Sustainable energy and climate action plan (SECAP)

Singerei city

2021-2030

Covenant of Mayors
for Climate & Energy

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1. EXECUTIVE SUMMARY

This Sustainable Energy and Climate Action Plan (SECAP) is a key document of Singerei's vision and commitment to decarbonizing its territory by improving energy efficiency measures and the deployment of renewable energy, and by strengthening its capacity to adapt to the inevitable impact of climate change. Mitigation and adaptation actions are defined here to achieve the objectives, together with the assigned time intervals and responsibilities.

The Covenant of Mayors is a unique movement that has brought together a large number of local and regional authorities to draw up action plans and direct investment towards climate change mitigation measures. The new Integrated Covenant of Mayors for Climate and Energy was launched by the European Commission on 15 October 2015, in a ceremony at the European Parliament in Brussels. The signatories now promise a minimum 40% reduction in CO2, a 27% increase in energy efficiency and renewable energy sources, and support the integration of climate change mitigation and adaptation under a common umbrella.

The initiative resulting from this association, the Covenant of Mayors for Climate and Energy, is both more ambitious and broader. The signatory cities are committed to taking action to support the implementation of the EU's greenhouse gas reduction target by 2030 and to adopt a common approach to tackling climate change mitigation and adaptation.

In order to translate their political commitment into practical measures and projects, the signatories of the Pact undertake to submit, within two years from the date of the local council decision, a Sustainable Energy and Climate Action Plan (SECAP) outlining the key actions on who intends to undertake them. The plan will include a baseline emissions inventory to track mitigation actions and an assessment of climate risks and vulnerability. The adaptation strategy can be either part of SECAP or developed and integrated into a separate planning document. This bold political commitment marks the beginning of a long-term process, with cities pledging to report every two years on the progress of implementing their plans.

Today's Communication proposes a net target for reducing EU greenhouse gas (GHG) emissions by at least 55% by 2030 compared to 1990 levels. This puts the EU on a balanced path towards achieving climate neutrality. by 2050. The Commission proposal is based on an in-depth impact assessment and confirms that reducing emissions by at least 55% by 2030 is a realistic and feasible course of action.

The Eastern Partnership Covenant Mayors' cities are committed to actively supporting the implementation of the 30% CO2 reduction target by 2020 and to adopting an integrated approach to climate change mitigation and adaptation. A Sustainable Energy and Climate Action Plan (SECAP) outlines the key mitigation and adaptation actions that the city of Singerei intends to undertake

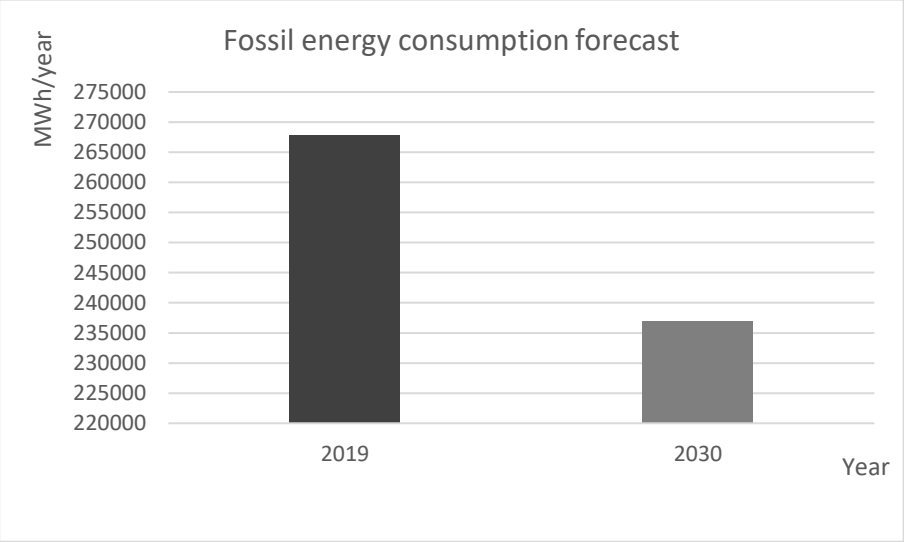

Fig. 1. Estimated fossil energy consumption

them. The following objectives will be achieved by implementing the proposed measures:

• the amount of energy from fossil fuels from the implementation of energy efficiency measures will be reduced by 34.9%;

• CO_2 emissions will be reduced by 49.3% by implementing SECAP measures.

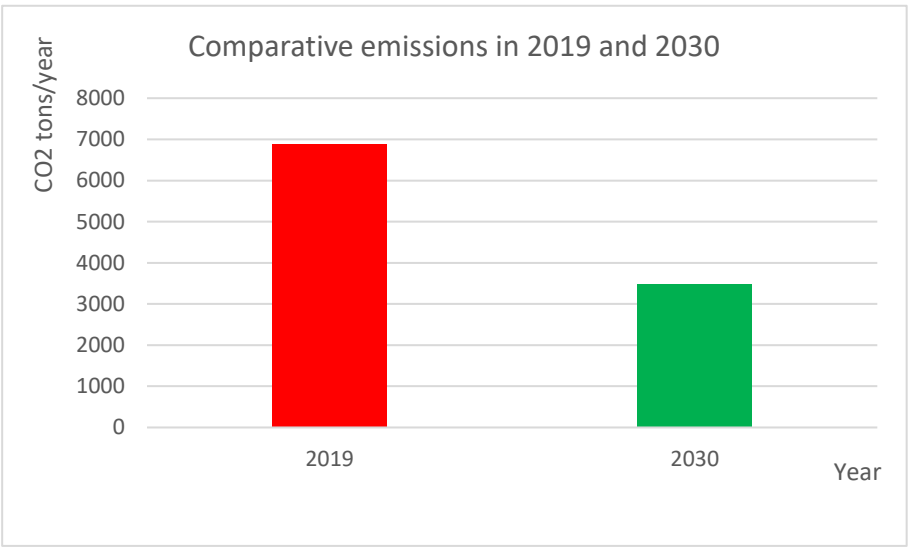

Fig. 2. Estimated reduction in CO_2 emissions

The average level of CO2 equivalent emissions per person in Singerei will have to be reduced from the current level of about 0.52 tons per person to 0.25 tons per person to reach the target (fig.2).

This SECAP describes the measures to be taken in the city of Singerei. Based on the data collected and analyzed, the city has an excellent outlook in terms of reducing GHG emissions and climate resilience.

A crucial element of SECAP will be strengthening community involvement, continued involvement with key stakeholders and partners, and a strong social impact.

1.1 The City of Singerei - general presentation

General characteristics

The town of Singerei is located in the northern part of the Republic of Moldova (coordinates: 47.634 ° N, 29.055 ° E). The city is located about 25 km southeast of Balti. Singerei is located on the left bank of the river Ciulucul-Mare and on the Chisinau - Chernivtsi highway, 114 km from Chisinau and 26 km from the Balti railway station (fig.3,4).

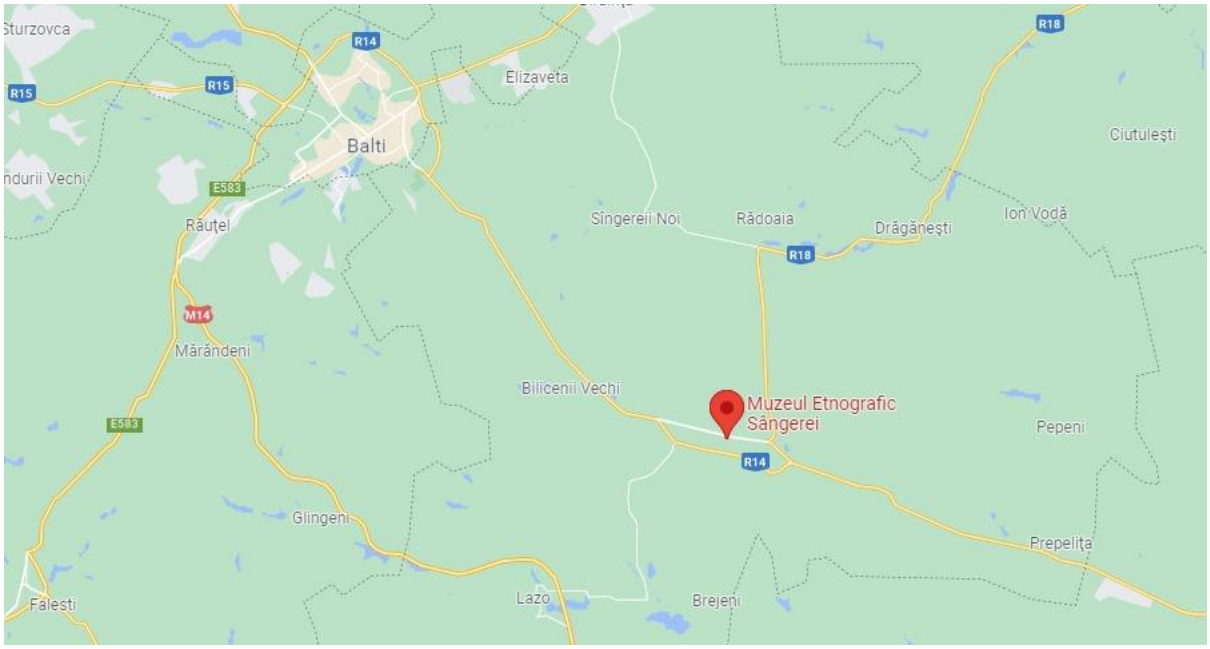

Fig. 3. The location of Singerei on the map of Moldova

The town of Singerei has an area of 83.37 km², most of which consists of agricultural land, which occupies about 5,700 ha or about 70%.

The steps, hills, valleys form the relief of the area. The highest point is 174 meters above the level of the Black Sea.

Fig. 4. Singerei City (view from space)

Climate

The city of Singerei has a moderate continental climate, with generally hot summers and mild winters.

Continental temperate climate with average annual temperature + 10 ° C, average temperature July + 22°C, average January -4°C. Annual rainfall is 500–600 mm. Average wind speed 3-5 m/s.

The average temperature in July is + 22°C - + 23°C, January is -4°C. The annual rainfall is 450–550 mm. The maximum temperature in the hottest months (July) is + 36°C– + 38°C, and the coldest months (January) -15°C.

Winds dominate from the north-west and north. The average annual wind speed varies between 6.8 m/s and 7.0 m/s, and over 50% of the days it varies between 7.0 and 12 m/s. It could have a wind potential for electricity production. There are several factors that need to be considered to encourage the installation of a wind farm in addition to the wind conditions and include good access to the electricity grid, road access, great distance from people's homes.

The city also has good potential for the production of photovoltaic (PV) electricity. The annual PV energy production is 1148kWh / kWp, and the irradiation in the plan is 1452kWh/m2.

Hydrography

The aquatic resources of the city are formed by the Ciulucul Mare stream, which passes on the outskirts of the city, and by 8 ponds and ponds with a total area of over 50 ha, the largest pond has an area of 21.6 ha.

The Ciulucul Mare river meadow is undeveloped and unused from an economic point of view. At the same time, the population of the city has few leisure places on the waterfront or in the forest. Territorially it could be used as a wetland to restore the flora and fauna of the area.

Geology

The seismic state of the territory is determined by the focal point of Vrancea (Romania, at the base of the Carpathians) 1, located approximately 224 km away from the city. The seismic activity in the area reaches a magnitude of up to 7 (Richter scale). The specific geological structure determines favorable conditions for the wide development of landslides and erosion, represented by various furrows, ravines, canyons and valleys.

Flora and fauna

Singerei is a town, the center of Singerei district. There is a great pressure of anthropological factors on natural resources, such as high population density, high land development rate, long-term settlements and anthropological use of land, especially the inadequate human attitude towards natural resources. Climatic conditions are favorable for different crops, especially those that require solar heat, such as cereals, industrial plants, grapes, fruits and vegetables. Meanwhile, the region is subject to climate threats: hail damage, drought, hot dry winds, early or late frosts. Due to these threats, measures should be taken to reduce their impact on the economy.

The vegetation is rich and varied. It is caused by several factors: geographical location, relief, climate, water, rock character.

The region is a traditional agricultural area due to the characteristics of good soils. The main

Soils are typical chernozems that contain significant amounts of rich humus. A wide range of vegetables, many types of fruit trees, grapes are grown in the area.

Over time, the Ciulucul-Mare River turned into a stream. At the same time there are natural fragments with rare plants and animals, some of them entered in the Red Book. Rabbits, deer, badgers, martens, foxes and moles are found in this region.

Vegetation and agriculture

The vegetation is rich and varied. It is caused by several factors: geographical position, relief, climate, water, the character of the rocks. The peculiarities of the climate and soil favor the general development of agriculture. The growing season usually begins on March 15 and lasts until the end of October.

The region is a traditional agricultural area due to the good characteristics of the soil. The main soils are typical chernozems that contain significant amounts of rich humus. A wide range of vegetables, many types of fruit trees are grown in the area.

The population

In 2019, the number of inhabitants was 13,400 people, according to the City Hall and is presented in the following table 1.

Table 1. Distribution of the population in the city of Singerei by age and gender

Age, years	Men	Women	Total	Percentage of total,%
0-18	991	1102	2094	15.7
19- 65	4510	5037	9547	71.2
Over 65	833	928	1759	13.1
TOTAL	6333	7067	13400	**100**

According to Table 1, the demographic situation at the moment is favorable, the majority of the population is between 18 and 65 years old and is strong and has a potential for employment. The dominant age groups are of working age and represent more than 71% of the total population.
The ethnic structure is relatively homogeneous (Table 2). The largest ethnic groups are Moldovans / Romanians - 12,171 (90.83%), Ukrainians -737 (5.50%), Russians - 405 (3.02%).
On the territory of the city there are social facilities of the education system: 4 preschool institutions, Anton Crihan gymnasium and high schools: Theoretical High School "Olimp", Theoretical High School "Mihai Eminescu", Theoretical High School "Dimitrie Cantemir".
The cultural institutions of the city are represented by the Museum of History and Ethnography, the House of Creation and Leisure, the District House of Culture "Nicolae Iorga", a public library and house of culture. The city has 4 sports venues.

Table 2. Distribution of the population in the city of Singerei by ethnicity

Nr.	Ethnicity	Number of inhabitants	Percentage, %
1	Moldovans / Romanians	12171	90.83
2	Ukrainians	737	5.50
3	Russians	405	3.02
4	Polish	12	0,09
5	Bulgarians	12	0,09
6	Other	63	0,47
	TOTAL	**13,400**	**100%**

The health care system includes a hospital, a family doctor center and more. There are 5 pharmacies in the city.

The length of local roads is 60 km, of which only 13 km are asphalted. Over 43 km of roads are paved. About 80% of them are in a satisfactory condition.

The housing stock of the settlement is 300,000m2, 2,894 households, 96% of which are equipped with centralized water and gas supply.

Fuel, energy and water supply

The town has its own gas distribution pipeline connected to the national one. Every household and public building is connected to it. Domestic and non-domestic consumers consume 2,600,000m3 of natural gas annually.

The city is supplied with electricity by the distributor "Red Nord" SA. A 35kV line of "Moldelectrica" passes near the city.

Households and businesses benefit from water from artesian wells that supply 268,000 m3 of water annually and provide 100% of public buildings and most residential homes with water through 50.5 km long pipes. The sewer has a length of 16.4km.

Entrepreneurship and economic activity

The town of Singerei is an urban locality with a high economic potential due to the rather large number of strong economic agents in the territory. Currently, 185 economic agents and 333 patent entrepreneurs work in the city. The vast majority of companies are private, only a few state-owned. Large economic agents are the main actors of the local economy, which provide first of all jobs, and secondly contribute to the formation of the local budget. The economic activity of the town is a significant source of income for the local administration, taking into account the fact

that a considerable part of the deductions from state taxes is formed from the income tax of legal persons.

There are currently 43 farms and several economic agents active in agriculture. There are 7 public catering units, 1 market and a vast network of retail units in the city. There are also subsidiaries of 3 commercial banks and an insurance company in the city. Legal advice services are provided by 3 professional centers.

2. GENERAL STRATEGY

By joining the Covenant of Mayors for Climate and Energy, the city of Singerei voluntarily commits itself to achieving a goal of reducing CO2 emissions by at least 40% by 2030, thus sharing a common vision for a sustainable future and committing itself to developing low carbon, durable, energy efficient community.

Commitment of the commune to take measures in the fields:

ENERGY EFFICIENCY improving energy use and the use of renewable energy.

ADAPTATION AND MITIGATION OF CLIMATE CHANGE. The mayor's office is aware that adapting to climate change brings a number of benefits to the village and its citizens. Disaster preparedness can reduce the cost of damage and future disaster response costs. The European Commission estimates that € 1 invested in risk prevention saves up to € 6 in disaster response efforts. Rehabilitating buildings can reduce tenants' energy costs and increase property values. Adaptation projects can create jobs and stimulate local business.

Co-benefits of local mitigation and adaptation actions Climate change for well-insulated buildings will bring energy savings (mitigation) and adaptation to rising temperatures, cooling through the use of solar systems. Planting trees and green spaces will lead to flood reduction, land shading, urban cooling (adaptation) and carbon sequestration (mitigation).

This Sustainable Energy and Climate Action Plan (SECAP) is presented and will be implemented by putting into practice the commitment made to the village. The following key actions are planned to be taken:

2.1 PURPOSE AND OBJECTIVES

The goal formulated by the city of Singerei is to reduce the influence of human beings on climate change by reducing greenhouse gas emissions and rehabilitating the environment.

Based on the purpose, the following objectives were formulated in the table below.

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Table 3. Objectives and targets for reducing energy consumption and mitigating and adapting to climate change

Zona de management	Index	Goal	Index	Description
Municipal, residential, tertiary buildings, equipment / facilities	**BE**	The building envelope	BE1	Thermal insulation of walls, replacement of old windows and doors, rehabilitation of roofs of public buildings and insulation.
		Renewable energy for domestic water heating and electricity generation	BE2	Installation of solar water heaters and PVT (thermal photovoltaic panels) on the roofs of public buildings and independent units
			BE3	Production of biofuel from energy willow. Use of wood pellets in public and residential buildings
			BE4	Use of "air-to-air", "air-to-water" or "water-to-water" heat pumps for heating public buildings and obtaining domestic hot water
			BE5	Replacement of the old heating system in public buildings
			BE6	Installation of individual heating plant operating on biofuel, their interconnection to solar heating systems.
		Energy efficiency of building heating and domestic hot water	BE7	Replacing kitchen appliances and washing gas, which runs on gas in kindergartens and schools, with electrical appliances
Public lighting	**LE**	Energy efficiency of lighting	LE1	Replacing old technology lighting with LEDs in buildings
			LE2	Replacement of old technology LED lighting in street lighting
Public and private electric transport	**TE**	Switching from public and private vehicles to electric drive	TE1	Construction of charging stations for electric cars with a capacity of 300 cars per day
Local electricity production	**PG**	Generation of photovoltaic energy	PG1	Construction of a 2.0 MW commercial photovoltaic park
Other	**WW**	Waste and wastewater management	WW1	Design and construction of the sewerage system and wastewater treatment plant
	CA	Planting energy willow	CA1	Planting 16.4 ha of energy willow on the banks of the river Ciulucul Mare based on public-private partnership
		Production of wood	CA2	Establishing the production of pellets

Climate change mitigation and adaptation		pellets		based on public-private partnership
		Creating a recreation area	CA3	Creation of a recreational area on the banks of the river Ciulucul Mare based on public-private partnership
		Afforestation of the banks of the river Ciulucul Mare	CA4	Planting 7.6 ha of trees on the bank of the river Ciulucul Mare
		Cleaning and deepening of Pobeda Pond (Victoria)	CA5	Cleaning and deepening of the 10.5 ha of Pobeda pond (Victoria)
		Cleaning and deepening of Lake Comsomolist	CA6	Cleaning and deepening of the 14.7 ha of Comsomolist Lake
		Construction of the rainwater accumulation basin and the recreational area on the banks of the Ciulucul Mare River	CA7	Construction of the 78.5ha rainwater storage basin

Also, the following policy instruments have been defined to implement the formulated measures.

Zona de management	Index	Goal	Index	Description
Buildings, Energetic efficiency	**GS**	Grants and subsidies	GS1	Incentives for energy efficiency and renewable energy generation
	SPF	Secondary financing. Public-private partnership	SPF	Design and construction of the sewerage system and wastewater treatment plant

2.2 THE CURRENT SITUATION

The overall development strategy of the city of Singerei has formulated the objectives of improving energy efficiency, using renewable energies and mitigating and adapting to climate change. The National Environmental Strategy for 2013-2023 specifies the rational use of natural resources, the creation of an intelligent waste management system and ensuring its operation, reducing the negative impact of economic activity on the environment, etc.

Moldova's energy strategy for 2013-2030 ensures the sustainability of the energy sector and measures to mitigate and adapt to climate change, competitive market development and their regional and European integration.

2.2.1 ENERGY CONSUMPTION IN PUBLIC BUILDINGS

THE CURRENT SITUATION

The town of Singerei has 17 public buildings, in which operates the City Hall (796m2), 4 kindergartens (4539m2), the city library (711m2), the center for people with disabilities (446m2), the cultural center of Vranești village (487m2), the sports complex (2143m2), pre-university education buildings (2 high schools and a gymnasium) (9338 m2), placement center (541m2), leisure center (782m2), health center (677m2), district hospital (7182m2). The total area of public buildings is 22307m2.

Energy consumption in public buildings

The buildings indicated in table 4 are owned by the Singerei City Hall.

Table 4. Buildings owned by the City Hall

Nr. ord.	Name of the institution	Area, m2
1	Local public administration buildings	796
2	Kindergartens in the city	4,539
3	City library	711
4	Center for people with disabilities	446
5	The cultural home of Vranești village	487
6	The sports complex	2143
7	Pre-university education buildings	9,338
8	Placement center	541
9	Recreation center	782
10	Health center	677
11	The district hospital	7,182
	TOTAL	**22,307**

In 2019 public buildings consumed 369,130kWh of electricity, 97,984m3 (911251.2 kWh) of natural gas and transport consumed 6240 liters of diesel. Street lighting consumed 238,812kWh of electricity.

The distribution of energy consumed is shown in the diagram below (fig.5).

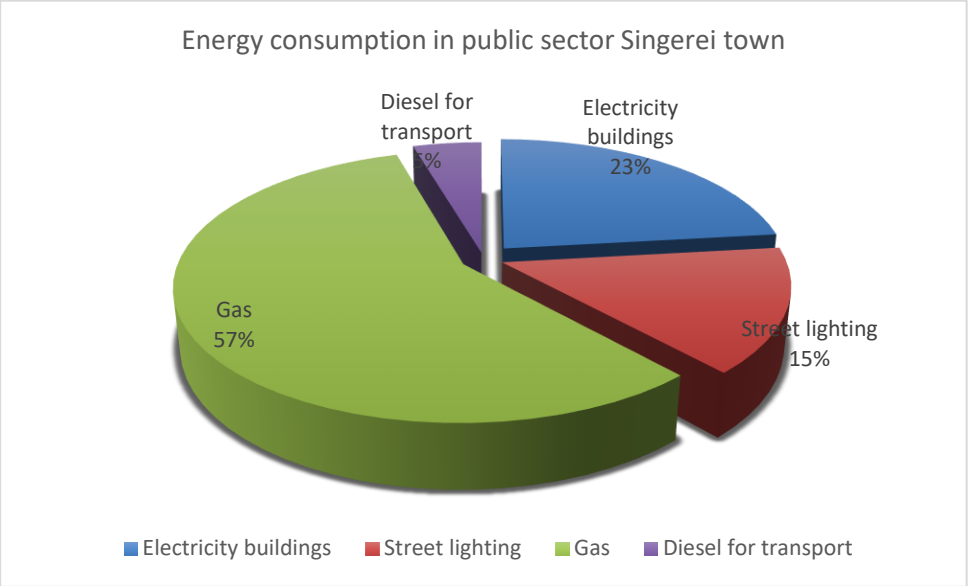

Fig.5. Energy consumption by Singerei City Hall in 2019

The diagram above (fig.5) indicates that energy consumption is dominated by natural gas consumption in proportion of 57%. Electricity consumption is 23%. Biofuel and solar and wind renewable energy are not used.

Photo 1. City Hall Building

Photo 2. The building of a kindergarten

Photo 3. The buildings of two kindergartens

Photo 4. Street and street lighting on the outskirts of the city

Electricity is mainly used for lighting (including street lighting), natural gas - for heating buildings and cooking food in kindergartens and schools.

Residential sector and energy consumption

The vast majority of houses are one- and two-story stone houses, but there are also apartment blocks, which represent the buildings in the residential sector. 1519 families live in individual houses and 1284 families in the blocks of flats.

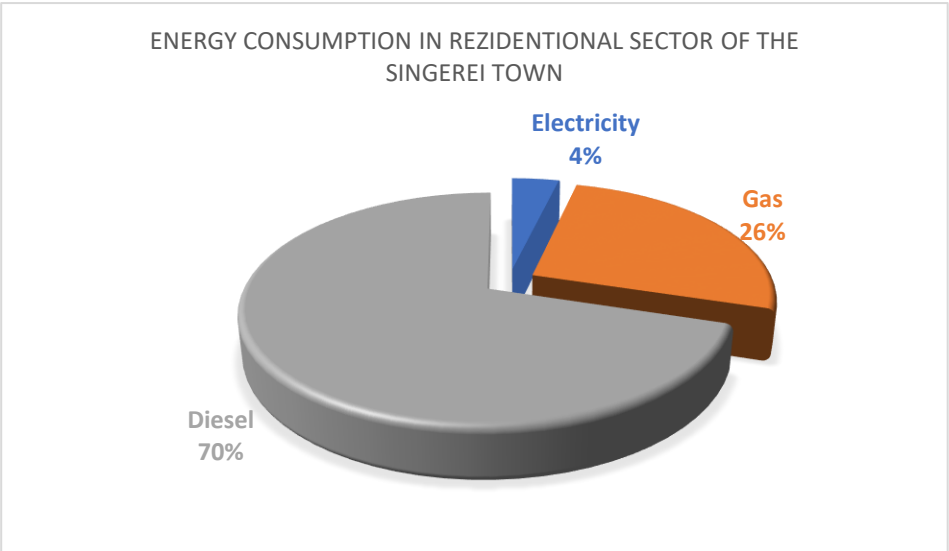

Fig. 6. Distribution of energy consumption in the residential sector in 2019

he residential sector consumes energy (fig.6) for transport (70% of total consumption), less natural gas (26%). Electricity is used in a small proportion (4%).

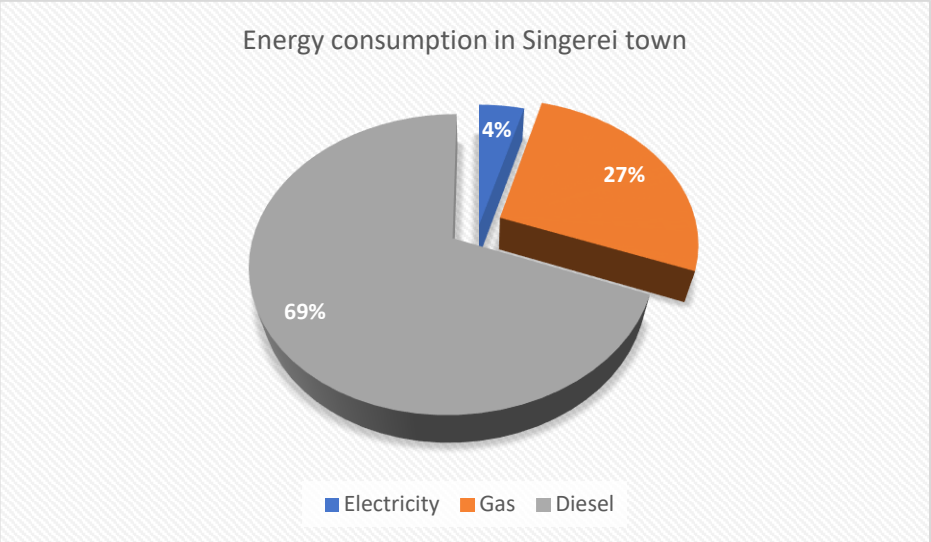

Fig. 7. Energy consumption in the city of Singerei in 2019

General energy consumption in the City of Singerei

In 2019, the city of Singerei consumed 3,472,800 kWh of electricity, 2,600,000m3 of natural gas and 5,621 tons of diesel. The distribution of energy consumption is presented in fig.7.

Most of the energy is obtained from diesel (69%). Natural gas is used by 27%, and electricity - only 4%.

CO_2 emissions in the town of Singerei

Calculations show that the city of Singerei emits over 24,306.52 tons of CO2 to a population of 13,400 people. The highest transport pollution by diesel consumption (72%). Natural gas contributes 21% and electricity consumption - 7%.

CO_2 emissions in the public sector amount to 472.96 tons. Pollution (fig.8) comes from electricity consumption (68%), natural gas (39%) transport (4%).

Most of the pollution comes from the residential sector (fig. 9) and is an index of poor development of the city's economy. It is an index of the lack of industries and services. Agricultural products are not processed locally.

CO2 emissions in the residential sector amount to 23833.56 tons. Pollution comes from the consumption of diesel (73%), natural gas (21%) and electricity (6%) (fig.8). The use of renewable energy and electricity can reduce greenhouse gas (GHG) emissions).

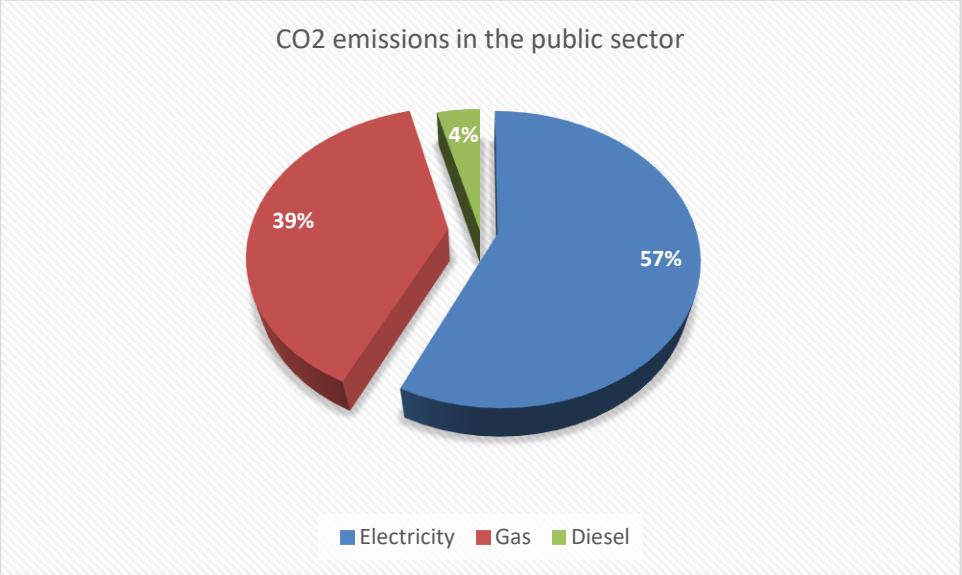

Fig. 8. CO_2 emissions in the public sector in 2019

As mentioned above, CO_2 emissions from the city's residential sector come from the consumption of diesel (73%), natural gas (21%) and electricity (6%). This sector certainly influences CO2 emissions throughout the city (Fig. 9), so that the distribution of pollution by type of fuel is almost the same as in the residential sector: from diesel (72%), natural gas (21%) and electricity (7%) (fig.10).

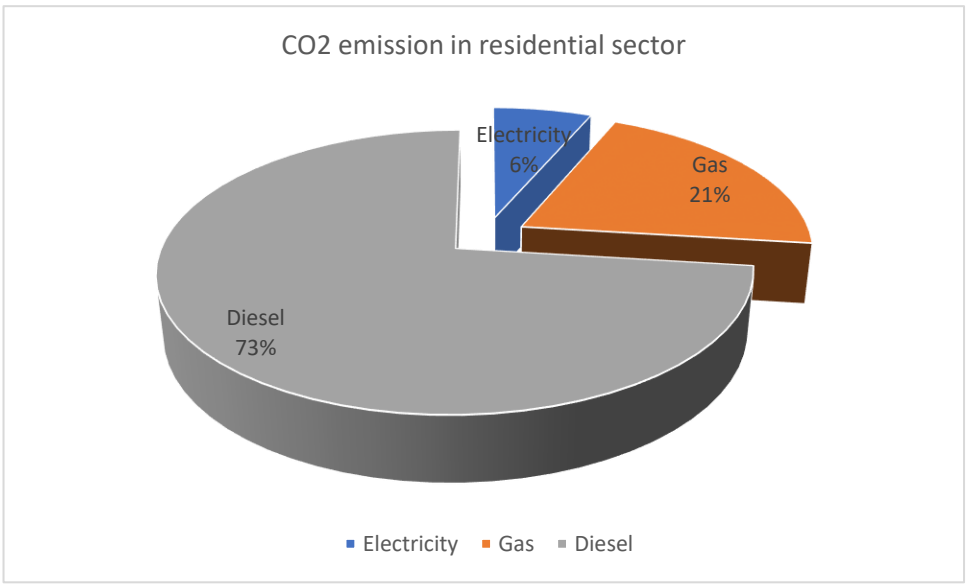

Fig. 9. CO_2 emissions in the residential sector in 2019

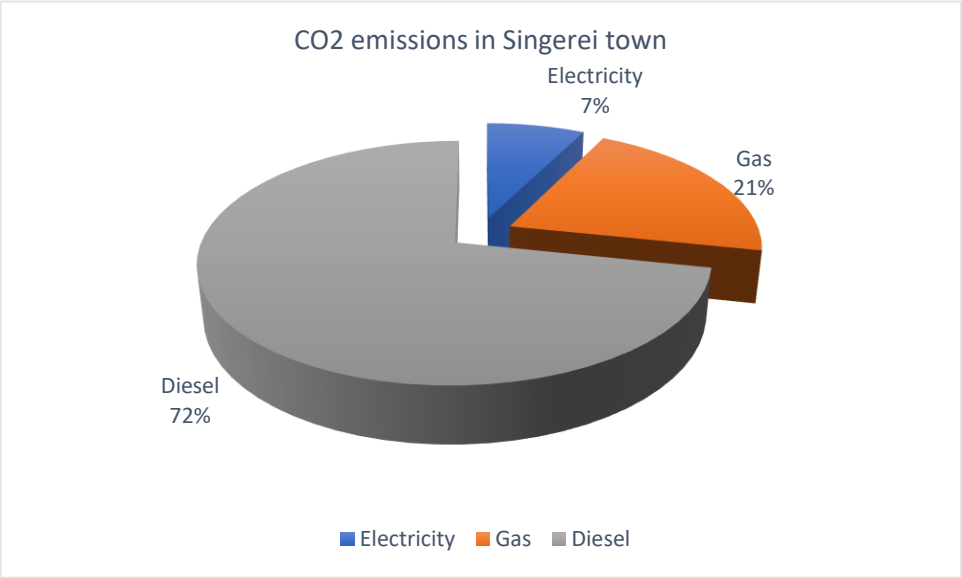

Fig. 10. CO_2 emissions in the City of Singerei depending on the type of fuel in 2019

The ecological situation

The city of Singerei is located in a green area with forests, ponds, lakes and the Ciulucul Mare stream, which passes on its edge. The meadow of the stream is undeveloped and almost dry (photo 5). It can be seen that in the past it was a humid area with rich flora and fauna. Ponds and lakes are also undeveloped and little used by the local population (photo 6).

The city practically does not have a sewerage and wastewater treatment system. At present, there is a treatment plant (photo 7) with a dubious efficiency, and the water passed through it for treatment is discharged into the environment. The wildlife in the

area is practically missing.

Photo 5. Ciulucul Mare River meadow

Photo 6. The current state of Lake Pobeda (Victoria)

Photo 7. Current state of the wastewater treatment plant

The large number of private cars, those that transit the city and those that pass around it on the R14 road is large, which generates a large amount of greenhouse gases (GHG).

3. The vision of actions

3.1 Buildings

Buildings are essential for the transition to a low-carbon economy. The average value U for existing walls and roofs is 1.4 ÷ 1.7 [W/m^{2}K], for windows U = 2.8 ÷ 3.2 [W/m^{2}K]. Mainly greenhouse gas emissions from this sector come from building heating and domestic hot water heating.

The solutions, which were defined after the analysis of the real situation, are presented in table 4 below.

BE1, BE2, BE3, BE4 and **BE5** refer to public buildings belonging to the city hall. **BE3** also refers to residential buildings.

LE refers to public buildings, mainly kindergartens, schools and street lighting.

Table 5. Energy efficiency measures in buildings

BE	Municipal, residential, tertiary buildings, equipment / facilities	Action
BE1	Building envelope	Thermal insulation of walls, replacement of old windows and doors, rehabilitation of roofs of public buildings and insulation.
BE2	Energy efficiency of building heating and domestic hot water preparation	Solar water heaters and PVT (photovoltaic thermal panels) installation on roofs and independent units
		Replacement of the old heating system in public buildings
		Production of biofuel from energy willow.
BE3	Installation of the individual heating boiler	Installation of individual heating plant operating on biofuel, their interconnection to solar heating systems.
BE4	Use of heat pumps	Use of "air-to-air" or "air-to-water" heat pumps for heating public buildings and obtaining domestic hot water
BE5	Energy efficiency of electrical appliances	Replacement of kitchen and laundry appliances operating in kindergartens and gas schools with electrical appliances
LE	Energy efficiency of lighting systems	Replacement of old technology lights with LEDs.

The detailed description of the defined solutions is presented below.

- **BE1. The building envelope. Thermal insulation of walls, replacement of old windows and doors, rehabilitation of roofs of public buildings and insulation**

The first step that must be applied in any type of existing engineering system is to reduce energy consumption. For this it is necessary to insulate the roof of the building and replace the old windows and doors in the first step.

The insulation of the walls must be made of mineral wool at least 100 mm thick and λ = 0.041 [W / m2K] with a density of at least 135 [kg / m3] according to SM SR EN 1602 or better.

The roof insulation must be made of mineral wool or extruded polystyrene (XPS) at least 100 mm thick and λ = 0.035 [W / m2K] with a density of at least 300 [kg / m3] according to SM SR EN 1602, covered with metal bonding made of concrete and waterproof layer of bituminous material. A good solution would be to use thermal insulation based on biomaterial that will not affect the environment after the expiration of the life of buildings. There is already a thermal insulation biomaterial with the same properties as those existing or even better, but the difference is that

when it enters the soil, it rots, preventing pollution.

In order to comply with buildings rehabilitated with local thermal requirements in terms of their elements, the U-value of the walls must be less than 0.22 [W / m2K] and the roofs 0.24 [W / m2K]. Replacement of old windows and doors should be done with windows and doors with non-recyclable PVC frame, with 7 rooms, U-type frame made of 1.2 mm thick reinforced metal covered with plastic layer, without thermal bridges. Low-emission double-glazed windows (Low-e) 4-20-4 [mm].

The U value of the windows must be less than 1.4 [W / m2K] and the doors - less than U = 1.8 [W / m2K].

The selected materials and their technical characteristics are based on good engineering practices and are in accordance with the regulations of the country.

Based on previous experience, heat consumption can be significantly reduced

compared to existing consumption. If the sanitary and hygienic norms are not observed, this reduction will be much smaller.

- **BE2. Solar water heaters and PVT (thermal photovoltaic panels) installation on roofs and independent units**

The city has a gas pipeline. Each residential house or apartment block uses its own gas or electric boiler.

Solar irradiation all year round is very favorable for the use of solar collectors for water heating (fig. 13) and photovoltaic panels (PV) for electricity generation (fig. 11,12). Moldovan legislation is also favorable.

1kWp of monocrystalline PV panel can generate 1,148kWh of electricity annually (fig. 11,13). Hybrid photovoltaic-thermal panels (PVT) include both, solar collector and photovoltaic panel that generates electricity and hot water. It is known that photovoltaic panels have a drawback that, with increasing temperature, decreases electrical efficiency by up to 70%, depending on temperature. PVT increases its efficiency by cooling and obtaining hot water for household needs. The average annual temperature and the low irradiation loss in the locality are 6.58%, according to fig. 10. Experience shows that a PVT panel (1.5m2) can supply 25 liters / day of hot water with a temperature of 55 ° C during the hot season, which is equal to 281kWh of additional annual energy efficiency from each panel.

Existing examples in the country show that energy consumption for water heating can be reduced by up to 80% by applying this type of measure.

Provided inputs:	
Location [Lat/Lon]:	47.628, 28.154
Horizon:	Calculated
Database used:	PVGIS-SARAH
PV technology:	Crystalline silicon
PV installed [kWp]:	1
System loss [%]:	14

Simulation outputs:	
Slope angle [°]:	35
Azimuth angle [°]:	0
Yearly PV energy production [kWh]:	1148.62
Yearly in-plane irradiation [kWh/m^2]:	1452.98
Year-to-year variability [kWh]:	58.42
Changes in output due to:	
Angle of incidence [%]:	-2.84
Spectral effects [%]:	1.28
Temperature and low irradiance [%]:	-6.58
Total loss [%]:	-20.95

Fig. 11. 1kWp monocrystalline (PV) photovoltaic panel inputs and outputs

Each public building is expected to have its own solar collector or photovoltaic-thermal panel (PVT) system, installed on the roof of the building or on the independent unit. The advantage of the PVT system is that it generates electricity and hot water simultaneously.

The solar collector and PV panels (PVT) must be installed at an angle of 35 ° to the south. They will be connected to a boiler that has the volume according to the needs or the number of family members consumer. An individual heating station will heat the water extra at the end of the month February to mid-November. About 30% of the primary heating energy in the residential sector is consumed for domestic hot water.

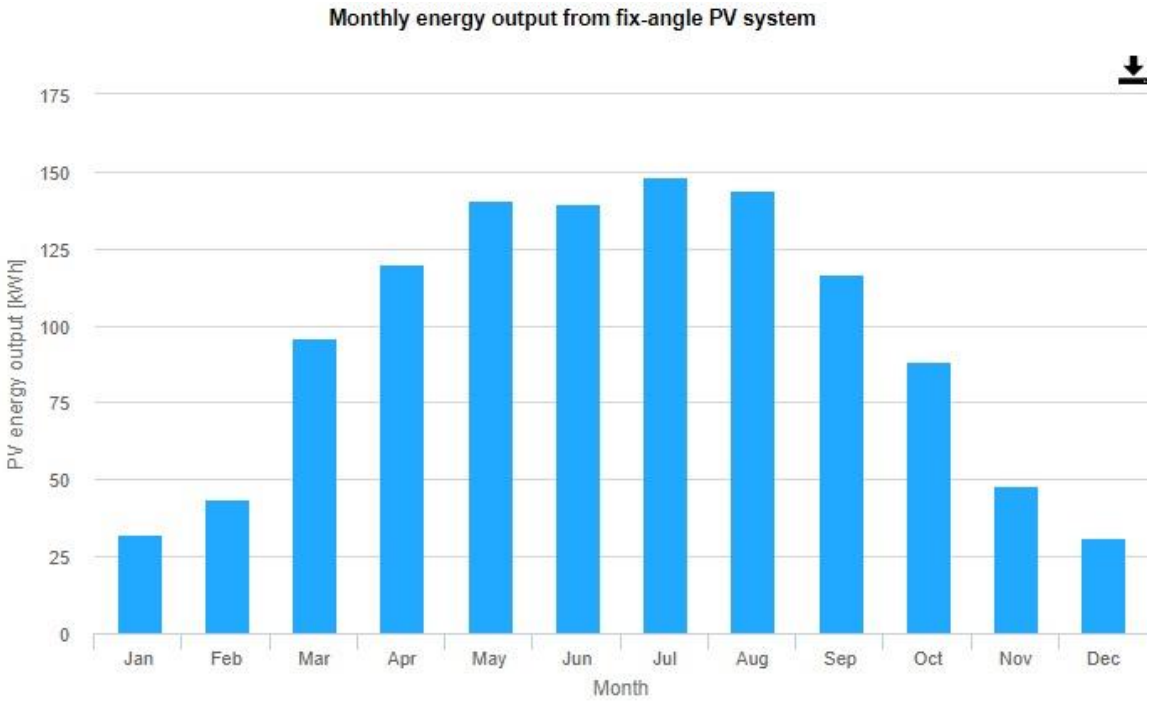

Fig. 12. Monthly electricity generation of the 1kWp monocrystalline (PV) photovoltaic panel in Singerei

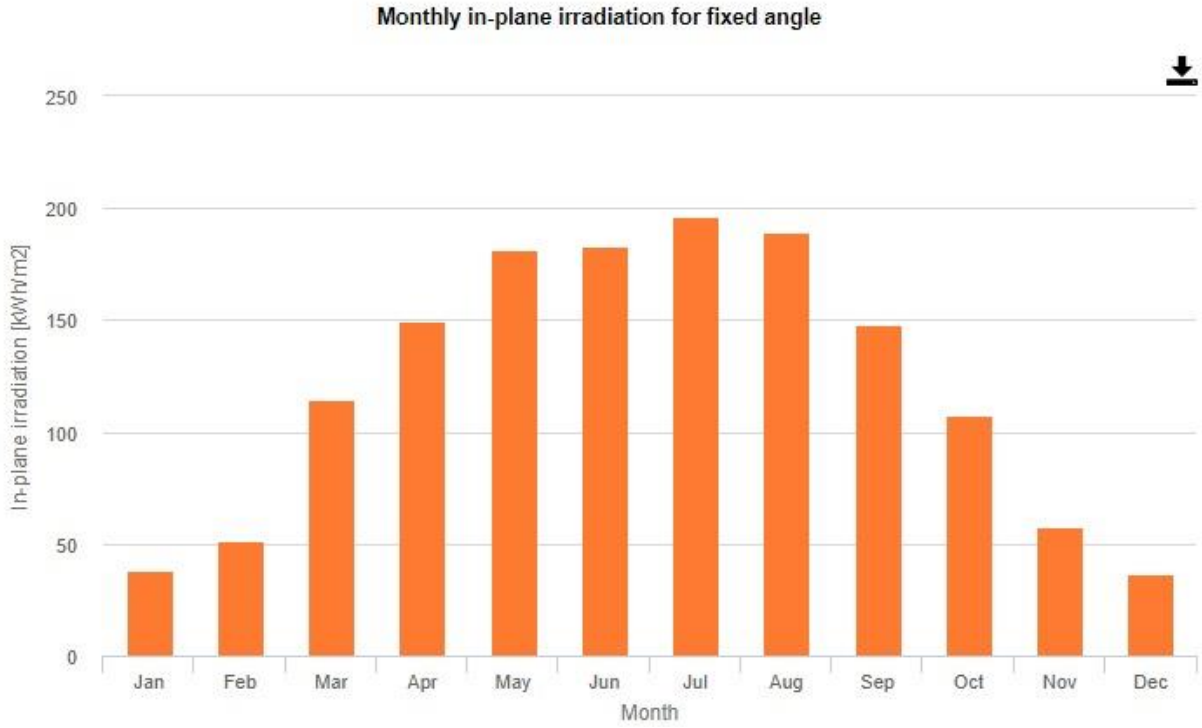

Fig. 13. Monthly solar irradiation per 1m^2 of photovoltaic-thermal panel (PVT) in Singerei

❖ **BE3. Production of biofuel from energy willow. Use of wood pellets in public and residential buildings**

There is a plot of 16.4ha (fig.17) on the banks of the Ciulucul Mare stream. This land can be used for energy willow plantations, which once every two to three years will have a yield of 20t / ha of dry material for pellets or chips. The total efficiency of the biofuel can reach 336 tons or 168 tons per year. Biofuel will replace coal and gas from the heating of public, residential and commercial buildings, improving interior comfort.

It will reduce CO2 emissions and provide the opportunity for a comfortable life.

Willow biomass crops can be planted on marginal agricultural land. A cultivator can harvest willow up to seven times from a single planting. Willow has the following advantages:

• It spreads easily from stem cuttings, on which new roots, shoots and leaves grow.

• Rapid growth rate, produces hardwood biomass 10-15 times faster than local forests.

• After each harvest, new stems re-grow rapidly from the remaining plant.

• Limited maintenance between harvests.

• The properties of willow chips are similar to forest residue chips and are suitable for mixing.

• High ornamental and landscape aesthetic value.

In addition to being a source of renewable energy and environmentally friendly products, the unique characteristics of willow make it ideal for a wide range of environmental applications:

• Live snow fences - prevents snow from blowing on the roads.

• Vegetable swabs - prevent the penetration of fertilizers and chemicals into rivers, ponds and waterways.

• Protection of soil resources - prevents erosion and stabilizes river banks.

• Environmental remediation - cleans and restores former industrial sites.

• Vegetable cover - a green alternative for the efficient coverage of landfills.

• Rehabilitated biodiversity - the plantation is an ideal location for birds, animals and insects.

It is possible to produce biofuel by implementing public-private partnership in the planting of energy willow and the production of pellets.

❖ **BE4. Use of air-to-air or air-to-water heat pumps for heating public buildings and obtaining domestic hot water**

A heat pump can ensure a healthy environment inside the building throughout the year, can provide warmth in winter and coolness in the warm season. It can provide the building with

domestic hot water all year round. An air source heat pump has three cycles: the heating cycle, the cooling cycle and the defrost cycle. During the heating cycle the heat is taken from the outside air and "pumped" inside the building. During the cooling cycle, the process described above is reversed for cooling the building during the summer. The heat pump draws heat from the air in the building and pushes it outside.

Modern heat pumps can operate at temperatures below -25 ° C and thus the building is provided with heat and cold throughout the year. The lowest temperature in the Republic of Moldova is -17 ° C for a period of 3 days.

It is necessary to compensate for the consumption of electricity from the city's own sources by using the "air-to-water" or "air-to-air" heat pump. The most suitable source is solar energy, which is the most valuable and cleanest renewable energy. Photovoltaic energy must cover the electricity demand of the heat pump for space heating, domestic water heating, LED lighting and other equipment.

From experience, the use of the "air-to-water" heat pump for space heating and domestic hot water (DHW) together with the use of photovoltaic-thermal panels (PVT) is the most feasible option for heating buildings and obtaining DHW. May exclude the use of fuel-based heating system (fossil or bio), significantly reducing greenhouse gas (GHG) emissions. The water temperature in the heating system can be 85 ° C, the domestic hot water temperature will not exceed 50 ° C. The simple payback period is 2.0-3.0 years with the life of the equipment 25-30 years.

The use of photovoltaic-thermal panels together with the "air-water" heat pump, LED lighting together with the thermal insulation of the walls and ceiling and the use of modern PVC windows and doors offers the possibility to pass the building in the class of passive buildings and transform it from a consumer of heat and electricity into a generator of them. The PVT system will operate in the net metering mode of the network, being permanently connected to the electricity distribution network, which means that the consumer generates electricity when he can, and consumes it when he needs. The hot water generated by the PVT system will be delivered to the building's domestic hot water pipe.

The PVT system combined with the "air-to-water" heat pump can provide space heating (100%), LED lighting (100%), food preparation (100%), domestic water heating (100%).

BE5. Replacement of the old heating system in public buildings

The replacement of the old heating distribution system is in line with EE Directive 2012/27 / EU.

Heating systems in public buildings were built over 25 years ago, with low maintenance. The radiators are made of cast iron. Radiators and water pipes have not been cleaned regularly, so they are sedimented with salts, rust and deposits of impurities. If the layer of salt sediments is 8 mm, then the efficiency of the system depreciates by 40%, so their renovation with new pipes and radiators is necessary.

The most efficient and reliable are bimetallic radiators with higher heat radiation than steel and cast iron and have 150-190W / section.

It is necessary to install individual control systems for heat consumption and control of consumption at the thermal point depending on the outside temperature with the renovation of the heating system.

The basic principle of automatic systems consists in regulating the flow of the thermal agent at the measured temperature inside (individual control) or outside the building. When adjusting the power of the boiler, it is used to measure the temperature of the outside air, when adjusting the radiators - the internal temperature. As the outside temperature and inside temperature increase, the flow of heat decreases proportionally and vice versa - it increases when the temperature inside the building and the outside air decreases. By reducing the heat flow, the value of the heat consumption decreases.

The internal heating distribution system will be redesigned. A heating control system based on internal and external temperatures will be installed at each station. The indoor temperature valve will be installed in each room.

- **BE6. Installation of new individual heating plants on biofuel, their interconnection with solar heating systems**

This measure will rehabilitate heating systems in public buildings. Now the heating plants are old, with low efficiency, running on coal and wood. They need manual operators.

The new stations will have to operate on wood pellets produced locally from energy willow. They will improve heating efficiency and reduce CO2 emissions.

Interconnecting the boiler with the solar water heating system will improve reliability

obtaining hot water throughout the year, having a balance between two energy sources: biofuel and solar.

BE7. Replacement of kitchen and laundry appliances operating in kindergartens and gas schools with electrical appliances

Incentives for the replacement of kitchen appliances and laundry for new ones in kindergartens and schools is Directive 2012/27 / EU. Kitchen equipment in kindergartens and schools in the city use natural gas, which creates the danger of accidental explosion. They need to be replaced with electrical appliances, which will eliminate the use of fossil fuels.

LE1.1 Replacement of lighting with old technology with LEDs in buildings

Public buildings are mainly lit with fluorescent lamps that lead to high energy consumption. Fluorescent tube lamps are more efficient than incandescent bulbs, but contain mercury vapor, being dangerous to humans and the environment. In addition, they have other shortcomings, and Ra is less than 80%. It is necessary to plan the rehabilitation of internal lighting systems in all public buildings by replacing old technology lamps with LEDs saving about 70% of energy.

In addition to saving energy, LED lighting has many advantages in indoor lighting:

- Ra is higher than 90%, which means a high color transmission. It is important for the health of children and adults;

- LED lamps do not contain dangerous elements and are environmentally friendly;

- They have the longest service life, which means saving on maintenance.

To raise awareness, the following solutions have been identified in the private, public and residential sectors.

Table 6. Administrative measures for existing buildings

BE1	Buildings	Action
BE11	Energy certification of public buildings	Elaboration and display of energy certificates for municipal buildings that will be rehabilitated
BE12	Regulation of energy efficiency for private buildings	Development and implementation of energy efficiency regulations for existing and new private buildings
BE13	Grants and subsidies	Partial subsidies / subsidies to replace old boilers with new ones for private homeowners
BE14	Grants and subsidies	Incentives to replace household appliances with new ones.

- **BE11. Energy certification. Elaboration and display of energy certificates for municipal buildings that need to be modernized**

  Placing certificates at the entrances of public buildings will raise awareness and produce more positive effects.

  The energy certificates displayed on the buildings related to the residential sector will show the owners the real energy consumption of the building and what will be the consumption after rehabilitation, as well as the cost of the measures. They can estimate the monthly bill expenses.

  The energy certificate for public buildings will make administrators look for ways to better manage energy consumption.

- **BE12. Regulation of energy efficiency for private buildings**

  The mayor's office will adopt regulations for the construction of new private buildings and the renovation of old ones. They will contain requirements on energy efficiency, waste collection and environmental protection.

- **BE13. Grants and subsidies. Incentives to replace household appliances with new ones**

  The mayor's office will look for opportunities to participate in competitions for international donors, country funds and government organizations.

- **BE14 Grants and subsidies**

  It is necessary to replace old, inefficient appliances in classes D or E in the residential sector, which need to be replaced with type A +++ equipment. Co-financing of the measure of up to 30% is foreseen. It is expected to finance this measure from local taxes, ESCOs or low interest loans and donor organizations.

- **B15. Subsidies/Subsidies for replacing old boilers with new biomass boilers for homeowners**

  Given that most of the buildings in the city belong to the private sector, it will be decided to make it easier for homeowners to replace old boilers with new, more efficient ones.

  A fund is expected to be formed that will attract investment from various donor organizations, which could cover about 50% of the cost of purchasing new boilers.

  All existing boilers mainly use gas, wood and coal with a low efficiency rate, around 60-70%.

  The new boilers are expected to use biomass with at least 90% heat generation efficiency.

This measure significantly reduces CO2 emissions. According to the SECAP template, the IPCC emission factor for municipal biomass waste is considered 0 (zero), which means that by applying this measure, emissions will be completely excluded.

The impact of the measures on public buildings is presented in the table below.

Table 7. Impact of the implementation of the measures

№	Actions	Estimated investment, [euro]	Calculated reduction in energy consumption, [MWh / year]	Calculated reduction in CO2 emissions, [tones / year]
BE1	Thermal insulation of walls, replacement of old windows and doors, rehabilitation of roofs of public buildings and insulation.	6,881,638	4,259.2	740,457
BE2	Solar water heaters and PVT (thermal photovoltaic panels) installation on roofs and independent units	600,000	1,200.0	348
BE3	Production of biofuel from energy willow. Use of wood pellets in public and residential buildings	75,000	450	91.0
BE4	Use of "air-to-air" or "air-to-water" heat pumps for heating public buildings and domestic hot water	229,500	1162.5	515.4
BE5	Replacement of the old heating system in public buildings	144,000	534	108
BE6	Installation of the individual heating plant, their interconnection to the solar heating systems.	248,000	9600	1,940
BE7	Replacement of kitchen appliances operating in gas kindergartens and electric schools	155,000	Securitatea copiilor se va îmbunătăți	
LE1	Replacing old technology lights with LEDs in buildings and street lighting	265,000	1,185.5	525.6
TE	Construction of charging stations for electric cars with a capacity of 300 cars per day	100,000	6,351	1,695.7
PG1	Construction of a 2.0 MW commercial photovoltaic park	2,000,000	2,296	1,018

WW1	Design and construction of the sewerage system and wastewater treatment plant	2,435,928	The level of environmental protection will increase
CA1	Planting 16.4 ha of energy willow	50,000	The level of environmental protection will increase
CA2	Establishing the production of pellets based on public-private partnership	50,000	The level of environmental protection and welfare will increase
CA3	Creation of a recreational area on the banks of the river Ciulucul Mare based on public-private partnership	300,000	The level of environmental protection will increase
CA4	Planting 7.6 ha of trees on the bank of the river Ciulucul Mare	150,000	The level of environmental protection will increase
CA5	Cleaning and deepening of the 10.5 ha of Pobeda Pond (Victoria)	300,000	The level of environmental protection will increase
CA6	Cleaning and deepening of the 14.7 ha of Comsomolist Lake	350,000	The level of environmental protection will increase
CA7	Construction of the 78.5ha rainwater storage basin of the water mirror	500,000	The level of environmental protection will increase

Note:
The national IPCC emission factor for electricity is 0.4434 [t · CO2 / MWh].
According to Part II "Basic Emission Inventory", the standard IPCC emission factor for natural gas is 0.202 [t · CO2 / MWh].
According to the SECAP template, the IPCC emission factor for municipal biomass waste is considered 0 (zero)

3.2 Street lighting

The current situation

The city of Singerei has 45 km of illuminated streets. On the illuminated streets are installed lamps of old technologies, mainly high-pressure lamps with sodium vapor and mercury vapor of 250W, which consumed 238,812kWh in 2019. Another 15km of streets have no lighting, which means that only 75% from the streets are illuminated.

On average, street lighting operates 3877 hours per year.

Vision for the future

In order to ensure road and human safety through energy efficient street lighting, the following measure is proposed:

Table 8. Energy efficiency measures in public lighting

LE	Public lighting	Actions
LE1	Energy efficiency of lighting in public buildings	Replacing old technology LED lights in public buildings
LE2	Energy efficiency of street lighting	Install smart street lighting on all streets

The detailed description of the defined solution is given below:

❖ **LE1.2 Replacement of old technological lights with LEDs in street lighting**

Modern street lighting is based on LED lamps and the use of lighting fixtures. Modern street lighting based on the use of LED luminaires offers great energy savings and money for maintenance. In addition, being used they allow the control of light intensity depending on the time of night, pedestrians or cars present.

Therefore, the street lighting in the city must be with LED and intelligent control, which can further inform about the maintenance of the system and other things.

Given that the streets proposed for lighting are S6 class, the installation of 25W LED lights is calculated.

The calculations were performed according to modern methods of calculating street lighting. The distance between the newly placed pillars is considered to be 30m and will be installed on one side of the street. In total, 500 luminaires based on LED technologies will be installed and another 1,500 will be replaced.

The impact of applying this measure is shown in the table below.

Table 9. Impact of the implementation of the measure in public lighting

№	Measure	Estimated investment, [euro]	Calculated reduction in energy consumption, [MWh / year]	CO2 reduction, [tones / year]
LE1	Replacing old technology LED lights in public buildings	140,000	85.5	37.9
LE2	Replacing old technology lights with LEDs and lighting new streets	75,000 50,000	825 275	365.8 121.9

Note: The national emission factor for electricity is 0.4434 [t · CO2 / MWh].

3.2 Transport

The current situation

The transport sector has an important role in the daily life of the city, supporting economic development.

The city of Singerei is connected to Bălți by the R14 Bălți-Chișinău road, which is forked - a part passing through the city.

A large amount of pollution comes from transport on the national highway, but most of it is generated by local transport in the private, residential and economic transport sectors. Transportation is regulated by the government.

Local road infrastructure is 60 km away. About 50% of the roads are in a satisfactory condition. Many roads are paved, and some are country roads, without rigid cover and without sidewalks, which makes it difficult for the elderly, people with disabilities, mothers with strollers and children. The city lacks public transport, which makes it difficult for children to travel to schools, people - to public institutions and hospitals.

All city roads are shown in fig. 14.

There are about 3,000 privately owned vehicles and about 1,000 vehicles pass through the city every day. It is estimated that car transport consumes 5,621 tons of diesel annually. As a result, CO2 emissions from transport is at the level of 17428.7 tons.

Transport regulation is the responsibility of the central authorities, so the City Hall cannot solve this problem.

3.4 Energy

POWER SUPPLY

The current situation

The National Electric System supplies the city of Singerei through the electricity distribution company "Red Nord" SA. „Red Nord” SA is the sole owner of the distribution networks in the north of the Republic of Moldova.

In order to ensure the city's energy autonomy and lower electricity consumption, it is appropriate to produce electricity locally using renewable energy sources.

The energy produced can cover the consumption of electricity in public buildings, street lighting, the operation of heat pumps, as well as the partial heating of domestic water.

Fig. 14. Roads, streets and the transport plan of the Singerei city

Table 10. Measurement of local electricity production

PG	Local electricity production	Measure
PG1	Photovoltaic	Construction of a 2.0 MW photovoltaic park

The detailed description of the defined solutions is presented below:

❖ **PG1. Construction of a photovoltaic park with a power of 2.0MWp**

The current legislation[2] of the Republic of Moldova encourages the construction of a commercial photovoltaic farm in order to produce clean energy. The city hall owns a large area of unused land, which is not available for agricultural use. The land with an area of 4.2ha can be used for the construction of a photovoltaic park. The mayor's office will attract private investment for its

[2]LAW No. 10 of 26-02-2016 on promoting the use of energy from renewable sources

construction and will form a public-private partnership. She will come with the land and the private

Table 11. Impact of the implementation of local electricity production

PG	Local electricity production	Measure	Amount of generated electricity, MWh / year	Reduced CO2 emissions, tons
PG1	Photovoltaics	Construction of a 2.0 MW commercial photovoltaic farm	2,297.2	1,018.5

investor - with the investment. The amount of electricity generated annually is 1148.6kWh for every 1 kWp of photovoltaic panel installed (fig. 15).

The advantage of the area is that a 35kV power line passes near the planned park. A 35 / 10kV power station is close to that place, where energy can be generated in the grid. As it can be seen

Fig.15. Location of the 2.0MWp photovoltaic farm

from the table 10, this action will annually replace 2,297,200kWh of fossil electricity and will reduce CO2 emissions by 1,018.5 tons.

THERMAL ENERGY

The current situation

Natural gas is delivered through gas pipelines in the city. They are used to obtain thermal energy for heating, domestic water and cooking food.

The mayor's office intends to plant 16.4 ha of energy willow on the banks of the Ciulucul Mare stream to reduce the consumption of natural gas and firewood obtained by cutting forests. The planned amount of pellets produced should cover the needs of public buildings, companies and households.

In addition, it is planned to replace the old individual heating stations with the new ones, which run on biomass.

The heating stations will be interconnected with the solar water heating installations.

3.3 Water and wastewater

The current situation

All households and businesses benefit from water. The city consumes 268,000m3 of water annually, being provided 100% of public buildings and residential houses with water through pipes with a length of 50.5 km. Domestic consumers use 242,000m3 and non-domestic consumers - 26,000m3.

The city of Singerei does not have a centralized sewerage system and a wastewater treatment system.

In the city there are 2,126 users of centralized sewerage and 2,866 users of local sewerage. Most of the wastewater is dumped into individual drains and then transported by cisterns to the authorized landfill outside the city. 100% of public buildings and 42% of residential houses have indoor toilets.

Most households do not have such a system, and wastewater is stored in hand-dug and unprotected outdoor pits, called toilets. Because of this, soils and groundwater sources are contaminated. The residential area has more than 2,000 outdoor toilets.

In addition, the sewerage from the neighboring households reaches directly into the Ciulucul Mare stream or into the groundwater. All this strongly pollutes the flow through industrial, agricultural and residential wastewater.

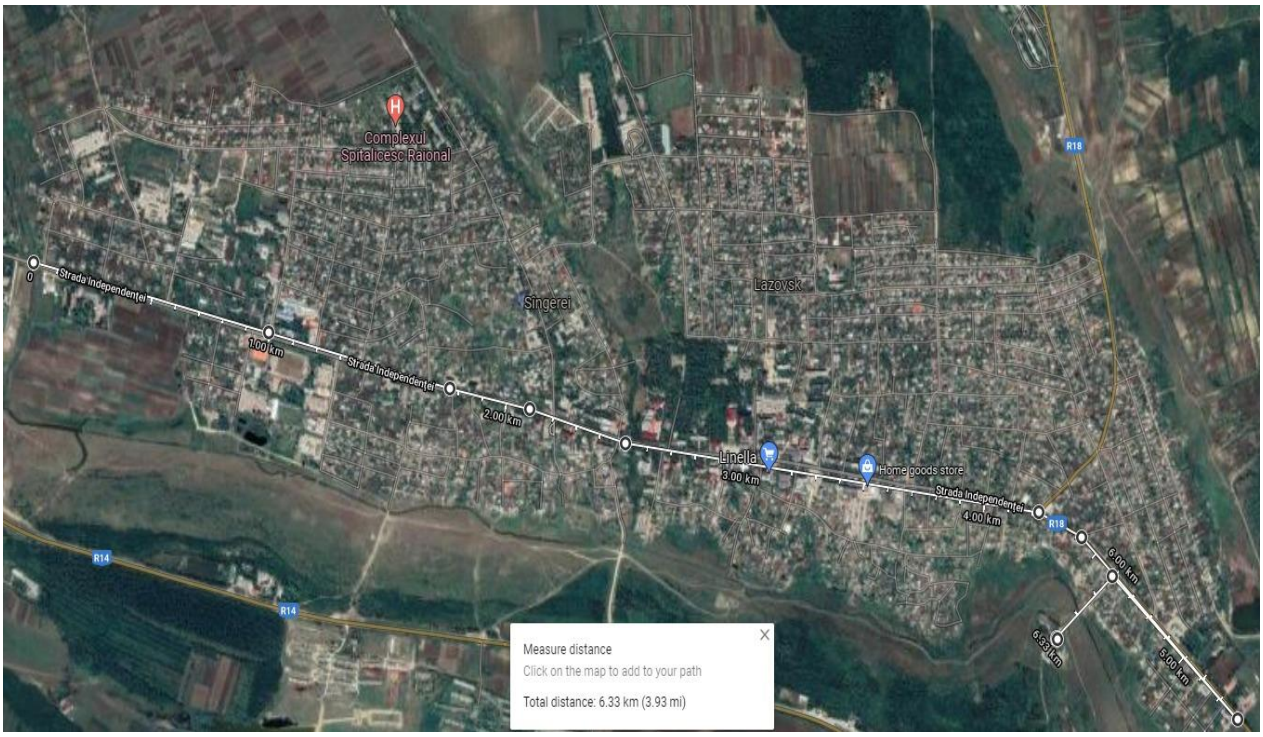

Fig.16. Diagram of the planned central line of the sewerage system

The treatment plant was built in 1973 and is in deplorable condition. It processes 130.4 thousand m3 of wastewater annually, which is only 48% of the volume of water used.

Household waste is managed by a municipal waste disposal company. About 70% of households use its services. The waste is stored in a specially equipped place.

Another problem is the storage of manure from about 195 cattle, 250 pigs, 1,545 sheep and goats, 21 horses and over 4,850 poultry. Now animal owners are dumping garbage outside the city, on agricultural fields to obtain organic fertilizers.

The mayor of the city obliged the municipal enterprise and the households to collect and deposit the waste outside the commune, in the authorized and arranged place.

The solution that was defined after the analysis of the situation is presented in table 12 below.

Table 12. Waste and wastewater management measures

WW	Name	Measure
WW1	Waste and wastewater management	Design and construction of a sewerage system together with the wastewater treatment plant

The detailed description of the defined solutions is presented below:

❖ **Waste and wastewater management**

There is a need to improve the living standards of 2,866 households by building a centralized sewer system. The city hall must design and build a sewage system together with their treatment plant, including the estimated cost of the executive project. Several years ago, the construction of the wastewater treatment plant was initiated, which was not completed and is not connected to the sewerage system. It must be completed together with the construction of a new sewerage system. The central pipe of the sewer system could be as illustrated in fig. 16, but will be materialized at the design stage. The centralized sewerage system and the wastewater treatment plant will considerably reduce the negative impact on the environment, especially on the Ciulucul Mare stream. It will also have a positive impact on groundwater resources and improve people's well-being.

❖ **WW1. Design and construction of the sewerage system and wastewater treatment plant**

The construction of the sewerage system and the wastewater treatment plant will solve the problem with the spread of wastewater inside and outside the city. As mentioned above, in the residential area of the city there are over 2,000 outdoor toilets, which intensely pollute groundwater.

By building the sewerage system and the wastewater treatment plant, the city will protect the environment from pollution.

❖ 3.5 Climate mitigation and adaptation

❖ **CA1. Planting 16.4 ha of energy willow**

Planting energy willow is an important action to improve climate change mitigation and adaptation. This will make the city greener, mitigate the influence of rainfall, the consequences of melting snow in winter and spring and air currents in summer. Willow will fix the river banks, steep slopes and help prevent landslides. It will also clean the air. One hectare of willow absorbs over 65 tons of CO2 annually from the air. Willow cultivation is also suitable for the climate less favorable to the conditions of classical agriculture. At the same time, it helps to conserve ecosystems.

The plantation will retain rainwater and snowmelt that will slow the evaporation of water during the dry summer period and will positively influence the mitigation and adaptation of climate change. The plantation will retain rainwater and snowmelt that will slow the evaporation of water

during the dry summer period and will positively influence the mitigation and adaptation of climate change.

Fig. 17. Planned energy willow plantation of 16.4 ha

Wildlife, birds and insects will host the plantation by rehabilitating biodiversity.

The city hall has no power to invest in this activity, therefore, it is wise to solve it by implementing the public-private partnership. The town hall can provide land (fig. 17) for the plantation and the private partner will bear all the expenses for planting and production.

biofuel. It also covers the costs of purchasing, caring for, harvesting, transporting and storing the marketing of willow pellets. Another option could be considered.

Energy willow is planted only once and harvested, starting in the second or third year, for 25-30 years. Energy willow can be cut about 12 times, once every two to three years.

- **CA2. Establishing the production of pellets based on public-private partnership**

Establishing the production of wood pellets from energy willow will reduce CO2 emissions in the city and will contribute to economic growth. It will open the biofuels market in this area, that most potential customers are in the city (kindergartens, school, other public buildings and

residents). In addition, there is a shortage of wood biofuel in the Republic of Moldova. The company will create jobs to operate. All this will increase the Town Hall budget.

- **CA3. Creation of a recreational area on the shores of Lakes Comsomolist and Pobeda (Victoria)**

The lakes Comsomolist and Pobeda (Victoria) (fig. 18,19) were built many years ago and are now muddy and impassable for recreation.

Their rehabilitation through deepening and development will lead to the emergence of biodiversity, will attenuate the influence of climate change, will keep the area warmer in winter and

Fig. 18. Comsomolist Lake development area

cooler during the hot time. The development of the banks and the creation of recreational areas will create jobs and business in services, which will create revenue in the local budget.

Fig. 19. The area of Lake Pobeda (Victoria)

❖ **CA4. Creation of a recreational area in the meadow of the Ciulucul Mare stream**

The area is located in the south of Singerei. The available surface is 78.5ha (fig.20). It is not used for agriculture or leisure.

In order to turn it into a recreational area, it is necessary to create a water basin, which will collect rainwater and groundwater. On the shores must be arranged a beach with recreational infrastructure, planting trees, building rest houses and places for amateur fishing.

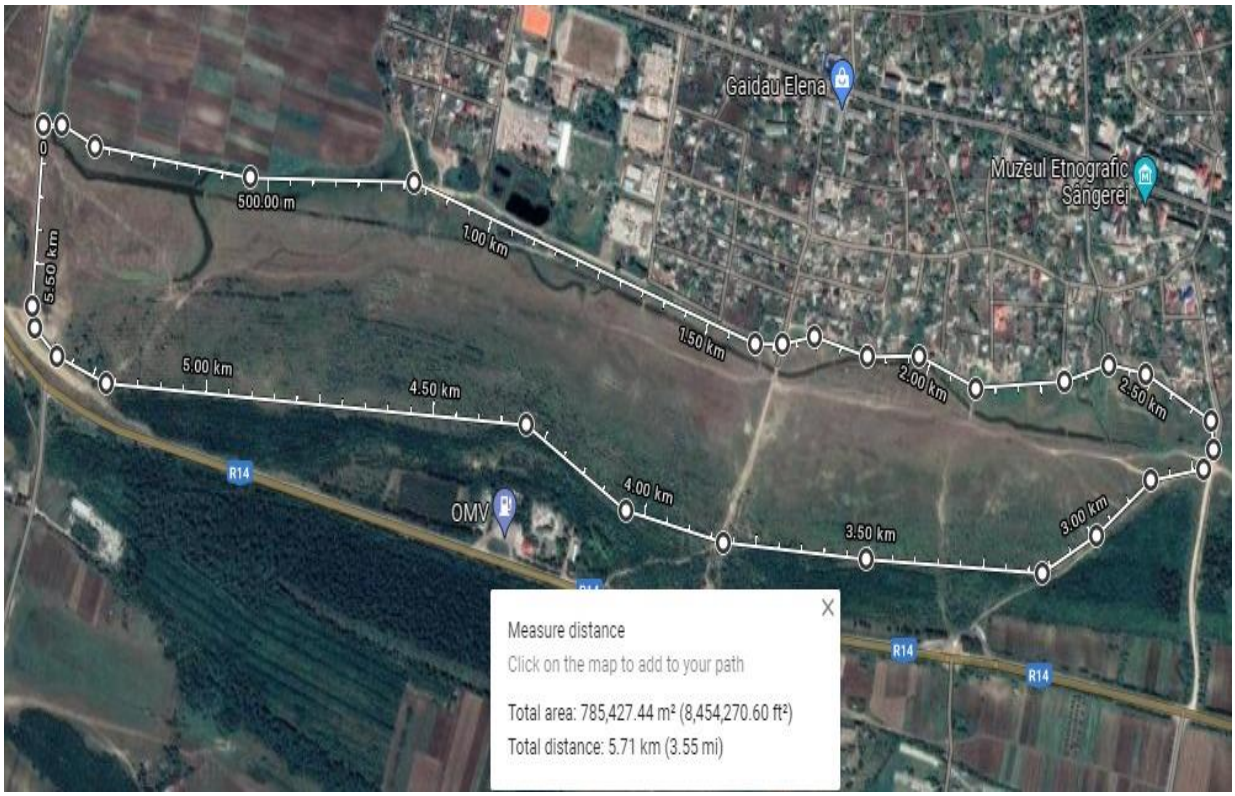

Fig.20. Plan of the water accumulation basin and recreational area

The mayor's office has no budget for such an action. An alternative source of funding can be the public-private partnership, where the City Hall will provide the land and the private partner will invest in building the lake and recreation area.

This measure will accumulate rainwater and help mitigate climate change, save and spread biodiversity, and help people use a modern form of rest.

This action will increase the City Hall budget through new jobs, business creation in services and through its bidder in the public-private partnership company.

❖ CA4. Afforestation of the banks of the Ciulucul Mare River

Ciulucul Mare River is practically dry during the summer. This phenomenon is the result of the lack of forests, wetlands, which would supply the stream with water.

There is a plot of land of 7.6 ha of land along the stream in the southwestern part of the city (fig.21), which can be used for planting trees. The situation should be used for planting the forest on both sides of it.

Young trees absorb CO2 at a rate of 5.9 kg per tree each year. Trees reach their most productive stage of carbon storage in about 10 years; at which time they are estimated to absorb 21.8 kg of CO2 per year. Typically, a high-density hardwood tree plantation uses a distance of 1.8 m

between trees and 6.6 m between rows of trees, and a high-density hardwood tree plantation uses a distance 3.3 m between trees and 10 m between rows. The town hall plans to have a plantation of high-density softwood trees. In this case it will be 1 tree at 3.0m^2 or 333 trees / ha. The total amount will be 2581 planted trees that will absorb 15.4t of CO_2 annually being young and 57.0t in 10 years. On average, they will absorb 36.2t of CO_2 annually.

This measure will keep the area cool during the hot summer and stop snow and moisture during the winter and spring. It will develop biodiversity. In addition, it will improve the well-being of residents as a place to walk and rest.

Fig.21. The area to be afforested

4. Organizational and financial aspect

The city hall will request funding from various sources to achieve the objectives of PAEDC with the prior approval of the Local Council. The city hall will hire professionals, who will be responsible for the management and development of energy efficiency and environmental projects in the city area. The overall budget required for the implementation of the actions of the current PAEDC is

estimated at 15,034,066 euros by 2030.

Several sources of funding have been defined:

Local donors: the national state budget, the local budget of the Singerei city, the Agency for energy efficiency and the National Ecological Fund.

External donors: Sweden (AIDS), Germany (GIZ), SUDEP, Horizon 2020, USAID, International Climate Initiative (IKI), GHG etc.

The technical supervision of the execution of the works will be ensured by the local consultancy companies contracted by the commune City Hall. The submission of the implementation and monitoring reports will be made by the person designated by the Town Hall.

5. Baseline Emission Inventory (BEI)

Baseline Emission Inventory		
1) Inventory year	2019	
2) Number of inhabitants in the inventory year	6,055	
3) Emission factors	☑	IPCC
	☐	LCA (Life Cycle Assessment)
4) Emission reporting unit	☐	tonnes CO_2
	☐	tonnes CO_2 equivalent

Table 13. Final energy consumption

Sector		FINAL ENERGY CONSUMPTION [MWh]						
		Electricity	Heat/cold	Fossil fuels				Total
				Gas	Diesel	Gasoline	Coal	
BUILDINGS, EQUIPMENT/FACILITIES AND INDUSTRIES								
Municipal buildings, equipment/facilities		369.13		911.25				**1,280.38**
Tertiary (non municipal) buildings, equipment/facilities		0		0				**0.00**
Residential buildings		3,472.80		24,180				**27,652.8**
Public lighting		238.81						**238.81**
Industry	Non-ETS	-		0			0.00	**0**
Subtotal		**4,080.74**		**25,091.25**				**29,171.99**
TRANSPORT								
Private and commercial transport					72.38			**72.38**
Subtotal		**0**	**0**	**0**	**72.38**			**72.38**
OTHER								
Agriculture, Forestry, Fisheries		0	0	0	0	0	0	**0**
TOTAL		**4,080.74**	**0**	**25,091.25**	**72.38**			**29,171.99**

Table 14. Adopted CO2 emission factor[t/MWh]

Electricity		Heat/cold	Fossil fuels			
National	**Local**		Gas	Diesel	Gasoline	Coal
0,4434			**0,202**	**0,267**	**0,249**	**0,354**

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Table 15. Emission inventory

Sector	CO_2 emissions [t] / CO_2 eq. emissions [t]						
			Fossil fuels				
	Electricity	Heat/cold	Gas	Diesel	Gasoline	Coal	Total
BUILDINGS, EQUIPMENT/FACILITIES AND INDUSTRIES							
Municipal buildings, equipment/facilities	164		184				**348**
Tertiary (non municipal) buildings, equipment/facilities	0		0				**0**
Residential buildings	1540		4884				**6424**
Public lighting	105.89		0				**105.89**
Industry		0				**0**	**0.00**
Subtotal	**1809.4**	**0**	**5068**	**0**	**0**		**6877.8**
TRANSPORT							
Private and commercial transport	0	0	0	19	0	0	19
Subtotal				19	**0**	**0**	19

OTHER							
Agriculture, Forestry, Fisheries	0	0	0	0	0		0
OTHER NON-ENERGY RELATED							
Waste management							0
Waste water management							0
Other non-energy related							0
TOTAL	**1809.4**	**0**	**5068**	**19**	**0**	**0**	**6,897.12**

6. Climate risk and vulnerability assessment (RVA)

As there were no climate disasters that led to harmful consequences, no risk and vulnerability assessment studies or LPA decisions for the urban area were developed. In the event of any risks, appropriate measures will be taken.

Possible hazard risks and their indicators in relation to the region are presented in the table below.

Table 16. Hazard indicators and risks

	<< Current Risks >>	<< Anticipated Risks >>		
Climate Hazard Type	**Current hazard risk level**	**Expected change in intensity**	**Expected change in frequency**	**Timeframe**
Extreme Heat	Moderate	Not known	Not known	Short-term
Extreme Cold	Low	Not known	Not known	Short-term
Extreme Precipitation	Low	Not known	Not known	Short-term
Floods	Low	Not known	Not known	Short-term
Droughts	Moderate	Not known	Not known	4 years
Storms	Low	Not known	Not known	Short-term
Landslides	Low	No change	No change	Short-term
Other [please specify]	[Drop-Down]	[Drop-Down]	[Drop-Down]	[Drop-Down]

Table 17. Other Risks and Indicators.

Impacted Policy Sector	Expected Impact(s)	Likelihood of Occurrence	Expected Impact Level	Timeframe
Buildings	Increased costs for maintenance of the buildings.	Likely	Moderate	Long-term
Transport	Pollution rising by increased number of vehicles	Possible	Moderate	Short-term
Energy	Strong wind and black ice may affect electrical distribution network.	Possible	Low	Short-term
Water	Droughts	Likely	Moderate	4 years
Waste	Waste management fail	Unlikely	Moderate	Short-term
Land Use Planning	Wrong planning (floods)	Unlikely	Low	Short-term
Environment & Biodiversity	Ecosystem degradation	Likely	Moderate	Not known
Health	Increasing mortality rate	Unlikely	Low	Long-term
Civil Protection & Emergency	Reduction of the civil protection and emergency services	Unlikely	Not Known	Not known
Other [please specify]		[Drop-Down]	[Drop-Down]	[Drop-Down]

5. Key actions for the duration of the plan (2030)

Table 18. Key actions for the duration of the plan (2021-2030)

Key Actions	Area of intervention	Policy instrument	Origin of the action	Responsible body	Implementation timeframe		Implementation cost	Estimates in 2030			Action also affecting adaptation
					Start	End		Energy savings	Renewable energy production	CO2 reduction	
							€	MWh/a	MWh/a	t CO2/a	
MUNICIPAL BUILDINGS, EQUIPMENT/FACILITIES							**8,473,138**	**4878.7**	**12,412.5**	**618.10**	
Thermal insulation of walls, replacement of old windows and doors, rehabilitation of roofs of public buildings and insulation.	Energy efficiency of public buildings		Local authority	Singerei Town Hall	2021	2030	6,881,638	4,259.2		108.1	Adapting to climate change
Solar water heaters and PVT (photovoltaic thermal panels) installation on roofs and independent units	Energy efficiency of public buildings,		Local authority	Singerei Town Hall	2021	2030	600,000		1,200.0	34.8	Adapting to climate change
Production of biofuel from energy willow. Use of wood pellets in public and residential buildings	Adapting to climate change		Local authority	Singerei Town Hall	2021	2030	75,000		450	60.7	Climate change mitigation and adaptation

Use of air-to-air or air-to-water heat pumps for heating public buildings and obtaining domestic hot water	Energy efficiency of public buildings. Climate change mitigation and adaptation		Local authority	Singerei Town Hall	2021	2030	229,500		1162.5	171.8	Adapting to climate change
Replacement of the old heating system in public buildings	Energy efficiency of public buildings		Local authority	Singerei Town Hall	2021	2030	144,000	534		10.8	
Installation of the individual heating plant, their interconnection to the solar heating systems	Energy efficiency of public buildings		Local authority	Singerei Town Hall	2021	2030	248,000		9600	194.0	
Replacement of kitchen appliances running on gas kindergartens and electric schools	Energy efficiency of public buildings		Local authority	Singerei Town Hall	2021	2030	155,000		Child safety will improve		
Replacement of old LED lighting technology in PUBLIC buildings	Energy efficiency		Local authority	Singerei Town Hall	2021	2030	140,000	85.5		37.9	
Estimated reduction not associated with any reported actions							0	0	0	0	

PUBLIC BUILDINGS							**8,473,138**	**4,878.7**	**12,412.5**	**618.1**	
STREET LIGHTING							**125,000**	**1,100**		**35.8**	
Installation of smart street lighting on all streets	Energy efficiency		Local authority	Singerei Town Hall	2021	2030	125,000	1,100		35.8	
Estimated reduction not associated with any reported actions							0	0	0	0	
LOCAL ELECTRICITY PRODUCTION							**2,000,000**		**2,297.2**	**1,018.5**	

2.0MW photovoltaic power generation	Electricity production, climate change reduction and adaptation		Local authority	Singerei Town Hall	2021	2030	2,000,000		2,297.2	1,018.5	Climate change mitigation and adaptation
Estimated reduction not associated with any reported actions							0	0	0	0	
OTHERS							**4,435,928**	**0**	**0**	**0**	
Design and construction of the sewerage system and wastewater treatment plant	Climate change mitigation		Local authority	Singerei Town Hall	2021	2030	2,435,928	The level of environmental protection and welfare will increase			
Construction of charging stations for electric cars with a capacity of 300 cars per day	Climate change mitigation		Local authority	Singerei Town Hall	2021	2030	50,000		6,351	1695.7	Climate change mitigation and adaptation
Planting 16.4 ha of energy willow	Climate change mitigation		Local authority	Singerei Town Hall	2021	2030	50,000	The level of environmental protection will increase			
Establishing the production of pellets based on public-private partnership	Climate change mitigation		Local authority	Singerei Town Hall	2021	2030	300,000	The level of environmental protection will increase			

Creation of a recreational area on the banks of the river Ciulucul Mare based on public-private partnership	Attenuating climate change adaptation		Local authority	Singerei Town Hall	2021	2030	300,000	The level of environmental protection and welfare will increase			
Planting 7.6 ha of trees on the bank of the river Ciulucul Mare	Attenuating climate change adaptation		Local authority	Singerei Town Hall	2021	2030	150,000			36.2	
Cleaning and deepening of the 10.5 ha of Pobeda pond (Victoria)	Attenuating climate change adaptation		Local authority	Singerei Town Hall	2021	2030	300,000	The level of environmental protection will increase			
Cleaning and deepening of the 14.7 ha of Comsomolist Lake	Attenuating climate change adaptation		Local authority	Singerei Town Hall			350,000	The level of environmental protection will increase			
Construction of the 78.5ha rainwater storage basin of the water mirror			Local authority	Singerei Town Hall	2021	2030	500,000	The level of environmental protection will increase			
TOTAL							**15,034,066**	**5,979**	**4,204**	**3,403.4**	