Sustainable Energy Action Plan for Bolnisi Municipality

May 2016

Enhancing Capacity for low Emission Development Strategies (EC-LEDS)/ Clean Energy Program

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1 Introduction

Location

Bolnisi Municipality lies in the south of Kvemo Kartli region, in the middle of the River Mashavera, 560m above sea level. Bolnisi Municipality borders Marneuli Municipality to the east, Tetritskaro Municipality to the north and Dmanisi Municipality to the west. In the south, the border to Armenia passes along Lori Marze (region).
The municipality center - town Bolnisi is located in 63km to the southeast of Tbilisi, and in 67km from Kvemo Kartli Administrative Center – town Rustavi, and (Marabda) – in 25km from the main railway line.

Fig. 1. Bolnisi Municipality Map

Total area of the municipality makes up 804 km^2. Two small towns and 45 villages are located in the municipality which are integrated in 14 administrative territorial units: town Bolnisi, town Kazreti, town Tamarisi, Kvemo Bolnisi, Nakhiduri, Mamkhuti, Akaurta, Talaveri, Darbazi, Tandzia, Ratevani, Kveshi, Rachisubani, village Bolnisi. Through the municipality, territory passes the Tbilisi-Guguti road used for international transit and the length of Bolnisi-Guguti section makes up 36 km.

Climate and Natural Threats

Climatically the territory of Bolnisi Municipality belongs to moderately humid subtropical climate zone where two basic types of climate may be distinguished: 1) the climate transitional from moderately warm steppe to moderately humid one with moderately cold winters, hot summers and two precipitations maximums (plain areas of the municipality); 2) moderately humid climate with moderately cold winters and long-lasting warm summers (foothills).

Average annual temperature in plain areas is 12^{0}C. Average temperature of the coldest month – January is 0.3^{0}C, absolute minimum - 24^{0}C. The average temperature of the hottest month – July is 23.6^{0}C. Absolute maximum is 39^{0}C. The average annual sunshine duration is 2 100 – 2 300 hours. Total annual precipitations make up 400-500mm. Daily maximum comes on May-June and makes up at average 80mm. Another daily maximum is observed in September-October making up 42-43mm. The minimum precipitations are observed in December. The average precipitations in this month make up 20mm.

The average annual wind speed equals to 2.1m/sec. Here mostly dominate the winds of westerly direction. The average annual number of days with hail is 2-3.

For summer period the processes related to deficit of precipitations represent high risk.

Among natural dangers, hail and drought are characterized to Bolnisi Municipality. The municipality territory, particularly its farthest western part, falls under high risk of hail.

Development Stages

In Kvemo Kartli, on the historical territory of Bolnisi a German settlement under the name of Katerinenfeld was established from 1818. With the "support" of the government of Russian Empire, in 1816-18 German people from Württemberg - "Schwabes" were moved to Southern Georgia. In 1818, about 500 families established 8 colonies near Tbilisi, among which the largest settlement was Katerinenfeld, where 95 households lived. Since 1818, the city type town has changed its name for several times. From 1818 up to 1921 it was called Katerinenfeld, from 1921 until 1943 – Luxemburg, and from 1943 its old name was reestablished and it returned its historical name – Bolnisi.

Picture 1. Tsughrughasheni, XIII century

More than 200 monuments are registered on the territory of Kvemo Kartli Region, among them, on the territory of Bolnisi. Some of the monuments are included in the World Heritage (Bolnisi Sioni, Tsughrughasheni).

Population and Employment

According to the data of National Statistics Office of Georgia, population in Bolnisi Municipality has an increasing tendency and in 2012-2014 population has been increased from 78600 up to 78900.

According to Bolnisi Municipality Development Plan, drafted in 2013, 50.4% of the municipality's total population makes up men, and 49.6% - women. 12% of the population lives in town Bolnisi, 17% - in the territorial units of small towns Tamarisi and Kazreti, and the rest 71% is distributed in the municipality villages.

Most part of the population represent Azeris – 50.2%, Georgian make up 40.8% of the population, 8.5% - Armenians, and 0.5% - different nationalities. Great part of Bolnisi population is Moslem ethnically represented by Azeris, after it come Orthodox Christians, and the rest of the population is Gregorian.

The refugees from Abkhazia and South Ossetia also live in Bolnisi. According to the data of the Ministry of Internally Displaced Persons from the Occupied Territories, Accommodation and Refugees of Georgia[1] and Social Service Agency[2], as of September 2014, the number of refugees registered in Bolnisi Municipality made up 824 persons and 277 households. In the table below is given the number of beneficiaries of social packages in Bolnisi Municipality according to groups.

Table 1. Number of beneficiaries of social packages in Bolnisi Municipality according to groups

#	Types of Bolnisi Municipality Social Package	Number of Beneficiaries
1	Pension Package	9 323
2	Social Package	1 870
3	Living Allowance	2 537
	Total	**13 730**

Currently, 34 public schools and 12 kindergartens operate in Bolnisi Municipality.

Economy

Bolnisi Municipality budget for 2016 makes up 16 165 000 GEL.[3] According to the Decree #58, as of December 2015, issued by Bolnisi Municipality City Assembly, financing for 2014, 2015 and 2016 according to sectors was allocated as follows:

Table 2. Allocation of Bolnisi Municipality Budget for 2014, 2015 and 2016

Sector	Actual fact 2014	Plan for 2015	Program for 2016
Agriculture, Forestry, Fishing and Hunting	1 300 000	213 300	160 000

[1] http://www.mra.gov.ge/

[2] www.ssa.gov.ge/

[3] http://bolnisi.gov.ge/wp-content/uploads/2015/02/biujeti-2016.pdf

Motor Transport and Roads	1 326 100	2 239 900	555 000
Environment Protection	683 700	882 300	1 812 000
Waste collection, recycling and disposal	632 600	688 800	700 000
Wastewater Management	51 100	193 500	1 112 000
Housing and utility services	627 200	2 219 100	1 224 000
Apartment Construction	82 500	581 400	334 000
Water Supply	33 100	363 500	200 000
Street Lights	507 600	641 700	690 000

According to the above-given table, in 2014-2015 the municipality has directed significant financial resources towards transport sector and motorway development and improvement. In 2016, environment protection, waste management, and streetlights remain as the priorities.

National Statistics Office of Georgia does not give any data about the Gross Domestic Product (GDP) volume. However, if we talk according to the current statistical data of Kvemo Kartli region, since 2009 the GDP increased significantly. In 2009, GDP of this region made up 1 325.3mln GEL, and in 2014 it made up 2 162.9mln GEL, i.e., in five years there was 63% increase.

Infrastructure

Drinking Water Infrastructure

Almost half of the municipality population is supplied with drinking water from Sakaplano springs of Dmanisi region, from where with 630mm pipes water falls into the water supply reservoirs of towns Bolnisi and Kazreti. The network and district water supply systems of 17 villages of the municipality are connected with the current pipeline from Sakaplano to Bolnisi. Through the pumping stations, water is supplied to 32 thousand residents of 18 villages, while 6000 residents of 5 villages are supplied with water by free-flow (500m^3 per 24hours) from collector reservoirs. The total length of the municipality population water supply system is 150km and the population is completely supplied with drinking water according to the schedule: town Bolnisi – 100%, and the villages through networking and district feeding – 95%.

Irrigation System Infrastructure

Irrigation channels in Bolnisi Municipality are managed by the State Ltd. "United Melioration Systems Company". The channels are supplied with water from water reservoirs of River Mashavera, and Dmanisi Municipality Rivers lakublo and Pantiani.

Due to malfunctioning of irrigation infrastructure, the agricultural lands are not irrigated completely. Current irrigation channel length is 62.8km.

Bolnisi Municipality Development Priorities

The supreme body of the municipality's local self-government is Sakrebulo (City Assembly), and the executive body is Gamgeoba (City Hall).

Picture 2. Building of Bolnisi Municipality City Assembly

In 2013, Bolnisi Municipality Development Plan was worked out, according to which in the next 3-4 years the priorities of the municipality development include agro-education and data availability, attracting investments to establish agricultural product (dairy and meat) processing enterprises and warehousing-refrigerating facilities, developing trans-boundary trade relations, and adopting modern agro-technologies.

On March 16, 2015, Bolnisi Municipality became a signatory of the Covenant of Mayors and, thus, it voluntarily took on itself the obligations under this Agreement – to develop and implement within its administrative boundaries Sustainable Energy Action Plan (SEAP) in purpose to reduce the GHG emissions by at least 20% by 2020. The present document is precisely this plan.

2 Sustainable Energy Action Plan

Sustainable Energy Action Plan for Bolnisi Municipality covers measures related to transport, buildings, public lighting, waste collection, green areas and agriculture sectors.

Present version of the Sustainable Energy Action Plan for Bolnisi Municipality was developed in 2016 with 2014 as a baseline year and covers the following 6 years until 2020. It should be foreseen that due to the short period left until 2020, it is expected Bolnisi won't be able to reach reduction of the GHG emissions by 20% by 2020, however, as the Mayors of the EU cities have already signed a new agreement which lasts until 2030 and implies -40% reduction along with climate change adaptation measures, Bolnisi Municipality plans to join this new agreement and renew this Action Plan. Developing agriculture adaptation plan in relations to climate change will be one of the major priorities in the renewed Action Plan.

Therefore, for the sectors referred to in Action Plan (buildings, transport and agriculture), the emissions reduction strategy is defined with only two periods: short-term period (2015-2018) and long-term period (starting from 2019). The measures planned for short-term period are specific and detailed, and the measures planned for long-term period are discussed for strategic reasons and need additional research, planning and feasibility studies. Such an approach is in full conformity with the guideline methodology for developing Sustainable Energy Action Plan the renewal of which will take place upon joining the new agreement.

Considering CO_2 growth rates of 2014 as a baseline year emissions inventory and until 2020, the sectoral strategy of GHG emissions reduction has been developed for all sectors discussed within the frames of the SEAP for Bolnisi Municipality and basic trends were outlined.

Transport Sector

Considering the results of 2014 year emissions inventory in Bolnisi Municipality, transport sector emissions bear responsibility for 26.4% of total emissions, out of which 99% comes on private and commercial transport. Several strategic areas are considered in transport sector, which include:

- Renewing municipal public transport in Bolnisi
- Creating additional municipal public transport in the entire territory of the municipality
- Promoting pedestrians

In short-term perspective Bolnisi Municipality administration plans renewal of the municipal transport in town Bolnisi which will serve the municipality with well-planned routes and comfortable buses. To this, in the entire territory of Bolnisi it plans to establish the buses connecting town and rural areas. This means that on comparatively long distances the buses will replace the currently established transportation alternative private cars.

Also, Bolnisi Municipality will continue promoting pedestrians with arranging pedestrian roads, sidewalks and crossings.

In long-term perspective, Bolnisi Municipality's transport sector strategic concept is arranging the rural roads, optimization of routes and developing modern energy-efficient comfortable municipal transport.

It is also planned to promote transportation by bicycles though Bolnisi Municipality territory geographically is rather limited in this respect.

Buildings Sector

Considering the results of 2014 year emissions inventory in Bolnisi Municipality, buildings sector emissions bear responsibility for 68.5% of total emissions. According to the data from this sector 95% of emissions are emitted[4] from the residential buildings. Due to this reason to reach the 20% emissions reduction benchmark, it is urgent to develop such programs for the residential buildings sector, which will promote adoption of energy-efficient and renewable energies in this sector. At the same time here should be considered the factor that in Bolnisi Municipality like in the entire territory of Georgia energy consumption is very low as the

[4] Here is a significant inaccuracy, because the electricity for the category of "other buildings" could not be found.

buildings are not heated and a great part of population lives in energetic poverty. Accordingly, such programs need urgent preparatory works, among them, working with donors in seek of external funding, perfecting legislative base and regulations in order the municipality to be able to work directly with the population. Bolnisi Municipality City Hall considers the fact that, after developing this plan only 5 years are left till 2020, and due to this reason implementing these programs completely may not to be managed by 2020 and it may be prolonged until 2030.

In 2015-2020 Bolnisi Municipality City Hall strategy implies providing maximum support to energy saving in municipal buildings and using renewable energies to create an example for the population and other commercial buildings. Besides, it is planned to promote energy saving measures and further those residential buildings which are comparatively organized and for which the City Hall already has co-financing programs. Such buildings are residential buildings the residents of which have established comradeships.

To reach the set emissions reduction goals it is also crucial to take energy-efficiency and renewable energy measures in private houses. For this purpose, the City Hall will develop special programs and approaches and will actively cooperate with other state structures, as well as, with funds and private organizations. In long-term perspective, the City Hall will also work on providing the population and construction organizations with construction standards, based on local climate conditions and explain them their importance for getting heating and financial savings.

According to the Sustainable Energy Action Strategy, there will be carried out the following measures in the Bolnisi Municipality buildings sector:

In municipal buildings:

1. Insulation of attic in municipal building;
2. Installation of new lighting system in municipal buildings;
3. Insulation of attics in kindergartens;
4. Replacement of windows in kindergartens;
5. Installation of new lighting system in kindergartens;
6. Using solar collectors in nursery-kindergartens;

In short-term perspective of residential sector, the municipality will cooperate with apartment-owners' comradeships to take the following measures:

1. Installation of sensor lightings in building entrances;
2. Insulation of common areas of residential buildings;
3. Insulation of attics of residential buildings;
4. Reduction of infiltration from windows of residential buildings;
5. Insulation of ceilings in typical private houses;

One more sector, which is not less important in the process of the GHG emissions reduction is Public Lighting.

Agriculture Sector

In 2014 year emissions inventory in Bolnisi Municipality, Agriculture sector emissions make up 4.9%, out of which 95% falls on dairy product manufacturing sector (Methane produced by livestock and poultry farming is not considered in these proportions).

As it was already mentioned above, according to the current municipality development plan, in the next 3-4 years the municipality development priorities include agro-education and data availability, attracting investments to establish agricultural product (dairy and meat) processing enterprises and warehousing-refrigerating facilities, developing trans-boundary trade relations, and adopting modern agro-technologies. Based on these trends, the municipality will do its best to promote adoption of modern energy-efficient technologies in agriculture sector, particularly:

- Maximum usage of solar energy in greenhouse farms and food industry (milk processing plants) to get hot water
- Usage of Methane produced in livestock and poultry farms as energy resource
- Complete renewal of agricultural technique (tractors, combines) with modern energy-efficient technique

In long-term perspective in the agriculture sector is planned rehabilitation of irrigation systems using energy-efficient pumps, increasing energy-efficiency of pumps in the municipality water supply system and developing refrigeration economy with energy-efficient modern technologies.

Public Lighting Sector

In the Public Lighting sector is planned to replace the current non-energy-efficient lightings with energy-efficient LED lightings that will help to save 76% of the forecasted demand on energy in this sector by 2020, however, in Georgia the network emissions factor is rather low and due to this reason, saving corresponding emissions is less than 1%.

Other Sectors

Except the above-listed trends, the plan contains measures of paper and plastic separation from the collected solid wastes (Methane emissions from wastes sector are not considered in total emissions as the landfill is being moved to the territory of another municipality) and increasing green areas.

Sustainable Energy Action Plan Summary Picture

The methodology of developing Bolnisi Municipality Sustainable Energy Action Plan does not imply using the fixed base year which may be obstructive for development process and hinder fulfilling the commitments undertaken by the municipality. The methodology used in the present document considers the country and the Bolnisi Municipality development perspective and the needed increase of emissions by 2020 (during growing demand on energy carriers). This increase is reflected in the Business As Usual (BAU) scenario against which emissions reduction is done in result of implementation of different measures and project proposals. The BAU scenario methodology is presented in details in Appendix I.

Tables (Table 3 and Table 4) show the summary of inventory results of 2014 – 2020 and the assessment of emission rates saved by implementation of the SEAP measures. As the tables show, by Bolnisi Municipality SEAP will be saved 42 038 tons of CO_2 equivalent emission making up 40.3% of 2014 emissions, and 34.9% - of 2020 emissions. However, we need to mention here that implementing most of these measures are rather difficult, as it requires longer period than it is left until 2020 and much more budget than Bolnisi Municipality has for implementing this kind of projects.

Table 3. GHG Emissions in Bolnisi Municipality in 2014 and 2020 (Tons CO2 eq.)

Sector	2014	Share in total emissions (%)	2020 (BAU)	Share in total emissions (%)
Transport	27 536	26.4	37 449	31.1
Buildings	71 407	68.5	75 282	62.4
Public Lighting	145	0.2	208	0.2
Agriculture[5]	5 161	4.9	7 655	6.3
Total	104 249	100	120 594	100

Table 4. Emissions Savings in different sectors according to Bolnisi Municipality SEAP

Sector	Saving (Tons CO_2 eq.)	%
Transport	1 364	3.20
Buildings	35 179	83.68
Public Lighting	158	0.39
Agriculture	5 161	12.29
Waste Collection	30	0.08
Green Areas	146	0.36
Total	42 038	100

Table 4 shows that emissions saving at this stage and in accordance with this Action Plan to the greatest extent (83.7%) is intended in building sector.

Fig. 2 shows distribution of emissions by sectors between 2014 as baseline year and 2020, and figures (Fig. 3, Fig. 4 and Fig. 5) show increases in emissions in different sectors for the BAU and the SEAP implementation scenarios.

[5] Methane emission which is calculated in Agriculture Sector from livestock and poultry farming sub-sector are not entered in the final table as in Georgia the experience of using this Methane is still very low and local technologies are not reliable. Accordingly, there is a high risk of taking the measures, especially, when it will be urgent to work with private farmers in this direction. At this stage to use the devices of biogases within the population at the household level was not discussed as the households do not have the needed number of livestock and in most periods of the year the cattle feeding is provided through pastures.

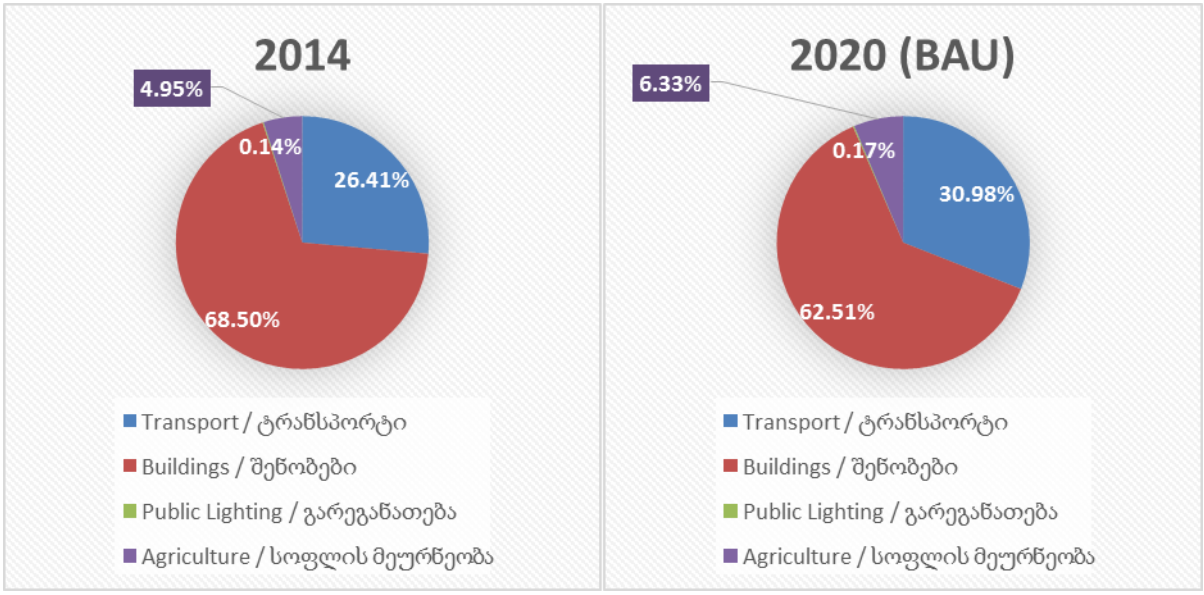

Fig. 2. Distribution of emissions by sectors between 2014 and 2020 (%)

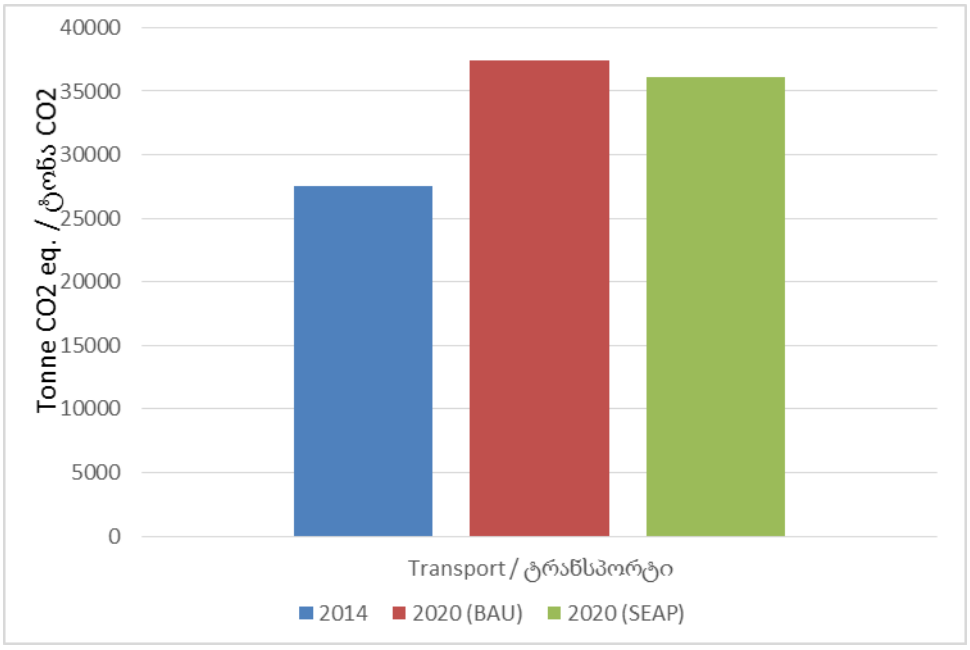

Fig. 3. Increases in emissions in Transport Sector for the BAU and the SEAP scenarios (Tons CO2eq.)

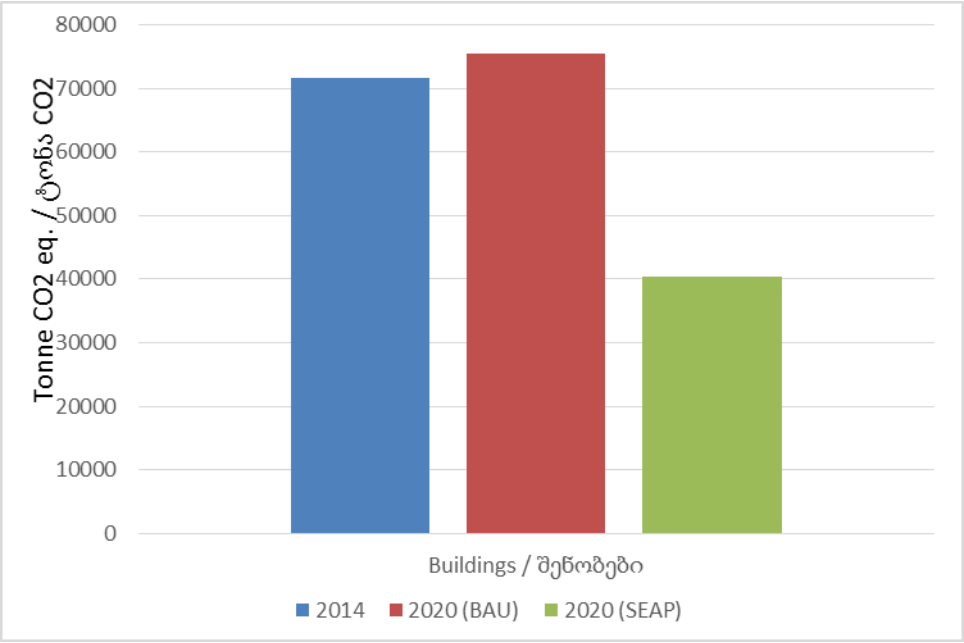

Fig. 4. Increases in emissions in Buildings Sector for the BAU and the SEAP scenarios (Tons CO2eq.)

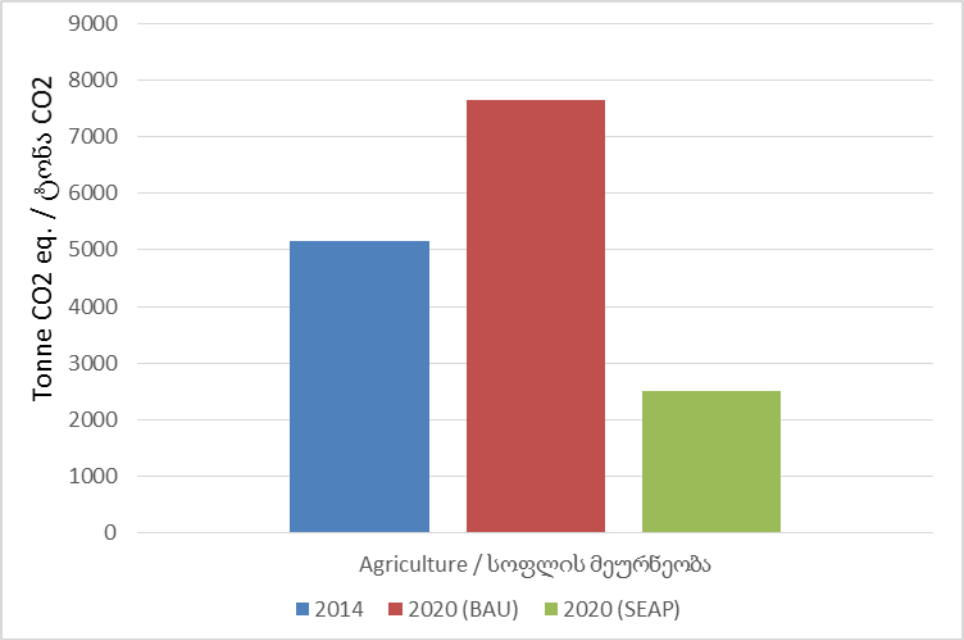

Fig. 5. Increases in emissions in Agriculture Sector for the BAU and the SEAP scenarios (Tons CO2eq.)

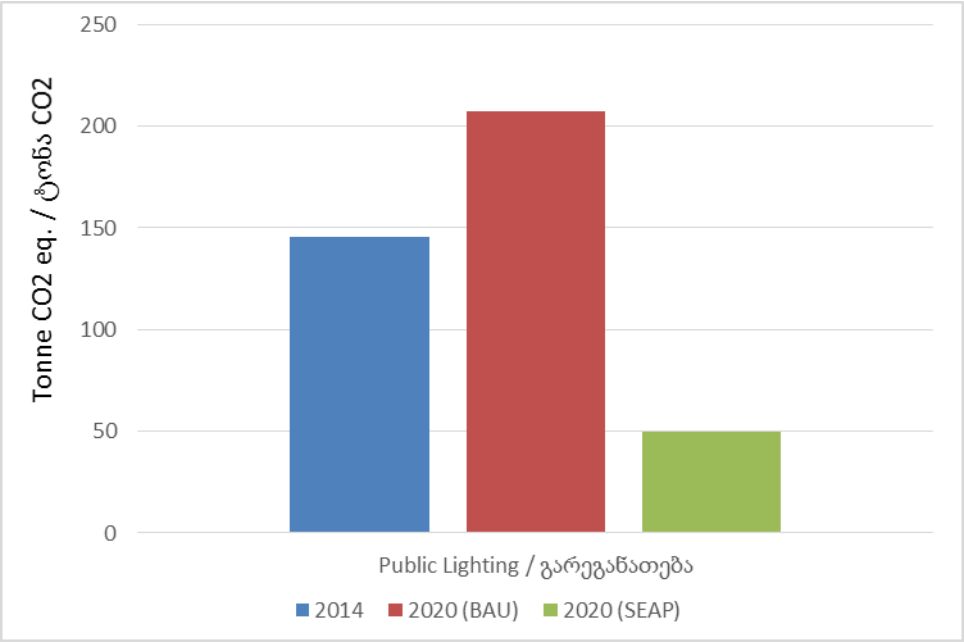

Fig. 6. Increases in emissions in Public Lighting Sector for the BAU and the SEAP scenarios (Tons CO2eq.)

3 Transport

3.1 Sector Overview

Bolnisi Municipality is economic, political and cultural center in Kvemo Kartli Region, bordering Tetritskaro, Marneuli, and Dmanisi Municipalities, as well as, the Republic of Armenia with Poladauri Valley and forests. Through the municipality passes the central road to Guguti (Dmanisi Municipality) connecting the country to Armenia. The number of villages entered in Bolnisi Municipality is 47 (forty-seven), as well as, here enter two small towns and one city. The municipality territory lies in the lower part of Kvemo Kartli that is shown in Fig. 7.

Fig. 7. Bolnisi Municipality Location

In the municipality and in the central part of the city gather different kinds of transport both light vehicles and big trucks entered from the bordering municipalities, as well as, from Armenia. This creates a serious problem in the city, as it does not have any alternative bypass road. Earlier when the town and the surrounding villages were being designed, the streets and the roads with their traffic capacity were proportional to the number of vehicles.

Road infrastructure of entire Bolnisi Municipality makes up 287.1km, of which 140.8km is central road, 146.3km - internal district road, of which asphalted is 77.1km, and dirt road – 210km. Compared to previous years, a significant improvement is noticed in respect of road infrastructure development and asphalting the roads. In accordance with information requested from the Infrastructure Development, Spatial Arrangement, Architecture and Construction Service, within the entire Municipality 35.1km road was asphalted and arranged (in 2012 – 22.5km asphalted road, in 2013 – 10.76km, and in 2014 – 1.8km).

Currently most part of the population is transported either by taxi or by private car that is conditioned due to the lack of public transport and transportation routes. Coming out of the tourist potential of the region and its location the role of Bolnisi Municipality is great for tourism development and for this purpose it is urgent to unload at maximum the Municipality territory from unnecessary transport. In Bolnisi Municipality due to the lack of public transport, private vehicles represent more means of transportation rather than a luxury. During 2012-2014, in the Municipality, the total number of transport has been increased significantly, by 28% (Table 5). The dirt and graveled roads and increased number of transport on the territory of Municipality resulted in the increase of final emissions, environment pollution and disturbing noise.

Table 5 shows the increase of vehicle number according to types in Bolnisi Municipality in 2012-2014. The average increase is 28%.

Table 5. Vehicle Number Increase Trend in Bolnisi Municipality

Year	Total	Motor cars	Truck	Different
2012	13 788	13 075	592	121
2013	15 713	14 882	687	144
2014	17 667	16 694	810	163
Increase (%)	28	28	37	35

By the end of 2014 21 801 vehicles are registered in the Municipality, the great part of which is gasoline powered, part of it is diesel powered; as for the natural gas powered vehicles, the absence of gas station on the territory of the Municipality and the current decrease in oil product prices almost removed the segment of natural gas powered vehicles on the territory of Bolnisi Municipality. In common car park 94.5% comes on motor cars, mostly consisting of BMW, MERSEDES, OPEL, TOYOTA, HONDA brand vehicles. After it come small trucks, mostly consisting of FORD-TRANSIT type of vehicles, and heavy trucks, the majority of which is employed in Joint-stock Company "RMG Gold" with gold and copper extraction and processing as its main occupation.

In the Municipality in the sphere of cargo shipping are occupied cargo tonnage (2tons and over) diesel-powered vehicles; in 2012-2014 the number of diesel-powered vehicles increased by 44% and they mostly carry ore from Abulbuki and Sakdrisi-Kachagiani deposits to town Kazreti processing plant. The mentioned trucks move through Bolnisi-Dmanisi central highway which due to heavy load is out of order and the motor cars have difficulties driving through this road. This obviously reduces fuel efficiency consumed by the vehicles and increases the GHG emissions from this sector. The Municipality administration jointly with the private

company discusses alternative ways in order the heavy trucks loaded with ore not to ruin asphalt cover and bring less pollution to the residential environment.

In the SEAP of Bolnisi Municipality is discussed the flow of traffic within the territory only of those vehicles registered in this territory, however, in accordance to the Municipality information, the share of transit should be much more higher. Detailed information about fuel consumption by the vehicles registered in Bolnisi Municipality territory according to their types is given in Table 6-Table 8. Here should be noted that obtaining statistics about transport is very difficult, as the Ministry of Internal Affairs has not removed from registration the old car park which is no longer used and that makes it difficult to define exact number of vehicles.

About 20 000households live in Bolnisi Municipality territory and, besides, local self-government and state sub-departmental bodies are located on this territory. Municipality Services and LTDs, bus terminals, population, state sub-departmental bodies, and gas-stations have been surveyed to collect the data.

Table 6. Vehicles in Permanent Ownership of Bolnisi Municipality in 2014

Vehicles	Motor vehicles (except for taxi and municipal vehicles)	Vehicles serving municipality	Motorcycles	Buses	Minibuses (passenger)	Taxis	Small Trucks (2 tons carrying capacity)	Heavy Trucks
Number according to type of fuel								
Gasoline powered	12 520	32	0	0	0	70	30	0
Diesel powered	4 174	2	0	6	53	0	400	380
Natural gas powered	0	0	0	0	0	0	0	0
Total	16 694	34	0	6	53	70	430	380

Source: Bolnisi Municipality Administration

Among other kinds of fuel, in Bolnisi Municipality gasoline (72%) is used mostly and the rest use diesel. As for the natural gas powered vehicles, due to the absence of gas station on the territory of the Municipality and the current decrease in gasoline and diesel prices, this segment is too small and it almost does not exist.

Municipal Transport

As it was mentioned in the introduction, the greatest problem in Transport Sector is the fact that municipal transport is not developed at all, that causes increasing transportation in private vehicles and on rather long distances. For the last several years, the Municipality has started working in this direction and first of all it works on the issues of providing town Bolnisi and its adjacent areas with municipal transport. Particularly, on the territory of town Bolnisi, in Ratevani-Rachisubani direction instead of two municipal buses at present

works three new type Bogdan buses (with more capacity). One direction of the route makes up 10km, and the travel cost is 40Tetri of which 20Tetri is paid by the passenger, and 20Tetri is subsidized by the Municipality. This measure increased the number of passengers carried by the buses with 300passengers. Starting from 2015, the Municipality has established new runs performed by Mercedes type minibuses that replaced taxis and private vehicles, which these passengers used for transportation before this time. These buses and minibuses are managed by LTD "Bolnisi Municipal Transport Service". Other types of public transport also work in the Municipality managed by "Bolnisi Bus Terminal". This LTD owns 60units of minibuses, which serve from town Bolnisi or from villages to Tbilisi-Marneuli direction. On the Municipality territory they pass at average 20km and their annual fuel consumption is calculated according to this mileage. In addition, LTD "Bolnisi Bus Terminal" provides transportation of passengers with 11 minibuses connecting the villages with town Bolnisi and which serve the passengers every day. More detail description of the on-going processes in Transport Sector is given in the section of measures.

The number of the minibuses serving on the territory of Bolnisi Municipality in 2014 is given in the following table.

Table 7. Public Transport (Minibuses) Serving in 2014

Minibuses	On the territory of town Bolnisi	From villages to town Bolnisi	From the Municipality to the territories beyond its boundaries (20km on the Municipality territory)
Diesel powered	0	11	31

Source: Bolnisi Municipality Administration

Distribution vehicles (fixed-route minivans, refrigeration vehicles, etc.) arrive and move on the territory of the Municipality to distribute different kinds of products in the shops. Every day about 430 vehicles move during the whole day to carry out distribution.

Table 8 shows the data of the consumed fuel by different types of transport and the mileage that was used for assessment of the fuel consumption:

Table 8. Bolnisi Municipality Transport Characteristics

Vehicles	Motor vehicles (except for taxi and municipal vehicles)	Vehicles serving municipality	Buses	Minibuses (passenger)	Taxis	Small Trucks (2 tons carrying capacity)	Heavy Trucks
Annual Mileage (km/vehicle)	4 745	10 760	38 400	21 900	20 075	7 300	18 250
Average fuel consumption on gasoline per vehicle (l/100km)	10.0	10.0			10.0	15.0	

Average fuel consumption on diesel per vehicle (l/100km)	10.0	10.0	25.0	12.0		12.0	35.0
Average fuel consumption on natural gas per vehicle (cub.m/100km)							

Source: Bolnisi Municipality Administration

3.2 Transport Sector Base Year (2014) Inventory and Baseline Scenario of the GHG Emissions (2015 – 2020)

Methodology of calculation of base year and baseline scenario of the GHG emissions is given in Appendix I.

The structure and the baseline year inventory regarding Bolnisi Municipality Transport Sector are based on 2014 data and include the following types of transportation:

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

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 territorial limits.

Bolnisi Municipality Transport Sector fuel consumption made up about 107.4 thousand MWh in 2014.

Table 9. Final Energy Consumption in Bolnisi Municipality Transport Sector (MWh) - 2014

Subsector	Natural Gas	Diesel	Gasoline	Total
Municipal Vehicle Fleet	0	23	317	340
Public Transport	8	837	0	845
Private and Commercial Transport	0	49 850	56 341	106 191
Total	8	50 710	56 658	107 376

Therefore, emissions of GHGs from the Transport Sector made up about 27.54 thousand tons of CO_2 equivalent in 2014.

Table 10. GHG Emissions from Bolnisi Municipality Transport Sector in CO2 Equivalent (Ton) -2014

Subsector	Natural Gas	Diesel	Gasoline	Total
Municipal Vehicle Fleet	0	5.96	79.10	85.06
Public Transport	0.12	221.39	0	221.51

Private and Commercial Transport and Taxis	0	13 183.51	14 045.84	27 229.35
Total	0.12	13 404.91	14 045.84	27 535.93

The table shows that the share of private and commercial transport in total energy consumption and total emissions equals to 99%. So, in the future the main target group should be this sector.

Forecast from Transport Sector emissions by 2020 was done in accordance with the ratio given in the JRC guideline document. According to the JRC ratios, as base year is 2014, emissions by 2020 will be increased by 36%. Therefore, by 2020 the forecasting mark of the GHGs for Transport Sector made up about 37.4 thousand tons of CO_2 equivalent.

Increase of Transport Sector emissions is given in Fig. 7.

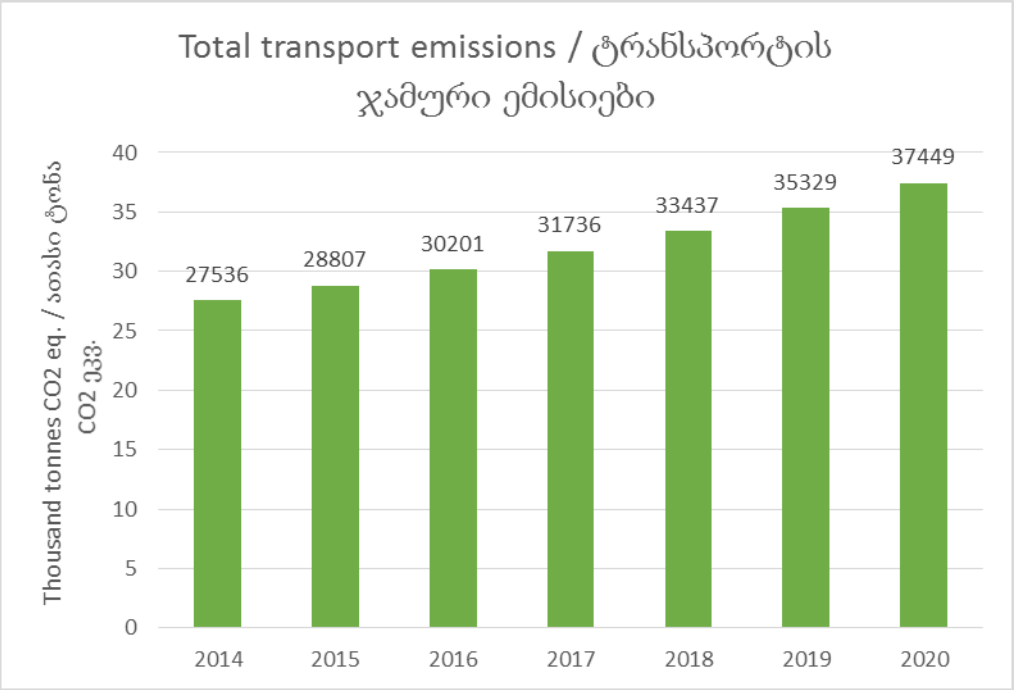

Fig. 8. Trend of Emissions from the Transport Sector according to the BAU scenario (thousand Tons CO2 eq.)

3.2 Action Plan of Emissions Reduction from Bolnisi Municipality Transport Sector

The rate of private vehicles ownership in Bolnisi Municipality is not high. In Bolnisi Municipality on every 1000 persons come 212 vehicles, which is a bit higher for Georgia compared to average rate.

As it was already mentioned, on the territory of the Municipality travel by taxi is very popular which is rather cheap. Therefore, for the case of Transport Sector a strategic perspective is developing public transport at maximum on the entire territory of Bolnisi Municipality, and for long-term perspective - to regulate/limit travel by private vehicles. To reach this target it is necessary to create and promote other alternative travel means (walking, ride by bicycle). In the process of public transport development it is very urgent to provide comfort.

In result of implementing the measures considered in Bolnisi Municipality SEAP, compared to the baseline scenario by 2020 emission of CO_2 from Transport Sector will be reduced by 1364 tons of CO_2 equivalent. All the measures will be implemented by the appropriate bodies of Bolnisi Municipality Administration.

Description of Measures

Measure PT1: Renewal of Existing Public Municipal Transport (Buses) and Improvement of Service. The measure implies purchasing new buses which will replace the old uncomfortable ones. For municipal transport comfortable bus stops (waiting places) will be arranged and public transport popularization campaign will be launched.

On the territory of town Bolnisi, in 2015 2 small Bogdan type buses were replaced with 3 new type Bogdan buses equipped with heating and cooling systems. In old buses there were 21 seats and about 15 standing places. In new buses there are 22 seats and about 30 standing places. The old buses worked from 8:00am till 7:00pm. The new buses work from 8:00am till 9:00pm. The run of town bus is about 20km round trip and each bus passes 250km per day. The new buses consume 25litres of diesel on 100km and the old ones used to consume less fuel on 100km, about 23liters. In total, all the three buses carry 800 persons per day which is 300 persons more than it was possible to carry earlier.

Implementing this measure 41tons of CO_2 equivalent emissions will be saved by 2020. Other details of this measure and methodology of reduced emissions calculation are described in monitoring section.

Measure PT2: Assigning New Runs by Municipal Minibus on the territory of Bolnisi Municipality. In 2015-2016, Ltd. "Bolnisi Municipality Transport Service" under Bolnisi Municipality Administration assigned three runs and one more run is getting ready to be assigned which are performed by minibuses and which should be replacement for those passengers who used taxis and private vehicles for travel in 2014.

These runs are:

1. **Bolnisi-Kazreti:** 2 runs are performed per day, each run (round trip) is 40km, in total 80km per day; it travels 5 days per week. Per day at average 120 passengers are carried. With this replacement 69.48 tons of CO_2 will be saved per year.
2. **Bolnisi-Parezi:** 2 runs are performed per day, each run (round trip) is 40km, in total 80km per day; it travels 5 days per week. Per day at average 70 passengers are carried. With this replacement 37.69 tons of CO_2 will be saved per year.
3. **Bolnisi-Darbazi:** 2 runs are performed per day, each run (round trip) is 50km, in total 100km per day; it travels 5 days per week. Per day at average 80 passengers are carried. With this replacement 55.07 tons of CO_2 will be saved per year.
4. **Bolnisi-Akaurta:** will travel twice a week (Saturday and Sunday carries parish to the church); round trip is 60km. Per day at average 100 passengers are carried. With this replacement 36.68 tons of CO_2 eq. will be saved per year.

With implementing this measure in total 199 tons of CO_2 eq. will be saved. The details of this measure and emissions calculation methodology are described in monitoring plan.

Measure UP1: Rehabilitation of the Road Pavement. Total Bolnisi Municipality road infrastructure makes up 287.1km of which 140km is central road, 146.3km - internal district road, of which 77.1km is asphalted, and 210 is dirt road. Compared to previous years a significant improvement is noticed in respect of road infrastructure development and asphalting the roads in the Municipality. In accordance with information requested from the Infrastructure Development, Spatial Arrangement, Architecture and Construction Service, for the last three years within the entire Municipality 35km road was asphalted and pavement was arranged.

In case of complete rehabilitation of the road pavement in 2016-2025, 1124tons of CO_2 eq. will be saved per year. The details of the measure and emissions calculation methodology are described in monitoring plan.

Measure UP2: Transport Flow Management in Bolnisi Municipality. This measure implies the following activities:

- Inventorying and organizing road signs and traffic lights. In this respect first of all the organizational issues should be decided to define who will be in charge of activities in this direction, after which complete inventorying of the road signs and traffic lights will be conducted and management will be carried out. At this stage it is planned
- To study the problematic streets (where very often is traffic jam) and find the alternative routes, and organize new routes and roads. The existing routes and roads will be reviewed and changed in the way to facilitate travel and reduce traffic jams. For example, some of the streets will be made into one-way street (Manvelishvili Street) and transport in opposite direction will travel through the parallel street.
- To construct new streets and bridges in purpose of reducing the travel distances.

Realization of the GHG emissions reduction potential related to traffic management (as well as, to improving road infrastructure) is a difficult and controversial process. Reduction of congested traffic will cause reduction of GHG emissions from individual vehicles at the expense of their effective travel. But, in total, this always may not cause decrease of emissions, as reduction of congested traffic makes travel in private vehicles more attractive that on its side causes increase of emissions. Assuming the above-mentioned, these measures and the reduction of emissions related to them may be considered as the component of a larger-scaled transport strategy along with other measures given in this document.

For this measure, reduction of emissions at this stage has not been calculated as the final plan is not known yet and this plan will be implemented in longer-term perspective after 2020. Revision and calculation of emissions will be conducted in the renewed action plan up to 2030.

Measure PRT1: Establishing Parking in Town Bolnisi

At the moment, Bolnisi Municipality parking policy is in the developing process. Its main target is decongestion of the streets (especially central districts) from vehicles. The details of parking are not known at this stage.

Assessing the parking policy effect separately from other measures is very difficult. However, in accordance with one of the surveys of assessment of emission reduction from transport sector measures[6], in case of availability of parking system each vehicle reduces the travel distance by 7-10%. In Bolnisi case the lowest rate 7% was taken and calculation was conducted only for motor vehicles and taxis. Considering the number of population, presumably in town Bolnisi there are 3500 private vehicles which pass per year 16 607 500km and consume 1 660 750litres of gasoline in result of which 3 815 tons of CO_2 eq. is emitted. Reducing the travel distance by 7% will cause emissions of 267 tons of CO_2 eq.

Activity PRT1. Encouraging Pedestrians and Travelers by Bicycles

In small towns travel by bicycle and walking is one of the most effective and, what's more, very healthy alternative of travel by road transport. However, it has some important barriers one of which is fixedness of population to vehicles and apprehending it as the social status defining criteria. Therefore, it is crucial to overcome this stereotype within the population and make the walking people and travelers by bicycles more

[6] Effectiveness of Efforts to Reduce Greenhouse Gas Emissions by Improving Transportation System Efficiency and Pavement Conditions„DRISI, Division of Transportation Planning, 2014

prominent. For popularization of this kind of transportation some campaigns should be launched which will introduce them to people as modern, European and effective approaches both from the point of transportation and maintaining healthy environment.

To encourage walking people Bolnisi Municipality will continue implementing measures of arranging sidewalks and crossing areas in order walking to become comfortable and safe. Improving the conditions for travel of disabled people will be also considered. For the moment, it is planned to arrange such sidewalks in Aghmashenebeli and Sulkha-Saba Streets the total length of which makes up 10km. It is also planned to asphalt Athoni Street of the town this year with total cost 780000GEL which is already obtained, and to arrange stone pavement in Merab Kostava Street with total cost 392000GEL which is also already obtained. It is also planned by 2018 to complete rehabilitation of historical district which presumably will be closed for vehicles, from the beginning at least for several days per week. This entire area is 500metres.

For successful completion of these measures, it is also urgent to implement the population's conduct change program within the frames of which explanation should be provided about the advantages of walking and travelling by bicycles compared to travelling by vehicles. For this measure emission reduction has not been calculated but the City Hall acknowledges that such measures are very important for the whole process and sustainable development of the town.

Table 11. Transport Sector Action Plan

Sectors and field of activity	Main Measures by sectors	Department/Person or Company in Charge (if the third party is involved)	Start/End Date	Cost	Expected Energy Savings from an Activity (MW/h)	Expected CO_2 Emission Reduction from an Activity (T)
Public Transport	Measure PT1: Renewal of Public Municipal Transport (Buses) in Town Bolnisi	Ltd. "Bolnisi Municipality Transport Service"	2015			41
Public Transport	Measure PT2: Increasing Number of Municipal Public Transport in Bolnisi (Mini-buses)	Ltd. "Bolnisi Municipality Transport Service"	2015-2016			199
Road Infrastructure Improvement	Measure UP1: Rehabilitation of the Road Pavement	Bolnisi Municipality City Hall and City Assembly	2016-2020			1 124
Transport Sector Flow Management	Measure UP2: Transport Flow Management in Bolnisi Municipality	Bolnisi Municipality City Hall and City Assembly	2016-2020			
Limiting Private Transport	Measure PRT1: Establishing Parking in Town Bolnisi	Bolnisi Municipality City Hall and City Assembly	2016-2025			267
Limiting Private Transport	Activity PRT1. Encouraging Pedestrians	Bolnisi Municipality City Hall and City Assembly	2017-2020			
Total						

4 Buildings

4.1 Sector Overview

Building sector of Bolnisi Municipality is one of the key points for the SEAP, which alongside with the residential buildings includes municipal and other commercial buildings (offices, shops, hotels, etc.). In the process of reducing the GHG emissions from the territory of the Municipality, the role of this sector is rather significant and therefore the measures of energy-efficiency of these buildings and increasing consumption of renewal energies should be planned with special attention.

Bolnisi Municipality Buildings Total Fund

On the territory of Bolnisi Municipality there are different types of buildings: municipal, governmental, and residential (individual and apartment buildings). Among the residential buildings we meet two-storey, four-storey, five-storey and nine-storey buildings. Private residential buildings are one and two-storey houses.

Information about Bolnisi Municipality residential buildings is given in Table 12.

Table 12. Bolnisi Municipality Residential Buildings

Building Title	Number of Storeys	Quantity	Number of Entrances	Number of Apartments	Total Area (sq.m)
Apartment Buildings	2	12	2	144	11 520
	2	24	2	224	16 800
Total		**36**		**368**	**28 320**
	4	2	2	80	6 350
	4	1	3	36	2 700
	4	6	4	214	14 890
Total		**9**		**330**	**24 030**
	5	14	3	720	49 680
	5	1	3	40	3 370
	5	4	4	240	15 520
Total		**19**		**1 000**	**68 570**
	9	7	1	252	21 080
	9	14	2	756	105 280
	9	4	4	392	35 280
	9	1	5	102	11 220
	9	2	6	252	32 400
Total		**28**		**1 754**	**205 260**
Total Sum of Apartment Buildings:		**92**		**3 452**	**326 180**
Private residential buildings	1	4 487		4 487	233 324
	2	10 319		10 319	2 105 942

Total private residential buildings		**14 806**		**14 806**	**2 339 266**
Total		**14 898**		**18 258**	**2 665 446**

Mentioned information about the summed up areas was provided by Bolnisi Municipality City Hall and was made on the basis of the public register data and surveys and inventory of the buildings.

Bolnisi architecture was founded in 1818 by German people emigrated from Swabia and settled near village Ratevani. The German settlement was called Katerinenfeld until 1921. In 1921, after occupation of Georgia and Azerbaijan by Soviet Russia, Katerinenfeld was called Luxemburg and had this name between 1921and 1943, and from 1943 its old name was reestablished and it was called again its historical name Bolnisi. In 1967 town Bolnisi was granted the status of a city.

Old German residential houses are preserved in King Parnavaz and Saakadze Streets. For today, most of them have damaged roofs and wooden balconies, and some of them are even ruined. Part of these buildings are seriously damaged and are not fit for living and in some part of them the residents resettled from different corners of Georgia still continue living. The renovation of these buildings is considered in "Bolnisi Historical Districts Reconstruction Project".

Modern architecture of Bolnisi is represented by the individual houses and two, four, five and nine-storey apartment buildings. Nine-storey buildings are completely located in micro-districts of small town Kazreti.

For construction of the walls of private residential buildings are mostly used stone and wooden beams among masonry, and for the roofing corrugated asbestos-and-cement tiles (asbestos sheeting), tiles, and tin sheeting.

Residential buildings were built in the 60-70ies of the last century. For construction were mostly used brick and concrete blocks. For roofing was used iron, aluminum, and tin. The entrances of residential buildings are in poor conditions (the entrances have no doors and windows) and total area requires insulation. Attics of residential buildings also need to be insulated. Only 25-30% of the apartments have the replaced PVC windows. The single-layer wooden windows need to be replaced or insulated to reduce infiltration. It is desirable to arrange sensor lighting in the entrances of apartment buildings. As for the private individual buildings the roofs should be insulated and replaced, as well as, it's necessary to replace about 70% of the single-layer wooden windows.

Except the residential buildings on the territory are located governmental and municipal buildings, as well as, different types of commercial buildings (restaurants, cafes and bars, hotels, shops, salons, filling stations, stations, banks, bus stations, covered bazaar, bakeries, pharmacies, different kinds of workshops, etc.)

In the ownership of Bolnisi Municipality there are 20 buildings with total area 218 981m^2 of which 12 are kindergarten buildings. The list of the buildings owned by the Municipality and the areas is given in

Table 13 and the list of kindergartens – in Table 14.

Table 13. The Buildings Owned by the Municipality (Except Kindergartens)

Building Title	Total Area (sq.m)
Administrative buildings	4 166
IDPs Compact Settlements	2 895
House of Culture	4 904
Cinemas	4 603
Ritual Palace	14 188
Sports Complex	1 694
Arts and Music Schools	9 234
Museum	694
Fire Station	1 589
Different buildings (currently non-functioning)	19 096
Total	**63 064**

Table 14. The Kindergartens Owned by Bolnisi Municipality

Nurseries and Kindergartens	Construction (sq.m)	Number of Storeys	Total area (sq.m)
1	574	2	1 148
2	707	2	1 414
3	524	2	1 048
4	882	2	1 764
5	528	2	1 056
6	357	2	714
7	761	1	761
8	969	1	969
9	337	2	674
10	1 031	1	1 031
11	1 354	2	2 708
12	503	2	1 006
Total			**14 293**

Besides, there are state owned (for example: schools, medical facilities) and commercial buildings in Bolnisi Municipality. They are listed in Table 15.

Table 15. Incomplete List of Central Authorities Owned and Commercial Buildings Functioning in Bolnisi Municipality

#	Real Estate Title	Quantity	Area sq.m
1	Public Schools	34	524 376
2	Medical Facilities	8	7 580
3	Mobilization Service	1	346
4	Courts	2	946

Other types of commercial buildings are not given in the table due to the lack of information. The table was not summed up, as the information is not complete.

Energy Consumption by the Building Sector in Bolnisi Municipality

Information about energy consumption by the Buildings Sector in Bolnisi Municipality was obtained from different sources. Particularly, information about electricity consumption was provided by the JSC "Energo-Pro Georgia" which carries out power distribution in Bolnisi Municipality. Information about natural gas consumption was provided by gas company "Socar" which supplies the Municipality with natural gas. The information about firewood consumption in the buildings was obtained by Bolnisi Municipality City Hall. The summed up information about consumption of different types of fuel is given in Table 16.

Table 16. Trends of Energy Resources (kWh) Consumed by Buildings in Residential and Non-residential Sector of Bolnisi Municipality in 2012-2014

Types of Buildings	Total Area (sq.m)	2012	2013	2014
Residential Buildings	2 665 446	**47 335 110**	**54 909 461**	**61 366 013**
Municipal Buildings	63 064	**323 396**	**501 602**	**723 621**
Gardens	14 293	**134 531**	**131 441**	**151 395**
Other Buildings	533 248[7]	**923 546**	**901 976**	**1 034 778**
Total Energy Consumption (kWh)		**48 716 583**	**56 444 480**	**63 275 807**

The target of the presented table is only the analysis of general trends of energy consumption but this data (except that of gardens) can't be used for calculation of the consumed energy per sq.m area, as it does not include firewood consumption the percentage of which in total consumption is rather high. Particularly, in residential sector consumption of firewood based on non-official statistics (calculated according to the quantity of the households consuming firewood and its annual consumption) equals to 142 529 275 kWh (68 425m^3 firewood per year), that is about 70% of the summed-up consumption. Thus, to get the picture based on more reliable statistics, table 16 presents only the electricity and natural gas consumption in which the increase in residential sector made up at average 5% and 10% accordingly. As for the firewood consumption, according to the information provided by City Hall, there is a significant reduction in firewood consumption that presumably is based on the official statistics and does not consider the consumption of firewood got by illegal ways that significantly changes the firewood consumption picture. Therefore, evaluation of the households consuming firewood and the quantity of firewood consumed at average by one household

[7] In the category of "other buildings" the areas and the list are not complete

(7m³/per year) are calculated. More detail information see in Appendix II. And, table 16 shows that in 2012-2014 the consumption of electricity and natural gas in Building Sector is increased presumably, by 30%, as in the category of "other buildings" where the increase is higher could not be created the complete energy consumption picture.

Table 17 shows energy consumption according to the fuel type and building categories in natural units the total sum of which is 165490 MW/h. The details see in Appendix II.

Table 17. Energy Resources Consumed by Buildings in Residential and Non-residential Sector of Bolnisi Municipality in 2014

Subsector of Buildings	Electricity (kWh)	Natural Gas (Thousand m³)	Firewood (m³)
Residential	20 743 528	4 322	14 234[8] (68 425)
Municipal	218 981	58	222
Other Buildings (schools, governmental and sub-departmental buildings, hotels, etc.)	108 070[9]	100	665[10]
Total	21 070 579 (21 071 MW/h)	4 480 (42.1 MW/h)	15 121 (69 312) (144 377 MW/h)

4.2 Methodology

For CO_2 baseline (2014) emissions inventory from the Building Sector and defining future trends (up to 2020) the Methodology given in Appendix I was used, which also includes carbon dioxide emissions 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 in Table 18.

Table 18. Methane and Nitrous Oxide Emission Factors for Buildings (kg/MW/h)

GHG	Natural Gas	Oil Products	Firewood

[8] According to the households consuming firewood and the information, provided by Bolnisi Municipality City Hall about consumption of firewood by one household (7m³/per year 1 household), minimal consumption in 2014 only in residential sector should be 68 425m³ that was used during calculation.
[9] Consumption of electricity could not be calculated in the category of "other buildings" and this sector contains only the consumption of electricity by schools.
[10] Firewood is mostly used by schools in the category of "Other Buildings" and this number is only the consumption by schools.

CH_4	0.01800	0.036	1.080
N_2O	0.00036	0.002	0.014

As for the emissions reduction potential resulted by energy saving measures, it has been assessed by selecting typical buildings for Bolnisi Municipality, carrying out energy audits and evaluating energy efficiency measures, then transposing these results to other buildings. Energy audit methodology is given in Appendix III.

In short, we can say that assessment of the energy consumption from Buildings Sector and on its basis calculation of carbon dioxide emissions may be conducted according to three different scenarios (E_1=E_2=E_3): first scenario (E_1) – based on the annual energy consumption from Buildings Sector (electricity, gas, firewood suppliers) obtained from different sources; second scenario (E_2) - based on the energy consumption calculated for area unit after auditing different types of buildings and planned to be generalized on the entire existing area; and third scenario (E_3) - also based on the buildings auditing or surveys, calculated with multiplying energy consumption per capita by the number of population. Comparing the results of these three scenarios it is possible to identify the accuracy of calculation according to each scenario (E_1=E_2=E_3).

To develop Bolnisi Municipality SEAP, detail energy audit was conducted in 2015 and for this purpose 8 objects different from one another with energy resource consumption specifics were selected They are:

Bolnisi Municipality Nursery-Kindergarten #3 "Aisi"

(Address: St Nino #38)

Bolnisi Municipality Public School #1

(Address: Sulkhan-Saba Orbelianis St. N121)

Bolnisi Municipality Medical Centre

(Address: David Agmashenebeli #25)

Two-storey residential building

(Address: David Agmashenebeli str.N 41)

Four-storey residential buidling

(Address: David Agmashenebeli str.N 41)

Five-storey residential buidling

(Address: David Agmashenebeli str.N 39)

Nine-Storey Residential Building

(Address: Daba Kazreti, 9/4)

Private Residential Building

(Address: Stalini Street #20)

Private Residential Building

(Address: Village Bolnisi)

Municipality Buidling

(Address: Sulkhan-Saba Orbeliani Stre. N106)

Hotel "Bolnisi"

(Address: Sulkhan-Saba Orbeliani Stre. N101)

Picture 3. Town Bolnisi Buildings

After specifying specific energy costs, annual energy consumption (E_2, kWh/y) in buildings for heating, hot water, cooking and electric appliances was identified for different types of buildings.

Third scenario of methodology (E_3) is based on statistical data about the number of residents in the populated object. Identifying the energy cost calculated per capita (kWh/y per capita) makes it possible to calculate the annual energy consumption for the entire population (E_3kWh/y).

4.3 Building Sector Base Year (2014) Inventory and Baseline Scenario of the GHG Emissions (2015 – 2020)

As it was already mentioned above, according to guidelines of developing SEAP, three sub-sectors are considered in the structure of Municipality Building Sector, which include: municipal buildings, residential buildings and others (commercial buildings).

Bolnisi Municipality is completely electrified and power supply is provided to all populated areas. However, the main problem is incomplete re-metering (only 58.7%) creating difficulties in administering the electricity bills and in the process of implementing energy efficiency.

Energy consumption in Buildings Sector in 2014 is shown in Table 19.

Table 19. Final Energy Consumption in Bolnisi Municipality Buildings Sector (MWh) - 2014

#	Subsector	Electric Power	Natural Gas	Firewood	Total
1	Municipal Buildings	219	554	463	1 236
2	Other (Commercial) Buildings	108	950	1 385	2 443
3	Residential Buildings	20 744	41 051	142 529	204 324
	Total	21 071	42 555	144 377	208 003

Consequently, the GHG emissions from buildings reached 71.4 thousand tons CO_2eq. Power grid average emissions factor is considered as the power emissions factor – 0.104 tons CO_2eq/MWh.

Table 20. GHG Emissions from Bolnisi Municipality Buildings Sector Ton CO2eq.

#	Subsector	Electric Power	Natural Gas	Firewood	Total
1	Municipal Buildings	22.77	111.51	195.09	329.38
2	Other (Commercial) Buildings	11.24	191.31	584.40	786.96
3	Residential Buildings	2 157.33	8 270.63	59 862.18	70 290.14
	Total	2 191.34	8 573.46	60 641.67	71 406.48

The baseline scenario of emissions calculated by JRC coefficients will be increased by 36% by 2020.

As of 2013, 32% of Bolnisi Municipality population consumes natural gas. Throughout the Municipality the needed entire infrastructure for providing natural gas supply is not arranged completely and it is necessary to install additionally 300km pipeline in order Bolnisi population completely to be provided with gas supply.

For forecast by 2020 it was assumed that firewood consumption will be less likely increased, on the contrary, there will be transition on gas and therefore 36% increase will imply only electricity and natural gas of which the total emissions in 2014 equaled to 10.8 thousand tons CO_2eq. Thus, 36% increase from electricity and gas consumption is 3 875 tons CO_2eq. Consequently, by 2020, emissions are expected to equal to 75.3 thousand tons CO_2eq. This in total is emission increase not by 36% but by 5%.

The figures (Fig. 9-Fig. 11) show CO_2eq. emissions summed up and given according to buildings and fuel types in 2016-2020.

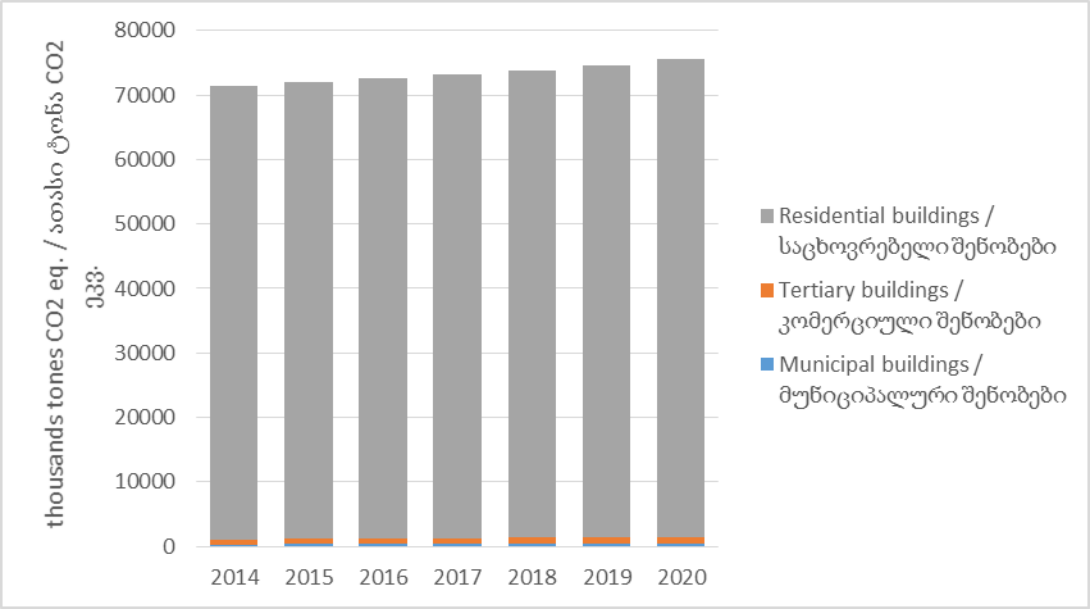

Fig. 9. BAU Scenario up to 2020 by Building Types

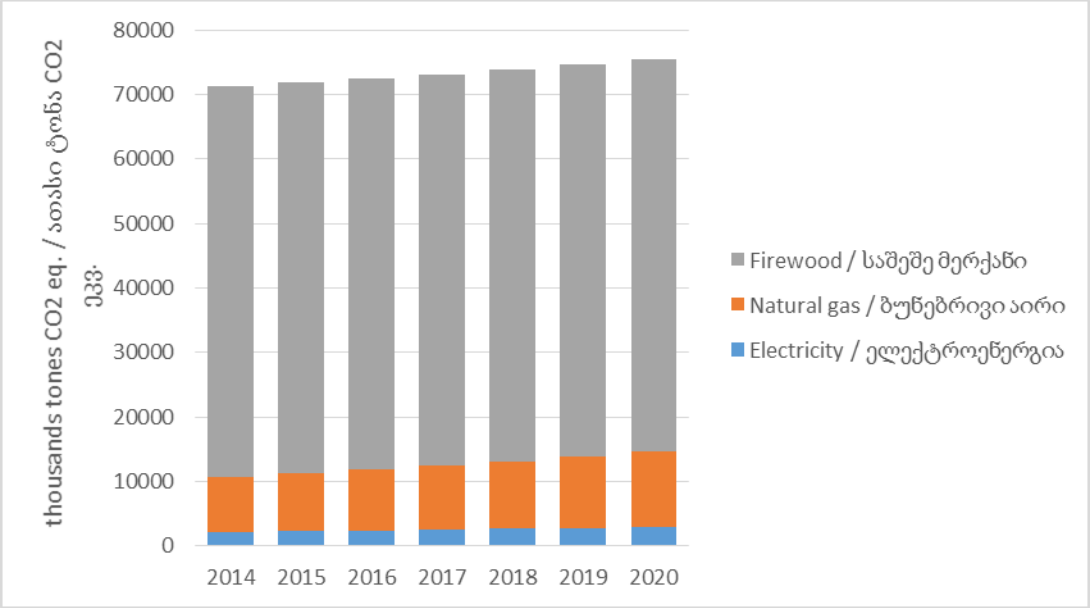

Fig. 10. BAU Scenario up to 2020 for Buildings Sector by Fuel Types

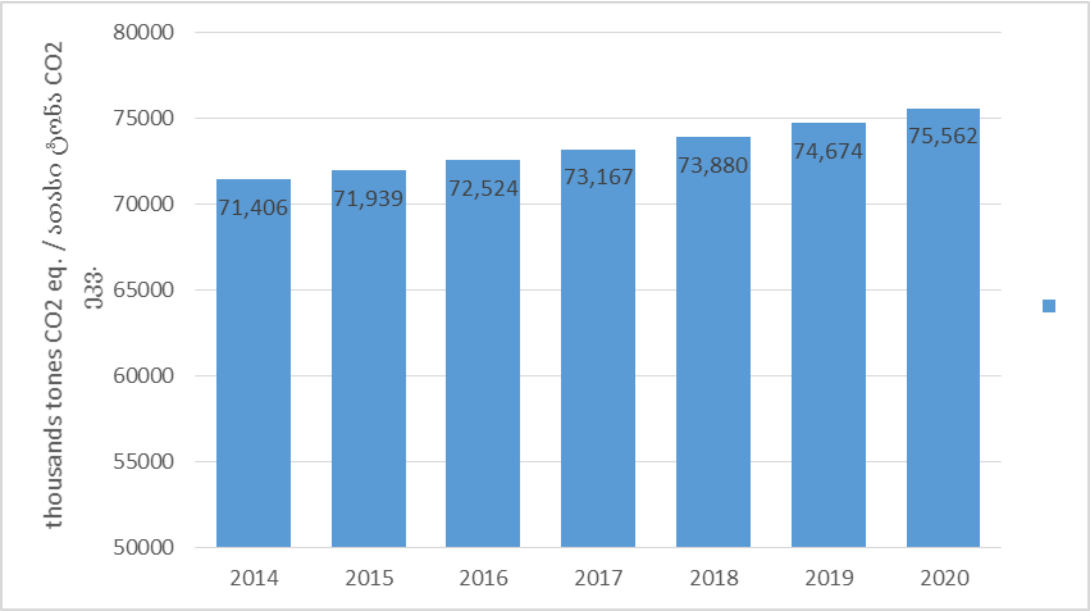

Fig. 11. BAU Scenario up to 2020 for Buildings Sector

4.4 The GHG Emissions Reduction Action Plan from Bolnisi Municipality Buildings Sector

As Table 20 shows, 98% of the GHG emissions from Bolnisi Municipality buildings are emitted from residential buildings[11]. Therefore, to achieve emissions reduction 20% benchmark it is crucial to develop programs for residential sector which will promote adoption of energy efficiency and renewable energies within this sector. To this, here should be considered the fact that supplying the population with power is comparatively low in Bolnisi Municipality, as the buildings are not heated completely and a big part of population experiences energetic poverty. Therefore, such programs need urgent preparatory works, among them, working with donors in seek of external funding, perfecting legislative base and regulations in order the Municipality to be able to work directly with the population to implement appropriate projects. Bolnisi Municipality City Hall considers the fact that, in the moment of developing this plan only 4 years are left till 2020, and due to this reason, most likely, complete implementation of such programs may not to be managed by 2020. Therefore, more realistic will be to postpone reaching the targeted benchmark by 2030 and it may become more ambitious (-40%) as it is considered in the new Covenant of Mayors, joining to which the Municipality is scheduling at the moment. In the nearest four years the City hall strategy implies maximum promotion to energy-saving and renewable energies in the municipal buildings in order these building to become examples for the population and other commercial buildings. Besides, it is planned to promote energy-saving measures and further those residential buildings which are comparatively organized and for which the City Hall has already got co-financing programs - such are comradeships (apartment buildings). The Municipality actively cooperates with gas company "Socar" to timely supply with natural gas those villages and population which consume firewood irregularly (illegally cut firewood). At the same time, the Municipality plans to establish Sustainable Development Agency the main function of which will be developing for the population energy efficiency and renewable energies programs.

Coming out of the above-mentioned, within the frames of the SEAP strategy, implementation and the following measures are scheduled:

In municipal buildings:

1. Insulation of attics;
2. Installation of new lighting systems;
3. Insulation of attics in kindergartens;
4. Replacement of windows in kindergartens;
5. Installation of new energy-efficient lighting systems in kindergartens;
6. Consuming solar collectors in nursery-kindergartens;

In short-term perspective for residential sector, the Municipality will cooperate with apartment-owners' comradeships to take the following measures:

1. Installation of sensor lightings in building entrances;
2. Insulation of common areas of residential buildings;
3. Insulation of attics of residential buildings;
4. Reduction of infiltration from windows of residential buildings;
5. Insulation of ceilings in typical private houses;

[11] Here is included the inaccuracy caused due to the fact that it was impossible to get power consumption data from commercial buildings that would have changed this picture significantly.

6. Offering highly-effective heat-generators working on bio-wastes for typical private two-storey houses.

Table 36 shows the existing buildings emissions reduction action plan and below is given description of measures to be implemented.

Measure MB1. Thermal Insulation of attics in Municipal Buildings

Measure MB1.1. Thermal Insulation of Attic of Municipality Building. The measure implies thermal insulation of 1 293m^2 attic of municipality building. Town Bolnisi Municipality building is located in Sulkhan-Saba Street #106. The expected energy-savings resulted by implementation of this measure will make up 92 197kWh per year that is equivalent to 92 197/(9.4x0.9)=10 898m^3/y natural gas. Considering the natural gas tariff (0.82GEL/m^3), the amount of annual savings will make up 10 898 x 0.82 = 8 936GEL.

Accordingly, reduction of CO_2 emissions from the Municipality building will be equal 92 197kWh x 0.202(kgCO_2/kWh)/1000 = 18.6T/y. The needed investment costs for completing thermal insulation of attic is 1 293 x 20 = 25 860GEL in which 1 293m^2 is the ceiling area.

Profitability parameters of Measure MB1.1 are given in Table 21.

Table 21. Profitability Parameters of Measure MB1.1

Measure	Investment Cost GEL	Payback PB	Internal Rate of Return IRR,%	Net Present Value Quotient NPVQ	CO_2 Reduction T/y
Thermal Insulation of Attic	25 860	3.2	30.9	2.0	18.6

'PB - Payback period; 'IRR- Internal Rate of Return; 'NPVQ - Net Present Value Quotient.

Measure MB1.2 – Thermal Insulation of Attics in Kindergartens. This measure is planned to be implemented in 12 kindergartens. The energy-savings resulted in by implementing this measure was calculated according to the ENSI computer program for the nursery-kindergarten building located in St. Nino Street #38 and makes up 30 286 kWh/y and CO_2 emissions reduction from attic equals 30 286 x 0.202/1000 = 6.1T/y. In case the natural gas is consumed as energy source its annual expenditure will be 30 286/(9.4 x 0.9) = 3 578m^3/y. Considering the natural gas tariff, the amount of annual expenditure makes up 3 578 x 0.82 = 2 934GEL.

The needed investment costs for completing thermal insulation of attic is 444 x 20 = 8 880GEL.

Profitability parameters of Measure MB1.2 are given in Table 22.

Table 22. Profitability Parameters of Measure MB1.2

Measure	Investment Cost GEL	Payback PB	Internal Rate of Return IRR,%	Net Present Value Quotient NPVQ	CO_2 Reduction T/y
Thermal Insulation of Roof in One Kindergarten	8 880	3.4	29.5	1.86	6.1

This Measure is Considered for Twelve (12) Kindergartens	106 560	3.4	29.5	1.86	73.2

Measure MB2. Installation of Energy-Efficient Lighting Systems in Municipal Buildings

Measure MB2.1. Installation of Energy-Efficient Lighting Systems in Municipality Building. Installation of new lighting system implies replacement of the non-effective incandescent bulbs widespread in the country with modern energy efficient ones. The widespread incandescent bulbs, due to their low energy efficiency, consume much electricity and it has low consumption length. This measure will result in replacement of 170 bulbs and the expected energy-savings will make up 26322kWh/y, considering electricity tariff (0.199GEL/kWh) the amount of annual savings will make up 26 322 x 0.199 = 5 238GEL.

Accordingly, reduction of CO_2 emissions from buildings will equal 26 322 x 0.104 /1000 = 2.74T/y. The needed investment costs for completing this measure makes up 2 600GEL.

Profitability parameters of Measure MB2.1 are given in Table 23.

Table 23. Profitability Parameters of Measure MB2.1

Measure	Investment Cost GEL	Payback PB	Internal Rate of Return IRR,%	Net Present Value Quotient NPVQ	CO_2 Reduction T/y
Reduction of Infiltration	2 600	0.5	200.7	7.0	2.74

'PB - Payback period; 'IRR- Internal Rate of Return; 'NPVQ - Net Present Value Quotient.

Measure MB2.2. Installation of Energy-Efficient Lighting Systems in Kindergarten Buildings. The energy-savings resulted by replacement of the existing bulbs with energy efficient ones was calculated according to the ENSI computer program for the building of nursery-kindergarten #3 located in St. Nino Street #38 and in case of replacement of 16 bulbs the annual savings will make up makes up 441 kWh/y and reduction of CO_2 emissions will equal 441 x 0.104/1000 = 0.05T/y.

Considering the electricity tariff (0.16GEL/kWh), the amount of annual savings will make up 441 x 0.16 = 71GEL. The needed investment costs for completing this measure is 250GEL.

Profitability parameters of Measure MB2.2 are given in Table 24.

Table 24. Profitability Parameters of Measure MB2.2

Measure	Investment Cost GEL	Payback PB	Internal Rate of Return IRR,%	Net Present Value Quotient NPVQ	CO_2 Reduction T/y
Thermal Insulation of Roof in one Kindergarten	250	3.6	12.4	0.11	0.05

Measure MB3. Renewable Energy Consumption in Municipal Buildings

Measure MB3.1. Consumption of Solar Collectors in Kindergartens. The measure aims at consuming solar collectors to provide hot water supply to the municipal buildings like kindergartens. In kindergartens today is consumed at average 4 000 liters of hot water per day for heating of which 24 907kWh energy is needed per year.

In Bolnisi Municipality the solar collector generates 1 050kWh/m^2 per year. If we use the solar energy collectors with vacuum, installed on the roofs from 24m^2 area, we will get 25 200kWh energy per year.

Standard solar energy collector's surface area is 2m^2 and costs 1300GEL. In our case we will need 12 such kind of collectors and accordingly the investment costs will be15 600GEL.

To get the mentioned energy (25 200kWh/y) from consumption of natural gas it would require the gas in the amount: 25 200/(9.4 x 0.9) = 2 978 m^3, the money equivalent of which is 2 978 x 0.82 = 2 442GEL. The reduction of CO_2 emissions if natural gas is changed to solar energy will be 25 200 x 0.202/1000 = 5.1Tons per year.

Profitability parameters of Measure MB3.1 are given in Table 25.

Table 25. Profitability Parameters of Measure MB3.1

Measure	Investment Cost GEL	Payback PB	Internal Rate of Return IRR,%	Net Present Value Quotient NPVQ	CO_2 Reduction T/y
Consumption of Solar Collector in one Kindergarten	15 600	7.1	12.8	0.36	5.1
This measure is Considered for Twelve (12) Kindergartens	187 200	7.1	12.8	0.36	61.2

Measure MB4. Renovation of Municipal Buildings

Measure MB4.1. – Replacement of Windows in Kindergartens. The energy-savings resulted in by implementing this measure was calculated according to the ENSI computer program for the nursery-kindergarten building located in St. Nino Street #38 and makes up 18 306kWh/y. Reduction of CO_2 emission from windows will be 18 306 x 0.202/1000 = 3.7T/y.

If natural gas is consumed as the energy resource its annual expenditure will be 18306/(9.4 x 0.9) = 2 164m^3/y. Considering the gas tariff the expenditure per year makes up 2 164 x 0.82 = 1 774GEL. The investment costs for replacement of windows is 115 x 150 = 17 250GEL.

Profitability parameters of Measure MB4.1 are given in Table 26.

Table 26. Parameters of Measure MB4.1

Measure	Investment Cost GEL	Payback PB	Internal Rate of Return IRR,%	Net Present Value Quotient NPVQ	CO_2 Reduction T/y

Replacement of Windows in Kindergartens	17 250	10.9	6.7	0.11	3.7

Measure RB1. Installation of Energy-Efficient Lighting Systems in Residential Buildings

Measure RB1.1 – Installation of Sensor Lightings in Entrances of Residential Buildings. Total number of entrances of multi-storey buildings in Bolnisi Municipality Buildings Sector is 232, and the number of bulbs installed in the entrances makes up 1 185. In Table 27 is given the cumulative data of Bolnisi Municipality residential buildings.

Table 27. Cumulative Data of Bolnisi Municipality Residential Buildings

#	Number of Storey	Number of Buildings	Number of Entrances	Number of Sensor Lighting
1	2-storey buildings	36	72	144
2	4-storey buildings	9	31	124
3	5-storey buildings	19	61	305
4	9-storey buildings	28	68	612
	Total	92	232	1 185

The measure implies replacement of the existing bulbs with sensor bulbs. On each sensor bulb the electricity savings make up at average 290kWh/y, and the corresponding emissions savings is 38kgt CO_2eq./y.

Considering the number of sensor bulbs (1 185), total electricity savings in Bolnisi Municipality building entrances will be 290 x 1 185 = 343 650 kWh/y, and money equivalent of these savings will be 343 650 x 0.13 = 44 675GEL. The corresponding emission reduction is expected to be 1 185 x 38/1000 = 45.0 T/y.

The cost of the sensor device is 15GEL, and the total investing costs will make 15 x 1 185 = 17 775GEL.

Profitability parameters of Measure RB1.1 are given in Table 28.

Table 28. Profitability Parameters of Measure RB1.1

Measure	Investment Cost GEL	Payback PB	Internal Rate of Return IRR,%	Net Present Value Quotient NPVQ	CO_2 Reduction T/y
Installation of Sensor Lighting in Entrances	17 775	0.4	250.8	9.0	45.0

Measure RB2. Renovation of Residential Buildings

Measure RB2.1. – Heat Insulation of Common Areas in Entrances of Residential buildings

Heat insulation measure covers installation of PVC windows in the openings of each storey in residential buildings. Under this measure, it will be needed PVC windows to be installed on about 1 185 stairway cells 1.5m^2, i.e. in total 1 185 x 1.5 = 1778m^2. Investment for windows will be 150GEL/m^2 x 1778m^2= 266 700GEL.

Specific importance of heat savings from common areas of residential building entrances for each storey cell will be 2 000 kWh/y. Corresponding savings considering the numbers of residential buildings and entrances are given in Table 29.

Table 29. Energy Savings with Heat Insulation of Building Entrances

#	Number of Storeys	Number of Buildings	Number of Entrances	Number of Stairway Cells	Energy savings kWh/y
1	2-storey buildings	36	72	144	288 000
2	4-storey buildings	9	31	124	248 000
3	5-storey buildings	19	61	305	610 000
4	9-storey buildings	28	68	612	1 224 000
	Total	92	232	1 185	2 370 000

Table 29 shows that the totals of energy savings make up 2 370 000kWh/y, that is equivalent to 2 370 000/(9.4 x 0.9) = 280 142m^3 natural gas. Its money equivalent will be 280 142 x 0.48 = 134 468 GEL per year. Emissions will be reduced by 2 370 000 x 0.202/1000 = 478.0 T/y.

Profitability parameters of Measure RB2.1 are given in Table 30.

Table 30. Profitability Parameters of Measure RB2.1

Measure	Investment Cost GEL	Payback PB	Internal Rate of Return IRR,%	Net Present Value Quotient NPVQ	CO_2 Reduction T/y
Heat Insulation of Common Areas in Entrances of Residential Buildings	266 700	2.2	45.3	3.3	478.0

Measure RB2.2. Heat Insulation of Attics of Residential Buildings. Heat savings received from thermal insulation of attics of residential buildings have been taken based on the conducted auditing and are given in Table 31.

Table 31. Energy Savings with Residential Building Heat Insulation

#	Number of Storeys	Number of Residential Buildings	Energy Savings in One Residential Building kWh/y	Energy Savings in All Residential Buildings kWh/y	Attic Area in One Residential Building m^2	Attic Area in All Residential Buildings m^2
1	2-storey buildings	36	23 268	837 648	310	11 160

2	4-storey buildings	9	25 889	233 001	348	3 132
3	5-storey buildings	19	34 795	661 105	468	8 892
4	9-storey buildings	28	28 558	799 624	384	10 752
	Total	92		2 531 378	-	33 936

Totals of savings make up 2 531 378 kWh/y energy that will result in reduction of CO_2 emissions 2 531 278 x 0.202/1000 = 511.0 T/y. Corresponding natural gas savings make up about 2 531 378/(9.4x0.9) = 299 217m^3. Money equivalent of these savings will be 299 217 x 0.48 = 143 624GEL per year. The investment will be 33 936m^2 x 20GEL/m^2 = 678 720GEL.

Profitability parameters of Measure RB2.2 are given in Table 32.

Table 32. Profitability Parameters of Measure RB2.2

Measure	Investment Cost GEL	Payback PB	Internal Rate of Return IRR,%	Net Present Value Quotient NPVQ	CO_2 Reduction T/y
Heat Insulation of Attics of Residential Buildings	678 720	5.3	18.4	0.84	511.0

Measure RB2.3. – Reduction of Infiltration from Windows of Residential Buildings. Due to double-way airflow, rooms are cooled very soon and a big amount of energy is needed to heat them. Through the gaps in the doors and windows, a cold flow of air comes in from outside and warm airflow goes out. Therefore, it is necessary to provide air tightness that makes it possible to reduce the energy needed for heating the room by 25-30%. To cover fissures, cracks, gaps, and reducing air leaking it is possible to use very simple and cheap methods: to fill the gaps between window glass and frame with silicone, scotch or putty. It is also possible to stick from both sides of glass scotch and special transparent plastic material and attach on the window frame surface foam rubber, penopoliurethane, silicone and rubber sealing.

The heat savings received from reducing infiltration in residential buildings have been taken based on the conducted auditing and are given in Table 33.

Table 33. Energy Savings with Infiltration Reduction in Residential Buildings

#	Number of Storeys	Number of Residential Buildings	Energy Savings in One Residential Building kWh/y	Energy Savings in All Residential Buildings kWh/y
1	2-storey buildings	36	5 585	201 060
2	4-storey buildings	9	15 566	140 094

3	5-storey buildings	19	26 627	505 913
4	9-storey buildings	28	60 637	1 697 836
	Total	92	-	2 544 863

Totals of energy savings make up 2 544 863kWh/y that is equivalent to 2 544 863 /(9.4 x 0.9) = 300 811m^3 natural gas. Money equivalent of these savings will be 300 811 x 0.48 = 144 389 GEL per year. Emissions will be reduced by 2 544 863 x 0.202/1000 = 514.0T/y.

Under this measure about 31 318m^2 windows will be sealed up. Investment for windows will be 2GEL x 31 318m2 = 62 636GEL.

Profitability parameters of Measure RB2.3 are given in Table 34.

Table 34. Profitability Parameters of Measure RB2.3

Measure	Investment Cost GEL	Payback PB	Internal Rate of Return IRR,%	Net Present Value Quotient NPVQ	CO_2 Reduction T/y
Reduction of Infiltration	62 636	0.5	207.2	19.0	514.0

Measure RB2.4. – Heating Insulation of Ceilings in Typical Private Houses. Heating savings received from heating insulation of ceilings at typical private houses was taken based on the conducted auditing and it makes up 11 739kWh/y that resulted in CO_2 emission reduction by 11 7739 x 0.202/1000 = 2.4T/y.

The corresponding natural gas savings make up about 11 739/(9.4x0.9) = 1 387m^3. Money equivalent of these savings will be 1 387 x 0.48 = 665GEL per year. Investment will be 156m^2 x 20GEL/m^2 = 3 120GEL.

Profitability parameters of Measure RB2.4 are given in Table 35.

Table 35. Profitability Parameters of Measure RB2.4

Measure	Investment Cost GEL	Payback PB	Internal Rate of Return IRR,%	Net Present Value Quotient NPVQ	CO_2 Reduction T/y
Heat Insulation of Ceilings in Typical Private houses	3 120	5.2	18.6	0.86	2.4
Heat Insulation of Ceilings in Typical Private houses (1 000)	3 120 000	5.2	18.6	0.86	2 400

Measure RB3. Fuel replacement

Measure RB3.1. Replacement of Unsustainably Produced Biomass (Firewood) with Natural Gas. Firewood consumption in residential sector of Bolnisi Municipality equals to about 70% of total energy

consumed in this sector. All this happens at expense of illegal wood cutting and becomes a very heavy burden for greenery existing in the Municipality territory. Therefore, replacement of firewood with gas was scheduled as one of the most important measures that will be promoted significantly by the Municipality, especially from the point of consumption energy-efficient technologies.

Therefore, it was assumed that in 2018-2020, 50% of the households, currently using firewood, will use gas. Currently, the residential sector consumes 68 425m^3 firewood equal to142 529 275 kWh energy. As this firewood was produced by unsustainable (illegal) cuttings, it is considered as the emissions source, and from firewood consumption annual emission is 142 529MWh*0.42= 59 862 T CO_2 eq. To receive the same amount of energy 142 529 275 kWh/9.4=15 162 689m^3 will be needed. In case of natural gas consumption, the same amount of energy is received 142 529 MWh*0.202= 28 791. Savings will make up 31 077 T CO_2 eq under this measure.

Table 36. Action Plan of Emissions Reduction from Bolnisi Municipality Buildings

Sectors and Activity Sphere	Main Measures in the Sphere of Activity	Department/Person or Company in Charge (if the third party is involved)	Implementation Period [start and End Date]	Expected Energy Savings from Each Measure (MW/h/y)	Expected CO_2Reduction from Each Measure [T/y]	Cost of Each Measure [in GEL]
Municipal Buildings (MB)						
Measure MB1	Improving Heating Insulation in Municipal Buildings					
MB 1.1	Heating Insulation of Attic in Municipality Building	Bolnisi Municipality Agency of Economic Policy	2016-2020	92.2	18.6	25 860
MB 1.2	Heating Insulation of Attics in Kindergarten Buildings (12)	Bolnisi Municipality Agency of Economic Policy	2016-2020	363.4	73.2	106 560
Measure MB 2	Energy Efficient Systems of Lighting					
MB 2.1	Installation of New Lighting Systems in Municipal Buildings	Bolnisi Municipality Agency of Economic Policy	2016-2020	26.2	2.74	2 600
MB2.2	Installation of New Energy-efficient Lighting Systems in Kindergartens	Bolnisi Municipality Agency of Economic Policy	2016-2020	0.441	0.05	250

Measure MB 3	Renewable Energy Resource Consumption to Provide Hot Water Supply					
MB 3.1	Consumption of Solar Collectors in Kindergartens (12)	Bolnisi Municipality Agency of Economic Policy	2016-2020	302.4	61.2	187 200
Measure MB4	Renovation of Buildings					
MB 4.1	Replacement of Windows in Kindergartens (1)	Bolnisi Municipality Agency of Economic Policy		18.3	3.7	17 250
Residential Buildings (RB)						
Measure RB 1	Installation of Effective Lighting Systems					
RB 1.1	Installation of Sensor Lighting in Entrances of Residential Buildings	Bolnisi Municipality Agency of Economic Policy	2016-2020	343.7	45.0	17 775
Measure RB 2	Renovation of Residential Buildings					
RB 2.1	Heat Insulation of Common Areas in		2016-2020	2 370	478	266 700

	Residential Buildings	Bolnisi Municipality Agency of Economic Policy				
RB 2.2	Heat Insulation of Attics in Residential Buildings	Bolnisi Municipality Agency of Economic Policy	2016-2020	2 531	511	678 720
RB 2.3	Reduction of Infiltration from Windows of Residential Buildings	Bolnisi Municipality Agency of Economic Policy	2016-2020	2 544	514	62 636
RB 2.4	Heating Insulation of Ceilings in Typical Private Houses (1000)	Investor and Proprietor	2016-2020	11 739	2 400	3 120 000
Measure 3 RB 3	Replacement of Fuel					
RB 3.1	In Villages/Residential Sector Replacement of Firewood with Natural gas	Bolnisi Municipality Agency of Economic Policy	2018-2020		31 071	
Total					35 179	

5 Street Lighting

5.1 Sector Overview

In Bolnisi Municipality there are two small towns, 47 villages and one city Bolnisi. The length of Bolnisi Municipality roads (streets) makes up about 310km, of which only one third (109km) has street lighting.

Table 37 shows the energy consumption and expenses for Bolnisi Municipality Street Lighting Sector 2014.

Table 37. Energy Consumption and Expenses for Bolnisi Municipality Street Lighting Sector 2014

Infrastructural facilities	Energy Consumption (kWt/h)	Financial Expenses (GEL)
Bolnisi Municipality Street Lighting	1 396 940	223 192.10
Total	1 396 940	223 192.10

As we see from the table, in 2014 energy consumption by Bolnisi Municipality made up a little less than 1.4mln kWt/h, which cost more than 223thousand GEL. Currently, in the Municipality there are installed 2 253 street lighting fixtures, the types and power of which is given in the table below.

Table 38. Parameters and Characteristics of Bolnisi Municipality Street Lighting Bulbs

#	Existing Lighting Fixtures	Characteristics	Quantity
		Power, Wt	
Street Lighting			
1	Sodium (Днат)-70	84	998
2	Sodium(Днат)-150	170	812
3	Sodium(Днат)-250	290	397
4	Sodium(Днат)-400	450	46
	Total		2 253

5.2 Methodology

As it was already mentioned, in 2014 the number of lighting fixtures was 2 253 pieces and covers 109 km which is 35% of the total length of streets (310km). As the final goal of the Municipality Administration is lighting all the streets/roads existing in the Municipality, it was assumed that in 2016 – 2020 gradually will be arranged lighting of those streets having no lighting in the way that by 2020 the 51% of total length of streets or 159km will have lighting, for what it is necessary at average to provide street lighting of 10km road per year. Thus, lighting of the total Municipality roads will be increased from 35% up to 51%. Under this assumption, by 2020 the total number of lighting fixtures will be 3 219. During the baseline scenario it was assumed that the additional lighting fixtures will be energy-efficient ones.

5.3 Base Year (2014) Inventory and the GHG Emissions Baseline Scenario (2015 – 2020) in Street Lighting Sector

In 2014, the energy consumption by the Street Lighting Sector amounted to 1 397GWT/h.

Emission from street lighting in 2014 was 145 tons CO_2eq.

The electrical grid average emissions factor in 2014 – 0.104 tons CO_2/MWT/h was considered as the energy emissions factor.

According to the baseline scenario, street lighting energy consumption will be increased in the future and by 2020 it will be 1.996GWT/h, and CO_2 emissions by 2020 will amount up to 207.6 tons CO_2.

5.4 Emissions Reduction Action Plan from Bolnisi Municipality Street Lighting Sector

As Table 38 shows, rather a great part of the streetlight bulbs used in Bolnisi is inefficient. Action plan measure considers replacing all the existing inefficient streetlight bulbs with modern LED streetlight bulbs by 2020, as well as, installing energy-efficient streetlight bulbs instead of the inefficient incandescent streetlight bulbs. In most cases 30W and 70W LED streetlight bulbs will be installed.

Table 39 shows the quantity of inefficient lighting fixtures existing in street lighting and the replacing efficient lighting fixtures according to their type, number and power.

Table 39. The Existing Street Lighting Fixtures and the Types, Powers and Light Flows of Replacing Energy-efficient Lighting Fixtures

	Existing Lighting Fixtures	Replacing LED Lighting Fixtures

	Type of Lighting Fixture	Quantity	Power W	Total Power kWt	Type of Lighting Fixture	Quantity	Power W	Total Power kWt	Flow of Light Lm
Street Lighting									
1	Днат-70	998	85	84.83	LED 30	998	30	29.94	2 700
2	Днат-150	812	170	138.04	LED 70	812	70	56.84	5 700
3	Днат-250	397	290	115.13	LED 70	397	70	27.79	5 700
4	Днат-400	46	450	20.7	LED 70	46	70	3.22	5 700
	Total	**2 253**		**358.7**		**2 253**		**117.79**	

Measure S1: It is considered that implementing the measure will start in 2016 and by that time the existing 2 253 inefficient lighting fixtures will be replaced with energy-efficient LED lighting fixtures gradually in 2016-2020. To this, new roads, in total 50km, will have efficient street lighting, as we are aware that 109km of the Municipality roads has lighting of which 7% has lighting on both sides of the road, i.e. in total street lighting has 109+109*7%=116.63km roads. If we divide this road mileage by the number of streetlight bulbs, it comes out that at average in every 52 meters is installed one streetlight bulb. If we discuss according to this principle, it will come out that for each 50km lighting fixtures will be needed 50000/52=966 new streetlight bulbs. The total number of lighting fixtures to be replaced is 2 253+966=3 219. If now the average energy consumption by one lighting spot equals 0.162kWt /h and providing lighting service will be continued with the current type of bulbs then in 2020 the annual energy consumption by street lighting system in Bolnisi Municipality will be 3 219(lighting fixture) * 0.162(kWt) * 3 832.5(hr) = 1 995 817kWt/h, and in case the energy-efficient LED lighting bulbs are used in the whole grid in lighting fixtures, the annual consumption will be 3 219(lighting fixture) * 0.04 (average kWt) * 3 832.5 (hr) = 489 376kWt/h. Accordingly, the savings in 2020 will equal 1 995 817 – 480 252 = 1 515 565 kWt/h energy, and the emissions will be reduced consequently (1 995 817 - 480 252) / 1 000 * 0.104 = 157.62 tons CO_2.

As replacing one lighting fixture costs at average 320GEL and installing new lighting fixtures costs at average 800GEL, the measure cost will be about 2 253 * 320 + 966 * 800 =1.5million GEL.

During consuming LED lighting fixtures along with the needed active power reduction, the losses of loading are also reduced within the transformers and transmission lines (at average by 2% which is already counted in the above-mentioned calculations).

The below-given diagram shows GHG emissions in case of completing baseline scenario and equipping the street lighting spots with energy-saving bulbs that is the most prioritized measure of the SEAP in this sector.

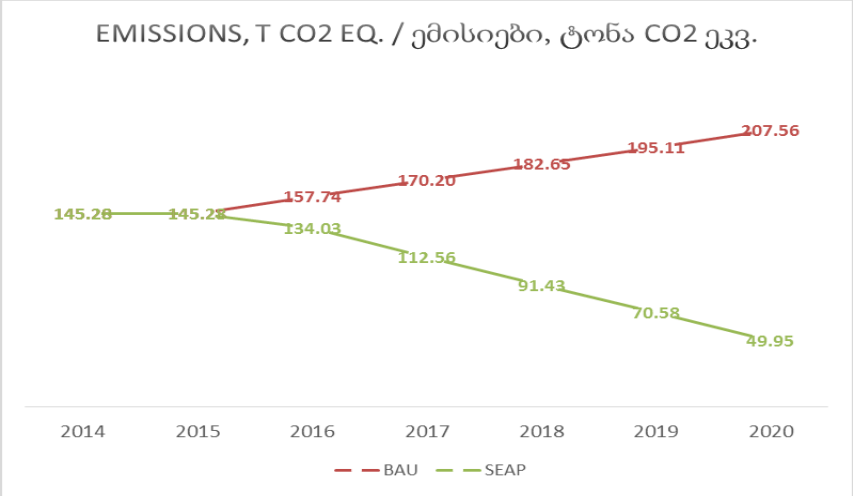

Fig. 12. Emissions if the Municipality Street Lighting is completed under the BAU Scenario and in Case of Implementing the Measures Considered under the SEAP

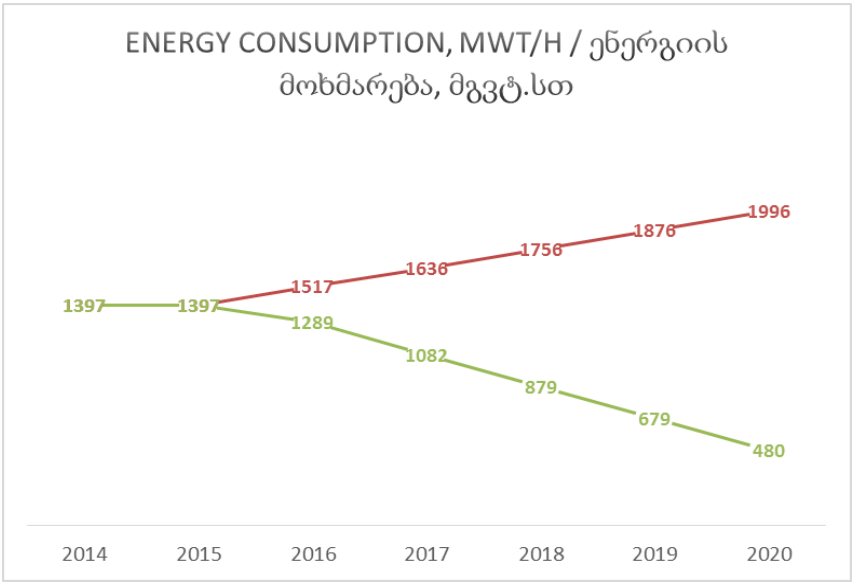

Fig. 13. Energy Consumption by the Municipality Street Lighting under BAU Scenario and in Case of Implementing the Measures Considered under SEAP

In total the implemented measure will save1 515MWT/H energy and 158 tons emissions CO_2 eq. by 2020

Table 40. Action Plan for Bolnisi Municipality Street Lighting Sector

Sectors and Activity Sphere	Main Measures in the Sphere of Activity	Department/Person or Company in Charge (if the third party is involved)	Implementation Period [start and End Date]	Expected Energy Savings from Each Measure (MWT/h/y)	Expected CO_2Reduction from Each Measure [T/y]	Cost of Each Measure [in GEL]
Street Lighting S				1 516	158	1 500 000
Energy-efficient Bulbs S1	Increase the Share of Energy-efficient Lighting Bulbs in Street Lighting Grid	Ltd. "Public Utilities"	2016-2020	1 516	158	1 500 000

6 Greening/Landscaping

6.1 Sector Overview

Bolnisi Municipality lies in the south of Kvemo Kartli region - the historical province of Eastern Georgia, in the middle of the River Mashavera, 560m above sea level. The Municipality Center is city Bolnisi. Climatically the territory of Bolnisi Municipality belongs to moderately humid subtropical climate zone where may be distinguished two basic types of climate:

The transitional climate from moderately warm steppe to moderately humid one with moderately cold winters, hot summers and two precipitations maximums (plain areas of the Municipality);

Moderately humid climate with moderately cold winters and long-lasting warm summers (foothills).

Within the boundaries of Bolnisi Municipality, natural vegetation is presented with steppe, half-wilderness, arid light forest, hemixelophile forests and shrubs, medium mountain forest, sub-alpine forests and shrubs, meadow shrubs and riparian forest vegetation modified to various degrees.

Within the Municipality territory, forest occupies 49.5% (41 000ha) of the total area and is spread 750-900m above sea level. Forest is mostly represented by broad-leaved plants. The Municipality owns about 50ha[12] of forest lands. On the territory of the Municipality, in fact, do not exist any riparian forests at all and the wind-breaking zones are also destroyed.

Green cover, existing in recreation zones of the Municipality (parks, squares, etc.) and in the homestead plots of the population, is mostly represented with artificially planted perennials.

Development of recreation zones and their landscaping works started mainly in the 60ies of the last century. At present the areas covered by perennials occupy different green zones within the Municipality, particularly such areas as the recreation zones (parks, squares, etc.), as well as, the homestead plots, areas near the governmental buildings, along the roads, cemeteries, agricultural lands (plantations of fruit trees, vineyards) covered by perennial plants. In total, the area covered with perennial plants in Bolnisi Municipality makes up 1 590ha (see Table 41).

Table 41. Areas Covered with Plants in Green Zones of Bolnisi Municipality

#	Green Zones	Covered by Plants, area, ha	%
1	Recreation Zones (parks, squares)	5	1
2	Greening of different areas in the Municipality (in the homestead plots, areas near buildings, along the roads, etc.)	130	8

[12]http://bolnisi.gov.ge/?page_id=10

3	Agricultural lands covered with perennial plants (among them vineyards)[13]	1382	87
4	Area covered by forest [14]	50	3
5	Cemeteries	23	1
Total Green Cover		1 590	100
1	Among them, fragmented cover	1 540	97
2	Covered with closed canopy plants	50	3

Within the boundaries of Bolnisi Municipality the natural and artificially set out groves of forests are mostly at disposal of Bolnisi forestry area in subordination to Kvemo Kartli Forestry Service. As for Bolnisi Municipality, as it was already mentioned, it owns only a small part of the forest area (50ha) (see Table 41).

Greatest part of the Municipality area covered with plants comes on the plantations of fruit trees and vineyards in the agricultural lands, particularly, as it is shown in table 41, their share in total area reaches 87%.

In green zones of the Municipality the least coverage by greenery, only 1%, comes on recreation zones (parks, squares, etc.). It should be noted that the most part of the landscaped area on the populated territories is concentrated in the yards of private residential houses and near different kinds of buildings. In the yards of private residential houses fruit trees are mostly planted.

In total, in Bolnisi Municipality the landscaped areas covered by perennial plants, if not counted forest areas (50%) which are far from the residential areas, occupy only 2% of the Municipality's total area.

Table 42. Recreation Zones Existing in Bolnisi Municipality

#	Recreation Zones (Parks, Squares)	Area Covered with Plants sq.m	Average Age of the Plants, year	Mostly Spread Species
1	Bolnisi Municipality Culture and Recreation Park	22 000	60-70	Asp, plane-tree, acacia, boxwood, lime, chestnut
2	Town Kazreti Recreation Park	17 000	40-45	Plane-tree, acacia, cedar, lime
3	Park located on David Aghmashenebeli Street of Bolnisi	4000	5-10	Soap tree, fir, cedar, plane-tree, lime
4	Square on the cross of Sulkhan Saba and Kostava Streets of Bolnisi	450	20-25	Spruce, plane-tree

[13]http://bolnisi.gov.ge/?page_id=10
[14]http://bolnisi.gov.ge/?page_id=10

5	Square in front of Liberty Bank on Sulkha-Saba Street of Bolnisi	350	25-30	Cedar, pine
6	Square in front of Post Office Building in Bolnisi	300	20-30	Cedar, pine
7	Square in front of Forest Management Building in Bolnisi	2 000	30-40	Cypress, cedar, pine
8	Square after Gia and Kakha on David Aghmashenebeli Street of Bolnisi	2 200	5-10	Soap tree, lime, cedar, pine
9	Square near Residential Building in II micro district of Town Kazreti	350	20-30	Cedar, pine
10	Square near Public School #2 of Town Kazreti	250	20-30	Cedar, pine
11	Square in the adjoining area to residential buildings on Sulkhan-Saba Orbeliani Street #188 and 190 of Bolnisi	330	30-35	Cedar, pine, spruce
	Total	**5ha (49 230sq.m)**		

As it was already mentioned, recreation zones in the Municipality occupy the least area (5ha), in total, in the Municipality there are 3 parks and 8 squares (see Table 42). Asp, plane-tree, acacia, boxwood, lime and chestnut and other perennial plants are set out in the largest central park (2.2ha) located on the territory of City Bolnisi.

Picture 4. Bolnisi Municipality Culture and Recreation Park

Pruning works In the green zones of the Municipality areas are conducted every year. The volume of the wood resource received from pruning depends on the amount of the plants damaged either by natural disaster taken place in the Municipality, or by some other reasons. For example: in 2014-2015 in the residential areas of the Municipality were pruned or cut 100m^3 different kinds of plants. The volume of the logged wood was conditioned with existence of over-dry trees within the area of the Municipality and the urgency of pruning the plants, otherwise at average 10m^3 wood recourse is logged per year that will be considered in further calculations.

As for the greening works, the Greening Service, established under the Municipality in 2014, has planted the following species and quantities of saplings in recreation zones in 2015: pine – 850 saplings, pavlonia – 150 saplings, soap three – 500 saplings, and in total 1500 trees have been planted. The mentioned plantings were considered in green zones of Municipality during assessment of Carbon accumulation potential.

Table 43. The Species Dominating in the Areas Covered by Plants in Bolnisi Municipality

Areas Covered by Perennial Plants	Dominating Species	Average Age	%
Recreation Zones (parks, squares)	Pine	40-50	30
	Ash	30-35	20
	Maple	30-45	15
	Cypress	40	10
	Cedar	40	10
	Other	-	15
	Ash	35-45	20

Greening of different areas in the Municipality (in homestead plots, near building, along roads, etc.)	Asp	50-60	20
	Apple	40	20
	Persimmon	35	15
	Cedar	30-45	10
	Other	-	15
Agricultural lands covered with perennial plants (among them vineyards)	Apple	5-15	37
	Persimmon	10-15	13
	Walnut	20-50	12
	Plum	10-15	10
	Cherry	5-10	9
	Mulberry	10-20	9
	Other	-	10
Area covered with forest	Oak	60-100	30
	Hornbeam	50-70	30
	Maple	60-80	20
	Other	-	20
Cemeteries	Cypress	30-40	40
	Tuya	20-30	40
	Pine	50-70	10
	Other	-	10

6.2 Methodology

The calculations of the accumulated Carbon and its annual increase in green zones of Bolnisi Municipality in base year (2014) was based on Intergovernmental Panel on Climate Change (IPCC) – 2003 methodological guidelines (see Appendix III). The calculations were conducted for "live biomass" (including underground biomass). According to the mentioned methodology was calculated the accumulated Carbon stock within the perennial plants in green cover of Bolnisi Municipality and the volume of Carbon accretion.

As for the indexes of some coefficients used in calculations, as the perennial arboreal plants in green zones of the Municipality are represented both in closed canopy and in fragmented forms, in calculations are used the corresponding indexes for both types of seedlings. Different sources were used to determine the indexes for these two different types of seedlings: for example, for closed canopy seedlings representing mainly forest areas were used the taxation materials for Bolnisi forestry. As for the indexes of the greenery presented in other green zones (which are mainly represented in fragmented form) their wood stocks and other data (average age 40 years), were taken from different scientific sources relevant to dominant types, for example,

Tables of Growth Rates and Stocks[15], etc. As a result, the average index has been obtained which allows the approximate assessment of wood stock (40m^3) at 1ha area of fragmented greening.

As it was already mentioned, the perennial arboreal plants in the city's 1590ha of green cover are represented by both closed canopy and fragmented forms of which closed canopy groves mainly cover 50ha territory of forestry area and the remaining 1540ha is covered by fragmented seedlings. Therefore, emission factors typical for both types of seedlings were used for calculations. Here it should be mentioned that in accretion coefficient used in calculations has been taken into account the factor of planting trees in green zones of town in 2014-2015, resulting the adjustment of accretion factor towards the growth rate.

More specifically, in calculations based on the taxation materials the data on average annual accretion and wood stocks of plants (see Appendix III) were used. And, to obtain the average wood volume weigh (D) index the data on absolutely dry wood volume weight for dominant arboreal plants were used that was taken from different scientific sources. The values of other parameters (BEF_1, BEF_2, R, CF) were taken from Tables attached to the IPCC Guidelines, particularly from the list of standard indexes typical for the region's climate conditions.

As to the Carbon accumulation potential resulting from the planned measures, the model CO2FIX has been used for its assessment. According to the scenario considered in the project (reconstruction and planting of greenery), two computing modules were used for calculations, namely: the biomass and soil modules.

6.3 Base Year (2014) Inventory and Carbon Dioxide Sequestration Baseline Scenario (2014-2020)

Calculation Outcomes

The calculation outcomes of the accumulated Carbon in Base Year 2014 are given in Table 44, and the values of annual accretion – in Table 45.

Table 44. Carbon Stocks Accumulated at Bolnisi Municipality Planted Areas in the Base Year 2014

Plants in Green Zones	Area, ha	Stock, M^3/ha	D	BEF_2	(1+R)	CF	Total Carbon Stock, thousand tC
2014							
Fragmented Covered Plants	1540	40.0	0.55	1.30	1.24	0.50	27 307.3
Closed Canopy Plants	50	70.0	0.65				1 833.6
Total	1590						**29140.9**

[15] Forestry Taxation Directory, V. Mirzashvili, G. Kuparadze

Table 45. Annual Accretion of Carbon at Bolnisi Municipality Planted Areas in the Base Year 2014

Planting Coverage	Area, ha	Accretion m^3/ha	D	BEF_1	(1+R)	CF	Total Accretion tC
2014							
Fragmented Covered Plants	1 540	1.6	0.55	1.15	1.24	0.50	966
Closed Canopy Plants	50	1.9	0.65				44
Total	1 590						**1 010**

In the baseline scenario (2014-2020) of Carbon stocks accumulation at Bolnisi Municipality planted areas, the index of annual accretion of Carbon in the biomass has been taken into account, resulting in the assessment of Carbon stocks' expected potential (see Table 46) which could be changed in future due to different causes of biomass decrease (biotic or abiotic).

Table 46. Baseline Scenario (2014-2020) for Carbon and Relevant Carbon Dioxide Sequestration

	Annual Accumulation						
	2014	2015	2016	2017	2018	2019	2020
Carbon Annual Accumulation tC	29 141.0	30 151.0	31 161.0	32 171.0	33 181.0	34 191.0	35 201.0
Carbon Dioxide Annual Sequestration, tCO_2	106 850.3	110 553.7	114 257.0	117 960.3	121 663.7	125 367.0	129 0.3

6.4 Action plan for the Increase of Carbon Dioxide Sequestration Source from Bolnisi Municipality Greening Sector

According to the Action Plan, in city Bolnisi has been planted 1000 pieces of saplings by 2015, covering about 0.4ha area. In the next years (2016-2020) conduction of greenery activities performed by the Municipality Greening Service is planned at several areas adjacent to city Bolnisi. First of all, by 2016 there is planned to start greening activities on the fenced 3.2ha territory (former Sasroleti territory) adjacent to city Bolnisi, namely, for the beginning (2016) is foreseen to plant 3000 pieces of saplings which will cover 1ha area. In the next two years it is planned to conduct greening of the whole allotted area (approximately, greening 1ha area per year). After finishing conducting this measure it is planned to continue greening activities at other territories adjacent to the city of the same area (1ha) per year, namely, greening will be continued on the Korani Mount slopes. In total, greening of 5ha area adjacent to Bolnisi is planned by 2020.

As it was already mentioned above, within the frames of the Action Plan measures, namely, after setting out the plantings on the landscaped areas the Carbon accumulation potential has been assessed using the model CO2FIX.

Planned Measure G1. As it was mentioned, in 2015 within the limits of city Bolnisi, in total 1000 pieces of saplings have been planted at different areas making up totally 0.4ha area (see Table 47).

Table 47. List of Saplings Planted at the 0.4ha Area in Bolnisi in 2015

Planted Arboreal Plants	Number of Planted Saplings, pieces	Age of Saplings
Pine	850	5-6
Paulownia	150	3-4
Total	1000	

At present, 70% of saplings have taken roots. Following this measure the expected Carbon accumulation potential has been assessed using the model CO2FIX and calculation outcomes are given in Table 48.

Table 48. Annual Accumulation Indexes in the 5ha Plantings

	2015	2016	2017	2018	2019	2020
Carbon Accumulated tC	1.1	1.8	2.9	3.7	4.9	6.2
Annual Carbon Dioxide sequestration, tCO_2	4.0	6.6	10.6	13.5	18.0	22.7

Planned Measure G2. In 2016-2020 it is planned to conduct greening of total 5ha in the vicinities of city Bolnisi. While designing planting of the area, most part of the territory should be occupied by plants similar to the forest landscape where no less than 3000 pieces of saplings will be planted at the 1ha area (Table 49).

Table 49. List of Perennial Saplings Planned for Planting in Bolnisi Municipality in 2016

List of Saplings Planned for Planting	Number of Saplings, pieces	Age of Saplings
Trees Planned for Planting at 1ha area Around the City		
Georgian Oak	1000	3-5year
Maple	1000	
Pine	500	
Fustic	250	
Paulownia	250	
Total:	3000	

As a result a perfectly featured Carbon accumulation pool may be obtained in which soils will be engaged in Carbon accumulation process and the city will acquire green zone comparable to valuable forest ecosystem. The selection of seedling material assortments plays an important role. While designing the territory to be greened the most important moment is correct selection of the species of trees and shrubs. Selecting arboreal species require foreseeing the environmental conditions of the location to be planted, for example, what kind of soil, climate conditions and slope exposition are there, and the potential of Carbon Dioxide sequestration by the arboreal plants.

Considering the above-mentioned criteria, several arboreal plants have been selected for planting. From leafy plants Georgian oak, fustic, and Paulownia have been selected. Georgian oak is not distinguished with its great ability of absorption but in local conditions it stands out with its well taking roots and growing process. As for coniferous trees, pine was selected for this location.

It should be noted that for completing the activities within the project territory it is urgent to develop a landscaping project the necessary components of which are: schematic maps of arranging planting and infrastructure utilities, list of the greenery selected for planting and budget of all scheduled activities. Below (see Table 50) are given the presumable expenditures necessary for implementing the planned measures.

Table 50. Budget of the Scheduled Activities per 1ha of Area in the Vicinities of Bolnisi (2016)

№	Description of Expenditures	Unit	Cost of Unit (US $)	Total Amount	Total Cost (US $)
I. Core Expenses					
1.	**Field Activities**				
1.1	Cleaning up the Area (from shrubs, sprouts, etc.)	ha	150.0	1	150.0
1.3	Marking the Area and Digging Pits	Sapling/ piece	0.08	3 000	240
1.4	Purchasing Saplings	Sapling/ piece	2.0	3 000	6 000
1.6	Planting Saplings	Sapling/ piece	0.11	3 000	330
1.7	Watering Saplings	Sapling/ piece	0.10	3 000	300
	Total Sum (USD)				**7 020**

Indexes of Carbon accumulation after planting the trees per 1ha are given in Appendix III, Table 3, and accumulation at 5ha – in Table 51.

Table 51. Indexes of Annual Carbon Accumulation after Planting Trees at 5ha Area

	2016	2017	2018	2019	2020
Carbon Accumulated tC	2.3	4.5	6.7	8.9	11.2
		2.3	4.5	6.7	8.9
			2.3	4.5	6.7
				2.3	4.5
					2.3
Total Annual Accumulation tC	2.3	6.8	13.5	22.4	33.6
Carbon Dioxide Annual Sequestration, tCO_2	8.4	25.0	49.5	82.1	123.2

In Table 52 is given Carbon accumulated in green cover of Bolnisi Municipality and annually sequestered Carbon Dioxide without implementation of measures and in case of their implementation.

Table 52. Carbon Accumulation Potential Resulting from the Planned Greening Activities in 2014 (Base Year) and within the Frames of Action Plan

	Annual Accumulation of Carbon, tC						
	2014	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**
Carbon accumulated in green cover of the city (without implementation of measures)	29 141.0	30 151.0	31 161.0	32 171.0	33 181.0	34 191.0	35 201.0
Greening of 0.4ha area within the limits of city Bolnisi	-	1.1	1.8	2.9	3.7	4.9	6.2
Greening of 5ha area in the vicinities of city Bolnisi	-	-	2.3	6.8	13.5	22.4	33.6
Total	**29 141.0**	**30 152.1**	**31 155.1**	**31 180.7**	**33 198.2**	**34 218.3**	**35 543.2**
Carbon accumulated in green cover of the city (without implementation of measures)	**106 850.3**	**110 557.7**	**114 235.4**	**114 329.2**	**121 726.8**	**125 467.1**	**130 325.1**

Table 53. Action Plan for the City Greening Sector

Activity	Planned Measures	Responsible Body	Implementation period (Start and End Dates)	Cost of Each Measure (GEL)	Expected CO_2 Reduction from Each Measure by 2020 (t)	Preliminary Quantitative Index of CO_2 Reduction by 2020 (t)
1	2	3	4	5	6	7
G	**Green Zones**					145.9
G1	Greening of 0.4ha Area within the Limits of the City	Bolnisi Municipality	2015	5 230	22.7	
G2	Greening of 5ha Area around the City	Bolnisi Municipality	2016-2020	17 550	123.2	-

7 Waste

7.1 Sector Overview

For today, as a result of adopting strict waste management regulations regions of Georgia appeared in the center of attention. Bolnisi Municipality is not an exception, where waste management represents one of the most important environmental problems. Till 2013 two landfills[16] existed in Bolnisi Municipality:

- Landfill of City Bolnisi with total area 3.5ha;
- Landfill of Town Kazreti with total area 1.5ha.

Both landfills of Bolnisi Municipality were transferred to the "Georgian Solid Waste Management Company" on July 10, 2013. By this time the conditions at landfills were extremely poor: the waste was delivered there in an unorganized way and the landfills did not operate in accordance with standards; they did not satisfy the ecological and sanitation norms, and no control and sanitary supervision was conducted at the landfills. The landfill areas were not fenced and both people and animals could enter into this territory[17]. At present the landfill in town Kazreti is closed and only the landfill of city Bolnisi serves the Bolnisi Municipality. The landfill of city Bolnisi has been operating since 1978 and until 2013 it was operated by the Municipality itself. Since 2013, after transferring it to "Georgian Solid Waste Management Company", aimed at the improvement of the landfill, the construction and assembling activities have been started, within the frames of which the internal roads of landfill and drainage channels were arranged, the waste was covered with insulation layer, dump pit was arranged for further exploitation, the landfill territory was fenced, the watch-box, the fire-brigade stand and landfill indicating banners and restriction signs were installed. The territory was electrified (solar photo-electric system was installed), the landfill was equipped with special equipment and a store-house for mechanisms was constructed. The works considered under the project have been completed on May 19, 2015. After putting into operation the renovated landfill, the delivery of waste and its placement in special boxes on the landfill area will be defined according to the active standards and, as the company informs, it will significantly reduce its hazardous effect on environment. It will provide secure environment and improved living conditions for the population[18].

Currently, Bolnisi landfill is a well-equipped area covering 5ha of territory and the amount of the delivered waste reaches 12-15meters. Collection of waste in the Municipality, its inventory and placement at the landfill area is carried out by Ltd. "Public Services". Daily, 55m^3 (11t)[19] of waste [20]. is delivered and placed at the landfill. According to the information of local Administration, for the last 10 years the amount of waste collected from the population has not changed[21]. The Municipality population is released from paying tax for cleaning service, therefore the number of physical persons – subscribers and the amount of waste generated by them and delivered to the landfill is not defined; the tax payers are only the juridical persons. The waste in city Bolnisi, towns Kazreti and Tamarisi is collected every day, and in villages and the districts which are

[16] http://www.care-caucasus.org.ge/uploads/reports/bolnisi1.pdf
[17] http://waste.gov.ge/ge/?p=1345
[18] http://waste.gov.ge/ge/?p=1345
[19] ρ=0.2t/m^3
[20] Bolnisi Municipal Service
[21] http://nala.ge/uploads/bolnisi.pdf

not equipped with trash bins – on every other day. In other settlements of the Municipality the domestic waste is thrown at illegal landfills such as river banks and ravins[22].

The Municipality is included in pilot program implemented for the Municipalities entering in Kvemo Kartli District, which consider construction of a large central landfill, namely in Marneuli, where will also be placed the waste collected on the territory of Bolnisi Municipality, and immediately after putting into operation this project the works for closing the current landfill will be started.

Intensive works are going on with non-governmental organizations in order to conduct separation of paper and plastic fractions from domestic waste for further utilization.

7.2 Methodology and Incoming Parameters

There are two ways to calculate methane emissions from landfills, suggested by the IPCC guidelines: (1) "Typical Default Method", - methodological approach Tier 1, and "First Order Decay Method" (FOD) – methodological approach Tier 2. The main difference between these two methods is that FOD method gives a time-dependent profile of emission production that 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 typical default method result is satisfactory if there is a permanent 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 in the country/region then the use of the Default Method is not recommended.

To calculate methane emission from waste generated throughout Bolnisi Municipality and delivered to the active landfill the FOD method or Tier 2[23], has been applied. Relevant formula and parameters are given in the box below.

Tier 2: "First Order Decay Method" (FOD)

Tier 2: "First Order Decay Method" (FOD)

Where:

$$CH_4\ Emissions = \left[\sum_x CH_4\ generated_{x,T} - R_T \right] \cdot (1 - OX_T)$$

Σ $CH_{4generated x,T}$ – is amount of methane generated, equal to CH_4 $generated_T$ = DDOCm $decomp_T$ • F •16 /12, where (DDOCm $decomp_T$ – is decomposed mass (DDOCm) of degradable organic carbon (DOC) , that will decompose in year T, Gg; F – fraction of methane in landfill gas; 16/12 - CH_4/C is ratio between molecular masses)
$CH_{4\ Emissions}$ - emitted into the atmosphere CH4 Gg, in the year *T*;

T – year of inventory;

[22] http://nala.ge/uploads/bolnisi.pdf
[23] http://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/5_Volume5/V5_3_Ch3_SWDS.pdf

x – fraction of waste/composition;

RT - collected from the landfill and rendered harmless CH4 Gg, in the year *T*;

OXT - Oxidation factor in the year *T*.

Activity Data

Population which generates the waste that is delivered or was carried to the landfills[24]

As of 2012 data of local Administration, Bolnisi Municipality population makes up 78 700 persons. There are 49 settlements in the Municipality, among them one city. Town population makes up 12 700 persons that is about 16% of the number of entire Municipality population[25]. The number of Bolnisi Municipality population was 78 900 persons [26] by 2014. Unfortunately, the long-term dynamics of Bolnisi Municipality population and moreover, that of city Bolnisi is not available. Therefore, the number of people living in the city (16%) was calculated based on the existing data (number of the Municipality population). In addition, to conduct inventory of methane emission from waste sector, the number of population from 1978 till 2005 was taken from permanent data 2005, and from 2014 – the growth of population by 0.5%[27] (Table 54).

Table 54. Actual Number of Bolnisi Municipality Population (2005-2014) and Actual (2012) and Theoretical (2005-2011 and 2013-2014) Values for the City of Bolnisi

Year	Thousand Person	
	Bolnisi Municipality	City Bolnisi
2005	74.0	11.8
2006	75.1	12.0
2007	75.6	12.1
2008	76.0	12.2
2009	76.7	12.3
2010	77.8	12.4
2011	78.3	12.5
2012	78.7	12.6
2013	78.6	12.6
2014	78.9	12.6

[24] http://geostat.ge
[25] http://nala.ge/uploads/bolnisi.pdf
[26] http://geostat.ge
[27] Prognosis for population number was made for 2015-2020 assuming that there is 0.5% growth per year as it was used in general (MARKAL) model and for other sectors as well

Waste Composition

There are no complete data on composition of municipal waste in Georgia. Only the results of single surveys on waste composition percentage for Tbilisi (1990, 2003 and 2010 GIZ [28] and 2014 – TbilService Group (Norio Landfill) data), Batumi (2009), Ajara (CENN 2015) and Kakheti (CENN 2015) are available. There is no information available on composition of waste for city Bolnisi, therefore for the period 1978-2020 the official data on composition of solid domestic waste generated in Kakheti Region was used for calculation (Table 55).

Table 55. Domestic Waste Averaged Composition Generated in Kakheti Region29 Applied for Bolnisi Municipality

Waste Fraction	% by Mass
Organic Waste	41.4
Paper/Cardboard	14.9
Wood	-
Textile/Leather	6.2
Hygiene Waste	4.2
Plastic/Inert Material	33.3
Total	100

Emission Factors

Different emission factors are used in the process of methane emission calculation from solid waste:

Methane Correction Factor – MCF

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 in the Oxygen-containing conditions. The IPCC 2006[30] gives default values of MCF which are presented in Table 56.

Table 56. Methane Correction Factor (MCF) Default Values for Different Types of Landfills

Type of Landfill/Landfill	MCF

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

[29] Waste Management Technologies in Regions "Report on Survey to Define Morphological Composition of Solid Domestic Waste Generated in Kakheti Region", CENN, 2015

[30] 2006 IPCC Guidelines for National Greenhouse Gas Inventories, http://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/5_Volume5/V5_3_Ch3_SWDS.pdf (pg. 3.14)

Managed [31]	1.0
Managed-thin (waste thickness<5m)[32]	0.5
Unmanaged – deep (waste thickness>5m)	0.8
Unmanaged (thin-waste thickness<5m)	0.4
Uncategorized Landfill	0.6
Bolnisi Municipality Landfill 1960-2013[33]	0.6
Bolnisi Municipality Landfill since 2014	0.5

Degradable Organic Carbon (DOC)

Degradable Organic Carbon (DOC) is the organic waste component which is decomposed biochemically and measured in GgC/Gg of waste.

The value of DOC depends on waste composition and country/region climate conditions. To calculate the value of DOC for waste components the IPCC 2006 methodology[34] has been used. The values of DOC according to waste composition are given in Table 57.

Table 57. Values of DOC According to Waste Fractions

Waste Fractions	Value of DOC
Food waste	0.15
Garden	0.20
Paper	0.40
Wood and Straw	0.43
Textiles	0.24
Disposable diaper	0.24

[31] A managed landfill implies the disposal area kept under control (waste is placed at specially prepared places where the waste has an airing and is controlled against self-flaring). At the same time the waste is covered, rammed and layered.

Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories, 2000, pg. 5.9

[32] 2006 IPCC Guidelines for National Greenhouse Gas Inventories, http://www.ipcc-nggip.iges.or.jp/public/2006gl (pg.3.16)

[33] Thickness of waste is not familiar

[34] 2006 IPCC Guidelines for National Greenhouse Gas Inventorieshttp://www.ipcc-nggip.iges.or.jp/public/2006gl (pg. 2.16)

Fraction of Degradable Organic Carbon Dissimilated-DOC_F

DOC_F is actually a dissimilated component of organic Carbon. A certain part of organic Carbon is not decomposed at all or decomposes very slowly. The IPCC GPG 2000 recommends for DOC_F the value which depends on a number of factors such as air temperature and moisture, pH, waste composition, etc.

IPCC GPG recommends for DOC_F to use national values though they should be based on well-documented surveys. To calculate methane emission from Bolnisi Municipality Waste Sector the IPCC default/typical value (0.6)[35] has been used.

Methane Content in Landfill Gas (F)

According to the IPCC 2006, methane content by volume in landfill gas is up to 50%. Only oil and fat containing materials generate biogas with more than 50% of methane. To calculate methane emission from Bolnisi Municipality Waste Sector the IPCC default/typical value (0.5) has been applied.

Oxidation Factor (OX)

Mentioned factor reflects the amount of methane generated in waste cover material (soil, etc.). In case of managed landfill (where waste are covered by oxidizing materials – soil, compost) the OX value equals to 0.1, while in case of unmanaged and managed landfills (when waste are not covered with oxidizing materials – soil, compost) OX value equals to 0[36]. As Bolnisi Municipality landfills are not covered by oxidizing material the value of OX for Bolnisi Municipality landfill has been taken equal to zero (0).

7.3 Waste Sector Base Year Inventory and GHG Emissions Baseline Scenario (2014-2020)

According to Bolnisi Municipal Service information, for today Bolnisi Municipality landfill has been transferred to the Solid Waste Management State Company which has arranged and takes care of the landfill. For future is planned to arrange regional (Kvemo Kartli Region) landfill on the territory of Marneuli Municipality at which will be located the solid waste collected in the territory of Bolnisi Municipality.

At present collecting the waste in the Municipality, inventory and placing it on landfill area is carried out by Ltd. "Public Services." On the landfill of city Bolnisi the waste is delivered not only from city Bolnisi but from town Kazreti and 14 villages[37] of Bolnisi Municipality.

Annually, at the landfill at average 20 075m^3 domestic waste is collected from all the above-mentioned areas. To this, what part of the population generates the mentioned waste is not defined, therefore inventory of current methane emission from the active Bolnisi landfill has been done based on the data of the collected waste amount, the permanent amount of waste from 1978 till 2015, and for future scenario it will be assumed

[35] http://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/5_Volume5/V5_3_Ch3_SWDS.pdf
[36] Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories, 2000, pg. 5.10. http://www.ipcc-nggip.iges.or.jp/public/gp/english/index.html (pg.5.10)
[37] http://nala.ge/uploads/bolnisi.pdf

that starting from 2015 the total amount of the collected waste on Bolnisi territory will be increased by 2.5% per year[38].

Table 58. Baseline Scenario (2015-2020) of CO2 Emission from Bolnisi Municipality Landfill

Year	Without Measure	
	CH_4,gg	CH_4-CO_2 eq, gg
2014	0.16	3.42
2015	0.16	3.45
2016	0.17	3.48
2017	0.17	3.60
2018	0.18	3.71
2019	0.18	3.80
2020	0.19	3.89

Table 58 shows that if waste sorting and recycling /reusing are not conducted, in the upcoming years (2017-2020) the amount of methane emitted into the atmosphere from waste generated from Bolnisi Municipality will be featured by rising tendency (≈2%/y) due to the growth of population and increased amount of waste.

Wastewater

The water resources existing in Bolnisi Municipality is not sufficient to meet residential, irrigation and industrial requirements[39], However, in the Municipality the appropriate treatment of domestic and industrial wastewater is not conducted, as malfunctioning of sewage and drainage system and frequent mixing it with drinking and irrigation waters cause inefficient use of valuable water resources.

52% of city Bolnisi population, 70% of town Kazreti population, and 60% of Tandzia population are provided with sewage system. The total length of sewage network is 24km[40]. Two wastewater treatment bio-terminals have been constructed in city Bolnisi in 2007 and 2009 which used to work with full capacity (mechanical and biological treatment) until 2011. Afterwards, due to the lack of funds, biological treatment process was ceased in the mentioned facilities[41]. In 2013 the bio-terminals of city Bolnisi were transferred to Ltd. "Georgian Water and Power" company. During transferring the bio-terminal was out of order. The company plans to carry out complete renovation of the bio-terminal after which the wastewater treating facilities will provide its full-capacity service[42] (≈40 %) to some part of Bolnisi territory (the terminal capacity is calculated for 6 000 residents [43]).

[38] The mentioned rising tendency was used for developing all SEAPs
[39] http://nala.ge/uploads/bolnisi.pdf
[40] http://www.care-caucasus.org.ge/uploads/reports/bolnisi1.pdf
[41] Bolnisi Municipal Service
[42] http://bolnisi.ge/?p=596
[43] http://www.care-caucasus.org.ge/uploads/reports/bolnisi1.pdf

In this Action Plan generation of methane was not considered as the bio-terminals are not in working position.

7.4 Emissions Reduction Action Plan from Bolnisi Municipality Solid Waste Subsector

Measure W1. According to Bolnisi Municipal Service information, for today no concrete measure is planned to be implemented at the Municipality active landfill (arranging biogas production system, methane collection and incineration/utilization), resulting in reduction of methane gas (CH_4) emission into the atmosphere; however, it is planned to carry out paper and plastic fractions separation from solid domestic waste for further utilization which will cause reduction of waste amount and, consequently, reduction of releasing into the atmosphere the emissions of decomposition products (among them methane). For the moment, collecting plastic fraction has been started and it is planned to start collecting paper fraction. Accordingly, these measures have been included in the Action Plan. To calculate methane saved in result of this measure, an assumption was made that sorting the waste will be started in 2017 and the amount of the generated waste placed at Bolnisi Municipality landfill will be less by 2.2% than it would have been in other case. Namely, in 2016 separation of 5% paper and 10% plastics will be conducted, with increase of separated paper by 5%, and plastics – by 10% in the upcoming years. In particular:

- In 2017 the amount of paper in the waste will be reduced by 5%, reaching - 20% by 2020;
- In 2017 the amount of plastics in the waste will be reduced by 10%, reaching -40% by 2020.

In case of complete implementation of the above-mentioned measure, methane emission will be reduced by 1.48t equaling CO_2 eq. 0.3gg and 0.8% of total emission from Bolnisi Municipality landfill by 2020. In case of project implementation, in total in 4 years about 2.5t methane (0.05gg emission CO_2 eq.) will be saved from emitting into the atmosphere, making up ≈0.35 % of the total emission (Table 59).

Table 59. In Case of Project Implementation the Reduced Amount of Methane CO2 eq. from Bolnisi Municipality Waste Sector

Year	Without Implementation of Measure		With Implementation of Measure		Methane Emission Reduction CH_4	
	CH_4,gg	CO_2 eq, gg	CH_4,gg	CO_2 eq, gg	t	%
2014	0.1630	3.4228	0.1630	3.4228	0	0
2015	0.1643	3.4499	0.1643	3.4499	0	0
2016	0.1655	3.4751	0.1655	3.4751	0	0
2017	0.1713	3.5967	0.1713	3.5967	0	0
2018	0.1764	3.7054	0.1762	3.7001	0.2557	0.1449
2019	0.1811	3.8032	0.1803	3.7873	0.7534	0.4160
2020	0.1853	3.8914	0.1838	3.8603	1.4803	0.7989

Total (2018-2020)	2.4894	0.3486

Table 60. Action Plan for Waste Sector

Activity	Planned Measures	Responsible Body	Implementation period (Start and End Dates)	Cost of Each Measure (GEL)	Expected CO_2 Reduction from Each Measure by 2020 (t)	Preliminary Quantitative Index of CO_2 Reduction by 2020 (t)
1	2	3	4	5	6	7
W	Solid Domestic Waste and wastewaters					30
W1	Separation of Paper and Plastics Fractions from Solid Domestic Waste for further Utilization	Bolnisi Municipality	2017		30	30

8 Agriculture Action Plan

Agriculture plays the leading role in Bolnisi Municipality economy despite the region's relatively high industrial potential. Bolnisi is distinguished from great majority of regions of Georgia just with the industrial potential, however agriculture remain the main source of employment and incomes for the residents of the region. Agriculture is the main economic activity of Bolnisi Municipality and developing the mentioned field is extremely important for the Municipality. In Bolnisi Municipality 39.3% of the total employed population (49%) is employed in agrarian sector.

Below are given characteristics of Bolnisi Municipality according to those climatic-geographic parameters which have great influence on the development of agriculture.

Climate: Bolnisi Municipality territory belongs to moderately humid subtropical climate zone where two basic subzones of climate may be distinguished: 1. the climate transitional from moderately warm steppe to moderately humid one with moderately cold winters (winter temperature 1.2^{0}C is increased up to 2.6^{0}C), hot summers (summer temperature 22.4^{0}C is increased up to 23.4^{0}C) and two maximums of precipitations (plain areas of the Municipality). 2. Moderately humid climate with moderately cold winters and long-lasting warm summers (foothills). In the Georgia's Third National Communication on Climate Change is assessed increase of the average annual temperature 12^{0}C by 0.8^{0}C on the territory of Municipality in 1960-2010, and in the same period, decrease of total sum of annual precipitations 512mm by 3.3%, relative humidity was a bit higher from 67% and returned to the value of the 60ies. The average annual wind speed was reduced from 2.1m/sec to 0.6m/sec.

Active temperature sum (above +10^{0}C) compared with the value before 1960 (3831 degree), for the last 25-year period (1986-2010) has been increased by 184 degree and became 4015 degree, and the number of days during vegetation period has been increased by 5 days (from 207 up to 212). Out of these 184 degrees 33% or 60 degrees were increased for the last 25 year period so that the number of days haven't been increased at all and remained 212 days, that means that the daily temperatures have been increased and represent rather high risk for developing of agriculture, especially when the irrigation systems are completely out of order in the Municipality.

Soils: On the territory of Bolnisi Municipality grey-brown soils and mountain-forest-meadow soils are spread that is favorable for developing field-crop cultivation. Besides, here we meet black, brown, meadow brown, humus-carbonate and alluvial soils.

Main problem of soils in Bolnisi municipality is their degradation and pollution with various substances. Degradation of soil is caused due to the fact that part of agricultural soils is not plowed up and consequently, is not cultivated and fertilizers are not applied. And, pollution with different substances is caused due to the fact that very often more organic and inorganic fertilizers and chemicals are applied to soils than it is needed. According to the available data[44], about 2 500ha from arable areas and about 30% (1590ha*0.3=477ha) of fruit gardens are degraded; as for the mowing and grazing lands no information could be obtained about them.

[44] (National Association of Local Self-governments)

Erosion (about 1/3 of the degraded area) and irrigating arable lands with water polluted by industries are considered as main reasons of degradation.

Some part of shelterbelts/windbreak barriers have been cut down years ago and part of them withered away (when the lands were let for lease or purchase), and the lands where these shelterbelts were set out has been plowed. Bolnisi Municipality does not consider it necessary to reestablish windbreaks/shelterbelts, as the loss caused by the winds is insignificant in this area compared to other municipalities, and due to the lack of appropriate legal base for today it is impossible to reestablish these barriers. Since 1960ies, the average wind speed in Bolnisi is reduced by 71% and it will not have significant increase either in the future. For agriculture more important are the so called spring turbulent winds, the speed of which can't be measured and are not known for local population and the Municipality. Earlier, the soviet farms used to take care of such windbreaks, and, at present, this represents a good will either of the government, or the municipality and the owner whether to reestablish/set out or not the new windbreak barriers. One of the reasons of reducing productivity is malfunctioning of irrigation systems on the irrigated lands.

Internal Waters: The territory of Bolnisi Municipality is rich with its internal waters. In the North, near Tetritskaro Municipality border, the River Khrami runs for a long distance, which represents the right tributary of the River Mtkvari. The River Khrami is fed with snow, rain and ground-waters. Among the tributaries of the River Khrami within the limits of the Municipality the most significant one is the River Saghzaghanistskali. The most important river of the Municipality is the River Mashavera, which is fed with snow, rain and ground-waters. It is the right tributary of the River Khrami. Within the limits of the Municipality main tributaries of the River Mashavera are Bolnisistskali (length 42km and starts at 1670m above sea level) and Talavristskali (length 21.7km and starts at 1323m above sea level). In Bolnisi Municipality there is a healing mineral spring. The Rivers Mashavera and Khrami are used for irrigation. The Municipality experiences lack of irrigational water due to malfunctioning of irrigation channels. As for the mineral water "Bolnisi", this is healing water and is used for drinking.

Among the agricultural fields four main trends are developed in Bolnisi Municipality: vegetable growing, livestock breeding, grain growing and viticulture, of which the leading branch is vegetable growing.

Vegetable Growing. Vegetable growing is one of the most developed trends of agriculture in Bolnisi Municipality. Local farmers are actively engaged in growing vegetable crops: potatoes, tomatoes, cucumbers, eggplants, peppers, onions, carrots, and other vegetables. Producing such products as tomatoes, cucumbers, and peppers take leading place in the Municipality. During the soviet period these products were processed locally and the final products were sent to former soviet countries. Accordingly, the potential which the region has got is undoubtedly promising for developing canning factory that on its side will contribute production of more vegetables locally. If local potential is used properly and effectively it will allow replacing the imported product with ecologically clean domestic product.

For proper management of the sector it is necessary to evaluate well the risks expected in this process and ensure their proper management. Namely, it is known that vegetables are pretty perishable products, especially at high temperature, which due to climate change is formed gradually on the territory of Bolnisi Municipality. Particularly, the total increase of temperature in summer period in 1961-2010 was 1^0C, of which increase of temperature by 0.9^0C took place during last 24 years (1986-2010). According to the future prognosis, increase of temperature on the territory of Bolnisi Municipality is being continued and by 2050, in summer period, it is expected to be increased additionally by 1^0C, and by 2100 it will be increased by 4^0C. Number of extremely hot days (SU25) during the period of last 24 years has been increased by 5 days (from

77 days which featured the first period (1961-1985) up to 82 days in the second period (1986-2010). At this stage, in the Municipality there is no refrigeration infrastructure that significantly limits the farmers producing perishable agricultural product and increases their risks. Existence of primary processing, product storage, refrigeration and warehousing infrastructure and wholesale center in the Municipality will contribute keeping the produced products for long periods and maintaining their quality and visual shape, expanding the distribution network and realization of the production. Availability of refrigeration and warehousing facilities will also contribute significantly both employment of the population and storage and realization of agricultural products for domestic and external (export) markets for autumn and winter periods. Accordingly, one of the priorities of the Municipality is to develop refrigeration infrastructure that obviously will increase energy consumption and, therefore, the energy-efficiency of the technologies used in this process should be considered at most.

Livestock/Poultry Farming. In Bolnisi Municipality the population is engaged in cattle, poultry, bees and pig producing the quantity of which as of 2014 is as follows: cattle – 16 929heads, sheep – 30 643heads, goat – 1 568heads, pig – 24 936heads, poultry – total 232 412birds, bees – 3 430families.

In Bolnisi Municipality in livestock farming are engaged non-specialized farmers with several exceptions who lead non-commercial domestic-farming. Such breeders make up almost 80% of the total number of farmers. At average, they have 3-4 heads of cattle. The access product (about 70-80%) they sell at domestic market. Livestock farming as commercial business is less developed on territory of the Municipality; actually, it is starting to be established. Under current conditions the farmers have difficulties in keeping the cattle as, from one side, there is a lack of grazing lands on the territory of the Municipality (mowing lands -785ha, grazing lands – 9 608ha, per 1ha grazing land comes about 5heads of all three types of animals: cattle, sheep and goat), and, from the other side, as it was already mentioned, due to hot climate, which becomes hotter, the grass on the grazing lands wither away during hot summers, and a big problem is also created in regard to getting drinking water for the animals in the grazing lands. In summer the grazing lands are withered away. Some territorial units do not have any grazing lands at all (in the Municipality there are 15 territorial units) and in summer the herdsmen drive the Bolnisi Municipality cattle to Dmanisi grazing lands. According to the obtained information, livestock farming in the Municipality experiences acute shortage of mowing/grazing lands for the last ten years. The following are considered as the reasons for this condition: changing the category of mowing and grazing land-use, erosion, much grazing, drought and degradation of grazing lands due to pollution. According to the working group's information, productiveness has been reduced during last 10 years due to insufficient feeding of animals because of the lack of cattle feeding stuff and low level of knowledge at the farms.

Grain Growing. Grain growing is rather well-developed in Bolnisi Municipality, however, from the commercial point, it is developed but relatively by minor percentage. In the field of grain crop production both small and medium, and large scale farmers are presented in the Municipality, while a part of them use the harvest for household demands, and other part sells big quantities of the produced grains at market.

Low harvest also represents a significant problem in grain farming sector, stipulated by different reasons. Within the current reporting period the average wheat yield per 1 hectare makes up 2.5tons that is rather low indicator compared with the indicator of wheat yield per 1ha in different countries in favorable conditions and during the period of existing soviet farms. The same may be said about other crops as well. Corn, barley and oats are also characterized with low harvest in Bolnisi Municipality. The reasons causing low harvest are: breaking agro terms, malfunctioning infrastructure of melioration system, lack of variety testing and seed farms

that on their side cause deficit of seeds and using low quality imported seeds, low quality of chemicals and fertilizers and incorrect applying to the ground, lack of knowledge of modern technologies.

To resolve the mentioned problems first of all it is necessary to establish or in the Municipality variety testing and seed farms in the region where it will be possible each farmer to get the good quality seed materials appropriate to local conditions. It is also important to establish a small laboratory where the farmers will be able to conduct analysis of the soil and get other needed information.

The total area of agricultural lands makes up **28 825ha** which is 35% of the total territory, of which arable lands are **17 758ha**, and perennial plants occupy **674ha**. In autumn 2013 and spring 2014 the area of 14 100ha land was plowed and sown 13 637ha in the Municipality. The biggest area of the sown grains comes on wheat and barley – 7 486ha, and corn is grown on 1 906ha. The area where potatoes are sown makes up 2 236ha, and different vegetable crops occupy 1214ha of land.

There are villages where the population uses arable lands as mowing lands.

8.1 Base Year (2014) Inventory and the GHG Emissions Baseline Scenario (2015-2020) for Agriculture Sector

In Agriculture Sector of Bolnisi Municipality, in terms of energy consumption the following activities have been discussed: greenhouses, livestock and poultry farms, food industry (dairy processing) and agricultural machinery. In Tables (Table 61-Table 64) are given energy consumption in 2014 and 2020 and emissions from different trends of Agriculture Sector.

Table 61. Final Energy Consumption in Agriculture Sector of Bolnisi Municipality (MWT/H) - 2014

Subsector	Electricity	Diesel	Firewood	Total
Greenhouses	0	0	75	75
Livestock and Poultry farms	2 013	0	0	2013
Food Industry (Dairy Processing)	47 144	0	0	47 144
Agriculture Machinery	0	5 668	0	5 668
Total	49 157	5 668	75	54 900

Table 62. GHG Emissions from Bolnisi Municipality Agriculture Sector CO2eq. (Ton) - 2014

Subsector	Electricity	Emission from Manure	Diesel	Firewood	Total
Greenhouse Facilities	0	0	0	32	32
Livestock and Poultry farms	210	132 425	0	0	132 635

Food Industry (Dairy Processing)	4 903	0	0	0	4 903
Agriculture Machinery	0	0	16	0	16
Total	5 113	132 425	16	32	137 586

Increase of emissions by 2020 is caused due to putting into operation with full capacity the dairy processing factories at present being constructed, and increasing the arable lands up to the benchmark at which they were in the soviet period. It is not excluded that gradually consumption of natural gas will be started in greenhouses, however for the moment it is expensive for the population and they prefer consumption of firewood. In this process it is very significant the government and the Municipality to provide support to farmers in consuming more solar energy and small boilers working on energy-efficient biomass.

In terms of the arable territory an assumption was made that by 2020 all those territories will be cultivated which were plowed during the soviet period (i.e. 18 000ha) and which will be 4 000ha more than the area which is plowed for today. Per tractor will come additionally 18.2ha area to cultivate, and correspondingly it will be:

170*18.2 (ha)*18 (L)+ 50*18.2 (ha)*22(L)=75 712 (L); 170*18.2 (ha)*9 (L)*2+50*18.2 (ha)*12 (L)*2 = 77532 (L); Total fuel consumed will equal 153 244 (L)=1 609 MWT/H more than it was in 2014.

As for the greenhouses, with assumption that by 2020 the greenhouses in Bolnisi Municipality will cover 5ha of lands and firewood will remain as priority, the firewood consumption will reach 450m^3 that will equal 937MWT/H.

Table 63. Final Energy Consumption in Agriculture Sector of Bolnisi Municipality (MWT/H) - 2020

Subsector	Electricity	Diesel	Firewood	Total
Greenhouses	0	0	937	937
Livestock and Poultry farms	2 013	0	0	2 013
Food Industry (Dairy Processing)	67 593	0	0	67 593
Agriculture Machinery	0	7 277	0	7 277
Total	69 606	7 277	937	77 820

Table 64. GHG Emissions from Bolnisi Municipality Agriculture Sector CO2eq. (Ton) - 2020

Subsector	Electricity	Emission from Manure	Diesel	Firewood	Total
Greenhouses	0	0	0	394	394
Livestock and Poultry farms	210	132 425	0	0	132 635

Food Industry (Dairy Processing)	7 030	0	0	0	7 030
Agriculture Machinery	0	0	20.4	0	20.4
Total	7 240	132 425	20.4	394	140 079.4

Greenhouses. Greenhouse business is gradually being established in Kvemo Kartli and, namely, in Bolnisi Municipality. The greenhouses operating during the fiscal year in case of proper management gives a good chance of getting high income, high cost-effectiveness, quick turnover and good profit opportunity. In this respect those potential farmers and investors have become active who earlier did not discuss greenhouse business at all. The non-seasonal (autumn-winter) production of agricultural crops, among them: cucumber, tomato, Bulgarian pepper, green onion, lettuce leaves and high realization prices of the products significantly increase the profit potential, which further has positive reflection on the life conditions of the farmers and the greenhouse owners and the people employed in there. On the territory of Bolnisi Municipality the resources and perspectives for development of small greenhouses is great. Based on current trends, by 2020 the greenhouses existing in Bolnisi Municipality from 0.4ha will be increased up to 5ha. Below is given information about current greenhouses.

By 2014 in Bolnisi Municipality 2 medium size greenhouses with total area 0.4ha were already operating.

- **In Town Kazreti** a vegetable greenhouse set out on 2000sq.m (0.2ha) area of land is located. The greenhouse is heated by solar energy and irrigation is carried out by letting water flow among vegetable beds. The greenhouse operates for 2013-2015. In the greenhouse 500kg tomatoes, 500kg cucumbers, 500kg green beans, 35kg Parsley and 35kg coriander are grown per year. For future the farmer plans to expand the business (heating with new technologies and installation of drip irrigation system). This greenhouse consumes 5-6 trucks of firewood per year that is approximately 15-18m^3. As consumption of firewood is absolutely unstable in Bolnisi, actually, consumption of firewood in this case is discussed as the source of emission and during the season its emission is 18 (m^3)*2083 (kWt/H/m^3)* 0.42 (kg CO_{2eq}/kWt/H)/1000= 16 t.

    - **In Village Bolnisi** is located a flower greenhouse set out on 2000sq.m (0.2ha) area of land. Firewood is used in the greenhouse for heating.

Picture 5. Greenhouse of Flowers in Bolnisi Operating on Firewood

Irrigation is carried out with letting water flow among the beds. The saplings of the flower /Alstroemeria/ are imported from Armenia (Yerevan), at present 7000 saplings of the flower are planted. For years (2012-2015) they get 30 000-35 000 each of flower which are realized in Tbilisi markets in wholesale prices. The farmer plans to take a low-interest agricultural loan and equip the greenhouse with modern technology. This greenhouse like that of Kazreti consumes 5-6 trucks of firewood per year that is approximately 15-18m^3. As consumption of firewood is absolutely unstable in Bolnisi Municipality, actually, consumption of firewood in this case is discussed as the source of emission and its emission during the season is 18 (m^3)*2083 (kWt/H/m^3)* 0.42 (kg CO_{2eq}/kWt/H)/1000= 16 t.

Livestock and Poultry Farms. In this sector basically is discussed one pig breeding farm and one poultry factory. The poultry factory on the territory of Bolnisi Municipality existed during the soviet period and it did not experience a long period of work termination. As for the pig breeding farm, it started operating since 2012. At present a cattle farm (for 70 heads) is being constructed, which is not large and mainly it will be focused on dairy industry, so it is discussed in food sector. Below is given assessment of GHG CO_2 eq. generated from annual operation of these two facilities and from manure too.

- "ABD Georgia" – pig-breeding farm, occupying 12ha of land on the territory of Village Akaurta operates since 2012 till present. The farm grows 20 000 heads of Danish breeds of pigs - Landrace, Yorkshire, and Duroc, among them 1430 sows. The farm produces meat and convenience food: big and small sausages, ham. The annual workload of the enterprise is 2000 tons of meat. Their annual energy consumption makes up 1200000kWt/H (1 200MWt/H) (hot water and???). Pig manure is placed in closed reservoirs. At the moment biogas energy is not consumed. According to IPCC methodology, per year from 1head of pig is generated 1kg CH_4 through enteric fermentation, 4kg CH_4 from consumption of manure, and also 16kg N_2O from consumption of manure. Accordingly, in a farm keeping 20 000heads of pig annually is generated 20 000 (1*21+4*21+16*310)/1 000 =**101 300** (t CO_2eq./y)
  From electricity 1 200 000 kWt/H*0.104kg CO_2/kWt/H= **125** t CO_2/y
  In total, annually is generated **101 425** t CO_2 eq./y
- A Poultry Factory is located on 17ha area of land in village Savaneti. They have 167 000 chicken. Among them, 119 000 are egg-giving hens, and annually producing 45 041 221each of eggs. The enterprise has its own birdseed base, which makes up 70%, and 30% of birdseed is imported. The domestic market is

supplied with the eggs produced by this factory, as well as, the eggs are exported to neighboring countries. The number of people employed in the plant is 130persons. The enterprise has a potential to increase its production that will allow the factory to expand the distribution network and the number of its employees. At present the Poultry Factory consumes annually 812 555kWt/H energy.

The factory counts many years of existence. They preserve the chicken manure in pits, and later the population takes it in the fields and use as fertilizer. According to IPCC, annually, from 1 chicken 0.018kgCH_4 is generated from consumption of manure and also 0.6kg N_2O from consumption of manure.

167 000 (0.018*21+0.6*310)/1 000 =**31 125** (t CO_2 eq./y)

From electricity 812 555 kWt/H*0.104kg CO_2/kWt/H = **85** t CO_2/y

In total **31 210** t CO_2eq./y is generated.

Besides, on the Municipality territory, namely, in town Tamarisi former Tamarisi Poultry Factory is located which used to be one of the leading enterprises in the country in poultry meat production. However, the factory does not operate for already many years and the enterprise needs to be reequipped and equipped with modern technologies. In case of full-capacity operation of the enterprise the local production of poultry product and contributions to the budget will be increased, rather a big number of local residents will be employed. At this stage, there is no perspective of reestablishing Tamarisi Poultry Factory and due to this reason it was not included in the Action Plan until 2020, however it is discussed in perspective up to 2030.

Food Industry. Population in some particular units of Bolnisi Municipality is engaged in dairy delivering, as well as, in dairy processing and producing dairy product. The dairy processing industry consumes a large amount of hot water for what it consumes electricity. Below is given calculation of the emitted GHG CO_2 eq. into the atmosphere from each enterprise during the manufacturing process.

- Dairy Processing Factory of Village Ratevani, cheese producing trend Ltd. "BMB" under brand name "Kazala" should be mentioned with special emphasis. The annual workload of the enterprise makes up 140tons of cheese production. "Kazala" produces different types of cheese: Sulguni, Imeruli and Karkhnuli (factory) cheese. The enterprise purchases milk from local population and from neighboring regions. 10% of the produced product is delivered to regional market, 30% - to central market and 60% is consumed by companies. The enterprise works with full capacity. To this, in village Ratevani operate 6 small dairy receiving and processing enterprises producing 186tons of cheese per year. Annually, "Kazala" consumes 20000754kWt/H energy. Considering this, we can say that to produce 1ton of cheese, at average, 142 863kWt/H energy is consumed. Supposedly, more energy is consumed in small enterprises. Basically, these small enterprises consume electricity. As in Georgia the cleanest type of energy is electricity we have also calculated the energy consumption of small enterprises and in total to produce 190tons of cheese it will be needed about 27 143 970 kWt/H energy. This will be total energy consumption by the dairy factories located on the territory of village Ratevani and the corresponding Carbon Dioxide remission is 4 903 tons CO_2/y.
- On the territory of village Disveli Dairy Processing Cooperative "Disveli" is being constructed, which will be put into operation in February-March 2016. Daily the cooperative will process 2-3tons of milk from which will be produced cheese, Nadughi (similar to cottage cheese), butter and other products. With 3 tons of milk per day it will be possible to produce at average 3000L/10L = 300kg cheese (if no other product is produced), making up 110tons per year. As "Disveli" has not started manufacturing the products yet, the experience of "Kazali" was applied for calculation that for producing 1 ton of cheese consumption of 143MWt/H energy is needed and the annual demand on electricity for the enterprise was assessed equal to 5 730MWt/H, which will generate annually 1 636 t CO_2 eq.

- In 2015 Ltd. "New Style" has started construction of Cattle Breeding Farm in the adjacent territory of village Khatisofeli of Bolnisi Municipality. This Ltd. owns 22ha area of land. On one section of the territory is sown grain crops and on other section cattle sheds are being built which is considered for 70 cows among which 45 will be permanent milking cows. The cattle sheds will be equipped according to European Standards. The farmer plans to use the feeding materials grown on his own land to feed the cattle. The owner plans to construct milk processing factory in autumn where the farmers from the neighboring villages will be able to deliver milk. On the first stage, realization of the product will be carried out on the domestic market, and further it may also reach the European market.

  As the enterprise has not been put into operation yet, the annual energy consumption has been calculated based on data of other enterprises. Namely, 45 milking cows will give at average 900L of milk per day (20L per 1 head) with which will be produced at average 90kg of cheese. 33tons of cheese will be produced per year without the milk delivered from outside and for producing this amount of cheese 33t*143MWtH/t=4719MWt/H energy will be consumed which will produce 491 t CO_2 eq. emission into the atmosphere. As the number of cattle is rather small the biogas consumption potential has not been assessed.

  In total, from Food Industry Sector 7 030 t CO_2 eq. is emitted per year.

Agricultural Machinery. In the Municipality in total there are 220 units of agricultural machinery (tractors) of which 50 units are "soviet" production which are old-fashioned and either can't meet modern requirements or are out of order and it is needed to replace them with new machines. 170tractors are completely new ones of which 97 units are in private possession among the population, and 73 units belong to Ltd. "Deve+" and Ltd. "Mechanizatori". These machines consume only diesel. Old tractors consume per hectare 22liters of diesel for plowing, and 12 liters - for sowing and cultivation. New tractors consume 18 liters of diesel per hectare for plowing, and 9 liters – for sowing and cultivation.

In 2014, in total, 14 100ha arable lands have been plowed from which each tractor had to plow 64.1ha of land. The new tractors have cultivated 10897ha, and the old ones – 3 205ha. In 2014, for carrying out different types of work have been consumed:

In result of plowing in total has been consumed 18L*10897+22L*3205= 266656L=2800 MWt/H

In result of sowing in total has been consumed 9L*10897+12L*3205=136533L=1434 MWt/H

During cultivation in total has been consumed 9L*10897+12L*3205= 136533L=1434 MWt/H

In total, 5 668 MWt/H energy has been consumed that in case of diesel equals 15.9tons CO2eq. per year.

Table 65. Agricultural Machinery Available in Bolnisi Municipality

Type of Agricultural Machinery	Quantity	Diesel for Plowing (L/ha)	Diesel for Sowing (L/ha)	Diesel for Cultivation (L/ha)	Comments
Tractor new	170	18	9	9	In 2014 in total cultivated 14 100ha

Tractor old	50	22	12	12	At average one tractor has to cultivate 64.1ha. 50 old tractors cultivate 3200ha

8.2 Emissions Reduction Action Plan from Agriculture Sector in Bolnisi Municipality

Measure A1. Greenhouses. For the moment, basically, there are two operating greenhouses in Bolnisi Municipality. One of them produces vegetables and another - flowers. Each of these greenhouses occupy 0.2ha (2 000sq.m) area. As it was described above, in Bolnisi Municipality the greenhouses mostly consume firewood, coal, tires. Gas is supplied to certain areas of the Municipality but it is expensive for the entrepreneurs. In Marneuli Municipality there is a modern type of greenhouse constructed by Chinese investors which operates100% on solar energy consumption. In this kind of greenhouse a special covering material was used. It costs 35USD arranging 1m^2 of such greenhouse. Agricultural Information Center of the Municipality is interested in offering the energy-efficient greenhouses to the owners of large and small greenhouses existing on the territory of Bolnisi Municipality, as well as, the greenhouse created by the Chinese partners which does not consume any additional energy. This greenhouse costs rather expensive, i.e., its starting cost is high but it gives significant energy saving during a long-term perspective.

Picture 6. A Solar Energy Consuming Energy-efficient (Chinese) Greenhouse in Marneuli

Measure A1.1. Energy consumption may be reduced in town Kazreti vegetable greenhouse after implementing the following measures:

- The existing firewood stove should be replaced with 12-section "Mch" boiler working on firewood which will be installed in the greenhouse. The catalyst should be installed to the smoke pipe of the boiler which will return the temperature back to the boiler. The cost of this measure is about 4 000GEL. This measure will significantly reduce the firewood consumption.

- It is also possible to change the pipe construction and heating of substrate will be carried out instead of heating the air. This measure will cost about 7-8thousand GEL that will also reduce firewood consumption.
- The existing polypropylene cover-film to be replaced with greenhouse HDP membrane. This will provide penetration of convective heat of solar rays into the greenhouse from exterior and will heat the interior. 1m^2 of this kind of film costs 8-9GEL and for 0.2ha of the greenhouse will be needed 3.5-4thousand m^2 film. This measure will significantly reduce the firewood consumption and it may drop to 0 if proper management is provided in case of Bolnisi. The cost of this measure is 32 000GEL and making the whole greenhouse energy-efficient in total will cost 44 000GEL.
  Mentioned amount of money is rather expensive for a fresh farmer. So it is needed such farmers to be provided with the targeted preferential loans and to strengthen grant component that is urgent for protection of forests and sustainable management of forest sector.
  According to the expert's assessment, this measure will reduce consumption of firewood at least by 50% and, accordingly, consumption of energy (19MWt/H), and emission (8t CO_2 eq./y) will be reduced by 50% .

Measure A1.2. The same type of measure that is given in A1.1is discussed for the flower greenhouse of village Bolnisi. Here the result will also be similar. Consumption of firewood will be reduced at least by 50% and, accordingly, consumption of energy (19MWt/H), and emission (8t CO_2 eq./y) will be reduced by 50% .

Measure A2: Livestock and Poultry Farming. In this sector the measure to be implemented is basically producing electric power from pig and chicken excrements that will meet all demands of both facilities and even access quantity will be remained. But in case of Georgian conditions, it may be economically more profitable to use it as gas for heating of the adjoining greenhouses, or for delivering it to the population. At this stage it is urgent to conduct technical and economic feasibility study and develop a project proposal. The Information Center of the Ministry of Agriculture in Bolnisi Municipality will be involved in the work with farmers in order together with them to take care of introducing these technologies.

Measure A2.1: Daily quantity of 1 pig's manure is 4kg with 65% moisture, and excrements 5.1kg with 86% moisture. The total excrements of 20 000heads of pig are about 102tons per day and 37 230tons per year. Producing biogas in case of pigs equals 60m^3/t that will give 2233800m3 biogas per year. Of which methane is about 70% (1 563 660m^3) that equals to 14 700MWt/H energy.

This gas may be consumed immediately as energy source, or get from it electricity. In case of generating electricity from this, of course, the generator's efficiency factor will significantly reduce this quantity but in case of 60% efficiency the amount of the received electricity (8 820MWt/H) is far more than the electricity consumed by the enterprise. In case of replacing the electricity with this energy the saving will equal 8 820* 0.104= 917 t CO_2 eq. plus the emission generated from manure that in this case will be 20000 (4*21+16*310)/1000=**100 880** (tCO_2 eq./y). If considered the leaking (about 10%) generated during transformations, then the total saving will equal 90792+917=91709 t CO_2 eq./y (90%).

Measure A2.2: Daily quantity of chicken manure like that of excrements equals 0.16kg with 75% moisture. Daily total quantity of excrements of 167 000birds is about 27tons and 9 753 tons per year. Generation of biogas in case of chickens is 55m^3/t that gives per year 536 415m^3 biogas of which about 70% is methane gas (375 491m^3). This quantity equals to 3 530MWt/H energy.

This gas may be consumed immediately as energy source, or get from it electricity. In case electricity is received from this gas, of course, the generator's efficiency factor will significantly reduce this quantity, but in case of 60% efficiency the amount of the received electricity (2 118MWt/H) will be far more than the electricity consumed by the enterprise. In case of replacing the electricity with this energy the saving will equal 2 118* 0.104= 220 t CO_2 eq. plus the emission generated from manure that in this case will be **311 255** tCO_2 eq./y. If considered the leaking (about 10%) generated during transformations, then the total saving will equal 280130+220=280 350 t CO_2 eq./y (90%).

Measure A3: Food Industry. This branch is just starting developing in Bolnisi Municipality and as earlier energy-efficient and renewable technologies are proposed, the more economically profitable will be this process for the private sector involved in this sector. As the dairy product manufacturing sector consumes a large amount of hot water for what basically is spent electricity, consumption of solar energy will be the basic offer to this sector for hot water supply which with preliminary calculations will replace electricity by 80%. However, for conservative purposes, an assumption was made that only 50% replacement of electricity will be provided and below are given the accordingly saved GHG emissions.

Measure A3.1: In case of consuming hot water supply received from 50% replacement by solar energy, by 2020 Village Ratevani Milk Processing Factory of Bolnisi Municipality will have saving of **2 452** t CO_2 eq. (50%) per year.

Measure A3.2: Milk Processing Factory "Disveli" being constructed in Bolnisi Municipality plans to consume 20% electricity and 80% solar energy. Calculation of electricity consumption by this enterprise and corresponding GHG emission was conducted based on the calculations for similar enterprise "Kazala" operating in Village Ratevani. As a result of implementation of the measure, 1309t CO_2 eq. (80%) will be saved per year by 2020. The Municipality is helping the enterprise to search high quality technologies and get into contact with the manufacturers of the corresponding technologies.

Measure A3.3: The Cattle Farm (Ltd. "New Style"), being constructed on the territory of Bolnisi Municipality, plans to create a modern, dairy processing enterprise meeting European Standards. Therefore, the enterprise management has a desire to obtain maximum information about the potential of renewable technologies, in which the Municipality provides an active support. Under the most conservative calculations, if 50% of hot water is generated by solar energy, by 2020 the enterprise will save 246 t CO_2 eq. (50%) per year. Supposedly, the saving will be much more.

Measure A4: Upgrading the Agricultural Machinery

Measure A4.1. Currently, 220 tractors serve Bolnisi Municipality of which 50 units are old ones and belong to private persons, and the remaining 170 tractors are new ones and part of them are in the ownership of private persons and part – of the newly established Ltds. These machines consume only diesel fuel. Old tractors consume 22liters of diesel per hectare for plowing, and 12 liters - for sowing and cultivation. New tractors consume 18 liters of diesel per hectare for plowing, and 9 liters – for sowing and cultivation. Based on current trend of soil utilization, an assumption was made that by 2020 18 000ha will be plowed which was utilized in the soviet period. Accordingly, each tractor will have to cultivate 18.2ha more area (plowing, sowing, cultivating), i.e. 50 old tractors will cultivate 82.2(ha)*50=4 115ha for what it will consume 4115 (ha) * 22(L) + 2 (4115 (ha) *12 (L)) = 189 290 (L) diesel (1988 MWt/H, 5 .6 t CO_2 eq.). In case of replacement with new tractors it will consume 4115 (ha) * 18(L) + 2(4115(ha) *9(L)) = 148 140L diesel (1556MWt/H, 4.4 t CO_2 eq.).

By 2020 emission saving per year will be 1.2 t CO_2 eq. that equals to 6% of emissions from this sector.

Within the limits of Energy Community Georgia will be tasked to consume at least 10% of bio-fuel in transport sector. In Georgia bio-fuel (small quantity, the pilot one) is already produced which is consumed by pilot buses in Tbilisi. In Bolnisi Municipality production of bio-diesel and its consumption in agricultural machinery instead of diesel is already being discussed for future plans.

Table 66.Action Plan for Emissions Reduction from Bolnisi Municipality Agriculture Sector

Sectors and Activity Sphere	Main Measures in the Sphere of Activity	Department/Person or Company in Charge (if the third party is involved)	Implementation Period [start and End Date]	Expected Energy Savings from Each Measure (MWT/h/y)	Expected CO_2Reduction from Each Measure [T/y]	Cost of Each Measure [in GEL]
Agriculture (A)						
Measure A1	Increase of energy-efficiency in greenhouses and consumption of renewable energy					
A 1.1	Effective consumption of energy-efficient firewood boiler and solar energy in town Kazreti vegetable greenhouse	Bolnisi Municipality Agricultural Information Center	2018-2020	19	8	44 000
A 1.2	Effective consumption of energy-efficient firewood boiler and solar energy in village Bolnisi flower greenhouse	Bolnisi Municipality Agricultural Information Center	2018-2020	19	8	44 000
Measure A2	Consumption of energy potential of manure in livestock and poultry farms					
A 2.1	Consumption of energy potential of	Bolnisi Municipality Agricultural Information Center	2018-2025	1 200	90 792 (from manure) 917	15 000

	manure in pig farm in village Akaurta				(energy)	
A 2.2	Consumption of energy potential of manure in poultry farm in village Savaneti	Bolnisi Municipality Agricultural Information Center	2018-2025	813	280 130 (from manure) 220 (energy)	15 000
Measure A3	Consumption of solar energy in food industry (dairy processing enterprises)					
A 3.1	Dairy processing factories in village Ratevani	Bolnisi Municipality Agricultural Information Center	2017-2020	47 145	2 452	
A 3.2	Dairy Processing Factory of village Disveli	Bolnisi Municipality Agricultural Information Center	2016-2020	12 584	1 309	
A 3.3	Ltd. "New Style" Cattle Farm and Dairy Processing Factory	Bolnisi Municipality Agricultural Information Center	2017-2020	3 360	246	
Measure A 4	Agricultural machinery					
A 4.1		Bolnisi Municipality Agricultural Information Center	2017-2020	337	1.2	
Total				**65 747**	**376 083**	

Adaptation of Agriculture

Agriculture is the most exposed sector in Bolnisi Municipality in respect to the current climate changes and among various dangers here should be outlined increase of droughts which on their side increase demand on water recourse and at the same time reduce water recourse, and soil degradation which is connected with these droughts. Therefore, for the Municipality it is essential to have proper operating irrigation systems. The irrigation systems existing in the Municipality both main lines and secondary irrigation channels need urgent rehabilitation. Since 2014 rehabilitation works have been carried out on the so called Imirasani irrigation channel which is in ownership of Ltd. "United Melioration Systems Company".

Adaptation is not included in this Action Plan as Bolnisi Municipality has not signed yet the new agreement. In case of renewal of this Action Plan, agriculture adaptation in respect to climate change will be considered as one of the main trend.

9 Awareness Raising and Staff Training Strategy

Involvement of the government and public structures in the process of sustainable development of energy is equally important. Raising public awareness for renewable energy development, energy efficiency and energy saving requires a complex and multilateral approach and the relevant communications strategy represents one of the most important components of the Action Plan (SEAP).

Despite the fact that self-government reform started in Georgia in 90ies and periodically important steps were made for strengthening self-government units (among them in terms of legislation), as well as, coming out of certain political (instable environment, governmental changes, etc.) and socio-cultural difficulties (mentality, tradition of central control, etc.) the potential of self-government units in terms of effective management, planning and gaining financial independence is still weak. In this respect Bolnisi Municipality is not an exception. To be more precise, the real decentralization processes are on the starting stage yet. Therefore, the main problem of municipalities and among them of Bolnisi Municipality is lack of independent management experience, and, accordingly, lack of experienced personnel, while, developing and implementation of the SEAP requires independent planning and searching additional funds. The SEAP preparation process within the frames of the CoM clearly revealed for Bolnisi Municipality those basic barriers which may create significant threats on the way of implementation of the strategy. Therefore, it is urgent to conduct proper evaluation of all identified barriers and set the ways of their overcoming. This assessment revealed that in the process of strategy implementation mainly three types of barriers will be dealt with, which are: country level barriers linked to bad past practices (especially in the sphere of public awareness), lack of knowledge related with technologies due to existing economic and social problems; barriers specific to Bolnisi Municipality and concrete project proposals and technology related barriers.

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

Barriers to Sustainable Energy Development Process in Georgia

1. **Wasteful Approach to Energy Sector**, which is kept in public from the practices in soviet period when energy was almost free of charge and consumption was unlimited;

2. Insufficient awareness of sustainable development process by local authorities and population. Mainly, the small part of public directly engaged in these activities is aware of this concept;

3. **Absence of common vision** of the relatively long-term prospects of the Energy Sector development (different target groups still have sharply contrasting positions which often are not based on real calculations);

4. **There is no single, well-considered and formulated vision of the role of energy efficiency and renewable energy resources** in short-term and long-term perspectives of Georgia's Energy Sector development, while in recent years at average the 10% growth rate is recorded in energy demand annually. Correspondingly, the potential of these recourses (except hydro) and the directions for development of this potential are not defined; there is no relevant legislation base and the set objectives similar to gasification of the country or hydro-energetics.

5. **The technologies market is inferior and contains high risks.** Each failure of a new technology and demonstration project is seriously damaging follow-up prospects of the development in this direction. The long-term planning of Energy Sector is not conducted considering 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**. However, it should be stressed that the raise of energy efficiency, despite its chaotic character, is going on in the country 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. Besides, the country has already started to work on developing Energy Efficiency Action Plan that on its side will contribute to the growth of energy efficiency coordination at the municipality level.

While identifying these barriers it has been considered that Bolnisi Municipality managerial team has a vision of sustainable energy development prospects, demonstrates great interest to the adoption of modern, clean, energy efficient and renewable technologies and has relevant knowledge to certain extent but lacks sufficient experience in managing present-day technologies and sustainable development planning, as well as, working with investors. Often, the support by the Municipalities is not fully reasoned out and lacks eyesight of what could be done at local level and how this or that measure could be realized effectively.

Barriers to Bolnisi Municipality Sustainable Energy Development:

Bolnisi Municipality faces the same main barriers in energy resource consumption planning process as other regions and Municipalities in Georgia. **This is their complete dependence on the centralized energy supply 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 for 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. Bolnisi Municipality has no complete statistics on the energy consumption that would serve as basis for planning growing energy demand. There is no vision and strategy to foresee energy supply of the Municipality in case of failure of

one of present rings of energy supply system. Accordingly, the Municipality managerial team has no sufficiently thought-out energy efficiency urgency and its role in the process of sustainable socio-economic development. There is no vision of what problems the Municipality could face in case of rapid growth of economy and number of population, as well as intensification of traffic network. The situation is aggravated by rigorous climate conditions and total dependence on firewood.

The Municipality **has no relevant experience, knowledge and sufficient expert potential** to plan energy sustainable development process, manage and implement the SEAP for Bolnisi Municipality; In particular, in the short-run strategy for energy sustainable development process in Bolnisi Municipality the priority sectors are **Buildings and Agriculture, however, to secure the painless transfer to clean/low emission buildings and rural industry a serious public awareness raising campaign should be undertaken to demonstrate advantages that energy saving and local renewable energy consumption in heat supply will bring to population.**

Very important barrier is as well **absence of free additional funds** (most of the budget resources are used for infrastructure development at this stage and for social projects that is very important) to develop this direction (provision of energy sustainable consumption);

The local energy resource consumption sphere (except hydro) is unmanaged and chaotic at the Municipalities level and entirely in the country as well;

In the case of Bolnisi Municipality all those barriers are acute, which are typical and general for the whole country.

In case of Bolnisi Municipality, Buildings and Agriculture Sectors are among those sectors which experience urgent need of public awareness raising programs. The the Buildings Sector consumes biggest energy resource and firewood as well that in this case is received by instable way. Firewood and coal (and in many cases, tires) are consumed in greenhouses as well.

Apart from the discussed above barriers related with each concrete technology there exists some specific barriers which are to be envisaged in the process of the SEAP implementation for assessment of the selected and applied technologies.

Barriers related to Technologies

Lack of knowledge about the 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 the risks related with their introducing in the country. Private banks and the private sector are not willing to take upon the risks. Consequently, the import of technologies, their dissemination and adaptation is almost totally in the hands of non-governmental sector or those big investors who are interested in developing market for their own technologies. Accordingly, high technologies which are imported at the limited scale are accompanied with large part of worthless technologies. This is mostly promoted by the cost of technology and unfortunately even for short-time prospective;

Lack of knowledge about the local environment in which certain technology should operate (for example, energy-efficient bulbs become absolutely ineffective and economically unprofitable within old and improper functioning electricity network). Studies of these aspects bring additional cost to technologies;

Lack of knowledge of 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 minimizing; in case of Georgia, experience of this type of risk assessment actually does not exist;

Lack of sufficiently trained local personnel which could be able to select correctly certain technology with respect to local conditions and provide its operation. This problem is especially acute at the Municipalities and self-governing cities level;

Most renewable technologies are not sufficiently flexible and easily adaptable to different environments. Majority of them lack market shape and their adaptation to local conditions requires additional funding and knowledge.

Analysis of stakeholders in the frame of Bolnisi Municipality SEAP has identified target groups for awareness raising and retraining with which active collaboration is necessary to overcome the majority of the listed above barriers. However, it should be noted that there are barriers common with the country the over-passing of which will be extremely difficult without the serious intervention from the side of the government.

The target groups to be engaged in the awareness raising process to which this strategy is addressed are as follows: Bolnisi Municipality staff and City Assembly members; agricultural cooperatives/farms engaged in greenhouse farming, food industry, livestock breeding, etc.; Bolnisi Municipality population and private companies/developers participating in Construction Sector activity.

As at the present stage the first priority for Bolnisi Municipality is Heat Supply and Buildings Sector, therefore, for implementation of the Action Plan it is necessary to plan and execute such measures which require intense informing and awareness raising among population and above-mentioned target groups on heat supply and energy consumption in Buildings Sector, as well as, on the energy efficiency measures and prospect for the sustainable development of this sector that, on its party, will provide sustainability of Heat Supply Sector.

The audit of buildings in Bolnisi Municipality has revealed that the existing buildings (including the private houses) do not satisfy even the minimum requirements on energy efficiency that presumably significantly affects the budget of population and demands on energy. The main detail is that the energy resource in Heat Sector is firewood (87%) that becomes a heavy burden for Forestry Sector and hinders its sustainable management. To this is also added the fact that the standards used in construction are very low and it is necessary to conduct active work in this direction with the population and developers/builders.

In general, it is essential to explain the population the objectives of the SEAP and the social and economic sequels which could be obtained in case of its successful implementation. At the stage when it requires carrying out some behavioral changes among the population to achieve maximum support from its side it is necessary to provide its engagement in the process of the SEAP development. Global practice has demonstrated that the higher is population's involvement at the early stage of the process the stronger is the management on implementation stage and the public support.

At the initial stage of the SEAP development the meetings and consultations with the population of Bolnisi Municipality (among which, presumably, the most part of behavioral changes will be needed) will be necessary to explain the expedience and benefits of the project implementation. During the consultations new project ideas could arise, or the necessity of making corrections in the planned projects may be revealed.

While developing Bolnisi Municipality SEAP, meetings with the Municipality Administration were arranged systematically. It is to be underlined that just the stakeholders acting in specific sectors, are owning the 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 the Bolnisi Municipality SEAP implementation, for purpose of the awareness raising and local staff training a shot-term strategy has been developed considered until 2020. As Bolnisi Municipality plans to join the new Covenant of Mayors (up to 2030) according to which the Action Plan will be renewed, a long-term awareness raising strategy 2020-2030 will be developed during strategy renewal process.

Short-term Strategy 2015-2020

Constantly informing local authorities on the trends of energy consumption, advantages and prospects of efficient use of energy and providing development sustainability, as well as, the social and economic benefits of this initiative. Constant retraining of local personnel for development of future plans and improving skills for mobilization of additional financial sources.

Training the Municipality personnel and external human resources to ensure successful implementation and monitoring of the SEAP;

Provision of Bolnisi Municipality with technical staff which will guarantee the development of energy efficient/low emission projects in Buildings, Transportation and other sectors.

Provision of the population with minimal construction standards, explaining the follow up cutback of their energy expenses by introducing these standards.

Preparation of information/education/illustration materials about successful experiences and modern technologies that are recommended for the green development of the Municipalities; Demonstration to the population the advantages of introduction in different sectors (Buildings, Agriculture) energy efficient measures and technologies;

Providing the involvement of private sector (Agriculture, Food Industry) in the implementation of the SEAP supplying them with information on energy efficient and economically beneficial technologies, offering programs on cooperation between public and private sectors.

Awareness Raising and Staff Training Short-term Strategy (2015-2020) in Bolnisi Municipality

Main Strategic Objectives	Main Target Groups	Measures to be Implemented	Potential Leading Organization(s)	Outcome	Potential Donors
Short-term strategic objectives (2015-2020) The major objective of the short-term strategy is to facilitate the systematic awareness of the Municipality Administration / Managerial Team on the prospects of sustainable development of energy consumption and its social and economic benefits; Highest possible notification and awareness raising of target audience (population, flat-owners cooperatives, and agricultual cooperatives) on energy efficiency in Buildings and Agriculture Sectors; Assisting the population and other stakeholders in getting advantages from this initiative and training appropriate personnel for implementing the Action Plan and provision of its monitoring.	• Bolnisi Municipality and the Municipality Assembly • Bolnisi Municipality population and flat-owners cooperatives • Cooperatives engaged in Agriculture Sector and farmers parties		• Bolnisi Municipality City Hall • Coordinators of CoM in Georgia (Ministry of Energy and Ministry of Environment and natural Resources Protection) • Different local and international programs going on in the frames of CoM and EC-LEDS	• Implementation of Bolnisi Municipality SEAP is advancing successfully • Bolnisi Municipality City Hall continues the same activity after 2020 and enhances it • Bolnisi Municipality population is informed about these initiatives undertaken by the authorities in the frames of this process	• Bolnisi Municipality City Hall • Coordinators of CoM in Georgia (Ministry of Energy and Ministry of Environment and natural Resources Protection) • Different local and international programs going on in the frames of CoM and EC-LEDS • International donors contributing to Climate Change mitigation and renewable

					energy, energy efficiency and sustainable development process.
1. Staff Training					
Training of technical personnel, which will be able to assist population, flat-owners cooperatives, and farmers engaged in agriculture sector in preparing energy efficient project proposals and their implementation	• Technical Experts Group under Bolnisi Municipality • Special Department at the City Hall (it could be the Energy Efficiency Agency or Sustainable Development Agency) which will serve the City Hall, the population and the private sector in preparing concrete project proposals and implementing these measures.	• Under the support of Bolnisi Municipality City Hall the "Energy Agency" / "Energy Manager" should be set up serving both City Hall and collaborate with the population, flat-owners cooperatives, cooperatives and generally with private sector in preparing energy efficient projects and offering modern energy efficient technologies. • Elaboration of Technical Group's training program. The program should include at least the analysis of contemporary technologies and barriers to their introduction, as well as the study of advantages of different energy efficiency measures. • Development of manuals for the Technical Group. • Involvement of Technical Group in exchange programs and various	• Bolnisi Municipality City Hall • Representatives of different countries' private sector, engaged in this sphere.	• The program and manual are developed for training personnel of the City Hall Technical Group. • The staff is trained and selected in accordance with competition rules. • Technical Group is actively participating in exchange programs and international networks to obtain newest information on present-day technologies and approaches in energy sector. • Technical Group is actively collaborating with cooperatives population, private sector and	• Bolnisi Municipality City Hall • EC-LEDS Project • USAID • GIZ • EU • Different projects and programs which work in the direction of enhancing local potential

		information networks for getting international experience.		Municipality in the process of energy efficiency measures' implementation	
Training for Bolnisi Municipality the personnel which will be able to perform skilled work in preparing future development plans, mobilization of additional financial resources and produce recommendations for successful implementation of CoM process	• Bolnisi Municipality City Hall SEAP Group • The special group (which may be Energy Efficiency Center, or Energy Manager, or Sustainable Development Agency) set up under the support of Bolnisi Municipality City Hall, serving both the City Hall and collaborate with the population, and private sector with recommendations	• Setting up of special group/service under the Bolnisi Municipality City Hall or outside it, serving the City Hall, as well as the population and private sector in the process of SEAP implementation and monitoring on offering modern technologies. • Working out of training program for the mentioned group. The program should include at least issues on sustainable energy, climate change mitigation measures, EU Directives, CoM requirements and the analysis of contemporary technologies in view of barriers to their deployment • Preparation of manual for mentioned group • Involving the Group in exchange programs and different information networks for getting local and international experience. • Tentative candidates for this group as far as possible should be	• Bolnisi Municipality City Hall • Ministry of Energy • Ministry of Environment and natural Resources Protection • Focal Point of CoM process in Georgia	• The program and manual are developed for training the City Hall's SEAP Group personnel. • The rights and obligations of this Group and its working program are formulated, envisaging both the City Hall assistance and the cooperation with citizens and the private sector. • The SEAP Group is actively involved in exchange programs and international networks to obtain newest information on modern technologies and approaches in energy sector.	• Bolnisi Municipality City Hall • EC-LEDS Project • USAID • GIZ • EU

		involved from the initial stage in the SEAP development process.		• Technical Group is ready to train necessary personnel for private sector.	
2. Public Awareness Raising and Dissemination of Information					
Widest possible dissemination of information and awareness raising among the general public. In this process the public should be well informed on social and economic advantages, which could be achieved as a result of energy sustainable development. The main direction of Municipality will be to inform the general population, flat-owners cooperatives, and private sector engaged in Agriculture Sector on energy efficiency measures In buildings and different sub-sectors, providing consultations and delivery newest information on technologies available at the market and especially on their introduction, on the	• Bolnisi population, flat-owners cooperatives • Farmers engaged in Agriculture Sector • Non-governmental sector • And other public associations	• Development of information materials on measures and technologies, which will improve the living environment of population and save expenses on energy consumption, makes their agricultural products competitive • Preparation of information materials for the population about the Bolnisi Municipality (e.g. on its potential in developing energy efficiency and greenery, and how can the population contribute to these processes). • Preparation of information material for the population on the energy efficiency measures undertaken by other cities and municipalities to the CoM and their outcomes. • Systematic meetings with population	• Bolnisi Municipality City Hall • Non-governmental sector	• The TV programs are prepared for local TV channel (The 9-th Channel) • Updating of information for the population of Bolnisi Municipality is performed at the Municipality web-site (http://bolnisi.ge/) and on Facebook page • Inforamtion booklets are developed on the preferences of energy efficiency measures and their application. • Several pilot projects are implemented, providing maximal involvement of population.	• Bolnisi Municipality City Hall • USAID • GIZ • EU

best practice world over in this field.		• Involving the population in the process of pilot projects development and implementation			
3. Systematically Informing Bolnisi Municipality and City Assembly Representatives					
Provision of informing local authorities on the advantages and prospects of sustainable energy consumption by the Municipality, on the social and economic benefits of this initiative.	• Bolnisi Municipality City Hall • Bolnisi Municipality Assembly	• Holding awareness raising workshops for City Hall and City Assembly representatives on the advantages and prospects of providing energy sustainable consumption. • Encouranging participation of City Hall and City Assembly staff at international meetings and conferences on the CoM process. • Inclusion of mass-media representatives in the high level meetings on the CoM issues and maximal public awareness raising by this way on the current processes. • Providing the decision making process in the frames of CoM via consultations with stakeholders.	• Regional Energy Efficiency Center (in case such center is established) • Ministry of Energy • Ministry of Environment and natural Resources Protection	• Illustratvie materials are prepared for holding information meeting; • Awareness raising meetings are being held (at least twice a year); • Experts from the EU and other donor countries are invited to carry out workshops on modern technologies and approaches; • The approved resolutions and discussed projects and measures are publisized by mass-media.	• EC-LEDS • USAID • EU-COM • GIZ • Partnership for mitigation • GHG emissions reduction projects • Georgia's National Communicatio ns on Climate Change

				• Representatives of City Hall and City Assembly are fully involved in processes going on both in the country and at the international level as well; • Constantly updated information on current processes and projects is available at the City Hall website/Facebook page.	
4. **Involvement of Private Sector in Achieving the SEAP Goals**					
Strengthening of private sector involvement in the SEAP implementation by providing information on energy saving and beneficial technologies, offering programs on cooperation between public and private sectors.	• Private Sector (at this stage engaged in Agriculture Sector and Food Industry) • Initiative groups of private sector	• Taking an interest of private sector using different stimulating mechanisms in the application of innovative technologies (e.g. establishing certain privileges in the frames of local taxes for companies, introducing energy efficient and innovation technologies); • Providing consulting services to private sector aimed at decreasing the risks; • Setting up of different funds, aiming the deployment of new technologies for the reduction of	• Bolnisi Municipality City Hall • Energy-efficient Center • Private Sector • Non-governmental Sector	• Various measures are being held annually • Motivating mechanisms for private sector are elaborated to provide its involvement in processes of new technologies development and introduction; • The Energy Efficiency Agency/Energy Manager is set up, providing	Bolnisi Municipality City Hall Private Sector EU COM GEF UNFCCC Programs

		risks, related with adapting of new technologies; • Promoting the creation of private sector initiative groups, facilitating maximal involvement of this sector in the CoM processes.		consultations on the deployment of new technologies; • Risk-insurance financial schemes related with technologies are created for the private sector; • Initiative groups are organized in different sectors, being the main connecting ring between the state and private sectors; • Representatives of private sector are incorporated in international processes, associations and professional networks.	
5. Identification of Barriers by consulting with Stakeholders					
Identification of barriers via consultations with stakeholders, which may arise in the process of introducing prohibitive measures and different types of standards which presumably will be the main	• Bolnisi Municipality City hall • Bolnisi Municipality City Assembly	• Identification of barriers in the process of consultations with the population on the developed standards and restrictive measures for the long-term SEAP sectors;	• Bolnisi Municipality City hall • Bolnisi Municipality City Assembly	• Groups are trained (private sector initiative group, non-governmental sector, mass-media) to carry out consultations;	• Bolnisi Municipality City Assembly

direction of the long-term strategy	• Bolnisi Municipality population • Private Sector operating in Bolnisi Municipality (Industry, Agriculture Sector) • Non-governmental sector	• Working out of measures to overcome the determined barriers by consulting with different target groups (e.g. transportation in certain district or the street should be prohibited gradually, in defined days of the week. Yet, some measures, e.g. technical inspection of cars, should be taken simultaneously under the government decision, etc.).		• For each sector, discussed in the SEAP, barriers are identified; • In cooperation with target groups the measures to overcome the barriers are revealed.	

Implementation Structure

- This strategy, as a constituent part of the Development Action Plan, is approved and its implementation is monitored by the Bolnisi Municipality City Assembly;
- The responsible body on updating the Strategy and its performing is the Bolnisi Municipality City Assembly;
- Responsible body for training local staff, necessary to execute the Strategy and monitor its implementation will be the "Energy Efficiency Agency"/"Energy Manager" (it may be "Sustainable development Agency") under the City hall, setting up of which is one of priorities to the Bolnisi Municipality City Hall and is planned to be established by the City Hall. To create the capacity for this Agency there will be used local and international programs, going on in the frames of the CoM.
- Development of awareness raising and information dissemination materials at the initial stage mainly should be conducted using the outside resources (non-governmental sector).

10 Plan for the Monitoring, Verification and Reporting on the Implementation of SEAP and GHG Emissions Reduction in Bolnisi

To plan and carry out monitoring measures on the implementation of Bolnisi SEAP and the reduction of GHG emissions, the way local government reforms are carried out is of significant importance. These reforms must ensure high quality of municipalities' independence. Obligatory factor for that is strengthening local potential in all directions including monitoring course of processes. Interior structures of municipalities have lack of adequate staff (especially high quality managers who own sectors and have information about the trends of their development) at this stage. During preparation of this monitoring plan municipality has a coordinator of CoM process (one person) who (together with other affairs) has created temporary working group that takes part in preparing SEAP. Strengthening existing potential and bringing additional resources will be needed for implementing SEAP and ensuring stability of monitoring. In this process it is very important how effective will be a mobilization, increasing and distribution of local financial and human resources. Lack (often even missing) of needed resources and adequate technical skills and knowledge is one of the biggest barrier for municipalities during preparing and implementing SEAPs.

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. This option means combine use of internal and external resources for monitoring.

Creating the action plan showed that one of the most important problem of Bolnisi 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. It must be said that this information was not needed in the past because municipalities were not self-governing units. 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 both, SEAP implementation and monitoring. To reduce the risks from a lack of data, the "Monitoring" section of the Bolnisi 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 Bolnisi SEAP monitoring group. 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 of Bolnisi 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.

Simple software Muni EIPMP for municipalities has been prepared by Sustainable Development Centre – Remissia in the network with Development of Potential for Low Emission Strategy under USAID. This software allows municipalities to calculate BAU scenario of energy consumption and reduction potential or reduced GHG emissions by themselves, in case of appropriate statistic data. Signatory municipalities of the CoM and self-governing cities including representatives of Bolnisi Municipality are systematically trained for using Muni EIPMP.

During preparation of monitoring periodic reports for implementation of action plan, that is obligatory due to terms of CoM, is possible to include invited expert(s) in monitoring process at least during preparation of the first obligatory report.

Main activities included in the Monitoring and Reporting process of Bolnisi are:

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. Determine how to simplify the monitoring system in future.

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

1. The Bolnisi Municipality: responsible for obtaining statistical information about main parameters (GDP, population, per capita income, share 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 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 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 includes elements of monitoring process, general parameters that have to be monitored during the SEAP implementation, quality assurance and quality control (QA/QC) procedures and emissions factors. Based on this, a specific year baseline scenario will be updated and reduced emissions calculated.

10.1 Responsible unit for the monitoring in Bolnisi Municipality

In Bolnisi Municipality the overall responsibility on the CoM and the development and implementation of the SEAP, its systematic updating according to new circumstances and development plans currently falls to specially appointed Coordinator and the City Hall Department on Property Management, Economic Development. It is not finally decided yet, but presumably, energy effective agency/Energy Manager will be established in Bolnisi municipality that will be responsible for monitoring, analysis of its results and foreseeing of these results in renewing process of action plan, verification of monitoring data and preparing final report of monitoring that will be approved by Bolnisi Municipality Assembly before presenting it in EU.

The Coordinator and relevant divisions of the Department of Economic Development also will be responsible for gathering the activity data, improvement of their quality and updating, identifying the new sources. The Coordinator and Economic Development Department can use in this process other Departments and LLC-es, subordinated to the Municipality, as well as certified external resources. Initially and later on the resources of nearest Regional Energy Efficiency Center could be employed as well. In case of setting up of Regional Energy Efficiency Centres, this part of monitoring should be correspondingly modified and significant portion of activities, listed here will be implemented by them.

There are six main sectors considered within the Sustainable Energy Action Plan of Bolnisi municipality: Buildings sector, Transport sector, Street lighting sector, Wastes, Agriculture 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 emission reductions can then be analyzed. At this stage, Bolnisi municipality 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 by the "Sustainable Development Agency", planned to be set up in the nearest future.

Figure below demonstrates departments of City hall and LTDs that were taking part in creation of SEAP and presumably will be responsible for gathering data for monitoring.

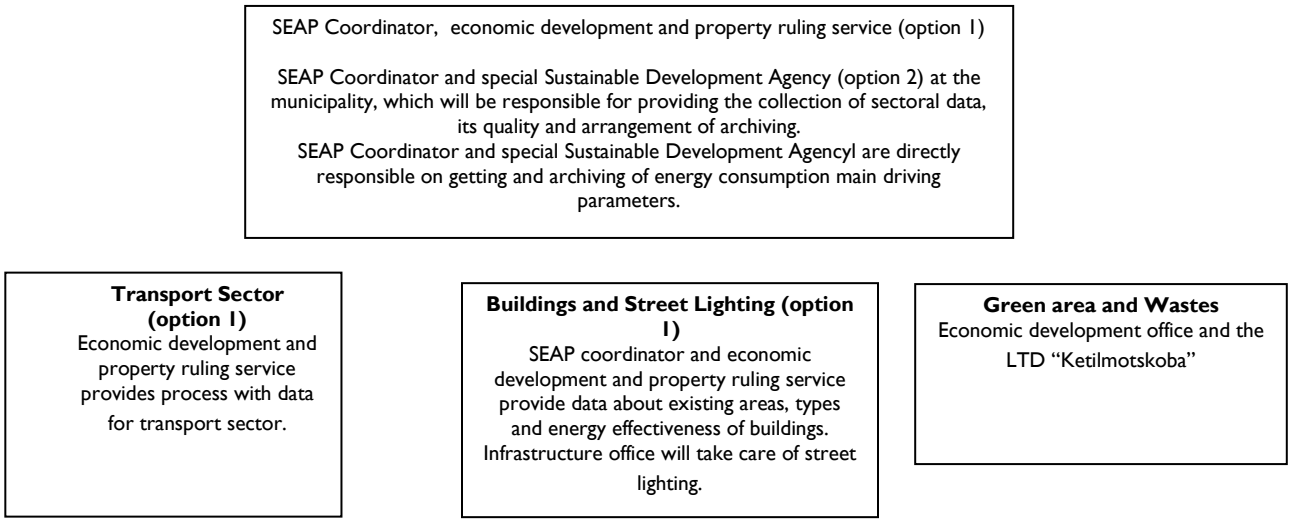

Fig. 14. Monitoring Process Management

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

- Annual emissions in CO_2equivalent;
- Measures and project implementation status and emissions savings for a given period;
- Driving parameters 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 parameters can be considered for the monitoring process, taken from primary and secondary data. Primary data is gathered from different sources by responsible group. Secondary data is based on primary data and then automatically calculated with muni_EIPMP software.

An approved special Technical Group and Energy Manager be responsible for annual reporting. These will be compiled every two years and submitted to an independent third party for verification. It is implied that the third party will be provided by EU Covenant of Mayors Office. The monitoring report structure is already worked out by the EU Research Centre, 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 conformity of results acquired in different years to the BAU data.

10.2 Monitoring of main driving parameters featuring GHG baseline inventory (BEI), BAU scenario and GHG baseline inventory monitoring (MEI)

The purpose of discussed below parameters is to conduct the MEI and update the BAU scenario in view of important social and economic changes going on in the city. Information presented in Tables below refers to 2014, taken as a base year for the GHG inventory in the Bolnisi SEAP. On the basis of these parameters and their 2014 values the Bolnisi municipality energy consumption development scenario (BAU) has been developed for 2020. In comments it is explained how to update these parameters for the compilation of SEAP Monitoring Report.

Data/Parameter # 10.2.1	**Population through the monitoring year**
Data unit:	Number of population
Description:	Primary data; Annual monitoring.
Source of data used:	Annual statistics (www.Geostat.ge) and local statistics
Value applied in SEAP:	**78 900 (2014)**
Any comments	On the basis of number of population in the monitoring year the increment should be calculated relevant to 2014 and the compliance with the reality of SEAP assumption on population growth must be assessed. This information will be used later in the comparative analysis of new and old BAU scenarios aimed at revealing the causes of deviation.

Data/Parameter # 10.2.2	**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.
Value applied:	This value has not been used in SEAP but must be observed for monitoring
Any comments	National Statistics Office publishes information only about annual GDP of the Region. In this case, using the region's GDP and its total population, the per capita GDP in this Region could be evaluated, multiplied further by the number of population in Bolnisi municipality. Besides such assessment more precise methods could be used which also must be well described as well. The value of GDP in the monitoring year is used for recounting the BAU scenario, additional

	check-up of different quantities and their observation, data control and monitoring of emissions trends per unit of GDP, assessment of emissions intensity in the process of economy development.

Emission Factors

Data/Parameter # 10.2.3	**Grid emission factor CO2 tCO_2/MWh**
Data unit:	tCO_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:	0.104 t CO_2/MWh (this is grid emission factor in 2014)
Any comments	The emissions factor is calculated using average method by dividing annual emissions from the power sector by annual electricity generation. This emission factor is calculated centrally in order to monitor low emissions and is delivered to municipalities for their SEAPs. During SEAP preparation the used grid emissions factor has been calculated by averaging, since Bolnisi municipality does not produce electricity independently but receives it from the centralized energy system of Georgia.

Data/Parameter # 10.2.4	**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 CO2 T/TJ; 5 CH4 Kg/TJ; 0.1 N2O Kg/Tj.
Any comments	It is recommended to use the national calculated value that depends on the natural gas calorific value (NCV). This should be updated constantly during the monitoring process using information about gas caloricity consumption.

Data/Parameter # 10.2.5	**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 (applied for Tier 1 calculations)
Value applied:	68.6 tCO2/Tj; 20 Kg CH4/Tj; 0.6 Kg N2O /Tj.
Any comments	It is recommended to use the national calculated value that depends on the carbon content of gasoline, and should be updated constantly during the monitoring process according to information on imported gasoline caloricity.

Data/Parameter # 10.2.6	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 (applied for Tier 1 calculations)
Value applied:	73.3 tCO2/Tj; 5 Kg CH4/Tj; 0.6 Kg N2O /Tj.
Any comments	It is recommended to use the national calculated value that depends on the carbon content of diesel, and should be updated constantly during the monitoring process according to information on imported diesel caloricity.

Data/Parameter # 10.2.7	Net Calorific Value of Different Fuels (NCV) for, NG, Gasoline, Diesel
Data unit:	TJ/Unit of fuel
Description:	Primary data. These data should be collected at the national level from fuel importers.
Source of data used:	At this stage, typical values are used in the SEAP, provided by the IPCC

Value applied:	Gasoline	44.80 TJ/1000 t
	Natural gas	33.59 TJ/million m^3
	Liquified Petrolium Gases (LPG)	47.34/1000 t
	Diesel	43.33 TJ/1000 t
	Firewood	7.50 TJ/thousand m^3
	Coal	4.65 TJ/1000 t
Any comments	These data should be collected in the future for each type of fuel used in the country. The information sources are mainly fuel importers and distributors. Systematic update is recommended taking into account fuel parameters. It would be better to apply these typical data if local statistics is not available.	

10.3 Transport Sector

Public Transport (minibuses)

Data/Parameter # 10.3.1.1	**Number of municipal public transport-minibuses**
Data unit:	Number of minibuses through the monitoring period (annual value)
Description:	Primary data.
Source of data used:	Bolnisi Municipality Transport Company
Value used in SEAP	2 minibuses (city), each on Diesel
Any comments	Responsible for this information is Municipal Transport Office of Bolnisi Municipality. Municipality must verify these data during monitoring process, comparing it with used fuel costs that must be requested from financial department.

Data/Parameter # 10.3.1.2	**Average distance traveled annually by one minibus according to fuel type (gasoline, diesel, NG)**
Data unit:	Km/yr
Description:	Primary data.
Source of data used:	Bolnisi Municipality Transport Company. Data from Municipal Transport Office is used in SEAP.
Value applied in SEAP:	91 250 Km/yr (2014)
Any comments	It is recommended that this data be gathered (according to daily covered distance that is 250 km for 1 bus) by appropriate transport company. Final information must be checked by monitoring group of Bolnisi municipality for SEAP. Responsible for giving this information to monitoring group is Municipality Transport Company. Municipality must verify these data comparing it with used

	fuel costs that must be requested from financial department. Alternative way would be giving annual value by Municipality Transport Company but its verification will be more difficult than verifying monthly data by random choosing. .

Data/Parameter # 10.3.1.3	**Total average distance traveled by all minibuses annually according to fuel type (gasoline, diesel, NG)**
Data unit:	Km/yr
Description:	Secondary data, calculated by 10.3.1.3=10.3.1.2*10.3.1.1
Source of data used:	Calculated by monitoring and SEAP groups
Value applied:	182 500 Km/yr (2014)
Any comments	Municipality must verify these data during monitoring process, comparing it with used fuel costs that must be requested from financial department.

Data/Parameter # 10.3.1.4	**Average consumption of fuel by 1 minibus per 100 km (by fuel type)**
Data unit:	L/100 Km
Description:	Primary data.
Source of data used:	Bolnisi Municipality Transport Department
Value applied:	23 L/100 Km (2014) (old Bogdan buses)
Any comments	This data must be checked with bus technical passport and must be explained in case of big difference.

Data/Parameter # 10.3.1.5	**Annual amount of used fuel by all city buses**
Data unit:	L/yr
Description:	Secondary data. Calculated
Source of data used:	2014 is calculated by SEAP group
Value applied:	41 975 L/yr=439.76 MWh=CO_{2eq} – 116.3 t
Any comments	This data is calculated so: 10.3.1.5.= 10.3.1.3*10.3.1.4 / 100 It can be calculated by parameter 1.2.1.3 and fuel cost on 100 Km if fuel types and buses are similar. This data must be checked by Economic Development and Property Departments and monitoring group by using financial costs used on fuel.

Data/Parameter # 10.3.1.6	**Passenger turnover per year (quantity of passengers ferried by all buses per year)**
Data unit:	Passenger/yr

Description:	Secondary data. For Bolnisi (city) it is calculated by Municipality Transport Office according to daily data, that was 500 passengers per day in 2014.
Source of data used:	Data of Bolnisi Municipality Transport Office is used in SEAP.
Value applied:	182 500 (2014)
Any comments	City bus company calculates by sold tickets that can be checked with data of financial department by economic development group.

Data/Parameter # 10.3.1.7	**Minibus annual passenger turnover (mobility)**
Data unit:	Passenger. km/yr
Description:	Secondary data which is usually calculated through the load factor
Source of data used:	Total distance travelled by buses per year is multiplied by one bus load factor.
Value applied:	In the Bolnisi Municipality 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 Office for entire country.

Public transport (microbuses)

Data/Parameter # 10.3.2.1	**Number of private microbuses (by fuel type)**
Data unit:	Number of cars through period of monitoring
Description:	Primary data
Source of data used:	Data of LTD Bolnisi Municipal Office and LTD Bolnisi Auto Station are used in SEAP
Value applied:	Total 42 (2014) NG – 1 Diesel - 41
Any comments	On the territory of municipality were 11 microbuses in 2014. 31 microbuses move from the municipality to outside. All of them belong to LTD Bolnisi Auto Station

Data/Parameter # 10.3.2.2	**Average annual distance traveled/run by one vehicle (by fuel type is recommended)**
Data unit:	km/yr
Description:	Primary data.
Source of data used:	Provided to the SEAP by LTD Bolnisi Auto Station

Value applied:	1 microbus on the territory of Bolnisi municipality covers 2 190 km annually (6 km per day). 1 microbus outside the territory of Bolnisi municipality covers 7 300 km annually (20 km per day)
Any comments	LTD Bolnisi Auto Station is private and does not belong to the municipality. It is not regulated by municipality but is financially accountable by Economic Development and Property Ruling groups. Verifying their data is possible by municipal government.

Data/Parameter # 10.3.2.3	**Average distance traveled by all microbuses per year (by fuel types)**
Data unit:	km/yr
Description:	Calculated by MUNI_EIPMP
Source of data used:	10.3.2.3=10.3.2.1.*10.3.2.2
Value applied:	7 300 Km/yr (NG) 1 microbus 292 000 Km/yr (Diesel) 40 intercity trips (30 microbuses) 24 090 Km/yr (Diesel) 11 microbuses on the territory of Bolnisi Total in 2014: 316 090 km (Diesel) 7 300 km (NG)
Any comments	All of them are property of Bolnisi Auto Station. 30 buses in Bolnisi, 10 of which run 2 times. That is why we have got 40 trips.

Data/Parameter # 10.3.2.4	**Average fuel consumption by microbuses per 100 km (by fuel type)**
Data unit:	l/ 100 km (Gasoline, Diesel) m^3/ 100 km (NG)
Description:	Primary data.
Source of data used:	Provided to the SEAP by LTD Bolnisi Auto Station
Value applied:	Diesel- 12 l/ 100 km NG- 12 m^3/ 100 km
Any comments	Logically, this data must be verified with microbus technical passport and must be explained in case of big difference. These microbuses are secondary, customized many times, move on a bad roads and that difference may be logical.

Data/Parameter # 10.3.2.5	**Fuel annual consumption by all microbuses according to fuel types (gasoline, diesel, NG)**
Data unit:	l/yr m^3/yr

Description:	Secondary data. Should be calculated by Monitoring Group
Source of data used:	Calculated with MUNI-EIPMP. 3.2.5=3.2.1.*3.2.2.*3.2.4/100 Number of fuel powered microbuses multiplied by fuel consumption per 100 km, multiplied by one microbus annual run and divided by 100.
Value applied:	2014: 37 931 l (Diesel) = 397.39 MWh=105.09 t CO_2 876 m^3 (NG) = 8.32 MWh = 0.12 t CO_2
Any comments	This data is calculated by the Monitoring Group

Data/Parameter # 10.3.2.6	**Microbus annual passenger turnover (mobility)**
Data unit:	Passenger/yr
Description:	Secondary data. In case of Bolnisi municipality is calculated by data of Bolnisi Auto Station. In 2014 suburban microbuses ferried 200 passengers per day and 73 000 annually. 11 microbuses onn the territory of Bolnisi ferried 70 passengers per day and 25 550 annually.
Source of data used:	Provided to the SEAP by LTD Bolnisi Auto Station
Value applied:	**73000+25500=98 550 passengers per year**
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. Its verification is possible by local government because this LTD is accountable with financial parameters.

Private cars (light)

Data/Parameter # 10.3.3.1	**Amount of cars registered in Bolnisi Municipality**
Data unit:	Number of vehicles
Description:	Primary data.
Source of data used:	Service Agency of MIA of Georgia. Data has been verified by SEAP group of Bolnisi Municipality
Value applied:	Total: 16 694 Gasoline- 12 520 Diesel- 4 174
Any comments	

Data/Parameter # 10.3.3.2	**Average distance traveled by one vehicle a year (by fuel types)**
Data unit:	km/yr
Description:	Primary data.
Source of data used:	Rated by survey of private cars that has been held by SEAP group of Bolnisi Municipality
Value applied:	4 745 km/yr
Any comments	In the future, in the monitoring process, interviews with car owners/drivers may be used. It may allow calculate average daily run and then annual run. Results of survey must satisfy criteria of statistical reliability. Interviews and surveys for calculating daily run (even annual is possible) must be held periodically together with implementation of SEAP.

Data/Parameter # 10.3.3.3	**Average distance travelled by all private cars annually (by fuel types)**
Data unit:	km/yr
Description:	Calculated data.
Source of data used:	Calculated by the MUNI-EIPMP. Data # 10.3.3.1 and 10.3.3.2
Value applied:	Total: 79 213 030 59 407 400 km (gasoline), 19 805 630 km (diesel).
Any comments	Annual distance covered by 1 vehicle multiplied by amount of vehicles

Data/Parameter # 10.3.3.4	**Fuel consumption per 100 km by fuel types**
Data unit:	l/100 km m^3/100 km Kwh/100 km
Description:	Primary data.
Source of data used:	Provided to the SEAP by Bolnisi Municipality.
Value applied:	Gasoline- 10 l/100 km Diesel- 10 l/100 km
Any comments	Logically, this data must be verified with technical passport of private cars (by vehicle types) and must me explained in case of big difference. Big part of private cars use bad roads and that may be a reason for primary consumption specified by technical passport.

Data/Parameter # 10.3.3.5	**Annual fuel consumption of private cars by fuel types**

Data unit:	l/ yr
Description:	Secondary data. Must be calculated by the Monitoring Group
Source of data used:	Calculated with MUNI-EIPMP. 10.3.3.5 = 10.3.3.1. * 10.3.3.2. * 10.3.3.4/100 Amount of cars on Gasoline multiplied by fuel cost on 100 km and multiplied by annual covered distance by 1 car and divided by 100.
Value applied:	2014: 5 940 740 (gasoline) 1 980 563 (diesel)
Any comments	This data is calculated by the Monitoring Group and must be verified with sold fuel but quite important difference is possible. On this stage, it is calculated by Remissia that helped municipality in technical aspects of SEAP.

Data/Parameter # 10.3.3.6	**Amount of passengers carried by all private cars annually**
Data unit:	passenger/ yr
Description:	Secondary data. Must be calculated by load factor
Source of data used:	This parameter was not rated during preparing Bolnisi Municipality SEAP
Value applied:	Not rated
Any comments	Amount of cars multiplied by annual covered distance and multiplied average load factor of 1 car

Data/Parameter # 10.3.3.7	**Load factor of transport type**
Data unit:	Passenger.km/ trans.km
Description:	This parameter must be rated different statistical methods and surveys. SISTRA surveys for Tbilisi was used in Bolnisi SEAP
Source of data used:	This parameter was not rated during preparing Bolnisi Municipality SEAP
Value applied:	1.85
Any comments	This parameter is used only for rating GHG emissions reduced by taken measures in sector. GHG emissions from transport sector are not dependent on it.

Auto transport used by municipality

Data/Parameter # 10.3.4.1	**Number of vehicles by fuel type**
Data unit:	Number of vehicles
Description:	Primary data.
Source of data used:	Provided to the SEAP by Bolnisi municipality local government
Value applied:	34: (total)

	32 (gasoline); 2 (diesel)
Any comments	Responsible for this data is Economic Development and Property Ruling departments of the Bolnisi municipality

Data/Parameter # 10.3.4.2	**Average distance traveled by one vehicle annually (by fuel and vehicle type)**
Data unit:	Km/yr
Description:	Primary data.
Source of data used:	Provided to the SEAP by Economic Development and Property Ruling departments of the Bolnisi municipality
Value applied:	10 760 km/yr
Any comments	

Data/Parameter # 10.3.4.3	**Average distance covered by vehicles annually**
Data unit:	Trans. km/yr
Description:	Calculated data.
Source of data used:	Calculated by the MUNI-EIPMP. Data # 10.3.4.1 and 10.3.4.2
Value applied:	344 320 km (gasoline) 20 520 km (diesel)
Any comments	Must be verified with comparing used fuel to covered distance

Data/Parameter # 10.3.4.4	**Fuel consumption on 100 km by fuel and vehicle types**
Data unit:	l/ 100 km
Description:	Primary data.
Source of data used:	Provided to the SEAP by Economic Development and Property Ruling departments of the Bolnisi municipality
Value applied:	Gasoline 10 l Diesel 10 l
Any comments	Responsible for this data is Economic Development and Property Ruling departments of the Bolnisi municipality. May be verified with passport data of transport type.

Data/Parameter # 10.3.4.5	**Annual fuel consumption of all auto park by fuel types**
Data unit:	l/yr

	m^3/yr
Description:	Secondary data. Calculated by the Monitoring Group. On this stage, calculated by Remissia.
Source of data used:	Computed by MUNI-EIPMP. 10.3.4.5=10.3.4.1.*10.3.4.2.*10.3.4.4./100
Value applied:	2014: 34 432 l (gasoline) 2 152 l (diesel)
Any comments	Must be verified by cost of used fuel

Commercial transport (taxi)

Data/Parameter # 10.3.5.1	**Amount of taxis in Bolnisi Municipality by fuel types**
Data unit:	Amount of taxis by fuel types
Description:	Primary data
Source of data used:	Provided to the SEAP by Economic Development and Property Ruling departments of the Bolnisi municipality based on surveys and expert rate
Value applied:	70 in total and all of them work on Gasoline
Any comments	This amount of taxis is doubtable because private taxis were most common transport of the municipality in 2014. Economic Development and Property Ruling departments of the Bolnisi City Court are responsible for primary verification of these data. This number must be verified during the monitoring process.

Data/Parameter # 10.3.5.2	**Average distance covered by single taxi annually by fuel types**
Data unit:	Km/yr
Description:	Primary data
Source of data used:	Provided to the SEAP by Economic Development and Property Ruling departments of the Bolnisi municipality based on surveys and expert rate
Value applied:	20 075 km
Any comments	Getting this data from Revenue Service and Taxi Union is possible for officially registered taxis, but there are no any officially registered taxi companies in Bolnisi Municipality. On this stage, taxi drivers' survey would be the most effective.

Data/Parameter # 10.3.5.3	**Average distance covered by all taxis annually by fuel types**

Data unit:	Trans.Km/yr
Description:	Calculated data
Source of data used:	Calculated by the MUNI-EIPMP. Data # 10.3.5.1 and 10.3.5.2
Value applied:	1 405 250 km/yr
Any comments	On this stage, it is calculated by Remissia. Will be calculated by the monitoring group in the future.

Data/Parameter # 10.3.5.4	**Fuel consumption by transport types**
Data unit:	l/100 km m^3/100 km
Description:	Primary data
Source of data used:	Provided to SEAP by SEAP group of local government of Bolnisi
Value applied:	Gasoline – 10 l/100 km
Any comments	Technical passport could be used for verifying but most of the taxis are secondary and their real consumption is different from technical passport data.

Data/Parameter # 10.3.5.5	**Fuel consumption by taxis annually by fuel types**
Data unit:	l/ km m^3/ yr
Description:	Secondary data
Source of data used:	Calculated by the MUNI-EIPMP. Data # 10.3.5.5 = 10.3.5.1. *10.3.5.2. * 10.3.5.4/100
Value applied:	2014 yr – 140 525l (Gasoline)
Any comments	On this stage, it is calculated by Remissia. Will be calculated by the monitoring group in the future

Data/Parameter # 10.3.5.6	**Amount of passengers ferried by all taxis annually**
Data unit:	passenger/ yr
Description:	Secondary parameter
Source of data used:	Monitoring group is responsible for calculation
Value applied:	Has not been rated
Any comments	

Data/Parameter # 10.3.5.7	**Load factor of taxis with passengers**
Data unit:	Passenger.km/trans.km
Description:	This parameter must be rated with different surveys and statistical methods
Source of data used:	Has not been rated for the Bolnisi Municipality SEAP but the same factor has been used as for motor cars.
Value applied:	1.85

Any comments	This parameter is used only for rating GHG emissions reduced by taken measures in sector. GHG emissions from transport sector are not dependent on it.

Commercial vehicles: light-duty trucks (down to 2 tons capacity)

Data/Parameter # 10.3.6.1	**Light-duty trucks driving inside Bolnisi Municipality by fuel types**
Data unit:	Number of light-duty trucks by fuel type
Description:	Primary data
Source of data used:	Provided to SEAP by SEAP group of Bolnisi Municipality Local Government. Service Agency of MIA of Georgia and private carrier companies are also used as a source.
Value applied:	430 (total) Gasoline- 30; Diesel- 400; NG- 0.
Any comments	Responsible for the initial verification of these data is the City Hall Monitoring Group.

Data/Parameter # 10.3.6.2	**Average distance traveled by one light-duty truck a year (by fuel type is recommended)**
Data unit:	km/yr
Description:	Primary data
Source of data used:	Provided for the SEAP by SEAP group of Bolnisi Municipality Local Government. Information is received from the surveys of private companies and drivers.
Value applied:	7 300 km
Any comments	Responsible for the initial verification of these data is the City Hall Monitoring Group.

Data/Parameter # 10.3.5.3	**Average distance traveled by light-duty truck a year (by fuel type is recommended)**
Data unit:	Trans. km/yr
Description:	Secondary data.
Source of data used:	Computed with MUNI-EIPMP by "Remissia". Data # 10.3.6.1 and 10.3.6.2
Value applied:	3 139 000 km in total

	219 000 km (gasoline) 2 920 000 km (diesel)

Data/Parameter # 10.3.6.4	**Fuel consumption by light-duty trucks according to vehicle types**
Data unit:	l/ 100 km m^3/ 100 km
Description:	Primary data
Source of data used:	Provided for the SEAP by SEAP group of Bolnisi Municipality Local Government. Information is received from the survey of private companies.
Value applied:	Gasoline- 151 Diesel- 121
Any comments	This data should be verified with vehicle technical passport and in case of significant discrepancy must be explained.

Data/Parameter # 10.3.6.5	**Annual fuel consumption by vehicle and fuel types**
Data unit:	l/ yr m^3/yr
Description:	Secondary data.
Source of data used:	Computed with MUNI-EIPMP by "Remissia" 10.3.6.5=10.3.6.1*10.3.6.2*10.3.6.4/100
Value applied:	2014: 32 850 l gasoline 350 400 l diesel
Any comments	Number of light-duty trucks powered by different types of fuel multiplied by fuel consumption per 100 km, multiplied by annual run of the track and divided by 100.

Data/Parameter # 10.3.6.6	**Light-duty trucks load factor**
Data unit:	Ton. Km/trans.km
Description:	This parameter should be evaluated by statistical methods and surveys.
Source of data used:	While developing the Bolnisi Municipality SEAP this parameter was not assessed.
Value applied:	Not estimated.
Any comments	Essential in calculations of measures taken

Data/Parameter # 10.3.6.7	**Transported freight by all light-duty trucks in a year (annual freight turnover)**
Data unit:	Ton. km/yr
Description:	Secondary data.
Source of data used:	Computed with MUNI-EIPMP by "Remissia".
Value applied:	Not assessed.
Any comments	Number of light-duty trucks (<2 ton capacity) multiplied by their annual run, multiplied by transported freight per one vehicle (ton).This parameter can by verified through freight actually transported and the relevant run by vehicles.

Commercial transport (Heavy-Duty Trucks up to 2 ton capacity)

Data/Parameter # 10.3.7.1	**Number of heavy duty trucks operating in Bolnisi Municipality**
Data unit:	Number of heavy-duty trucks by fuel type
Description:	Primary data.
Source of data used:	Provided to SEAP by SEAP group of Bolnisi Municipality Local Government; Service Agency of MIA of Georgia
Value applied:	2014: 380 (total) 380 (diesel)
Any comments	Primary verification of these data will be the responsibility of the Infrastructure Department of the City Hall and the Monitoring Group.

Data/Parameter # 10.3.7.2	**Average distance covered by one heavy-duty truck a year (by fuel type is recommended)**
Data unit:	Km/yr
Description:	Primary data.
Source of data used:	Provided to the SEAP SEAP group of Bolnisi Municipality Local Government and by independent local expert on the basis of questioning among private companies and expert judgement.
Value applied:	18 250 km/yr
Any comments	Primary verification of these data will be a responsibility of the City Hall Monitoring Group.

Data/Parameter # 10.3.7.3	**Average distance covered by all heavy-duty truck a year (by fuel type is recommended)**
Data unit:	Trans. km/yr
Description:	Calculated data.
Source of data used:	Computed with MUNI-EIPMP by "Remissia". Data # 10.3.7.1 and 10.3.7.2

Value applied:	6 935 000 km (diesel)

Data/Parameter # 10.3.7.4	**Fuel consumption by vehicle type**
Data unit:	l/ 100 km m^3/ 100 km
Description:	Primary data.
Source of data used:	Technical passport of the vehicle. Provided to the SEAP SEAP group of Bolnisi Municipality Local Government. Source – survey of private companies
Value applied:	Diesel- 35 l

Data/Parameter # 10.3.7.5	**Annual fuel consumption according to vehicle and fuel types**
Data unit:	l/yr
Description:	Secondary data.
Source of data used:	Computed with MUNI-EIPMP by "Remissia".
Value applied:	2014: 2 427 250 l diesel

Data/Parameter # 10.3.7.6	**Heavy-duty trucks load factor**
Data unit:	Ton. Km/car. km
Description:	Primary data.
Source of data used:	While developing the Bolnisi Municipality SEAP this parameter was not assessed
Value applied:	Not estimated
Any comments	Required to assess emissions saving from measures implemented during the monitoring period.

Data/Parameter # 10.3.7.7	**Transported freight by all heavy-duty trucks in a year (annual freight turnover)**
Data unit:	Ton. km/yr
Description:	Secondary data.
Source of data used:	Computed with MUNI-EIPMP by "Remissia"
Value applied:	Not assessed
Any comments	These parameters could be verified via actual annually transported freight and relevant total run of trucks.

Data/Parameter # 10.3.7.8	**Total amount of fuel consumed in Bolnisi Municipality Transport sector by fuel types**
Data unit:	l/yr (Mwh) m^3/yr (Mwh)
Description:	Secondary data calculated during the monitoring and SEAP development process
Source of data used:	Calculated by the SEAP tean ("Remissia") using emissions growth index derived by the EU Research Center.
Value applied:	Consumed through 2014 under the SEAP: 107 376 MWh equivalent fuel, corresponding to 27 536 tCO_2eq emission. In 2020 the emission of 37 449 tCO_2eq is projected.
Any comments	This is one of the most important data for balance verification during the monitoring process.

Monitoring on planned measures in Bolnisi Municipality Transport sector

Measure #PT1	**Improvement of Bolnisi public transport (buses)**
Implementation date	**2015**
Description	2 old small Bogdan buses were replaced with 3 new Bigdan buses in 2015. 21 seats and 15 standing places were in old buses. In new buses – 22 seats and 30 standing places. Old runs worked from 8 AM to 7 PM. New – from 8 AM to 9 PM. Distance to cover on each side is 20 km and each bus covers 250 km per day. New buses use 25 l diesel per 100 km and old buses used less (approximately 23 l). In total buses carry 800 passengers per day. Old buses carried approximately 500 passengers.
Indicators that must be monitored	• Number of passengers carried per day • Average distance covered by passengers per day • Fuel consumption by buses per 100 km
Amount of reduced emissions reached in the period of monitoring	Even though the number of buses has increased and new buses use more diesel per 100 km than the old ones, this measure has led to reduced emissions. The reason for that is increased number of passengers (300 per day; 109 500 per year). According to the local government, these passengers used taxis and private cars previously. Single passenger covers 5-8 bus stops per one run that is around 2.5-4 km. The distance between bus stops is 0.5 km (19 bus stops on 10 km). Quite conservative approach has been made that single passengers covers 6 bus stops per day (3 km) that is equal to 328 500 km for 109 500 passengers. To carry 109 500 passengers by taxi/car

	59 189 cars would be needed (distance of each one is 3 km). These cars would cover 177 567 km and would consume 71 757 l Gasoline (this approach is also conservative because about 25% of cars run on Diesel) in total. So, as a result of this measure, 41 t CO_2 will be saved.
Any comments	41 t is 0.1% of presumable total emissions from transport sector for 2020
Responsible structure	LTD Bolnisi Municipal Transport Department

Measure #PT2	**Setting new runs of municipal microbuses in Bolnisi**
Implementation date	**2015-2016**
Description	4 new microbus runs were set by LTD Bolnisi Municipal Transport Department of Bolnisi Municipality local government in 2015-2016. Sets: 1. **Bolnisi – Kazreti:** runs twice per day each of them (to and fro) about 40 km that means 80 km in total per day. 5 days per week. 120 passengers are carried per day and 1 passenger covers 20 km per day that means 5 120 km per year. This run was set in 2015. 30 720 passengers are being carried per year and 16 605 private cars (load factor 1.85) is needed for it. This amount of cars will cover 332 100 km per year and will consume 33 210 l Gasoline with emission of 76.29 t CO_2. Microbuses consume 2 458 l Diesel for carrying the same number of passengers with emission of 6.81 t CO_2. So, annual emission saving is 69.48 t CO_2. 2. **Bolnisi – Pharezi:** runs twice per day each of them (to and fro) about 40 km that means 80 km in total per day. 5 days per week. 70 passengers are carried per day and 1 passenger covers 20 km per day that means 5 120 km per year. This run was set in 2015. 17 920 passengers are being carried per year and 9 686 private cars (load factor 1.85) is needed for it. This amount of cars will cover 193 720 km per year and will consume 19 372 l Gasoline with emission of 44.5 t CO_2. Microbuses consume 2 458 l Diesel for carrying the same number of passengers with emission of 6.81 t CO_2. So, annual emission saving is 37.69 t CO_2. 3. **Bolnisi – Darbazi:** runs twice per day each of them (to and fro) about 50 km that means 100 km in total per day. 5 days per week. 80 passengers are carried per day and 1 passenger covers 25 km per day that means 6 400 km per year. This run was set in 2015. 20

	480 passengers are being carried per year and 11 070 private cars (load factor 1.85) is needed for it. This amount of cars will cover 276 750 km per year and will consume 27 675 l Gasoline with emission of 63.58 t CO_2. Microbuses consume 3 072 l Diesel for carrying the same number of passengers with emission of 8.511 t CO_2. So, annual emission saving is 55.07 t CO_2. 4. **Bolnisi – Akaurta:** runs twice per day (carries parish on weekends) each of them (to and fro) about 60 km.120 passengers are carried per day and 1 passenger covers 30 km per day that means 3 120 km per year. This run was set in 2016. 10 400 passengers are being carried per year and 5 622 private cars (load factor 1.85) is needed for it. This amount of cars will cover 168 620 km per year and will consume 16 866 l Gasoline with emission of 38.75 t CO_2. Microbuses consume 748 l Diesel for carrying the same number of passengers with emission of 2.071 t CO_2. So, annual emission saving is 36.68 t CO_2.
Indicators that must be monitored	• Total number of passengers carried by these 4 microbuses (must be checked by the numbers of sold tickets) • Distance covered by microbuses per day (year) • Fuel consumption by microbuses per 100 km
Amount of reduced emissions reached in the period of monitoring	Bolnisi – Kazreti annual savings : 69.48 t CO_2 Bolnisi – Pharezi annual savings : 37.69 t CO_2 Bolnisi – Darbazi annual savings : 55.07 t CO_2 Bolnisi – Akaurta annual savings : 36.68 t CO_2 Total savings: 198.92 t CO_2
Any comments	
Responsible structure	LTD Municipal Economy of the Bolnisi Municipality

Measure #UP1	**Road reconstruction**
Implementation date	**2016-2025**
Description	Total length of Bolnisi Municipality road infrastructure is 287.1 km 140.8 of which is main road and 146.3 km – interior regional (asphalted – 77.1 km, soiled – 210 km). Through the last years there has been an important

	progress in infrastructural development and asphalting roads. In the last 3 years, on the territory of the municipality, has been 35 km of road has been asphalted by Infrastructural development, Spatial arranging, architecture and Building department. Total amount of emission from all types of Bolnisi Municipality transport sector is presumably 37 449 t CO_2 for 2020. Already asphalted 77.1 km road is 1/3 of the whole transport infrastructure but mainly these are central roads. So we can say that 50% of total annual covered distance of all types of transport and appropriate emission comes to this 1/3 part of infrastructure. The rest (18 725 t CO_2) comes exactly on those rehabilitative roads. Municipality plans to renew whole infrastructure for 2020-2025. According to appropriate researches it will save at least 6% from this 50% of emission. This approach is quite conservative because asphalted road must be replaced with concrete road and in case of Bolnisi the situation is even worse and graveled road must be replaced with asphalted road. As Bolnisi Municipality is mostly industrial region heavy trucks move on graveled roads and that surely reduces effectiveness of fuel consumption. As a result of this measure 1 124 t emission will be saved (18 725*0.06)
Indicators that must be monitored	• Total length of asphalted roads • Reduction of GHG emission from all types of transport • Consumed fuel by single car (by types) per 100 km
Amount of reduced emissions reached in the period of monitoring	As a result of this measure 1 124 t emission will be saved (18 725*0.06) in 2020.
Any comments	According to different sources this measure is not exact because emission flows even during road construction and reconstruction process. But it must be said that in a long-term perspective emission reduction effect will be higher on loaded roads than emission during road construction and reconstruction. Heavy truck that works for industrial objects covers 4.5 times bigger distance than small car. Even though their quantity is much less, it has tendency of growing (2012-265; 2013-300; 2014-380).
Responsible structure	LTD Municipal Economy of the Bolnisi Municipality

Measure #UP2	**Transport stream management in Bolnisi Municipality**
Implementation date	**2017-2025**
Description	This measure consists of following measures:

	• Description and organizing of road signs and traffic lights. Installation of 3 traffic lights is planned on the most loaded street of Bolnisi in 2016 • Studying problematical streets and finding alternative routes. Organizing new roads. Existing roads must be reviewed and changed so that it could lead to reducing traffics. For example, some streets will re-work to one-sided streets and transport will move reconverted on the parallel street. • Building of a new streets and bridges which will reduce the distance.
Indicators that must be monitored	• Tendency of street traffic changes (increase – decrease?) • Amount and duration of heavy traffics and reduction. • Fuel used by single car for covering the same distance on traffic and non-traffic time,
Amount of reduced emissions reached in the period of monitoring	At this stage, for this measure emission reduction has not been counted because final plan is not known yet and in more long-term perspective after 2020 it will be realized. Revision of this measure and calculation of emission will take place in renewed action plan until 2030.
Any comments	Realization of GHG emissions reduction potential that is connected with road motion management (as well as an improvement of road infrastructure) is hard process with barriers. Reducing traffic will cause reducing of GHG emissions from private cars by their more effective motion. But it does not always reduce emissions because it makes moving by cars more attractive when streets are not overloaded that increases emissions. As a result, this measures and emission reduction connected with them can be discussed as a part of a large-scale transport strategy with documents mentioned with this measure.
Responsible structure	Infrastructural Development, Spatial Arrangement, architecture and building departments of Bolnisi Municipality Local Government.

Measure #PRT1	**Parking in Bolnisi City**
Implementation date	**2018-2025**
Description	On this stage, parking politic of Bolnisi municipality is planning. The main purpose (especially of the central districts) is to unload it from cars. Most of the parking lots will be located in the central streets, where are more cars. On the first stage, parking is discussing only in territory of Bolnisi City. According to the population, there are 3 500 private cars in the city. They

	cover 16 607 500 km in total and consume 1 660 750 l Gasoline, which produces 3 815 t CO_2 GHG emission. Based on the literature about measures for reducing emissions in Transport Sector, we can say that every single car reduces distance by 7-10% where there are parking systems. An approach has been made for Bolnisi that reduction will be 7% and only in case of private cars in the city. In this case 267 t CO_2 will be saved.
Indicators that must be monitored	• Amount of parking lots the distance covered by private cars annually (survey). • Share of restricted parking area in city area • Fuel consumption by single car per 100 km
Amount of reduced emissions reached in the period of monitoring	In total 3 500 cars, emission is 3 815 t CO_2 and it's 7% is 267t CO_2 (Because, this measure restricts car movement by 7-15%)
Any comments	
Responsible structure	Infrastructural Development, Spatial Arrangement, architecture and building departments of Bolnisi Municipality Local Government.

Measure #PRT2	**Helping pedestrians in Bolnisi Municipality**
Implementation date	**2017-2025**
Description	For helping pedestrians Bolnisi Municipality Local Government will continue arrangement of pavements and crossings. The purpose is safer and more comfortable walking (also for valetudinarians). On this stage this is planned for Agmashenebeli str. And Sulkhan-Saba str. That are 10 km in total. Asphalting Atoni str. is also planned this year that will cost 780 000 GEL that has already been found. Constructing paving on Merab Kostava street is also planned and it will cost 392 000 GEL (also found). Rehabilitation of a historical district is also planned to be done by the year 2018. This district probably will be closed for cars. At first for at least several days per week. This territory is 500 meters long.
Indicators that must be monitored	• Increase of pedestrians (surveys before and after the measure) • Average distance covered by a single pedestrian before and after measure (survey and researches)

Amount of reduced emissions reached in the period of monitoring	Emission has not been calculated but the City Hall recognizes that this kind of measures is important for the whole process and sustainable development of the city.
Any comments	Programs for changing public behavior are also needed for successful measure. The difference and advantage between cycling/walking and driving must be explained.
Responsible structure	Infrastructural Development, Spatial Arrangement, architecture and building departments of Bolnisi Municipality Local Government.

10.4 **Buildings sector**

Baseline Emissions Monitoring

Data/Parameter # 10.4.1	**Areas of municipal buildings according to their purpose (kindergartens, administrative, etc.)**
Data unit:	m^2
Description:	Primary parameter
Source of data used:	SEAP Development Coordinator of Bolnisi Municipality local government and City Hall Economic Development and Property Ruling Departments.
Value applied:	Total- 77 357 Kindergartens- 14 293 Municipal administrative buildings- 4 166 Other municipal buildings- 58 898
Any comments	Information possessed by the City Hall.

Data/Parameter # 10.4.2	**Annual consumption of electric energy by municipal buildings**
Data unit:	MWh/yr
Description:	Primary parameter.
Source of data used:	The Bolnisi Municipality City Hall Finance Department. Final accuracy of data is under the responsibility of Bolnisi Municipality SEAP Coordinator.
Value applied:	Total- 219 Kindergartens- 73.1 Other municipal buildings- 145.8
Any comments	These data should be revised at the Energo-Pro distribution company and by energy audit assessments.

Data/Parameter # 10.4.3	**Areas of the Bolnisi Municipality residential buildings by types (one and two-storey private houses, multi-storey buildings, etc.**
Data unit:	m^2
Description:	Primary parameter.
Source of data used:	Provided to the SEAP Group by the Bolnisi Municipality City Hall Economic Development and Property Ruling Departments. Information on the multi-storey buildings is possessed by the City Hall's Economic Development Department, which implements various types of social projects for these buildings. Data on the number of private houses (mainly one- and two-storey) are owned by the City Hall Architecture/ Urban Development Department. The total area of these buildings was assessed by the local expert.
Value applied:	Total- 2 665 446 Residential buildings- 326 180 Private dwelling houses- 2 339 266
Any comments	

Data/Parameter # 10.4.4	**Annual energy consumption by residential buildings according to their types**
Data unit:	MWh/yr
Description:	Primary parameter.
Source of data used:	"Energo-Pro Georgia". Representative of Bolnisi Municipality City Hall/Coordinator is responsible for the eventual quality of data.
Value applied:	Total- 20 744
Any comments	Acquiring data on energy consumption according to types of the buildings proved to be impossible. This data could be verified by questioning of typical buildings and relying on energy audit estimations. The presented data reflects the 2014 consumption.

Data/Parameter # 10.4.5	**Total area of commercial buildings in Bolnisi Municipality**
Data unit:	m^2
Description:	Primary parameter.
Source of data used:	The SEAP team was provided by Bolnisi Municipality City Hall Coordinator. Large part of commercial areas was counted using the cleaning tax value, mostly determined by the area of commercial buildings, and the remnant areas by estimation at the site.
Value applied:	Total- 533 248 Schools- 524 376

	Other state buildings- no information Other commercial buildings- 8 872
Any comments	

Data/Parameter # 10.4.6	**Annual electricity consumption by commercial buildings**
Data unit:	MWh/yr
Description:	Primary parameter.
Source of data used:	"Energo-Pro Georgia". The Bolnisi Municipality City Hall is responsible for the ultimate quality of data.
Value applied:	Unable to get this information from the "Energo-Pro Georgia"
Any comments	This data could be verified by the questioning of commercial buildings and using the energy audit assessments.

Data/Parameter # 10.4.7	**Annual consumption of natural and liquid (LPG) gas by municipal buildings**
Data unit:	m^3/yr; kg/yr (MWh/yr)
Description:	Primary parameter.
Source of data used:	Bolnisi Municipality City Hall Finance Department. Final quality of data is under the responsibility of Bolnisi Municipality City Hall.
Value applied:	58 268 m^3
Any comments	Could be verified at the gas supply company.

Data/Parameter # 10.4.8	**Annual consumption of natural and liquid (LPG) gas by residential buildings**
Data unit:	m^3/yr; kg/yr (MWh/yr)
Description:	Primary parameter.
Source of data used:	Gas distribution company Socar that serves Bolnisi Municipality. Eventual quality of data is under the responsibility of Bolnisi Municipality City Hall.
Value applied:	Natural Gas – 4 321 541 m^3

Data/Parameter # 10.4.9	**Annual consumption of natural gas by commercial buildings**
Data unit:	m^3/yr; (MWh/yr)
Description:	Primary parameter (annual).
Source of data used:	Gas distribution company Socar that serves Bolnisi Municipality. Eventual quality of data is under the responsibility of Bolnisi Municipality City Hall.
Value applied:	Natural gas- 98 586 m^3
Any comments	This data could be verified by the questioning of commercial buildings and energy audit assessments. This data is not exact and needs to be recalculated.

Data/Parameter # 10.4.10	**Annual consumption of liquid gas (LPG) and diesel by municipal buildings**
Data unit:	M^3; l (MWh/yr)
Description:	Primary parameter.
Source of data used:	Information obtained from the Bolnisi Municipality Local Government
Value applied:	Not applied.

Data/Parameter # 10.4.11	**Annual consumption of firewood in municipal buildings**
Data unit:	m^3
Description:	Primary parameter.
Source of data used:	Financial Department of the Bolnisi Municipality Local Government
Value applied:	Total firewood- 222 m^3/yr. This number is delivered from the Bolnisi Municipality Local Government.
Any comments	

Data/Parameter # 10.4.12	**Annual consumption of firewood in residential buildings**
Data unit:	m^3
Description:	Primary parameter.
Source of data used:	Given vouchers to the population. Eventual quality of data is under the responsibility of Bolnisi Municipality City Hall
Value applied:	Total firewood- 14 234 m^3/yr. This number is delivered from the Bolnisi Municipality Local Government. Rated by SEAP group – 68 425 m^3/yr
Any comments	Level of firewood consumption in Bolnisi Municipality is very high. This consumption is calculated by SEAP group only in the schools where there is no Natural Gas and only firewood is being used. Calculated by the amount of firewood consumer families and consumed firewood by single family (7 m^3).

Data/Parameter # 10.4.13	**Annual consumption of firewood in other buildings**
Data unit:	m^3
Description:	Primary parameter.
Source of data used:	Bolnisi Municipality Local Government.
Value applied:	Total firewood- 665 m^3/yr. This number is delivered from the Bolnisi Municipality Local Government.
Any comments	In this category the most part of this consumption comes from Schools.

Data/Parameter # 10.4.14	**Annual consumption of liquid gas and diesel by commercial buildings**
Data unit:	M^3 (MWh/yr)
Description:	Primary parameter (annual).
Source of data used:	Questioning of commercial buildings. Bolnisi Municipality Local Government and Energo-Pro are responsible for the final quality of data.
Value applied:	At present stage diesel and firewood are not used in commercial buildings, although monitoring is necessary.
Any comments	This data could be verified by the questioning in commercial buildings.

Data/Parameter # 10.4.15	**Annual monitoring of CO_2 emission from all three sub sectors (municipal, residential and commercial)**
Data unit:	tCO_2/yr
Description:	Secondary parameter (annual).
Source of data used:	Calculated by the Monitoring Group.
Value applied:	2014 baseline year- 99 088 2020 year- 112 939 (projected).
Any comments	

Monitoring of planned activities in the Bolnisi Municipality building sector

Activity #MB2.1; MB 2.2; RB 1.1	**Replacing old lamps with new energy effective lamps**
Planned implementation (dates)	**2016-2020**
Description of activity:	The aim of an activity was installation of energy effective lighting system in the Municipality buildings (170 lamps), in 12 kindergartens (16 in each) and installation of 1185 lightings in entrances of many-stored residential buildings.
Indicators to be monitored	• Amount of replaced lamps, capacities of old and new lamps • Electricity consumption of building/system before and after replacing of lamps • Annual working duration (in hours) before and after replacing • Ensuring of lighting standard - satisfactory
Amount of reduced emission, achieved during the monitoring period	48 t CO_2 will be saved annually in total
Any comments	
Implementing body	Bolnisi kindergarden agency

Activity #MB3.1	**Using sun collectors in kindergartens**

Planned implementation (dates)	**2017-2020**
Description of activity:	Aim of this measure is to use sun collectors for delivering hot water in municipal buildings like kindergartens and schools. Nowadays, 4 000 l of hot water is being spent in these buildings every day that is equal to 24 907 KWh electricity. Sun collector in the Bolnisi Municipality produces 1 050 KWh/m^2 per year. In case of using vacuum sun collectors that are installed on the roof, 25 200 KWh energy could be produced on 24 m^2 per year. Area of standard sun collector is 2 m^2 and costs 1 300 GEL. In case of Bolnisi 12 collectors will be needed that will cost 15 600 GEL.
Indicators to be monitored	• Areas of installed sun collectors (m^2) • Consumed thermal energy (measured) • Amount of consumed hot water (l) and its temperature (measured)
Amount of reduced emission, achieved during the monitoring period	For gaining this energy (25 200 KWh/yr) 25 200/(9.4x0.9)=2 978 m^3 natural gas is needed that is equal to 2 978x0.82=2 442 GEL. In case of replacing natural gas with solar energy, reduction of CO_2 emissions will be 25 200x0.202/1000=5.1 t CO_2 per year
Any comments	
Implementing body	Bolnisi kindergarten agency

Activity #RB4.1	**Replacing unsustainably produced biomass (firewood) with natural gas in residential buildings**
Planned implementation (dates)	**2018-2020**
Description of activity:	Firewood consumption in residential sector of Bolnisi Municipality is about 70% of whole energy consumption. This happens because of illegal wood cutting and has serious results effect on green area. That is why one of the most important measures is replacement of firewood with natural gas. Municipality is interested in this measure to begin using more energy effective technologies. So an approach has been made for 2018-2020 that 50% of those families who use firewood nowadays will use natural gas. Nowadays residential sector consumes 68 425 m^3 firewood annually that equals to 142 529 275 KWh of electricity. As this firewood is received from non-sustainable (but illegal) cuttings it is treated as an emission source and emission from firewood is 142 529 MWh*0.42=59 862 t CO^2. 142 529 275 KWh/9.4=15 162 689 m^3 firewood and 142 529 MWh*0.202=28 791 m^3 natural gas would be needed for the same energy.
Indicators to be monitored	• Amount of families that replaced firewood with natural gas • Average heated area in a single family and energy consumption during firewood consumption (base scenario, rated with the amount of consumed firewood in m^3) • Average heated area in a single family and energy consumption during natural gas consumption (measured) • Total natural gas consumption by residential sector

Amount of reduced emission, achieved during the monitoring period	As a result of this activity 31 077 t CO_2 will be saved annually for 2020
Any comments	
Implementing body	Bolnisi population and local government

Activity #MB4.1; RB 2.1; RB 2.3	**Activities mainly implicate window covering, reduction of infiltration from windows and entrance covering**
Planned implementation (dates)	**2016-2020**
Description of activity:	One activity is planned for a kindergarten on St. Nino N38 that will lead to save 18 306 KWh/yr energy during heating season. The second activity implicates covering common areas in the entrances of residential buildings. It means installing windows on each floor of an each floor of the entrance. According to this activity 1.5 m^2 metallic-plastic window will be needed on every 1 185 stairs cell that means 1 185*1.5=1 778 m^2. Specific meaning of thermal savings from total area of entrances of residential buildings is about 2 000 KWh/yr on a cell of each floor and total saving will be 2 370 MWh/yr. The third activity implicates reduction of infiltration of windows from residential buildings. Because of draught of flows room chills soon and too much energy is needed for its heating. Cold air stream goes in in the room from door and window holes and warm air goes out. Because of it, ensuring impermeability of doors and windows is needed that gives an opportunity of saving about 25-30% of energy needed for room warming. Using quite simple and cheap methods for covering holes in doors and windows and reducing air motion is possible: closing up existing holes with silicone, glue tape or putty. Attaching glue tape and special transparent plastic material on both sides of window-glass and installing paralone, peno-polyurethane foam or rubber condensate on the surface of window frame are also possible. As a result of these measures 2 545 MWh thermal energy will be saved annually on average from all multi-stored buildings.
Indicators to be monitored	• Total area of covered windows; • Total area of new windows; • Energy consumption reduction on covered area (window) unit and area of new window unit; • Must me rated or chosen these sizes rated in other countries; • Natural gas (other fuel) consumption after activities •
Amount of reduced emission, achieved during the monitoring period	As a result of this activity 31 077 t CO_2 will be saved annually for 2020
Any comments	

Implementing body	Bolnisi population and local government

10.5 Street Lighting Sector

Data/Parameter # 10.5.1	**Annual amount of electricity consumed for street lighting**
Data unit:	KWh/yr
Description:	Primary data
Source of data used:	Bolnisi Municipality local government Infrastructure Development, Spatial Arrangement, Architecture and building Department and Ltd "Deve Plus", which is responsible for the delivery of monthly/annual data on the amount of electric energy, consumed for street lighting.
Value applied in SEAP:	1 396 940 KWh (in 2014) 1 995 817 KWh (projection for 2020)
Any comments	This data should be verified by the paid expenses. The projection for 2020 is calculated by the SEAP developing group.

Data/Parameter # 10.5.2	**Carbon dioxide emission from street lighting sector**
Data unit:	tCO_2/yr
Description:	Secondary data
Source of data used:	Calculated by the Monitoring Group
Value applied:	145.28 tCO_2eq (2014) 207.6tCO_2eq (projection for 2020)

Data/Parameter # 10.5.3	**Amount of street lamps in Bolnisi Municipality**
Data unit:	Quantity
Description:	Primary data
Source of data used:	Ltd "Deve Plus", which is responsible for the registration and delivery of monthly/annual data on the amount of street lamps.
Value applied:	2 253 (in 2014) 3 219 (projection for 2020)
Any comments	On this stage there is incandescent lighting in Bolnisi Municipality.

Data/Parameter # 10.5.4	**Duration of lamp/street lighting or evaluable system**
Data unit:	H/day or h/yr

Description:	Primary data
Source of data used:	LTD Ketilmotskobis Samsaxuri of Bolnisi Municipality
Value applied:	10.5 h/day 3 832.5 h/yr
Any comments	Street lighting in Bolnisi Municipality mainly consists of street lamps.

Data/Parameter # 10.5.5	**Grid effectiveness in the Bolnisi Municipality**
Data unit:	KWh/yr consumed averagely by one lamp
Description:	Secondary data
Source of data used:	Calculated by Remissia
Value applied:	In 2014 – 621 KWh/yr (one lamp consumes 162 W per hour) 2020 – 583 (as a result of the activity one lamp will consume 152 W per hour)
Any comments	

Monitoring on planned measures in Bolnisi Municipality street lighting sector

Activity S1	**Replacing blaze lamps with energy effective LEDS lamps**
Planned implementation (dates)	2016-2020
Description of activity:	The activity will begin in 2016 and existing 2 253 non-energy effective lamps will be replaced with energy effective LED lamps from 2016 until 2020. Replacing old lamps with new lamps is planned in 2016: 1) Atoni str.- 1 015 m 2) M.Kostava str – 310 m 3) St. Nino str. – 450 m 4) L.Asatiani str. – 530 m Besides, rehabilitation of sewerage system for interior streets of the city will be finished until 2018. The length in total is 18 km. Asphalting these streets and replacing old lamps with new energy effective LED ones is also planned until 2020. One LED lamp will be installed on every 52 meters. 20.31 km distance will be covered with these lamps. Also an approach has been made that new roads (50 km. in total) will be lightened with energy effective lamps. Number of needed lamps in grid is 3 129 in total.
Indicators to be monitored	• Amount of lighting points by types • Annual time of lighting (h/yr) • Average usage of a single lamp
Amount of reduced emission, achieved during the monitoring period	Reducing CO_2 emissions by 158 t in 2020

Any comments	
Implementing body	LTD Deve Plus of the Bolnisi Municipality.

10.6 Greening

Baseline Emissions Monitoring

Data/Parameter # 10.6.1	**Total planted area in the Bolnisi Municipality(2014)**
Data unit:	ha Number of plantings by species
Description:	Primary parameter
Source of data used:	Bolnisi Municipality City Hall Infrastructure Department and NELP Bolnisi Municipality Greening Service
Value applied:	1 590 ha are covered by plants within the limits of the მუნიციპალიტყ 50 ha are joint canopy plants occupying city suburbs. 1 540 ha are covered by fragmentary plantings.
Any comments	Does not contain agricultural plants

Data/Parameter # 10.6.2	**Annual removal of carbon dioxide from the Bolnisi Municipality territory under the baseline conditions of 2014 greening**
Data unit:	tCO_2/yr
Description:	Secondary parameter
Source of data used:	Calculated through the SEAP development process
Value applied:	Annual removal- 616 tCO_2/yr. Amount of sequestered carbon in 2014 at the whole territory of 458 ha equals to 7 992 tC.
Any comments	Among them: cemeteries- 35 ha, recreation zones- 2.2 ha, other territories including population orchards- 173 ha and outskirts slopes of the city- 248 ha.

Data/Parameter # 10.6.3	**Annual cutting/ trimming of trees by species**
Data unit:	m^3
Description:	Primary parameter
Source of data used:	NELP Bolnisi Municipality Greening Office
Value applied:	Trees are being trimmed every year Approximate reduction of biomass as aresult of trimming – 10 m^3
Any comments	Trimmings should be considered in the monitoring process.

Data/Parameter # 10.6.4	**Annual fires or other causes of damage to trees**
Data unit:	m^3
Description:	Primary parameter
Source of data used:	NELP Bolnisi Municipality Greening Office
Value applied:	Fires should be considered in the monitoring process.

Data/Parameter # 10.6.5	**Annual monitoring of CO_2 removal changes**
Data unit:	tCO_2/yr
Description:	Secondary parameter. Calculated by the Monitoring Group
Source of data used:	At this stage calculated by the SEAP developing group
Value applied:	Resulting from different measures taken by 2020 at the territory of Bolnisi Municipality 35 543 tC will be sequestered.

Monitoring of carbon sequestration increase resulting from the adoption of measures

Activity #G1	**Planting 1000 trees on 0.4 ha**
Planned implementation (dates)	2015
Description of activity:	Planting 1000 trees in total on 0.4 ha in Bolnisi. Planted arboretum 850 trees 5-6 years old pine-trees and 150 trees 3-4 years old paulownia. 70% of planted trees are flourished.
Indicators, according to which the monitoring should be performed	• Number of planted species according to areas; • Coverage of territory with canopy/crown; • Application of fertilizers; • Cuttings and wildfires.
Amount of reduced emissions, got through the monitoring period	Area covered with new plantings will remove annually 22.7 t of carbon dioxide by 2020 and sequesters 6.2 t of carbon.
Comments	The cost of project implementation makes 2 152 USD
Implementing body/unit	LTD Communal Farming of Bolnisi Municipality and NELP Bolnisi Municipality Greening Office
Activity #G2	Greening of 5 ha area in total in Bolnisi suburbs
Planned implementation (dates)	2016-2020
Description of activity:	Greening 5 ha area in total is planned in Bolnisi Municipality suburbs. During projecting of greening it is recommended to plant such kind of plants which are suitable for forest landscape. At least 3 500 plants (including bushes) will be planted on 1 ha. As a result we will get the reservoir with the best accumulation

	of carbon where soil will be a part of this accumulation that will lead to valuable forest ecosystem. Several types of arboretum plants have been selected for planting. From leafy plants: maple, Georgian oak, smoke tree and paulownia. Georgian oak is not famous for a big potential of absorption but in local conditions it grows fast and effectively. From pines pine-tree was selected.
Indicators, according to which the monitoring should be performed	• Number of planted species according to areas; • Area covered by new plantings; • Planted tree species according to age; • Coverage of territory with canopy/crown; • Application of fertilizers; • Cuttings and wildfires.
Amount of reduced emissions, got through the monitoring period	Area covered with new plantings will remove annually 123.2 t of carbon dioxide by 2020 and sequester 33.6 t of carbon.
Comments	The cost of project implementation equals to 7 222 USD
Implementing body/unit	LTD Communal Farming of Bolnisi Municipality and NELP Bolnisi Municipality Greening Office

10.7 Waste

Baseline Emissions Monitoring

Data/Parameter # 10.7.1	**Parameters of Bolnisi Municipality landfill**
Data unit:	Area, ha; Depth, m.
Description:	Primary data.
Source of data used:	During the SEAP development process data has been provided by the LTD Communal Farming of Bolnisi Municipality which should remain the main source of information through the monitoring process, as well.
Value applied:	Total area- 5 ha and the depth- less than 12-15 m.
Any comments	The Bolnisi Municipality landfill was opened in 1978.

Data/Parameter # 10.7.2	**Daily amount of waste delivered to the Bolnisi Municipality landfill**
Data unit:	m^3 or ton
Description:	Primary data.
Source of data used:	During the SEAP development process data has been provided by the LTD Communal Farming of Bolnisi Municipality which should remain the main source of information through the monitoring process, as well.

Value applied:	55 m^3 (11 t) of waste is delivered daily from the Bolnisi Municipality itself in 2014.

Data/Parameter # 10.7.3	**Calculation of generated methane**
Data unit:	m^3 or ton
Description:	Secondary data. The amount of methane generated should be computed applying the First Order Decay (FOD) model. The computation is under the responsibility of Monitoring Group.
Source of data used:	2006 IPCC Guidelines for National Greenhouse Gas Inventories, http://www.ipcc-nggip.iges.or.jp/public/2006gl (p. 3.36). This is ready software prepared for the input of necessary parameters.
Value applied:	Parameters necessary for computation: • Waste composition Composition of waste (% by mass): Food products- 41.4%, Textile/leather- 6.2%, Paper/cardboards- 14.9%, hygienic waste- 4.2%, Plastic/Inert material- 33.3%. • 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 Textiles 0.24 Disposable Diapers 0.24 • Actually Dissimilated Component of Organic Carbon (DOC_F) – 0.6 • Methane Content of Landfill Gas (F) – 50% • Oxidation Factor (OX) (Managed landfill) - 0 2014- 3.42 $GgCO_2eq$ 2020- 3.89 $GgCO_2eq$ (projected)
Any comments	As to the emissions from the landfill, their projection to 2020 is based on the assumption that number of population grows annually by 0.5%, and the amount of waste disposed at the landfill- by 2.5% per annum.

Monitoring of emissions reduction, resulting from measures implemented

Activity #W1	**Reduction of paper, plastics and glass content in the waste due to preliminary separation**
Planned implementation (dates)	2017-2020
Description of activity:	In Tbilisi, in the Orkhevi Settlement currently functions the paper processing mill, producing toilet paper. Setting up of paper processing facility in Tbilisi and the regions has facilitated the process of collecting and handing over of secondary paper. The leading position in this process belongs to state agencies (ministries, City Halls, schools, etc.). Consequently the mentioned fraction in overall waste composition is being decreased, causing corresponding reduction in the generation of methane from the landfill. The Bolnisi Municipality authorities plan to separate along with paper the plastics and glass as well. According to experts assessment about 5% of secondary paper and 10% of plastic materials will be separated to 2017, while by 2020 the amount of separated paper could reach 20% and plastic – 40% generated waste. The calculation of emission from the Bolnisi Municipality landfill has been performed taking into consideration the fact that currently the share of paper in the waste makes 14.9 % and of plastics- 33.3 %.
Indicators, according to which the monitoring should be performed	Here only the general indicators are given, the monitoring of which would be necessary to conduct a project of that type. • Annual amount of collected and utilized, or flared at the site methane; • Share of paper in the waste before implementing the project- 14.9%; • Share of plastics in the waste mass before implementing the project- 33.3%; • Share of paper in the waste mass after implementing the project; • Share of plastics in the waste mass after implementing the project; • Share of glass in the waste mass after implementing the project; • Amount of waste generated per capita or total amount of waste produced in the municipality; • Amount of separated and recycled paper, kg; • Amount of separated and recycled plastics, kg; • Amount of separated and recycled glass, kg.
Amount of reduced emissions, got through the monitoring period	According to preliminary assessments the methane emission to 2020 would be reduced by 1.48 tons in CO_2eq (0.8%) that equals to 31.5 t. In case of project implementation during 3 years 52.3 tCO_2eq of methane emission will be saved from the discharge into the atmosphere.
Comments	
Implementing body/unit	This is a planned activity and presumably it will be implemented by the LLC "Ketilmotskoba".

10.8 Agriculture sector

Activity #10.8.1	**Total area of greenhouses in the Bolnisi Municipality**
Data unit	Ha (m^2)
Description of activity:	Primary data
Source	Information center of Ministry of Agriculture in the Bolnisi Municipality
Value applied	2014 – 0.4 ha
Any comments	

Activity #10.8.2	**Energy consumption in greenhouses by fuel types**
Data unit	MWh (t, l, m^3)
Description of activity:	Primary data
Source	Information center of Ministry of Agriculture in the Bolnisi Municipality, farmers
Value applied	2014 – 75 MWh (36 m^3 firewood)
Any comments	Unfortunately, gathering full information but we know that part of the farmers use coal, tire, etc. Natural gas almost is not used because of high costs for farmers.

Activity #10.8.3	**Quantity of animal farms and cattle by types in the Bolnisi Municipality**
Data unit	Quantity, wings
Description of activity:	Primary data
Source	Information center of Ministry of Agriculture in the Bolnisi Municipality, farmers
Value applied	2014: Pig farm ABD GEORGIA – 20 000 pigs Poultry farm Savaneti 167 000 wings of chicken
Any comments	101 300 t CO_2 is produced annually in the pig farm 311 255 t CO_2 is produced annually in the poultry farm

Activity #10.8.4	**Energy consumption by animal and poultry farms by fuel types**
Data unit	MWh
Description of activity:	Primary data
Source	Information center of Ministry of Agriculture in the Bolnisi Municipality, farmers
Value applied	2014: 2 013 MWh in total

Any comments	

Activity #10.8.5	**Food industry (production of dairy products) in the Bolnisi Municipality by types**
Data unit	t
Description of activity:	Primary data
Source	Information center of Ministry of Agriculture in the Bolnisi Municipality
Value applied	2014: 140 t cheese
Any comments	

Activity #1.8.6	**Food industry (milk production) in the Bolnisi Municipality by types**
Data unit	MWh (t, l, m^3)
Description of activity:	Primary data
Source	Information center of Ministry of Agriculture in the Bolnisi Municipality, farmers
Value applied	2014: 20 002 MWh electricity
Any comments	

Activity #10.8.7	**Agriculture technic (by types)**
Data unit	Quantity
Description of activity:	Primary data
Source	Information center of Ministry of Agriculture in the Bolnisi Municipality, farmers
Value applied	2014: Tractor (new) Tractor (old) Combine
Any comments	

Activity #10.8.8	**Total ploughed area by agriculture technic (by technic types)**
Data unit	Ha
Description of activity:	Primary data
Source	Information center of Ministry of Agriculture in the Bolnisi Municipality, farmers
Value applied	2014:

	14 000 ha
Any comments	

Activity #10.8.9	**Fuel consumption on1 ha of ploughed area by agriculture technic (by types)**
Data unit	T, l, m^3
Description of activity:	Primary data
Source	Information center of Ministry of Agriculture in the Bolnisi Municipality, farmers
Value applied	2014: Old tractor – 22 l diesel for plough, 12 diesel for cultivation New tractor - 18 l diesel for plough, 9 diesel for cultivation
Any comments	

Activity #10.8.10	**Total emission from agriculture sector**
Data unit	T CO_2
Description of activity:	Secondary data
Source	Calculated by the SEAP group
Value applied	2014: Unknown 2020: Unknown
Any comments	

Monitoring on emission reduction activities in agriculture

Activity #A1.1; A1.2	**Implementation of energy effective measures in greenhouses**
Planned implementation (dates)	2018-2020
Description of activity:	The measure is for increasing energy effectiveness in 2 greenhouses in the Bolnisi Municipality. Now greenhouses use firewood. Each of them are 0.2 ha (0.4 ha in total) and consumes 18 m^3 firewood. With the help and support of Information center of Ministry of Agriculture in the Bolnisi Municipality, in case of using new energy effective small boiler that works on biomass waste, instead of existing non-energy effective ovens/boilers, they will save at least 50% of firewood and 37.5 MWh energy in total.
Indicators, according to which the monitoring should be performed	Here only the general indicators are given, the monitoring of which would be necessary to conduct a project of that type. • Amount of consumed firewood before and after the measure (m^3) • Greenhouse temperature before and after the measure (t°C) • Amount (kg/t) of crop on 1 ha before and after the measure

Amount of reduced emissions, got through the monitoring period	2020: 16 t CO_2 emission will be saved
Comments	
Implementing body/unit	Farmers with the help and support of Information center of Ministry of Agriculture in the Bolnisi Municipality.

Activity #A2.1; A2.2	**Emission reduction in animal and poultry farms**
Planned implementation (dates)	2018-2025
Description of activity:	One pig and one poultry farm are described in this measure. In this case GHG emission has 2 sources: energy consumption (electricity) and dung produced from farms. So 2 measures are described: • Partial replacement of electricity with solar energy in hot water distribution • Cleaning or using as energy source of Methane. Using Methane for producing electricity and private use and distribution in the grid is described below: Daily amount of 1 pig dung is 4 kg with the humidity of 65% and excrements are 5.1 kg with humidity – 86%. In total: 20 000 pig , excrements – approximately 102 t per day and 37 230 t per year. In case of pigs, biogas ejection is 60 m^3/t that gives 2 233 800 m^3 biogas annually. Share of Methane is about 70% (1 563 660 m^3) this amount is an equivalent of 14 700 MWh energy. Daily amount of 1 chicken dung, as well as of excrements, is 0.16 kg with the humidity of 75% In total: 167 000 chicken, excrements – approximately 27 t per day and 9 753 t per year. In case of chicken, biogas ejection is 55 m^3/t that gives 536 415 m^3 biogas annually. Share of Methane is about 70% (357 491 m^3) this amount is an equivalent of 3 530 MWh energy. This gas should be used as energy source directly or receipted electric energy from it. If electric energy will be receipted from gas, for sure, of generator will considerably reduce the amount of energy, but in case of 60% effectiveness, the amount of receipted electric energy in pig farms will be 8 820 MWh, in poultry farms- 2 118 MWh. In both cases this energy is more than el. energy consumed by manufactures.
Indicators, according to which the monitoring should be performed	Here only the general indicators are given, the monitoring of which would be necessary to conduct a project of that type. • Amount of consumed hot water before and after the measure (l) • Temperature of consumed hot water before and after the measure (t°C) • Energy consumed for heating 1 l water • Consumed el. energy (KWh) before and after the measure • Measured amount of receipted biogas (m^3) • Amount of receipted el. energy consumed/delivered to grid (KWh), measured to customers • Numbers of pigs and chickens in farms

	• Annually produced dung by types (t/yr)
Amount of reduced emissions, got through the monitoring period	Replacement of grid el. energy with el. energy produced from biogas will save 1 137 t CO_2 per year. But 412 135 t CO_2won't eject from dung per year.
Comments	
Implementing body/unit	Farmers with the help and support of Information center of Ministry of Agriculture in the Bolnisi Municipality.

Activity #A3.1; A3.2; A3.3.	**Food industry (production of dairy products)**
Planned implementation (dates)	2016 – 2020
Description of activity:	In this measure will be discussed already acting milk reprocessing company from village Ratevani and replacement of 50% of hot water distribution with solar energy in two already planned manufactures ("Disveli" and "Akhali Stili") Municipality helps industries in finding quality technologies and in connecting to the producers.
Indicators, according to which the monitoring should be performed	Here only the general indicators are given, the monitoring of which would be necessary to conduct a project of that type. • Amount of consumed hot water before and after the measure (l) • Temperature of consumed hot water before and after the measure (t°C) • Energy consumed for heating 1 l water • Consumed el. energy (KWh) before and after the measure • Measured amount of receipted biogas (m^3)
Amount of reduced emissions, got through the monitoring period	In case of all of these already mentioned industrial measures, 4 007 t CO_2 will be saved by the year 2020. (50% replacement).
Comments	
Implementing body/unit	Farmers with the help and support of Information center of Ministry of Agriculture in the Bolnisi Municipality.

Activity #A4	**Renovation of agriculture technic (tractors)**
Planned implementation (dates)	2017 – 2020
Description of activity:	In this measure will be discussed already acting milk reprocessing company from village Ratevani and replacement of 50% of hot water distribution with solar energy in two already planned manufactures ("Disveli" and "Akhali Stili") Municipality helps industries in finding quality technologies and in connecting to the producers.
Indicators, according to which the monitoring should be performed	Here only the general indicators are given, the monitoring of which would be necessary to conduct a project of that type. • Number of old tractors. • Average area cultivated by old tractors annually (ha).

	• Amount of fuel necessary for cultivation 1 ha area with an old tractors (t, type) • Amount of fuel necessary for cultivation 1 ha area with a new tractors (t, type) • Averagely area cultivated by replaced tractors annually (ha) • Consumed fuel/energy before and after measure in total (in the monitoring year)
Amount of reduced emissions, got through the monitoring period	
Comments	
Implementing body/unit	Farmers with the help and support of Information center of Ministry of Agriculture in the Bolnisi Municipality.

11 Sustainable Development Criteria

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

- Local capacity building of Bolnisi Municipality (staff, plans);
- Increase in population's quality of life and energy expenditure savings (per capita hot water consumption, expansion of heated areas/space, approximations of per area energy consumption to European standards, etc.);
- Promotion of residential condominiums creation;
- Improved comfort and energy savings in municipal/commercial buildings (heat, electricity, hot water consumption per area unit);
- Introduction of modern waste recycling technologies;
- Expansion of per capita green areas;
- Reduction of local pollutants (mainly due to measures taken in the transport sector);
- Increased number of jobs;
- Better gender equity;
- Demonstration and piloting new technologies;
- Promoting private sector development;

Municipalities are able to report on additional criteria that were influenced by measures carried out within the SEAP framework, as well as on main barriers hampering the plan implementation, plans in place to avoid and overcome main obstacles, and steps towards achieving success.

12 Annex 1

Methodology and coefficients for calculation of baseline emissions and BAU scenario

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$_j$ (GgCO2) =
$\square\square_i$ {Actual fuel consumption ji (unit) x caloric value of fuel i(MW.h45/per unit)
x carbon emissions factor (TC/MW.h)/1 000 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 emissions (GgGas) =
$\square\square$i {Actual fuel consumption ji (unit)
x caloric value of fuel(MWh/per unit)
x Gas emissions factor ji(TGas/MWh)/1 000].

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

Table 67. 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/ MWh)
Gasoline	1 000 liters	0.00950	0.247
Diesel	1 000 tons	0.01070	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	0.00210	--

The average emissions factor from the electricity grid was applied in 2014, which was 0.104 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.

[45] 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

Typical values of oxidized carbon recommended by the IPCC and used for 2006-2011 inventory are given in Table 68.

Table 68. 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 69.

Table 69. Methane and Nitrous Oxide Emission Factors for Transport Sectors (kg/MWh)

GHG	Gasoline	Diesel	Natural Gas
CH_4	0.072	0.018	0.180
N_2O	0.0020	0.0020	0.0004

Global warming potential values (GWP) of these gases for converting methane and nitrous oxide into carbon dioxide equivalent are presented in Table 70.

Table 70. 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[46] 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 Bolnisi SEAP uses emissions reduction calculations for the BAU scenario. There are two options of scenario construction described by the guidance document:

[46]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

1. The country can develop its own methodology, which will be evaluated by the JRC later;
2. The country may use national ratios indicated in the guidance document, developed for the Global Atmosphere Research (EDGAR) project CIRCE[47] employing an emissions database. The POLES (Prospective Outlook for the Long-term Energy Systems)[48] 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[49].

For the Bolnisi Municipality the second approach has been applied, i.e. JRC ratios, according to which the 2014 emissions will grow by 36% 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 Bolnisi Municipality 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 Bolnisi SEAP the BAU national scenario has not been generated yet, the JRC coefficients were applied.

[47] 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

[48] 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

[49] 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

13 Annex II

Energy Consumption in building sector of Bolnisi Municipality

Table 71. Energy consumption in residential buildings

Building type	Total area (m^2)	2012	2013	2014	Comment
Total consumption of electricity by the municipality (KWh)		108 580 812	124 551 107	117 347 216	Growth: 15%; -5.8% On average 4.6%
Residential buildings (KWh)	2 665 446	17 285 687	18 685 395	20 743 528	Growth: 8.1%; 11% On average 9.5%
Total consumption of natural gas by the municipality (m^3)		4 571 214	4 811 892	5 536 628	Growth: 5.3%; 15.1% On average 10.2%
Natural gas consumption by residential buildings (m^3)		3 622 279	3 853 624	4 321 541	Growth: 6.4%; 12%. On an average 9.2%
Natural gas consumption by residential buildings (KWh)		34 049 423	36 224 066	40 622 485	
Total consumption of firewood by the municipality (m^3)		22 477	7 803	15 121	Growth: -65 %; 94%.
Firewood consumption by residential buildings (m^3)		21 577	6 892	14 234 68 425[50]	
Firewood consumption by residential buildings (KWh)		44 944 891	14 356 036	29 649 422 142 529 275	
Total energy consumption by residential buildings (KWh)		**96 280 001**	**69 265 497**	**91 015 435**	

Table 72. Energy consumption in municipal buildings

Building type	Total area (m^2)	2012	2013	2014	Comment

[50] This number is the result of calculations: families that use firewood * average annual amount of firewood per one family (7 m^3 per year)

Total consumption of electricity by the municipality (KWh)		108 580 812	124 551 107	117 347 216	Growth: 15%; -5.8% On average 4.6%
Municipal buildings (KWh)	71 934	136 770	146 470	145 850	Growth: 7%; -0.4% On an average 3.3%
Total consumption of natural gas by the municipality (m^3)		4 571 214	4 811 892	5 536 628	Growth:5.3%;15.1% On average 10.2%
Natural gas consumption by municipal buildings (m^3)		18 635	37 780	49 942	Growth:103%; 32% On average 67%
Natural gas consumption by municipal buildings (KWh)		175 169	355 132	469 455	
Total consumption of firewood by the municipality (m^3)		22 477	7 803	15 121	Growth:-65%; 94%.
Firewood consumption by municipal buildings (m^3)		5.5	0	52	
Firewood consumption by municipal buildings (KWh)		11 457	0	108 316	
Total energy consumption by municipal buildings (KWh)		**323 396**	**501 602**	**723 621**	

Table 73. Energy consumption in kindergartens

Building type	Total area (m^2)	2012	2013	2014	Comment
Total consumption of electricity by the municipality (KWh)		108 580 812	124 551 107	117 347 216	Growth: 15%; -5.8% On average 4.6%
Kindergartens (KWh)	14 293	64 482	65 562	73 131	Growth: 1.7%;11.5%. On an average 6.6%
Total consumption of natural gas by the municipality (m^3)		4 571 214	4 811 892	5 536 628	Growth: 5.3%; 15.1% On average 10.2%
Natural gas consumption by kindergartens (m^3)		7 452	6 902	8 326	Growth: -7.4 %; 20.6%. On an average 6.6%

Natural gas consumption by kindergartens (KWh)		70 049	64 879	78 264	
Total consumption of firewood by the municipality (m^3)		22 477	7 803	15 121	Growth: -65 %; 94%.
Firewood consumption by kindergartens (m^3)		175	220	170	
Firewood consumption by kindergartens (KWh)		364 525	458 260	354 110	
Total energy consumption by kindergartens (KWh)		**499 056**	**588 701**	**505 505**	

Table 74. Energy consumption in "other buildings"

Building type	Total area (m^2)	2012	2013	2014	Comment
Total consumption of electricity by the municipality (KWh)		108 580 812	124 551 107	117 347 216	Growth: 15%; -5.8% On average 4.6%
Other buildings (only schools) (KWh)	40 490	82 237	87 804	108 070	Growth: 6.8%; 23%. On an average 15%
Total consumption of natural gas by the municipality (m^3)		4 571 214	4 811 892	5 536 628	Growth: 5.3%; 15.1% On average 10.2%
Natural gas consumption by other buildings (m^3)		89 501	86 614	98 586	Growth: 14%; 14% On an average 14%
Natural gas consumption by other buildings (KWh)		841 309	814 172	926 708	
Total consumption of firewood by the municipality (m^3)		22 477	7 803	15 121	Growth: -65 %; 94%.
Firewood consumption by other buildings (m^3)		690	691	665	Growth: -3.6%.
Firewood consumption by other buildings (KWh)		1 437 270	1 439 353	1 385 195	
Total energy consumption by other buildings (KWh)		**2 360 816**	**2 341 329**	**2 419 973**	

Table 75. Total energy consumption by building categories and by fuel types (KWh)

Building type	Total area (m^2)	2012	2013	2014
Residential buildings	2 665 446	**47 335 110**	**54 909 461**	**61 366 013**
Municipal buildings	63 064	**323 396**	**501 602**	**723 621**
Kindergartens	14 293	**134 531**	**131 441**	**151 395**
Other buildings	533 248[51]	**923 546**	**901 976**	**1 034 778**
Total energy consumption (KWh)		**48 716 583**	**56 444 480**	**63 275 807**

The aim of described table is analysis of common trend of energy consumption, but this data (except kindergartens) can not be used for calculating energy consumption per 1 m^2 because the share of firewood consumption in total consumption is quite high and it is not included. Particularly, according to unofficial statistics (families that use firewood and calculated with annual consumption), firewood consumption is 142 529 275 KWh (68 425 m^3 annually) that is about 70% of the whole consumption. So, for gathering more reliable statistics, Table 16 describes only electricity and natural gas consumptions, where a growth about 5% and 10% has been detected respectively in residential sector. According to the information received from the municipal government, massive decrease has been detected in firewood consumption. This data is probably based on official statistics and does not include illegal firewood consumption that significantly changes firewood consumption trend. That is the reason why firewood consumption has been calculated by estimating families that use firewood and average amount of firewood (7 m^3 per year) per one family. More detailed information is given in Annex II. It is visible from Table 16 that electricity and natural gas consumption by buildings sector has been increased, probably by 30% at least, in 2012-2014, because the whole picture of energy consumption in the category of "other buildings", where the growth must be approximately two times bigger, could not be received.

14 Annex III

Methodology for energy audit

An energy audit of typical buildings in Bolnisi Municipality 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

[51] Areas in the category of other buildings is incomplete, as well as the list

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 designed/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 savings the calculated values of energy consumption should be used as a "baseline scenario", which describes the building's energy consumption under the comfort conditions.

In order to assess the energy consumption and relevant emissions three different scenarios (E_1=E_2=E_3) could be used: E_1- to get statistical data on energy (power, NG, wood,etc) consumption by building sector from energy providers; E_2- to calculate specific consumption of energy per sq. meter of building based on the results of energy audits and applied the data to other buildings. E_3- to calculate per capita energy consumption based on the results of building audit or surveys and multiply it by city population. Finally, cross comparison of these three scenarios makes it possible to determine the accuracy of calculation for each scenario (E1 = E2 = E3).

According to the **first scenario (E_1)**, it is possible to estimate an annual energy consumption on the basis of annual statistical data of consumed natural gas, electricity and firewood obtained from providers. Usually data on consumption are provided in standard units (kWh/yr, m^3, l, etc) and should be converted to kWh in order to compare, sum up or do any other mathematical operations (E1, kWh/yr).

The **second scenario (E_2)** needs a detailed energy audit of different types 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 by various appliances. An energy audit carried out using ENSI software would allow us along to the assessment of energy consumption to determine the actual potential of energy-savings, involves a situational analysis and other tools to reduce energy consumption and CO_2 emissions.

15 Annex IV

Methodology for calculation of carbon stock and annual carbon accumulation in green sector

The calculation of carbon accumulated in Bolnisi Municiopalitygreen cover and its annual accretion was performed using the IPCC methodological Guidelines. The calculations were conducted for so called "Live biomass" (including the underground biomass). Carbon stocks in the green cover were calculated separately for joint canopy and fragmentary plants. The losses in biomass due to falling down and trimming are also considered in calculations. Namely, the following equations were used in computations:

1. Equation calculating carbon savings in live biomass (including the underground and above ground love biomass):

   $C_F = [V \bullet D \bullet BEF_2] \bullet (1+R) \bullet CF$

   Where
   V is the 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. Equations system to calculate annual increment in carbon stocks of biomass based upon the biomass accretion – decrease method (see Error! Reference source not found.):

$$C_{F_{LB}} = (C_{F_G} - C_{F_L})$$

$$C_{F_G} = (A \bullet G_{TOTAL}) \bullet CF \qquad C_{F_L} = H \bullet D \bullet BEF_2 \bullet CF$$

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

$$G_W = I_V \bullet D \bullet BEF_1$$

Fig. 15 System of equations to calculate carbon accretion in biomass

Where
$C_{F_{LB}}$ is annual increase in carbon stocks due to biomass accretion, t C/yr.;
C_{F_G} –annual increase in carbon stocks due to biomass accretion, t C/yr.;

C_{F_L} –annual decrease in carbon stocks due to biomass losses, t C/yr.;

A- area covered by wood/plants;

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

CF- share of carbon in biomass, t C/ton of dry mass;

G_W- aboveground biomass increment, t day mass;

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;

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

H- amount of annually purveyed timber volume, m^3/yr.;;

BEF_2- biomass increment coefficient for converting commercial wood stock into the total stock of above-ground biomass (including rind/bark).

Using the above given equations the carbon stocks in perennial plants of Bolnisi green cover and the annual sequestration of carbon have been determined.

Concerning the values of some coefficients used in calculations, as the perennial arboreal plants in city green cover are represented both in joined canopy and in fragmentary forms, corresponding to both cases indexes were applied in computations.

In particular, for joint canopy plants, mainly occupying slopes of hills surrounding the city, the Bolnisi Forestry taxation materials were used, while for city greenery (represented mainly in the fragmentary form) the wood stocks and other data (average age 40 years) were taken from different reference sources relevant to dominant in the city kinds, such as Tables of growth rates and stocks52 , etc. As a result average value of index has been obtained, permitting the approximate assessment of wood stock at 1 ha of fragmentary greening (40 m3).

As it has been mentioned above, the perennial arboreal plants in the city 1 590 ha of green cover are represented both in joined canopy and in fragmentary forms, from which joint canopy groves are dominating mainly at 50 ha of state forest territories, and the remaining 1 540 ha are covered with fragmentary plantings. Therefore, emission factors, typical for both types of plantings were applied in computations. Here it should be mentioned as well that in Accretion Factor, used in calculations, the vegetation extension ratio due plantings, conducted in 2014-2015 has been taken into account. Ensuing from this, the Accretion Factor was adjusted towards the growth rate.

In particular, the data on average annual accretion and woody stocks were used from the taxation materials (see Table 76), while for the specific weight of the wood (D) the data on absolutely dry wood volume weight of the dominant species were taken from different reference sources. The values of other coefficients (BEF1, BEF2, Rand CF) were brought from the standard Tables of IPCC methodology, relevant to climate conditions of examined region.

[52] Mirashvili V., Kuparadze G. Forest Taxation Reference Book (in Georgian)

Table 76. Indexes used in calculations and their sources

Main indexes applied in calculations	Used value of indexes	
	Fragmentary plants	Joint canopy plants
V- Tree stock m3/ha[53]	75	105
I_V- Woody plants (trees) mean annual increment, m³ [54]	1.6	1.8
D - volume weight of totally dry wood, ton totally dry mass[55]		0.490
BEF_1- Coefficient for conversion of wood mean increment into total aboveground (including crown) mean increment [56]		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.[57]		1.3
R - Ratio of root mass to trunk[58]		0.24
CF-carbon share in dry wood. [59]		0.5

The model has been developed under the project CASFOR II, which was financed by the European Commission programme INCO2. 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;

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

[54]Average taxation rates of Batumi wood and plants; Adjara Forest Inventory, 2004
"Global Wood Database" http:/datadryad.org; მახვილაძე ე. მერქანმცოდნეობა, თბილისი 1962; Боровников А.М., Уголев Б. Н., Справочник по древесине. «ЛеснаяПромышленность», Москва, 1989;

[56]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;

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

[58]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;

[59]Good Practice Guidance for Land Use, Land Use Change and Forestry, (IPCC 2003).

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 Fig. 16**Error! Reference source not found.**.

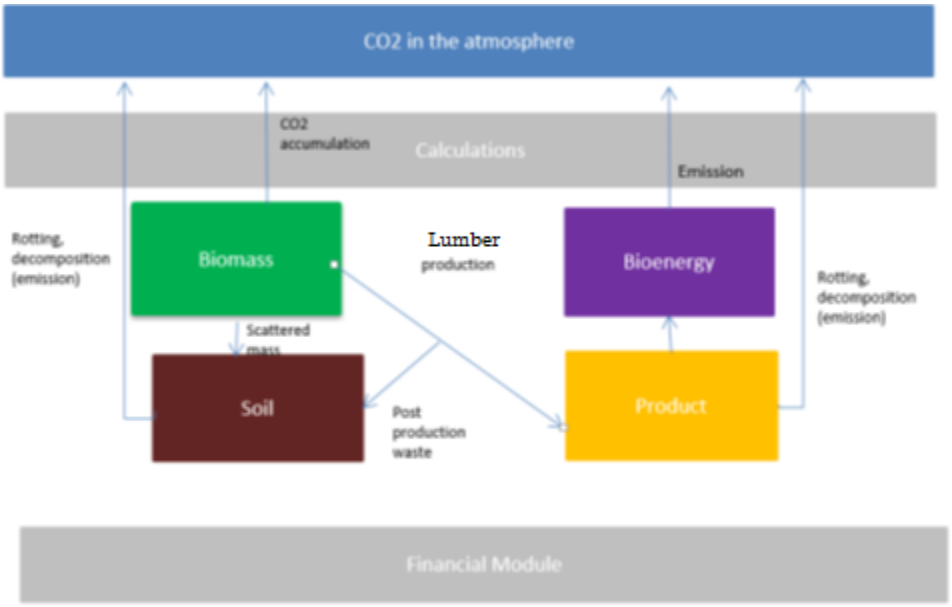

Fig. 16. Model Structure

Two counting modules – biomass and soil modules have been applied to calculate accumulation potential as a result of greening 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 77.

Table 77. Values of indexes used in the biomass module for the project scenario in Bolnisi

Indexes used in the Biomass Module	Value of the index

Carbon content	0.5 t.C /t dry mass
Wood density t dry mass/m³	
Maple	0.655
Plotinus orientalis	0.720
Ash	0.645
Horse Chestnut	0.680
Linden	0.550
Cypress	0.540
Cedar	0.470
Initial carbon stocks	0 t C/ha
Growth correction factor	1
Turnover rate of phytomass	
Coniferous:	
Needles	0.3
Branches	0.04
Roots	0.03
Deciduous:	
Leaves	1
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 CO2FIX system) describes carbon decomposition and its dynamics in dry soil. It is calibrated for detection of total carbon stock in any soil layers. This model is suitable for coniferous, as well as for deciduous forests, and was tested in different countries with dissimilar climate zones to describe the influence of specific climate conditions on the decomposition process of the fallen leaves and branches.