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SUSTAINABLE ENERGY DEVELOPMENT ACTION PLAN FOR THE TOWN OF TSAGHKADZOR BY 2020
(Final Draft)

Tsaghkadzor 2014

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SECTION 1: Introduction

Ensuring sustainable energy development is an important component of the strategic development of the town of Tsaghkadzor. The Municipal Council of Tsaghkadzor joined the European initiative on climate change mitigation “Covenant of Mayors” in 2009. The Covenant of Mayors obliges the local and regional authorities to improve energy efficiency and increase the usage of alternative energy sources on their territories. Following these commitments, the signatories of the Covenant seek to reduce CO2 emissions by at least 20% by 2020.

By signing the “Covenant of Mayors”, the town of Tsaghkadzor:

- On the one hand, has got the unique opportunity to completely transform their municipal energy system according to principles of sustainable energy development based on the experience of cities in Europe.
- On the other hand, assumed the obligations that require the mobilization of all available human and resource potential of the town aiming to ensure an adequate level of energy security.

The development of the Sustainable Energy Development Action Plan (SEAP) for the town of Tsaghkadzor is the next step towards realization of long-term strategies on energy efficiency and environmental protection in the town of Tsaghkadzor.

The SEAP development process includes:

- Description of the energy sector of Tsaghkadzor and structure of energy resources’ use by categories of consumers;
- Developing an overall strategy to reduce energy use, increase alternative energy sources in the town;
- Development of an inventory of carbon emissions.

The main objective of the SEAP is to define a set of organizational, economic, technical and technological, investment activities focused on the long term perspective, the implementation of which will ensure a high level of energy efficiency, decreasing consumption of energy resources, reducing CO_2 emissions and improving the ecological situation in the town.

The document envisages a set of measures in the residential sector, municipal transport, as well as in budgetary sector institutions. By signing the "Covenant of Mayors" Tsaghkadzor demonstrated a willingness to accumulate all possible human and financial resources to ensure sustainable energy-efficient development on the best European level.

1.1 Brief description of the town

Historical review: Town of Tsaghkadzor in Kotayk marz of Armenia (in the past Kecharis, before 1947- Darachichak) is located on the eastern slopes of Mount Kecharis. Since 1958 Tsaghkadzor was an urban type settlement, then since 1984 by order of the Supreme Council of the Armenian SSR was granted a town status. The climate is temperate, healthy.

As an inhabited locality, it is known since III-V centuries. At the beginning of the XVII century nomadic tribes invading the lands of the locality gave it the name Darachichak. For most of the XVIII century, the region has been the stage for the Persian-Turkish clashes. In 1828, upon the end of the Russian-Persian war, the region became a part of the Erivan province of the Russian Empire.

The town has retained its status as recreational area during the Soviet era. More than two dozen pioneer camps and recreation houses operated in the valley, where citizens from all over the USSR spent their vacation. On the eve of the Olympic Games of 1968 in Mexico, a large sports complex was built in Tsaghkadzor, where representatives of different sports have been exercising in conditions close to those of Mexico. In 1972 a ropeway was built on the slopes of the mountain Teghenis and Tsaghkadzor became known as ski center.

In the post Soviet period Tsaghkadzor continues to attract fans of mountain recreation and winter sports due to temperate climate and comfortable leisure conditions for visitors.

Geographical position: The town is located on the mountain slopes, 6 km north-west of the regional center Hrazdan and 50 km north-east of the capital Yerevan. The average altitude is about 1850 m. The total area of the town is 1618.3 hectares, of which 1228.7 ha are the municipal property, only 59.2 hectares are in the agricultural use. The ridges crossing the town territory are partly covered with forests; the highest peaks are Teghenis (2851 m) and Tsagkunyants (2820 m). A small stream flows through the town into the river Marmarik and further into the Hrazdan River.

Climatic conditions: The winters are mild; the number of sunny days is 270, yet snow precipitation is quite significant and provides a solid up to 1.40 m thick snow cover. Skiing season lasts from mid-November till mid-April. The average temperature in January is -6 ° C, the average temperature of the heating season is -1,6 ° C, the duration of the season is 201 days. Average annual precipitation is 600-700 mm. There is not a meteorological station or point in Tsaghkadzor. Guided by the normative data of the meteorological station of Hrazdan town, located about 50-60 meters below Tsaghkadzor and at a distance of 6 km, we can state the following indicators: annual total solar radiation on a horizontal surface: 1726 kWh/m^2, which is slightly above the national average, the average annual share of direct sunlight radiation: 61%. There is little wind on the territory of community; the average wind speed in January is 2.4 m/sec, which in terms of energy is considered an extremely poor wind flow potential.

Population: The town is attractive from a touristic point of view. In Soviet times, numerous hotels were built in Tsaghkadzor, boarding facilities, complexes for children's and recreational sports and workouts. In post Soviet times their number increased significantly, including those due to private investments. As of 2012 the total number of hotels and recreational complexes registered in the community was 35, with the total capacity of about 5000 person. In post Soviet times a substantial population migration became apparent. The population of 3350 registered in 1989 reached the number 1503 in 2013, i.e. it has declined by almost 55%. According to the Town Hall of Tsaghkadzor, the population employment level is unprecedented low, approximately 46%.

Housing stock: The number of apartment buildings in the urban community is 7. These are 2-6 storey buildings, with the number of apartments from 11 to 50, built of tuff stone yet in

the Soviet era, in the 1970-80s fully privatized and gasified. The number of buildings in the residential houses sector is 400, with a total area of nearly 125,000 square meters.

Educational, cultural and healthcare institutions: The town has one school with only 150 students and one pre-school educational institution. The outpatient medical institution is equipped with the necessary medical equipment and has one ambulance vehicle. The town has house museum of Orbeli brothers, located in the building of a kindergarten, children's arts school, the town library, the Chess Academy of Armenia. Most of these institutions have a local boiler, heated by natural gas.

1.2. Plan objectives and general strategy

"The Sustainable Energy Development Action Plan" is the main document of the participants of the "Covenant of Mayors", whereby the commitments of the actors are being approved, as well as the ways and mechanisms of their implementation. The Action Plan defines a long-term strategy for the execution of own obligations and sets out the actions needed to achieve the goals.

The main objectives of the Plan

The main purpose of the Plan is to achieve a reduction of greenhouse gas emissions (mainly carbon dioxide) at least 20% over the time period from the baseline year till 2020. It is assumed that the Plan would allow local authorities to realistically assess the energy efficiency issues of community in all major areas of activity and have an accurate idea of the priority directions of energy efficiency promotion. The plan must be viewed as a document that can directly respond to the reduction of emissions in a varying degree, as a result of processes of community development, and proceeding from appropriate conclusions make the necessary changes, even in the already approved Plan. This will enable local authorities to:

- track the effectiveness of project activities,
- have a correct idea of the volume of primary energy consumption and efficiency of its use,
- to compile the annual energy balance of the community,
- to develop the most realistic programs for the development of communities.

SEAP is not a stereotype, and certain changes may be introduced already in the process of implementation, taking into account the accumulated experience and skills, however, the target – commitment to reduce greenhouse gas emissions by at least 20% - remains unchanged.

Long-term projections

The "Covenant of Mayors" is a document at the local government level and the commitment to reduce greenhouse gas emissions and improve energy efficiency, the planned activities and actions are subject to the jurisdiction of these authorities. It is assumed that local authorities will initiate appropriate actions in their own buildings, structures, vehicles and other places, serving as an example for the public and other property owners in improving

energy efficiency. The SEAP can be designed also for a longer period, i.e., beyond 2020, but in this case the levels specified for the boundary 2020 should be achieved.

1.3. Regulatory and legal framework

The Action Plan has been developed based on:

- *The «Energy Law of the Republic of Armenia» (adopted in 07.03.2001)*

The law regulates the relations of the state authorities of the Republic of Armenia, legal entities carrying out activities in the energy sector in accordance with the Law, and consumers of electricity, heat, natural gas. The purpose of the Law is to define the principles of state policy of the Republic of Armenia in the field of energy and mechanisms for their implementation.

According to the Article 5 of the Law, one of the main principles of state policy in the energy sector of the country are the efficient use of local energy resources, alternative energy sources and application of the economic and legal mechanisms towards them, as well as the promotion of scientific and technical progress and introduction of new energy efficient and energy saving technologies.

In order to promote the development of renewable energy, the 59th article of the Law specifies that all the energy (capacity) produced by the small Hydro Power Plants and other renewable energy sources is subject to purchase in accordance with the established market rules for 15 years from the date of issuance of the license for the production of electricity (capacity).

- *The « Energy Saving and Renewable Energy Law of RA» dated 09.11.2004.*

The purpose of the Law is to define the principles of state policy in the field of energy saving and renewable energy, as well as mechanisms for their implementation aiming to:

- Strengthen the economic independence and energy independence of Armenia;
- Increase the economic and energy security and improve security level of the energy systems in Armenia;
- Establish and develop a new industrial infrastructure and organize services that contribute to energy saving and development of renewable energy sources;
- Reduce the negative impacts of technology on the environment and human health.

The Article 5 of the Law defines the following principles of state policy in the sphere of energy saving and renewable energy:

- Realization of energy saving as well as development and enforcement of the legal and economic mechanisms to encourage the use of renewable energy sources;
- Ensuring a high priority for efficient use of energy, given the growth of energy resources imports;
- Ensuring increased use of renewable energy resources, as well as the application and development of new technologies in the field of renewable energy sources;
- Ensuring high priority of environmental protection issues and rational use of natural resources in the implementation of measures/activities aimed at developing energy saving and renewable energy sources;

- Promoting energy-efficient production of electricity and/or thermal energy, including those for independent power producers;
- Implementation of the state (national) targeted programs in the field of energy saving and renewable energy sources.

- *The National Program on Energy Saving and Renewable Energy (2007)*

The main objective of the Program is formulation of the goals in the field of energy saving and renewable energy in Armenia and definition of measures aimed at achieving those.

The National Program aims at achieving the following objectives:

- Support for sustainable economic development of Armenia;
- Reduced reliance on foreign energy suppliers through the development of energy saving and renewable energy sources;
- Efficient consumption of fuel-energy resources and maximum use of renewable energy sources through the use of targeted economic and legal mechanisms.

The program provides an assessment of the energy saving potential in the electricity, heat and gas supply, the transport and housing sectors, as well as assessment of the potential for the use of renewable energy sources and measures on economically justified use of energy-saving potential.

- *The Action Plan of the Government of the Republic of Armenia to implement the National Program for Energy Saving and Renewable Energy dated 04.11.2010 (Resolution of the Government of RA No43)*

The Action Plan for energy saving implies increased energy efficiency of residential buildings, in the area of public services, in industry and transport and water management. Of primary importance is considered the task of creating a national statistical system in the field of energy. The phased implementation of the Plan, which should be completed by the end of 2018, provides:

- Improvement of the legal and regulatory framework;
- Development of Urban Planning Code, which will take into account the energy characteristics of (heating, hot water supply, ventilation, air conditioning) buildings and structures and will approve certain limit levels;
- Development of technical regulations, national standards on energy saving, technical specifications;
- Harmonization of national standards and norms with international standards, etc.

The country has adopted a number of strategic documents aimed at improving the energy security of the country, improving energy efficiency in various sectors of the economy and promoting wider use of renewable energy sources.

- *The Action Plan of the Ministry of Energy of Armenia based on the provisions of the National Security Strategy (2007)*
- *The National Action Plan for Energy Efficiency (2010)*
- *The concept of ensuring energy security of Armenia (2013)*
- *The programs on social-economic development of the community dated on December 14, 2012*

The program was developed and approved by the Town Council of Tsaghkadzor as a normative act "A four-year program of socio-economic development of the town of Tsaghkadzor (2013-2016)". The program sets out assessments of the local self-government authorities for the existing issues in different spheres of social life and outlines solutions to these issues. However, the program does not provide specific measures, the volume of financial resources needed to solve the mentioned problems, their source and granting conditions. Overall, the program provides an in-depth analysis of the opportunities of the urban community, the strengths and weaknesses of the urban economy, emphasizes the objectives and expected results.

SECTION 2: Analysis of production, supply and consumption of energy resources

Tsaghkadzor is a unique town in terms of production and consumption of energy resources. This is explained by the fact that the given populated locality is small in size and number of inhabitants, and developing a large infrastructure for the production and supply of energy resources is not an appropriate and economically justifiable solution.

It should be noted that the Public Services Regulatory Commission (PSRC) of the Republic of Armenia founded in 1997 handles the issues of pricing and licensing in the field of Energy. The regulatory functions of PSRC apply to electricity, gas supply, and district heating with an installed capacity of more than 5.8 MW of power, water supply, irrigation and telecommunication.

There is virtually no district heating in Tsaghkadzor and all the consumers without exception use individual heating supply system with a natural gas as a primary resource. A monopoly company "Gazprom-Armenia" CJSC which is the owner of all gas transmission and distribution system of the Republic of Armenia, is the actor on the energy resources market of Armenia.

Particularly noteworthy is the tariff for this energy resource, which is single-rate and depending on the volume of consumption per month – a two-step tariff. This means that the final tariff for natural gas depends on the amount of consumption in the past month. Thus, there are two tariff levels - for those who consume up to 10 thousand m^3 of natural gas per month and those who consume more. At the same time, for the same consumer the tariff may be different in different months of the year and this difference can reach up to 40%. This tariff system works since 1997 and is not efficient and rational.

It does not encourage conservation, but rather "stimulates" the theft of energy resources. This issue has been raised repeatedly for consideration by the PSRC; however, this structure refuses to respond to the calls of experts to revise the pricing policy of natural gas. Also, a single-rate, two-band (daytime - from 7am to 11pm and nighttime - from 11pm to 7am) tariffs for the end-user are effective in the energy sector, depending on the voltage level. Since about 40% of electricity for the internal market is generated by thermal power plants, electricity tariffs are directly dependent on the natural gas tariffs. The monopoly owner and operator of electrical energy distribution is the company "Electric Networks of Armenia" CJSC.

2.1. Energy balance of the town of Tsaghkadzor by type of energy resources

The energy balance of Tsaghkadzor town is compiled based on the natural gas, electricity, petroleum and diesel fuel consumption data by the budgetary sector, the population, as well as by transport.

To enable a reliable analysis of the results of energy resources consumption, we consider the population dynamics for 2011-2013 in Figure 2.1.1.

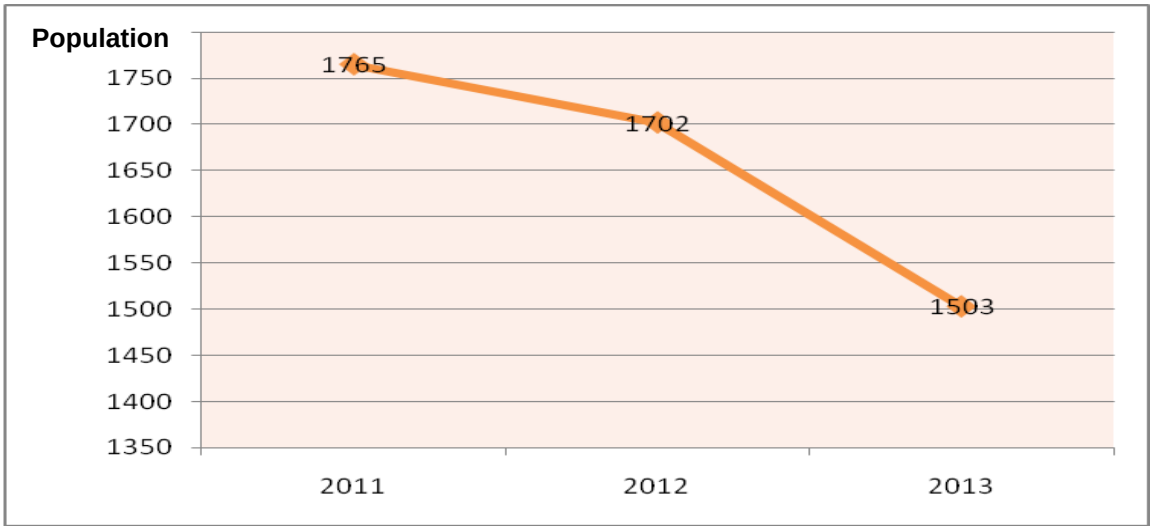


Figure 2.1.1: The population dynamics of Tsaghkadzor town for 2011-2013

A stable decline of population in Tsaghkadzor is obvious on this figure. In 2013, the town's population was 1503 inhabitants that is 17.4% or 263 people less than in the baseline year of 2011. To some extent, this process is a consequence of the complex socio-economic situation and high unemployment rate in the town and in the Republic of Armenia. In order to determine the relationship between population and the volume of consumption of energy resources, consider the table 2.1.1.

Table 2.1.1 The consumption of energy resources in Tsaghkadzor for 2011-2013 (MWh)

Energy resource type	Fiscal year		
	2011	2012	2013
Natural gas	8505,4	8454,7	8550,4
Electricity	1294,6	1255,2	1160,3
Liquid fuel (total)	1052	1039,4	1011
including petroleum	*900*	*891,2*	*871*
including diesel fuel	*152*	*148,2*	*140*
Total	10852	10749,3	10721,7

The data in Table 2.1.1 shows a strong, albeit slight, downward trend in the consumption of all energy resources, with the exception of natural gas. In 2013 Tsaghkadzor consumed

10721.7 MWh of energy resources in total, which is about 1% less than in the baseline year and the same amount less than in 2012. For a clearer picture of the situation, consider Figure 2.1.2.

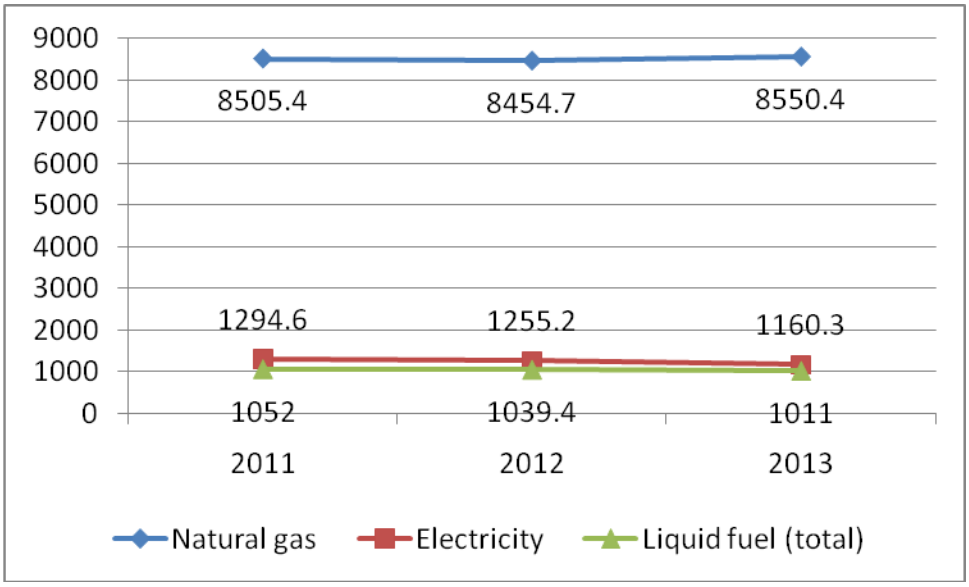


Figure 2.1.2: The dynamics of consumption of energy resources in Tsaghkadzor for 2011-2013 (MWh/year)

In this figure, it is clear that consumption of energy resources has in fact reduced. This is not the case with natural gas, as its consumption in 2013 was by 1.01% or 45 MWh higher than in 2011. This circumstance is due to the fact that the vast majority of the population of Tsaghkadzor reequipped their private vehicles to consume natural gas (methane) instead of petroleum.

As to electricity and liquid fuels, these energy resources were consumed less by 11.5% and 4%, respectively, over the same period.

The Figure 2.1.3 presents the percentage share of each type of energy resources in the total energy balance of the town. The natural gas has the largest share, namely 80%, so it is of the most interest to us, and fundamental measures to reduce energy consumption should be directed at this very energy resource.

The share of electrical energy is only 11%, and fuels' share is even less, namely 9%. This situation is simply unacceptable, since there is practically no diversification of energy resources and the situation in Tsaghkadzor completely depends on natural gas only, which excludes energy security per se.

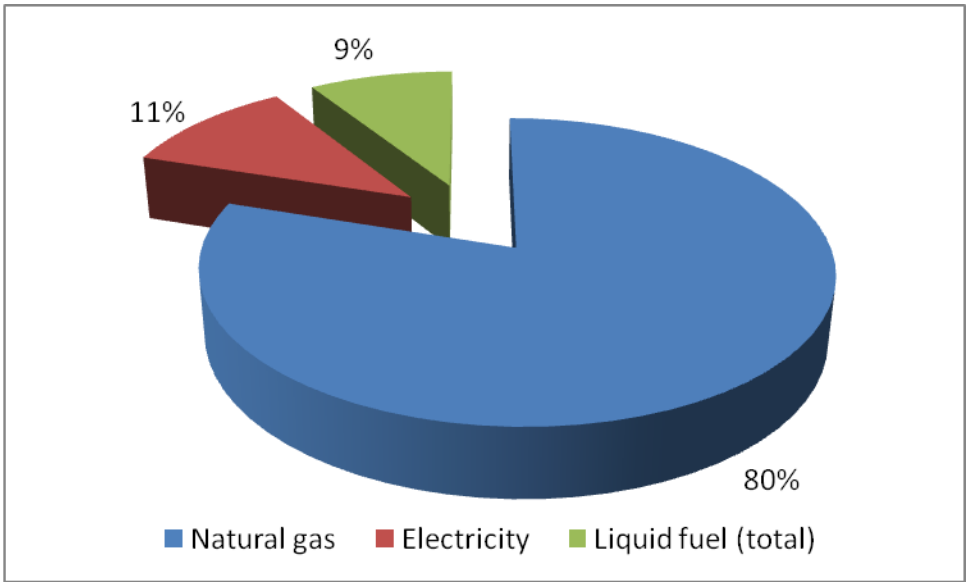


Figure 2.1.3: The share of each energy resource type in the total consumption of Tsaghkadzor in 2013

The structure of natural gas consumption by main consumers is shown in Table 2.1.2

Table 2.1.2. The consumption of natural gas in Tsaghkadzor for 2011-2013 (MWh)

Consumer	Fiscal year		
	2011	2012	2013
Budgetary organizations	525,2	498,2	448,7
Population	3575,2	3319,7	3325,7
Transport sector	4405	4636,8	4776

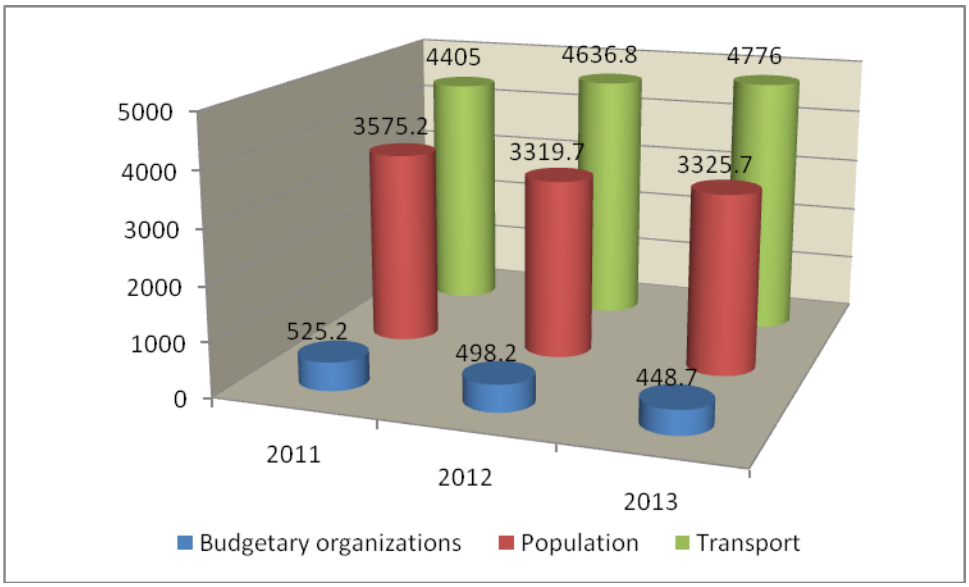


Figure: 2.1.4. The dynamics of natural gas consumption in Tsaghkadzor for 2011-2013 (MWh)

As a result of the analysis of natural gas consumption, the following data has been revealed:

- In 2013, the largest consumer is the transport sector having used 4776 MWh, which is 8% or 371 MWh more than in 2011;
- The budgetary sector consumed less, namely 448.7 MWh, which is 14.6% or 76.5 MWh less than in 2011;
- The transport sector's share is 56%, the population - 39%, the budgetary orginizations - 5% (Figure 2.1.5).

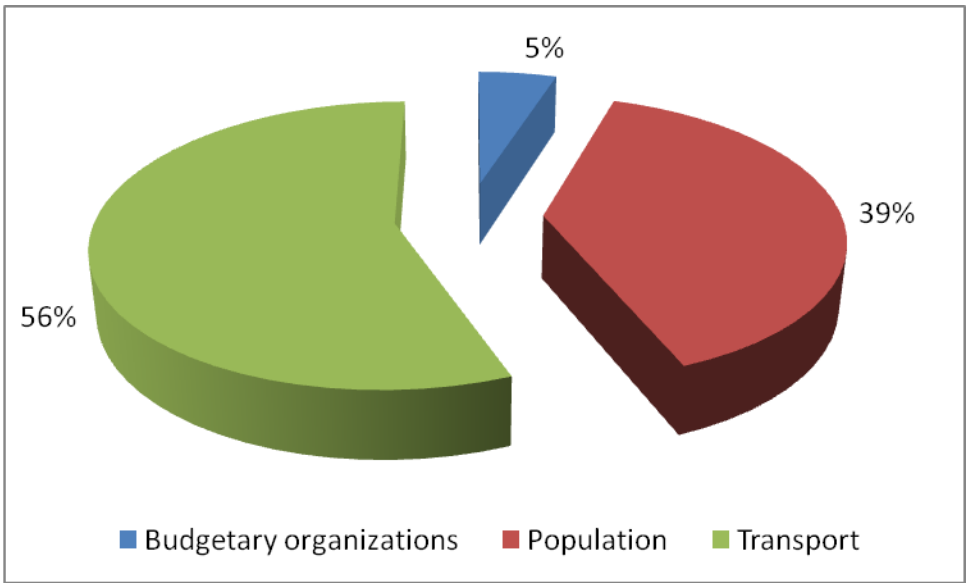


Figure 2.1.5: The share of natural gas consumption by the main consumers

The calculations of electrical energy consumption are shown in the Table 2.1.3.

Table 2.1.3. Electrical energy consumption in Tsaghkadzor for 2011-2013 (MWh)

Consumer	Fiscal year		
	2011	2012	2013
Budgetary organizations	249,1	232,2	232,3
Population	1045,5	1023	928

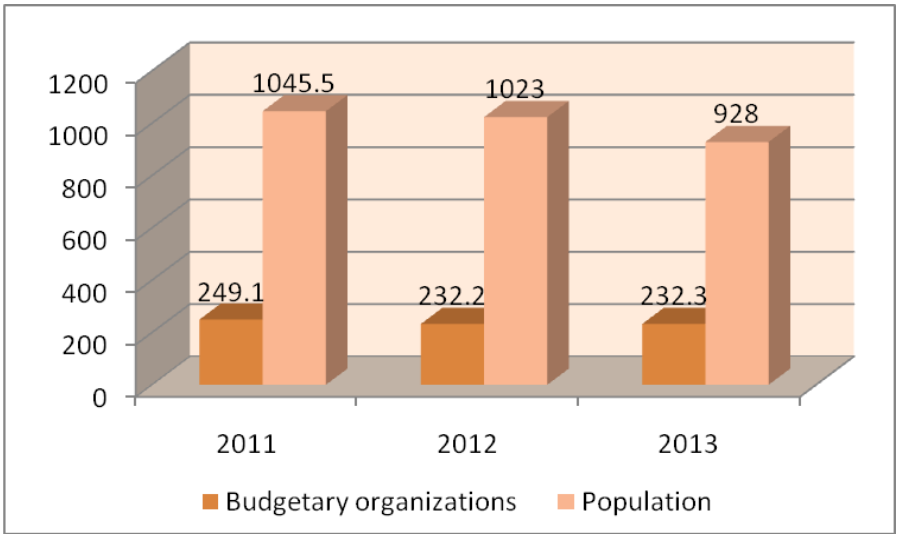


Figure: 2.1.5. The dynamics of electricity consumption in Tsaghkadzor for 2011-2013 (MWh)

An insignificant, yet stable trend towards electrical energy consumption decrease can be observed from the abovementioned data: 928 MWh of energy was consumed by population in 2013, i.e. 12% or 117,5 MWh less, than in 2011. The budgetary organizations reduced their consumption by 7% or 16,8 MWh.

The structure of electrical energy consumption is presented in the Figure 2.1.6.

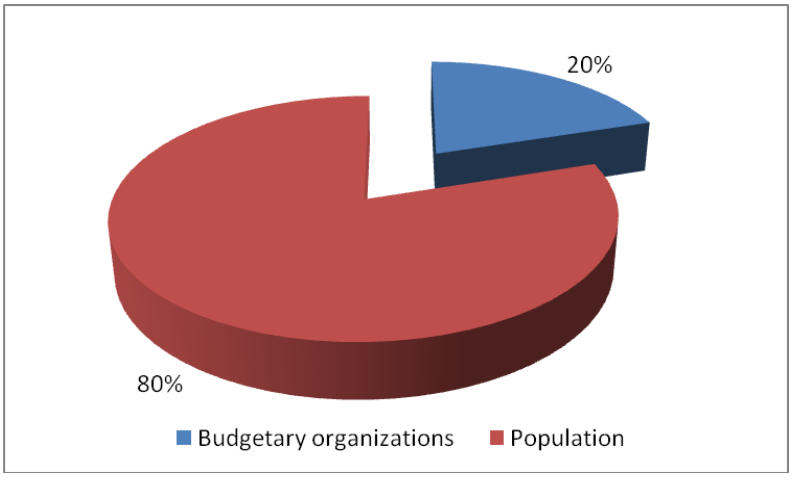


Figure: 2.1.6. The structure of electrical energy consumption by the main consumers

2.2.1. The end-use energy consumption by the buildings and structures of the community

This sector of energy consumption includes the municipal buildings and structures, the so-called "tertiary" (not municipal) buildings and structures and the urban street lighting.

In all of the mentioned facilities the major energy sources in use are - electrical energy and natural gas.

The data on the use of energy sources in these objects are listed in the Table 2.2.1.

Table 2.2.1 The consumption of energy sources by the budgetary sector of Tsaghkadzor for 2011-2013 (MWh)

Energy source	Fiscal year		
	2011	2012	2013
Electrical energy	291,1	232,2	232,3
Natural gas	525,2	498,2	448,7

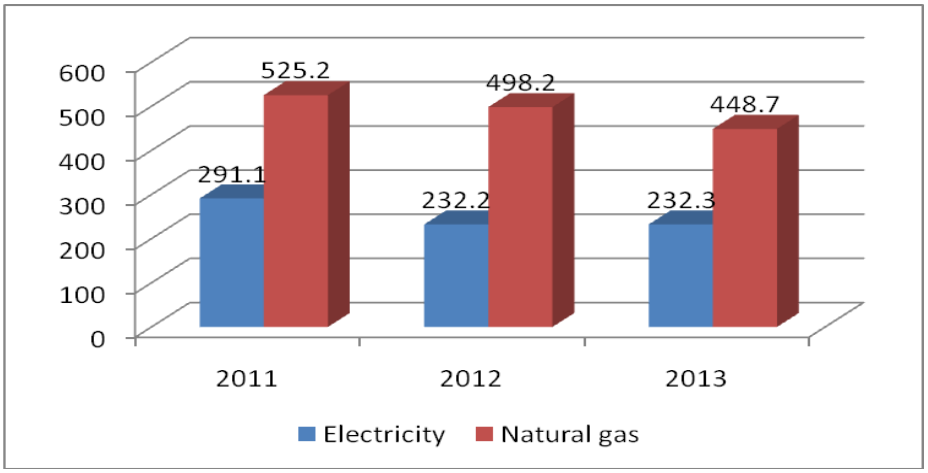


Figure 2.2.1: The dynamics of energy resources consumption by the budgetary sector of Tsaghkadzor for 2011-2013 (MWh)

Proceeding from the analysis of the consumption of energy resources by the budgetary sector of Tsaghkadzor, we can confidently state that the municipal government is really working towards energy conservation. Proof of this is the reduction of natural gas consumption in 2013 by 14.6% or 76.5 MWh, compared to the year of 2011, as well as decrease in electrical energy consumption by 7% or 16.8 MWh.

Information on the consumption of natural gas by the budgetary sector of Tsaghkadzor in terms of its subordinate entities is given in the Table 2.2.2

Table 2.2.2 The consumption of natural gas by the budgetary sector of Tsaghkadzor for 2011-2013 (MWh)

Consumer	Fiscal year		
	2011	2012	2013
Municipality	92,3	53,7	69,7
Kindergarten	111,3	117,0	156,8
Library	108,6	111,7	100,9
Secondary school	190,8	197,0	105,8
Ambulant clinic	22,2	18,9	15,5

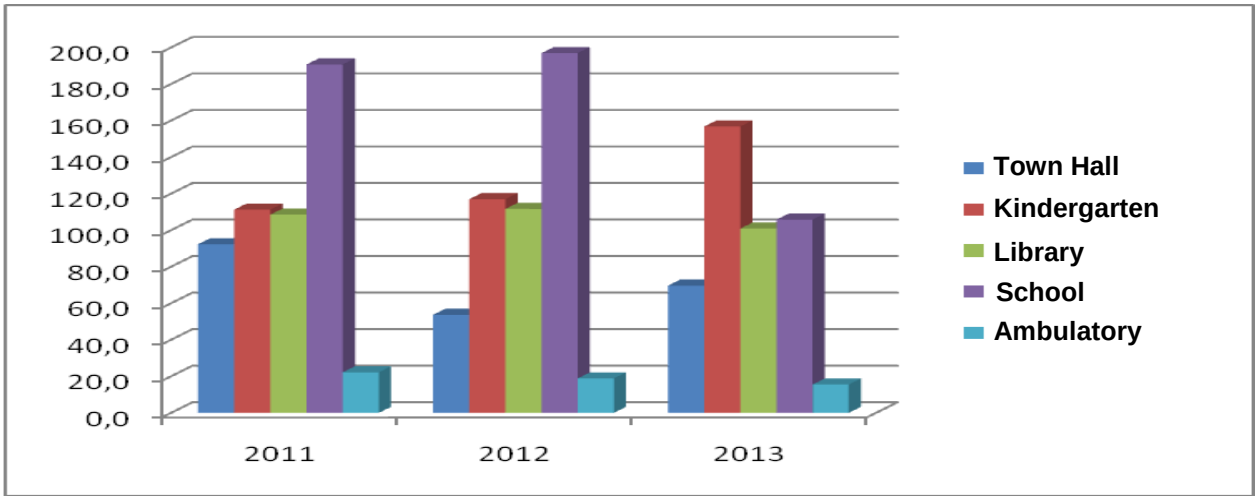


Figure 2.2.2: The dynamics of natural gas consumption by the budgetary sector of Tsaghkadzor for 2011-2013 (MWh)

In municipal buildings and structures, the average monthly consumption during the summer months is only 5-10% of the monthly index of the heating period and is obviously a result of the influence of gas heating.

Based on the analysis of natural gas consumption by the budgetary sector of Tsaghkadzor, one can draw the following conclusions:

- The situation in the kindergarten is the worst in terms of energy saving: in 2013 the consumption increased by 40.9% or 45.5 MWh, as compared with 2011.
- The best situation is in the secondary school, where consumption decreased by 44.5% or 84.9 MWh.
- In 2013, the largest share belongs to the kindergarten, 34.9%, therefore the energy saving measures here are the most relevant.
- The information on the consumption of electrical energy by the budgetary sector of Tsaghkadzor is shown in the Table 2.2.3.

Table 2.2.3 Power consumption in the budgetary sector of Tsaghkadzor town for 2011- 2013 (MWh)

Consumer	Fiscal Year		
	2011	2012	2013
Municipality	7,1	6,0	9,2
Kindergarten	3,5	3,4	1,6
Library	0,9	0,7	2,0
Secondary school	4,2	5,4	4,9
Ambulant clinic	2,2	0,8	2,2
Nursery in Jrarat community	14,9	15,5	15,8
Parking lot	4,1	5,1	5,9
Municipal lighting	212,2	195,3	190,7

The largest share in this energy carrier's consumption, namely, 82.1%, belongs to street lighting. However, this figure decreased by 10.1% or 21.5 MWh by 2013 compared to 2011. As of 2013, the total length of the illuminated city streets was 4150 m with 395 lamps located along them. From 2011 to 2013, 56 sodium lamps were replaced with LED ones. By 2020, it is envisaged to replace all sodium street lights with LED ones. The plans of the City Hall outline an expansion of the street lighting's geography and extension of 'switch-on' hours in the daily lighting schedules.

Electricity consumption in municipal buildings and structures is distributed unevenly and features strong seasonality. The data for the first three buildings in Table 2.2.3 shows that the average monthly power consumption during the heating period (Figure 2.2.3, the lower curve) jumps almost 2.5 times above that of the rest of the year. The uneven energy consumption in these three completely gasified buildings is hard to explain solely by longer 'switch-on' hours in winter. Obviously, electrical heaters are also used in the buildings, either as a peak or a backup power source.

The same pattern holds for the parking lot and the nursery. Figure 2.2.3 demonstrates a graph of monthly power consumption in this group of buildings in 2013 (upper curve).

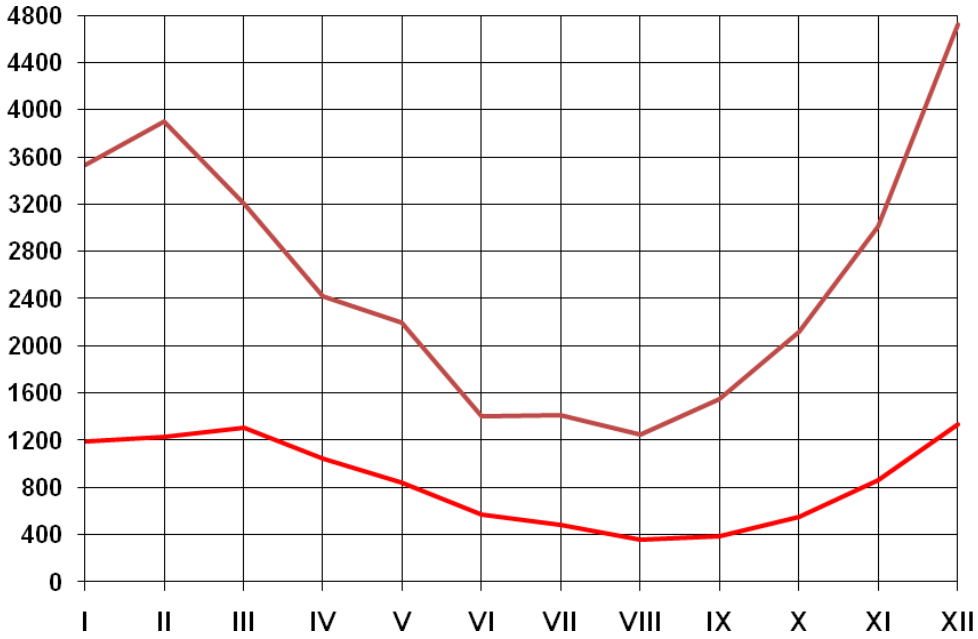


Figure 2.2.3: Power consumption in municipal buildings in 2013, kWh/month

2.2.2. The end-use energy consumption in multi-apartment buildings and residential houses

The population of Tsaghkadzor town was 1503 people in 2013, residing mostly in private houses of one or two storey.

To analyze energy resources consumption by the population of Tsaghakdzor town, we consider Table 2.2.2.1.

Table 2.2.2.1 Energy resources consumption by the population of Tsaghakdzor town for 2011-2013 (MWh)

Energy carrier	Fiscal year		
	2011	2012	2013
Electrical energy	1045,5	1023	928
Natural gas	3575,2	3319,7	3325,7

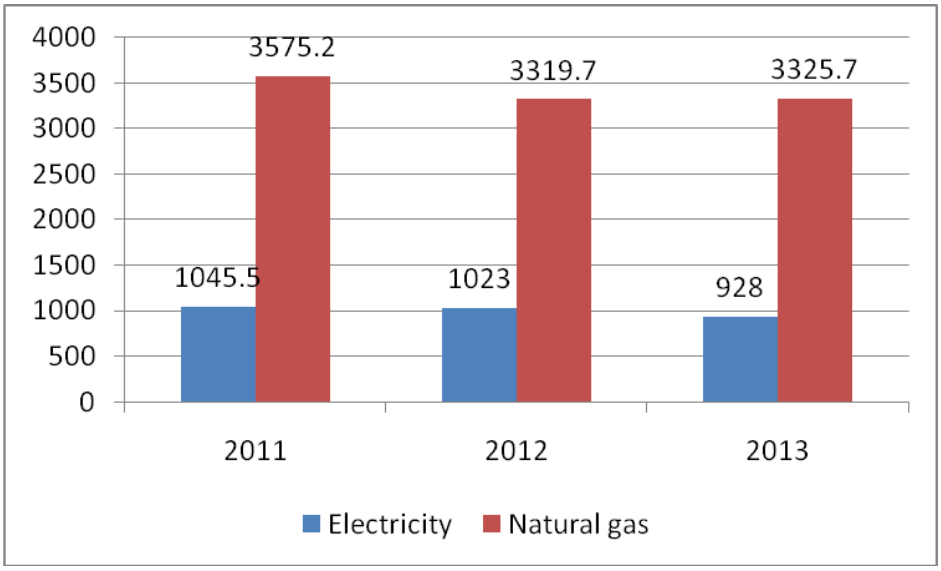


Figure 2.2.2.1: Dynamics of energy resources consumption in budgetary sector of Tsaghkadzor town in 2011-2013 (MWh)

Natural gas consumption by the population decreased by 7% or 249.5 MWh, while power consumption dropped by 11.2% or 117.5 MWh in 2013 compared to 2011.

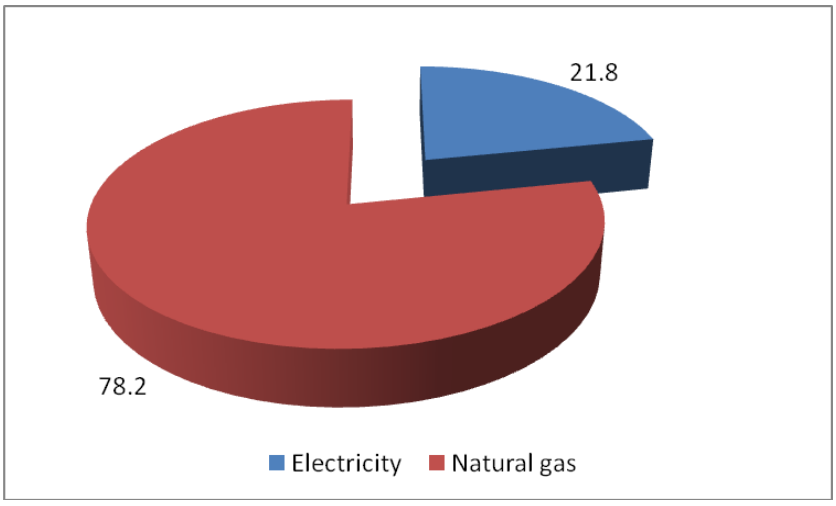


Figure 2.2.2.2: Share of energy resources in the total energy consumption by the population of Tsaghkadzor town in 2013

In the total energy consumption by the population of Tsaghkadzor town, the share of natural gas reaches 78.2%, while electrical energy covers 21.8% only.

2.2.3. The end-use energy consumption in transport sector

The transport sector of Tsaghkadzor town appears as follows.

- There are 269 private passenger cars, 27 trucks and 11 special purpose vehicles registered in the town.
- Average annual mileage of passenger cars is 20,000 km.
- Average annual mileage of trucks is 8,000 km.
- There are about 4,000 buses of small and average passenger capacity plying the routes Yerevan-Tsaghkadzor (about 55 km) and Hrazdan-Tsaghkadzor (about 7 km) annually.
- Share of cars of all types consuming liquefied natural gas of 7900kcal/m3 caloric content is close to 80%, while the remaining 20% use liquid motor fuels.

Energy resource consumption in transport sector of Tsaghkadzor town is presented in Table 2.2.3.1.

Table 2.2.3.1 Energy resource consumption in transport sector of Tsaghkadzor town for 2011-2013 (MWh)

Fuel type	Fiscal year		
	2011	2012	2013
Natural gas	4405	4636,8	4776
Petroleum	152	148,2	140
Diesel fuel	900	891,2	871
Total of liquid fuel	1052	1039	1011

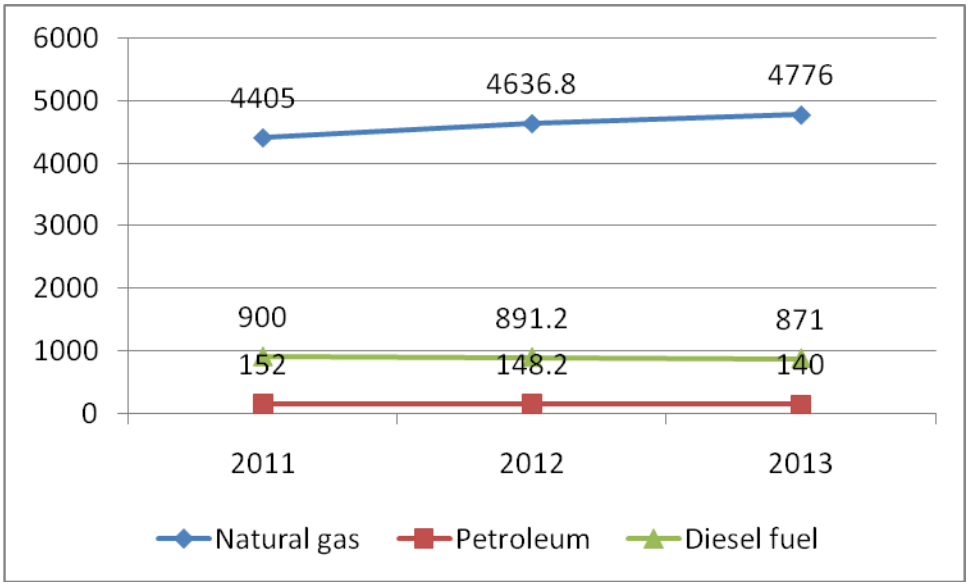


Figure 2.2.3.1: Dynamics of energy resource consumption in transport sector of Tsaghkadzor town in 2011 to 2013 (MWh)

The findings on energy resource consumption in transport sector show that the majority of cars consume natural gas. An evidence to this statement is the decrease in consumption of

petroleum and diesel fuel in 2013 compared to the baseline year 2011, while consumption of natural gas grew by 8.4% or 371 MWh.

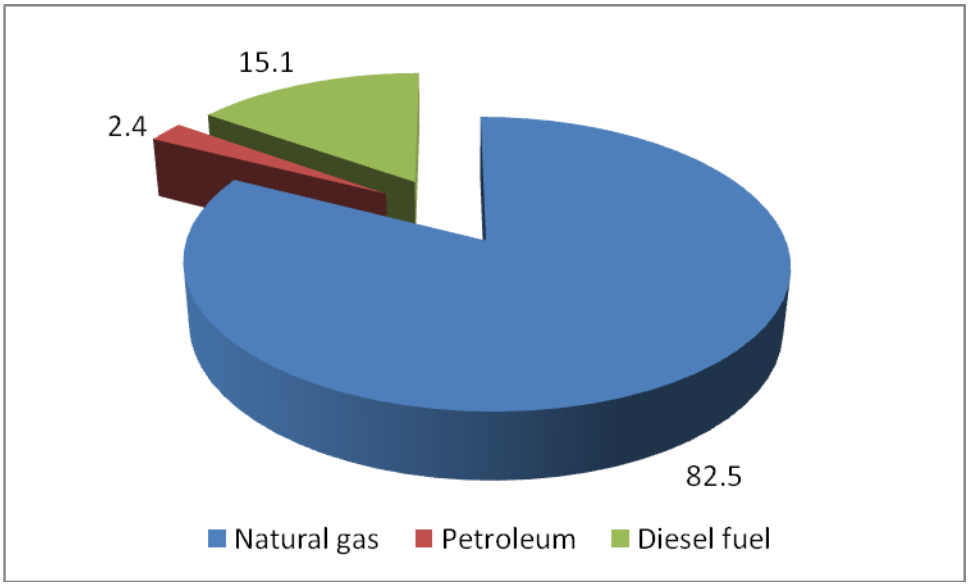


Figure 2.2.2.2: Share of energy resources in the total consumption in transport sector of Tsaghadzor town in 2013

As pertains to the resources consumed in the transport sector, the share of natural gas reaches 82.5%, with 15.1% covered by diesel fuel and 2.4% - by petroleum.

SECTION 3: Development of emissions inventory: assessment of the current situation

To perform an estimation of emissions inventory in Tsaghkadzor town, we chose data for year 2011 as the baseline, as since that year the complete and accurate information on consumption of energy carriers can be obtained.

3.1. Emission sources

The main sources of baseline CO_2 emissions, as indicated in the sustainable energy action plan (SEAP) of Tsaghkadzor town to 2020, are the follows:

- population: emissions due to burning of natural gas in residential buildings, power consumption;
- budgetary organizations: emissions due to consumption of natural gas and power;
- transport sector: emissions due to consumption of liquid fuels (petroleum, diesel fuel) and natural gas.

3.2. Analysis of baseline emissions' inventory

For compilation of baseline emissions inventory (BEI), we use emission factors recommended by the Intergovernmental Panel on Climate Change (IPCC). Absolute values of annual consumption by energy source are used as a basis for BEI estimation. The CO_2 BEI is presented in Table 3.2.1.

Table 3.2.1 Emissions of CO_2 in Tsaghkadzor town for 2011-2013, ton

Type of energy source	Fiscal year		
	2011	2012	2013
Natural gas	1718,1	1707,8	1727,2
Electrical energy	282,2	273,6	252,9
Petroleum	224,1	221,9	216,9
Diesel fuel	40,6	39,6	37,4
Total	2265,0	2243,0	2234,4

As of year 2011, CO_2 emissions amount in Tsaghkadzor town was 2265 ton or 1.283 tCO_2 / (person. year) in per capita terms. Nevertheless, this indicator decreased by 1.35% or 30.6 ton by 2013 already.

Generalized distribution of emissions in accordance with the baseline data of year 2011, depending on sources, appears as follows.

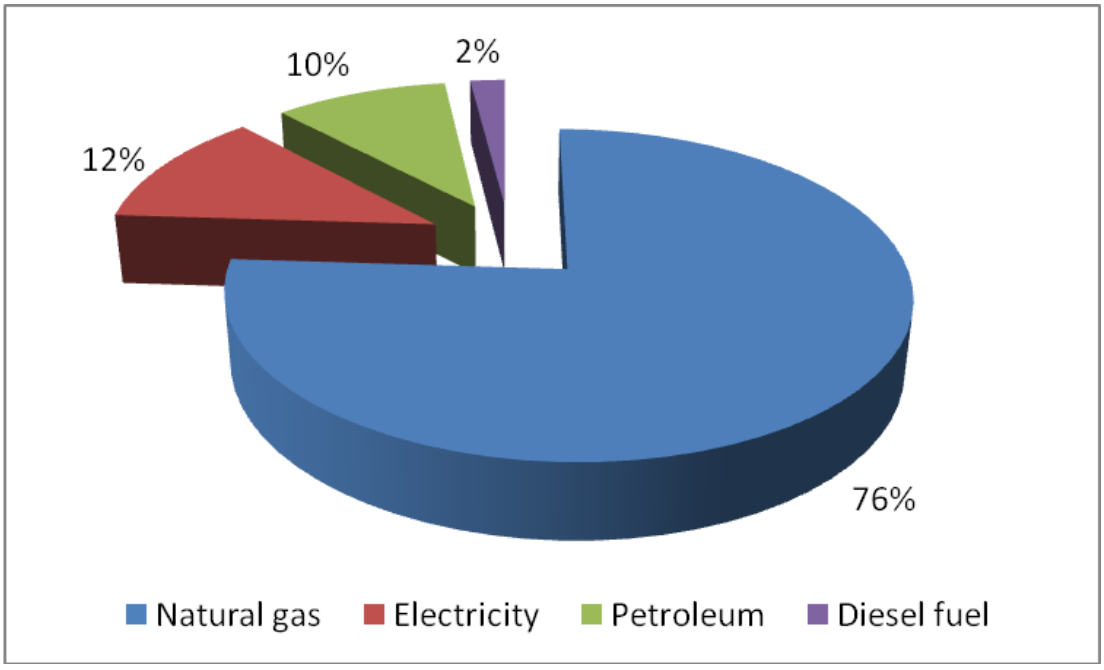


Figure 3.2.1: Distribution of CO_2 emissions by energy carrier

This Figure shows clearly that the greatest amount of CO_2 emissions, 76%, originates from burning the natural gas and the lowest, 2%, - from diesel fuel.

Distribution of CO_2 emissions among the sectors under consideration by source of emission in accordance with the baseline data of year 2011 appears as follows.

Table 3.2.2 Distribution of CO_2 emissions by sector and emission source in the baseline year 2011 (ton)

Type of energy resource (source of emissions)	Budgetary organizations	Population	Transport sector	Total
Natural gas	106,1	722,2	889,8	1718,1
Electrical energy	54,3	227,9		282,2
Petroleum			224,1	224,1
Diesel fuel			40,6	40,6
Total				2265,0

Sectoral distribution of CO_2 emissions is presented in Figure 3.2.2.

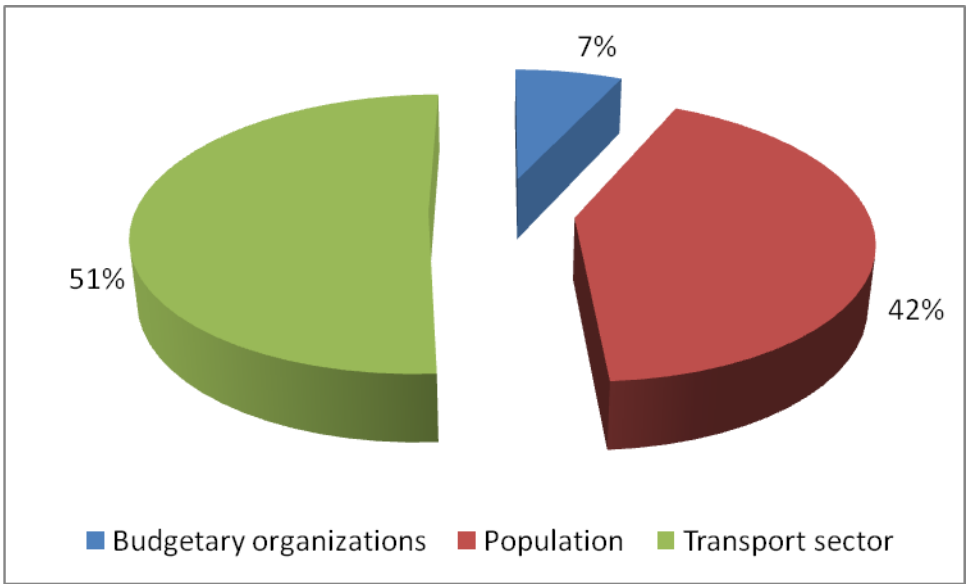


Figure 3.2.2: Sectoral distribution of CO_2 emissions

The findings based on the data obtained are as follows:

- The largest amount of total CO_2 emissions originates from natural gas consumption;
- The greatest share of emissions, 51%, holds the transport sector with population producing 42% of those;
- Therefore, the principal objective of the Action Plan is to ensure CO_2 emissions' reduction in the mentioned sectors.

3.3. Substantiated choice of the baseline year

The base year for the Eastern Partnership and Central Asia countries is selected, accounting for the opportunity to obtain the most reliable and representative statistical data. As distinct from the recommendations for European countries to use the year 1990 as the baseline for SEAP preparation, the recommendation for countries-participants of the Eastern Partnership and Central Asian countries is to use as the baseline a year, closer to the current period – a year, for which reliable data can be collected and processed.

It is well-known that the countries of the former Soviet Union experienced a period of sharp economic decline in the first decades of post-Soviet era. During this period, the amount of greenhouse gas emissions dropped abruptly, too. Specifically, in Armenia, in 2000s, the indicator has shrunken to about one-fifth of its value in 1980s, about 25 million tons (CO2). In this regard, to develop a SEAP for the town of Tsaghkadzor, it is feasible to choose the year 2011, to ground the estimations onto reliable energy consumption data by public institutions and individuals, as well as to account for the circumstance of the community's population being stabilized throughout the post-Soviet era. Nevertheless, to avoid exclusion of population migration factor from the analysis, it is feasible to present emission reduction commitments in specific terms, i.e., per capita.

The objective of SEAP is to reduce emissions of the main greenhouse gas (CO_2) by 20% by 2020 as compared to the baseline year. The Plan's objectives can be achieved through the implementation of measures aimed at reducing energy consumption and promoting the use of renewable energy sources.

SECTION 4: Measures for emissions' reduction by sector for the whole period of SEAP

Tsaghkadzor town is considered a largest and a best ski resort in the Republic of Armenia. This is the main source of income for the majority of the population and the city budget. Nevertheless, the town wants to be more energy efficient, too. To achieve that objective, it is necessary to implement a set of energy efficiency measures envisaged and proposed via the Action Plan.

4.1. Municipal buildings and structures

Municipal buildings and structures of Tsaghadzor town like of any other settlement are among the most important in terms of energy efficiency, because energy consumption charges are covered from the town's funds. Despite the small number of budget-relying buildings, local budget expenses maybe high enough to become a burden.

A positive solution to this problem is the implementation of energy efficiency and energy saving measures in all the budgetary sector entities of the town without exemption. Core activities should be aimed at reducing the natural gas and power consumption due to:

- Introduction and establishment of energy management system;
- Procurement or development of a program of **daily** monitoring of energy carriers' consumption;
- Implementation of complex of audits;
- Exploration of buildings to elicit mechanical damages in them, including checking their roofs' and basements' integrity, elaboration of recommendations for improvement;
- Setting limits for energy consumption;
- Heat insulation of basements and attics;
- Analysis and inspection of electrical networks;
- Regulation of energy carrier delivery to all rooms;
- Continuous monitoring of sanitary and heating devices;
- Installation of reflecting screens on the part of wall with heating devices;
- Heat insulation of heating system's pipes in basements and attics;
- Constrain airing time and ensure vent lights and doors being closed afterwards;

- Replace or heat-insulate doors and windows;
- Furnish buildings' entrances with vestibules (tambours) with two doors;
- During the buildings' renovation, account for surface of window openings and, where excess lighting indicated, diminish the surface in combination with replacement of old windows with the new ones, while where deficit of lighting is noticed – enlarge, vice versa.
- Cleaning of lamps' and fixtures' surfaces;
- Replacement of incandescent lamps with luminescent and LED ones;
- Never exceed the installed capacity of lamps and control sufficiency of lighting using luxmeter;
- Maintain clean window glazing;
- Switch off lighting lamps in non-working hours;
- Forbid application of electrical heating devices if indoor temperature exceeds 18ºC;
- Install movement sensors for spaces of common use.

To achieve the maximum effect due to implementation of energy-saving measures, the highest possible attention should be paid to the issue and all available means should be used to turn consciousness of the population towards energy efficiency. In Tsaghkadzor town, there are one school, a kindergarten and a library, and these places exactly should be used first to advocate energy saving as a lifestyle.

This can be achieved by implementing various campaigns, conferences, exhibitions so that teachers, parents and students acquire the necessary level of consumer knowledge on energy saving, and to enable them to develop a new vision and understanding of what is our future and how it depends on us. To achieve this, it is necessary to:

- Raise the awareness of employees and students of budgetary sector institutions;
- Attract the younger generation to all the events on energy saving;
- Practice active advocacy of energy saving;
- Raise awareness on innovations in energy-saving technologies.
- Reduce energy consumption in school, kindergarten and library, and by the families of students and teachers.

To reach these objectives, it is necessary to:
- Arrange seminars, training, scientific and extension conferences, round tables and contests on the energy saving issues;
- Development of town programs and projects on energy efficiency;
- Incorporate courses on energy efficiency and global warming into the learning process;
- Organize Energy Days in the town etc.

4.2. Multi-apartment buildings

The population of Tsaghkadzor town is the largest consumer of energy resources and tackling this issue is the most complicated part of the activities to be undertaken. As trivial as it may sound, there can be only three ways to force the population to consume less:

- Value of energy carriers;
- Changed consciousness of the population;
- Implementation of energy saving measures.

As noted above, seven multi-apartment and about 400 private residential buildings and placed seven apartment buildings are located in Tsaghkadzor town. Peculiarity of these buildings is that almost all of them were built in the 1970's and 1980's. So, clearly, the housing is not in the best condition, because at those times energy saving issues were not considered. To improve the situation, it is necessary to:

- Actively attract the public to energy efficiency measures;
- Arrange public hearings on energy saving topics;
- Popularize energy saving among the town's population;
- Implement pilot projects on thermal sealing of buildings;
- Recovery and reconstruction, and heat insulation of residential buildings to finally achieve their orderly and effective appearance;
- Gradually change fixtures in entrances of residential buildings, and enforce using luminescent and LED lamps of lower capacity by population in their separate spaces.
- Development of incentive mechanisms for building owners towards a rational use of energy resources.

4.3. Houses build-up area

In construction of new buildings, it is necessary to use incentives for the population to apply advanced and energy efficient materials that should be:

- Safe for the residents and the environments;
- Wear-proof and durable;
- Moist- and water-proof;
- Of low transfer conductivity.

Advisory materials can be of a fair use for the owner of new housing, as only a small share of population has a substantial idea of energy saving issues.

To achieve the highest possible effect in these circumstances, exhibitions of the newest energy saving technologies should be organized with testing and comparative analysis of the demonstrated products.

Via involvement of independent experts, the economic effect of application of this or that material and equipment can be estimated to identify the most energy efficient one. Besides, development of a comparative table featuring price versus quality can assist a consumer to choose his most appealing option.

Another measure to create an energy efficient town is development of local norms for construction of new housing.

4.4. The street lighting system of the town

The length of the street lighting system of Tsaghkadzor town is about 4 km, with 395 fixtures of 250W capacity located along them that consumed 195 MWh of electricity in the baseline year.

Most of them are equipped with sodium lamps that are substantially inferior to LED ones. Meantime, the city authorities move actively towards energy efficiency and at the end of 2013 were able to install 25 LED lamps of 70W, 25 lamps of 98W and 6 lamps of 90W capacity. These steps show a positive trend in development of the street lighting system, however, for maximal effect, the following should be performed:

- Replace all the sodium lamps with LED ones without exemption;
- Expand the length of outdoor lighting network as it is insufficient;
- Apply an automatic control system for lighting devices operation regimes;
- Actively introduce movement sensors in the most remote and unfrequented spots;
- Install photocells on lighting devices.

4.5. Transport sector

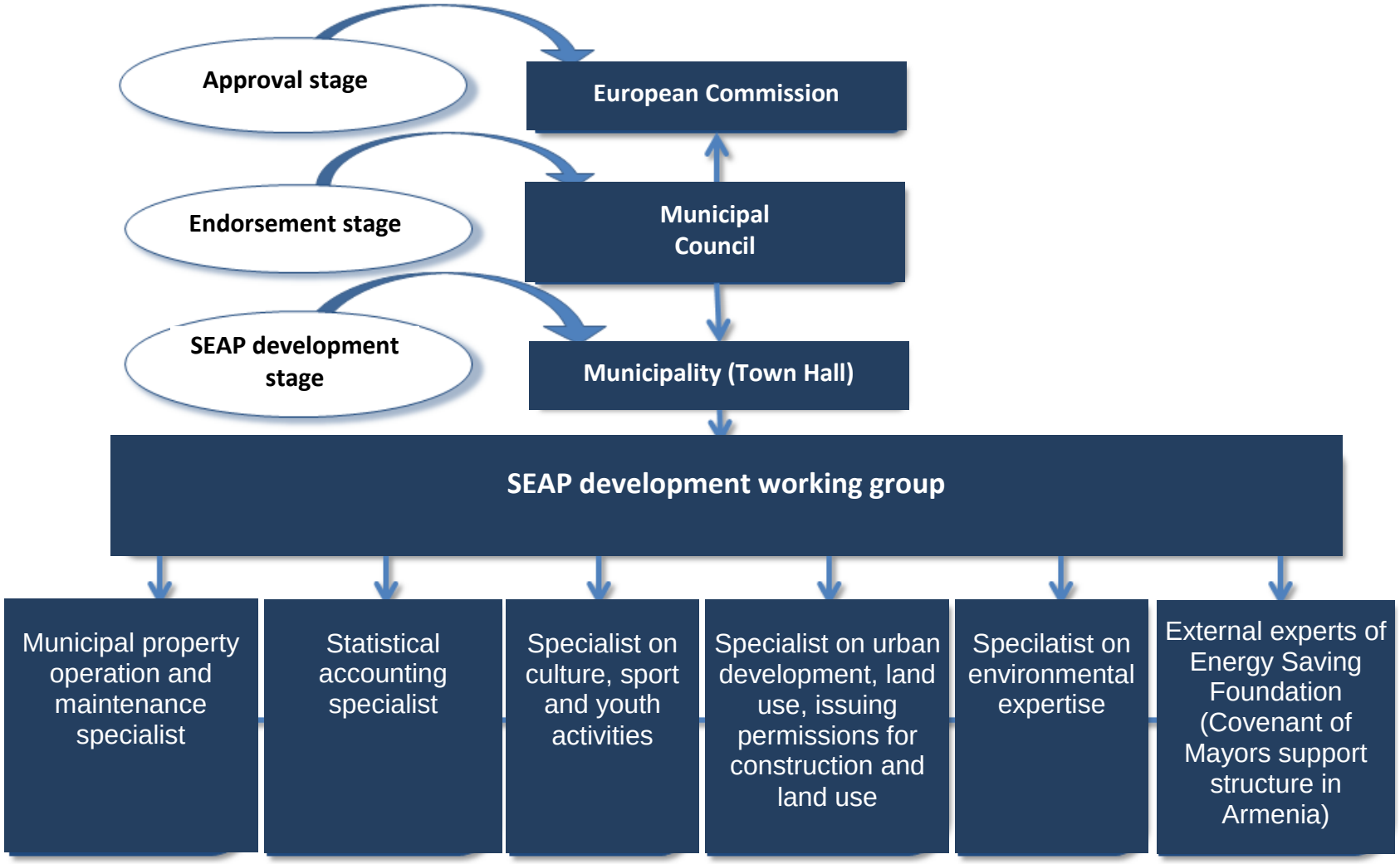
Transport infrastructure in Tsaghkadzor town is not particularly developed. Due to modest size of the town there is no explicit need in public transportation and the majority of population uses private cars. Nevertheless, the situation should be addressed to improve environmental situation in the town.

So, the key measures in the transport sector are as follows:

- Analysis of technical condition of road pavement with urgent elimination of revealed defects;
- Optimization of the traffic structure towards highest efficiency of passenger and cargo flows;
- Construction of new bypass roads to prevent passing of transit transport through the town;
- Organization of activities towards improvement of the town's traffic;
- Incentives for the population to renovate private vehicles to decrease emission of dangerous substances;
- Organize a sanction system for carriers using vehicles in unsatisfactory technical condition (especially as pertains to engines);
- Increase the numbers of ecological transport/vehicles;
- Re-equipment of municipal transport to use natural gas;
- Expand the use of non-traditional and renewable energy sources and alternative fuels at mobile and stationary operating units;
- Incentives for the population to re-equip their own private vehicles to use natural gas and so reduce emissions of carbon dioxide (currently, about 80% of cars use natural gas)
- Implementation of measures to promote cycling and construction of bicycle paths;
- Incentives for the population to use bicycles instead of private cars the more that the town's length is inviting to that, etc.

SECTION 5: Administrative structure for development and implementation of the Action Plan

5.1. Administrative structure for development and implementation of SEAP



5.2. Monitoring and control

Monitoring and control consist of processes performed for the purpose of inspection and control of the document implementation, so that potential enforcement problems be timely identified and corrective actions taken. The main achievement is the regular inspection and assessment of the project implementation process to identify deviations from the SEAP.

The introduction of an energy monitoring is envisaged as a basis for the local energy management system. It would enable monthly control over power consumption by local entities. Besides, an energy manager should be the appointment at the Town Council, who would regularly collect statistics on other sectors and monitor the implementation of SEAP.

Overall responsibility for the writing and implementation of SEAP in the town does not lies on a particular implementer or department. Since activities all sectors should be consolidated and commonly targeted, responsibility of failing SEAP would be the town's as a whole.

Certainly, to ensure efficient enforcement of the respective technical or administrative measures, it is vitally important to assign a certain person or entity to be responsible for SEAP implementation control, which in case of untimely or low quality performance would bear the responsibility in accordance with the respective mandate.

Biannually, in accordance with its assumed obligations, the Town Council will submit a report on the implementation of activities specified by the SEAP to the headquarters of "Covenant of Mayors".

SECTION 6: Funding sources

This section discusses the possible funding sources for projects set forth in the SEAP of Tsaghkadzor town.

The financial component is an integral part of the process of reaching the set goals by the town of Tsaghkadzor, as undertaken by signing the Covenant of Mayors.

Funding of measures planned for implementation in Tsaghkadzor town from 2014 to 2020, shall be performed from the following sources:

- Local budget;
- Budgets of other levels (province/marz, national/state);
- Own financial means, budgets of enterprises, organizations and individuals;
- International and domestic lending institutions and funds;
- Financial means emerged as energy resources savings due to reduction of energy consumption;
- International technical assistance;
- - Sponsors' and donors' assistance;
- State and international targeted programs, grants.

A painful obstacle in achieving the set goals is the inability of the town budget to cover all activities aimed at energy efficiency, energy saving and reduction of CO_2 emissions.

Given the problems mentioned, Tsaghkadzor Town Council and its executive bodies will use all possible sources of funding. These include: own funds, funds allocated from the state budget for targeted programs' financing, technical assistance, credit/loan resources, use of revolving funds, and involving of ESCO companies.

Town Council funds shall be used for all the mandatory pre-design activities and for financing of low-cost, fast-payback measures.

State budget funding is oriented towards implementation of targeted programs, to maintain public-private partnership and fund allocation from the relevant ministries and agencies.

Tsakhkadzor town becomes a consistent part of international projects related to energy saving and energy efficiency. In this way, the Town Council acquires invaluable experience and has an opportunity to practice energy saving approaches and implement relevant measures. Besides, an integral part of the technical assistance is grant programs that enable demonstration projects' implementation, resulting not only in a higher energy efficiency level, but also in an improved image of the town.

ANNEXES

Annex 1

Complex of measures for saving of energy carriers in 2011 to 2020

№	Title of measure	Implementer	Funding amount, thousand €	Savings of energy carriers	
				Natural gas, thousand m³	Electrical energy, MW*h
Budgetary sector					
1	Implementation of energy management system	Town Council	-	-	-
2	Complex sanitization of the school and the pre-school educational institution	Responsible/functional units of the Town Council	60	10	-
3	Replacement of lighting devices in the budgetary sector entities relying on the town's budget	Town Council	2	-	5
4	Implementation of awareness campaigns on energy saving issues among the town's population	Town Council	10	-	52
5	Introduction of joint investment projects on technical re-equipment and capital renovation of residential buildings, where condominiums[1] are being formed or already operating	Town Council, condominiums	-	50	20
6	Capital renovation of the housing stock	Responsible/functional units of the Town Council, condominiums	70	60	14
7	Capital renovation of outdoor lighting system	Responsible/functional units of the Town Council	2	-	45
8	Implementation of energy audit in entities and organizations relying on the town's budget	Responsible/functional units of the Town Council	4	-	-

[1] Condominium, also known as multi-apartment building owners' union

9	Monitoring of energy resources' consumption	Town Council	3	15	30
10	Using "Display" for energy certification of budget-relying entities and residential buildings	Town Council	0,5	5	10
11	Supplementing budgetary institutions and housing stock with energy and energy resources consumption metering tools	Responsible/functional units of the Town Council	10	5	5
12	Organization of "Energy Days"	Town Council	-	15	5
13	Introduction of innovation technologies and energy efficient technical and engineering solutions aimed at lowering energy consumption in the town's budget-relying and housing-municipal sectors	Town Council, condominiums	-	10	20
14	Implementation of energy saving popularization measures aimed at development of conscious attitude of the society towards the necessity to improve energy efficiency	Town Council	10	15	10
15	Development, printing and dissemination of information materials, users' guides, acquisition of demonstration materials	Responsible/functional units of the Town Council	15	2	5
16	Organization of contests, conferences on issues in energy efficiency and energy saving, including those for learning youth and students	Town Council	10	-	10
17	Setting up solar collectors to provide electrical energy for buildings and structures of budget-relying sector	Town Council	100	-	10
Sound Housing					
18	Complex thermal modernization and sanitization	Town Council, condominiums	100	15	-

	of multi-apartment residential buildings				
19	Renovation of residential buildings' facades	Town Council, condominiums	30	2	-
20	Introduction of energy saving technologies including energy saving lamps	Town Council, condominiums	25	-	20
21	Setting up solar collectors on residential buildings	Town Council, condominiums	75	-	15
22	Renovation and reconstruction of electrical networks and electrical equipment	Responsible/functional units of the Town Council	30	-	100
Total			556,5	194	219
Total, MW*year				1833,3	219