calculated data
Source of data used:	Calculated by the MUNI_EIPMP: Data # 3.7.1 and 3.7.2
Value applied:	180 000 (Diesel) 36 000 (Gas)
Any comments	

Data/Parameter # 3. 7.4	**Fuel consumption by vehicle type**
Data unit:	L/100 km.
Description:	Primary data
Source of data used:	Registration Certificate of a motor car. Provided to the SEAP by Zugdidi Municipality.
Value applied:	Diesel 35 L
Any comments	

Data/Parameter # 3. 7.5	**Annual fuel consumption by vehicle and fuel types**
Data unit:	L/year
Description:	Secondary data
Source of data used:	Calculated by the MUNI_EIPMP
Value applied:	63,000 L Diesel
Any comments	

Data/Parameter # 3.7.6	**Large trucks load factor (load factor)**
Data unit:	ton-km/ car-km
Description:	Primary data
Source of data used:	Provided by the Transport Service of the Municipality. Survey based data
Value applied:	5
Any comments	Required to assess emissions savings from measures implemented during the monitoring period.

Data/Parameter # 3. 7.7	**Transported freight by all large trucks in a year (annual freight turnover)**
Data unit:	Ton.km/year
Description:	Secondary data
Source of data used:	Calculated by the MUNI_EIPMP: Data #3.7.1*3.7.2*3.7.6.
Value applied:	972,000
Any comments	These parameters can be verified through actual transported freight and kilometrage

Data/Parameter # 3. 7.8	**Fuel consumed by Zugdidi transport sector by fuel type**
Data unit:	L/year (MW.h) M^3/year (MW.h)
Description:	Secondary data calculated during Monitoring and SEAP preparation process
Source of data used:	Calculated by the SEAP team
Value applied:	Consumed throughout 2012 under the SEAP: 121,896 MWh equivalent fuel, corresponding to 30,600 t CO2 emissions
Any comments	This data is important for balance verification during the monitoring period.

Waste Management

Data/Parameter # 4.1	**Amount of waste (collected and deposited in the landfill daily)** **Current landfill in Zugdidi**
Data unit:	m^3 or ton
Description:	Primary data

Source of data used:	The data has been provided by Zugdidi Municipality during the SEAP preparation process
Value applied:	New landfill, bordered by two villages – Tsaishi and Didinedzi started operating in 2010; 120 m^3 waste dumped in a day in 2012, or 45,000 a year.
Any comments	In the territory of village Chitatskari, in 10 km distance from the city center and 2 km away from the nearest settlement, a landfill with total area of 6 ha and depth of 3 meters was used from 1972 to 2010. The landfill served Zugdidi City and some neighboring villages. 2009-2010 data show about 40-45,000 m3 solid and construction waste was delivered there annually. Most is now compacted.

Data/Parameter # 4.2	**Zugdidi Municipality landfill parameters (area, depth, waste composition)**
Data unit:	Area -ha Depth -m Waste composition-%
Description:	Primary data. Used for methane quantitative assessment
Source of data used:	The data has been provided by Zugdidi Municipality during the SEAP preparation process
Value applied:	Area -15 ha Depth – up to 2 m Waste composition : organic waste 62.76%, paper 7.6%, textiles 11.79%, polyethylene /plastic 10.15%, inert material 3.54%, metal 1.19% other 2.97%
Any comments	This data is used to estimate annual methane emissions. Compositions of recent municipal waste fractions were estimated in 2003 for Tbilisi (GIZ) and in 2010 for Batumi (by Environmental and Natural Resources Agency of Adjara[77]). There are some differences between the results that is quite normal since Tbilisi is much bigger regarding the territory and population. Zugdidi differs from bigger cities in terms of the lifestyle, quality of life and living conditions thus data from Batumi have been applied. Percentage composition of generated waste is measured (measures in 2007, EU[78]) (Table 3).

Data/Parameter # 4.3	**Amounts of collected and burnt methane locally**
Data unit:	m^3
Description:	Primary data. Being obtained through measurements
Source of data used:	This data/quantity has been estimated by FOD model of the IPCC in the SEAP preparation process.
Value applied:	Assuming that the landfill closes in 2016 and methane combustion is planned from 2017, an average of 960 t CO_2equivalent will be saved annually, or 3843 t CO_2 equivalent in 4 years (2017-2020), or 26% of that generated.
Any comments	

[77] http://www.greenalt.org/webmill/data/file/EIA_Adjara_%20SWM1.pdf
[78] http://www.greenalt.org/webmill/data/file/EIA_Adjara_%20SWM1.pdf

Data/Parameter # 4.4	**Generated methane calculation (If closing and project proposal are not implemented)**
Data unit:	m^3 or ton
Description:	Secondary data. Generated methane amount will be calculated through the first-order decay model. Calculations are the Monitoring group's responsibility.
Source of data used:	2006 IPCC Guidelines for National GHG Inventories, http://www.ipcc-nggip.iges.or.jp/public/2006gl (p. 3.36) This is ready-made software in which parameters can be entered.
Value applied:	Parameters necessary for calculations: Population size • Per capita waste (daily or annually) • Waste composition (from new evaluations) • Methane Emission Correction Factor (MCF) -1 • Degradable organic carbon Waste composition DOC Food waste 0.15 Garden 0.20 Paper 0.40 Wood and straw 0.43 Textile 0.24 Diapers 0.24 • Portion of rotten degradable organic carbon (DOCF)-0.5-0.6 • Portion of methane in landfill gas (F)-50% • Oxidation factor (OX)-0.1 (on controlled landfill) Generated and emitted methane in 2012 from both landfills, - 0.17 GG (3 570 T CO2eq.) while 0.33 GG methane is expected for 2020 (6 930 T CO2eq.)
Any comments	In case of the landfill isn't closed or the project implemented, methane measurements are likely to fail as well and these parameters will be observed through monitoring and generated methane assessment.

Street Lighting Sector

Data/Parameter # 5.1	**Total amount of electricity consumed for street lighting annually**
Data unit:	kW.h/year
Description:	Primary data
Source of data used:	Zugdidi City Hall Infrastructure Service office. The office is responsible for providing a report about amount of electricity consumed for street lighting a year or annually.
Value applied:	1655213 kW.h (in 2012) 2 070 000 kW.h (2020 forecast)
Any comments	The data will be verified with paid amounts. The data for 2020 have been calculated by the SEAP developing group.

Data/Parameter # 5.2	**Quantity of energy-efficient bulbs, to partially replace inefficient/old bulbs and to be used in new installations**
Data unit:	Quantity of energy-efficient bulbs
Description:	Primary data
Source of data used:	Project/measure implementation unit
Value applied:	100% new, energy-efficient bulbs in street lighting by 2020. 14700 pieces 3767 pieces
Any comments	If the measure is taken the issue of what will happen to the replaced bulbs must be resolved.

Data/Parameter # 5.3	**Energy saved by one energy-efficient bulb per hour**
Data unit:	kW.h
Description:	Primary data
Source of data used:	Technical description of the bulb
Value applied:	0.236 kW.h
Any comments	

Data/Parameter # 5.4	**Emissions savings through measures by 2020 (energy-efficient bulbs)**
Data unit:	T $CO_{2eq.}$
Description:	Secondary data calculated by the monitoring group annually
Source of data used:	SEAP developing group
Value applied:	Savings of 1.66 GWh electricity equaling to 226 t $CO_{2\ eq}$ has been estimated by 2020
Any comments	

Greening of Zugdidi

Data/Parameter # 6.1	**Total planted area in Zugdidi (2012)**
Data unit:	ha Number of plantings by species
Description:	Primary parameter

Source of data used:	City greening service, Botanical Garden (Dadiani Palace) Management
Value applied:	64 ha (including 23 ha of Dadiani Palace Garden)
Any comments	

Data/Parameter # 6.2	**Annual carbon dioxide sequestration against the background of greening activities in 2012**
Data unit:	TCO2/y
Description:	Secondary Parameter
Source of data used:	Calculated during the SEAP development process
Value applied:	167,200 t
Any comments	

Data/Parameter # 6.3	**Botanical garden restoration activities (1 ha)**
Data unit:	ha Quantity of plantings by species
Description:	Primary parameter
Source of data used:	City greening department, botanical garden management
Value applied:	Restoration/reconstruction of Zugdidi botanical garden. Sequestration of 70 more tons of CO_2 in 2020.
Any comments	

Data/Parameter # 6.4	**Afforestation of promising development area of Zugdidi (5ha)**
Data unit:	ha Quantity of plantings by species
Description:	Primary parameter
Source of data used:	City greening department
Value applied:	Afforestation of promising development area of Zugdidi (5ha) – sequestration of 246 more tons of CO2 in 2020.
Any comments	

Data/Parameter # 6.2	**Annual cutting/trimming of trees (by species)**

Data unit:	m^3
Description:	Primary parameter
Source of data used:	City greening service, botanical garden management
Value applied:	The SEAP assesses only current accumulation of carbon in Zugdidi and annual accumulation before 2020. Cuttings will be considered in the monitoring process.
Any comments	

Data/Parameter # 6.3	**Annual fires or other causes of damage to trees**
Data unit:	m^3
Description:	Primary parameter
Source of data used:	City greening service, botanical garden management
Value applied:	The SEAP assesses only the current accumulation of carbon in Kutaisi and annual accumulation before 2020. Fires and plant diseases, and other causes of destruction of trees will be considered in the monitoring process
Any comments	

Data/Parameter # 6.4	**Botanical Garden monitoring**
Data unit:	Ha
Description:	Primary parameter. Annual monitoring of area changes
Source of data used:	Botanical garden management
Value applied:	Current condition only has been assessed under the SEAP
Any comments	

Data/Parameter # 6.5	**Botanical Garden area changes (fire, diseases and reducing amount of trees)**
Data unit:	m^3
Description:	Primary parameter
Source of data used:	Botanical Garden
Value applied:	The Botanical Garden's current condition and sequestration up to 2020 have been assessed within the SEAP. Biomass change monitoring will be conducted annually.
Any comments	Typical indicators for the greening sector and characterizing indicators of regional forests for

	botanical garden have been taken at this stage (biomass increment, dry biomass quantity). Continuous monitoring for all used parameters and relevant changes in calculations required in case of parameters update.

Data/Parameter # 6.6	**Annual monitoring of CO_2 sequestration changes**
Data unit:	T CO_2 a year
Description:	Secondary parameter. Calculated by the monitoring group
Source of data used:	Has been calculated by the SEAP developing group
Value applied:	Greening of Zugdidi covers 64 ha (with fragmentary covered plantation areas and botanical gardens). Now 3690 t. carbon are reserved with annual sequestration of 167,200 t CO_2.
Any comments	

Buildings Sector

Data/Parameter # 7.1	**Annual energy consumption of municipal buildings**
Data unit:	MW.h/Year
Description:	Primary parameter
Source of data used:	Zugdidi City Hall Financial Service. Final quality of data is under the responsibility of Energy Manager assigned by Zugdidi City Hall.
Value applied:	5085
Any comments	This data will be checked at Energo-pro Georgia and by energy audit estimations.

Data/Parameter # 7.2	**Annual energy consumption of residential buildings**
Data unit:	MW.h/year
Description:	Primary parameter
Source of data used:	Energo-pro Georgia. Final quality of data is under the responsibility of the Energy Manager assigned by Zugdidi City Hall (or monitoring group)
Value applied:	39, 049
Any comments	This data can be checked by a survey of typical buildings or energy audit estimations.

Data/Parameter # 7.3	**Annual energy consumption of commercial buildings**
Data unit:	MW.h/year
Description:	Primary parameter
Source of data used:	Energo-pro Georgia. Final quality of data is under responsibility of Energy Manager assigned by Zugdidi City Hall (or monitoring group)
Value applied:	17,954
Any comments	This data can be checked by a survey of typical buildings or energy audit estimations.

Data/Parameter # 7.4	**Annual consumption of natural and liquid gas by municipal buildings**
Data unit:	m^3/year; kg/year (MWh)
Description:	Primary parameter
Source of data used:	Zugdidi City Hall Financial Service. Final quality of data is under responsibility of Energy Manager assigned by Zugdidi City Hall.
Value applied:	29,176 thousand m3 natural gas. Liquid gas - 0
Any comments	Can be checked at gas supply company

Data/Parameter # 7.5	**Annual consumption of natural and liquid gas by residential buildings**
Data unit:	m^3/year; kg/year((MWh)
Description:	Primary parameter
Source of data used:	Gas distribution company serving Zugdidi. Final quality of data is under responsibility of Energy Manager assigned by Zugdidi City Hall.
Value applied:	Natural gas – 11,120.72 thousand m3, liquid gas -36750 kg
Any comments	

Data/Parameter # 7.6	**Natural gas annual consumption by commercial buildings**
Data unit:	m^3/year; kg/year (MWh)
Description:	Primary parameter. Annual
Source of data used:	Gas distribution company, serving Zugdidi. Final quality of data is under responsibility of Energy Manager assigned by Zugdidi City Hall.
Value applied:	Natural gas -735,564 m^3

Any comments	This data to be checked by a survey of commercial buildings or energy audit estimations

Data/Parameter # 7.7	**Annual consumption of firewood and diesel by municipal buildings**
Data unit:	m^3; l (MWh)
Description:	Primary parameter
Source of data used:	Zugdidi City Hall Financial Service. Final quality of data is under responsibility of Energy Manager assigned by Zugdidi City Hall.
Value applied:	Firewood - 401 m3 Diesel – 23,280 L
Any comments	

Data/Parameter # 7.8	**Annual firewood consumption by residential buildings**
Data unit:	m^3
Description:	Primary parameter
Source of data used:	Vouchers issued for residents. Final quality of data is under responsibility of Energy Manager assigned by Zugdidi City Hall.
Value applied:	Firewood – 10,109 m^3, hazelnutshells -14,750 t
Any comments	According to experts' estimations, the annual consumption of firewood in Zugdidi is about 3000-4 000 m^3. Have to be checked with periodic surveys. Firewood consumption rates are much higher than voucher issuances

Data/Parameter # 7.9	**annual consumption of firewood and diesel by commercial buildings**
Data unit:	MW.h/year
Description:	Primary parameter. Annual
Source of data used:	Commercial buildings survey. Final quality of data is under responsibility of Energy Manager assigned by Zugdidi City Hall.
Value applied:	Hazelnut shell s- 4000 Tons
Any comments	This data can be checked by a survey of commercial buildings

Data/Parameter # 7.10	**Annual CO_2 monitoring from all three sectors**
Data unit:	T/year
Description:	Secondary parameter. Annual
Source of data used:	Calculated by the monitoring group
Value applied:	2012 Base year- 15,131 2020 year – 18,500
Any comments	

Data/Parameter # 7.11	**Savings through measures carried out in buildings sector**
Data unit:	MW.h/per measure
Description:	Secondary parameter. Annually calculated for each measure.
Source of data used:	Project executors (population, municipality, head of commercial building)
Value applied:	This parameter is calculated when carrying out each specific measure in accordance with the monitoring plan accompanying each measure.
Any comments	The assessment/measurement of energy consumption with the corresponding CO2 baseline scenario and actual measurements is required for all buildings and fuel types. Energy consumption can be reduced due to various reasons (technical disconnections, disconnections because of unpaid bills, etc.). Therefore, proving that reduction has actually resulted from fulfilling a measure without the interference from other sources is important. Emissions savings estimation methods will be described separately for each measure. Preliminary theoretical estimates of saved emissions are presented in the SEAP.

Sustainable Development Criteria

Monitoring reports should also include the results of observations on sustainable development criteria/indicators, as listed:

8.1. Local potential improvement of Zugdidi Municipality (staff, plans);
8.2. Increase in population's comfort and energy expenditure savings (per capita hot water consumption, expansion of heated areas, approximations of per area energy consumption to European standards etc.);
8.3. Promotion of residential apartments;
8.4. Improved comfort and energy savings in municipal/commercial buildings (heat, electricity, hot water consumption per area unit);
8.5. Waste recycling technologies;

8.6. Expansion of per capita green areas;
8.7. Reduction of local pollutants (mainly in the transport sector);
8.8. Increased number of jobs;
8.9. Better gender equity;
8.10. Demonstrations and piloting new technologies;
8.11. Promoting private sector development;
8.12. Municipalities able to report on additional criteria that were influenced by measures carried out within the SEAP framework;
8.13. Plans in place to avoid and overcome main obstacles, and steps towards achieving success.