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Sustainable Energy Action Plan for Gori

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

SUSTAINABLE ENERGY ACTION PLAN FOR GORI

August 2015

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1. TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF PICTURES

ACRONYMS

BAU	Business As Usual
C	Carbon
CDM	Clean Development Mechanism
CH_4	Methane
ClimaEast	European Union funded project package assisting the Eastern Neighborhood Partnership Countries and Russia in approaches to climate change mitigation and adaptation
CO	Carbon monoxide
$CO_{2\ eq}$	Carbon dioxide equivalent ($CO_{2\ eq}$)
CoM	Covenant of Mayors
EC -LEDS	Enhancing capacity for low emission development strategies
EU	European Union
EU –COM	European Union Covenant of Mayors
HSW	Household Solid Waste
IPCC	Intergovernmental Panel on Climate Change
JRC	Joint Research Centre of the EU
LED	Light Emitting Diodes
LEPL	Legal Entity of Public Low
LLC	Limited Liability Company
Lm	Lumen (illumination unit)
MCF	Methane Correction Factor
MDF	Municipal Development Fund
Mg	Megagram (10^6g = 1t)
MJ	Megajoule (10^6 Joule)
MSW	Municipal Solid Waste
Muni- EIPMP	Municipal emissions inventory, projection and mitigation measures planning
MW	Megawatt (106 watts)
NALA	National Association of Local Authorities

N2O	Nitrous Oxide
NCV	Net Calorific Value
NG	Natural Gas
NH3	Amonia
QA/QC	Quality Assurance/Quality Control
RDF	Regional Development Fund
SEAP	Sustainable Energy Action Plan
SME	Small and Medium Enterprises
SWDS	Solid Waste Disposal Sitr
TJ	Terajoule (1012 Joule)
UNFCCC	United Nations Framework Convention on Climate Change
USAID	US Agency for International Development
VOC	Volatile Organic Compound

1. 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 Gori City Municipality joined an initiative aiming at GHG emissions reductions by at least 20% to 2020 – a goal that has to be reached while simultaneously improving social and economic development. Gori 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 Gori 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 Gori sectors of at least 27.5% compared to the BAU of 2020.

2. GORI CITY – OVERVIEW

General Characteristics

Gori is a medium-size town occupying strategic site at the confluence of rivers Mtkvari (Kura) and Liakhvi. The initial idea of its foundation was defending from invasions of enemies and developing of trade, but later its development concentrated on the industry and agriculture. The rapid growth of Gori as an urban settlement is connected with the Soviet period, during which 4 different city strategic development plans have been worked out – in 1938/39, 1961, 1971 and 1989.

The strategic disposition of the city determined its formation as an administrative center of the Shida (Inner) Kartli Region. Its name "Gori" is associated with the fortress erected at the hill ("Gori") nearby the settlement. This fortress even today significantly defines the urban landscape of the city with old narrow streets (the district of "Tsikhisubani" – "Fortress district"), which at the central square of Gori joins quite different urban form and style – the Stalin Avenue being the central part of contemporary Gori[1].

[1] Kiev Initiative Regional Programme. *Pilot Project on Rehabilitation of Cultural Heritage in Historic Towns. Preliminary Technical File. Gori, Georgia.*

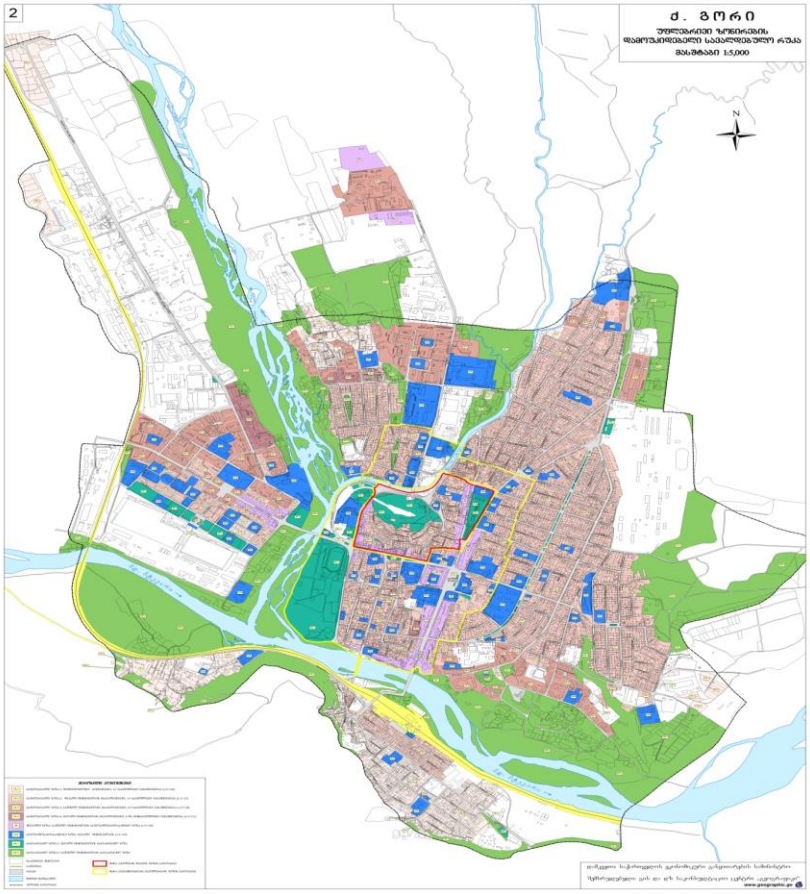


Figure 1. Map of the Gori municipality

The city mainly occupies the left bank of river Mtkvari and both banks of rivers Liakhvi and Mejuda. The climate in Gori is moderately warm, transient from the steppe to temperate humid, characteristic to dry subtropics with cold winter and hot summer. Mean annual temperature equals to 11.3 ^{0}C with – 0.9 ^{0}C in January and 23.1^{0}C in August. The annual sum of precipitation makes 500 mm. Dominant winds are westerly and easterly. The distance between Gori and Tbilisi equals to 76km.

Strategies of development

Due to its strategic location the city of Gori has played important role at almost every stage of Georgia's history. It always had been and continues to be the administrate, cultural and educational center of Shida Kartli. There are different opinions on the foundation date of the city. In historical sources it is first mentioned in VII century AD, though during the archaeological investigations at the Gori fortress fragments of walls belonging to Antique Age have been discovered.

In the Middle Ages at the present site of the city the strategically important fortress ("Gori Tsikhe") was built, the slopes of which have been gradually populated. In the feudal Georgia Gori positioned itself not only as a center of Shida Kartli but as a main city of East Georgia.

Picture 1. The Gori Fortress. Drawing by Christopher Castell, XVII century

Picture 2. Inner view of eastern part of the Gori Fortress. End of XIX century

In the XII century during the rule of David the Builder number of towns in Georgia has grown caravanserais, hotels and other types of infrastructure -built. Naturally, this period coincides with the further development of Gori as a town. Being at the crossroad of important communications Gori becomes an important trading center and this position was subsequently retained.

According to 1770 census there were 500 houses in the town. From the beginning of XIX century, after the joining of Georgia to the Russian Empire, the Gori Fortress lost its initial

function and Gori became a district center. New housing estates have emerged (Tsikhisubani, Rustubani, Sulukhi and Gareubani). The first topographical survey of the town has been conducted.

According to the 1806 data the population of the town comprised 1 200 persons, the majority of them being merchants and craftsmen. The slopes of Gori Fortress became covered with narrow streets, up to 10 small churches, taverns, dwelling houses and other buildings.

Picture 3. Gori-Royal Street. The beginning of XX century

Picture 4. The Bridge on the R. Mtkvari in Gori, 1904

From the beginning of XIX century Gori gradually loses the look of feudal fortress-town and transforms into typical peripheral district town of the Russian Empire. The life in town descends to the lower quarters and becomes more active. In 1872 the railway transportation was opened between Tbilisi and Poti resulting in the establishment of railway station in Gori. The railway connection between different towns of the country gave a new impetus to the development of the town. After the commencement of XX century the growth of Gori has accelerated, that is evident from the Table 1.

Table 1. DYNAMICS OF GORI POPULATION (THOUSANDS)

1915 year	1939 year	1959 year	1970 year	1979 year	1989 year	2002 year	2015 year
18.2	19.6	35.1	48.2	56.0	69.0	52.7	50.4

During the Soviet era a number of important objects have been constructed in the city: First cinema theatre on the Royal (Lenin) street, hotel on the same street, the bridge on the River Liakhvi, Teachers Training Institute (now the Gori State University); the railway station has been reconstructed, etc. The city gained modern appearance from 1950-ies.

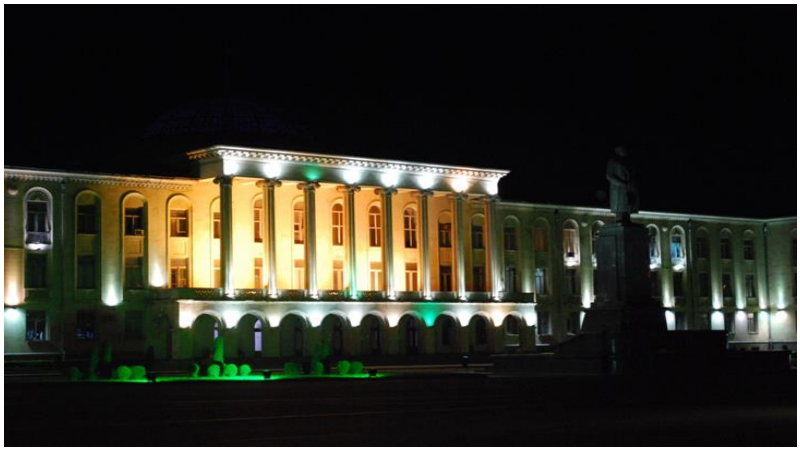
Picture 5. Gori State University, 2009

Picture 6. Gori Railway Station, 2009

Gori- COM Signatory and Self-Governing city

According to the "Organic Low on Self-Governance" approved by the Parliament of Georgia, since February 2014 the city of Gori has acquired the status of self-governing city[2]. The gaining of self-governing city status brings important changes in the form of city governance concerning its rights, duties and the mandate. The management of the city gets more freedom from the central government in decision-making process and in planning and developing the city within the limits of its own possibilities. In accordance with the Article 2 of Self-governance Code citizens of Georgia have a right to resolve problems of local importance through the bodies of local self-governance on the basis of Georgia's legislation. The self-governing unit is municipality which has its administrative borders and administrative centre, has elected governing bodies and possesses its own property, budget and income. The Municipality is an independent legal entity of public low (LEPL)[3].

[2] https://matsne.gov.ge/ka/document/view/2244429
[3] https://matsne.gov.ge/ka/document/view/2244429



Picture 7. Gori Municipality at night

After obtaining the status of self-governing city Gori became a legatee of subscribe to the COM[4]. Gori Municipality has signed the COM as early as in July 2012 and thus has undertaken an obligation to prepare and implement within its administrative borders the SEAP aimed at the reduction of GHG emissions to 2020 at least by 20%[5]. The management of Gori Municipality already has expressed several times its readiness and interest in fulfilling this obligation[6]. It should be mentioned that in 2012-2013 the first version of Gori Municipality SEAP has been developed which was approved by the Gori Municipality Local Council (Sakrebulo) on 12 July 2013 under the Decree No137[7]. In view of the fact that after the 2014 elections of local self-governing bodies the Gori Municipality was divided into two self-governing units – Gori Municipality Directorate (Gamgeoba) and Gori Municipality Mayor's Office (City Hall), as well as considering the necessity to insert some amendments after receiving comments from the COM office, it was decided to work out a new version of SEAP for the city of Gori.

[4] Gori Municipality Decree N 03/04/2015
[5] http://www.covenantofmayors.eu/about/signatories_en.html?city_id=4592
[6] EC-LEDS/Clean Energy Program. *Updated List of Selected Municipalities according to Selection Criteria.* 2014
[7] SEAP of Gori Municipality. 2013

Picture 8. Central Park of Gori

As far as the city has only one year of self-governance experience, its present state, potentialities and prospects are not yet studied and analyzed in detail. Hence, the available information concerns mainly the Gori Municipality, based on which the data about the city of Gori are not sufficiently precise and important features characterizing the city could be assessed approximately.

According to 2012 data the population of Gori equals to 50 400[8], main portion of which (39.2%) is aged from 15 to 40 years. It should be noted that since 1990-es number of migrants from Gori to Tbilisi or other countries is increasing that is caused by the search for better conditions of employment. Under the unspecified information about 17% of population is unemployed[9].

At the level of entire municipality (including city of Gori) the main direction of local economic activity is agriculture (production of fruit, vegetables, cereals, animal husbandry). Other important sectors of economy are trade, transportation, construction and tourism[10]. After the consultations and meetings with the representatives of Gori Municipality it has been defined that tourism is one of the priority sectors of economy and a number of concrete measures are planned to be taken.

8 Information provided by the Gori City Hall

9 Kiev Initiative Regional Programme. Pilot Project on Rehabilitation of Cultural Heritage in Historic Towns. Preliminary Technical File. Gori, Georgia

10 National Association of Legal Administrations (NALA). Adaptation to climate change and mitigation at the local level. Present state in the Gori Municipality.

Plans of Gori development and their analysis

The elaboration of Initial General Plan for the development of Gori has started in 1936 and was concluded in 1939. According to this plan the dominant position in special planning was attributed to the Gori Fortress located at the hill near the confluence of rivers Liakhvi and Mejuda. In the planning structure the composition axis was represented by the Stalin new Avenue which on one side ended at the Railway Station and in another northern direction stretched to the triangular park, where the Stalin House-Museum (Memorial) complex is disposed. From this triangle one branch was connected to the Tbilisi Highway and another-to the Tskhinvali Highway. General Plan was designed for the period of 1937-1952 with the rated population 30 thousand people. Economic details of the Plan were agreed with the Georgian government but the World War 2 has drastically delayed its implementation.

The Second General Plan has been approved in 1950 designed for the period of 1950-1965 with the rated population 40 thousand by 1965. In the new Plan the right bank of R. Liakhvi was developed where in 1950-es the cotton textile enterprise was constructed with its worker's settlement numbering 5 000 residents.

Currently a new city development documentation is worked out, prepared in 2004 by the consulting centre "Geographic" under the order of the Ministry of Economics and Sustainable Development[11]. According to this document the vision of city first of all envisages the territorial development of Gori (in particular, the development of residential territories by increasing the density of population or using the territories of abolished enterprises, or by spreading of the city in the northern and north-eastern direction; by functional zoning (in particular, separation of residential and industrial territories that may lead to the liquidation of small enterprises and construction of public facilities instead, arrangement of recreation zone or their use as a residential territory; improvement of planning structure and space organization (in particular perfection of highways and transportation lines as well as rearrangement of the territory bordering the Fortress – transfer of bus terminal to the Tskhinvali Highway, organizing an open market-place on its territory, reconstruction of covered market, widening of existing square, arrangement of pedestrian zone[12], development of transportation (in particular, perfection of inner-city traffic), territory's engineering preparation and regulation of rivers (in particular, maximal preservation of natural river-beds and landscapes, arranging dams and vegetative reclamation zones for the embankment of rivers, construction of draining canal in the northern part of the city, as well as sanitary cleaning of the city (in particular, putting in order according to

[11]Ministry of Economy and Sustainable Development of Georgia. GIS Consulting Center "Geographic". Gori city construction documentation. Project "Development of city construction documentation for country's settlements". Tbilisi, 2004.
[12] Former Ministry of Economy development of Georgia.

norms the mechanism of municipal waste management), arrangement of the landfill at a new territory 2.5 km away from the city with the 500 meter wide protection zone).

This plan created a basis for raising the space and territorial management of the city at a new higher level. It should be noted that part of the measures planned in the frames of this document has been already implemented, however after 2014, due to fundamental changes in the society the document needs essential renovation.

After the 2008 Russian-Georgian war in 2009 under the assistance and aegis of EU the project "Immediate steps for the revival of socio-economic and cultural environment of Gori municipality population" was implemented. A major part of the document consisted of "Development Program for the Gori Region" has started. In the elaboration of the project experts representing Ministry of Economy and Sustainable Development of Georgia, Ministry of Culture of Georgia, Municipality of Gori, EU and different consultants took part. As a result of their activities the Gori Region Sustainable Economic Development Program has been worked out.

In view of the fact that for that moment the territorial arrangement of the city of Gori and villages of its district was envisioned within the limits of single municipality, the document does not include separate program for the development of the city of Gori. The program is mainly focused on the damaged and outdated infrastructure and monuments of cultural heritage. Necessary steps have been identified for the reconstruction of infrastructure and living environment – roads, potable and irrigation water, natural gas and electricity supply, sewerage system, healthcare, schools, churches, street lighting, recreation parks, etc.

It must be noted that a number of planned steps have been already realized. Firstly, the damaged and ruined in the war houses were reconstructed. More than 5 000 privately owned and 15 multi-story buildings were rehabilitated in the city and the region, among them more than 400 privately owned houses and 15 multi-storey buildings in the city itself. Expenses on these works in the city exceeded 7 million Lari. However, energy efficiency was not provided in the reconstruction works.

The Shida Kartli Regional Development Strategy for 2014-2021 approved by the Government of Georgia on 17 September 2013 under the Decree #1 364 could be regarded as a strategic development plan. Though this document is of general character and does not envisage the creation of development strategy for the city of Gori as a separate territorial entity.

3. THE SUSTAINABLE ENERGY DEVELOPMENT STRATEGY

The city of Gori has acquired status of self-governing entity not far ago, in 2014. Correspondingly, the strategic vision of Gori development is not yet being formulated and thus the presented below Sustainable Energy Action Plan (SEAP) is to be regarded as an only first step in this direction. It includes the transport, buildings, street lighting, solid waste and greening sectors. This Plan must be integrated as soon as possible in the process of city's strategic planning and become inseparable part of Gori development strategy to be worked out in future.

This version of city Gori SEAP is prepared in 2015 and includes the remaining 5 years. That is why in the Action Plan the emissions reduction strategy is defined for only two periods: short-term period (2015-2017) with concrete and detailed measures, while measures planned for the long period are discussed predominantly from the strategic viewpoint and require additional survey, planning and technical and economic sustainable substantiation. Such an approach is in full compliance with the Guidelines for the preparation of SEAP.

Based on the 2012 baseline emissions inventory results and projections of CO_2 emissions anticipated increase by 2020 for all sectors discussed in Gori SEAP the sectorial strategy for the reduction of GHG emissions was worked out and on its basis the SEAP overall strategy was determined. In particular, taking into account priorities defined by the Gori Municipality first priority has been attributed to the emissions reduction in the buildings sector, from which 62% of total emissions comes from the city and according to the BAU scenario by 2020 this value may reach 69%. After the buildings sector, measures to be taken in the transportation sector have second ranking followed by other sectors. One of the main priorities of Municipality in the process of infrastructure development is street lighting; though saving in this segment is minimal out of the measures planned for this sector. Sectors and measures listed in the SEAP have been placed in the following order:

Building sector

In the Building sector the Gori City Hall plans to introduce energy efficiency and renewable energy application at the beginning in buildings belonging to the city or owned by relatively organized citizens having some experience in cooperation with the City Hall. These are municipal buildings and cooperatives of flat owners. However, to achieve the planned reduction of emissions it is very important as well to introduce energy efficiency and renewable energy measures in one- and two-storey privately owned houses. For achieving this goal the City Hall will elaborate special programs and approaches for owners of private houses and will actively collaborate with other state structures, different funds and private organizations.

According to Gori SEAP the following measures will be taken in the buildings sector:

- In municipal buildings:

    1. Thermal insulation of attics (in the administrative buildings and kindergartens);
    2. Adoption of fluorescent bulbs in kindergarten's lighting system;
    3. Introduction of solar collectors in kindergartens and day nurseries;
    4. Implementation of pilot projects in new technologies (i.e. "Green Building", etc.).

In 2015-2020 these measures will be taken in the administrative buildings of the City Hall and in maximum possible number of kindergartens. At the same time the pilot project is planned – the rehabilitation of Anna Peradze School of Arts' building which is to be transformed into "Green Building" acquiring relevant volunteer certificate. This building will serve as an example to other types of buildings and in case of success will facilitate the spread of "Green Buildings" concept in Gori and Georgia in general. In case of some deficiencies in technology, the recommendations will be prepared to be used in the follow-up projects.

- In the residential buildings sector the City Hall in the short-term prospective will collaborate with flat owners cooperatives for implementing the following measures:

    1. Installation of fluorescent bulbs in apartment;
    2. Sensory lighting of entrances;
    3. Thermal insulation of common spaces in residential buildings.

In the long-run perspective to collaborate with flat owners cooperatives the City Hall will work out programmes and schemes facilitating the introduction of following measures:

1. Thermal insulation of private houses' roofs;
2. Substitution of existing windows with plastic window frames in private houses

Transportation sector

In the transportation sector the following 3 strategic directions are discussed:

1. Management of public transport (including the creation of municipal transport) and improvement of services;
2. Facilitation of walkable localities and cycling routs in the city;
3. Energy efficient urban planning of the city and traffic management.

In the public transportation subsector first of all local regulations are to put in order that will improve the transit services. At the initial stage (in the short-term prospective) on the basis of tender those companies (or company) should be selected which will serve Gori population with their own mini-buses and perform the function of regulated city public transport. This kind of public transport will operate according to optimal routes approved by the Municipality. In a more long-term perspective it is envisaged to provide the city with the well-planned routes and comfortable buses operating on a relatively clean fuel. These buses will serve as an efficient alternative to private cars transporting population on relatively long distances.

In the long-run prospective the strategic vision of Gori transportation sector embraces the promotion of pedestrian and cycling routes substituting traffic using taxi or private cars in a healthier way on a shorter distances.

For the development of road infrastructure and city urban planning a number of measures is discussed for the transportation sector aimed at optimizing the traffic routes and shortening of travel choices. This includes planning of travel on new routes in a shorter prospective as well as the construction of new bridges and streets in a long-term planning.

Municipal infrastructure sector

The municipal infrastructure development strategy includes 3 subsectors and is aimed at the recovery and flaring (2016) of methane at the municipal landfill, substitution of all presently functioning street lighting bulbs with LED lamps and widening the green areas in the city. The greening measures include the completion of planting of 5 ha forest-park in the eastern part of the city and the arrangement and planting of 5 squares in the centre of the city.

Summary of the SEAP

The methodology for working out of Sustainable Energy Action Plan for the city of Gori does not imply the use of a baseline year, which includes great risks for the process of city development and creates almost impossible conditions for implementing the commitments taken by the cities. The used method provides envisaging the development perspective of the country and the discussed city as well as inevitable growth of emissions to 2020 as a result of increased demand

on energy carriers. This increase is considered in the BAU scenario, in comparison to which the reduction of emissions is evaluated as a result of implementation of different measures and project proposals. The methodology for the development of BAU scenario is discussed in more details in the Transport Sector.

The GHG inventory summary results for 2012 and BAU projections for 2020 as well as saving from the implementation of SEAP in Gori are presented in Table 2 and Table 3.

Table 2. DYNAMICS OF GORI POPULATION (THOUSANDS)

#	Sector	2012	2020 (BAU)
1	Transport	10 559	15 733
2	Buildings	35 241	52 509
3	Street lighting	403	521
4	Waste	10 712	12 166
	Total	**56 916**	**80 928**

Table 3. GHG emission savings in different sectors according to the Gori SEAP

#	Sector	Saving (tons in CO2eq.)
1	Transport	1 106
2	Buildings	12 205
3	Street lighting	326
4	Waste	8 482
5	Greening	158
	Total	**22 277**

According to this SEAP 22 277 tons of GHG emissions will be saved by 2020 in Gori, representing 27.5% of BAU scenario in 2020 and 39% of 2012 emissions.

Figure 2. shows the redistribution of sectoral emissions between 2012 baseline year and 2020 data according to BAU scenario. In Figures (Figure 3; Figure 4; Figure 5; Figure 6) the growth of emissions in different sectors is shown in accordance with the BAU and SEAP scenarios.

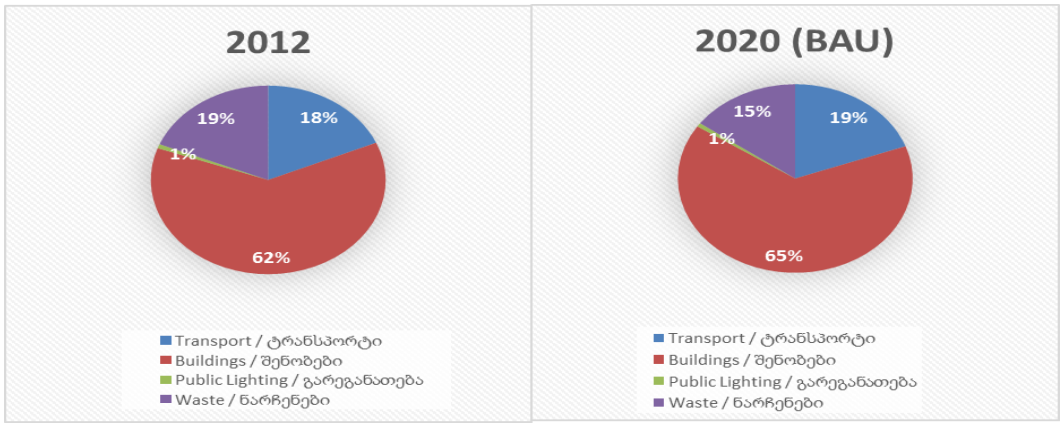


Figure 2. Redistribution of sectoral emissions between 2012 and 2020 years

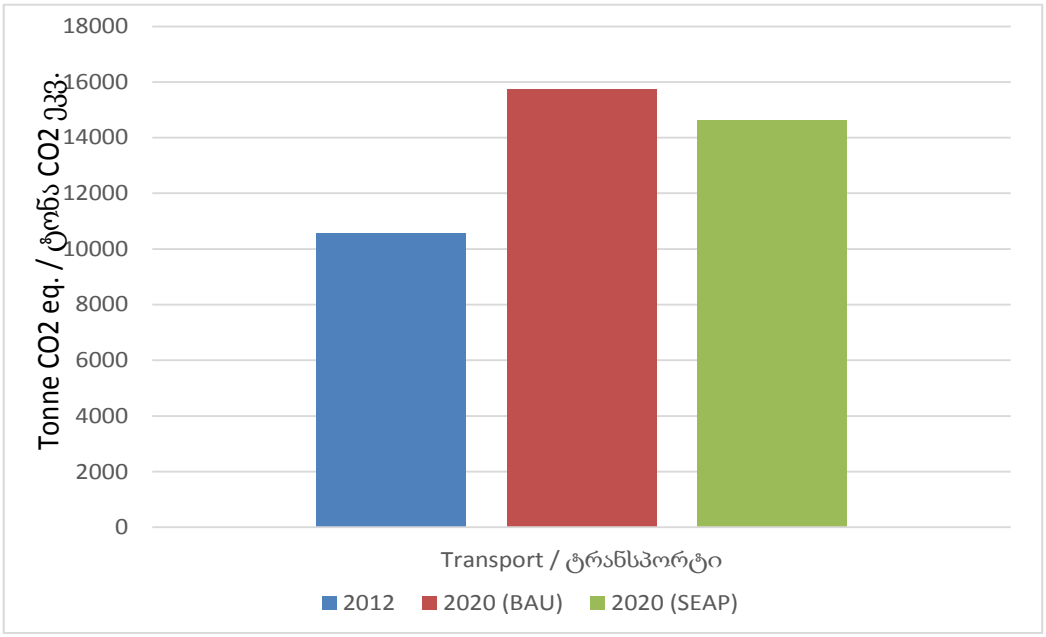


Figure 3. Growth of emissions according to BAU and SEAP scenarios in the transport sector

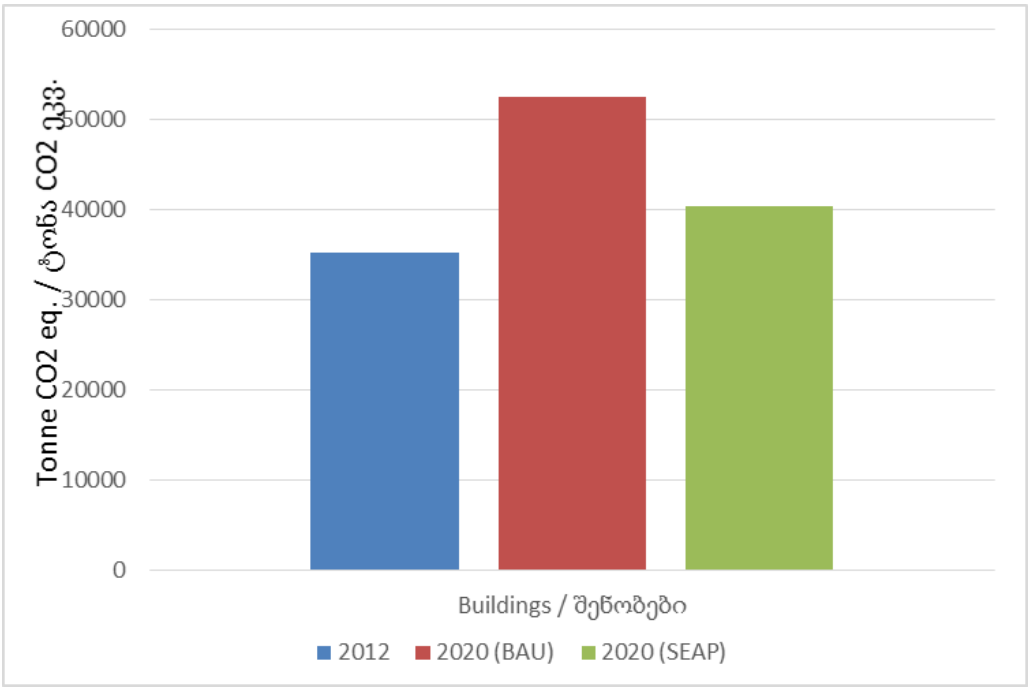


Figure 4. Growth of emissions according to BAU and SEAP scenarios in the buildings sector

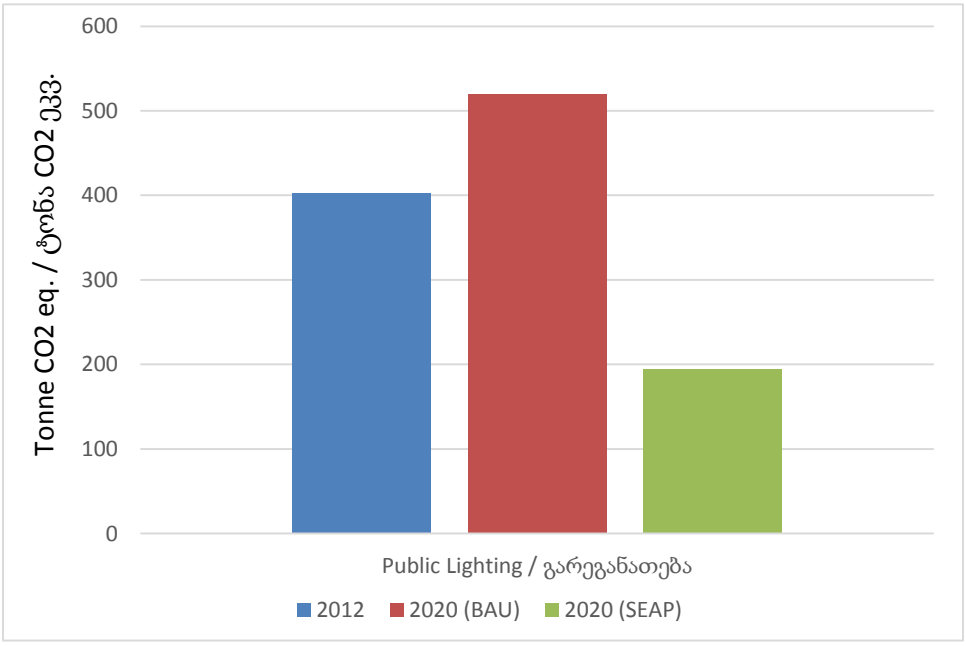


Figure 5. Growth of emissions according to BAU and SEAP scenarios in the street lighting sector

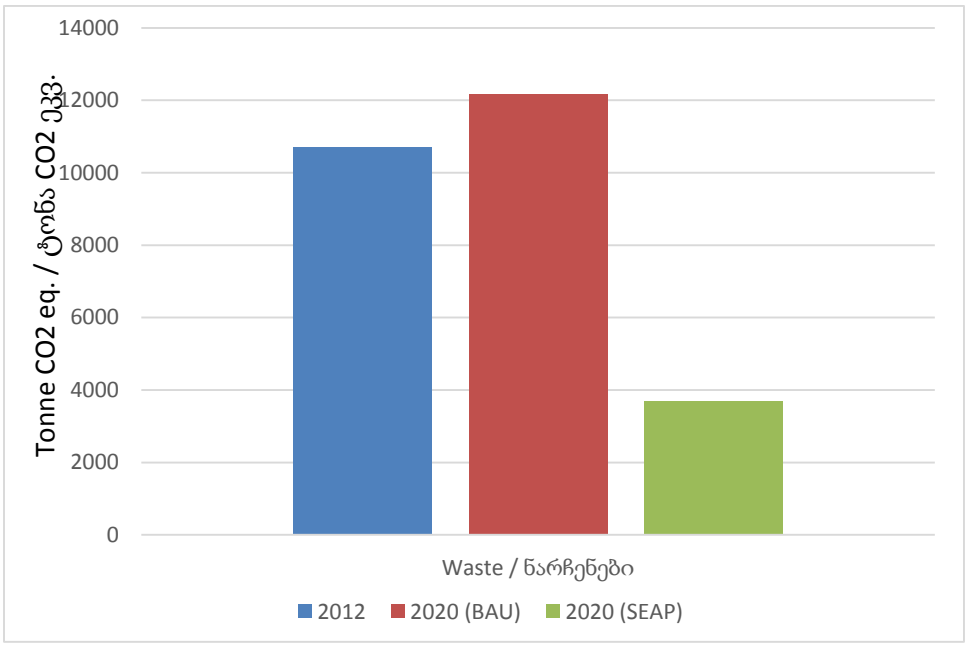


Figure 6. Growth of emissions according to BAU and SEAP scenarios in the waste sector

4. TRANSPORT

4.1. OVERVIEW OF THE SECTOR

The city of Gori is located at the confluence of rivers Mtkvari (Kura) and Didi Liakhvi, on 588 m a.s.l, at 76 Km distance from Tbilisi (by the railway). Gori is an important railway junction, connecting central railway with the city of Tskhinvali.

Earlier the traffic intensity in Gori was high due to the direct connection with Tbilisi. However, in recent years the new highway has significantly reduced the traffic in Gori. At one kilometer distance from Gori passes the international autobahn Tbilisi-Senaki-Leselidze as well as the interstate highway Kareli-Gori-Kaspi-Mtskheta- Tbilisi.

Major traffic flows gather at the central streets, most intensive traffic being at rush-hours.

At the territory of the city about 160 streets are accounted for, with total length of 82.3km, from which 73.2km are covered with asphalt and 9.1km – by gravel. The key artery is the David Agmashenebli Avenue, cutting city in two parts and representing central pass way. The streets of Gori are divided in parallel and perpendicular directions, simplifying the traffic and making it possible to unload the vehicle currents.

In the city in general the regulated traffic streets and roads are classified into three A, B and C categories, according to maximum intensity (unit/h) of traffic. Among them 15 streets belong to A category (1 000 – 3 000 unit/h), 11 – to B category (>500 unit/h) and others to C category (<500 unit/h).

The state of the streets is good. The exceptional rehabilitation of street started since 2004. The number of remained gravel-covered streets in the city is small. In 2015 the paving with asphalt of 4.5km long streets is planned costing about 2 150 000 GEL.

The automobile fleet mainly consists of outdated cars, 80% of which are aged more than 10-15 years, the majority of them being technically faulty. According to 2012 data 70% of vehicle fleet consists of cars aged more than 20 years and 10-15% of cars are aged 11-20 years. The majority of vehicle has no catalytic converters facilitating complete combustion of fuel in the engine and minimizing the noxious exhaust. It should be noted as well that in imported second hand cars, the number of which in recent years is rising rapidly, the catalytic converters have overpassed expiry periods or are out of order due to the use of low quality fuel. The state of permanently owned cars in Gori in 2012 according to types of fuel is demonstrated in Table 4.

Table 4. Permanently owned motor-cars in Gori as of 2012

Type of motor-vehicles number according to fuel type	Passenger cars (except taxi and municipal transport)	Municipal Transport	Motorbikes	Buses	Passenger mini-buses	Taxi	Light-duty vehicles	Heavy-duty trucks
Operating on gasoline	7 437	29	17	7	14	18	42	14
Operating on diesel	285	9	0	16	23	0	168	285
Operating on natural gas	1 294	8	0	22	58	180	858	48
Total	**9 016**	**46**	**17**	**45**	**95**	**198**	**1 068**	**347**

Source: Analytic Center of the Ministry of Internal Affairs, Transport Department of the Gori City Hall Economic Service, Private companies

At the territory of Gori Municipality 2 types of public transport are functioning:

- ✓ Mini-buses operated by 3 private companies. The vehicles are 12-place, mainly the "Ford Transit" mini-buses, comprising 58 units working on the city lines;
- ✓ Light-duty taxi parks. 7 private companies are transporting passengers with light-duty vehicles in the city. Besides there are passenger taxis which are not united in any enterprise. Part of them operates on gasoline, and the rest on natural gas.

Despite the presence in the city of mass transport (shuttle mini-buses), due to the small size of the city, the majority of population uses private taxis. The cost of trip by shuttle mini-bus is 0.40 GEL while the cost of taxi trip varies between 1 and 3 GEL. Hence, the taxis are more popular among the residents.

To calculate the consumption of fuel by buses and mini-buses registered in the city only those vehicles have been accounted which are running within the limits of the city. Other motor vehicles operate on outer lines or are obsolete and are out of use. The number of buses and mini-buses functioning in the city in 2012 is given in Table 5.

Table 5. Public transport operating in the city

Type of motor vehicles	Buses	Mini-buses
Operating on the natural gas	0	58

Source: Transport Department of the Gori City Hall Economic Development Service

The data on fuel consumption and covered distance (run) by different types of motor vehicles which were used to assess the fuel spending are presented in Table 6.

Table 6. Features of the transport in Gori

Types of motor vehicles	Passenger cars (except taxi and municipal transport)	Municipal Transport	Motorbikes	Buses	Passenger mini-buses	Taxi	Light-duty vehicles	Heavy-duty trucks
Annual run (km/vehicle)	3 840	4 560	1 680	840	11 260	14 400	7 200	8 560
Average fuel consumption per 1 vehicle Gasoline (l/100km)	8	8	2	30	12	8	14	32
Average fuel consumption per 1 vehicle Diesel (l/100km)	6	6	0	22	10	0	10	25
Average consumption of natural gas (m^3/100km)	8	8	0	16	10	8	10	18

Source: Expert judgment, questioning, private companies

4.2. METHODOLOGY

Same as for other sectors, the baseline year for the transportation sector was chosen to be 2012. GHG emissions are calculated using a formula adapted for the Intergovernmental Panel on Climate Change (IPCC) methodology Tier 1 sectoral approach for the local level, which is based on actual fuel consumption data:

Carbon Dioxide emissions$_j$ ($GgCO_2$) =
$\square\square_i$ {Actual fuel consumption ji (unit) x caloric value of fuel i(MWh13/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) =
$\square\square$i {Actual fuel consumption ji (unit)
x caloric value of fuel (MWh/per unit)

[13] 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

x Gas emissions factor ji(TGas/MWh)/1000].

The IPCC default 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.

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	1 000 liters	0.0095	0.247
Diesel	1 000 tons	0.0107	0.267
Liquid Gas	1 000 tons	0.0132	0.227
Natural Gas	1 million m^3	0.00935	0.202
Firewood	1 000 m^3	0.0021	--

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[14] 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 Gori 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[15] employing an emissions

[14]"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

[15] 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

database. The POLES (Prospective Outlook for the Long-term Energy Systems)[16] 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[17].

For the city of Gori the second approach has been applied, i.e. JRC ratios, according to which the 2012 emissions will grow by 49% to the year of 2020.

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", which has been used for the creation of Gori SEAP. Applying this program it is possible to produce the baseline scenario on the basis of JRC ratios as well as using any other national factors. Since at the time of Gori SEAP the BAU national scenario has not been generated yet, the JRC coefficients were applied.

4.3. 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 the Gori 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 above mentioned facilities is not within the city's territorial limits.

Energy consumption in Gori transport sector reached about 44 thousand MWh in 2012 (Table 11).

[16]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

[17]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

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

Subsector	Natural Gas	Diesel	Gasoline	Total
Municipal Vehicle Fleet	27	26	101	154
Public Transport	2 550	0	197	2 747
Private & Commercial Transport	10 185	8 541	22 478	41 204
Total	**12 762**	**8 568**	**22 775**	**44 105**

Emissions of GHGs from the transport sector reached about 10.6 thousand tons of CO_2 equivalent in 2012.

Table 12. GHG Emissions from Gori Transport Sector in CO2Equivalent - 2012

Subsector	Natural Gas	Diesel	Gasoline	Total
Municipal Vehicle Fleet	6	7	25	38
Public Transport	522	0	49	571
Private & Commercial Transport	2 086	2 263	5 600	9 950
Total	**2 614**	**2 270**	**5 674**	**10 559**

As it has been mentioned above, according to JRC factors, in comparison to 2012, GHG emissions to 2020 will increase by 49%. Correspondingly, according to the BAU scenario, to 2020 emissions of GHGs from the Transport Sector will amount to 15 737 tons in CO_2eq.

The rise of emissions from the Transportation sector is shown in Figure 7.

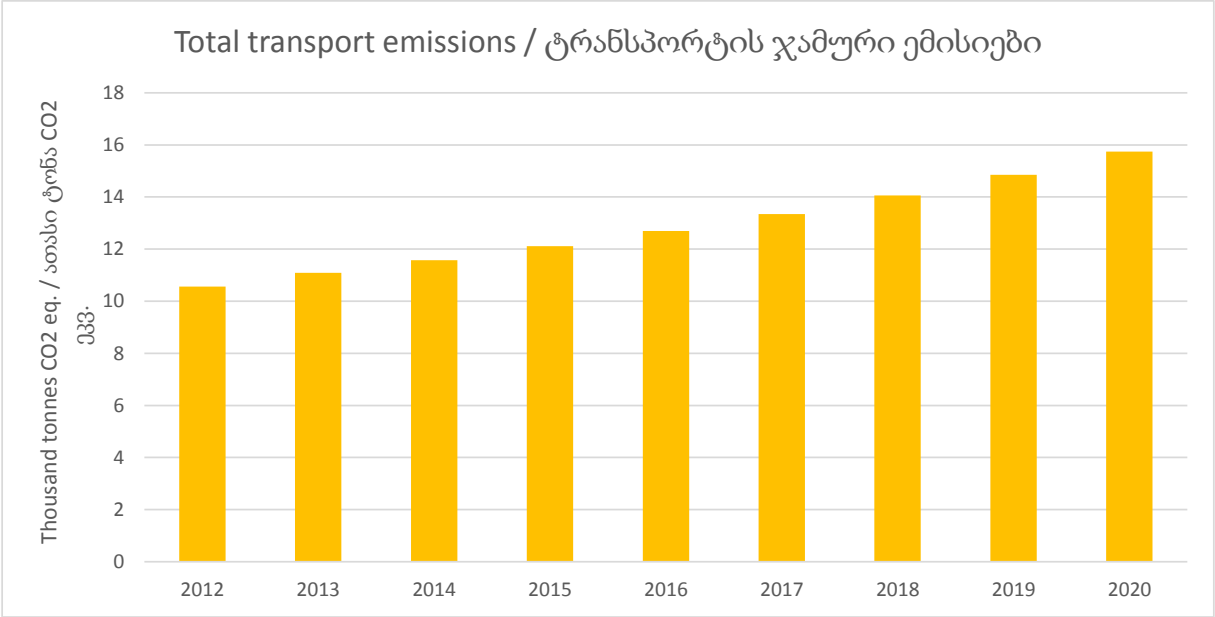


Figure 7. Trends of GHG emissions from Transportation sector according to BAU scenario

4.4. ACTION PLAN FOR THE REDUCTION OF EMISSIONS FROM THE GORI TRANSPORTATION SECTOR

Gori is a relatively small city with the total area of only 13km^2. Due to the consequently minor scale of traffic the public is mainly served by shuttle mini-buses and taxis, from which the latter is most popular after the private passenger cars. Hence, the strategic vision of Gori transportation sector development should be based upon facilitating the walking and cycling modes of travel, being the healthier alternative to the movement on short distances by taxi. At the same time the mass transit must be transformed into municipal ecologically clean public transport and perform efficient services at long distances.

As to the motor vehicles owned by the Gori City Hall, presently at the stage of dividing the municipalities their owners are being determined, some vehicles must be transferred to other entities (Gori Community Municipality, Ministry of Internal Affairs, etc.) and thus, until the final decision is made, a final measure could not be identified. However, in case of purchasing new vehicles their fuel consumption and emission features will be taken into consideration. Trucks serving municipal landfill are already transferred to the natural gas powering. As a result of implementing the measures envisaged by the Gori SEAP emissions of CO_2 from the transportation sector will be reduced by 1 106 tons in CO_2eq by 2020 compared to the baseline scenario (Table 13).

Table 13. Transportation Sector's 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 (in GEL)	Expected Energy Savings (MW/h) from an Activity	Expected CO2 Emission Reduction from an Activity (t)
Public Transport						
Activity PB1	**Public transport management**			85 000		500
PB1.1.	Correction of legislative basis of newly formed self-governing city of Gori transportation sector	Transport Department of Gori City Hall Economic Development Service	2015-2017			
PB 1.2.	Optimization defining and approving by City Hall the regular passenger routes within the climate of Gori City Hall	Transport Department of Gori City Hall Economic Development Service	2015			
PB 1.3	Monitoring of city regular passenger transportation	Transport Department of Gori City Hall Economic Development Service	2015-2020			
PB 1.4.	Improving Public Transport services (arranging displays at stations, setting out of stoppings, introducing integrated ticketing)	Transport Department of Gori City Hall Economic Development Service	2015-2017			
PB 2	**Setting up of municipal public transport**	Transport Department of Gori City Hall Economic Development Service	2017-2020	USD 2 500 000		50
Activity UP1	**Restoration and development of transport infrastructure**					157
UP 1.1	Describing road signs and adequate placing	Transport Department of Gori City Hall Economic Development Service	2015			

UP 1.2	Study of problematic streets in the city (usually jammed), identification of alternative routes, establishing new lines	Transport Department of Gori City Hall Economic Development Service	2015-2016	25 000		
UP 1.3	Construction of a new street at the left bank of R.Liakhvi to relieve the Tskhinvali Highway	Transport Department of Gori City Hall Economic Development Service	2015	3 500 000		
UP 1.4	Construction of a new street and bridge joining the Tskhinvali and Shindisi highways	Transport Department of Gori City Hall Economic Development Service		11 000 000		
UP 1.5	Construction of a new street and bridge joining the Guramishvili street and "Chala" settlement to unload the city center traffic	Transport Department of Gori City Hall Economic Development Service	2015-2017	900 000		
Activity UP2	**Supporting cycling and creation of walkable localities**					304
UP 2.1	Improving infrastructure of walkable localities	Transport Department of Gori City Hall Economic Development Service	2015-2016	1 000 000		
UP 2.2	Arranging cycling paths and popularization/promotion of cycling	Transport Department of Gori City Hall Economic Development Service	2016-2017	600 000		
UP 2.3	Closing of definite streets for private vehicles and transforming them into walking facilities	Transport Department of Gori City Hall Economic Development Service	2018-2020	5 700		
UP 2.4	Arranging bridges on the rivers for pedestrians and cyclists	Transport Department of Gori City Hall Economic Development Service		4 700 000		
Activity PRT 1	**Setting up of parking system**	Transport Department of Gori City Hall Economic Development Service		1 350 000		95
Total				**28 665 700**		**1 106**

4.4.1. Detailed description of measures

Measure PB1. Public transport management.

The management of public transport by the Gori Municipality was not conducted till 2015, since before 2014 Gori was not a self-governing city and hence this sector was not legally controlled. After 2014 as a result of obtaining the status of self-governing city, it became possible to partly regulate the public transportation, meaning first of all bringing into order the local jurisdiction by the Decrees of City Council and planning the transport routes to cover entire territory of the city. According to the strategic plan it is intended to set up the Gori Municipal Transportation Enterprise (Measure PB2). However, this action must be preceded by the announcement of tenders and selection of companies which serve the Gori population by mass transit. It is important as well to improve the public transportation service in the city. From the transportation infrastructure only stopping stations are arranged and even those are scanty. Information digital displays do not exist. Transportation fees are formed spontaneously. Thus, it is planned to carry out a number of measures to regulate the public transport and its management. These measures include:

1. Putting into order the local jurisdiction regulating public transportation of newly formed self-governing city of Gori through the Decrees of City Council (2015-2016);
2. Optimizing the regular passenger transportation routes within the Gori City Hall administrative borders, their definition and approval by the City Council (2015);
3. Working out of regulation for conducting contest to obtain the license on regular passenger transportation in the city and establishment of transport fees, organizing the contest and issuing the licenses (2015);
4. Conduction of monitoring on city regular passenger transportation (IV quarter of 2015);
5. Improvement of public transportation services (arranging information displays at stopping stations, establishing stations, adopting the integrated ticketing system (2015-2017).

The listed above measures should be implemented by the Transportation Department of the Gori City Hall Economic Development Service. All measures will be conducted using internal facilities and human resources of the City Hall. As to the fifth position, its fulfillment will require an additional investment of about 85 thousand GEL.

For the calculation of GHGs reduction it was assumed that as a result of listed above measures the traffic of private transport (including taxis) will be decreased by about 5% and that of public transport will grow by the same value bringing the cutback of emissions by nearly 500t CO_2eq/yr. to 2020 compared with the BAU scenario.

Measure PB2. Setting up of Municipal Public Transport

From 2017 the creation of Gori Municipal Transportation Enterprise is planned, which will substitute the shuttle mini-bus taxis operating on the contest basis. According to initial estimations about twenty 25-passenger buses will be needed, powered by natural gas. In case of getting adequate financing the Gori City Hall will try to import electric vehicle to operate on the central lines aiming the popularization of clean transport. In case of successful realization of this venture after 2020 their number in public transport fleet may increase even more.

These measures will be implemented by the Transportation Department of the Gori City Hall Economic Development Service. The approximate expenses on these measures will make about 2.5 million USD, from which nearly 1.5 million USD will be required for the purchase of buses and the remaining 1 million-for the creation of vehicle fleet services and other infrastructure elements. The land area for the enterprise will be allocated by the City Hall at its own territories.

For the assessment of emissions reduction it was assumed that shuttle mini-bus taxis operating nowadays in Gori will be replaced by natural gas powered buses, which will carry the same number of passengers on the same distance. As the bus passenger capacity overpasses about two times that of minibus, while the fuel consumption per 100 km exceeds it only by 60%, the saving of fuel makes about 40% equaling to 50 tons of CO_2eq annually.

Measure UP1. Restoration and development of transportation infrastructure

This measure includes the following activities:

1. Description of traffic signs and bringing to compliance (2015-2016);
2. Study of problematic streets (often creating traffic jams) and searching for alternative routes, setting up of new traffic lines (2015-2016);
3. Construction of a new street at the left bank of R. Liakhvi, aimed at the alleviation of traffic on the Tskhinvali Highway;
4. Construction of a new street and a bridge joining the Tskhinvali and Shindisi highways;
5. Construction of a street connecting the Guramishvili street and "Chala" settlement to relieve the traffic in the centre of the city.

To unload the city a number of measures is planned in 2015-12017, some of which will be started in the current year and the realization of others depends on the financing from the central budget, as their implementation with the Gori budget is unrealistic in view of large sum to be invested:

- The existing in the city traffic lines will be revised and altered in such a way to improve traffic in the city and reduce the jamming, e.g. some streets will become one-way drive. The measure will be implemented by the Transportation Department of the Gori City Hall Economic Development Service and its cost is about 25 000 GEL;
- Up to now the most loaded lane is the Tskhinvali Highway, which is city's central road in the northern direction. In 2015 the arrangement of a parallel street is planned extending the Nadiradze street along the Liakhvi River. This measure will enable to transform the Tskhinvali Highway into the one-way drive. Its enacting will be carried out by the Transportation Department of the Service costing about 3.5 million GEL.
- According to perspective Plan a bridge will be constructed on the R. Liakhvi connecting the Tskhinvali and Shindisi highways and providing the traffic alleviation in the central part of the city. Currently at the territory of the city only one bridge exists, causing traffic overloading on the Chavchavadze and Stalini streets. The initiative and design will be prepared by the Gori City Hall Economic Development Department and the financing will be provided by the central government. The approximate cost of the design is 11.0 million GEL, in view of which the problem of financing has not solved yet;
- In the plan for coming two years the connection of city eastern part with the "Chala" settlement by the Guramishvili street through the Barnovi street is foreseen. This measure will enable to unload the Chavchavadze and Stalini streets. The measures will be prepared and performed by the Gori City Hall Economic Development Service and financing will be

provided by the central government. The tentative cost of the measure is about 900 thousand GEL.

The implementation of possibilities to reduce the GHG emissions, related with traffic management (as well as with the improvement of traffic infrastructure) is a complicated and challenging process. The curtailing of traffic will result in lessening of GHG emissions from individual vehicles as they will be able to move more efficiently. However, this may not result in the reduction of overall emissions, because the downsizing of traffic makes the use of private cars more attractive that from its part again causes the rising of emissions. Thus, these measures and related with them reduction of emissions may be discussed in the context of wider transportation strategy coupled with other measures discussed in this document.

According to the performed assessments of emissions reduction, it was assumed that as a result of introduction of all listed above measures the distance covered annually by all types of motor-cars could be decreased to 2020 by 1% that will bring the cutback of emissions to 2020 by 157 tons in CO_2 equivalent.

Measure UP2. Supporting cycling and creation of walkable localities

Facilitation of cycling and walking is one of the most effective and, that is more important, healthiest ways of emissions reduction. Walking is sufficiently widespread ways of travel in Gori, the majority of pavements are comfortable and well organized, though in some places require improvement. One of the main obstacles for the pedestrians is the fact that central part of Gori is surrounded by three rivers and pedestrians have to cross them by bridges which often are overloaded by transport. Hence, to promote the travel by walking and cycling the implementation of following measures is planned:

1. Improving the infrastructure for pedestrians that include the restoration of damaged sidewalks, putting into order crossroads, and addition of ramps for disabled persons (2015-2016). The measure will be enacted by the Gori City Hall Economic Development Service. The rehabilitation of pavements (with total length of 7.5 km) will cost about 750 thousand GEL. The arrangement of ramps for disabled persons to slide up and down from the pavement (250 ramps in total) will cost 250 thousand GEL;
2. Arranging cycling pathways and facilitating/popularization of cycling (2016-2017). The measure will be undertaken by the Gori City Hall Economic Development Service. The estimated overall cost of the arrangement of cycling lanes on the streets of Mshvidoba, Shindisi, Stalini, Chavchavadze and Sukhishvili (total length – 15km) makes 600 thousand GEL;
3. Closing of certain streets for private cars and their transformation into walkable streets (2018-2020). This measure concerns mainly the historic centre of Gori, which includes the Gori Fortress and nearby ancient district, ethnographic and Stalin museums. The existence of such a territory will contribute not only to curtailing the emissions, but to promotion of tourism and economic development. The measure will be carried out by the Gori City Hall Economic Development Service and the approximate cost of compiling its technical and economic survey is 5.7 thousand GEL. This survey will further determine the overall cost of the measure;
4. Constructing the bridges for pedestrians and cyclists on the rivers. The measure will be conducted by the Gori City Hall Economic Development Service and its estimated cost is about 4.7 million GEL. For the successful implementation of these measures it would be necessary to perform programs on behavioral changes among the population that will explain the advantages of walking and cycling to the travel by motor-car.

For the assessment of emissions reduction, related with the introduction of walking and cycling pathways it was assumed that these measures will reduce the necessity of using private passenger transport and taxis by about 3%, being the equivalent of saving up to 304 tons of CO_2 annually.

Measure PRT1. Setting up of parking system

The parking policy in Gori may be aimed at the unloading of the city (especially its central districts) from motor vehicles. The parking system in Gori already exists, but it is to be revised along with parking places. The arrangement of separate parking for taxis and special vehicles is planned as well.

The assessment of parking policy effectiveness separately, without taking into account other measures is difficult. However, according to the Guidelines on Mitigation in Transport Sector, the increase in expenses on vehicle ownership by 10% brings the decrease in the number of owners by about 3%. Based on conservative assumption, that the parking policy will reduce the number of car owners by only 1%, the saving of CO_2 emissions will make about 95 tons of CO_2eq annually. The measure will be fulfilled by the Gori City Hall Economic Development Service at the cost of 1.35 million GEL.

Other measures

It is expected that the technical check-up in Georgia will become obligatory from 2015, although it is not fully determined what kind of control it will be. The Gori City Hall will cooperate with other Municipalities and national structures to work out standards for engines and fuels, conforming to European ones. As a result both fuel consumption and GHG emissions will be lowered as well as local pollutants will be discounted, facilitating the improvement living conditions and state of healthcare. Technical control will promote the better maintenance and adequate equipment of vehicles. According to the Guidelines on Mitigation in Transport Sector the fuel consumption by a well-maintained vehicle may be reduced by 3-7%, causing the relevant decline in emissions. As the majority of vehicles in Georgia are obsolete and inefficient, this measure could have a significant effect, though at this stage specific steps in this direction are not planned by the Gori City Hall.

5. BUILDINGS

5.1. OVERVIEW OF THE SECTOR

The most important part of the Gori SEAP is the sector of buildings which includes municipal and other commercial buildings (offices, shops, hotels, etc.). One of the important preconditions for the reduction of GHG emissions is the lowering of energy consumption in these buildings, hence special attention should be given to measures directed towards the planning of energy efficiency and renewable energy application measures.

5.2. TOTAL FUND OF RESIDENTIAL BUILDINGS IN GORI

According to the Gori City Hall information at present the number of dwelling houses in Gori is 11 814 with the total space area of 1 837 886 m^2 (Table 14).

Table 14. Aggregated data on the residential buildings in Gori

#	Quantity of stories	Number	Total area, m^2
1	1 and 2 - storey private	11 567	1 619 380
2	2-Storey	54	28 035
3	3- Storey	41	31 872
4	4- Storey	42	49 882
5	5 -Storey	98	102 777
6	9 -Storey	12	5 940
	Total	**11 814**	**1 837 886**

In 2014 under the USAID project EC-LEDS the survey of population was undertaken, according to which the average dwelling area in the house equals 81 m^2 while the non-dwelling area makes only 25 m^2. The majority of Gori residential houses are built in 1950-1980 and brick and stone are used predominantly for the construction. Tiling and tin-plate are commonly used for the roofing. Frames of windows are usually made of wood, though about a quarter of all households have installed plastic window-frames. Buildings belonging to the municipal property in Gori are listed in Table 15.

Table 15. List of buildings belonging to the municipal property in Gori

#	Name of realty	Number	Area, m^2
1	Administrative building of the City Hall	1	1 522
2	School of Arts	1	700
3	State Kindergartens	19	23 825

4	Student Tourism Center (Tontio)	1	2 400
5	Boxing school	1	1 450
6	Central sports school	1	8 000
7	Swimming pool	1	5 000
8	Wrestling sports school	1	2 000
9	Football school "Dila"	1	2 500
10	Public library	1	1 800
11	Music school	1	2 200
12	Ethnographical museum	1	4 300
13	Gori State Theatre	1	4 700

In addition to above listed buildings in Gori are functioning 11 public schools, St. George School-Lyceum and St. George Mtatsmindeli Gori School-Gymnasium (both occupying an area of 46 627 m^2), 8 hospitals and medical units (total area 11 810 m^2) and commercial institutions (total area 11, 500 m^3).

5.3. ENERGY CONSUMPTION IN GORI

According to the results of the survey carried out under the EC-LEDS program, the absolute majority of households living in Gori municipality state that they heat the house in the cold season of the year. Usually one or some rooms in the house are heated individually using different kinds of stoves, fire-places, electric heaters and other devices (97%). As a result only a quarter of living space is heated in Gori, while the majority of villages in the municipality are heated by firewood. It should be mentioned that firewood is being used for heating by a significant part of Gori households as well.

For the heating of water each tap in the house is connected individually to the heating source (69%). The majority of water heaters operate on natural gas (NG) and the remaining – on electric energy. For cooking gas stoves are used.

The majority of population owns TV sets and fridges, 41%-the washing machines. It is to be noted that air conditioners or coolers are not in use at all. For the lighting of space the majority of households use traditional incandescent bulbs, while only 6% of households changed habits in favor of using energy efficient bulbs. One-tenth of households are using simultaneously both traditional and energy efficient bulbs (8%).

In 2012 in residential, municipal, commercial and other buildings 34 857 301 KWh of electricity was consumed, among them:

- Residential buildings – 33 783 500 KWh;
- Municipal buildings – 759 686 KWh;
- Schools – 163 150 KWh;
- Medical institutions – 89 849 KWh;
- Hotels – 61 125 KWh.

In 2012 in residential, municipal, commercial and other buildings of Gori 15 999 465m^3 of natural gas has been consumed, among them:

- Residential buildings – 15 458 900m^3;
- Municipal buildings – 114 805 m^3;
- Schools – 257 340 m^3;
- Medical institutions – 132 680 m^3;
- Hotels – 35 740 m^3.

5.4. METHODOLOGY

The methodology for calculating CO_2 baseline (2012) emissions and future trends (up to 2020) for the Gori 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 are shown below (Table 16).

Table 16. Methane and Nitrous Oxide Emission Factors for Buildings (kg/Mwah)

#	GHG	Natural Gas	Oil Products	Firewood
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 for Gori 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/yr.) as the figure doesn't include size of the building. A clearer picture can be obtained by calculating the energy used per m^2 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, and 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 appliances, air conditioning and outdoor equipment.

Dividing the budget into eight sections makes it easier to analyze energy and power consumption modifications annually. Annual energy consumption (KWh/yr.) must be determined as well as specific annual energy consumption values (energy consumption for 1 m^2 space heating KWh/m^2yr). 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 Gori 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.

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", for getting the correct value of energy saving it is necessary to use calculated values of energy consumption as a "baseline", which describes the building's energy consumption in comfort/smart conditions.

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 annual energy consumption on the basis of annual statistical data of consumed natural gas, electricity and firewood (E1, KWh/yr.). 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, KWh/m^2yr) on heating, cooking and electricity use. An energy audit carried out with appropriate methods and the software format would allow to determine the actual potential of energy-savings, involves a situational analysis and other measures to reduce energy consumption and CO_2 emissions. Following this, specific energy consumption, the estimation of annually consumed energy on heating, hot water, cooking and electricity becomes possible (E2, KWh/yr.) 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/yr. per capita) allows calculating the approximate annual energy consumption of the entire population (E3, KWh/yr.) 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).

5.5. BASE YEAR INVENTORY & GHG EMISSIONS BASELINE SCENARIO (2013 – 2020)

The Buildings' Sector structure of Gori 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 by the buildings sector in 2012 is given below (Table 17).

Table 17. Final Energy Consumption in Gori Buildings Sector (MWh) - 2012

#	Subsector	Electricity	Natural Gas	Firewood	Total
1	**Municipal Buildings**	760	1 074	0	1 833
2	**Other (commercial) buildings**	314	3 981	0	4 295
3	**Residential buildings**	33 786	144 554	13 303	19 643
	Total	**34 860**	**149 608**	**13 303**	**197 771**

In 2012 GHG emission from the Buildings sector amounted to 35 241 tons in CO_2 eq (Table 18).

Table 18. GHG Emissions from Gori Buildings Sector (tons CO_2 –eq.) - 2012

#	Subsector	Electricity	Natural Gas	Firewood	Total
1	**Municipal Buildings**	103	216	0	**320**
2	**Other (Commercial buildings)**	43	802	0	**845**
3	**Residential buildings**	4 595	29 121	361	**34 077**
	Total	**4 741**	**30 139**	**361**	**35 241**

According to BAU scenario calculations using JRC factors, to 2020 GHG emissions will grow by 49% and correspondingly will reach 52.5 thousand tons in CO_2 eq.

5.6. GHG EMISSIONS REDUCTION ACTION PLAN FOR GORI BUILDINGS SECTOR

A short-term strategy of GHG emissions reduction from municipal and residential buildings in Gori implies the slow-down of energy resources consumption by such measures as thermal insulation of buildings and transition to the use of energy efficient bulbs, improving of thermal insulation of roofs, entrances and areas of common use, repairing of roofs and replacing of doors and windows. All these measures save considerable thermal energy and are relatively affordable, while transfer to

modern fluorescent lamps is energy efficient and long-lasting. At the same time appropriate training and public awareness raising campaigns should be carried out.

A promising way to reduce carbon dioxide emissions is the use of renewable energy sources. It's well known that most energy resources are used for heating and hot water supply. Therefore, the use of biomass and solar energy will significantly reduce the natural gas consumption and CO_2 emissions.

The City Hall of Gori plans to introduce measures of such kind first of all in buildings being in its ownership, as well as in residential buildings, which are more organized and are engaged in City Hall's co-financing programs. At the same time, to achieve the emissions reduction targets it is highly important to carry out the energy efficiency and renewable energy introduction measures in private houses as well. The City Hall will elaborate specific programs for this task and will collaborate with appropriate funds, private technological and banking organizations. The awareness raising planned activities are given in the Awareness Raising Section.

According to short and long-term SEAP strategy for the city of Gori the implementation of following measures could be carried out:

- In municipal buildings:

1. Thermal insulation of roofs in City Hall's administrative building and kindergartens;
2. Equipment of lighting systems with fluorescent lamps in kindergartens;
3. Application of solar collectors in kindergartens and day nurseries.

These measures are to be implemented in 2015-2020 in the administrative building and in as much as possible number of kindergartens. Besides the pilot project is planned – the rehabilitation of Anna Peradze School of Arts building which is to be transformed into "Green Building" possessing adequate voluntary certificate. This building will serve as an example to other types of buildings and in case of success will promote the dissemination of "Green Buildings" concept in Gori and Georgia in general.

- In the residential sector in a short-run perspective the City Hall will collaborate with cooperatives for the adoption of following measures:

1. Installation of fluorescent bulbs in flats;
2. Sensory lighting of entrances;
3. Thermal insulation of common spaces in residential buildings.

- In a long-term perspective the City Hall will work out programs and schemes to collaborate with private houses owners in introducing the following activities:

1. Thermal insulation of roofs in private houses;
2. Replacing of existing windows in private houses with plastic window-frames.

For the determination of emissions reduction potential according to formulated above strategy on 2 to 4 February 2015 the detailed energy audit was conducted in the Gori buildings sector. 11 constructions were selected differing by the type of their energy consumption.

Picture 9. #16 kindergarten of Gori (9 I. Abramishvili str.)

Picture 10. The Gori #3 Public School (26 D. Amilakhvari str.)

Picture 11. Private residential house (63 E. Ninoshvili str.)

Picture 12. Two-storey residential building (39 I. Chavchavadze str.)

Picture 13. Three-storey residential building (28 I. Chavchavadze str.)

Picture 14. Four-storey residential building (20 Stalin Ave.)

Picture 15. Five-storey residential building (7 Tsabadze str.)

Picture 16. Nine-storey residential building (49 Sh. Rustaveli str.)

Picture 17. Anna Peradze School of Arts (1 Parnavazi str.)

Table 19. Emissions Reduction Action Plan from Buildings in Gori

Sectors and Activities	Key Measures in Activities	Responsible Department, Person or Company (If a third party is involved)	Implementation Period (Start and End Dates)	Expected Energy Saving from each Measure (MWh/yr.)	Expected CO2 Reduction (T/yr.) from each measure	Cost of each Measure (GEL)
Municipal Buildings (MB)						
Activity MB1	Improve Thermal Insulation in Municipal Buildings					
MB 1.1	Thermal insulation of ceiling in the municipal buildings	Economic Policy Agency at the Gori City Hall	2015	136	18.5	37 500
Activity MB 2	Mounting of efficient lighting systems in municipal buildings					
MB 2.1	Lighting system with fluorescent bulbs in kindergarten	Economic Policy Agency at the Gori City Hall	2015	130.9	17.8	8 500
Activity MB 3	Municipal Buildings Renewal					
MB 3.1	Insulation of Building's roof in Kindergarten	Economic Policy Agency at the Gori City Hall	2015-2018	683	137.7	127 500
Activity MB 4	Application of renewable energy resources in hot water supply					
MB 4.1	Use solar collectors in kindergarten	Economic Policy Agency at the Gori City Hall	2015-2020	403	81.4	249 600
Residential buildings (RB)						
Activity RB 1	Install Efficient Lighting Systems					
RB 1.1	Install 1 energy efficient bulb in each flat of 7 residential buildings	Economic Policy Agency at the Gori City Hall	2015-2017	83	11.2	3 780
RB 1.2	Sensory lighting of entrances	Economic Policy Agency at the Gori City Hall	2015-2017	862	113	45 580
Activity RB 2	Residential Buildings Renewal					
RB 2.1	Add Thermal Insulation to Common Areas of Residential Buildings	Economic Policy Agency at the Gori City Hall	2015-2017	46.6	9.4	14 490
RB 2.2	Thermal Insulation of Roofs in Two-Storey Typical Private Houses	Investor and owner	2017-2020	51 285	10 359	8 644 125

RB 2.3	Replace Existing Windows in Two-Story Private Houses with double-glaze windows	Investor and owner	2017-2020	6 915	1 394	2 913 750
Activity RB 3	Popularization of "Green Building's" concept					
RB 3.1	Rehabilitation of Gori Anna Peradze School of Arts	Economic Policy Agency at the Gori City Hall	2015-2016	223.9	62.5	164 700
Total				60 771	12 204	12 209 525

Detailed description of Measures

Measure MB 1.1. Thermal insulation of roof in municipal building (16 Stalin Ave.).

Due to the limited amount of budget financing the described measure is planned to be implemented in one municipal building. In particular, the thermal insulation of the ceiling should be carried out in the City Hall building located at 16 Stalin Ave. As a result of this measure the anticipated annual saving of energy will be equal to 136 080 KWh with the corresponding reduction of CO_2 making 18.5 ton/yr. Taking into account the current price of electric energy (0.16 GEL/KWh) the annual saving will be equal to 136 080 x 0.16 = 21 772 GEL. The investment necessary for the accomplishment of ceiling thermal insulation makes 1 500 x 25 = 37 500 GEL. The parameters of Measure MB 1.1 profitability are given in Table 20.

Table 20. Profitability parameters of measure MB 1.1.

Measure	Investment Cost GEL	Payback PB	Internal Rate of Return IRR, %	Net Present Value Quatinent	CO2 reduction ton/yr.
Thermal insulation of ceiling	37 500	1.7	58.1	4.57	18.5

Hence, accounting only for construction investments, their cost may be covered in less than 2 years, without considering the environmental benefit due to the reduction of CO_2 emissions.

Measure MB 2.1. Energy-efficient Lighting Systems in Kindergarten

The energy saving potential was determined by comparing the incandescent bulb lighting system to the fluorescent lighting system. The mean annual energy saving in kindergartens as a result of introducing this measure will be equal to 7 700 KWh/yr., giving in monetary units 7 700 x 0.16 = 1 232 GEL.

The amount of investment necessary for the transfer to energy-efficient bulbs will be 50x10=500 GEL (1 bulb – 10 GEL). The CO_2 emission reduction makes 7 700 x 0.136 = 1.05 ton/yr. profitability parameters of the measure MB 2.1 are presented in Table 21.

Table 21. Profitability parameters of measure MB 2.1.

Measure	Investment Cost GEL	Payback PB	Internal Rate of Return IRR, %	Net Present Value Quotient	CO2 reduction ton/yr.
Energy efficient lighting system in one kindergarten	500	0.4	245.5	8.74	1.05
Energy-efficient lighting system in 17 kindergartens	8 500	0.4	245.5	8.74	17.8

Measure MB 3.1. Thermal Insulation of Roofs in Kindergartens

The energy saving got as a result of this measure was calculated using the ENSI Software. For the kindergarten disposed at #9 I. Abramishvili str. It makes annually 40 234 KWh and the corresponding saving of CO_2 emissions is 40 234 x 0,202 = 8.1 ton/yr. In case of using natural gas as an energy source its annual expenditure will amount to 40 234/(8x0.9) = 5 588 m^3/yr. and considering the costs of NG the relevant expenses will make 4 191 GEL. The required investment for thermal insulation of roof is equal to 500 x 15 = 7 500 GEL. Profitability parameters of the MB 3.1. measure is given in Table 22.

Table 22. Profitability Parameters of MB 3.1. measure

Measure	Investment Cost GEL	Payback PB	Internal Rate of Return IRR, %	Net Present Value Quotient	CO2 reduction ton/yr.
Thermal Insulation of roof for one kindergarten	7 500	1.8	56	4.35	8.1
The same measure for 17 Kindergartens	127 500	1.8	56	4.35	137.7

Measure MB 4.1. Solar Collectors for Kindergartens

Solar collectors convert solar radiation for space heating and getting hot water. This measure aims to install solar collectors for hot water supply to such municipal building as kindergartens. About 4 000 liters of hot water is consumed daily by kindergartens in Gori, requiring annually 24 907 KWh of energy.

It is known that solar energy received on the 1m^2 horizontal surface can be oriented at 90-degree angle, leading to 25% increase of solar radiation thus amounting to 1 500 KWh/m^2/yr. Taking into

account that solar energy collector efficiency is 70%, it would be available to get 1 050 KWh/m^2 of energy annually.

In case of using solar energy vacuum collectors mounted at the 24 m^2 roof of kindergarten building, it would be possible to obtain 25 200 KWh of energy annually per one building. The surface area of standard solar energy collector is 2 m^2 costing 1 300 GEL. Thus, in our case per one kindergarten 12 such collectors are needed with the corresponding investment of 15 600 GEL. To obtain the same amount of energy (25 200 KWh/yr.) by burning the natural gas, its volume will amount to 25 200/8.00 = 3 150m^3 co 3 150 x 0.75=2 362 GEL reduction of CO_2 emissions resulting from the transfer from natural gas to solar energy will make 5.09 tons annually. The profitability parameters of this measure, rated at 16 kindergartens, are presented in Table 23.

Table 23. Profitability Parameters of MB 4.1. Measure

Measure	Investment Cost GEL	Payback PB	Internal Rate of Return IRR, %	Net Present Value Quotient	CO2 reduction ton/yr.
Hot water supply through solar energy	15 600	6.60	14.00	0.45	5.09
16 Kindergartens	249 600	6.60	14.00	0.45	81.4

Measure RB 1.1. – Installing one energy-efficient bulb in flats of 7 residential buildings

This measure is aimed at the distribution of one energy efficient bulb in each family living in pilot multi-apartment buildings (seven 9-story buildings) expected to be installed in a most frequently illuminated room where family members gather in the evening and spend most of time.

The Planned measure must be accompanied by the awareness raising activities among residents of pilot buildings about the features, as well as economic and ecological usefulness of energy-efficient bulbs. It has to be noted that this measure will be implemented in the same residential buildings, in which the thermal insulation of entrances is planned.

The number of flats in the residential building was calculated on the example of 9-storey standard two-entrance building containing 9 x 3 x 2 = 54 flats/apartment. Consequently, in each building 54 energy-efficient bulbs will be distributed. In case of incandescent bulbs, if it supposed that the annual consumption of each bulb is 365x10x0.1=265 KWh, its substitution by florescent lamp will reduce the consumption down to 146 KWh, saving 365-146=219 KWh of energy and correspondingly 219x0.16=35 GEL.

The total number of replaced bulbs is one building is 54, giving a saving of 54x219=11 826 KWh per year, and a saving in expenses of 11 826 x 0.16x7=13 245 GEL for all 7 buildings. The relevant energy saving for these 7 buildings will make 11 826 x 7=82 782 KWh annually, requiring an investment of 540 x 7=3 780 GEL. The CO_2 emissions reduction for all 7 buildings will be equal to 11.2 tons/yr. Profitability data are given in Table 24.

Table 24. Profitability Parameters of RB 1.1. Measure

Measure	Investment Cost GEL	Payback PB	Internal Rate of Return IRR, %	Net Present Value Quotient	CO2 reduction ton/yr.
Lighting with energy-efficient bulbs in 7 buildings	3 780	0.3	350	12.88	11.2

Measure RB 1.2 – Sensory lighting in residential building entrances/halls

The Gori public residential sector is represented by 54 two-storey, 41 three-storey, 42 four-storey, 98 five – storey and 12 nine-storey buildings. Total number of entrances makes 725 and of lighting bulbs – 2 972. As a result of conducted monitoring it has been established that the saving of electric energy on each sensory lamp on the average equals to 290 KWh/yr. and the saving of CO_2 emission – 38 Kg/yr.

Thus, the total energy saving in the city of Gori will amount to 290 x 2 972 = 861 888 KWh/yr. that is equivalent to 861 888 x 0.16 = 137 900 GEL in monetary calculation. The CO_2 emissions will be reduced by 38 x 2 972 = 113 ton/yr. The price of a sensory device is 15 GEL and the cost of total investment will make 15 x 2 972 = 45 580 GEL. The profitability parameters of RB 1.2 measure are given in Table 25.

Table 25. Profitability Parameters of RB 1.2. Measure

Measure	Investment Cost GEL	Payback PB	Internal Rate of Return IRR, %	Net Present Value Quotient	CO2 reduction ton/yr.
Sensory lighting in 725 entrances	45 580	0.3	302.6	19.0	113

Measure RB 2.1. Heat conservation of common spaces in seven 9-storey residential buildings

The heat conservation measure incorporates the insertion of metal-plastic windows into the entrances of 9 – storey buildings, arranging one window on each floor. The annual saving of energy by this heat conservation measure minimizing heat losses will amount to 1 260 x 37 = 46.6 MWh. The corresponding economy of natural gas equals to about 46 600/ (8.00 x 0.9) = 6 472 m^3 and the equivalent emissions reduction- 9.4 ton/yr. In monetary expression this cut will total 6 472 x 0.45 = 2 912 GEL annually.

For this measure the metal-plastic window having dimensions of 9 x 2 x 7 x 1= 126 m^2 will be applied. The investment to purchase the windows will come to 115 GEL/m^2 x 126 m^2 = 14 490GEL. Profitability parameters are given in Table 26.

Table 26. Profitability Parameters of RB 2.1. Measure

Measure	Investment Cost GEL	Payback PB	Internal Rate of Return IRR, %	Net Present Value Quotient	CO2 reduction ton/yr.
Heat conservation of common spaces in residential buildings	14 490	5	20	1.07	9.4

Measure RB 2.2. Thermal insulation of roofs in 2-storey private houses

The additional thermal insulation of 2-storey private residential house or the increase of roof's thermal resistance from R=0.55 m^2 deg/W up to R=2.0 m^2 deg/W, will save in such typical house 13 200 KWh of energy annually, giving CO_2 emissions reduction by 2.7 t/yr. and saving in monetary expression equals to 13 200 x 0.062 = 818 GEL annually. The expenses on investment per one house is equivalent to 150 m^2 x 15 GEL/ m^2 = 2 225 GEL. The total energy saving from the thermal insulation of roofs in the Gori private houses (numbering in total 3 885) will amount to 51 285 MWh and the corresponding emissions reduction 10 359 tons of CO_2 annually. Profitability features of the offered measure RB 2.2 are presented in Table 27.

Table 27. Profitability Parameters of RB 2.2. Measure

Measure	Investment Cost GEL	Payback PB	Internal Rate of Return IRR, %	Net Present Value Quotient	CO2 reduction ton/yr.
Thermal insulation of roof in the typical private house with the ceiling area of 150 m^2	2 225	2.7	37	2.53	2.7
3 885 private houses	8 644 125	2.7	37	2.53	10 359

Measure RB 2.3. Replacement of existing windows by plastic window frames in private houses

The substitution in 2-storey private houses of existing windows by metal-plastic ones aiming the increase of thermal resistance coefficient from R=0.17 m^2 deg/W up to R=0.30 m^2 deg/W will save in the typical house on the average 1 780 KWh of energy annually, resulting in CO_2 emissions reduction by 0.4 ton/yr. and economy in monetary expenses totaling 1 780 x 0. 062 = 110 GEL annually. According to this measure in each house the total area of new metal-plastic windows will be about 30 m^2, requiring the investment of 75 GEL/m^2 x 10 m^2=750 GEL. The profitability parameters of the measure are given in Table 28. The overall energy saving resulting from the substitution of wooden windows in the Gori private houses (3 885 units) by the plastic windows amounts to 6 915 MWh, while CO_2 emissions will be decreased by 1 394 tons annually.

Table 28. Profitability Parameters of RB 2.2. Measure

Measure	Investment Cost GEL	Payback PB	Internal Rate of Return IRR, %	Net Present Value Quotient	CO2 reduction ton/yr.
Thermal insulation of roof in the typical private house with the ceiling area of 150 m^2	2 225	2.7	37	2.53	2.7
3 885 private houses	8 644 125	2.7	37	2.53	10 359

Measure RB 3.1. The Gori "Green Building" – Rehabilitation of Gori Anna Peradze School of Arts

The objective of the project is the implementation of heat supply pilot demonstrative project using modern pyrolytic boiler operating on biomass in the Gori Anna Peradze School of Art's building. At the same time, aimed at the reduction of heat losses the pilot project provides the thermal insulation of building's roof and walls, replacement of windows and creation of vegetation cover at the roof of the building. After the execution of planned measures the mentioned above building would be transformed into "Green Building" and should be given relevant certificate. Each of the listed over measures is described below.

1. Roof thermal insulation in the building of Arts School

The thermal insulation of the roof in the building of School of Arts foresees the reduction of roof thermal transfer coefficient from 1.8 W/m^2K down to 0.3 W/m^2K. In this case the annual saving of energy, calculated with the ENSI key numbers software will be equal to 80 227 KWh.

If the natural gas is used for heating the building this saving of energy is equivalent to the economy of natural gas equal to 80 227/(8x0.9)=11 143m^3 (here 8 KWh/m^3 stands for the 1m^3 natural gas energy capacity and 0.9 – the efficiency of heating device). Accounting for the natural gas tariff (0.75 GEL/m^3), the annual cost of saved gas makes 11 143x0.75=8 357 GEL, while the CO_2 emissions annual reduction in this case will come to 80 227x0.202/1 000 = 16.2 ton/yr. Hence, by the way of thermal insulation of roofing in the building of Gori School of Arts 80 227 KWh of energy may be saved annually that is equivalent to the decrease of NG consumption by 11 143m^3 costing 8 357 GEL and reduction of CO_2 emissions by 16.2 t per annum.

2. Thermal insulation of walls In the School of Arts building

Thermal insulation of walls in the building of School of Arts intends the lowering of walls' thermal transfer coefficient from 2.13 W/m^2K down to 0.34 W/m^2K. In this case the annual saving of energy, calculated using the ENSI Key number computer program will make 80 493 KWh/yr., corresponding to the economy in consumption of 80 493/(8x0.9) = 11 780m^3 of natural gas. Considering the NG tariff this amount of natural gas costs 11 780 x 0.75=8 835 GEL and the reduction of CO_2 emissions will be equal to 80 493 x 0.202/1 000 = 16.3t/yr. Consequently, through the thermal insulation of walls in the building of Gori School of Arts 80 493 KWh of energy could be saved annually, being an equivalent of cutting 11 780 m^3 of natural gas, economy of 8 835 GEL and reducing of 16.3t of CO_2 emissions annually.

3. Replacing windows in the School of Arts building

The energy saving measures, among others, aim to replace the existing in the School of Arts building windows by new plastic ones. In this case the thermal transfer coefficient of windows will be decreased from 5.8W/m^2K to 2.0 W/m^2K. In this case the annual saving of energy, calculated by the ENSI Key numbers software will make 63 178/ (8x0.9) = 8 775m^3 of natural gas. Considering the NG tariff this amount of natural gas costs 8 775x0.75=6 581 GEL and the reduction of CO_2 emissions will make 63 178 x 0.202/1 000 = 12.8 t/yr. Therefore by replacing windows in the building of Gori School of Arts 63 178 KWh of energy will be saved annually, that is equivalent to the decrease of NG consumption by 8 775 m^3 costing 6 581 GEL and the reduction of CO_2 emissions by 12.8 t annually.

Finally, by the thermal insulation of roofing and walls, as well as the replacement of windows in the Gori Anna Peradze School of Arts 80 227+80 493+63 178 = 223 898 KWh of energy will be saved, bringing the economy in natural gas consumption up to 11 143 + 11 780 + 8 775= 31 698

m^3 costing 8 357 + 8 835 + 6 581 = 23 773 GEL and resulting in the reduction of CO_2 emissions by 16.2+16.3+12.8=45.3 tons annually.

4. Substitution of natural gas with biomass in the heating system of School of Arts

Till the introduction of energy saving measures the heating of Gori Anna Peradze School of Arts building demands 309 199 KWh of energy annually. As it comes from the Table 29, after the thermal insulation of roofing and walls of the School and substitution of windows, the new heating system considering the saved energy resources, will require annually 85 301 KWh of energy, being an equivalent of 11 246 m^3 of natural gas costing 8 435 GEL, while the CO_2 emissions will be reduced down to 17.2 tons annually.

According to project proposal, the natural gas required for heating the school building should be substituted by the biofuel, the annual consumption of which in this case will be 85 301/(4.7x0.9)=20 165 kg/yr., where 4.7 KWh/kg is energy capacity/potential of kg of biomass, and 0.9 – the efficiency of heat generator (pyrolytic boiler).

Table 29. Combined parameters of energy saving measures' profitability

Measure	Investment Cost GEL	Payback PB	Internal Rate of Return IRR, %	Net Present Value Quotient	CO2 reduction ton/yr.
Thermal insulation of roofing and creation of green cover	86 700	10.4	8.9	0.05	16.2
Thermal insulation of walls	26 400	3.2	32.0	2.47	16.3
Replacement of windows	36 600	5.6	17.0	0.72	12.8
Heating system	15 000	3.5	28.0	0.39	17.2
Total	164 700	6.0	-	-	62.5

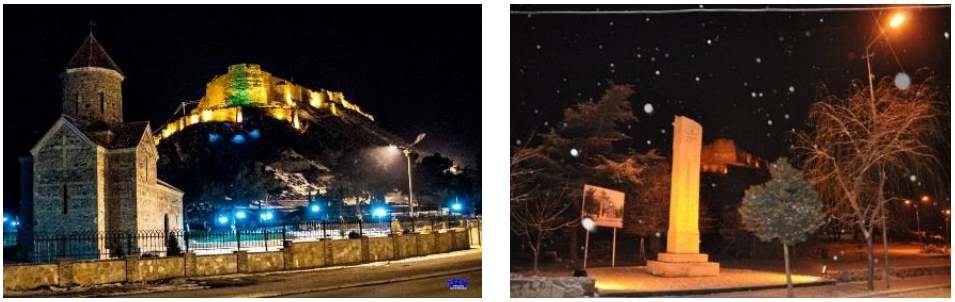
Accounting for the price of biofuel (0.20 GEL/Kg) its annual cost makes 20 165 x 0.20=4 033GEL, while the CO_2 emission, in this case, will be zero.

Consequently, in case of natural gas substitution by the biofuel in Gori School of Arts will be saved 11 246 m^3 of natural gas, the price of fuel will be reduced by 8 435-4 033=4 402 GEL and the CO_2 emissions will be cut by 17.2 tons annually.

6. STREET LIGHTING

6.1. SECTOR OVERVIEW

In Gori there are about 160 streets which require lighting. Besides there are 23 squares and the Central Park "Akhalbagi". Gori is rich in remarkable sites (the Gori Fortress, Gori Cathedral, Gori Theatre, etc.) which are illuminated from outside. As for 2014 96% of Gori streets are being lighted.



Picture 18. Illuminated remarkable sites of Gori

The energy consumption and expenses on street lighting in Gori in 2012 are given in Table 30.

Table 30. Energy consumption and expenses of the Gori street lighting sector in 2012.

Infrastructure Units	Electric energy consumption (KWh)	Expenses
Gori street lighting*	2 965 461	474 473.76
Total	**2 965 461**	**474 473.76**

** The expenses on the lighting of buildings, cultural monuments and other units of the same category are included in spreading lighting*

As it comes from this Table, in 2012 the consumption of electric energy by the Gori street lighting system amounted to about 3 million KWh, costing nearly 475 thousand GEL. All in all 3 871 lanterns are installed in the streets of Gori, the types and energy consumption of which are given in Table 31.

Table 31. Types, features and number of illuminators applied in the Gori street lighting system in 2012.

#	Existing lantern	Features		Number
		Power, w	Flux of light, Lm	
Street lighting				

1	Eiko (CFL) 65-75	65	5 550	1 582
2	HPSL-70	84	6 000	44
3	HPSL-150	140	6 250	10
4	HPSL-250	170	14 000	269
5	CFL-125	290	24 000	1 234
Total street lighting				**3 139**
Decorative illumination of buildings and constructions				
1	Eiko (CFL) -11	11	2 200	20
2	Eiko (CFL) -36	36	2 900	32
3	HPSL-70	84	6 000	92
4	HPSL-150	170	14 000	485
5	CFL -400	450	20 000	103
Total decorative illumination				**732**
Grand total				**3 871**

6.2. METHODOLOGY

In 2013-2014 the Gori street lighting system has been widened and the number of lanterns grew up to 4 800. The baseline scenario reflects actual data on the number of lighting fixtures in 2012-2014, while till 2020 foresees the lighting of remaining streets which up to now make only 4% of the total number of streets.

6.3. BASE YEAR INVENTORY & GHG EMISSIONS BASELINE SCENARIO (2012-2020)

Total energy consumption by the Gori street lighting sector in 2012 amounted to 2 965 KWh. The corresponding emissions from lighting made 403.3 tons in CO_2eq. The electrical grid average emissions factor – 0.136t CO_2eq/MWh is considered as the emission factor in 2012. According to the baseline scenario, street lighting energy consumption will increase up to 3.82 thousand MWh by 2020 equaling to 520 tons of CO_2 emissions in 2020.

6.4. EMISSIONS REDUCTION ACTION PLAN FOR THE GORI STREET LIGHTING SECTOR

Main objective of the Action Plan consists of total substitution of existing inefficient lanterns with the efficient bulbs based upon Light Emitting Diode (LED).

There are a plenty of LED producers in the USA, Germany, Japan, South Korea and China. Their produce could not be simply compared by such parameters as USD/Lumen and Lumen/W. The additional parameters are required, e.g. operational regime of LED, duration of work, degradation features (gradual decline of flux of light) and producer company's name. Table 31 contains

information about type, number, cost and power/wattage of existing energy efficient bulbs, applied for street lighting.

Table 32. Features of energy efficient bulbs used in street lighting, their number required for illuminating the Gori streets and expenses for installation

#	Activity and name of device	Unit	Number	Cost of material or device		Salary		Total price, GEL
				Unit price, GEL	Total	Unit price, GEL	Total	
1	LED bulbs, SNS SLD-006A 6 W	piece	20	220.0	4 400.0	8	160	4 560.0
2	LED bulbs, SNS SLD-006A 16 W	piece	32	230.0	7 360.0	8	256	7 616.0
3	LED bulbs, SNS SLD-006A 30 W	piece	2075	273.0	566 475.0	8	16 600	583 075.0
4	LED bulbs, SNS SLD-006A 36 W	piece	92	273.0	25 116.0	8	736	25 852.0
5	LED bulbs, SNS SLD-006A 50 W	piece	44	285.0	12 540.0	8	352	12 892.0
6	LED bulbs, SNS SLD-006A 60 W	piece	279	304.0	84 816.0	8	2 232	87 048.0
7	LED bulbs, SNS SLD-006A 80 W	piece	485	313.4	151 999.0	8	3 880	155 879.0
8	LED bulbs, SNS SLD-00A 90 W	piece	1299	328.1	426 201.9	8	10 392	436 593.9
9	LED bulbs, SNS SLD-004A 250 W	piece	103	415.3	42 775.9	8	824	43 599.9
10	LED bulbs, SNS SLD-004A 150 W	piece	371	426.6	158 268.6	8	2 968	161 236.6
11	Control cupboard with controller, GSM modem and electric energy meter	Compl.	38	5 020	190 760.0	80	3 040	193 800.0
12	Automated working place with PC equipped by operational licensed system	Compl.	1	3 000.0	3 000.0	0	0	3 000.0
13	Special software for monitoring and control	package	1	0.0	0.0	2 350	2 350	2 350.0
14	Programming and adjusting of controllers	Compl.	38	0.0	0.0	518	19 699	19 699.2
	Total				**1 661 952.0**		**63 073**	**172 5026.0**
	Transportation and mechanisms from materials and devices	%	5		83 098.0			83 098.0
	Total							1 808 123.0
	Overheads	%	8					144 650.0
	Total							1 952 773.0
	Planned accumulation	%	6					117 166.0
	Total							2 069 939.0
	Surcharge Tax	%	18					372 589.0
	Total							**2 442 529.0**
	Exploitation expenses for 2 years							0.0
	Grand Total							**2 442 529.0**

It is planned to replace existing 4 800 lanterns by LED bulbs in 2016. As it is seen from the Table, the overall cost of the measure is about 2.5 million GEL. The application of LED bulbs along with the reduction of required active power brings the decrease loading losses on transformers and transmission lines.

Selected of LED bulbs main parameters and features are given below:

1. Voltage of feeding source: 160 – 260 V;
2. Frequency of feeding source: 50 Hz;
3. Light distribution class according to ГОСТ 17 677-82: II type;
4. Light power curve type according to ГОСТ 17 677-82: III type;
5. Quality of bulb protection: I 65 (dampness protection);
6. Color temperature: 4 900-5 100;
7. Color transfer index: 75;
8. Duration of bulb operational period: no less than 15 years;
9. LED resource: no than 80 000 h;
10. Class of protection from electric current damage: I.

The graph below demonstrates the difference between the BAU emissions and CO_2 emissions in case of applying energy efficient bulbs (2015-2016), that is the most priority measure of SEAP in this concrete sector (Figure 8).

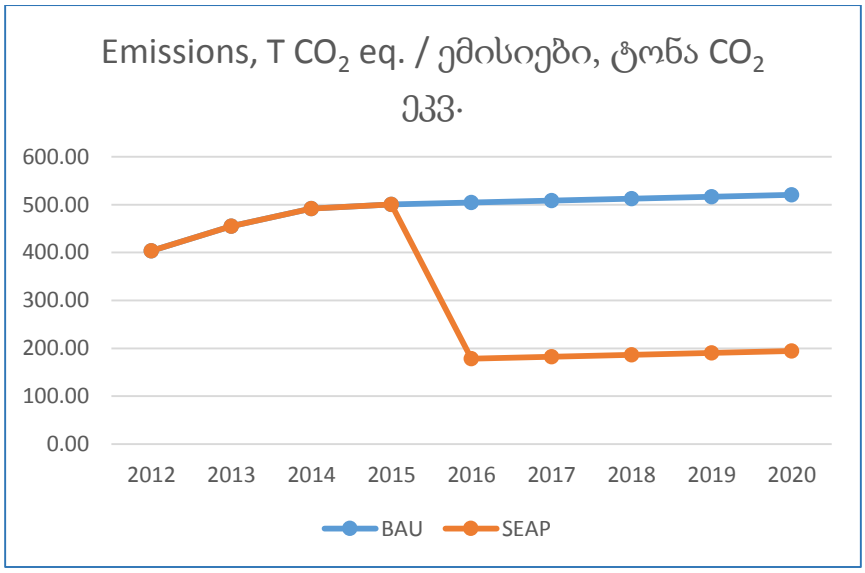


Figure 8. Emissions from the street lighting sector according to BAU scenario and in case of implementing measures envisaged by the SEAP in Gori

Correspondingly, Figure 9. shows the anticipated benefit which would be obtained by the Gori Municipality as a result of downsizing of energy consumption by applying the LED bulbs.

Besides the replacement of lanterns with energy efficient bulbs it may be possible to substitute the existing source of energy by solar energy. In this case the emissions from the sector would become zero, however the measure will cost about 180 thousand GEL more.

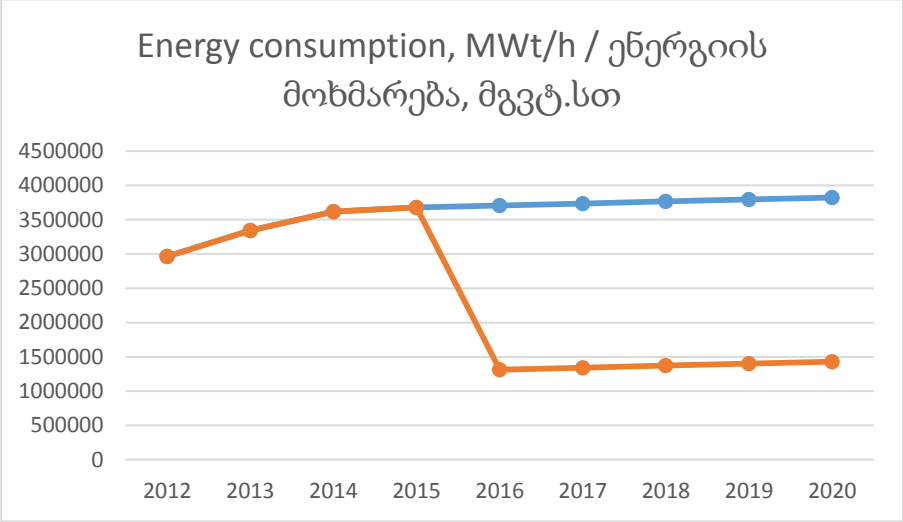


Figure 9. Energy consumption from the street lighting sector according to BAU scenario and in case of implementing measures envisaged by the SEAP in Gori

7. WASTE

7.1. SECTOR OVERVIEW

In recent years in the Shida Kartli Region activities in the field of putting into order road infrastructure and irrigation systems, development of tourism are going on. For today the priorities of Gori socio-economic development are local roads, water supply, non-permanent social assistance and municipal waste management.

In 2009 the sewerage system has been arranged in the Gori main part with the exception of so called "Railway Settlement" at the right bank of R. Mtkvari, in 2013 the rehabilitation of old landfill was completed and in October 2015 setting up of wastewater handling facility is to be finished. These activities represent major steps in the process of country's sustainable development.

To calculate GHG emissions from the Gori waste sector the methodology and handbook developed by the UNFCCC and IPCC has been used, based on the following source-categories:

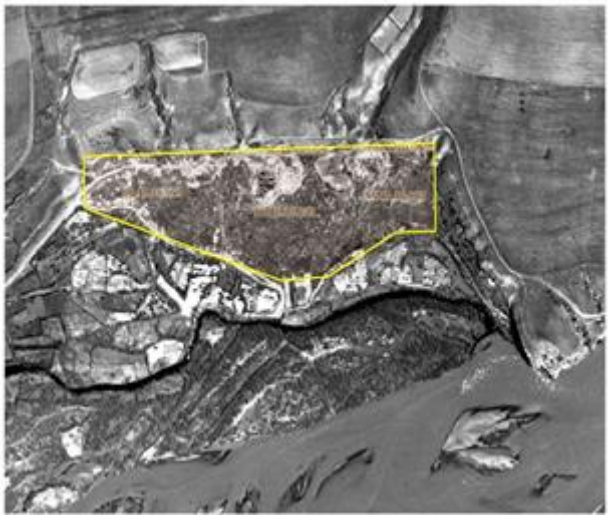
- Solid waste disposal (6A);
- Wastewater Treatment (6B1, 6B2);
- Waste Incineration (6C);
- Other Waste (industrial, medical and hazardous) (6D).

For the city of Gori the inventory in the Waste sector has been conducted for 2 sub-categories: "Solid Waste Disposal" (6A) and "Domestic and Commercial Wastewater Treatment" (6B1). The subcategory "Industrial Wastewater" (6B2) is not discussed in view of the fact, that industrial wastewater generated in Gori, as well as major part of city domestic and commercial wastewater is poured into the R. Mtkvari without handling. IPCC source categories "Waste Incineration" and "Other Waste" are not examined, as the incineration of waste does not take place in Gori and other categories of waste (industrial, medical and hazardous) are not being accounted for and disposed. At the same time it should be noted that at the Gori Landfill along with residential waste the construction waste is being disposed as well, that is not taken into account in the process of total emissions calculation from the landfill because construction waste virtually does not contain organic carbon and consequently does not generate methane.

Solid Waste Disposal

In the Gori Municipality there is one Solid Waste Disposal Site (SWDS), located in 700 m to the south-east from the "Kvernaki" settlement and occupying an area of 6 ha (Picture 19). Since the opening of the site in 1980-ies the waste on the landfill territory was dumped chaotically and at present its depth reaches 5-7 meters. Till 2013 the waste management in the Gori Municipality was performed by the "Gori Amenities Service" Ltd which was obliged to collect, register the

volume, dispose at the site and cares the waste[18]. In May 2013 the Gori Municipal Landfill was transferred into the ownership of "Georgian Solid Waste Management Company". The SWDS has been rehabilitated and up to now the following activates are under way at the landfill[19]: the waste is piled in consecutive order – one meter thick layer is pressed by bulldozer and covered by 0.5m thick stratum of the soil, after which it is pressed once again. The polygon is divided into sections and trash is dumped turn by turn. The landfill is equipped with the truck weighing-machine and each truck is weighed and registered in a special journal. The waste is not sorted and hence its composition could not be defined at this stage. The site is fenced by the wire netting and illuminated, there are watch-box and registration building at the territory. The City Hall has no data on the increase in the amount of waste[20]. It should be mentioned as well that there is a number of scrap collecting centers and some illegal landfills at the territory of Municipality[21].



Picture 19. The Gori Landfill

At the city territory of Gori Municipality 183 streets are registered, from which, according to the City Hall information, residential waste is collected with 100% coverage[22]. However, the cleaning service is performed at only 26 streets and hence, the tiding up index is only 12.2%. At the same time, apart from gathered in the city residential trash, till 2013 the industrial and other types of waste were dumped at the landfill[23]. It should be mentioned too that since 2013 the SWDS is serving the population of 14 villages surrounding the city as well.

[18] http://nala.ge/uploads/gori.pdf
[19] https://www.facebook.com/SWMCGEORGIA/photos/a.269227036596376.1073741862.156551237863957/269227053263041/
[20] Municipal Service
[21] http://nala.ge/uploads/gori.pdf
[22] Municipal Service
[23] Shida Qartli Region Development Strategy for 2014-2021; https://matsne.gov.ge/ka/document/view/2024388

7.2. METHODOLOGY

There are two ways to calculate methane emissions from landfills suggested by the IPCC guidelines: Default (Tier 1), and FOD (First Order Decay) (Tier 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.

To calculate methane emissions the Gori landfill the FOD method (Tier 2) has been applied. Relevant formulas and parameters are given below:

Tier 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

$MSW_T = Pop \bullet GR.$

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 CH_4 in landfill gas

R -recovered CH_4

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 number producing waste deposed at the landfill

As for 1 January 2010 the population of Gori Municipality was 144 100 from which 51 200 (35.53%) lived in the city and 92 900 (64.47%) – in villages. The density of population made 62 persons/km^{2}[24].

According to 2012 data the population of Gori Municipality equaled to 146 100 (Table 33). The area of tiding up services in Gori Municipality is limited by the city and adjacent 14 villages[25]. Nowadays the landfill is serving both the population of the city and villages and the private enterprises and state organizations, the total number of which amounts to 894 customers. The actual and projected number of population is given in Table 34 and the number of population in nearby villages is shown in Table 35. It has to be noted that since 2013 the services of Gori Landfill cover the city population and that of 14 villages by 100%.

Table 33. Actual number of Gori Municipality population (2004-2014)

Year	1000 persons
2004	146.4
2005	146.9
2006	135.9
2007	135.8
2008	135.6
2009	135.8
2010	144.1
2011	145.3
2012	146.1
2013	145.7
2014	145.8

Table 34. Actual number of the city of Gori population, interpolated (*) and projected (2015-2020) numbers

Year	Persons	Year	Persons
1959	35 100	1990*	67 502
1960*	36 291	1991*	66 003
1961*	37 482	1992*	64 505

[24] http://economists.ge/pdf/66geo.pdf
[25] Gori municipal Service

1962*	38 673	1993*	63 006
1963*	39 864	1994*	61 508
1964*	41 055	1995*	60 009
1965*	42 245	1996*	58 511
1966*	43 436	1997*	57 012
1967*	44 627	1998*	55 514
1968*	45 818	1999*	54 015
1969*	47 009	2000*	52 517
1970	48 200	2001*	51 018
1971*	49 089	2002	49 520
1972*	49 978	2003*	48 575
1973*	50 867	2004	47 630
1974*	51 756	2005	46 680
1975*	52 644	2006	48 290
1976*	53 533	2007	48 250
1977*	54 422	2008	48 180
1978*	55 311	2009	48 250
1979	56 200	2010	51 200
1980*	57 480	2011	51 630
1981*	58 760	2012	51 910
1982*	60 040	2013	51 770
1983*	61 320	2014	51 800
1984*	62 600	2015	52 060
1985*	63 880	2016	52 320
1986*	65 160	2017	52 580
1987*	66 440	2018	52 850
1988*	67 720	2019	53 110
1989	69 000	2020	53 380

Table 35. Number of population of villages in the Gori Municipality served by the Gori Landfill (2013)

#	Settlement Name	Number of persons		
		Local	Refugees	Total
1	Vil. Scra and Refugees Settlement	1 700	1 400	3 100

2	Vil. Uplistsikhe	728	0	728
3	Vil. Kvakhvreli	2 434	0	2 434
4	Vil. Khidistavi	2 800	0	2 800
5	Vil. Ateni	4 154	0	4 154
6	Vil. Tiniskhevi	1 620	0	1 620
7	Vil. Berbuki and Refugees Settlement	980	400	1 380
8	Vil. Kheltubani	3 355	0	3 355
9	Vil. Shvashvebi and Refugees Settlement	600	530	1 130
10	Vil. Khurvaleti and Refugees Settlement	710	410	1 120
11	Vil. Shakasheti and Refugees Settlement	1 000	300	1 300
12	Vil. Karaleti	1 500	0	1 500
13	Vil. Gare Jvari	800	0	800
14	Vil. Patara Gare jvari	700	0	700
	Total	23 081	3 040	26 121

Features of Waste Generation and Disposal

Processes

The Gori landfill is serving the city since 1980, and since 2013 – the neighboring 14 villages as well. As there is no data on the multi-year dynamics of waste disposal at the site, it has been assumed that initially it was serving only 50% of Gori population and has reached 100% only in 2000. Besides, along with the domestic garbage the landfill gets construction waste, the share of which is only 4%[26]. According to 2012 data the landfill annually got from the population and different entities on the average 66 960m^3 or 13 392 tons of waste (assuming that 1m^3 of waste is equivalent to 0.2 tons). Bearing in mind that till 2013 the landfill was serving only the city of Gori, it could be obtained that in 2012, after subtracting 4% of construction waste, the landfill was piled with 64 281.6m^3, or 12 856.32 tons of residential trash. Considering that this amount of waste was generated by 100% of Gori residents and 894 commercial customers, this makes (51 910 + 894[27]) = 52 804 persons. Hence, the amount of waste generated annually per capita equals to 12 856.32/52 804 x 1 000 = 243.5 kg.

According to 2014 data the amount of domestic waste makes 48 470m^3 (9 694 t)[28]. Number of population generating this quantity of trash totals 78, 824 persons (51 800 + 26 121 + 903)[29], thus 9 694/78 824 x 1 000 = 123kg of waste is produced per capita. Essential difference between the rated amount of waste in 2012 and 2014 (the data of 2013 is incomplete due to the transfer of management from one company to another) could be explained by the fact that till May 2013

[26] Gori Municipal Service
[27] It was assumed that 1 commercial customer equals to 1 resident.
[28] For the time being the management of the landfill has been changed and consequently the construction waste is not any more dumping on the landfill.
[29] The increase of commercial customers by 0.5% compared to base year (894 customers in 2012)

the Gori landfill was unmanaged and it was possible for the construction waste to exceed the 4% limit as well as to register the waste less accurately. The very low showing for 2014 (123 Kg of waste per capita) may be explained as well by another fact that the actual number of residents served by the landfill is really less than 100% of population. Proceed from this assumption, in the calculations below the norm of waste generation typical for Georgia (240 kg/per capita)[30] was used as it is near to the value, obtained from the early assessments. At the same time the rate of annual growth of waste by 2% was assumed since 2014 (Table 36).

Table 36. Dynamics of waste disposed at the Gori landfill

Year	Responsible Entity	Daily amount of disposed waste, m³	Monthly amount of disposed waste, m³	Annual amount of disposed waste, m³
2012	Gori Amenities Service, Ltd	183.45	5 580.00	66 960.00
2013	Georgian Solid Waste Management Company Ltd	179.37	5 455.83	65 470.00
2014	Georgian Solid Waste Management Company Ltd	132.79	4 039.17	48 470.00

The growth of population from 1980 till 2012 was assessed by standard interpolation method with mentioned above assumptions. Data on the number of population and customers served by the Gori landfill and the amount of disposed waste are given in Table 37.

Table 37. Actual and interpolated number of population generating corresponding amount of waste disposed at the Gori landfill

Year	Number of population, persons		Number of commercial customers	Total number of population and commercial customers	Share of population the waste of which is disposed at the landfill		Accumulated residential waste. tons
	Gori	Villages			%	persons	
1980	57 480	0	753	58 233	50.0	29 116	6 988
1981	58 760	0	757	59 517	52.5	31 247	7 499
1982	60 040	0	762	60 802	55.0	33 441	8 026
1983	61 320	0	766	62 086	57.5	35 700	8 568
1984	62 600	0	771	63 371	60.0	38 022	9 125
1985	63 880	0	775	64 655	62.5	40 409	9 698
1986	65 160	0	779	65 939	65.0	42 861	10 287
1987	66 440	0	784	67 224	67.5	45 376	10 890
1988	67 720	0	788	68 508	70.0	47 956	11 509
1989	69 000	0	793	69 793	72.5	50 600	12 144
1990	67 502	0	797	68 299	75.0	51 224	12 294
1991	66 003	0	802	66 805	77.5	51 774	12 426
1992	64 505	0	806	65 311	80.0	52 249	12 540
1993	63 006	0	810	63 816	82.5	52 649	12 636

[30] The Gori City Hall

1994	61 508	0	815	62 323	85.0	52 974	12 714
1995	60 009	0	819	60 828	87.5	53 225	12 774
1996	58 511	0	824	59 335	90.0	53 401	12 816
1997	57 012	0	828	57 840	92.5	53 502	12 840
1998	55 514	0	832	56 346	95.0	53 529	12 847
1999	54 015	0	837	54 852	97.5	53 481	12 835
2000	52 517	0	841	53 358	100	53 358	12 806
2001	51 018	0	846	51 864	100	51 864	12 447
2002	49 520	0	850	50 370	100	50 370	12 089
2003	48 575	0	855	49 430	100	49 430	11 863
2004	47 630	0	859	48 489	100	48 489	11 637
2005	46 680	0	863	47 543	100	47 543	11 410
2006	48 290	0	868	49 158	100	49 158	11 798
2007	48 250	0	872	49 122	100	49 122	11 789
2008	48 180	0	876	49 056	100	49 056	11 773
2009	48 250	0	881	49 131	100	49 131	11 791
2010	51 200	0	885	52 085	100	52 085	12 500
2011	51 630	0	890	52 520	100	52 520	12 605
2012	51 910	0	894	52 804	100	52 804	12 673
2013	51 770	0	898	52 668	100	52 668	12 640
2014	51 800	26 121	903	78 824	100	78 824	9 694*
2015	52 060	26 121	907	79 088	100	79 088	9 888*
2016	52 320	26 121	912	79 353	100	79 353	10 086*
2017	52 580	26 121	917	79 618	100	79 618	10 287*
2018	52 850	26 121	921	79 892	100	79 892	10 493*
2019	53 110	26 121	926	80 157	100	80 157	10 703*
2020	53 380	26 121	930	80 431	100	80 431	10 917*

** Amount of waste doesn't depend on population. Actual data on waste disposed in 2014 is taken with further annual increase by 2%.*

According to the waste management company, the running of the landfill is put in adequate order. After regulating the site (2013) the self-flaring of methane does not occur, the air and underground water is not being polluted[31].

Waste Composition

There are no complete/accurate data on the composition of municipal waste in Georgia. However, the results of single surveys on this subject are available for Tbilisi (2003, GIZ) and Batumi (2010, EU), though distinct differences between the waste compositions in these cities are obvious. As Batumi is a tourist city and its waste composition, presumably, will be unlike that of Gori, the data on waste composition in Tbilisi has been taken as a basis for performing calculations. Despite the fact that there are some of other sources concerning the composition of waste, they are more approximate and based upon 2003 measurements. According to some available sources in recent years the composition of waste has changed compared to 1989/1990 period. In particular, the fraction of organic waste, paper, cupboard and metal has decreased, while the share of plastic materials has significantly increased[32] (Table 38 and Table 39).

[31] The analysis of waste collection, transportation and utilization service in the Gori Municipality

[32] http://geocities-tbilisi.ge/failebi/2388-Introduction.pdf

Table 38. Composition of municipal waste in Tbilisi (sources: 1990 and 2003 – "2004, GIZ"; 2010 – "GEO-cities Tbilisi: Integrated Environmental Assessment of Status and Trends for the Capital of Georgia".

Fraction	By volume, %, 1990	By mass %	
		2003[33]	2010
Paper	34	5.0	6
Plastics	2	6.0	6
Inert material	4	5.5	5
Mixed	NA	1.0	1
Metal	5	3.0	3
Green residues	NA	3.0	3
Hygienic residues	NA	2.0	2
Textile/Leather	5	3.0	3
Fine/Remaining fraction	8	27.8	NA
Organic remains	42	43.7	71

As it comes from this Table, in 1990 and 2003 data, compared to that of 2010, exists the remaining fraction which supposedly is mainly or partly of organic origin (by comparing the 2003 and 2010 data it becomes evident that the sum of remaining and organic fractions equals to organic fraction in 2010). Hence, it has been assumed that mentioned above two fractions in 1990-2003 (Fine/Remaining and Organic remains) have joined in one item – Organic remains.

The 1990 data[34] were transferred from volume units into mass units[35], while in interim years (1990, 2003 and 2010) the data have been interpolated. These data given in Table 39 were used in calculations.

Table 39. Composition of waste – 1990, 2003 and 2010 actual and in remaining years – interpolated data

Year	Mass of fraction,%								
	Paper	Plastics	Inert material	Metal	Textile/ Leather	Organic remains	Mixed	Green residues	Hygienic residues
1990	10.50	0.50	8.00	4.00	1.40	75.60	0.00	0.00	0.00
1991	10.08	1.00	7.85	3.92	1.52	75.28	0.04	0.23	0.15
1992	9.65	1.40	7.70	3.85	1.65	74.97	0.08	0.46	0.31
1993	9.23	1.80	7.55	3.77	1.77	74.65	0.12	0.69	0.46
1994	8.81	2.20	7.40	3.69	1.89	74.34	0.15	0.92	0.62
1995	8.38	2.60	7.25	3.62	2.02	74.02	0.19	1.15	0.77
1996	7.96	3.00	7.10	3.54	2.14	73.71	0.23	1.38	0.92
1997	7.54	3.40	6.95	3.46	2.26	73.39	0.27	1.62	1.08
1998	7.12	3.80	6.80	3.38	2.38	73.08	0.31	1.85	1.23
1999	6.69	4.20	6.65	3.31	2.51	72.76	0.35	2.08	1.38
2000	6.27	4.60	6.50	3.23	2.63	72.45	0.39	2.31	1.54
2001	5.85	5.00	6.35	3.15	2.75	72.13	0.42	2.54	1.69

[33] GIZ, The Analysis of Waste Generated in Tbilisi, 2003.

[34] http://geocities-tbilisi.ge/failebi/2388-Introduction.pdf and GIZ, The Analysis of Waste Generated in Tbilisi, 2003

[35] Average density of fractions: paper-63 kg/m³, plastics-55 kg/m³, inert material 435 kg/m³, metal- 165 kg/m³, textile/leather- 56 kg/m³, organic remains-330 kg/m³ (source: GIZ, The Analysis of Waste Generated in Tbilisi, 2003)

2002	5.42	5.40	6.20	3.08	2.88	71.82	0.46	2.77	1.85
2003	5.00	6.00	6.00	3.00	3.00	71.50	0.50	3.00	2.00
2004	5.14	6.00	5.86	3.00	3.00	71.43	0.57	3.00	2.00
2005	5.29	6.00	5.71	3.00	3.00	71.36	0.64	3.00	2.00
2006	5.43	6.00	5.57	3.00	3.00	71.29	0.71	3.00	2.00
2007	5.57	6.00	5.43	3.00	3.00	71.21	0.79	3.00	2.00
2008	5.71	6.00	5.29	3.00	3.00	71.14	0.86	3.00	2.00
2009	5.86	6.00	5.14	3.00	3.00	71.07	0.93	3.00	2.00
2010	6.00	6.00	5.00	3.00	3.00	71.00	1.00	3.00	2.00

Currently, the waste management in Georgia is at the initial stage, thus there is no reliable information on waste composition in the country, especially data for separate cities. Hence, the only realistic way to calculate GHG emissions from the Gori SWDS is to perform them based upon the data for Tbilisi.

Emission Factors

Different Emission Factors are used in the process of methane emissions calculation 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 layer is aerobic and releases carbon dioxide. The IPCC 1996[36] given default values of the correction factor, presented below in Table 40.

Table 40. Methane Correction Factor (MCF) Values for Different Types of Landfills

Type of Landfill/Landfill	Average thickness of waste m	MCF
Managed[37]		1.0
Managed– thin[38]	Waste thickness<5	0.5
Unmanaged – deep	Waste thickness>5	0.8
Unmanaged – thin	Waste thickness<5	0.4
Uncategorized Landfill		0.6
Gori 1980-2000	Waste thickness<5	0.4
Gori 2001-2012	5 -7	0.8

[36] 1996 IPCC Guidelines for National Greenhouse Gas Inventories, http://www.ipcc-nggip.iges.or.jp/public/gl/pdfiles/rusch6-1.pdf (p. 6.8)

[37]Managed SWDS must have controlled placement of waste (i.e. waste directed to specific deposition areas, a degree of control of scavenging and a degree of control of fires) and will include some of the following: cover material, mechanical compacting or leveling of waste. Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories, 2000, p. 5.9

[38] 2006 IPCC Guidelines for National Greenhouse Gas Inventories, http://www.ipcc-nggip.iges.or.jp/public/2006gl (p.3.16)

Gori 2013-2020	7	1.0

In 2013 the Gori landfill has been put in order and approximated the status of managed landfill – the depth of waste equals on the average to 5-7m, the landfill has a draining system, systematic treatment of delivered waste is taking place – covering by the soil (in some cases construction materials and the soil taken from the city are disposed).

Accordingly, as since 2013 the Gori landfill is being considered as a managed one, the waste thickness exceeds 5m and reaches 7m, in line with the Table 40 the value of Methane Correction Factor for 1980-2000 was taken to be 0.4, for 2001-2012 period – 0.8 and after 2013 – equal to 1.

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 research, (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[39], are applied to calculate DOC for the waste components. Default values of the DOC are given in Table 41, and the formula assesses the DOC by waste composition.

Table 41. Default Values of the DOCi by Waste Composition

Waste Composition	DOC_i
Food waste	0.15
Garden	0.20
Paper	0.40
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);

[39] 2006 IPCC Guidelines for National GHG Inventories http://www.ipcc-nggip.iges.or.jp/public/2006gl (p. 2.16)

W_i - Portion of waste by type/fraction (i)

Fraction of degradable organic carbon dissimilated-DOC_F).

DOC_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[40] carbon is included in the DOC value). DOC_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 is covered by oxidizing materials – soil, compost) is equal to 0.1, amounting to 0[41] for unmanaged dumps. This volume (OX=0) has thus been taken for the Gori landfill.

7.3. BASE YEAR INVENTORY AND GHG EMISSIONS BASELINE SCENARIO (2012-2020)

In conformity with the work being done by the Solid Waste Management Company in 2013 the Gori landfill has been rehabilitated and correspondingly the growth of methane emissions has started from the existing landfill. Table 42 demonstrates the projected methane emissions from the Gori operating landfill after its rehabilitation (2013). The calculations were carried out under the assumption that the amount of trash delivered to the landfill will grow incrementally each year by 2% and the methane generated will not be utilized.

[40] 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

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

Table 42. Methane Emissions from the Gori Landfill in 2012 - 2036

Year	GG/year	Kg/Year	m³/Year	m³/day
2012	0.51	510 100	708 472	1 941
2013	0.52	520 700	723 194	1 981
2014	0.55	550 600	764 722	2 095
2015	0.55	551 900	766 528	2 100
2016	0.55	554 800	770 556	2 111
2017	0.56	559 200	776 667	2 128
2018	0.56	564 900	784 583	2 150
2019	0.57	571 600	793 889	2 175
2020	0.58	579 300	804 583	2 204
2021	0.59	587 900	816 528	2 237
2022	0.60	597 100	829 306	2 272
2023	0.61	607 000	843 056	2 310
2024	0.62	617 500	857 639	2 350
2025	0.63	628 600	873 056	2 392
2026	0.64	640 000	888 889	2 435
2027	0.65	652 000	905 556	2 481
2028	0.66	664 300	922 639	2 528
2029	0.68	677 100	940 417	2 576
2030	0.69	690 200	958 611	2 626
2031	0.70	703 700	977 361	2 678
2032	0.72	717 600	996 667	2 731
2033	0.73	731 800	1 016 389	2 785
2034	0.75	746 300	1 036 528	2 840
2035	0.76	761 200	1 057 222	2 896
2036	0.78	776 400	1 078 333	2 954

The obtained results show that in 2020 methane emissions from the Gori landfill will grow by about 13% compared to 2012 value and will reach 0.58 Gg (Table 42).

7.4. EMISSIONS REDUCTION ACTION PLAN FOR THE GORI SOLID WASTE SECTOR

At the present stage one measure is planned in the framework of the Gori SEAP – arranging the system for the collection and flaring at the site of methane, as a result of which the emission of methane (CH_4) will be substituted by the emission of CO_2, having much less global warming effect.

The amount of reduced emissions is calculated for the described above case – the present status of the landfill will remain unchanged. It was assumed that the mentioned above flaring system will be installed in 2016.

Table 43. 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	0.51	10.71	0	0
2013	0.52	10.93	0	0
2014	0.55	11.56	0	0
2015	0.55	11.59	0	0
2016	0.55	11.65	0	0
2017	0.56	11.74	1.23	8.16
2018	0.56	11.86	1.24	8.25
2019	0.57	12.00	1.26	8.35
2020	0.58	12.17	1.27	8.46
2017-2020 total	**2.28**	**47.78**	**5.01**	**33.22**

According to the scenario, CO_2 emissions in 2020 will be reduced by 8.46 Gg under the assumptions that technically it would be possible to collect only 80% of emitted methane and as a result of flaring of 1 ton of methane 2.75 t of CO_2 is emitted into the atmosphere. In case of project implementation overall saving of CO_2 emitted to the atmosphere will make 33.22 Gg for the mentioned 4-year period (Table 43).

8. GREENING/LANDSCAPING

8.1. THE EXISTING SITUATION

Total area of Gori City is approximately 1 680 hectares, of which about 36ha are landscaped, including the recreation areas that occupy 27ha.

The arrangement of first park in Gori started since 1930-es. Initially this was a natural riverine grove at the confluence of rivers Mtkvari and Liakhvi. In the mentioned period the territory has been put in order and plants were cared of. The walkable pathways have been arranged together with various side-shows and public entertaining facilities including the Concert Hall and open air concert stage. Lately, since 1950-es different infrastructural sites have been constructed. In particular, according to the first general plan developed in 1950, the construction of squares, lawns and borders have begun with good amenities and greening. In 1990-es, resulting from civil turmoil this process has been broken for some years, but since 2004 the planting of squares and new grass-plots has been resumed. Up to now there are 32 squares and lawns and 2 parks in the city (Table 44).

Table 44. Gori recreation zones and their areas

#	Name	Area m²
1	Square adjacent to Stalin Memorial Museum	7 326
2	Square adjacent to Shota Rustaveli Memorial	972
3	Brothers Romelashvili Square	2 008
4	Square at the crossing of Chacchavadze and Razmadze streets	464
5	Square in the Vologda Settlement adjoining 41 Tskhinvali Highway	1 280
6	Square at the crossing of Tkviavi and Nadiradze streets, at 1 Tkviavi st.	2 700
7	Square adjacent to 9B and 15B Tskhinvaly Highway	360
8	Square around the Lomchabuli statue	8 762
9	Heroes square at the Guramishvili st.	778
10	Square adjacent to 1A Mshvidoba st.	927

11	Square adjacent to 2A Mshvidoba st.	790
12	Square adjacent to former administrative building, Moscow st.	8 330
13	Square adjacent at the Shindisi Highway	2 556
14	S. Tsabadze Square	205
15	Square adjacent to the State Theatre	6 848
16	Shio Square	886
17	Square at the Amilakhvari st.	1 495
18	April 9 Square	576
19	Square in front of Queen Tamar V block	3 040
20	Square at the Ketskhoveli st.	291
21	Square adjacent to Glory Museum	583
22	Nokoloz Baratashvili Square	1 818
23	Square adjacent to 51 Kachinski st.	1 980
24	Lawns at the Stalin st.	4 247
25	Lawns at the Sukhishvili st.	9 130
26	Lawns at the David Agmashenebeli st.	7 830
27	Lawns at the Mshvidoba st.	2 559
28	Lawns at the Chavchavadze st.	1 545
29	Lawns at the Royal street	1 287
30	Lawns at the 26 May Riverside	4 153
31	Lawns at the Parnavazi st.	1 743
32	Lawns at the Tbilisi st.	1 421
33	Forest-park planted in 2014 at the eastern edge of the city	40 000
34	Central Park "Akhalbagi"	230 000
	Total	358 890 (35.9 ha)

It comes from this Table that total area of recreation zones equals to nearly 36 ha. The plant coverage density in the area reaches 45% that finally makes 16.2 ha including 4 ha of newly planted in 2014 vegetation in the eastern part of the city. The plants existing at the city cemetery are considered in calculations as well (Table 45).

Table 45. Green cover area of Gori

Green cover	Total area, ha	Including green cover area, ha	Coverage by plants, %
Recreation zones	35.9	16.2	45
Cemetery	3.8	0.6	15
Green cover of Gori		16.8	

The green cover of Gori consists only of fragmentary verdure which does not create the joint canopy groves. The complete inventory of planted areas in Gori has not been undertaken yet. At this stage the register data obtained by local expert is being used which mainly comprises mature big trees. Hence, it could be assumed that significant part of carbon stock, accumulated in the Gori green cover is deposited in the perennial ligneous or woody plants. The majority of trees planted in the Gori recreation zones consists of the following species (Table 46).

Table 46. Trees and plants set out in the Gori recreational zones

№	Plant species	QTY, pieces	Age, year
	Deciduous		
1	Lime	820	40-20
2	Aspen	105	60
3	Ash	180	20
4	Horse-chestnut	95	15
5	Acacia	85	65
6	Plane orientalis/Platanus	415	50-60
7	Box-tree/Buxus	120	45
	Total	1 820	
	Coniferous		
1	Cedar	215	30-40
2	Silver spruce	115	30-40
3	Pine	340	20-30
4	Thuja	140	20-30
5	Cypress	35	25

	Total	845	
	Grand total deciduous and coniferous	2 665	

As it comes from the listed above data, the city experiences obvious shortage of vegetation covered areas – in particular, only 1% of city total area is covered by plants and recreation area per capita equals to 7.7 m^2, out of which 3.6 m^2 is covered directly by trees. Thus the city urgently needs the greening of its territory.

As it was mentioned above, since 2004 the landscaping activities have started in the city: the rehabilitation of Central Park has begun, 7 recreation squares have been arranged nearby the multi-story buildings, about 1 200 trees and plants of different kind has been planted in various parts of the city.

In 2014 in the eastern edge of the city, at the slopes of Kvernaki Range near the Gori cemetery the planting of Gori forest-park has started on the area of 4 ha, for which the saplings from the Gori nursery garden have been used.

This nursery was created in Gori in 2010 at the new territory of 4ha. All plants have been transferred from the old nursery and it could be said that presently Gori has one of the best nursery gardens in Georgia (the nursery is financed from the city budget). This preconditions the proceeding of greening activities using the seedlings from the Gori nursery.

The trimming of trees in the city is performed according to the necessity, e.g. in case when the canopy of the trees becomes dangerously large and creates hazard to the buildings and other infrastructure utilities. The last clipping of trees in Gori has been undertaken 7 years ago and at present these works are not required. Hence, the mentioned above maintenance activities are not considered in the city budget.

The carbon accumulation and absorption potential of Gori green cover was assessed by the IPCC – 2003 methodology.

As to the estimation of carbon accumulation potential after carrying out the planned landscaping works, it was evaluated using the CO_2FIX model.

8.2. BASE YEAR ACCUMULATED CARBON AND ABSORPTION POTENTIAL FOR THE GORI EXISTING GREEN COVER

8.2.1. Methodology

The IPCC calculations were conducted from "Live biomass" (including the underground biomass). Namely, a calculation of collected carbon and its subsequent increase in biomass was calculated by the following equations:

1. 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.

2. 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;

3. If G_W data are not available, so the following 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.

Given equations were used to assess the accumulated carbon stocks and carbon accretion volumes in the perennial verdure of Gori recreation zones.

8.2.2. Calculation outcomes for the carbon uptake by existing green cover in Gori (except newly planted 4 ha)

Values of some coefficients required for carrying out the calculations were taken from the Kaspi Forestry taxation data which correspond to the districts adjacent to the Gori Municipality Forestry districts.

Under the mentioned above methodology calculations were carried out only for areas covered with mature plants, particularly for 12.8 ha. For the 4 ha of forest-park, covered by newly planted trees, the carbon accumulation potential was assessed separately using the CO2FIX model. As far as the green cover in the city is mainly represented by fragmented vegetation, the data were used relevant to sparse groves. From the taxation materials the data were used on the average annual accretion and stocks of plants, while for defining the averaged volume weight of wood, the relevant features for the dominant kinds were taken from different literary sources. The values of other coefficients (BEF_1, BEF_2, R, CF) were brought from the standard tables of IPCC methodology, relevant to the climatic conditions of selected regions (Table 47).

Table 47. Indexes used in calculations and their sources

Indexes suitable for calculations	Used value of index
A - Green cover area , h[42]	12.8
V- Tree stock m3/ha[43]	90.0
D - volume weight of totally dry wood, ton totally dry mass[44]	540.0
I_V- Woody plants (trees) mean annual increment, m^3 [45]	1.6
BEF_1- Coefficient for conversion of wood mean increment into total aboveground (including crown) mean increment [46]	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.[47]	1.3
R - Ratio of root mass to trunk[48]	0.24
CF- carbon content in dry wood[49]	0.5

The process of calculations and corresponding results are given below

- Carbon stock accumulated at the Gori planted areas (12.8 ha)

Carbon accumulated at 1ha area

[42]Zugdidi, local expert ,http://www.zugdidi-sakrebulo.ge.
[43] "Land Use Planning "of Samegrelo Zemo-Svaneti Regional Department, 2008;
"Global Wood Database" http:/datadryad.org; Makhviladze E. Timber Management. Tbilisi, 1962; Боровников А.М., Уголев Б. Н., Справочник по древесине. «ЛеснаяПромышленность», Москва, 1989;
[45]Average taxation rates of Batumi wood and plants; Adjara Forest Inventory, 2004
[46]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;
[47]Good Practice Guidance for Land Use, Land Use Change and Forestry, (IPCC 2003),Table 3A1.10;
[48]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;
[49]Good Practice Guidance for Land Use, Land Use Change and Forestry, (IPCC 2003).http://www.ipcc-nggip.iges.or.jp/public/gpglulucf/gpglulucf.html

$\Delta C_{F_{LB}}$ = [V●D●BEF_2] ●(1+R) ●CF=[90●0.54●1.3] ●(1+0.24) ●0.5= 63.2●1.24●0.5= 39.2 tC /ha

Total amount of carbon, accumulated on the area covered by plants (12.8 ha): 12.8x39.2=501.8 tC.

- Annual accumulation of carbon on the area covered with plants in Gori (12.8 ha):

$\Delta C_{F_G} = (A \cdot G_{TOTAL}) \cdot CF = 12.8 \cdot 1.24 \cdot 0.5 =$ **7.9 tC**

$G_{TOTAL} = G_W \cdot (1 + R) = 1.0 \cdot 1.24 = 1.24$

$G_W = I_V \cdot D \cdot BEF_I = 1.6 \cdot 0.54 \cdot 1.15 = 1.0$

As it comes from the calculations, on the area of 12.8 ha covered by plants in Gori totally is deposited 501.8tC. Annually is absorbed 7.9tC, corresponding to the removal of 29.0 tons of CO_2 from the atmosphere.

As there is no need in the annual trimming of trees in the recreation zone, correspondingly there is no annual reduction in carbon stocks and biomass due to the anthropogenic impact. Accordingly, for the assessing green cover accumulation potential (till 2020) the annual accumulation of vegetation and the scale of verdure accretion as a result of planting were taken into consideration. The obtained results are presented in the summary.

8.3. MEASURES PLANNED WITHIN THE FRAMEWORK OF THE ACTION PLAN

8.3.1. Calculations methodology and values of coefficients used in computations

- CO2FIX V3.1. Model general overview.

The model has been developed under the project CASFOR II, which was financed by the European Commission programme $INCO_2$. The project was additionally financed by the Ministry of Agriculture, Nature Management and Fishing of the Netherlands and the National Council on Science and Technology of Mexico (CONACYT).

The model CO2FIX V3.1 determines the amount of carbon accumulation in the nature using the called "Accounting Method" of carbon stock-taking. In particular, the model calculated changes in carbon stockpiles, taking place for the specific span in all carbon "reservoirs" existing in the forest. (The carbon "reservoir" is considered to be that part of the ecosystem where the accumulation of carbon is taking place – the living biomass, litter, organic soils and produced timber resources).

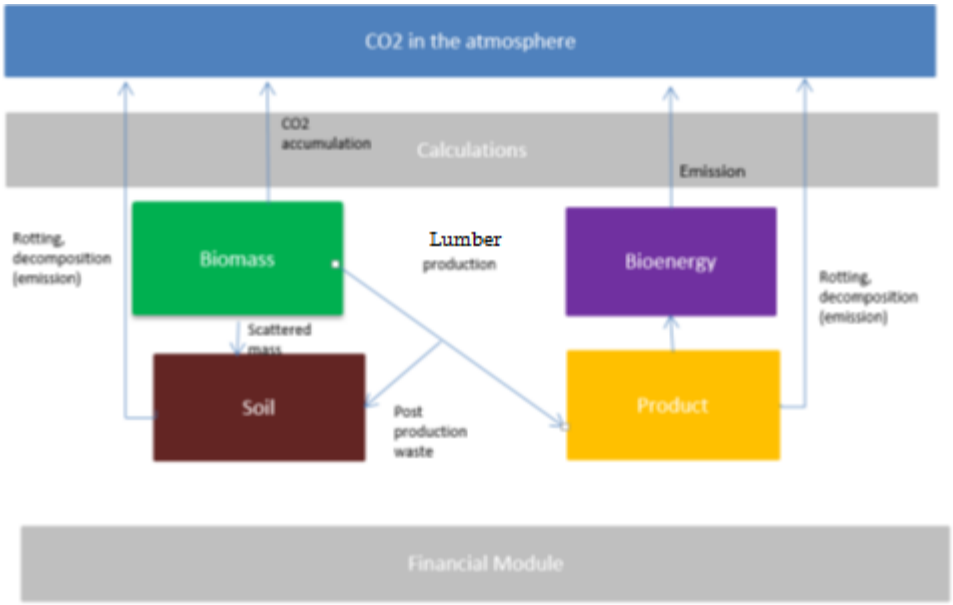
In the model CO2FIX V3.1 the calculations are performed for one year and one ha scale in existing 6 main modules:

1. Biomass module;
2. Soil module;
3. Produce of timber resources module;
4. Bioenergy modules;
5. Financial module;
6. Carbon credits accounting module (for 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).

The structure of the model is given on the Picture 20.



Picture 20. 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.

As an example the values of the main coefficients used in 2014 calculations are given in Table 48.

Table 48. Values of indexes used in the biomass module for the project scenario in Gori

Indexes used in the Biomass Module	Value of the index
Carbon content	0.5 t.C /t dry mass
Wood density t dry mass/m^3	
Maple	0.655
Platanus orientalis	0.720
Ash	0.645
Catalpa	0.680
Akaki-tree	0.650
Cypress	0.540
Pine-tree	0.480
Lugustrum	0.410
Thuja	0.480
Initial carbon stocks	0 tC/ha
Growth correction factor	1,00
Turnover rate of phytomass	
Coniferous:	
Needles	0.30
Branches	0.04
Roots	0.03
Deciduous:	
Leaves	1.00
Branches	0.05
Roots	0.08

Soil module: The Yasso model is applied to determine carbon dynamics in soil. (http://www.efi.fi/projects/yasso/). The model (included into CO_2FIX 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 dissimilar climate zones to describe the influence of specific climate conditions on the decomposition process of the fallen leaves and branches.

8.3.2. Measures taken in 2014 and planned within the framework of the Action Plan

As it was mentioned earlier, the new vegetation cover has been planted in 2014 in the easternmost part of the city. As result of planting the carbon stock growth scale has been assessed and 2 measures have been planned to raise the potential of carbon annual accumulation in the Gori plant cover.

In particular, the first measure foresees the completion of the forest-park planting in the eastern side of the city and the second measure provides for the reconstruction of Central Park. Up to now companies responsible for the landscaping and maintenance of plants within the city limits are "The Gori amenities Service" and "Akhalbaghi".

8.3.3. Planting activities undertaken in 2014 on the 4ha area

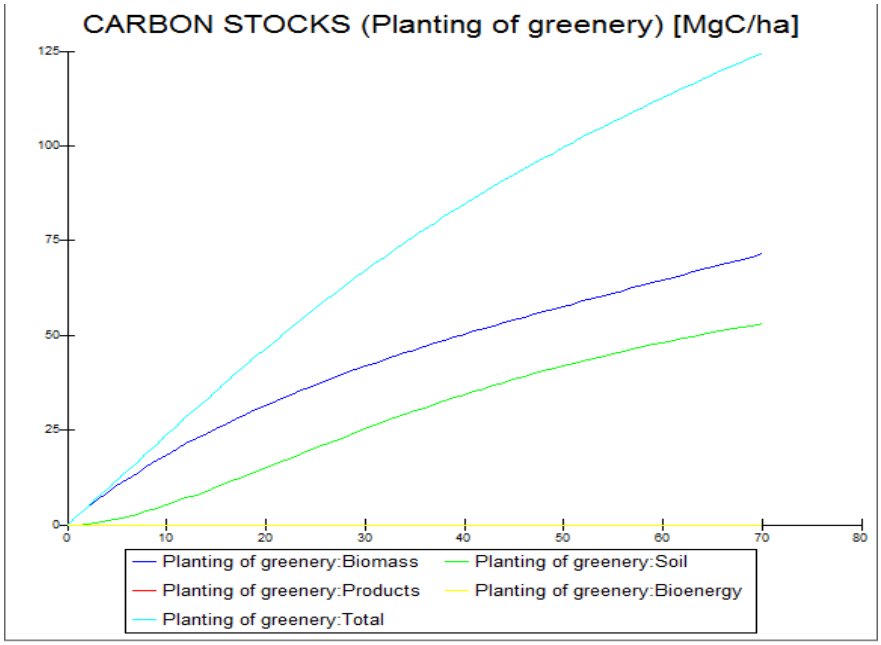
In 2014 to the east of Gori, at the flank of the Kvernaki Range in the vinicity of the Gori cemetery the planting of Gori forest-park has started: on the area of about 4ha 4 500 saplings of different plants were placed, among them: Pine-tree – 1 000 saplings, Cypress – 400, Lugustrum-1 450, Ash-250, Maple-210, Mould-180, Catalpa-190, Oak-220, Akaki-tree-180, Althaea-420 saplings. The expenses on the planting made 15.0 thousand GEL. The selected kinds of trees are quite suitable for planting in Gori climate conditions. At the same time, in further planting activities the dominance of deciduous kinds of trees must be provided as they are better absorbers of carbon dioxide compared to coniferous kinds and are more resistant to the exhaust gases. In particular, from the listed above species the best absorbents of CO_2 are known to be maple, ash and catalpa.

The list of main coefficients used in calculations is given in Table 5. The features of carbon sequestration resulting from the planting of 4 ha territory are presented in Picture 21 and the dynamics of carbon stockpiling is shown on Picture 22.

From the obtained with the model summary tables it becomes evident that in the initial from the planting year (2014) the amount of sequestered carbon and relevant values of removed CO_2 at the 4ha planted area till 2020 are given in Table 49.

	Sequestered Carbon Planting of ...	Sequestered Carbon Planting of ...		Sequestered Carbon Planting of ...	Sequestered Carbon Planting of ...		Sequestered Carbon Planting of ...	Sequestered Carbon Planting of ...
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	0.08	0.30	17	39.93	146.40	34	74.43	272.92
1	2.37	8.68	18	42.16	154.59	35	76.22	279.46
2	4.69	17.20	19	44.37	162.69	36	77.97	285.89
3	7.05	25.84	20	46.56	170.70	37	79.69	292.20
4	9.41	34.51	21	48.72	178.63	38	81.38	298.40
5	11.79	43.21	22	50.85	186.47	39	83.04	304.50
6	14.16	51.94	23	52.97	194.22	40	84.68	310.48
7	16.55	60.67	24	55.06	201.89	41	86.28	316.36
8	18.93	69.41	25	57.13	209.49	42	87.86	322.14
9	21.31	78.14	26	59.17	216.97	43	89.41	327.82
10	23.69	86.87	27	61.18	224.34	44	90.93	333.40
11	26.06	95.54	28	63.16	231.59	45	92.42	338.89
12	28.41	104.17	29	65.11	238.74	46	93.90	344.30
13	30.75	112.74	30	67.03	245.77	47	95.36	349.64
14	33.07	121.26	31	68.92	252.71	48	96.79	354.91
15	35.38	129.74	32	70.78	259.54	49	98.21	360.11
16	37.67	138.12	33	72.62	266.28	50	99.61	365.25

Picture 21. Sequestration of carbon by greenery planted in 2014 (per 1ha)



Picture 22. Dynamics of carbon stocktaking after planting of greenery

From the obtained with the model summary tables it becomes evident that in the initial from the planting year (2014) the amount of sequestered carbon and relevant values of removed CO_2 at the 4ha planted area till 2020 are given in Table 49.

Table 49. Features of annual sequestration of carbon on the 4ha area planted in 2014

Year	2014	2015	2016	2017	2018	2019	2020
Annual sequestration of carbon, tC	8.8	17.6	26.4	35.2	44.0	53.2	62.0
Corresponding absorption of carbon dioxide, tCO_2	32.3	70.4	96.8	129.1	161.3	195.1	227.3

Planned Measure 1. The completion of forest-park planting in the eastern side of the city (total span of activities includes 6 years). After the conclusion of planned plantation activities the planted in 2014 territory of the forest-park will be widened, by planting annually additional 1ha of greening, thus increasing the total planted area of the recreation zone till 2020 up to 10ha. The creation of green zones around the city is of great important for Gori as far as this will curtail the intensity of dusty winds in the city and improve the

The arrangement of recreation infrastructure is planned at the territory of forest-park, including planting of lawns, construction of walkable pathways, etc. In the process of designing the territory for planting it is very important to select correctly the kinds of trees and bushes. The right selection of woody spices requires taking into consideration of such elements as the type of soil and climate conditions as well as the potential of CO_2 removal by the greenery and resistance to the transport or industrial enterprise exhausts.

Mindful of all these criteria the following woody species were selected to be dominant among the deciduous plants: maple, green (American) ash, platanus, catalpa. These plants, first of all, are featured by the high CO_2 absorption capacity. The mixing of some kinds, having less sequestration ability is possible, that will enrich the forest-park biodiversity. In particular, from the deciduous species were selected: oak, Akaki-tree, lugustrum and from the coniferous kinds-cypress, pine-tree and thuja.

While designing the planting, keeping different distance among the plants is to be considered. In particular, for the first order big trees this will equal to 5m, for the second order trees – 4m and for the third order trees – 3m. On the 40% of entire territory the light-loving first order woody kinds will be planted (0.40 ha), the second order plants – on 35% of the area (o.35ha) and the third order plants (smaller trees and shrubs) – on the remaining 25% of the territory (0.25ha). In the process of landscape designing, especially near the squares and walkable roads it is recommended for the age of woody plants to be more that 5-7 years with formed canopy and well-developed healthy root system (for the coniferous saplings the root system must be kept in

dense clouds of soil). As a result the early formation of the recreational forest-park could be expected at the territory of project implementation.

Taking into consideration the distancing between the saplings, the following number of them will be required for the planting of 1ha area:

- First order big woody plants – 963 saplings;
- Second order woody plants – 625 saplings;
- Third order woody plants – 420 saplings.

In total 2008 saplings will be needed for planting 1ha of project territory. For the arrangement of infrastructure utilities (walkable lanes, squares, borders and other elements of infrastructure) at the 0.3ha area of forest-park territory the expenses were assessed according to spending made for the setting out of same squares in Gori in 2011-2013.

It should be mentioned that for the implementation of described above activities the planting design must be developed, the necessary components of which are: schemes of planting and infrastructure, list of selected for greening plants and budget for carrying out of all required activities. The estimated costs of activities planned for the first year on the projected territory are given in Table 50.

Table 50. Estimated budget of scheduled activities per 1ha of project territory

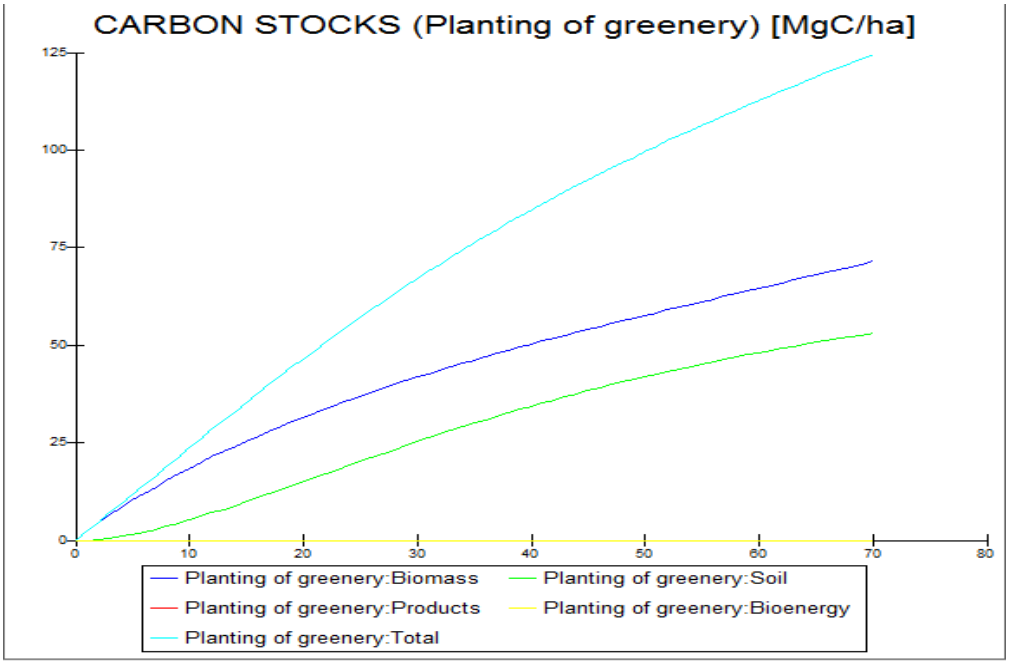
№	Description of expenditures	Size unit	Price per unit (US $)	Total amount	Total price (US $)
		8.3.3.1.1. I. Core expense			
I.	**Field activities**				
1.1	Cleaning of area from shoots and weeds	ha	300.00	1	300
1.2	Marking of area and digging the holes	sapling	0.40	2 008	803
1.3	Taking saplings from the nursery	sapling	0.15	2 008	301
1.4	Transporting the saplings	km	10.00	25	250
1.5	Planting saplings	sapling	0.20	2 008	402
1.6	Watering saplings	sapling	0.10	2 008	201
1.7	Arranging the infrastructure	m^2	5.00	5 000	25 000
	Total (SUD)				27 257

As it comes from the Table, the cost of planned measures for 1ha of projected territory equals to 27 257 USD. Values of main coefficients used in calculations are given in Table 48.

The features of carbon sequestration as a result of planting are presented on the Picture 23, while the dynamics of this process is shown on the Picture 24.

	Sequestered Carbon Planting of ...	Sequestered Carbon Planting of ...		Sequestered Carbon Planting of ...	Sequestered Carbon Planting of ...		Sequestered Carbon Planting of ...	Sequestered Carbon Planting of ...
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	0.08	0.30	17	39.93	146.40	34	74.43	272.92
1	2.37	8.68	18	42.16	154.59	35	76.22	279.46
2	4.69	17.20	19	44.37	162.69	36	77.97	285.89
3	7.05	25.84	20	46.56	170.70	37	79.69	292.20
4	9.41	34.51	21	48.72	178.63	38	81.38	298.40
5	11.79	43.21	22	50.85	186.47	39	83.04	304.50
6	14.16	51.94	23	52.97	194.22	40	84.68	310.48
7	16.55	60.67	24	55.06	201.89	41	86.28	316.36
8	18.93	69.41	25	57.13	209.49	42	87.86	322.14
9	21.31	78.14	26	59.17	216.97	43	89.41	327.82
10	23.69	86.87	27	61.18	224.34	44	90.93	333.40
11	26.06	95.54	28	63.16	231.59	45	92.42	338.89
12	28.41	104.17	29	65.11	238.74	46	93.90	344.30
13	30.75	112.74	30	67.03	245.77	47	95.36	349.64
14	33.07	121.26	31	68.92	252.71	48	96.79	354.91
15	35.38	129.74	32	70.78	259.54	49	98.21	360.11
16	37.67	138.12	33	72.62	266.28	50	99.61	365.25

Picture 23. Sequestration of carbon and CO2 removal per 1ha of forest-park territory



Picture 24. Dynamics of carbon accumulation after planting 6ha of greenery at the Gori forest – park

As it could be seen from Table 23, in the first year from the planting 2.4t of carbon will be sequestered per 1ha of forest-park, and till 2020 after greening 6ha of territory the rate accumulation is given in Table 51.

Table 51. Annual indices of carbon accumulation in the Gori forest-park

Annual sequestration, t C	2015	2016	2017	2018	2019	2020
	2.4	4.7	7.0	9.4	12.0	14.2
		2.4	4.7	7.0	9.4	12.0
			2.4	4.7	7.0	9.4
				2.4	4.7	7.0
					2.4	4.7
						2.4
Carbon accumulation according to years, tC	2.4	7.1	14.1	23.5	35.5	49.7
Annual absorption of carbon dioxide, tCO_2	8.7	26.0	52.0	86.2	130.2	182.2

Planned Measure 2. The reconstruction of Central Park (total span of activities equals to 1 year).

The reconstruction of city Central Park implies the additional planting of a new greenery at the 6 ha territory of existing verdure and extra planting of supplementary 4ha territory.

Similar to Measure 1 case, before the field activities commencement the park reconstruction design is to be worked out, the main components of which are: schematic maps of saplings planting and arranging the infrastructure elements (walkable pathways, lawns, grass-plots, etc.), list of greenery selected for planting and the budget for implementing all required activities. At this stage the plan of main actions and estimated budget are given that is necessary for carrying out of the project.

As it has been mentioned in the previous Measure 1, the correct selection of trees and shrubs is a very liable moment in designing the territory subjected to planting. The right selection of woody plants requires taking into consideration such features of the area selected for planting as soil and climate conditions, as well as CO_2 absorption potential and resistance to noxious exhaust gases of woody plants. After considering these criteria the following woody species were selected to

be dominant among the deciduous plants: maple, green (American) ash and catalpa. These plants, first of all, are distinguished by the high CO_2 absorption capacity. From the coniferous species were chosen cypress, pine-tree and thuja. The coniferous kinds are to be used only for the decoration of landscapes in the squares.

The plants at the territory must be placed at different distances from each other. In particular, for the first order big trees the distance will be 5m, for the second order trees – 4m and for the third order trees – 2m. At the 20% of the whole territory the light-loving arboreal plants have to be planted, the second order plants-on the 35% of total area and the third order plants (smaller trees and shrubs) at the remaining 45%. The age of arboreal plants must be no less than 5-6 years (for the quick formation of a green landscape in the recreation zone) with the molded canopy and well-developed healthy root system (for the coniferous saplings the root system must be kept in the dense clods of soil).

Taking into consideration the distancing between the saplings and the placing of infrastructure components, the following number of saplings will be required for the planting of 1ha area:

- First order woody/arboreal plants – 770 saplings;
- Second order woody plants – 1 348 saplings;
- Third order woody plants – 1 732 saplings.

All in all 3 850 saplings will be needed for the entire project territory. While selecting the arboreal planed species specific local conditions for each kind of plant will be taken into account. The estimated expenditures for the planting of woody greenery at the project territory are given in Table 52.

Table 52. Costs of planned activities

№	Description of expenditures	Size unit	Price per unit (US $)	Total amount	Total price (US $)
7.3.3.1.21 Core expenses					
1.	**Field activities**				
1.2	Marking of area and digging the holes	Sapling	0.25	3 850	962.5
1.3	Taking saplings from the nursery	Sapling	0.10	3 850	385.0
1.4	Transporting the saplings	Km	10.00	15	150.0
1.5	Planting saplings	Sapling	0.20	3 850	770.0
1.6	Watering saplings	Sapling	0.10	3 850	385.0
1.7	Arranging the infrastructure	m^2	5.00	15 000	75 000.0
	Total (USD)				**77 652.5**

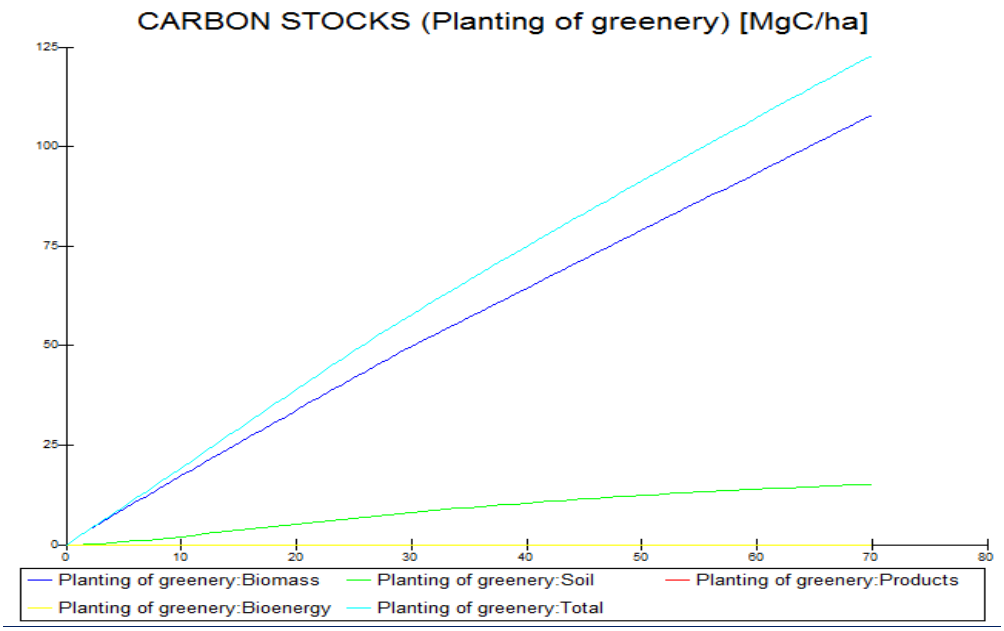
As it is seen from the Table, the total cost of activities planned to be implemented at the project area equals to 77 652.5 USD.

Values of main coefficients used in calculations are given in Table 48.

The features of carbon sequestration resulting from planting are presented on the Picture 25, and the dynamics of this process is shown by the curve on the Picture 26.

	Sequestered Carbon Planting of ...	Sequestered Carbon Planting of ...		Sequestered Carbon Planting of ...	Sequestered Carbon Planting of ...		Sequestered Carbon Planting of ...	Sequestered Carbon Planting of ...
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	17	32.27	118.31	34	59.68	218.83
1	1.85	6.78	18	34.07	124.93	35	61.06	223.88
2	3.73	13.66	19	35.85	131.47	36	62.41	228.84
3	5.63	20.64	20	37.61	137.92	37	63.74	233.70
4	7.54	27.64	21	39.35	144.29	38	65.04	238.49
5	9.45	34.66	22	41.07	150.59	39	66.32	243.19
6	11.37	41.70	23	42.76	156.80	40	67.58	247.81
7	13.30	48.77	24	44.44	162.94	41	68.82	252.35
8	15.23	55.85	25	46.09	169.01	42	70.04	256.82
9	17.16	62.93	26	47.72	174.97	43	71.24	261.21
10	19.10	70.02	27	49.31	180.81	44	72.42	265.53
11	21.02	77.06	28	50.88	186.55	45	73.58	269.78
12	22.93	84.07	29	52.41	192.18	46	74.72	273.96
13	24.83	91.03	30	53.92	197.71	47	75.84	278.08
14	26.71	97.94	31	55.40	203.14	48	76.94	282.13
15	28.59	104.82	32	56.85	208.47	49	78.03	286.11
16	30.44	111.61	33	58.28	213.70	50	79.10	290.04

Picture 25. Sequestration of carbon and CO_2 removal per 1 ha of Central Park territory



Picture 26. Dynamics of carbon accumulation after greenery 4ha of territory in the Gori Central Park.

From the obtained results it comes that in the first year after the planting at the area of 1ha 2.3 tons of carbon will be accumulated, while till 2020 after greening 4ha in the Gori Central Park 45.5 tons of carbon will be sequestered annually being equivalent of 166.8t CO_2 annual absorption/removal (Table 53).

Table 53. Features of annual accumulation of carbon in the Gori Central Park

Years	2015	2016	2017	2018	2019	2020
Carbon accumulation according to years, tC	7.4	14.9	22.5	30.2	37.8	45.5
Annual absorption of carbon dioxide, tCO_2	27.1	54.6	82.5	110.7	138.6	166.8

Obtained Results

Table 54. Carbon accumulation potential resulting from the planned greening activities in Gori

Scheduled measures	Annual sequestration of carbon, tC					
	2015	2016	2017	2018	2019	2020

Widening of forest-park planted in 2014 in Gori, additional greening by 1ha annually till 2020, in total 6ha. Budget in the initial year of planting 27 257.0 USD	2.4	7.1	14.1	23.5	35.5	49.7
Reconstruction of Central Park, additional greening of 4ha. Budget of the project: 77 652.5 USD	7.4	14.9	22.5	30.2	37.8	45.5
Total	9.8	22	36.6	53.7	73.3	95.2
Annually absorbed carbon dioxide, t CO_2	36.0	81.0	134.2	197.0	269.0	349.1

Table 55. Sequestered carbon in the Gori green zones and carbon accumulation potential resulting from planned greening activities

Years	Annual sequestration of carbon, tC								
	2012	2013	2014	2015	2016	2017	2018	2019	2020
Carbon sequestration in the green zones (12.8ha) (without taking greening measures)	501.8	509.7	517.6	525.5	533.4	541.3	549.2	557.1	565.0
Annual sequestration of carbon resulting from greening activities (4ha) carried out in the city (2014)	-	-	8.8	17.6	26.4	35.2	44.0	53.2	62.0
Annual sequestration of carbon after the planned greening (planting of 6ha forest-park)	-	-	-	2.4	7.1	14.1	23.5	35.5	49.7
Reconstruction of Central Park, additional greening of 4ha	-	-	-	7.4	14.9	22.5	30.2	37.8	45.5
Total	501.8	509.7	526.4	552.9	581.8	613.1	646.9	683.6	722.2
Absorbed carbon dioxide, t CO_2	1 840.0	1 868.9	1 930.2	2 027.3	2 133.3	2 248.0	2 372.0	2 506.5	2 648.1

9. PUBLIC OUTREACH

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 and therefore inclusiveness of all national stakeholders is vitally important for this process. 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 Gori's Sustainable Energy Action Plan (SEAP). The SEAP preparation process clearly revealed potential barriers to the effective implementation of strategyg. 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:

1. National level barriers linked to bad past practices (especially for public awareness);
2. Current economic and social difficulties and a lack of technical know-how;
3. Barriers specific to Gori context and barriers to concrete project proposal and technologies.

The list of these barriers is given below on the scheme:

Barriers to Sustainable Energy Development Process in Georgia

1. Wasteful energy consumption. During Soviet times when energy was cheap, consumption was almost unlimited;
2. Lack of awareness or knowledge about sustainable development among local policy-makers and general public. Only a few people are aware of sustainable development concepts which are directly engaged in this activities.
3. Absence of a clear vision of the relatively long-term prospects of the energy sector development (different target groups yet have sharply contrasting positions, which often are not based upon real calculations);
4. There is no joint, well-considered and formulated vision of the role of energy efficiency and renewable energy resources in a short-and long-term perspectives of Georgia's energy sector while in recent years the 10% growth rate in energy demand is being recorded. Correspondingly the potential of these resources (except hydro) is not defined as well as the directions of the development of this potential, there is no relevant legislation and declared objectives similar to gasification of the country or hydro energetics.
5. The technology market is inferior and contains several risks. Each failure of a new technology and demonstration development in this direction. The long-run planning of energy sector does not consider the availability of technologies;
6. Activities in the field of energy efficiency and renewable energies (except hydro) conducted by separate non-governmental organizations are mainly uncoordinated and non-purposeful. Though it should be mentioned that the raise in energy efficiency, despite its chaotic character, is going on in the century that is partly facilitated by the market of contemporary technologies (mainly of domestic profile and intrusion in Georgia of energy standards, existing on the international level.

While identifying these barriers it has been considered that the managerial team of Gori Municipality has a vision of sustainable energy development prospects, demonstrates great interest to the adoption of modern, clean, energy efficient and renewable technologies, but lacks relevant knowledge and experience in managing present-day technologies. However, the support by the Municipalities is not fully reasoned out and lacks eyesight of what could be made at the place by themselves and how could by realized a concrete measure effectively.

Barriers to the Gori Sustainable energy development

1. Shida Kartli Region and the Gori Municipality are facing almost the same obstacles to sustainable energy development as other regions or municipalities in Georgia, and in particular the self-governing cities like Gori. Among these barriers first of all should be mentioned their complete dependence on the centralized energy supply in energy sector and full reliance on the private sector concerning other energy carriers. This dependence on centralized processes partly deals with the gas supply sector, where municipalities mainly rely on the processes determined by plans worked out under the central government guidance. As to the gasoline, diesel and other kinds of fuel, this is the prerogative of private importers. Correspondingly, at this stage municipalities have no vision on their roles in the energy planning process, as well as on the risks related with centralized supply and do not plan measures to lessen these risks and hazards.
2. The Gori Municipality has no complete statistics on the energy consumption by the city that would serve as a basis for the planning of growing energy demand of the city. There is no vision and strategy to foresee the energy supply of the city in case of failure of one of present rings of energy provision. Accordingly, the city has no sufficiently thought out energy efficiency substantiation, determining its role in the process of sustainable socio-economic development of the city. There is no vision of what problems could face the city in case of rapid growth of economy and number of population, as well as intensification of traffic.
3. The Gori Municipality has no relevant experience, knowledge and no sufficient expert potential to plan, manage and implement the energy sustainable development process. In particular, in the short-run strategy for the energy sustainable development process in Gori, one of the priority sectors is the buildings sector. In this direction the Municipality renders some co-financing to cooperatives and the population for the rehabilitation of residential buildings. However, for the preparation of energy efficiency measures the local trained personnel is needed, the shortage of which at the present stage is obvious.
4. Very important is as well the absence of extra funds. Most of the budget resources are used for infrastructure growth and social projects, that hampers the development of long-term energy policies;
5. The energy resources consumption sphere is unmanaged and chaotic at the Municipalities level and entirely in the country as well.

6. In the case of Gori more or less all those barriers are acute, which are typical and general for the whole country.

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

Barriers related to Technologies

1. Lack of knowledge about modern energy-efficient and renewable technologies available at the international market. Only a few technologies are assessed and studied for their adaptation in Georgia that significantly increases risks related with their introduction in the country. Taking of these risks are not welcome both in private banks and in private sector. Consequently, the import of technologies, their dissemination and adoption is almost in the hands of non-governmental sector or those big investors who are interested in developing markets for own technologies. Accordingly, high technologies which are imported at the limited scale, are accompanied with large part of worthless technologies. At the same time this is mostly promoted by the cost of technology and unfortunately even for the short-time prospective;
2. Lack of knowledge about the local environment, in which certain technology should operate (e.g. energy-efficient bulbs become absolutely ineffective and economically unprofitable within old and improperly functioning electricity networks). Studies of these aspects bring additional burden to technologies.
3. Lack of knowledge and awareness on environmental and social counter-indications. The study of technical risks associated with technologies requires profound understanding of technology by the accepting party to insure relevant assessment of risks and their minimization;
4. Lack of sufficiently trained local personnel which could be able to select correctly certain technology with respect to local conditions and provide its proper operation. This problem is especially acute at the municipalities and self-governing cities level;
5. Most renewable technologies are not sufficiently flexible and easily adaptable to different environments. Majority of them have no market shape and their adaptation to local conditions requires additional funding and knowledge.

The analysis of stakeholders has identified target groups for awareness rising and retraining, active collaboration with which is necessary to overcome the majority of listed above barriers. However, it should be noted that there are common to the country obstacles the overpassing of which will be extremely difficult without the serious intervention from the side of Central Government.

The target groups to which this strategy is addressed are as follows: Gori City Municipal Staff and Members of Gori City Council, Gori flat owners' associations/cooperatives and the Gori city population in general.

In the process of preparation of present document and consultations with local stakeholders it has been revealed that at the present stage the priority of Gori Municipality is Buildings sector. Accordingly, to implement the Action Plan it is essential to carry out these measures which will provide awareness rising among the Gori population on the necessity of increasing energy efficiency in buildings. 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 process of developing action plans. Global practice has shown that the higher the involvement of population at the earlier stages, the easier the management of the process is, and the stronger the support of the project from the public.

At the initial stage of the Gori SEAP development the meetings and consultations with the population in the most vulnerable districts are necessary to explain the need for the implementation of certain project and the benefits it can bring about. During the consultations new project ideas could arise or the necessity of making corrections in the planned projects may be revealed.

While preparing the Gori SEAP, the meeting with Gori Administration and representatives of City Hall relevant departments were held (Economic Development Service – Department of Transport and Infrastructure Development, Education, Sports and Culture Service, Finance and Budget Service), since the staff of these departments owns major part of information necessary to develop and carry out the SEAP and they represent the basis determining the success of the entire project.

In the process of Gori SEAP implementation the awareness raising and local staff training strategy consists of the following steps:

Short-term Strategy (2015-2017)

1. Raising local authorities' awareness on sustainable energy development advantages as well as the social and economic benefits;
2. Training the Municipality staff and bringing in external human resources to ensure successful implementation and monitoring of the SEAP;
3. Provision of Gori with technical staff which will ensure the development of energy efficient projects in Buildings sector for cooperatives and residents;
4. Setting up of an information –education campaign to raise public awareness. Preparation of information/education/illustration materials about successful experiences and modern technologies that are recommended for the green development of cities; Demonstration to the population the advantages of energy efficiency measures and technologies introduction in different sectors;

5. Involvement of private sector in the activities of the SEAP through information campaigns on energy efficient and economically profitable technologies, offering cooperation strategies to public and private sectors.

Long-term Strategy (2018-2020)

In the long-term strategy the private sector starts active involvement in the Buildings sector that would bring the necessity for many restrictions causing changes in population awareness and partly in traditional behavior. The main directions of long-term strategy are:

1. Initiation of consultations with stakeholders (city population, private sector, non-governmental sector) on regulations and standards to be adopted by the municipality in different sectors (Buildings, Transportation, Waste) to identify potential barriers to their introduction;
2. Development and implementation of awareness raising and incentive programs for different target groups to ensure the unimpeded introduction of standards and regulations (e.g. in energy efficiency).

Table 56. City of Gori Public Outreach Action Plan 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)	• **Gori Municipality & the City Council** • **Gori City Households Condominiums** • **Citizens of Gori**	**Main goal of short term strategy is 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 target groups (households condominiums and citizens of Gori); to provide assistance to the population and other stakeholders for receiving benefits from this initiative; to provide specialists / future experts with relevant training to ensure optimal implementation and monitoring of the Action Plan.**	• **Gori 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**	• **Gori SEAP is being successfully implemented** • **Gori City Hall continues the same activity after 2018** • **Gori population is informed on initiatives launched by the city authorities**	• **Gori 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. SEAP and Other Technical Staff Training					
Training of technical expert for Gori Municipality who are qualified to assist the condominiums and citizens in preparation and implementation of project proposals with the elements of energy efficiency. Mainly these technical experts will work on projects co-	• Special technical service group established by the City Hall to serve the City Hall, Gori population and the private sector in preparation and implementation of special project proposals on building energy efficiency	• Facilitate training of special technical support groups/services under the responsibility of Municipality or outside of Municipality working with municipality, condominiums, private sector, etc. on preparation and implementation of energy efficiency building projects and publicity of new efficient technologies	• Gori City Hall • Private sector (including foreign investors) working on buildings energy efficiency	• Program and manual for training the technical staff for the City Hall technical support group • Personnel is trained and selected on a competitive basis • Technical support staff actively involved in exchange	• **Gori City Hall** • **EC-LEDS Project** • **USAID** • **GIZ** • **EU**

financed by condominiums and Municipality		• Develop the technical support team training programs. Programs as minimum should be focused on analysis of state-of-the -art building technologies, barriers to implementing such technologies, and advantages and disadvantages of existing EE technologies • Prepare manuals for technical support groups • Include technical support team in exchange programs and international information networks		programs and international networks to obtain the latest information on technologies and approaches in the energy sector • A technical team intensively works with condominiums	
Training the staff of Gori Municipality to make qualified recommendations to ensure successful implementation of the Covenant of Mayors Process	• The SEAP Team of Gori Municipality	• Technical group/service • Establish special support group/service within or outside Gori 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 in order to get	• Gori 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 for training of specialists for the City Hall technical support group • Clearly defined responsibilities and working program for selected specialists for City Hall, the public and private sectors • SEAP support staff is actively involved in exchange programs and international networks to obtain the latest information on technologies and approaches in the energy sector	• **Gori City Hall** • **EC-LEDS Project** • **USAID** • **GIZ** • **EU**

	• Special service[50] established by the City Hall to serve the City Hall, Gori population and the private sector through giving relevant recommendations	experience in international best practice • Involve potential candidates for the support team early in the SEAP preparation process.		• SEAP support team is ready to assist private sector and train specialists for the private sector	
2. Public information and awareness raising					
Awareness raising among households condominiums 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	• Domestic Partnership • Households Condominiums • 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 Gori. (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 energy efficient	• Gori City Hall • NGOs	• TV ads and leaflets for Gori residents on effective technologies on the market and their advantages are prepared and showed on TV channels "Trialeti" & "Dia" • Number of pilot projects with maximum	• **Zugdidi City Hall** • **USAID** • **GIZ** • **EU**

[50] At the initial stage of implementation this function could be performed by the economy development unit of Gori Municipality or by Energy Manager working on SEAP preparation

on consulting the city population on energy efficient measures in buildings, and on providing the information on modern technologies and the best practices for implementation		measures carried out by signatory cities of the Covenant of Mayors and subsequent outcomes • Hold regular meetings with the public and train PR workers within residential condominiums • Involve the public in the preparation and implementation of pilot projects		involvement of local population are implemented • Updating of information is going on at the municipality website (www.gori.gov.ge) and Facebook page • Information booklets on energy efficiency measures are prepared	
3. Raised Awareness of Gori Municipality and Council Representatives					
Raise local officials' awareness on the advantages of the city's energy consumption sustainability and social and economic benefits of the measures	• Gori City Hall • Gori City Council	• Carry out seminars for the representatives of Gori City Hall and City Council on the advantages and perspectives of sustainable energy consumption in the city. • Support participation of representatives of City Hall and City Council in meetings and conferences connected to the Covenant of Mayors process at local and international levels. • 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	• Gori City Hall • Gori City Council • Regional Energy Efficiency Center (in case of its establishment) • Ministry of Energy of Georgia • Ministry of Environment and Natural Resources Protection	• 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	• **EC-LEDS** • **USAID** • **EU-COM** • **GIZ** • **Partnership for mitigation** • **GHG reduction projects** • **National Communications of Georgia on Climate Change**

				City Council are fully involved into the current processes at local and international level • Regularly updated information at the City Hall web site on current processes and projects	
Long-term goals (2018-2020) **Main goal of the 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**	• **Gori City Hall** • **Gori City Council** • **Gori City Population** • **Private sector** • **NGOs**		• **Gori City Hall** • **Gori City Council** • **Energy Efficiency Center (in case its establishment)** • **Private Sector Initiative Group** • **CoM's Programs and Projects**	• **Gori 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. Involving the private sector in reaching SEAP goals					
Enhance involvement of the	• Private sector	• Raise private sector interest in renewable energy for using	• Gori City Hall	• Each year different activities are	**Gori City Hall** **Private sector**

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	• A private sector initiative groups	innovative technologies by levying local tax and tariff concessions for companies implementing energy efficient and innovative technologies, etc. • 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; • Encourage the creation of an initiative group from the private sector working to include the renewable energy field in the CoM process.	• Technical group/Service of Gori City Hall • Energy Efficiency Regional Center (in case of its establishment) • Private sector • NGOs	arranged on the subject • Incentive mechanisms are created to ensure involvement of the private sector in processes to develop 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	**EU COM** **GEF** **UNFCCC-programs**
2. Intensifying consultations with stakeholders in the introduction of regulations and standards					
• Intensify consultations with stakeholders (city population, private sector, non-governmental	• Gori City Hall • Gori City Council • Gori city residents • Private sector • NGOs	• Ensure maximum information on standards and regulations elaborated for the sectors considered in the city sustainable energy plan to the public and	• Gori City Hall • Technical group/service of the Gori City Hall • Regional center of energy efficiency and Innovative	• Specialists who will work with target groups are prepared • Explanatory work and consultations	Gori City Hall Gori City Council

sector) on the regulations and standards to be introduced by municipality in different sectors (construction, transport, waste management)		private sector 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	Technologies (in case of its establishment)	on regulations and necessary standards for implementation of SEAP are conducted regularly 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.)	
3. Identifying barriers through consultations with stakeholders					
Identify barriers encountered during the implementation of regulations and standards through consultations with stakeholders	• Gori City Hall • Gori City Council • Gori residents • Private sector • NGOs	• Identify barriers found during consultations with residents regarding standards and regulations/restrictions being considered for SEAP sectors • Develop measures aimed at overcoming identified barriers by consulting with target groups (e.g. traffic restrictions must be introduced gradually, setting up of "pedestrian's days" on some streets, etc. Though individual measures, e.g. vehicles technical control, will be taken simultaneously under the government's decision)	• Gori City Hall • Gori City Council	• 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	Gori City Hall
4. Raise awareness of decision makers, public and private sectors about the needs for regulations/restrictions 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 implementing structures.	• Gori City Hall • Gori City Council • Gori city residents • Private sector operating in Gori	• Inform decision makers and 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	• Gori City Hall • Programs and projects of the CoM	• Decision makers and implementing structures 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 Structure

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

- The implementation strategy, as an integral part of the city SEAP, is approved and monitored by the Gori City Council;
- Updating and implementing the strategy is under the responsibility of Gori City Hall (Technical Group);
- Training of local staff to implement and monitor the Strategy will become the responsibility of the Technical Group at the City Hall, the setting up of which is planned by the City Hall and the structure of which is presently discussed. For this, local or international programs currently going on in the frames of Mayors' initiative will be used;
- The preparation of materials on awareness raising and informing target groups mainly should be performed using the external resources (non-governmental sector).

10. MONITORING, VERIFICATION AND REPORTING ON THE IMPLEMENTATION OF SEAP AND GHG EMISSIONS REDUCTION IN GORI

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, especially to those, which gained the self-governing status in 2014, e.g. the city of Gori. 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 Gori 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 evaluate

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 Gori 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 Gori SEAP monitoring group.[51]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 Gori 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 Gori are as follows:

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

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

1. The Gori 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 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 as well as the simplified computer program (MUNI – EIPMP) will be sent to the City Hall under the

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

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 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 that 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 Gori Unit Responsible for Monitoring

The overall responsibility for preparing and implementing the CoM and SEAP, and for updating them falls 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 Gori: buildings sector, transportation sector, street lighting sector, methane emissions from waste sector and increasing emission sinks by green area development. In order to evaluate each sector's baseline scenario, information on activity data is necessary. 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, Gori 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. Figure 10 shows City Hall offices and LCCs responsible for data collection.

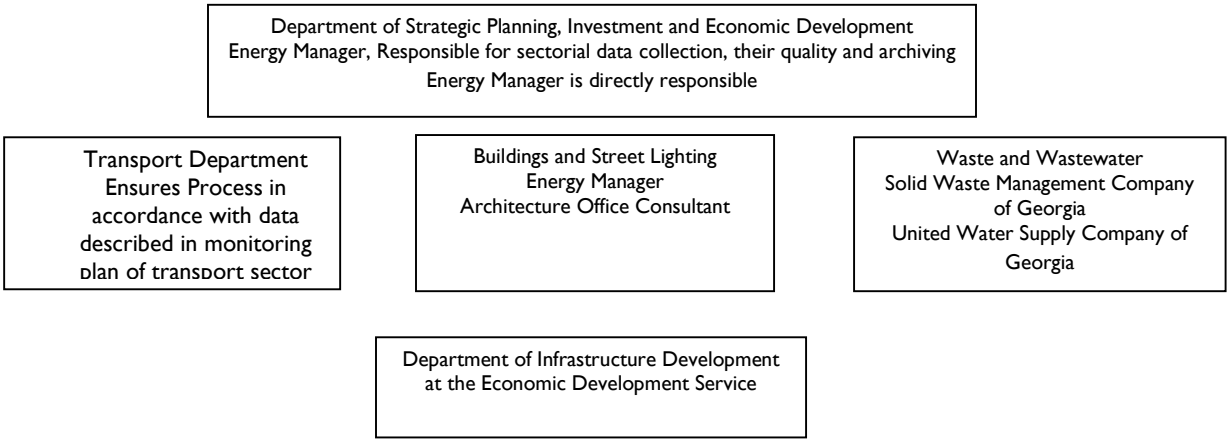


Figure 10. Monitoring Process Management

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

- Annual emissions in CO_2 equivalent;
- 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, and then automatically calculated with muni_EIPMP software. An approved monitoring group from the Gori 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.[52] The reporting structure will be created by the monitoring group in alignment with a common format developed and proposed by the Covenant of Mayors. However, it is expected that for the perfection of monitoring process new approaches and methodologies will be gradually introduced. In this case, where it will be relevant, the results obtained under the old methodology must be recounted with the new one to provide the conforming of results acquired in different years to the BAU data.

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

10.1. MONITORING OF MAIN DRIVING PARAMETERS FEATURING GHG BASELINE INVENTORY (BEI), BAU SCENARIO AND GHG BASELINE INVENTORY MONITORING (MEI).

The purpose of these parameters is to update the baseline scenario taking into account current significant social and economic changes in Gori.

Data/Parameter # 2.1	**Population through the monitoring year**
Data unit:	Number of population
Description:	Primary data[53]; Annual monitoring .
Source of data used:	Annual statistics (www.Geostat.ge) and local statistics
Value applied:	**50 400 (2012)**
Any comments	The Gori population of the monitoring year is used to make BAU scenario calculations in terms of new circumstances, test additional values, and ensure data control and monitoring of per capita emissions trends. The surplus to 2012 value will be used to compare new BAU with the old one.

Data/Parameter # 2.2	**Gross Domestic Product (GDP) in the monitoring year**
Data unit:	Million GEL
Description:	Calculated data; Annual monitoring
Source of data used:	Statistical annual (www.Geostat.ge) and local statistics. This SEAP source was Gori 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, Shida Kartli Region's GDP and total amount of the same region's population make it possible to determine per capita GDP in the Shida Kartli region and then, during the monitoring year, to estimate the GDP of Gori 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.

[53]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.

Emission Factors

Data/Parameter # 2.3	**Grid emission factors t CO_2 MWh**
Data unit:	T **CO_2**/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 Gori does not produce electricity independently but receives it from the centralized energy system of Georgia.

Data/Parameter # 2.4	**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 (applied for Tier 1 calculations)
Value applied:	55.78 t CO_2 /TJ; 5 kg CH_4 /TJ; 0.1 kg N_2O /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 # 2.5	**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 Tier 1 calculations)
Value applied:	68.6 tCO_2/Tj; 20 Kg CH_4/Tj; 0.6 Kg N_2O /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 # 2.6	**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 Tier 1 calculations)
Value applied:	73.3 tCO_2/Tj; 5 kg CH_4/Tj; 0.6 kg N_2O /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 # 2.7	**Net Calorific Value of Different Fuels (NCV for NG, Gasoline, Diesel)**
Data unit:	TJ / Unit of fuel
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.

10.1.1. Activity Data Necessary for Monitoring the Gori Transport Sector

Public Transport (Mini-buses)

Data/Parameter # 3.2.1	**Quantity of mini- buses**
Data unit:	Quantity of buses during the monitoring period (annual value)
Description:	Primary data
Source of data used:	Data provided for SEAP by Gori Municipality. Transport Department of the Gori City Hall Economic Development Service.
Value applied:	58 (Natural Gas)
Any comments	Transportation is provided by 3 private companies. Buses are 12-seat "Ford-Transit". Transport is non-organized and has no relation with the City Hall.

Data/Parameter # 3.2.2	**Average distance traveled by one mini-bus per year by fuel type (gasoline, diesel, gas)**
Data unit:	km/year
Description:	Primary data
Source of data used:	Information provided for SEAP by Gori Municipality. Information obtained with experts judgment after questioning private companies.
Value applied:	11 260 (Natural Gas)
Any comments	It is recommended that this data be taken directly from private transport companies by the monitoring group, and that it shows daily run (km) of buses in order to calculate annual data. Data validation and verification is the responsibility of the Gori Municipality Transport Service, which is responsible for regulating city transportation.

Data/Parameter # 3.2.3	**Total distance traveled by all buses annually (by fuel type)**
Data unit:	Km / year
Description:	Secondary data, calculated by the MUNI_EIPMP.
Source of data used:	Number of mini-buses multiplied by the annual run of each bus
Value applied:	653 080 km/yr.
Any comments	

Data/Parameter # 3.2.4	**Average consumption of Natural Gas per 100km by 1 mini-bus**
Data unit:	M^3/100 km
Description:	Primary data
Source of data used:	Provided to the SEAP by Gori Information obtained under expert judgment, questioning transport companies.
Value applied:	M^3/100 Km
Any comments	This data should be checked with bus registration certificates and analyzed in case of significant discrepancies. Mini-buses are second-hand, altered, operating on very poor roads, hence their fuel consumption drastically differs from certified consumption

Data/Parameter # 3.2.5	**Annual consumption of fuel by all mini-buses (by fuel type – gasoline, diesel)**
Data unit:	M^3/year
Description:	Secondary data. Is to be calculated by monitoring team.
Source of data used:	Calculated by the MUNI_EIPMP
Value applied:	65 308 (Natural gas)
Any comments	The data is calculated by the monitoring group.

Data/Parameter # 3.2.6	**City mini-bus load factor[54]**
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:	In case of Gori SEAP this parameter was not evaluated
Value applied:	Not assessed
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 3.2.7 (mobility) is known, it can be calculated.

Data/Parameter # 3.2.7	**Annual passenger turnover per mini-bus**
Data unit:	Passenger.km/year
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:	In the Gori SEAP at this stage this parameter was not estimated.
Any comments	This parameter is calculated by City Hall Transport Department, transportation companies or Statistics National Service for entire country

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

Private Passenger Cars

Data/Parameter # 3.3.1	**Number of private cars registered in Gori (by fuel types)**
Data unit:	Number of Cars
Description:	Primary data
Source of data used:	Ministry of Internal Affairs – Analytical Center, Transport Department of Gori City Hall. Provided to SEAP by Gori Municipality
Value applied:	9,016 (total): 7,437 (on gasoline); 285 (on diesel); 1 294 (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 to SEAP by Gori Municipality. Assessed through surveys
Value applied:	3 840 Km/Year
Any comments	In future the National Statistics Office and interviews with drivers could be used to learn average daily run, then to make yearly calculation. Surveys should meet reliability criteria. Interviews and surveys to determine daily run and the SEAP implementation will be conducted simultaneously.

Data/Parameter # 3.3.3	**Average distance traveled by all passenger 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 run (km) 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:	In general taken from the registration certificate of a motor vehicle. Provided to the SEAP by Gori Municipality according to the survey among passenger cars
Values applied:	Gasoline -8 l/100 km Diesel-6 l/100 km Natural gas-8 m^3/100 km
Any comments	This data should be rechecked via registration certificate and surveys. In Gori private cars are old or second hand, operating on poor roads, hence their fuel consumption greatly differs from certificate data

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 Number of gasoline powered motor vehicles multiplied by fuel consumption (100 km) multiplied by one car annual run and divided by 100.
Value applied:	2284 646 L (Gasoline) 2 65 664 L (Diesel) 397 517 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. At this stage is calculated by "Remissia"

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:	While preparing the Gori SEAP this parameter was not assessed
Value applied:	Not evaluated
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:	While preparing the Gori SEAP this parameter was not assessed
Value applied:	**Not evaluated**
Any comments	Number of vehicles is multiplied by one car's annual run and multiplied by the average load factor of a car.

Municipality- Owned Fleet

Data/Parameter # 3.4.1	**Gori municipality service vehicles (by fuel type)**
Data unit:	Amount of vehicles
Description:	Primary data
Source of data used:	Provided to the SEAP by Gori Municipality
Value applied:	**Total 46** **On gasoline -29, diesel- 9, Natural gas - 8**
Any comments	Gori 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 Gori Municipality
Value applied:	**4 560 km/year**
Any comments	Gori 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:	**209 760**
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 or m^3/100km
Description:	Primary data.
Source of data used:	Provided to the SEAP by Gori Municipality
Value applied:	**Gasoline -8** **Diesel – 6** **Natural gas - 8**
Any comments	Gori Municipality Transport Department is responsible for these data. Could be checked by the certificate data.

Data/Parameter # 3.4.5	**Annual fuel consumption of the entire municipal fleet (by fuel type)**
Data unit:	l/yr. – m^3/year
Description:	Secondary data. Calculated by the monitoring group. At this stage calculated by "Remissia"
Source of data used:	Calculated by the MUNI_EIPMP: 3.4.5 = 3.4.1. * 3.4.2. * 3.4.4/100
Value applied:	10 574 (Gasoline) 2 462 (Diesel) 2 918 (Gas)
Any comments	Verification will be done in accordance with consumed fuel costs

Commercial Transport (Taxi)

Data/Parameter # 3. 5.1	**Taxi cabs of Gori by fuel type**
Data unit:	Number of taxis by fuel type
Description:	Primary data
Source of data used:	Ministry of Internal Affairs. Analytical Center. Provided to SEAP by Gori Municipality
Value applied:	198 (total) 18 (on gasoline); 180 (on natural gas)
Any comments	Gori 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 Gori Municipality. Expert judgment. Survey among private companies/taxis
Value applied:	**14 400**
Any comments	The Gori 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. Present data is obtained by observations and questioning/survey

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:	2 851 200 total run 259 200 (on gasoline); 2 592 000 (on natural gas m^3)
Any comments	At this stage calculated by "Remissia". Further will be calculated by the monitoring group

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:	Provided for the SEAP by Gori Municipality. Expert judgment, survey, private companies
Value applied:	Gasoline 8 L Gas 8 m^3
Any comments	Registration certificate could be used for rechecking, but majority of taxis are second-hand and their real consumption differs from certificate data

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:	20 736 (Gasoline) 207 360 (Natural Gas)
Any comments	Quantity of gasoline or gas-fueled taxis multiplied by fuel expenses (100 km) multiplied by one taxi's annual run and divided by 100. At this stage calculated by "Remissia". Further will be calculated by the monitoring group.

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 by other method.
Source of data used:	Was not assessed for Gori SEAP
Value applied:	**Not estimated**
Any comments	

Data/Parameter # 3. 5.7	**Total number of passengers carried by all cabs a year (annual mobility of cabs)**
Data unit:	Passenger.km/year
Description:	Secondary parameter
Source of data used:	Calculation must be conducted by the monitoring group
Value applied:	**Not assessed**
Any comments	3.5.7. = 3.5.1. * 3.5.2. * 3.5.6.

Commercial Transport Small (Light-Duty) Trucks (up to 2 tons)

Data/Parameter # 3. 6.1	**Small trucks driving inside Gori**
Data unit:	Small trucks by fuel type
Description:	Primary data
Source of data used:	Provided for the SEAP by Gori Municipality. Transport Department. Municipality got this data from the analytical Center of the Ministry of Internal Affairs.
Value applied:	**1 068 (total)**
Any comments	Primary verification of these data is the responsibility of Gori City Hall Monitoring group

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 Gori Municipality. A result of surveys and expert assessments
Value applied:	7 200
Any comments	Primary verification of these data will be the responsibility of City Hall Transport Department or the monitoring group

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 ("Remissia") Data# 3.6.1 and 3.6.2

Value applied:	7 689 600 Total run 1 209 600 (diesel), 302 400 (gasoline), 6 177 600 (gas)
Any comments	

Data/Parameter # 3. 6.4	**Fuel consumption by vehicle types**
Data unit:	l/100 km m^3/100km
Description:	Primary data
Source of data used:	Provided for the SEAP by Gori Municipality. A result of surveys and expert assessment
Value applied:	Gasoline-14 l, Diesel – 10 l, gas – 10 m^3
Any comments	This data should be checked with registration certificate of each motor vehicle and analyzed in case of significant discrepancies.

Data/Parameter # 3. 6.5	**Annual fuel consumption by vehicle and fuel types**
Data unit:	l/year m^3/year
Description:	Secondary data
Source of data used:	Calculated by the MUNI_EIPMP/(Remissia) : 3.6.5. = 3.6.1. * 3.6.2. * 3.6.4/100
Value applied:	42 336 l (Gasoline), 617,760m^3 (gas) 120 960 l (Diesel)
Any comments	Number of small trucks multiplied by fuel consumption per 100km multiplied by annual run of the truck and divided by 100.

Data/Parameter # 3.6.6	**Small trucks load factor (load factor)**
Data unit:	t.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:	While preparing the Gori SEAP this parameter was not assessed

Value applied:	**Not estimated**
Any comments	Essential in calculations of measures taken

Data/Parameter # 3. 6.7	**Transported freight by all small trucks in a year (annual freight turnover)**
Data unit:	t.km/year
Description:	Secondary data
Source of data used:	Calculated via MUNI_EIPMP (Remissia): Data #3.6.1*3.6.2*3.6.6.
Value applied:	**Not assessed**
Any comments	Quantity of small trucks multiplied by annual run and multiplied by transported freight for one vehicle. These parameters can be verified through freight actually transported and kilometrage.

Commercial Transport Large (Heavy-Duty) Trucks

Data/Parameter # 3. 7.1	**Number of large trucks driving in Gori (diesel)**
Data unit:	Number of large trucks by fuel type
Description:	Primary data
Source of data used:	Provided to the SEAP by Gori Municipality Transport Department, which got this information from the Analytical Center of Ministry of Internal Affairs and private companies.
Value applied:	347 (total) 14 Gasoline, 285 Diesel, 48 Gas
Any comments	Primary verification of these data is the responsibility of the City Hall Transport Department and the monitoring group

Data/Parameter # 3. 7.2	**Average distance covered by one large truck a year (by fuel type is recommended)**
Data unit:	Km/year
Description:	Primary data
Source of data used:	Provided to the SEAP by Gori Municipality. Survey results. Expert judgment
Value applied:	8 560

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 (Remissia): Data # 3.7.1 and 3.7.2
Value applied:	2 970 320 (total) 119 840 (Gasoline) 2 439 600 (Diesel) 410 880 (gas)
Any comments	

Data/Parameter # 3. 7.4	**Fuel consumption by vehicle type**
Data unit:	l/100 km. m^3/100km
Description:	Primary data
Source of data used:	Registration Certificate of a motor car. Provided to the SEAP by Gori Municipality. Expert assessment, survey in private companies
Value applied:	32 l (gasoline) 25 l (Diesel) 18 m^3 (gas)
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 (Remissia)
Value applied:	38 349 l (Gasoline), 609 900 l (Diesel) 73 958 m3 (gas)
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:	For the Gori SEAP this index was not assessed
Value applied:	Not estimated
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:	t.km/year
Description:	Secondary data
Source of data used:	Calculated by the MUNI_EIPMP (Remissia): 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	**Total Fuel consumed by Gori transport sector by fuel type**
Data unit:	l/year (MWh) m^3/year (MWh)
Description:	Secondary data calculated during Monitoring and SEAP preparation process
Source of data used:	Calculated by the SEAP team (Remissia) using emissions raise index derived by the EU Research Center
Value applied:	Consumed throughout 2012 under the SEAP: 44 105 MWh equivalent fuel, corresponding to 10 559 t CO_2eq emissions. In 2020 emission of 15 733 t CO_2 eq is projected
Any comments	This data is important for balance verification during the monitoring period.

10.1.2. Waste

Data/Parameter # 4.1	**Amount of waste (deposited and collected daily at the landfill) Existing Gori Municipal landfill (operating since 1980)** **Current landfill in Gori**
Data unit:	m^3 or ton/yr.
Description:	Primary data
Source of data used:	The data has been provided during the SEAP preparation process by the city Energy Manager and Georgian Solid Waste Management Company
Value applied:	66 960 m^3 or 13 392 ton of waste (as for 2012)
Any comments	In 2013 the Gori landfill has been rehabilitated and now waste is being dumped in turn with soil. Landfill is divided by sections piled alternately with soil and composted. Since 2013 the landfill is serving 14 villages nearby Gori

Data/Parameter # 4.2	**Gori Municipality landfill parameters (area, depth, waste composition)**
Data unit:	Area -ha Depth -m Waste composition-%
Description:	Primary data. Used for methane emission quantitative assessment
Source of data used:	During the SEAP preparation process the data has been provided by the Gori Energy Manager's Service
Value applied:	Area -6 ha Depth – 5-7m (2012); >7m (2013-2020) Waste composition taken for calculations: Food waste – 71%; garden -0%, paper – 6%, wood-3%, textile -3%, pumpers -2%, plastics and other inert material -15%.
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[55]). There are some differences between the results that is quite normal since Tbilisi is much bigger regarding the territory and population. Gori differs from bigger cities in terms of the lifestyle, quality of life and living conditions, nevertheless data from Tbilisi have been applied in view of climate similarity. Percentage composition of generated waste is measured in Tbilisi is: organic waste -71%, paper -6%, textile -3%, plastics -6%, inert material -5%, metal -3%, other -6%. These data were transferred by expert into fractions used in methodology and applied in calculations. Other sources have more estimation character.

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

Data/Parameter # 4.3	**Generated methane calculation (in case if landfill is not closed and project proposal not realized)**
Data unit:	m^3 or ton
Description:	Primary data. Being obtained through measurements by the monitoring group
Source of data used:	This data/quantity has been estimated by FOD model of the IPCC 2006: http://www.ipcc-nggip.iges.or.jp/public/2006gl (p.336)
Value applied:	• Parameters for calculation • Number of population • Waste generated per capita (daily or annually) • Composition of waste (index 4.2) • Methane 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 Pumpers/Diapers 0.24 • Fraction of actually decomposed DOC (DOC_F) -0.5 -0.6 • Fraction of methane in landfill gas (F) – 50% • Oxidation ratio (OX)-0.1 *managed landfill) According to SEAP in 2012 generated and emitted into the atmosphere methane was 0.51 Gg (10 710 t CO_2eq), while in 2020 this quantity would be 0.58 Gg methane (12 180 t CO_2eq)
Any comments	If methane would not be flared, its emission would not be measured and listed parameters will be monitored and methane generation will be assessed.

Data/Parameter # 4.3	**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 number • 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)
Any comments	In case if 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.

Data/Parameter # 4.4	**Amount of collected and flared on the site methane**
Data unit:	m^3
Description:	Primary data. Obtained by measurement
Source of data used:	During the process of SEAP preparation this data, amount was assessed by the IPCC FOD mode
Value applied:	Assuming that the methane at the site flaring technology will be applied and methane will be flared from 2017, annually will be saved from emitting into the atmosphere on the average 8,000 t CO_2eq, and in 4 years (2017-2020) 33 000 tons of CO_2eq, making 69% of total (2012-2020) amount of generated methane (47, 700 tCO_2eq).
Any comments	

10.1.3. Street Lighting Sector

Data/Parameter # 5.1	**Total amount of electricity consumed for street lighting annually**
Data unit:	KWh/year
Description:	Primary data
Source of data used:	Gori City Hall Infrastructure Service office. The office is responsible for providing a report about the amount of electricity consumed for street lighting monthly or annually.
Value applied:	2 965 461 kW.h (in 2012) 3 824 226 kW.h (2020 forecast)
Any comments	The data will be verified with paid amounts. The projected data for 2020 have been calculated by the SEAP developing group.

Data/Parameter # 5.2	**Emissions savings in the Street Lighting Sector**
Data unit:	t CO2eq./yr.
Description:	Secondary data
Source of data used:	Calculated by the monitoring group annually
Value applied:	403.3 t CO2eq (2012); 520.1 t CO2eq (projection for 2020)
Any comments	

Data/Parameter # 5.3	**Quantity of energy-efficient (LED) bulbs, to partially replace inefficient/old bulbs and to be used in new installations**
Data unit:	Quantity of energy-efficient LED bulbs
Description:	Primary data
Source of data used:	Project/measure implementation unit
Value applied:	4 800 bulbs
Any comments	In 2013-2014 new lightening points were installed in Gori increasing the number of points/bulbs up to 4 800. It is planned under the Gori SEAP measures to replace all existing 4 800 bulbs by high efficiency LEDs bulbs in 2016. For accurate and conservative assessment of emission reductions the replaced old bulbs should be monitored from the perspective of their further utilization.

Data/Parameter # 5.4	**Energy saved by one energy-efficient bulb per hour**
Data unit:	KWh
Description:	Primary data
Source of data used:	Technical description of the bulb as well as assessment of actual difference in consumption between old and new type of bulbs
Value applied:	0.17 KWh
Any comments	More precise data should be used from the technical certificates of the bulb

Data/Parameter # 5.5	**Energy consumed by one LED bulb in 1ha**
Data unit:	KWh
Description:	Primary data
Source of data used:	Technical certificate of the bulb
Value applied:	0.061 KWh
Any comments	

Data/Parameter # 5.6	**Operational duration of street lighting system**
Data Unit:	h/day or h/year
Description:	Primary data
Source of data used:	Amenities Service of Gori Municipality
Value applied:	12 h/day; 4,380 h/year
Any comments	Street lighting includes illumination of streets and decoration lighting of buildings

Data/Parameter # 5.7	**Emissions saved by 2020 with the taken measure (introducing the LED bulbs)**
Data unit:	t CO_2eq
Description:	Secondary data. Calculated annually by the monitoring group
Source of data used:	SEAP preparing team
Value applied:	2.4 GWh energy will be saved by 2020 equivalent to 326t CO_2eq saving
Any comments	

10.1.4. Greening

Data/Parameter # 6.1	**Total planted area in Gori (2012)**
Data unit:	ha Number of plants by species
Description:	Primary parameter
Source of data used:	City greening service, Central Park (Akhalbaghi) Management, Management of the new 4ha forest-park
Value applied:	12.8ha of plants in the city (including 32 squares and 6ha greening in the Central Park
Any comments	12.8 ha does not include 4 ha of forest- park planted in 2014, that is included in measures to be taken

Data/Parameter # 6.2	**Annual carbon dioxide removal at the Gori territory against the background of greening activities in baseline 2012**
Data unit:	tCO2/yr.
Description:	Secondary Parameter
Source of data used:	Calculated during the SEAP development process

Value applied:	Annual sequestration 29.0t CO2/yr. Amount of carbon accumulated at the whole territory 12.8 ha makes 501.8 t C.
Any comments	

Data/Parameter # 6.3	**Planting 4 ha of forest-park in 2014**
Data unit:	ha Quantity of plants by species. Increase of carbon sinks
Description:	Primary parameter
Source of data used:	"Akhalbaghi" Ltd
Value applied:	Kinds and number of plants: maple, ash, lugustrum, cypress, pine, Althaea, Akaki-tree. Total number 4 500 saplings. By 2020 from this 4 ha annual removal of CO_2 will be 227 t higher than in other case.
Any comments	

Data/Parameter # 6.4	**Reconstruction of existing Central Park (Planting of 4ha new greenery)**
Data unit:	Planted area, ha Quantity of plants by species. Increase of carbon sinks
Description:	Primary parameter
Source of data used:	"Akhalbaghi" Ltd
Value applied:	Kinds and numbers of plants: maple, green (American) ash, catalpa, lugustrum, cypress, pine, total 3 850 saplings. 23ha will be rehabilitated gradually. By 2020 extra planting of 4 ha will be added to existing 6 ha. Resulting from the reconstruction of 4 ha of the Gori Central Park the annual removal of CO_2 will be increased by 167 tons to 2020.
Any comments	Total area of the Park is 23 ha that includes riparian groves and sporting territories. Perennial trees remain at only 6 ha and are highly degraded. They require rehabilitation and sustainable management that correspondingly will increase the potential of Park as a major sink of CO_2.

Data/Parameter # 6.5	**Planting of forest-park at the territory of Gori**
Data unit:	Area to be planted – ha; Number of plants by species; Increase of CO_2 sink
Description:	Primary parameter
Source of data used:	Gori "Amenities Service" Ltd
Value applied:	6 ha step-by-step planting kinds and number of plants: maple, green (American) ash, platanus, catalpa, oak, Akaki-tree, lugustrum, cypress, pine, thuja. All in all 2 008 saplings per 1 ha.

	Widening of 4 ha forest-park planted in 2014, namely planting 1 ha area annually till 2020, planting in total 6 ha verdure, increasing entire territory up to 10 ha. Planting extra 6 ha of forest-park till 2020 at the territory of Gori will provide additional removal of 182.2 t of CO_2 from the atmosphere
Any comments	4 ha of forest-park are already planted and planting of 1 ha more is planned in 2015. Remaining territory will be planted gradually. As the Gori Municipality has no precise greening plan of this territory, the SEAP used planting rate equal to 1 ha per annum

Data/Parameter # 6.6	**Annual cutting/trimming of trees by species**
Data unit:	m^3
Description:	Primary parameter
Gori "Amenities Service" Ltd	Gori "Amenities Service" Ltd and "Akhalbaghi" Ltd
Value applied:	In Gori SEAP only presently accumulated carbon on the Gori territory is assessed as well as annual sequestration by 2020. Cutting should be provided during the monitoring process
Any comments	

Data/Parameter # 6.7	**Annual fires or other causes of damage to plants**
Data unit:	ha
Description:	Primary parameter. Annual monitoring of area changes
Source of data used:	City Amenities Service
Value applied:	SEAP assesses only presently accumulated carbon and its annual sequestration till 2020, as well as measures to be taken. Forest fires, plant diseases and other injures to them should be provided during the monitoring process
Any comments	

Data/Parameter # 6.8	**Central Park monitoring**
Data unit:	ha
Description:	Primary parameter. Annual monitoring of area changes
Source of data used:	"Akhalbaghi" Ltd
Value applied:	Current condition of Gori Central Park is assessed under the SEAP
Any comments	

Data/Parameter # 6.9	**Gori Central Park changes (fire, diseases and reducing amount of trees)**
Data unit:	m^3
Description:	Primary parameter
Source of data used:	"Akhalbaghi" Ltd
Value applied:	SEAP assesses only present state of Central park and CO_2 removal by 2020. Monitoring of changes in biomass should be conducted annually
Any comments	At the present stage to calculate carbon sequestration by greenery default values are taken of the forests in similar regions (biomass increment, dry biomass quantity). Continuous monitoring for all used parameters is to be carried out and relevant changes in calculations required in case of parameters update should be made

Data/Parameter # 6.10	**Annual Monitoring of CO_2 sequestration changes**
Data unit:	t CO_2/yr.
Description:	Secondary parameter. Calculated by the monitoring group
Source of data used:	At this stage calculated by the SEAP developing team
Value applied:	Gori greening area in 2012 constituted 12.8 ha (about 34 recreation zones are fragmentally covered by plants, including Central park and the Cemetery. By 2012 up to 501.8 t C has been deposited at this territory (parameter 6.2). By 2020 resulting from different measures 722.2 t C will be accumulated at the Gori territory
Any comments	

10.1.5. Buildings Sector

Data/Parameter # 7.1	**Areas of municipal buildings according their purpose (kindergartens, administrative, etc.)**
Data unit:	m^2
Description:	Primary parameter
Source of data used:	Energy Manager appointed by the Gori City Hall for the preparation of SEAP
Value applied:	Total – 60 397 Kindergartens – 23 825 Municipal administrative buildings – 1 522 Other municipal buildings – 35 050
Any comments	Information possessed by the City Hall

Data/Parameter # 7.2	Annual consumption of electric energy by municipal buildings
Data unit:	MW.h/year
Description:	Primary parameter
Source of data used:	Gori City Hall Financial Service. Final quality of data is under the responsibility of Energy Manager assigned by Gori City Hall
Value applied:	Total – 759.7 Kindergartens – 35.1 Municipal administrative buildings – 532.3 Other municipal buildings – 192.3
Any comments	This data will be checked at "Energo-pro Georgia" and by energy audit estimations.

Data/Parameter # 7.3	**Areas of Gori residential buildings by types**
Data unit:	m^2
Description:	Primary parameter
Source of data used:	Provided to SEAP group by the Energy Manager of Gori City Hall. Part of information obtained from the Architecture/Urban Development Service of the City Hall; Information on the multi-storey buildings possesses City Hall's Economic Development Service, which implements different types of social projects for these buildings; Information on the number of private buildings (mainly one-and-two-storey) is stored at the Architecture/Urban Development Service. The total area of such buildings was assessed by the expert (Energy Manager).
Value applied:	Total – 1 837 887 Residential buildings – 218 507 Private dwelling houses – 1 619 380
Any comments	

Data/Parameter # 7.4	**Annual energy consumption of residential buildings by types**
Data unit:	MWh/yr.
Description:	Primary parameter
Source of data used:	"Energo-pro Georgia". Final quality of data is under the responsibility of Gori Energy Manager (or the monitoring group)
Value applied:	Total – 33 783.5 Residential buildings – 11 806.2 Private dwelling houses – 21 977.3
Any comments	This data can be checked by a survey of typical buildings and energy audit estimations. Given values belong to 2012 consumption

Data/Parameter # 7.5	**Total area of commercial buildings in Gori**
Data unit:	M^2
Description:	Primary parameter
Source of data used:	SEAP group was provided by Gori Energy Manager. Part of commercial areas was assessed using the cleaning tax value mostly determined by the area, and the remaining areas – by estimation at the site. Earlier schools belonged to the City Hall and accordingly areas of schools were assessed by this old data as they were not significantly changed in recent years
Value applied:	69 937
Any comments	

Data/Parameter # 7.6	**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 the Gori City Hall (or monitoring group)
Value applied:	314.1
Any comments	This data can be checked by a survey of typical buildings or energy audit estimations.

Data/Parameter # 7.7	**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:	Gori City Hall Financial Service. Final quality of data is under responsibility of Energy Manager assigned by Gori City Hall.
Value applied:	114 805m^3 natural gas
Any comments	Can be checked at gas supply company

Data/Parameter # 7.8	**Annual consumption of natural and liquid gas by residential buildings**
Data unit:	m3/year; kg/year((MWh)
Description:	Primary parameter
Source of data used:	Gas distribution company serving Gori. Final quality of data is under responsibility of Energy Manager assigned by Gori City Hall.
Value applied:	Natural gas – 15 458 900 m3,
Any comments	

Data/Parameter # 7.9	**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 Gori. Final quality of data is under responsibility of Energy Manager assigned by Gori City Hall.
Value applied:	Natural gas -425 760 m^3
Any comments	This data to be checked by a survey of commercial buildings or energy audit estimations

Data/Parameter # 7.10	**Annual consumption of firewood and diesel by municipal buildings**
Data unit:	m3; l (MWh)
Description:	Primary parameter
Source of data used:	Information got from the Energy Manager of Gori City Hall
Value applied:	At present stage is not consumed
Any comments	

Data/Parameter # 7.11	**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 Gori City Hall.
Value applied:	Firewood total – 6 385 m_3 Residential buildings – 2 100 m^3 Private dwelling houses – 4 285 m^3
Any comments	Have to be checked with periodic surveys. Firewood consumption rates are much higher than voucher issuances

Data/Parameter # 7.12	**Annual consumption of firewood and diesel by commercial buildings**
Data unit:	m^3, MWh/year
Description:	Primary parameter. Annual
Source of data used:	Commercial buildings survey. Final quality of data is under responsibility of Energy Manager assigned by Gori City Hall.
Value applied:	At the present stage diesel and firewood are not consumed in this type of buildings, though the monitoring is necessary
Any comments	This data can be checked by a survey of commercial buildings, although the monitoring is necessary

Data/Parameter # 7.13	**Annual CO_2 monitoring from all three sectors**
Data unit:	t CO_2/year
Description:	Secondary parameter. Annual
Source of data used:	Calculated by the monitoring group
Value applied:	2012 Base year- 35 241 2020 year – 52 509
Any comments	

Data/Parameter # 7.14	**Savings through measures carried out in buildings sector**
Data unit:	MW.h/per single 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 CO_2 baseline scenario and actual measurements are required for all buildings and fuel types. Energy consumption can be reduced due to various reasons (technical disconnections, cutting off 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 should be described separately for each measure. Preliminary theoretical estimates of saved emissions are presented in the SEAP.

10.2. SUSTAINABLE DEVELOPMENT CRITERIA

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

8.1. Local potential improvement of Gori Municipality (staff, plans);
8.2. Increase in population's comfort and energy expenditure savings (per capita hot water consumption, expansion of heated areas/space, 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. Introduction of modern 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. Demonstration 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. Main barriers hampering the plan implementation, plans in place to avoid and overcome main obstacles, and steps towards achieving success.