Sustainable Energy and Climate Action Plan (SECAP)

Tarigrad village

2022-2030

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 the vision and commitment of the village of Tarigrad in decarbonizing its territory by improving energy efficiency measures and deploying renewable energy, as well as strengthening the village's ability to adapt to the inevitable impact of climate change. Mitigation and adaptation actions to achieve the objectives are defined here along with time frames and assigned responsibilities.

The Covenant of Mayors is a unique movement that has brought together a large number of local and regional authorities to develop action plans and direct investments 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 at a ceremony in the European Parliament in Brussels. Now the signatories promise a reduction in CO2, an increase in energy efficiency and renewable energy sources and support the integration of climate change mitigation and adaptation under a common umbrella.

The resulting initiative from this partnership, the Covenant of Mayors for Climate and Energy, is both more ambitious and broader in scope. The signatory municipalities commit to support the implementation of the EU's greenhouse gas reduction target by 2030 and the adoption of a common approach to 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's decision, a Sustainable Energy and Climate Action Plan (SECAP) that describes the key actions that intend to undertake them. The plan will include a baseline emissions inventory to track mitigation actions and a climate risk and vulnerability assessment. The adaptation strategy can be part of the SECAP or developed and integrated in a separate planning document. This bold political commitment marks the start of a long-term process, with cities committing to report every two years on the progress of implementing their plans.

The 27 member states of the European Union approved on 28.06.2021 the legislative text by which the targets for reducing greenhouse gas emissions become legally binding. The member states' agreement comes after the plenary of the European Parliament gave the green light to the EU's commitment to achieve climate neutrality by 2050, i.e. not to emit more greenhouse gases than it can absorb.

The European Commission adopted on 14 July 2021 a package of proposals for EU policies on climate, energy, land use, transport and taxation to enable the reduction net gas emissions with

greenhouse effect by at least 55% by 2030 compared to 1990 levels.

Achieving these emissions reductions over the next decade is crucial for Europe to become the world's first climate-neutral continent by 2050 and to make the European Green Deal a reality. The Commission is putting forward the legislative tools needed to meet the goals agreed under the European Climate Law and to fundamentally transform our economy and society for a fair, green and prosperous future.

A comprehensive and interconnected set of actions is envisaged to enable the necessary acceleration of greenhouse gas emission reductions over the next decade. They combine: applying the ETS to new sectors and strengthening the current EU ETS; increased use of renewable energy; greater energy efficiency; faster development of low-emission transport modes and the infrastructure and fuels to support them; an alignment of fiscal policies with the European objectives of the Green Pact; measures to prevent the relocation of carbon dioxide emissions and tools for the conservation and development of natural carbon sinks.

The EU's Emissions Trading System (ETS) sets a price for carbon emissions and lowers the emission ceiling from certain economic sectors each year. Over the past 16 years, it has contributed to a 42.6% reduction in emissions from electricity production and energy-intensive industries. Today the Commission is proposing that the global emissions cap be lowered further and the annual rate of emissions reduction be increased. The Commission also proposes phasing out free allocations of emission allowances for the aviation sector and aligning it with the Global Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA) and including for the first time emissions from sea transport in the EU ETS. To address the lack of emissions reductions in the road transport and buildings sectors, a new separate trading system for emissions certificates is being established for the distribution of road transport and building fuels. The Commission also proposes to increase the financial envelope of the Innovation Fund and the Modernization Fund.

In addition to the substantial spending provided for in the EU budget for climate actions, member states should fully channel the revenues from the trading of emissions certificates to climate and energy projects. Part of the revenues generated by the new system applicable in road transport and in the buildings sector should be allocated to actions to mitigate the possible social impact of this measure on vulnerable households, micro-enterprises and means of transport users. The Land Use, Forestry and Agriculture Regulation sets a general EU target for the elimination of carbon dioxide through natural absorbers, corresponding to a volume of 310 million tonnes of CO2 emissions by 2030. National emission reduction targets provide for the obligation of member states to protect absorbers from carbon and to strengthen their role so that the objective can be reached.

By 2035, the EU should aim to achieve climate neutrality in the land, forestry and agriculture sectors, including non-CO2 agricultural emissions such as those from fertilizer use and livestock farming. The EU Forest Strategy aims to improve the quality, quantity and resilience of EU forests. The strategy supports foresters and the forest bioeconomy, while emphasizing sustainable forestry and biomass use, as well as biodiversity conservation. The strategy also includes a plan to plant three billion trees across Europe by 2030.

As energy production and use account for 75% of EU emissions, it is essential to accelerate the transition to a greener energy system. The Renewable Energy Directive will set a more ambitious target for 40% of our energy to be produced from renewable sources by 2030. All Member States will contribute to this target and specific targets are proposed for the use of renewable energy in the transport sector, for heating and cooling systems, in buildings and in industry. In order to achieve our climate and environmental goals, sustainability criteria for the use of bioenergy are strengthened and Member States must develop support schemes for bioenergy that respect the principle of cascading the use of wood biomass.

To lower total energy consumption, reduce emissions and tackle energy poverty, the Energy Efficiency Directive will set a more ambitious mandatory annual target for reducing energy consumption at EU level. It will guide how national contributions are set and impose a mandatory annual energy saving target on member states almost double the current one. The public sector will need to renovate 3% of its buildings each year to drive the wave of renovations, create jobs and reduce energy use and costs to taxpayers.

A combination of measures needs to be used to address rising emissions in road transport, in addition to the trading of emission allowances. Setting stricter standards for CO2 emissions from cars and vans will accelerate the transition to zero-emission mobility by requiring average new car emissions to fall by 55% in 2030 and 100% in 2035 compared to levels in 2021. Therefore, all new cars to be registered from 2035 onwards will have zero emissions. To ensure that, anywhere in Europe, drivers will be able to charge or refuel their vehicles from a reliable network, the revised Alternative Fuels Infrastructure Regulation will oblige Member States to expand charging capacity, aligning it with the sales volume of zero-emission cars, and to install charging and refueling stations at regular intervals on main highways: every 60 km for electric charging and every 150 km for hydrogen refueling.

The energy taxation system must protect and enhance the single market and support the green

transition by setting appropriate incentives. A revision of the Directive on energy taxation proposes to align the taxation of energy products with EU policies in energy and climate, promoting clean technologies and eliminating outdated practices such as the application of tax exemptions and reduced tax rates, practices that currently encourage the use of fossil fuels. The new rules aim to reduce the harmful effects of fiscal competition in energy, helping to ensure stable revenues for Member States from green taxes, which are less damaging to growth than taxes on labor income.

The Covenant of Mayors municipalities in the Eastern Partnership region have committed to actively support the implementation of the EU's CO2 reduction target and to adopt 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 Cotova commune intends to undertake. The following objectives will be achieved by implementing the proposed measures

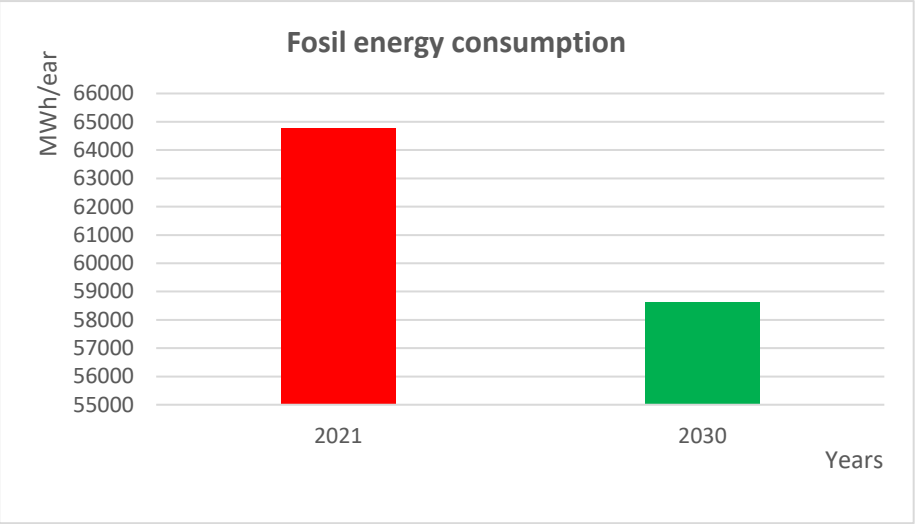

Fig. 1. Estimated consumption of fossil energy

The reduction in fossil fuel consumption in 2030 will constitute 46% of the consumption in 2021, of which 22% of the energy savings will come from the implementation of energy efficiency measures, and 78% of the energy savings will be achieved through the use of renewable energy sources.

CO_2 emissions in the village of Ţarigrad in 2021 were 1,909 tons or 0.47t per inhabitant.

The implementation of the given SECAP will require investments of €3,963,721 for the period 2022-2030. It will bring fossil energy saving 1,343MWh and will allow the use of renewable energy

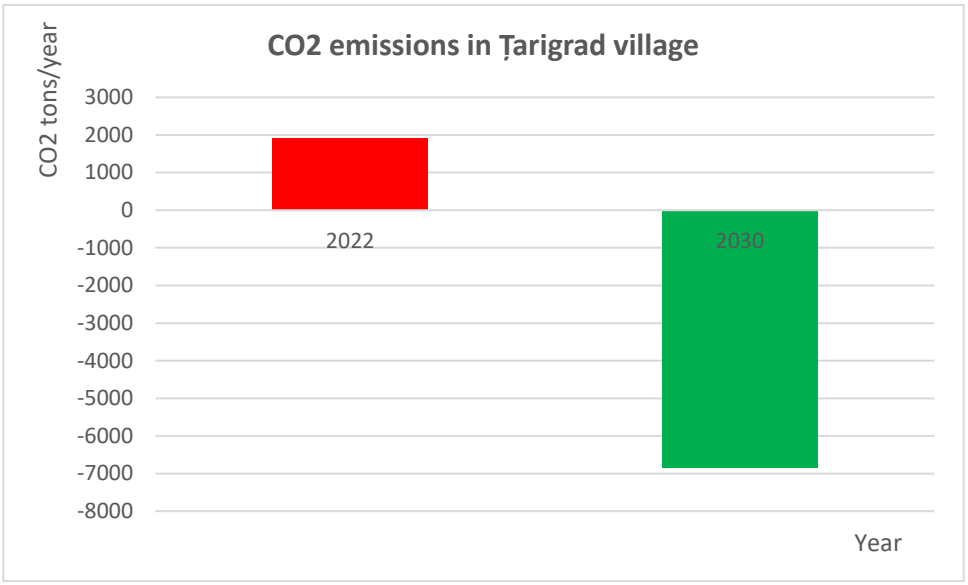

Fig. 2. Reducerea estimată a emisiilor de CO_2

in the amount of 4.782MWh. All activities will reduce annual CO_2 emissions by 8,768 tons (fig.2), which means that the village will change from a CO_2 generator to a CO_2 consumer. Consumption will be 6,858 tons or 1.7t per inhabitant annually. This is due to the massive afforestation of the region.

Most of the CO_2 emissions of the village of Tarigrad come from the consumption of natural gas (80%). Natural gas emits 58.5 percent less carbon dioxide than coal, according to the US Energy Information Association. The European Union voted on 07/06/22 to maintain specific uses of natural gas and nuclear energy in its taxonomy of sustainable energy sources.

In general, the use of natural gas to generate electricity or to heat or cool many homes simultaneously will be considered sustainable, while other uses may be excluded. They will have to be below certain emission thresholds and be approved only until 2030 or 2035, depending on the specific situation.

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

A crucial element of the PAEDC (SECAP) will be the strengthening of community engagement, ongoing engagement with key stakeholders and partners, and outstanding social impact.

1.1. Tarigrad village

GENERAL PRESENTATION

The village of Țarigrad, Drochia district, is located in the northern part of the Republic of Moldova

(coordinates: latitude 48.0447, longitude 27.7508 and altitude of 213 meters above sea level). Its surface is 4,065 ha, of which 2,882 ha are part of the land fund, and 4 ha are covered by forest strips.

The direct distance to the Drochia district center is 5 km, and to Chisinau - 160 km. Steppes, hills, valleys form the relief of the area.

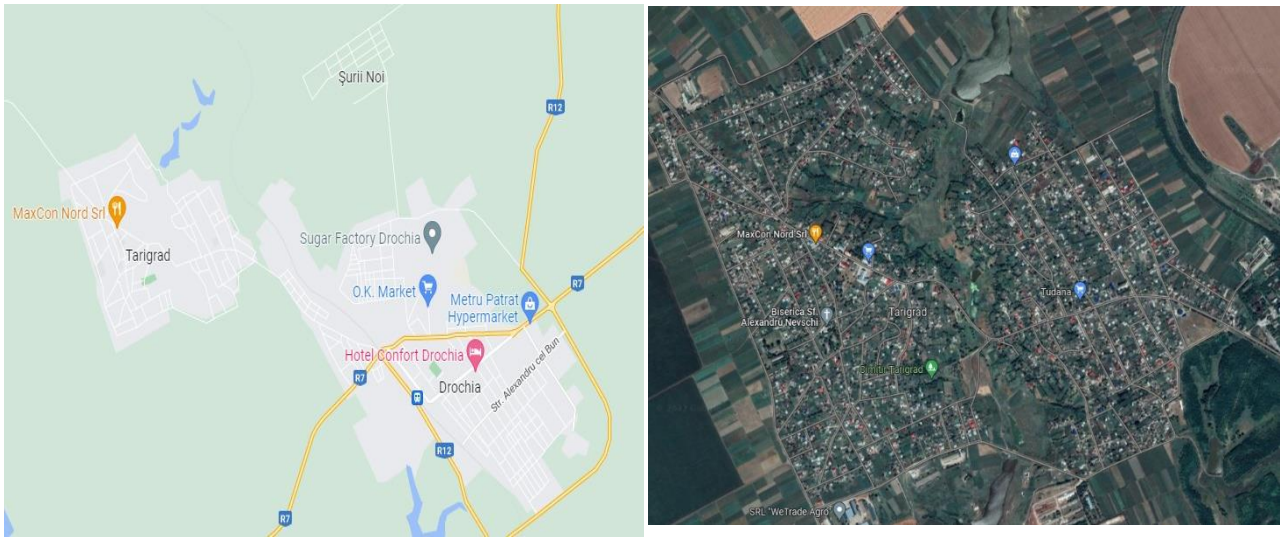

Fig. 3. The settlement of the village of Tarigrad

Climate

The village of Tarigrad has a moderate continental climate with generally hot summers and mild winters.

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

Hydrography

The area is crossed by the Răut river, which is fed by spring. There are also other water sources around the village. There are 7 ponds in the vicinity with a total area of 117.0ha. Răul Răut crosses the border between the villages of Țarigrad, Ochiul Alb and Nicoreni for a length of 11 km. All taken together form the water resources of the village. Water from these sources and ground water play an important role in its supply of water resources.

Geology

The seismic state of the territory is determined by the focal point from Vrancea (Romania, at the base of the Carpathians)1, located approximately 258 km away from the village. Seismic activity

in the area reaches a magnitude of 7 (Richter scale)[1]. The specific geological structure determines favorable conditions for the development of landslides and erosion, represented by various furrows, ravines, canyons and valleys.

Vegetation and agriculture

The vegetation is rich and varied. It is caused by several factors: geographical position, relief, climate, water, character of the rocks. The peculiarities of the climate and the soil favor the general development of agriculture. The growing season usually starts from 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 containing significant amounts of rich humus. A wide range of vegetables, many types of fruit trees are grown in the area.

The population

In 2021, the number of inhabitants was 4082 people, according to the Village Hall, and is presented in the following table 1.

Table 1. Distribution of the population in the commune of Tarigrad by age and gender

Age, years	Men	Women	Total	Percentage of total, %
0-18	300	320	620	15.2
19- 65	1,379	1,529	2,908	71.2
Over 65	258	296	554	13.6
TOTAL	1937	2145	4082	**100**

According to table 1, the demographic situation at the moment is favorable, the majority of the population is between the ages of 18 and 65, that is, it is in the workforce 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 - 4000 (98%), Ukrainians -61 (1.5%), Russians - 21 (0.50%).

On the territory of the village there are social facilities: 2 gymnasiums, 2 kindergartens, family doctors' office, cultural center.

[1]Ilieș, Ion. Integrated seismic monitoring system Romania – Republic of Moldova. *Akademos*, nr. 1 (20), march 2011, p. 62 - 69.

The length of local roads is 41.9km, of which only 20km are paved. About 70% of these are in satisfactory condition.

The housing stock of the village is over 223,352m^2. There are 2,233 houses in the village, of which 99.3% are equipped with centralized water supply.

Table 2. Distribuția populației în comuna Tarigrad după etnie

Nr.	Ethnicity	Number of inhabitants	Percentage, %
1	Moldovan/Romanian	4000	98
2	Ukrainian	61	1.5
3	Russian	21	0.5
	TOTAL	**4082**	**100.0**

Fuel, power and water supply

The village has a centralized gasification system. Public, residential and business buildings are heated with natural gas and wood.

The village is supplied with electricity by the distributor S.A. "North Electric Energy Supply". A 35kV line of "Moldelectrica" passes near the village.

There are artesian wells that supply the village with drinking water. Constituent water consumption is distributed as follows: 99.3% - the population, 0.1% - public buildings and economic agents - 0.6%. The aqueduct has a length of 42.7 km.

Entrepreneurship and economic activity

Several economic agents operate on the territory of the town hall, among which there are local and international economic agents. All companies are private with the organizational form limited liability companies and peasant households.

The economic activity of the village represents a significant source of income for the local administration, taking into account the fact that a considerable part of deductions from state taxes is formed from the income tax of legal entities.

2. GENERAL STRATEGY

By signing up to the Covenant of Mayors for Climate and Energy, the village of Țarigrad voluntarily commits to achieving a goal of reducing CO2 emissions by at least 55% by 2030 compared to 1990 levels, thus sharing a common vision for a sustainable future and committing to developing a low-carbon, resilient, energy-efficient community.

The village's commitment is to take measures in the following areas:

ENERGETIC EFFICIENCY improving energy use and using renewable energy.

ADAPTATION AND MITIGATION OF CLIMATE CHANGE. The town hall is aware that adapting to climate change brings a number of benefits to the village and citizens. Disaster preparedness can reduce the cost of damages and future disaster response costs. The European Commission estimates that €1 invested in risk prevention saves up to €6 in disaster response efforts. Building rehabilitation can reduce tenants' energy costs and increase property values. Adaptation projects can create jobs and boost local businesses.

The co-benefits of local climate change mitigation and adaptation actions for well-insulated buildings will bring energy savings (mitigation) and adaptation to temperature rise, cooling through the use of solar systems. Planting trees and green spaces will reduce flooding and retain soil and subsoil moisture, shade land, cool the urban environment (adaptation) and sequester carbon (mitigation).

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

2.1 PURPOSE AND OBJECTIVES

The goal formulated by the village of Tarigrad is to reduce the influence of the human being 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.

Table 3. Goals and targets for energy reduction and climate change mitigation and adaptation

Management area	Index	Aim	Index	Description
Municipal, residential, tertiary buildings, equipment/facilities	**BE**	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	Solar collectors for water heating and installation of PVT (photovoltaic thermal panels) on roofs and independent units
			BE3	Providing buildings with electricity, heating, domestic hot water and cold.
			BE4	Biofuel production from energy willow. The use of wood pellets in public and residential buildings
			BE5	Using air-to-air or air-to-water heat pumps to heat public buildings and obtain domestic hot water

		Energy efficiency of building heating and domestic hot water	BE6	Replacing the old heating system in public buildings
			BE7	Installation of the individual heating plant operating on biofuel, their interconnection to the solar heating systems.
		Use of energy-efficient electrical appliances	BE8	Replacing gas-powered kitchen and laundry appliances in kindergartens and gymnasiums with electric appliances trice
Public lighting	**LE**	Energy efficiency of lighting	LE1	Replacing old technology lights with LEDs in buildings
			LE2	Replacing old technology lights with LEDs in street lighting
Local production of electricity	**PG**	Photovoltaic energy generation	PG1	Construction of a commercial photovoltaic farm of 0.2MW
Climate change mitigation and adaptation	**WW**	Waste water management	WW1	Design and construction of a sewage system together with the wastewater treatment plant
		Solid waste management	WW2	Arrangement of the solid waste storage site
			WW3	Organization of the solid waste collection, transport and storage service
	CA	Planting the energy willow	CA1	Planting of 5.4 ha of energy willow
		Production of wood pellets	CA2	Establishment of pellet production based on public-private partnership
		Creation of a wetland in the center of the village	CA3	Creation of a wetland in the center of the village with an area of 2.7ha
		Creating a recreation area	CA4	Creation of a recreation area on the shore of the pond in the southeast of the village with an area of 8.7ha
		The transformation of the football stadium into a sports center	CA5	The transformation of the existing football stadium into a multifunctional sports center
		Afforestation of the banks of the river Raut	CA6	Planting of 5.0 ha of trees on the banks of the Raut river
		Afforestation of the banks of two ponds	CA7	Afforestation of the banks of two ponds in the northern part of the village with an area of 47ha

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

Management area	Index	Aim	Index	Description
Buildings, energetic efficiency	**GS**	Grants and subsidies	GS1	Incentives for energy efficiency and renewable energy generation
	SPF	Secondary funding. Public-private partnership	SPF	Design and construction of the sewage system and wastewater treatment plant

2.2. THE CURRENT SITUATION

The general development strategy of the village of Tărigrad formulated the objectives regarding the improvement of energy efficiency and the use of renewable energy. In the National Environmental Strategy for 2013-2023, it is specified 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.

The energy strategy of the Republic of Moldova for 2013-2030 ensures the sustainability of the energy sector and mitigation and adaptation measures to climate change, the development of competitive markets and their regional and European integration.

2.2.1 ENERGY CONSUMPTION IN THE VILLAGE

The current situation

On the territory of the village there are several public buildings: the town hall, 2 gymnasiums, 2 kindergartens, the family doctors' office, a house of culture. The total area of public buildings is 9,116.5m^2.

Energy consumption in public buildings and transport

The village consumes energy mostly in the form of electricity and natural gas. In 2021, the buildings of the Țarigrad City Hall consumed 149,185kWh of electricity and 80,240m^3 of natural gas.

The town hall has a "Skoda Rapid" car, which consumed 1300 liters of fuel (gasoline).

Photo 1. Tarigrad Town Hall building

Photo 2. The building of the House of Culture

Photo 3. The building of the gymnasium "Tarigrad"

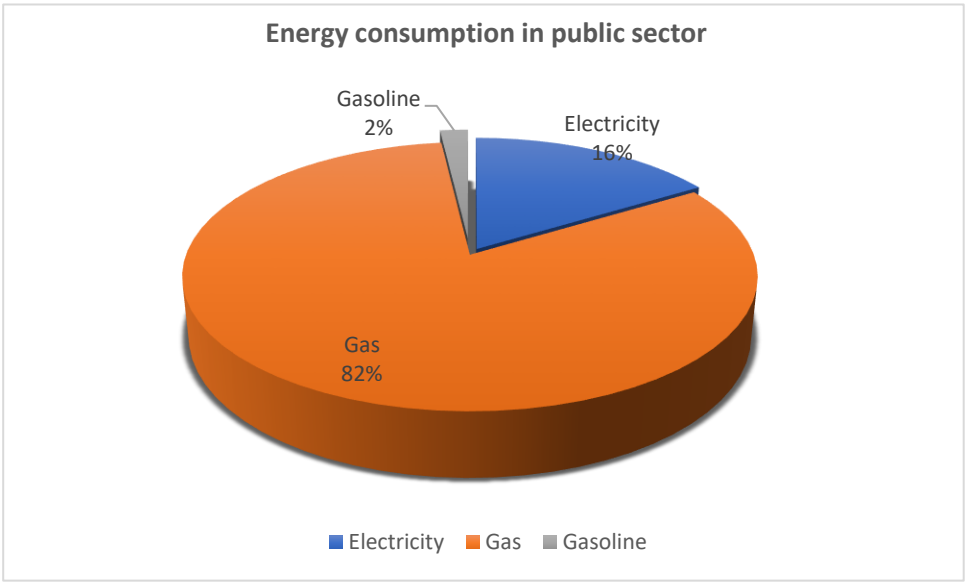

Fig.4. Energy consumption by Tarigrad City Hall consumers in 2021

The diagram above (fig. 4) indicates that energy consumption is dominated by the consumption of natural gas to the extent of 82%. Electricity consumption is only 16%, and gasoline used for transport - 2%.

Electricity is mainly used for lighting (including street lighting), and natural gas for heating and cooking.

The residential sector and energy consumption

The overwhelming majority of houses are one-story stone houses and, less often, two-story houses, and represent the buildings of the residential sector.

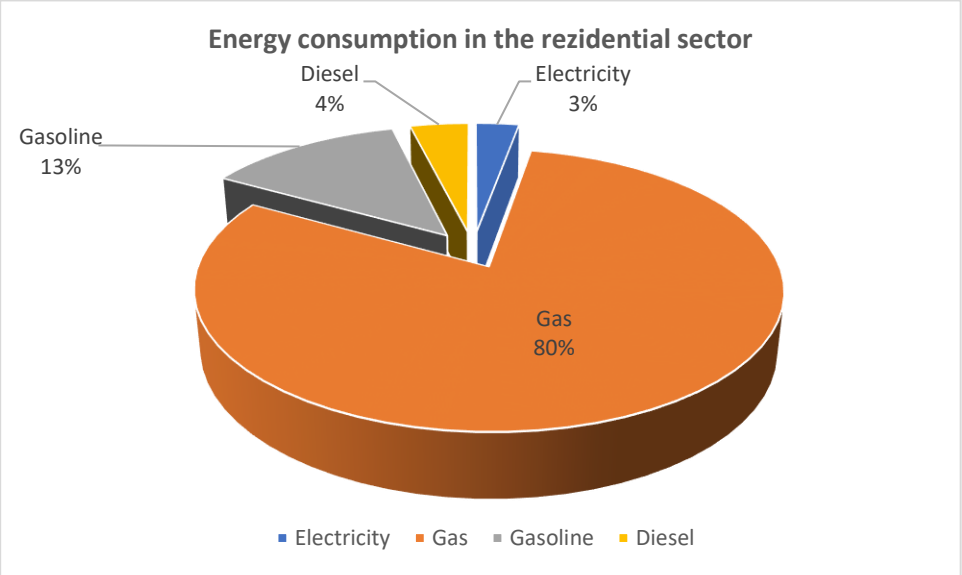

Fig. 5. Distribution of energy consumption in the residential sector in 2021

The village has 2,233 residential houses. In 2021 they consumed approximately 221,900kWh of electricity and 669,900m^3 of natural gas.

In addition, it is estimated that local transport annually consumes 77.0 tons of gasoline and 26.0 tons of diesel fuel.

From fig. 5 shows that the residential sector of the village of Ţarigrad consumes 80% natural gas, 13% gasoline, 4% diesel and less than 3% electricity.

General energy consumption in the village of Tarigrad

The village of Ţarigrad (fig. 6) consumes 371,085 kWh of electricity, 750,140 m^3 of natural gas, 78,300 liters of gasoline and 26,000 liters of diesel fuel, which each of them constitutes a proportion of 80% of energy from natural gas, 12% from gasoline , electricity- 4% and diesel- 4%. The total annual energy consumption of the village of Ţarigrad is 64,684,155 kWh or 64,684MWh.

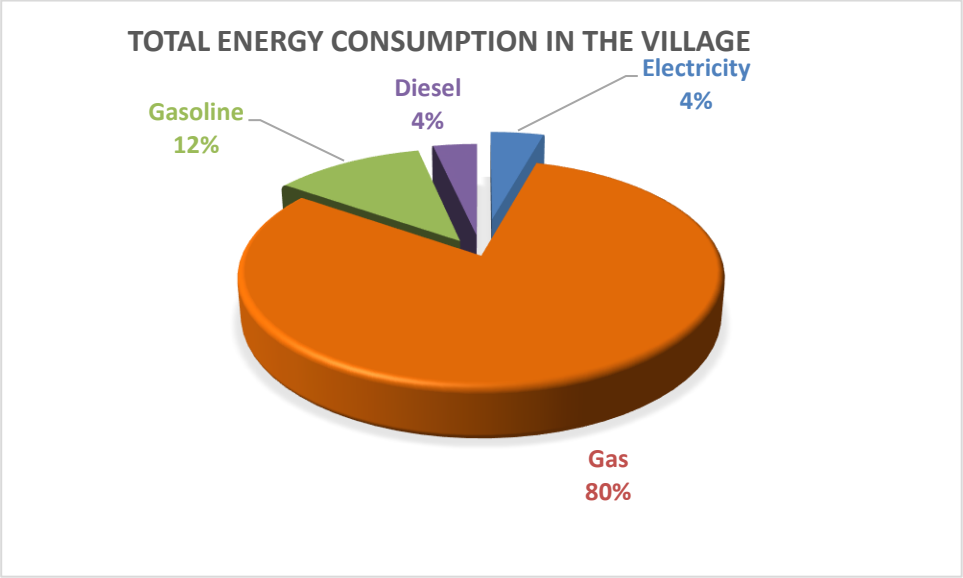

Fig. 6. Energy consumption in the village of Tarigrad by fuel type in 2021

CO_2 emissions in the village of Tarigrad

alculations show that the village of Ţarigrad emits 1909.7 tons of CO_2 or 0.47 tons per inhabitant annually. The amount of emissions also includes the consumption of diesel and gasoline for local and transit transport. All once the diagram in fig. 7 shows that they constitute 17% of the total emissions (diesel 4%, gasoline 13%). The main emissions come from the consumption of natural gas (74%), especially from residential sector.

Pollution in the public sector (fig.8) comes from the consumption of natural gas (68%), electricity (30%) and gasoline (2%).

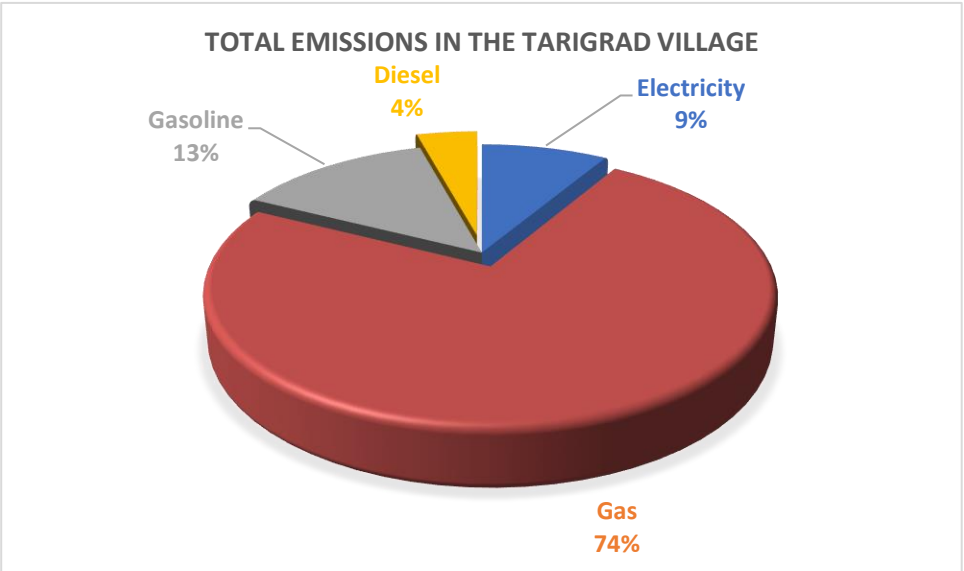

Fig. 7. CO_2 emissions in the village of Tarigrad by fuel type in 2021

Most of the pollution comes from the residential sector (fig. 8) and comes from the large consumption of natural gas, which denotes a high standard of living.

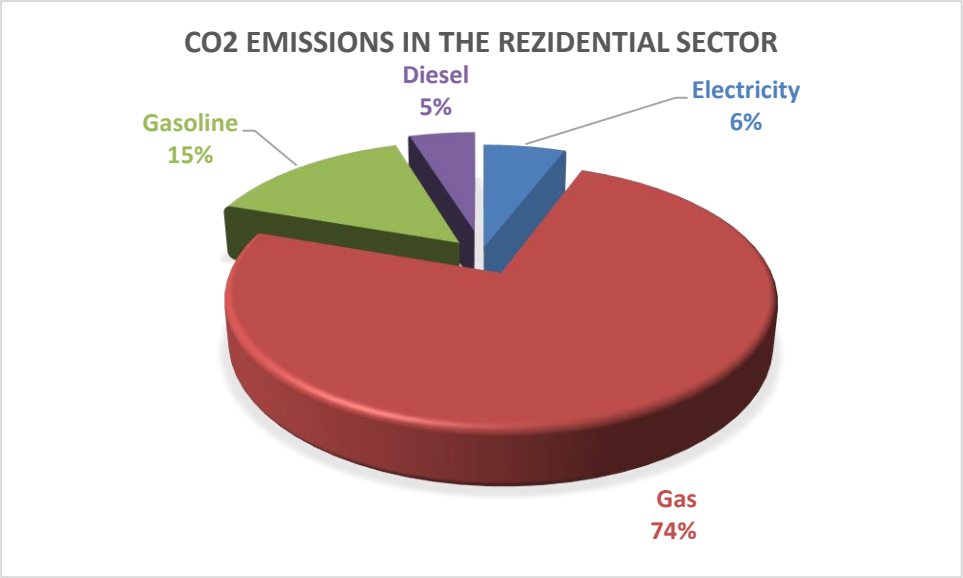

Fig. 8. CO_2 emissions in the residential sector in 2021

Pollution in the residential sector comes from the consumption of natural gas (74%), gasoline (15%), electricity (6%) (fig.8). Emissions from diesel consumption constitute 5%.

CO_2 emissions come from the consumption of natural gas (68%), electricity (30%) and petrol (2%).

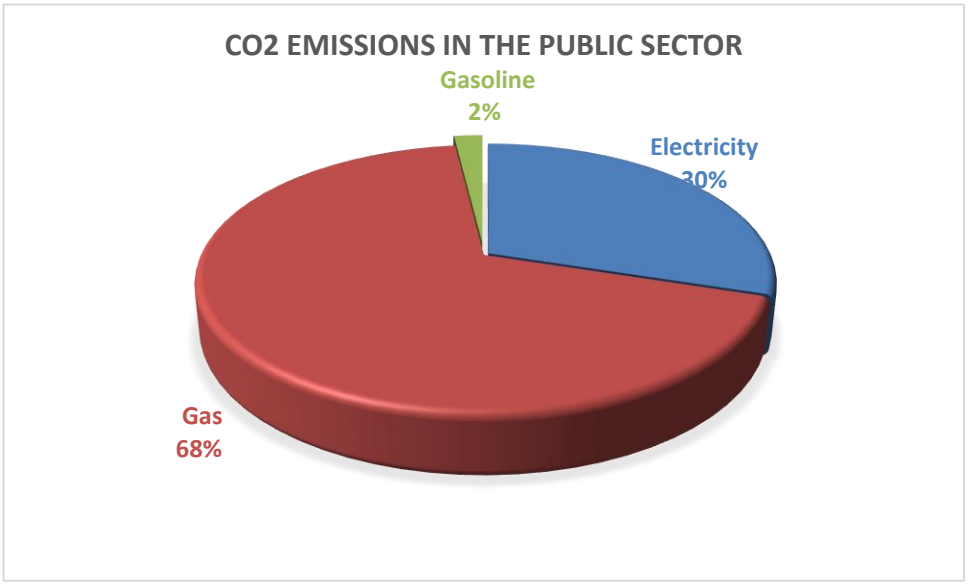

Fig. 9. CO_2 emissions in the public sector in 2021

3. Vision of actions

3.1 Buildings

Buildings are critical to the transition to a low-carbon economy. The average U value for existing walls and roofs are 1.4 ÷ 1.7 [W/m2K], for windows U = 2.8 ÷ 3.2 [W/m2K]. Mainly greenhouse gas emissions in this sector come from building heating and domestic hot water heating.

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

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

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

Table 4. 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 heating collectors and PVT (photovoltaic-thermal panels) installation on roofs and independent units
		Replacing the old heating system in public buildings
		Biofuel production from energy willow.
BE3	Installation of the individual heating plant	Installation of the individual heating plant operating on biofuel, their interconnection to the 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	Replacing gas-powered kitchen and laundry appliances in kindergartens and schools with electric appliances
LE	Energy efficiency of lighting systems	Replacing old technology lights with LEDs.

The detailed description of the defined solutions is given below.

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

The first step to be applied in any type of existing engineering system is to reduce energy consumption. This requires insulating the building envelope and replacing old windows and doors as a first step.

Wall insulation must be made with mineral wool at least 100 mm thick and λ = 0.041 [W/ m2K] with a density of at least 135 [kg/m^3] according to SM SR EN 1602 or better.

The roof insulation must be made with 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/m^3] according to SM SR EN 1602, covered with metal bond 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

Photo 4. The exterior of the "Spicușor" kindergarten building

environment after end of life of buildings. There is already a heat-insulating biomaterial with the same properties as the existing ones or even better, but the difference is that when it enters the soil, it rots, preventing pollution.

In order for rehabilitated buildings to comply with local thermal requirements for their elements, the U-value of walls must be less than 0.22 [W/m2K] and roofs 0.24 [W/m2K].

Replacement of existing old windows and doors should be made with non-recyclable PVC frame

windows and doors, 7-chamber, 1.2 mm thick reinforced metal U-frame covered with plastic layer, without thermal bridges. Double-glazed windows with low emissivity (Low-e) 4-20-4 [mm].

The U-value of windows must be less than 1.4 [W/m2K] and 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 in the country.

Based on past experience, heat consumption can be considerably reduced compared to existing consumption. In conditions where the sanitary and hygienic rules are not respected, this reduction will be much smaller.

❖ **BE2. Solar collectors for water heating and PVT installation (thermal photovoltaic panels) on roofs and independent units**

The village has a gas pipeline. Natural gas is the main source of thermal energy. The use of solar energy to obtain domestic hot water is at an early stage (photo 5).

Year-round solar radiation is very favorable for the use of solar collectors for water heating and photovoltaic (PV) panels for electricity generation. Moldovan legislation is also favorable.

Photo 5. Solar collectors at the "Spicușor" kindergarten

At the point in fig.10, 1kWp of monocrystalline PV panel can annually generate 1.159kWh of electricity (fig.11) in the photovoltaic park installed on the ground and 1.115kWh in the PV systems framed in the roof (fig.13). Hybrid photovoltaic-thermal (PVT) panels include both, solar collector and photovoltaic panel, which generate electricity and hot water. Photovoltaic panels

are known to have a shortcoming that as the temperature increases, the electrical efficiency decreases up to 70%, depending on the temperature. PVT increases its efficiency by cooling the photovoltaic cells and obtaining hot water for household needs. The average annual loss of electricity from temperature and low radiation in the locality is from 6.9% to 10.39%, according to fig. 11, 13. Experience shows that a PVT panel (1.5m^2) can provide 25 liters/day of hot water with a temperature of 55°C during the hot season, from March to October (fig. 12,14,15). Additional annual yield to energy generation can bring more than 281kWh to each panel.

Fig. 10. The calculation point of solar energy use

Solar collectors can accumulate more thermal energy when heating domestic water and provide households 7-8 months a year with hot water at a temperature of 60-90°C, solar radiation being 1427kWh/m^2 which means that each square meter can annually heat approximately 2.5 m^3 of water at a temperature of 60°C.

Each public building is expected to have its own solar collector or photovoltaic-thermal (PVT) panel system, installed on the building's roof or stand-alone 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 36° (optimal) to the south. They will be connected to a boiler that has the volume according to the needs or the number of members in the consumer's family. An individual heating station will additionally heat the water from the end of February until the middle of November.

Provided inputs:	
Location [Lat/Lon]:	48.042,27.761
Horizon:	Calculated
Database used:	PVGIS-SARAH2
PV technology:	Crystalline silicon
PV installed [kWp]:	1
System loss [%]:	14

Simulation outputs:	
Slope angle [°]:	36 (opt)
Azimuth angle [°]:	0
Yearly PV energy production [kWh]:	1159.38
Yearly in-plane irradiation [kWh/m^2]:	1470.69
Year-to-year variability [kWh]:	48.21
Changes in output due to:	
Angle of incidence [%]:	-2.86
Spectral effects [%]:	1.36
Temperature and low irradiance [%]:	-6.9
Total loss [%]:	-21.17

Fig. 11. Inputs and outputs of the 1kWp monocrystalline photovoltaic (PV) panel on the ground

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.

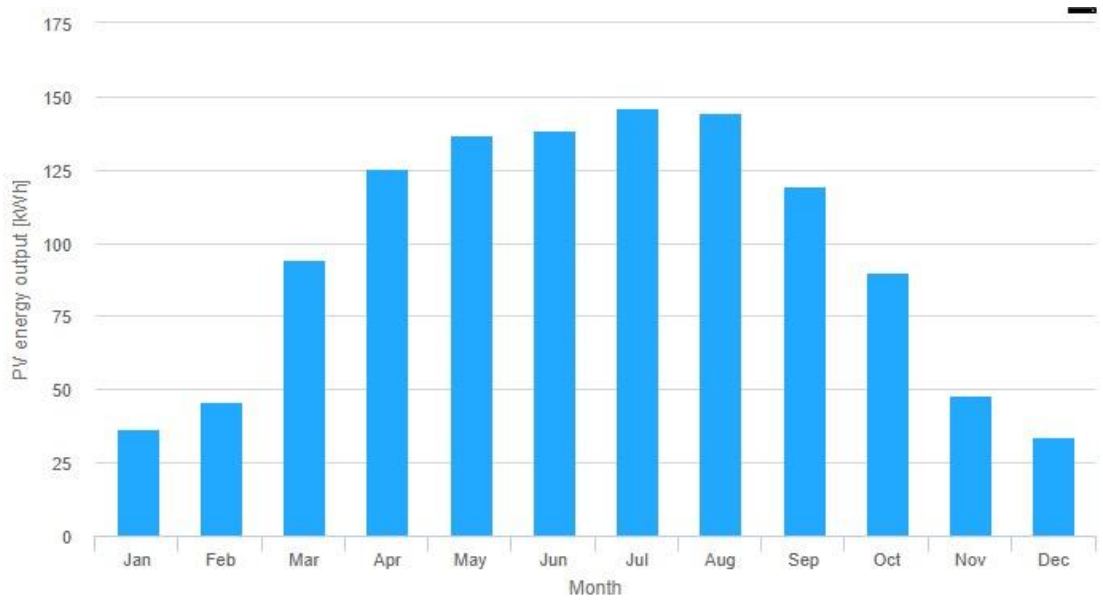

Fig. 12. Monthly electricity generation of the monocrystalline photovoltaic panel (PV) of 1kWp on the ground

Provided inputs:	
Location [Lat/Lon]:	48.042,27.761
Horizon:	Calculated
Database used:	PVGIS-SARAH2
PV technology:	Crystalline silicon
PV installed [kWp]:	1
System loss [%]:	14

Simulation outputs:	
Slope angle [°]:	36 (opt)
Azimuth angle [°]:	0
Yearly PV energy production [kWh]:	1115.95
Yearly in-plane irradiation [kWh/m^2]:	1470.73
Year-to-year variability [kWh]:	45.81
Changes in output due to:	
Angle of incidence [%]:	-2.87
Spectral effects [%]:	1.37
Temperature and low irradiance [%]:	-10.39
Total loss [%]:	-24.12

Fig. 13. Inputs and outputs of the 1kWp monocrystalline photovoltaic (PV) panel integrated into the roof

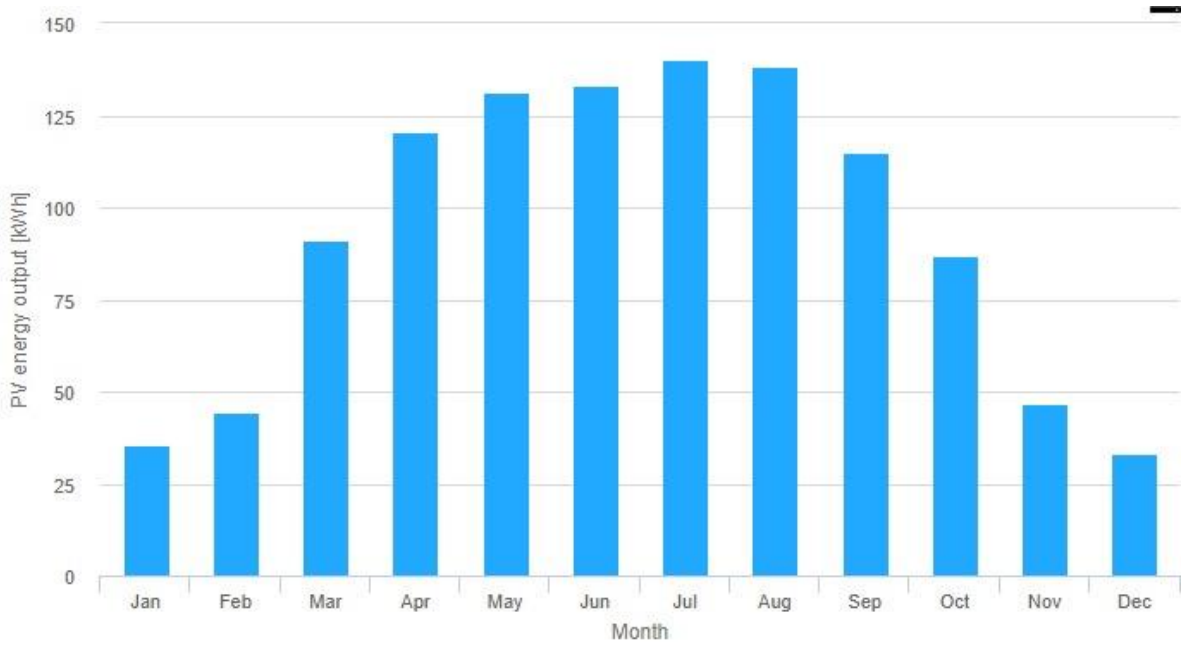

Fig. 14. Monthly electricity generation of the 1kWp monocrystalline photovoltaic (PV) panel integrated into the roof

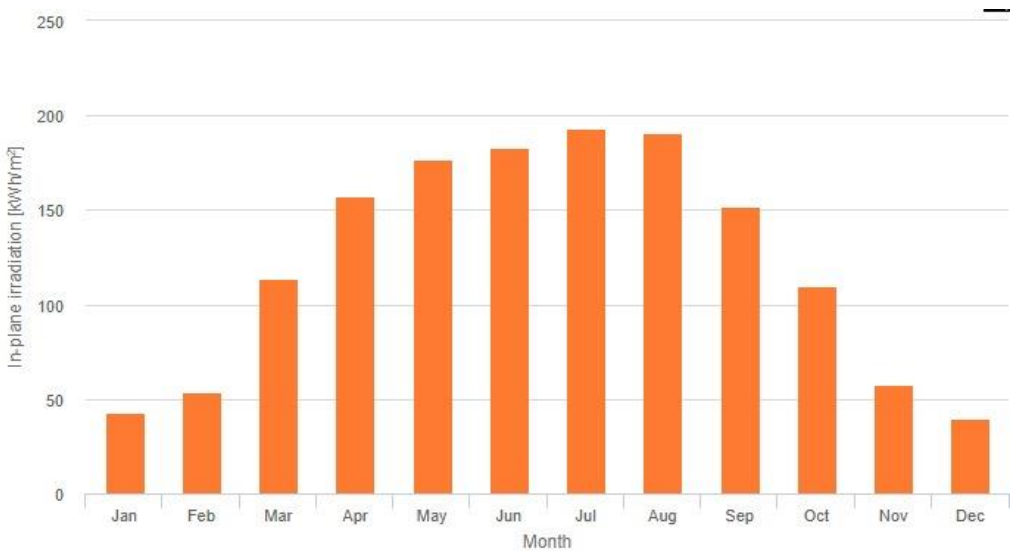

Fig. 15. Monthly solar irradiation per 1m^2 of thermal photovoltaic panel (PVT)

About 30% of primary heating energy in the residential sector is consumed for domestic hot water.

Recent developments and national research in this field have demonstrated the possibility of switching to autonomous energy systems through the wider use of photovoltaic-thermal panels (photo 6).

a) *b)*

Photo 6. Examples of use of thermal photovoltaic panels

a). System with photovoltaic-thermal panels for the generation of electricity and hot water during the warm period of the year;

b). Autonomous energy system with the generation of electricity, hot water and cold all year round.

Systems with PVT of different options can provide the consumer with electricity all year round using the net-metering mode and hot water 7 months a year or all year round by using the autonomous energy system (SEA). In both cases the electricity generation efficiency is higher.

The advantage of SEA is that it provides the consumer with electricity, hot water for heating and as household water and cold all year round. The average annual power generation efficiency is 10-15% higher than ordinary photovoltaic panels.

In this way, SEA can provide public consumers (kindergartens, hospitals, schools, etc.), residential and economic consumers with energy all year round without fuel consumption (natural gas, coal, fuel oil, firewood).

- **BE3. BE3 Installation of Autonomous Energy Systems (SEA). Providing buildings with electricity, heating, domestic hot water and cold.**

This is an ultra-modern technology that generates year-round electricity, hot water for building heating, domestic hot water and cold. It has the following properties:

- Higher efficiency than usual photovoltaic systems in generating electricity;
- Generates hot water with a temperature of 50°C and more for use in everyday life (bathing, washing clothes, kitchen dishes, etc.);
- Generates hot water with a temperature of 50°C and more for heating the building;
- Generates cold air for air conditioning in rooms;
- De-icing system allows snow and ice to melt on the photovoltaic-thermal panels during the winter;
- Works in automatic mode;
- Has the frost protection function of the room heating system;
- Electricity generation and consumption is carried out according to the net metering method: "generate when you can and consume when you need"; The balance of generation and consumption is made at the end of the year: you consumed more than the contract stipulates - you pay the defense according to the supplier's tariff, you generated more - the supplier pays you at the contract's tariff.

It can be applied in family houses, apartment blocks, public buildings
(kindergartens, hospitals, schools, administrative and social buildings), buildings for offices, industrial enterprises, curative and leisure buildings (sanatoriums, rest centers, cottages, etc.), seasonal and permanent greenhouses, vegetable dryers and fruit, agricultural production processing enterprises, poultry and animal breeding buildings. The technology is very efficient and allows obtaining energy all year round without the use of gas, coal, fuel, firewood, etc.

❖ **BE4. Biofuel production from energy willow. The use of wood pellets in public and residential buildings**

There is a land of 5.4 ha (fig.21) on the shore of one of the 3 ponds located in the northern part of the village. This land can be used for energy willow plantations, which every two to three years will have a yield of 20t/ha of dry material for pellets or chips. The total biofuel yield can reach 480 tons or 240 tons annually. Biofuel will replace coal and firewood for heating public, residential and commercial buildings, improving indoor 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 grower can harvest willow up to seven times from a single planting. Willow has the following advantages:

- Easily propagated from stem cuttings which grow new roots, shoots and leaves.
- Fast growth rate, produces hardwood biomass 10-15 times faster than native forests.
- After each harvest, new stems quickly re-grow 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, willow's unique characteristics make it ideal for a wide range of environmental applications:

- Hedges of snow - prevents blowing snow on the roads.
- Plant buffers - prevents the penetration of fertilizers and chemicals into ponds and rivers.
- Protects soil resources - prevents erosion and stabilizes riverbanks.
- Environmental remediation - cleans up and restores former industrial sites.
- Vegetal cover - a green alternative for the efficient covering of landfills.
- Biodiversity restored - the plantation is an ideal location for birds, animals and insects.

It is possible to produce biofuel by implementing public-private partnership together with energy willow plantation.

- **BE5. Using air-to-air or air-to-water heat pumps to heat public buildings and obtain domestic hot water**

  A heat pump can ensure a healthy environment inside the building all year round, providing heat in the winter and coolness in the warm season. It can provide the building with domestic hot water throughout the year. An air source heat pump has three cycles: heating cycle, cooling cycle and defrost cycle. During the heating cycle heat is taken from the outside air and "pumped" into it. During the cooling cycle, the process described above is reversed to cool the building during the summer. The heat pump extracts heat from the building's air 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 over a period of 3 days.

  It is necessary to compensate the consumption of electricity from the municipality's own sources with the use of the "air-water" or "air-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 requirement of the heat pump for space heating, partly for 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 (SEA system) is the most feasible option for heating buildings and obtaining DHW. It can exclude the use of fuel-based heating (fossil or bio), significantly reducing greenhouse gas (GHG) emissions. The water temperature in the heating system will be 65-85°C, the domestic hot water temperature will not exceed 50°C. The simple payback period is 2.0-3.0 years.

  The use of photovoltaic-thermal panels together with the "air-water" heat pump, the LED lighting together with the thermal insulation of the walls and ceiling and the use of modern PVC windows and doors offer the possibility to pass the building to the class of passive buildings and to 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. 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%).

❖ **BE6. Replacing the old heating system in public buildings**

The replacement of the old heating distribution system complies with Directive EE 2012/27 / EU. The heating systems of public buildings were built over 25 years ago with little maintenance. The radiators are made of cast iron. Radiators and water pipes have not been cleaned, so they are sedimented with salts, rust and deposits of impurities. If the layer of salt sediments is 8mm, 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 heat energy consumption control systems and heat point consumption control 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 to the temperature measured inside (individual control) or outside the building. When adjusting the power of the thermal plant, the measurement of the outside air temperature is used, when adjusting the radiators - the internal temperature. With the increase of the external temperature and the internal temperature, the flow of the heat agent decreases proportionally, and vice versa - it increases when the temperature inside the building and the outside air decrease. By reducing the heat flow, the amount of 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.

❖ **BE7. Installation of new individual biofuel heating power plants, their interconnection with solar heating systems**

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

The new stations should run on wood pellets produced locally from the energy willow. These will improve heating efficiency and reduce CO_2 emissions.

The interconnection of the thermal plant with the solar water heating system will improve the reliability of obtaining hot water throughout the year, having a balance between two energy sources:biocombustibil și solar. Solar preheating of the water entering the boiler can reduce fuel consumption by up to 80%.

❖ **BE8. Replacing gas-powered kitchen and laundry appliances in kindergartens and schools with electric appliances**

Incentives for replacing kitchen and laundry appliances for new ones in kindergartens and schools is Directive 2012/27/EU. The kitchen equipment in the kindergartens and schools of the commune use liquefied gas, which creates the danger of accidental explosion. They must be replaced by electric appliances, which will eliminate the use of fossil fuel.

❖ **LE1.1 Replacing old technology lights with LEDs in buildings**

Public buildings are mainly lit with fluorescent tube lamps which lead to high energy consumption. Fluorescent tube lamps are more efficient than the incandescent bulb, but they contain mercury vapor, which is dangerous to people and the environment. In addition, they have

other shortcomings, and Ra is less than 80%. Ra is the color transmission index (Sunlight - 100%, incandescent lamp - 95%). It is planned to rehabilitate the internal lighting systems in all public buildings by replacing old technological lamps with LEDs saving approximately 70% of energy.

Apart from saving energy, LED lighting has many advantages in indoor lighting:

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

- LED lamps do not contain dangerous elements and are ecological;

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

Table 5. 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 for replacing old boilers with new ones for private house owners
BE14	Grants and subsidies	Incentives for replacing household appliances with new ones.

To sensitize the population, the following solutions have been identified in the private, public and residential sectors.

- **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 sensitize the population 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 the consumption will be after rehabilitation, as well as the cost of the measures. They can estimate the monthly expenses of the bills.

  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 Town Hall will adopt regulations for the construction of new private buildings and the renovation of old ones. It will contain requirements on energy efficiency, waste collection and environmental protection.

- **BE13. Grants and subsidies. Incentives for replacing household appliances with new ones**

  The Town Hall will look for opportunities to participate in competitions from international donors, country funds and government organizations.

- **BE14. Grants and subsidies**

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

- **B15. Partial subsidies/Subsidies for replacing old boilers with new biomass boilers for private house owners**

  Taking into account the fact that most of the buildings in the commune belong to the private sector, it will be decided to facilitate the house owners to replace the old boilers with new, more efficient ones.

They are expected to form a fund that will attract investments from various donor organizations, which could cover about 50% of the cost of purchasing the new boilers. ll existing boilers use mainly wood and coal with a low efficiency rate of around 60-70%. The new boilers are expected to use biomass with heat generation efficiency of at least 90%. This measure considerably 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 in public buildings is presented in the table below.

Table 6. The impact of the measures implementation

№	Action	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.	326625	202.1	40.8
BE2	Solar collectors for water heating and installation of PVT (photovoltaic thermal panels) on roofs and independent units	120,000	240.0	69.6
BE3	Installation of Autonomous Energy Systems (SEA). Providing buildings with electricity, heating, domestic hot water and cold.	220,000	1,353.7	305.5
BE4	Use of air-to-air or air-to-water heat pumps for heating public buildings and domestic hot water	229,500	1,162.5	515.4
BE5	Biofuel production from energy willow. The use of wood pellets in public and residential buildings	142,850	858	173
BE6	Replacing the old heating system in public buildings	28,800	106.8	21.6
BE7	Installation of the individual heating plant, their interconnection to the solar heating systems.	24,800	960	194.0
BE8	Replacing gas-powered kitchen appliances in kindergartens and schools with electric ones	31,000	Children's safety will improve	
LE1	Replacing old technology lights with LEDs in buildings	27,846	17.0	7.5

LE2	Replacing old technology lights with LEDs in street lighting	217,300	57.2	25.4
PG1	Construction of a photovoltaic park with a power of 0.2MW	200,000	231.8	102.78
WW1	Design and construction of a sewage system together with the wastewater treatment plant	560,000	The level of environmental protection will increase	
WW2	Arrangement of the solid waste storage site	100,000	The level of environmental protection will increase	
WW3	Organization of the solid waste collection, transport and storage service	100,000	The level of environmental protection will increase	
CA1	Planting of 24.0ha of energy willow	80,000		1,673
CA2	Establishment of pellet production based on public-private partnership	70,000	936.0	189.0
CA3	Creation of a wetland in the center of the village	500,000	The level of environmental protection will increase	
CA4	Creation of a recreation area on the shore of the pond	200,000	The level of environmental protection will increase	
CA5	The transformation of the football stadium into a sports center	200,000	The level of environmental protection and well-being will increase	
CA6	Afforestation of the banks of the Raut river with an area of 50.3ha	300,000		3,480
CA7	Afforestation of the banks of two ponds with an area of 47.6ha	285,000		3,270

Note:

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

According to Part II "Baseline Emissions Inventory", the IPCC standard 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 Public lighting

The current situation

The village of Tarigrad is partially illuminated. Of the total length of the streets of 41.9km, 31.7km or 76% are lit. The main street (photo 7) with a length of 6.0 km, which is asphalted, is fully illuminated. The secondary gravel streets (photo 8) are partially lit. 250W high pressure sodium vapor and mercury vapor lamps are installed.

On average, street lighting operates 3877 hours per year.

Until now, street lighting has been partially financed by the Local Public Administration to improve the standard of living and the safety of citizens.

Photo 7. The lighting of the main street

Vision for the future

To ensure road and people safety through energy efficient street lighting, the following measures are proposed, the detailed description of which is given below.

Table 7. Energy efficiency measures in public lighting

LE	Public lighting	Actions
LE1	Energy efficiency of lighting in public buildings	Replacing old technology lights with LEDs in public buildings
LE2	Energy efficiency of street lighting	Installation of intelligent street lighting on all streets

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

Modern street lighting is based on LED lamps and the use of lighting fixtures with them. This technology offers great savings in energy and maintenance money. In addition, it is widely used with dimmable LED lamps, which allow the control of lighting intensity depending on the night, pedestrians or cars present and the transition to intelligent lighting.

Photo 8. The lighting of a secondary street

Therefore, the street lighting in the commune should be with LED and intelligent control, which, in addition to controlling the light intensity depending on the time of night, pedestrians or cars present can inform about the maintenance of the lighting system, the situation on the streets and others .

Currently, 31.7 km of streets are lit. Another 10.2 km are to be illuminated.

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

The calculations were carried out according to modern street lighting calculation methods. The distance between the newly placed poles is considered to be 30m and they will be installed on one side of the street. In total, 940 lighting fixtures based on LED technologies will be installed, of which 520 will be replaced.

The impact of the application of this measure is presented in the table below.

Table 8. The impact of the implementation of the measure in public lighting

№	Measure	The estimated investment, [euro]	Calculated reduction in energy consumption, [MWh/year]	Calculated reduction of CO2 emissions, [tons/year]
LE1	Replacing old technology lights with LEDs in public buildings	27,846	17.0	7.5
LE2	Replacing old technology lights with LEDs in street lighting	156,700	20.9	9.3
	New street lighting with LED	60,600	36.3	16.1

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

3.3 Transport

The current situation

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

The village of Țarigrad is connected by an asphalt road with the village of Pervomaiscoe and the city of Drochia, and from there with Chişinău via the R12 road.

Major transport pollution comes from local transport of residents and economic agents. The village of Țarigrad owns 650 cars, 260 trucks, 62 tractors, 6 combines and 200 motorcycles.

Approximately 6,300 cars, 2,200 trucks, 1,800 tractors and more than 8 combines pass through the village annually.

It does not take into account the major pollution from the transport that runs on the mentioned highways, which are national and regulated by the government. Other transport sectors in the locality are private, residential and economic in the commune. They are also regulated by the government.

About 50% of the roads are in a satisfactory condition. Most of the roads are country roads with no hard surface and no sidewalks, making it difficult for the elderly, disabled, mothers with strollers and children to walk. Rural roads become impassable in rainy weather, which makes it difficult for people to move to public institutions, makes it impossible to use personal transport and is an

Photo 9. Drochia-Tîrnova road

important barrier to providing quality services throughout the commune. Poor road infrastructure can make access difficult for emergency services, fire and police.

It is estimated that local transport consumes 77.0 tons of gasoline and 26.0 tons of diesel fuel annually. Approximately the same amount of fuel is burned when transiting the commune.

3.4 Energy

POWER SUPPLY

The current situation

The National Electric System provides electricity in the commune of Cotova through the electricity distribution company S.A. "North Electric Energy Supply". S.A. "Red nord" is the sole owner of the distribution networks in the north of the Republic of Moldova.

In order to ensure the energy autonomy of the commune and to reduce expenses for electricity consumption, it is appropriate to produce electricity locally using renewable energy sources.

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

Fig. *16. Roads, streets and the transport plan of the village of Tarigrad*

Table 9. Measure of local electricity production

PG	Local production of electricity	Measure
PG1	Photovoltaic	Construction of a 0.2MW photovoltaic park

The detailed description of the defined solutions is given below:

❖ **PG1. Construction of a commercial photovoltaic park of 0.2MWp**

The current legislation[2] of the Republic of Moldova encourages the construction of a photovoltaic park with the aim of producing clean energy. The town hall of the commune owns a large area of land that is unusable and not available for agricultural use. The land with the surface of 0.55ha

2 LAW No. 10 of 26-02-2016 regarding the promotion of the use of energy from renewable sources

(photo 10, fig.17) in the middle of the village of Țarigrad can be used for the construction of a photovoltaic park. The town hall will attract investments for its construction. The amount of electricity generated annually is 1.156 kWh for every 1 kWp of installed photovoltaic panel (fig. 11).

Table 10. Quantity of local electricity production

PG	Local electricity production	Measure	Amount of electricity generated, MWh / year	Reduced CO2 emissions, tons
PG1	Photovoltaics	Construction of a 0.2 MW photovoltaic farm	231.8	102.8

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 power can be generated into the grid. As seen in table 10, this action will annually replace 231.8MWh of fossil electricity and reduce CO^2 emissions by 102.8 tons.

Photo 17. The land for the location of the 200kWp photovoltaic park

THERMAL ENERGY

The commune has no urban heating system or domestic hot water system.

The municipality intends to plant 50.3ha of energy willow on the banks of the Răut river to reduce the consumption of natural gas and firewood obtained by cutting down forests. The planned amount of produced pellets should cover the needs of public buildings, some companies and households. This action will establish a market for biofuels, create new businesses and generate jobs.

In addition, it is planned to replace individual old heating stations with new biomass-powered ones.

The heating stations will interconnect with the solar water heating installations.

3.5 Water and wastewater

The current situation

The village of Țarigrad has a modern aqueduct with a length of 42.7 km. All consumers are provided with drinking water.

At the same time, the village does not have a centralized sewage system and a wastewater treatment system.

Villagers have 2,200 backyard toilets. The liquid from them penetrates directly into the underground waters, polluting them intensely. Public buildings and economic agents have 175 internal toilets, the contents of which are transported outside the town, being dumped on a lot nearby the commune. This method is as hazardous as external toilets.

The large number of households in the residential area do not have a centralized sewage system, and wastewater is stored in hand-dug and unprotected outdoor pits, called toilets. Because of this, soils and groundwater sources are contaminated.

In addition, the waste water from the neighboring households of the Cainar river ends up directly in or in the ground water. Industrial and agricultural waste water also heavily pollutes the environment.

The construction of a sewerage and sewage treatment system is imperative.

Țarigrad City Hall will initiate the design of the sewerage and wastewater treatment system, the orientation scheme of which is presented in fig. 18.

The solution that was defined after analyzing the situation is shown in table 11 below.

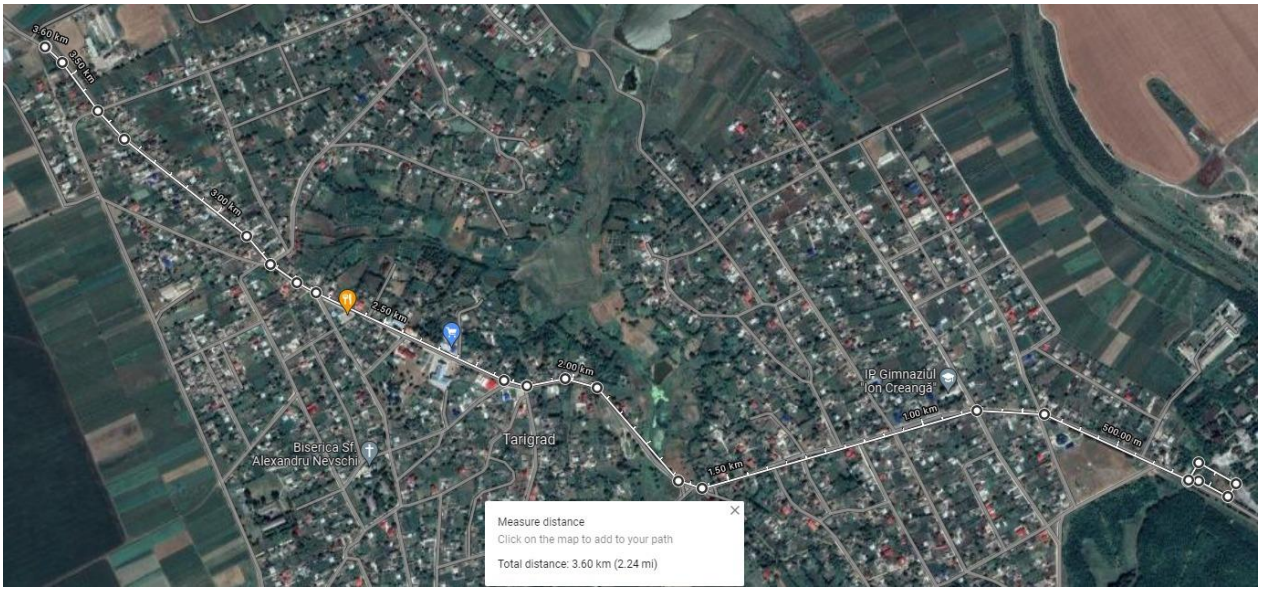

Fig. 18. The central line of the planned sewer system

Table 11. Water, wastewater and solid waste management measures

WW	Name	Measure
WW1	Waste water management	Design and construction of a sewage system together with the wastewater treatment plant
WW2	Solid waste management	Arrangement of the solid waste storage place, creation of their collection service
WW3	Solid waste management	Design and construction of a sewage system together with the wastewater treatment plant

The detailed description of the defined solutions is given below:

WW1. Design and construction of a sewage system together with the wastewater treatment plant

It is a must to improve the standard of living of 2,233 households by building a centralized sewage system. The town hall of the commune must build a modern aqueduct that would satisfy the needs of public consumers and the inhabitants of the village. It is necessary to initiate the technical execution project of the sewage system and the treatment plant. The city hall must undertake actions to attract investments from development partners by participating in the contests announced by them.

The construction of the sewage system and the treatment plant will solve the problem of environmental pollution with waste water from inside the village territory.

In the residential sector of the village there are more than 2,200 toilets outside the polluting buildings intense environment. In addition to this, there are animal and bird breeders in the village, which also contribute to pollution.

The central pipe of the sewage system could be as illustrated in fig. 16, but it will be concreted at the design stage. The centralized sewage system and the wastewater treatment plant will considerably reduce the negative impact on the environment, especially on the Răut River and the 7 surrounding ponds. It will also have a positive impact on groundwater resources and improve people's well-being and health.

3.5 Solid waste

The current situation

A pressing problem of the village of Țarigrad is the storage of manure from about 200 cattle, 84 pigs, 1,470 sheep and goats, 12 horses and over 17,000 poultry. Now

Photo 10. Unauthorized storage of solid waste

animal owners evacuate garbage outside the village, in unauthorized places (photo 10) and on agricultural fields to obtain organic fertilizers.

Fig. 19 shows the view from space of the environmental pollution situation with solid waste.

Fig. 19. Unauthorized storage of solid waste seen from space

The environment is polluted with plastic, manure, construction waste and various packaging residues. Rains and melting snow transport a good part of them into the Răut River, which flows through the meadow further down. As a result, not only the Răut is polluted, but also the Dniester, whose tributary it is. In other words, unauthorized dumping pollutes a vast area of the country.

WW2. Arrangement of the solid waste storage site

The centralized collection of solid waste, transportation and storage in a specially designed place will change the appearance of the locality, reduce the impact on the terrestrial environment and ground water. The site of the waste deposit is valued (fig. 20), a land with an area of 12ha. Its construction does not require large investments. Tarigrad Town Hall to solve the problem of their collection, transpotation and storage.

WW3. Organization of the solid waste collection, transport and storage service

The organized collection of solid waste, its transport to the specially arranged storage place and its qualified storage is necessary.

For this, a specialized service is needed, equipped with transport and specialized cars. The minimum number of staff will organize the removal of waste and manure outside the towns, at the place of storage.

Fig.20. Plan of the location of the solid waste storage site

❖ **Solid waste management**

The solid waste and manure collection, transport and storage service will take care to store and process the waste with the subsequent use of the obtained products.

3.7 Climate mitigation and adaptation

❖ **CA1. Planting of 5.4 ha of energy willow**

Planting energy willow is an important action to improve climate change mitigation and adaptation.

This will make the village greener, mitigate the influence of precipitation, the consequences of snowmelt in winter and spring, and hot air currents in summer. Willow fixes riverbanks, steep slopes and helps prevent landslides. It also cleans the air. A hectare of willow absorbs more than 65 tons of CO_2 from the air annually. Willow cultivation is also suitable for the climate less favorable to the conditions of classical agriculture. At the same time, it helps preserve ecosystems.

Fig. 21. Planned plantation of energy willow of 24 ha

The plantation will retain rainwater and snowmelt water that will slow water evaporation during the dry summer period, positively influence climate change mitigation and adaptation. Wildlife, birds and insects will host the plantation restoring biodiversity.

The village municipality has no power to invest in this activity, therefore it is wise to solve it by implementing public-private partnership. The municipality can provide land (fig. 20) for the plantation and the private partner will bear all the expenses for the planting and the production biofuel. It also covers the costs of purchasing, caring for, harvesting, transportation and storage of production and marketing of willow pellets. Another option could be considered.

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

❖ **CA2. Establishment of pellet production based on public-private partnership**

Establishing the production of wood pellets from the energy willow will reduce CO2 emissions in the commune

and will contribute to economic growth. It will open the biofuels market in this area, as most of the potential customers are in the commune (kindergartens, school, other public buildings and residents). Apart from this, there is a shortage of wood biofuel in the Republic of Moldova.

The company will create jobs to operate. All this will increase the budget of the Town Hall.

❖ **CA3. Creation of a wetland in the center of the village**

The wetland would be flooded from stormwater and springs. It will retain water both temporarily and permanently, as long as the environmental conditions allow, it will brake the departure of underground water to the deep. It will maintain a large amount of biodiversity and provide unparalleled natural wealth to adults and children. It will become a rest area with coolness on the heat.

Photo 11. General view of the site to be converted into a wetland

Its realization will conserve biodiversity that is in danger of extinction, but it can also become a tourist destination to provide an environmental service and help convey the values of nature conservation.

Hydrophilic vegetation will return, i.e. that which has a good predisposition to water. It will restore

the habitat of a large number of species, notably migratory birds that come from wetlands around the world to feed and rest. Some of the mammals, birds, reptiles, amphibians, fish and insects will also return.

a) This action has a significant ecological importance for the proper functioning of nature. Along with the forested Răutului ponds and meadow, the clouds will stop above the estate of the village to discharge the rains during the hot season.

b) The land to the right of the road *b) The land to the left of the road*

Fig. 22. The land intended for wetlands

❖ **CA4. Creation of a recreation area on the shore of the pond**

The area with the surface of 8.7ha (fig. 21) is located in the southeast of the village of Țarigrad. Its arrangement provides for the arrangement of the pond for bathing and rest, the arrangement of places for rest and recreation, the creation of infrastructure, the construction of rest houses and places for amateur fishing, additional planting of trees around the pond.

The municipality has no budget for such an action. An alternative source of funding can be a public-private partnership, where the City Hall will provide the land around the pond, and the private partners will provide the pond and invest money to build the recreation area.

This measure will accumulate water from springs and rain and help mitigate climate change, saving

and spreading biodiversity and will help people to use a modern form of leisure.

Photo 12. The area to be developed for recreational purposes

The action will increase the budget of the City Hall through new jobs, will attract local and foreign tourists, which will activate services in the commune.

Fig. 23. Plan of the area to be developed for recreational purposes

❖ CA5. The transformation of the football field into a sports center

The village has a well-equipped football field. The quality of the housing is well maintained and surrounded by a modern fence. The village is proud of such an object.

Photo 13. The current state of the football stadium

The city hall makes an effort to implement sports. It is rational to continue the arrangement of this sports object by turning it into a multifunctional center for the wider attraction of children and adults in the practice of several outdoor sports. At the same time, it can become a green area of the village by improving the grass cover, planting trees and shrubs, building sidewalks, etc.

The soccer field, together with the related land, which can be used for this purpose, constitutes 2.4ha.

The Town Hall will attract designers specialized in sports constructions to carry out the execution project of the multifunctional sports center.

Fig. 24. The land around the stadium, to be developed

❖ **CA6. Afforestation of the banks of the river Răut**

There is a 5.0ha land in the meadow and on the hills of the Răut river in the south-west part of the village of Tărigrad (photo 14,15 and fig.22), which will be used for planting trees. This

Photo 14. The place to be afforested

measure will contribute to mitigating the impact of climate change by absorbing carbon dioxide,

will

Fig. 25. The land to be afforested

it keeps the area cool during the hot summer and will stop snow and moisture in the winter and spring. In addition, it will improve the well-being of residents as a place to walk and rest.

❖ **CA7. Afforestation of the banks of two ponds**

A chain of 3 ponds is located north of the village of Țarigrad. Two of them have large unused 47.7ha land that can be used for afforestation. The forest will retain in the soil the moisture accumulated during the period of rain and snow, feeding the ponds with water, cooling your area during the heat. At the same time, the forest will host insects, birds and animals, contributing to the restoration of the biosphere.

It is important to plant trees of several species, which will give the forest ecological stability. Hydrophilous tree and shrub species can be planted near the banks to attract waterfowl.

Photo 15. General view of the afforestation site

Fig.26. Plan of the area to be afforested

4. Organizational and financial aspect

The Town Hall of the commune will request funding from various sources to achieve the SECAP objectives with the preliminary approval of the Town Council. The town hall of the commune will hire professionals, who will be responsible for the management and development of energy efficiency and environmental projects in the area of the commune. The global necessary budget for the implementation of the actions of the current SECAP is estimated at 3,022,474 euros until 2030.

Several funding sources have been defined:

Local donors: the national state budget, the local budget of the Cotova commune, the Energy Efficiency Agency and the National Ecological Fund.

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

The technical supervision of the execution of the works will be provided by local consulting companies contracted by the municipality's Town Hall. The submission of reports on implementation and monitoring will be done by the person designated by the Municipality of the Municipality.

3 Baseline Emission Inventory (BEI)

Baseline Emission Inventory		
1) Inventory year	2019	
2) Number of inhabitants in the inventory year	3,350	
3) Emission factors	☑	IPCC
	☐	LCA (Life Cycle Assessment)
4) Emission reporting unit	☑	tonnes CO_2
	☐	tonnes CO_2 equivalent

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Table 12. Final energy consumption

A. Final energy consumption

ⓘ Please note that for separating decimals dot [.] is used. No thousand separators are allowed.

Sector		FINAL ENERGY CONSUMPTION [MWh]															
				Fossil fuels								Renewable energies					Total
		Electricity	Heat/cold	Natural gas	Liquid gas	Heating oil	Diesel	Gasoline	Lignite	Coal	Other fossil fuels	Plant oil	Biofuel	Other biomass	Solar thermal	Geothermal	
BUILDINGS, EQUIPMENT/FACILITIES AND INDUSTRIES																	
Municipal buildings, equipment/facilities		73.485		151													819.71
Tertiary (non municipal) buildings, equipment/facilities				0													0
Residential buildings		221.90		6,230													6451.9
Public lighting		75.7		0													75.7
Industry	Non-ETS															0	0
	ETS (not recommended)															0	0
Subtotal		**165**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**2946.3**	**0**	**0**	**948378**	**0**	**0**	**0**	**7347.317**
TRANSPORT																	
Municipal fleet								17.03									**17.03**
Public transport																	**0**
Private and commercial transport							301.60	1,008.70									**1310.3**
Subtotal		**165**	**0**	**0**	**0**	**0**	**301.6**	**1025.73**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1327.33**

OTHER	1															
Agriculture, Forestry, Fisheries																**0**
TOTAL	**371.08**	**0**	**6976.232**	**0**	**0**	**301.6**	**1025.73**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**8674.647**

Table 13. 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

Tabelul 14. Inventarul de emisii

Sector	CO_2 emissions [t] / CO_2 eq. emissions [t]						
	Electricity	Heat/cold	Fossil fuels				Total
			Gas	Diesel	Gasoline	Coal	
BUILDINGS, EQUIPMENT/FACILITIES AND INDUSTRIES							
Municipal buildings, equipment/facilities	33		151				**183**
Tertiary (non municipal) buildings, equipment/facilities	0		0				**0**
Residential buildings	98		1258				**1357**
Public lighting	34		0				**34**
Industry						**0**	**0.00**
Subtotal	**165**	**0**	**1409**	**0**	**0**	**0**	**1574**
TRANSPORT							
Municipal fleet							332
Public transport					4		
Private and commercial transport	0	0	0	81	251	0	332

Subtotal	**0**	**0**	**0**	81	255	**0**	**332**

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	**165**	**0**	**1409**	**81**	**255**	**0**	**1910**

4. 4. Assessment of climate risks and vulnerabilities (RVA)

Since there were no climate disasters that resulted in harmful consequences, no risk and vulnerability assessment studies or LPA decisions were developed for the urban area. 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 15. Hazard Risks and Indicators.

	<< 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 16. 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]

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

Table 17. Key actions for the entire duration of the plan (2022-2030)

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 MWh/a	Renewable energy production MWh/a	CO_2 reduction t CO_2/a	
MUNICIPAL BUILDINGS, EQUIPMENT/FACILITIES							**1,151,421**	**1,285.9**	**3,614.2**	**1,327.4**	
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	Tarigrad Town Hall	2022	2030	326625	202.1		40.8	Adaptation to climate change
Solar collectors for water heating and installation of PVT (photovoltaic thermal panels) on roofs and independent units	Energy efficiency of public buildings,		Local authority	Tarigrad Town Hall	2022	2030	120,000		240.0	69.6	Adaptation to climate change
Installation of Autonomous Energy Systems (SEA). Providing buildings with electricity, heating, domestic hot water and cold.	Adaptation to climate change		Local authority	Tarigrad Town Hall	2022	2030	220,000		1,353.7	305.5	Climate change mitigation and adaptation

Use of air-to-air or air-to-water heat pumps for heating public buildings and domestic hot water	Energy efficiency of public buildings,		Local authority	Tarigrad Town Hall	2022	2030	229,500		1,162.5	515.4	Climate change mitigation and adaptation
Biofuel production from energy willow. The use of wood pellets in public and residential buildings	Adaptation to climate change		Local authority	Tarigrad Town Hall	2022	2030	142850		858	173	Climate change mitigation and adaptation
Replacing the old heating system in public buildings	Energy efficiency of public buildings,		Local authority	Tarigrad Town Hall	2022	2030	28,800	106.8		21.6	
Installation of the individual heating plant, their interconnection to the solar heating systems	Climate change mitigation and adaptation		Local authority	Tarigrad Town Hall	2022	2030	24,800	960		194.0	
Replacing kitchen appliances that run on gas in kindergartens and schools with electric ones	Energy efficiency of public buildings		Local authority	Tarigrad Town Hall	2022	2030	31,000	Children's safety will improve			
Înlocuirea iluminării vechi de tehnologie cu LED-uri în clădirile PUBLICE	Energy efficiency of public buildings		Local authority	Tarigrad Town Hall	2022	2030	27,846	17.0		7.5	
Estimated reduction not associated with any reported actions							0	0	0	0	

PUBLIC BUILDINGS							**1,151,421**	**1,285.9**	**3,614.2**	**1,327.4**	
STREET LIGHTING							**217,300**	**57.2**		**25.4**	
Installation of smart street lighting on all streets	Energetic efficiency		Local authority	Tarigrad Town Hall	2022	2030	217,300	57.2		25.4	
Estimated reduction not associated with any reported actions							0	0	0	0	
LOCAL ELECTRICITY PRODUCTION							**200,000**	**0**	**231.8**	**102.78**	
Photovoltaic energy generation 0.2MW	Electricity production, climate change adaptation		Local authority	Tarigrad Town Hall	2022	2030	200,000		231.8	102.78	Climate change mitigation and adaptation
Estimated reduction not associated with any reported actions							0	0	0	0	
OTHERS							**2,395,000**	**0**	**936.0**	**8,612**	
Design and construction of a sewage system together with the wastewater treatment plant	Climate change mitigation		Local authority	Tarigrad Town Hall	2022	2030	560,000	The level of environmental protection will increase			

Arrangement of the solid waste storage site	Climate change mitigation and adaptation		Local authority	Tarigrad Town Hall	2022	2030	100,000	The level of environmental protection will increase			
Organization of the solid waste collection, transport and storage service	Climate change adaptation mitigation		Local authority	Tarigrad Town Hall	2022	2030	100,000	The level of environmental protection will increase			
Planting of 24.0ha of energy willow	Climate change mitigation and adaptation		Local authority	Tarigrad Town Hall	2022	2030	80,000			1,673	
Establishment of pellet production based on public-private partnership	Climate change mitigation and adaptation		Local authority	Tarigrad Town Hall	2022	2030	70,000		936.0	189.0	
Creation of a wetland in the center of the village	Climate change mitigation and adaptation		Local authority	Tarigrad Town Hall	2022	2030	500,000	The level of environmental protection will increase			
Creation of a recreation area on the shore of the pond	Climate change mitigation and adaptation		Local authority	Tarigrad Town Hall	2022	2030	200,000	The level of environmental protection will increase			

Transformation of the football stadium into a sports center	Climate change mitigation and adaptation		Local authority	Tarigrad Town Hall	2022	2030	200,000	The level of environmental protection will increase			
Afforestation of the banks of the river Răut	Climate change mitigation and adaptation		Local authority	Tarigrad Town Hall	2022	2030	300,000			3,480	
with an area of 50.3ha	Climate change mitigation and adaptation		Local authority	Tarigrad Town Hall	2022	2030	285,000			3,270	
Estimated reduction not associated with any reported actions							0	0	0	0	
TOTAL							**3,963,721**	**1,343.1**	**4,782**	**8,767.58**	