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CCGE consulting

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Sustainable Energy and Climate Action Plan of Akhuryan Community, Shirak Region, RA

Akhuryan 2026

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Abbreviations

BIE	Baseline inventory of greenhouse gas emissions
USAID	United States Agency for International Development
RP/H	Residential/Private Houses
MAB	Multi-apartment Building
GEF	Global Environment Facility
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit (German Agency for International Cooperation, GIZ) GmbH
EC	European Commission
EU	European Union
SECAP	Sustainable Energy and Climate Action Plan
NDC	Nationally Determined Contributions
LED lamps	light-emitting diode lamps (bulbs, lights)
RA	Republic of Armenia
LPG	Liquified Petroleum Gas
CNPO	Community Nonprofit Organization
MP	Municipality
MEMS	Municipal Energy Management System
UNDP	United Nations' Development Program
UNO	United Nations' Organization
CPC	RA Competition Protection Commission (CPC)
REGAD	Regional Administration
PEI	Preschool educational institution
SNPO	State Non-Profit Organization
TPP	Thermal Power Plant
LGB	Local government body
HH	Household
GHG	Greenhouse gases
CNG	Compressed Natural Gas
ENA	“Electric Network of Armenia” CSJC
PSRC	Public Service Regulation Committee of RA
CJSC	Closed Joint Stock Company
COM	Covenant of Mayors
PV	Photovoltaic (conversion, module, panel, etc.)

Units of measure

kWh	kilowatt-hour, 1 kWh = 3600 kJ
MWh	Megawatt-hour, 1MWh =1000 kWh
GWh	Gigawatt-hour, 1 GWh = 1000 MWh = 1,000,000 kWh
kcal	kilocalorie, 1 kcal = 1/860 kWh = 4.1868 kJ
ha	hectare, 1 ha = 10,000 m^2 = 100 acres
nm^3	Normal (standard) cubic meter
kt $CO_{2\ eq.}$	kilotons $CO_{2\ eq.}$ of Carbon dioxide equivalent

Introduction

The "Covenant of Mayors for Climate and Energy" initiative

The "Covenant of Mayors" is an initiative launched by the European Union, which is designed to unite local governments and regional authorities with a shared voluntary responsibility in regards to "green economic growth" and improving the quality of life. The communities signing the Covenant voluntarily agree to implement appropriate actions in the fields of energy efficiency and renewable energy within their administrative settlements that will allow for a reduction of carbon dioxide (CO_2) emissions by at least 30% by 2030 or by 40% by 2050, compared to the emission level of the baseline year chosen by the community. To achieve this goal, community authorities should develop and implement Sustainable Energy and Climate Action Plans (SECAPs), which assess CO_2 emissions in urban communities in the baseline year by main sources, as well as describe measures to reduce these emissions, their implementation deadlines, and funding sources.

The initiative was initially intended for cities in the European Union member states, but in September 2011, the regional program "Support to the participation of cities in the Eastern Partnership and Central Asia in the Covenant of Mayors process" (Covenant of Mayors East) was launched, in which 11 countries, including Armenia, participate.

Participation in the Covenant of Mayors initiative enables communities to ensure the following outcomes:

- improve the environment by reducing emissions of greenhouse gases and other substances,
- identify the main energy consumption sectors of the community economy and assess the technical and economic potential of energy saving in these sectors,
- increase the quality of services provided (e.g., outdoor lighting, heat supply, transportation, etc.) and the appropriate level of comfort,
- promote more efficient use of energy resources at the community level,
- develop and prioritize energy saving measures,
- promote the attraction of local and international investments and job creation aimed at implementing the proposed measures,
- reduce the municipality's expenses related to energy consumption, increase the awareness of community residents about the advantages of using green and clean technologies.

Analysis of the Energy and Climate Policy of the Republic of Armenia

The Republic of Armenia is a party to both the United Nations Framework Convention on Climate Change (UNFCCC) and the Paris Agreement. In fulfilment of its obligations under these international agreements, Armenia submits biennial transparency reports (BTRs) and greenhouse gas (GHG) inventory reports.

The Ministry of Environment (MOE) is the authorized state body responsible for developing and implementing state policy aimed at addressing climate change issues, as well as for fulfilling commitments undertaken under the UNFCCC and the Paris Agreement.

The Government of the Republic of Armenia adopted Resolution No. N 54-N "On Approving the Procedure for Greenhouse Gas Emissions Inventory" on 11.01.2024, thereby creating the national system for monitoring and reporting GHG emissions, ensuring the transparency, accuracy, completeness, consistency and comparability of the GHG emissions inventory.

In 2022, Armenia's GHG emissions amounted to 13,314.08 kt of carbon dioxide equivalent (kt CO_2 eq.), excluding the "Land Use, Land-Use Change and Forestry" (LULUCF) sector. In 2022, the country's total emissions were about 50.2% (13,442.01 kt) below 1990 levels.

Net emissions (including removals) in 2022 amounted to 12,932.2 kt $CO_{2\ eq}$. Overall, net emissions have decreased by 50.3% compared to 1990.

The "Energy" sector is the largest source of GHG emissions in Armenia; emissions from the sector have continuously maintained absolute dominance and, therefore, are the main factor in shaping emissions trends.

Energy-related emissions in Armenia show annual fluctuations, mainly depending on economic trends, energy supply structure, electricity export volumes, and climatic conditions.

Compared to 1990, GHG emissions from the "Energy" sector have decreased by 62.1%, due to structural changes in the economy, the widespread use of environmentally friendly fuel - natural gas (instead of previously used fuel oil and coal), the re-commissioning of the Armenian Nuclear Power Plant, and the unprecedented growth of renewable energy sources.

Since 2000, the growth in energy sector emissions has been about 90.2%, driven by increased road transport, improved household heating comfort, and electricity exports.

Armenia faces distinct challenges in addressing climate change. From 1929 to 2016, temperatures in Armenia increased by an average of 1.23°C, and projections show that they will increase by another 2.8°C by the 2050s. Along with the increase in temperatures, precipitation is projected to decrease by up to 8.3% by the end of the century.

These trends are already leading to more frequent droughts, heat waves, and extreme weather events, including floods and hailstorms, which pose significant risks to populations, economies, land degradation, and food security.

Due to rising temperatures and changes in precipitation, water resources vital for agriculture and hydroelectric power are being depleted, river flows are decreasing, and unmet water demand in some basins is projected to exceed 50% by 2050.

In 2021, Armenia's Nationally Determined Contributions (NDCs) were approved for a ten-year period (2021-2030), setting a new mitigation target to be achieved by 2030 through mainstreaming and integrating climate change concerns into national and sectoral development policies.

In December 2023, the Government of the Republic of Armenia approved the Long-Term Low-Emission Development Strategy of the Republic of Armenia (until 2050) (LT-LEDS).

The National Inventory document for 1990-2022 includes data on anthropogenic emissions and removals, covering GHGs not controlled by the Montreal Protocol, namely carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs), and sulfur hexafluoride (SF6)[1]:

Nationally Determined Contribution NDC 3.0, approved by Resolution No. 1962-L of December 25, 2025, which, based on the assessment of the progress of the previous NDC and taking into account the country's conditions, presents ambitious targets for 2026-2035.

The effectiveness of the Paris Agreement in reducing global GHG emissions depends on the reliability of the emissions data used to monitor the emission reduction targets. In this regard, the Covenant of Mayors for Climate and Energy CoM-EU climate and energy action plans and their subsequent analysis play a key role.

According to the amendments to the "Strategic Program for the Development of the Energy Sector of the Republic of Armenia (until 2040)" (Decision of 26 October 2023 N 1827-L), the Government of the Republic of Armenia has planned to increase the share of renewable energy (including large hydropower plants) in electricity production to at least 50% by 2030 (and to 60% by 2040). For this purpose, it is planned

[1] The national inventory also includes estimates of emissions of precursors: carbon monoxide (CO), nitrogen oxides (NO_x), non-methane volatile compounds (NMVOCs), and sulfur dioxide (SO_2).

to build solar power plants with a capacity of about 1,500 MW, including autonomous ones, and wind power plants (500 MW).

Armenia's transition to a low-carbon economy is further hampered by its landlocked geography, closed borders, and heavy dependence on imported fossil fuels, which accounted for 73.5% of energy use in 2023 according to the RA Energy Balance. This dependence poses risks to economic and energy security, while limiting affordable heating options in communities.

Armenia is committed to reducing emissions while strengthening the country's adaptive capacity to address climate vulnerability. Building on previous commitments under the Paris Agreement, the NDC reflects significant progress towards Armenia's climate goal. With broad coverage of the economy, it sets targets for reducing GHG emissions by 44% (unconditional) and 52% (conditional) by 2035 compared to 1990 levels.

According to the 1990-2022 National GHG Inventory Report, net GHG emissions in the Republic of Armenia in 1990 amounted to 26,013.8 kt CO_{2eq} (or Gg CO_{2eq}), taking into account the recalculations made in connection with the requirement to apply the values of the IPCC 5th Assessment Report on Global Warming Potential (GWP) (new values with a 100-year time scale). Therefore, the absolute value of the target indicator (emissions in 2035) will be 14,609.8 kt CO_{2eq} (unconditional) and 12,497.8 kt CO_{2eq} (conditional[2]).

At the same time, according to that report, net GHG emissions in the Republic of Armenia in 2022 amounted to 12,932.2 kt CO_{2eq}, therefore, according to the NDC the increase in GHG emissions in 2035 compared to 2022 should be restrained (in an unconditional version) to within 13.0%[3].

The Covenant of Mayors for Climate and Energy (CoM-EU) is the largest European initiative for climate and energy action. Through this CoM-EU framework, cities voluntarily commit to fighting climate change and thus pursue and advance the commitments of national governments at the local level.

The CoM GHG emissions accounting framework is based on the core principles of improving the quality, consistency, transparency and comparability of CoM data, while providing flexibility to meet local and regional circumstances and needs.

The Covenant of Mayors' GHG emission reduction targets are in line with the commitments and objectives set by the EU, in particular the European Climate Law (Regulation (EU) 2021/1119) , which aims to reduce GHG emissions by 55% by 2030, 90% by 2040 (compared to 1990) and achieve climate neutrality by 2050. To achieve these climate goals, EU cities must also be ambitious in their climate change mitigation strategies.

Climate change adaptation, together with mitigation measures, became one of the "cornerstones" of the EU's "Covenant of Mayors for Climate and Energy" initiative in 2015. As a result, starting this year, municipalities joining the Covenant are committing to develop adaptation measures aimed not only at reducing GHG emissions, but also at reducing identified climate risks.

In terms of adaptation, community action plans should include measures in those areas and sectors that are most vulnerable in the context of the projected impacts and risks (hazards) of climate change.

Within the framework of the UNDP/GCF "National Adaptation Program to Advance Medium- and Long-Term Adaptation Planning in Armenia" project, the National Climate Change Adaptation Action Plan (NAP)

[2] Unconditional or non-conditional measures are those that Armenia is committed to implementing using identified domestic and international resources within the framework of existing national and sectoral strategies, policies and planned investments. Conditional measures are aimed at achieving a more ambitious emission reduction target by 2035, which is impossible to achieve without attracting additional international resources.

[3] In the energy sector, actual emissions in 2022 are 62.1% lower than in 1990, therefore, in order not to exceed the indicator set by the 2035 NDC (to ensure a 56% reduction compared to 1990), it is necessary to restrain (in the unconditional version) the growth of emissions to within 11.5%, and in the conditional version (in order not to exceed the 62% reduction compared to 1990 in 2035 according to the NDC), emissions in 2035 should be maintained equal to emissions in 2022 (0% growth).

and the list of measures for 2021-2025 were developed in 2021 and approved by the RA Government's Resolution No. 749-L dated 13.05.2023.

The document guides the implementation of adaptation goals and aims to combine the efforts of the government, regional administrations, local governments, civil society and academic institutions, business, and the international community to strengthen the country's capacity to adapt to climate change in 2021-2025.

In essence, the main objective of the National Adaptation Action Plan (NAP) process is to contribute to climate risk reduction and management in Armenia by identifying the most important hazards, implementing adaptation measures that eliminate or mitigate the negative impacts of these hazards, reducing socio-economic vulnerabilities and avoiding losses and damages caused by climate change. At the same time, there is a goal to ensure the coordination of adaptation measures implemented in different sectors and levels in order to optimize their effectiveness. All these processes are fully consistent with the goals of the Covenant and the commitments undertaken by the countries under the initiative.

The impacts of climate change already pose a serious challenge for almost all communities around the world: they threaten to increase vulnerability to climate hazards, reduce access to natural resources and weaken ecosystem functionality, limit citizen safety, reduce business, hinder socio-economic development, etc. Therefore, adaptation to climate change is increasingly becoming an important priority for cities.

All communities that submit a SECAP and sign the Covenant must include an energy poverty component in their action plans and submit a report on the issue of energy poverty and its reduction. Alleviating energy poverty is one of the commitments of the Akhuryan community within the framework of the Covenant. Reducing energy poverty under the Covenant means ensuring access to affordable, secure and sustainable energy for community residents.

Signatories to the Covenant that have not committed to addressing energy poverty in their accession documents and have submitted/adopted SECAPs should progressively include this issue through the monitoring report template.

Chapter 1.Framework of the Sustainable Energy and Climate Action Plan of the Akhuryan Community

In accordance with the Law of the Republic of Armenia "On Administrative-Territorial Division of the Republic of Armenia" of September 24, 2021 HO-328-N, as a result of the amendments made and the process of enlargement of communities, the Akhuryan multi-residential community of Shirak region was formed, which includes the following settlements of Shirak region: Akhuryan, Azatan, Akhurik, Akhuryan kayarani, Aygabac, Arapi, Arevik, Bayandur, Basen, Beniamin, Getk, Yerazgavors, Lernut, Kamo, Kaps, Karnut, Karmrakar, Krashen, Haykavan, Hacik, Hacikavan, Hovit, Hovuni, Gharibdjanian, Mayisyan, Marmashen, Mets Sariar, Shirak, Voskehask, Jajur, Jajuravan, Jrarat, Vahramaberd, Pokrashen, Keti rural communities. Therefore, the processes for developing the Sustainable Energy and Climate Action Plan (SECAP) and the geographical scope of the document refer to the enlarged Akhuryan community (35 rural settlements).

In accordance with the requirements of the methodological guidelines of the "Covenant of Mayors East" EU initiative (hereinafter referred to as the Covenant)[4], the development of the Akhuryan community's SECAP includes the following activities:

- Compilation of a baseline inventory (BIE) of greenhouse gas (GHG) emissions:

To compile the BIE, it is necessary to define the base year (the year to which the emission reduction volume in the target year is compared). To define the base (baseline) year, the energy consumption volumes in the community are collected for five years (in this case, for 2020 - 2024) and the CO_2 emissions resulting from the use/combustion of energy carriers are calculated. As a result, the most reliable and characteristic year for the community is selected as the base (baseline) year.

According to the Covenant's methodological guidelines, the BIE must include at least three of the Covenant's four main sectors [Community buildings, equipment/structures, Tertiary (non-community) buildings, equipment/structures, Residential buildings, Transport], and GHG emission reduction measures must be proposed in at least two of the three selected main sectors (in this case, mitigation measures are included in the three proposed main sectors).

- Calculation of the target amount of GHG emissions to be reduced in the target year, based on the BIE:

The target volume of GHG emission reduction in the target year can be calculated in two scenarios: a) according to the base year scenario, in which the target volume of emissions reduction is determined based on the value of the calculated volume of emissions in the base year, and b) according to the usual development (business-as-usual) scenario, in which the target volume of GHG emission reduction is determined taking into account the development of the community and the factor of the expected growth of GHG emissions in the target year.

- Definition of mitigation measures that ensure the calculated reduction of GHG emissions in the target year:

The list of mitigation measures is identified by the sectors for which the BIE was calculated.

The main part of the proposed mitigation measures aimed at reducing GHG emissions in the SECAP are **investment** or so-called **"hard"** measures (thermal modernization of buildings, use of energy-saving technologies in lighting systems, development of a fleet of vehicles with electric motors in transport, promotion of local energy production from renewable sources, etc.).

[4] Bastos, J., Bezerra, P., Davide, M., Hernandez Moral, G. and Melica, G., How to prepare a greenhouse gas emission inventory - Covenant of Mayors Guidebook Complementary document 1, Publications Office of the European Union, Luxembourg, 2025

The other part of the proposed measures is of an **organizational** or so-called **"soft"** nature (support for the implementation of a community strategy for mitigating GHG emissions, raising awareness of stakeholders, strengthening capacities, developing an energy management system in the community).

The SECAP presents descriptions of mitigation measures, key actors, approximate volumes of required investments and possible sources of their financing, implementation deadlines and expected results (in terms of energy consumption reduction/energy production (MWh/year) and emissions reduction (t CO_2/year)).

It is expected that the full implementation of these actions will ensure the fulfilment of the commitments undertaken by the Akhuryan community within the framework of the Covenant and will allow it to achieve the target of reducing GHG emissions by at least 40% (30%) by target year 2050 (2030) according to the selected scenario.

1.1. Basis for the development of the Akhuryan Community SECAP

The Akhuryan community of the Shirak region of the Republic of Armenia joined the EU "Covenant of Mayors" initiative on May 16, 2025 by decision No. 130-A [5][6][7] of the Akhuryan community council of the Shirak region of the Republic of Armenia of the 5th session of May 14, 2025, according to which the Akhuryan community council of the Shirak region of the Republic of Armenia gave its consent to the membership of the Akhuryan enlarged community (Akhuryan + 34 rural settlements) in the European Commission's "Covenant of Mayors for Climate and Energy" initiative and to the development of the community's SECAP. Therefore, the current SECAP program of the Akhuryan enlarged community is being developed taking into account the energy and climate issues of all 35 rural settlements for 2020-2024. period, subject to the selection of a base year and the adoption of 2050 as the target/target year. By joining the EU "Covenant of Mayors" initiative, Akhuryan community undertakes to implement the following actions by 2050[8]:

1) to reduce greenhouse gas emissions in its territory,
2) to increase the resilience of communities and prepare for the negative impacts of climate change,
3) fight energy poverty.

To this end, during 2026, the possibility of creating a community energy manager position/department will be studied in the community to contribute to the implementation of the community's approved SECAP.

1.2. Action Plan objectives and related areas

The main goal of the SECAP is to initiate prospective mid-term complex measures in various areas of community life, which will ensure a high level of efficiency in energy production and use, contributing to the reduction of energy consumption and greenhouse gas (GHG) emissions.

The Action Plan includes areas of vital activity in which support from local partners, international organizations, and financial institutions can be expected for the implementation of planned activities.

To achieve the goals of the SECAP of the Akhuryan community of the Shirak region of the Republic of Armenia, the community must solve the following main issues:

1. Implementation of programs to increase the efficiency of energy production and use and encourage energy saving,
2. Use and application of modern technologies for the production of electrical and thermal energy, including renewable energy sources,

[5] https://eu-mayors.ec.europa.eu/en/signatory/32250
[6] https://eu-mayors.ec.europa.eu/en/signatories
[7] https://mycovenant.eumayors.eu/storage/web/mc_covenant/documents/27/1nw_ALeatgYaeszcegv6eQjx1D1nHAmp.pdf
[8] https://mycovenant.eumayors.eu/storage/web/mc_covenant/documents/4/C0DecGPz02O8GsC2n2TTiM1aowClMqhc.pdf

3. Implementation of measures aimed at reducing final energy consumption by various budgetary institutions (mainly municipal),

4. Promoting the efficient use of energy sources and end-use energy among the population and the public sector, conducting periodic awareness campaigns and monitoring,

5. Attracting investments to implement measures supporting sustainable energy development and climate protection.

The following primary objects of vital activity are included in the SECAP of the Akhuryan community of the Shirak region of the Republic of Armenia:

- residential buildings of the community (multi-apartment buildings and residential private houses),
- community-owned buildings and structures,
- community, public, commercial, private automobile transport,
- outdoor street lighting.

The program may also involve republican or regional budgetary institutions or organizations, as well as individuals or legal entities providing various types of services.

1.3. Legal and methodological foundations of Action Plan development

The following methodological materials have been developed and adopted for use by the EC Research Centre for the development of SECAPs:

1. Guide: "How to Develop a Sustainable Energy Action Plan (SECAP) in Eastern Partnership and Central Asian cities", EC Joint Research Centre, Part I, 2013, revised on 26.11.2020.

2. Guide: "How to Develop a Sustainable Energy Action Plan (SECAP) in Eastern Partnership and Central Asian cities", EC Joint Research Centre, Part II, Baseline Emission Inventory, 2014, revised on 26.11.2020.

3. Guide: "How to Develop a Sustainable Energy Action Plan (SECAP) in Eastern Partnership and Central Asian cities", EC Joint Research Centre, Part III, Efficiency and technical measures for renewable energy provision, 2013, revised on 26.11.2020.

4. "CoM-DeP" Project Implementation Guidelines 2015, revised January 2018.

5.«Technical Guide for the Modernization of Buildings under the "CoM-DeP" Program, 2015. Revised on 17.12.2020.

6.«CoM-DeP" program: street lighting guide, 2015. Revised on 17.12.2020.

7."CoM-DeP" program: technical supervision, 2017. Revised on 17.12.2020.

8."CoM-DeP" program: measurement and verification guidelines, July 2016. revised on 17.12.2020, Thermal modernization of buildings, Repair of centralized heating systems, Street lighting.

9. Guide "How to develop a sustainable energy and climate action plan in the Eastern Partnership countries" EC Joint Research Centre, 2018,

10. "CoM-Reporting Guidelines", March 2020.

11. «How to develop an energy poverty assessment», 2025.

The SECAP is also guided by the fundamental goals included in the following international and national documents:

International agreements, obligations

1. United Nations Framework Convention on Climate Change (UNFCCC) (RA ratified in May 1993 as a developing country not included in Annex 1 of the Convention.),
2. Kyoto Protocol to the UNFCCC (RA ratified in December 2002),

3. The Paris Agreement and the Doha Amendment to the Kyoto Protocol (The National Assembly of the Republic of Armenia ratified on February 8, 2017),

4."Nationally Determined Actions/Contributions" of the Republic of Armenia under the UN Framework Convention on Climate Change (Protocol Decision No. 41 of the Government of the Republic of Armenia dated 10.09.2015),

5."National Determined Contributions of the Republic of Armenia for 2021-2030 under the Paris Agreement" (Resolution No. 610-L of 22.04.2021 of the Government of the Republic of Armenia),

6. "Long-term Strategy for Low-Greenhouse Gas Emissions Development of the Republic of Armenia (until 2050)" (Resolution of the Government of the Republic of Armenia № 2318-L of 28.12.2023),
7. Third Biennial Update Report under the UNFCCC, 2021,

8. Comprehensive and Enhanced Partnership Agreement (CEPA) between Armenia and the European Union (ratified by the Parliament of Armenia on April 18, 2018),

RA legislation in the field of energy efficiency

9. The Law of the Republic of Armenia "On Energy Efficiency and Renewable Energy" (adopted on 09.11.2004) ՀՕ-122-Ն, Amendment HO-67-N of 12.05.2016)

10 The Law of the Republic of Armenia "On Accreditation" (adopted on 08.02.2012) ՀՕ-20-Ն)

11. National Programs: Energy Efficiency and Renewable Energy Program 2022-2030 (Appendix No. 1 to the RA Government Decision N 398-L of 24.03.2022)
12. Decisions of the Government of the Republic of Armenia:

- Resolution N 1399-Ն on approving the "Procedure for Conducting Energy Expertise" (adopted on 31.08.2006, amended on 10.09.2015 by No. 1026-N)
- Resolution N426-Ն "On establishing the technical regulations for electrical and electronic equipment in newly constructed residential multi-apartment buildings, as well as in facilities constructed (reconstructed, renovated) at the expense of state funds" (adopted on 12.04.2018)
- Resolution N 1504-Ն on the application of measures aimed at increasing the energy efficiency and energy consumption of facilities being constructed (reconstructed, renovated) at the expense of state funds (adopted on 25.12.2014)

13. "Long-term (until 2036) Development Pathways of the Energy System of the Republic of Armenia" strategic document (2015)
14. "Program-schedule ensuring the implementation of the first phase (2022-2024) of the Energy Efficiency and Renewable Energy Program 2022-2030" (RA Government Decision No. 398-L of 24.03.2022),
15. "Strategic Program for the Development of the Energy Sector of the Republic of Armenia (until 2040)", (RA Government Decision No. 48-L of 14.01.2021),
16. "On Amendments and Supplements to the Decision of the Government of the Republic of Armenia No. 48-L of 14.01.2021" (RA Government Decision No. 1827-L of 26.10.2023),

Community development programs and work plans:

17.Five-year development program for the Akhuryan community of the Shirak region of the Republic of Armenia for 2022-2026 (Approved by the decision of the Council of Elders of Akhuryan Community of Shirak Region of the Republic of Armenia No. 218-A dated 17.11. 2022),

18.Medium-term expenditure program of communities of the Republic of Armenia for 2023-2025.

19. Akhuryan Community Annual Work Plan for 2024

20. Report on the implementation of the 2024 Annual Work Plan of the Akhuryan community of the Shirak region of the Republic of Armenia

21. Akhuryan Community Annual Work Plan for 2025

Regulatory and legal acts in the field of energy efficiency:

- Construction Norms:
  - RACN 24-01-2016 "Thermal protection of buildings"
  - RACN II -7.02-95 "Construction Thermophysics of Building Enclosing Structures: Design Norms"
  - RACN 22-01-2024 "Construction Climatology"
  - RACN IV-12.02.01-04 "Heating, ventilation and air conditioning"
  - RACN 22-03-2017 Artificial and natural lighting
  - RACN 24-02-2022 "Ensuring energy efficiency of buildings: energy efficiency assessment indicators"
  - "Energy efficiency assessment indicators"
- National standards:
  - AST 362-2013 Energy efficiency. Building energy performance certificate. Basic provisions. Standard form
  - AST 371- 2016 Methodology for conducting energy audits in residential and public buildings
  - List of current standards in the field of energy efficiency and energy saving in Republic of Armenia.

European Union (EU) legislation in the field of energy efficiency in buildings:

- Directive 2010/31/EU of the European Parliament and of the Council of 19.05.2010 on the energy performance of buildings. Member States shall ensure that by 31.12.2020 all new buildings are nearly zero-energy buildings (NZEBs), and that new public buildings are NZEBs from 31.12.2018. Member States shall develop national plans to increase the number of NZEBs.
- Directive 2024/1275/EU of the European Parliament and of the Council of 24.04.2024 on the energy performance of buildings. All new buildings must be zero-emission buildings by 2030, and existing buildings must be converted to zero-emission buildings by 2050.

1.4. Project implementation financing options

Funding from various sources is envisaged for the implementation of the measures included in the Action Plan. An important tool can be the redirection of financial flows from cost financing (grants) to resource-saving financing. Below are examples of some possible sources of funding.

Local sources of funding

At the local level, the main financial source for the implementation of the Program may be the community budget. Community loans or bonds secured by state guarantees may serve as one source. It is desirable to include in the medium-term community development programs the issues of financing energy modernization of buildings, increasing the efficiency of street lighting, re-equipping public transport and other similar measures.

There is a possibility to attract funds on a co-financing basis from international institutions and donor organizations, with the mandatory condition of joint participation of the community.

a) National sources of funding

Targeted programs and funds, loans, targeted cash transfers, etc. can serve as national sources.

Subsidy programs aimed at developing the economic and social infrastructure of communities implemented by the RA Government are also a proven financial source. They are a new format of community-state horizontal cooperation, which implies co-financing of a part of the cost of a capital project from the state budget if the community submits a capital project and receives a positive conclusion from the government. Depending on the specific project sector, specificity, geographical location, as well as the impact of that project on the socio-economic situation of a given community, the state budget co-finances 30 to 70 percent of the total cost of subvention programs aimed at developing community infrastructure.

b) Local sources of funding

The main financial source for the implementation of the Action Plan may be the community budget. Loans or bonds secured by state guarantees may also serve. In cases of community participation, there is an opportunity to attract funds from international institutions and donor organizations.

c) financial resources of the community population

For the implementation of the SECAP measures, in case of initiative by the population, citizens have access to "soft", "green" loans operating in commercial banks. Even in case of partial co-financing by the population, these loans can finance the work of heat preservation in apartments, thermal modernization of buildings and structures, efficient heating systems, solar water heaters and installation of PV systems of the necessary capacity for their own needs.

d) The business environment as a source of financing

Promoting sustainable energy development and climate protection technologies is also possible through real business: encouraging the production of materials, developing entrepreneurship, etc. through advertising support, including minimum energy requirements in public procurement and providing for appropriate orders, as well as through co-financing schemes, the use of public-private partnership formats, and incentive systems.

e) Other possible sources of funding

Such funds may include environmental fees paid by enterprises that have a harmful impact on the environment in the community, international assistance funds, environmental donations, national targeted fundraising, grants, and special financial support funds.

Below is a list of a number of donor organizations and financial institutions with which you can cooperate to implement investment programs to increase energy efficiency and encourage the development of energy conservation and renewable energy:

- Global Environment Facility (GEF)
- United Nations Development Programme (UNDP)
- German Agency for International Cooperation (GIZ)
- Global Climate Partnership Fund (GCPF)
- Green Climate Fund (GCF)
- Armenia Renewable Resources and Energy Efficiency Fund (R2E2 Fund)
- World Bank (WB)
- Asian Development Bank (ADB)
- Kreditanstalt für Wiederaufbau (KfW)
- Eastern Europe Energy Efficiency and Environmental Partnership (E5P) Fund
- Habitat for Humanity Armenia (HFHA), etc.

1.5. Monitoring results as a means of controlling energy efficiency and encouraging further development

The implementation of the SECAP is supervised and coordinated by the Akhuryan Municipality. The implementation of the Action Plan will be supervised by the relevant specialists of the Municipality. It is desirable to introduce a system of energy managers specifically designated for these purposes, with their direct participation and coordination.

The implementation of program measures is monitored in accordance with the provisions of the Covenant. The monitoring procedure can be much more detailed and divided into intermediate stages at the local level. Such a system will be transparent, quantitative, manageable and will make it possible to monitor

energy use, set priorities for increasing energy efficiency and quantify and financially assess the savings resulting from reducing energy consumption.

Public oversight of the implementation of the Action Plan is carried out by representatives of public organizations whose regulations provide for activities in the fields of environmental protection, energy efficiency, energy saving, as well as renewable energy.

Control over the use of budgetary funds aimed at ensuring the implementation of the SECAP is carried out in accordance with the established procedure and in accordance with the current legislation of the Republic of Armenia.

1.6. The objectives of the five-year development plan of the Akhuryan community

The main objectives of the Akhuryan Community Five-Year Development Plan 2022-2026 are:

- To have well-maintained and well-lit roads and streets within the settlement
- To improve the building and property conditions of the municipality and administrative representatives
- To improve the quality of services provided in the field of preschool education
- To improve the quality of drinking water supply services
- To expand and improve the irrigation water supply network
- To update the machinery and tractor fleet
- To have a community with a clean environment, without violating the sanitary and hygienic state of nature and the environment, and to avoid diseases and epidemics
- To make the community more interesting, attractive and comfortable for tourists
- To activate the cultural life of the community
- To provide community residents and tourists with pleasant conditions for organizing and communicating
- To have well-maintained and functioning sports infrastructures equipped with gymnastics equipment
- To have well-maintained parks and playgrounds
- To efficiently use irrigation water resources
- To facilitate agricultural work by having paved inter-field roads
- To organize events to manage and reduce disaster risks and to cope with disasters.

It is expected that the full implementation of the mitigation actions presented in the SECAP will ensure the fulfilment of the commitments undertaken by the Akhuryan community within the framework of the Covenant and will enable it to achieve the target of at least a 40% reduction in GHG emissions by 2050 (compared to the base year).:

1.7. About energy poverty

The "Food Security and Poverty" report published by the Statistical Committee of the Republic of Armenia reveals a worrying social picture in the Shirak region, including the Akhuryan community, in terms of the relatively high level of poverty.

According to the RA Energy Efficiency and Renewable Energy Program for 2022-2030:

a) 58.6% of households in Armenia are unable to heat their homes sufficiently during the cold months and can be considered energy poor. The low intensity of energy consumption is largely due to the standard of living of the population.

b) Firewood is used as a heating medium by 71% of rural households. Firewood and manure remain the most common sources of heating in rural households.

c) Energy consumption in households largely depends on their standard of living.

d) The final energy consumption per capita in the HHs is about 2 times lower than the average for the EU-28 countries. And the final energy consumption per unit of the actually inhabited housing stock in the HH is 17% lower than the EU average.

e) Given the prospects for economic development and rising living standards over the next ten years, it is expected that energy demand from households will increase as a result of reducing energy poverty and underheating levels in residential areas.

Energy poverty refers to a household's lack of access to basic energy services.

Energy services should ensure an adequate level of health and well-being, including adequate heating, hot water supply, cooling, lighting and the availability of energy to power household appliances, in the appropriate national context, in accordance with existing national social policies and other relevant national policies.

Energy poverty is caused by a combination of factors, including, at least, inaccessibility, insufficient disposable income, high energy costs and low energy efficiency of housing.

Energy access and energy poverty are a cornerstone of the Covenant.

At the global level, this cornerstone/pillar is built on three energy attributes:

- **Reliable energy:** The availability and/or reliability of energy supply ensures access to economic, social and cultural interaction.
- **Sustainable energy:** Energy is produced from renewable and environmentally friendly resources, avoiding negative impacts on health, social well-being and gender equality.
- **Affordable energy:** Energy is affordable and/or buildings are energy efficient, allowing for the most cost-effective use of energy and the use of energy for economic, social and cultural purposes.

For each energy indicator, communities are provided with a set of indicators to assess local energy access and energy poverty levels.

Each region joining the Covenant can choose the most appropriate energy indicator based on its local characteristics and energy needs, adjusting its energy consumption estimate accordingly.

The measures proposed within the framework of this SECAP project will greatly contribute to the reduction of energy poverty in the Akhuryan community, while ensuring the full implementation of the community's commitment to reducing GHG emissions.

The low standard of living of the population and the actual underheating of private houses and apartments in rural areas reduce the financial and economic indicators of such projects and the actual impact of climate mitigation.

Poverty in Armenia has been assessed since 1996 using the indicators of "extremely poor" (food line), "moderately poor" (lower line), and "poor" (upper line). Since 2019, a new, revised World Bank methodology has been in use, which has also added a median poverty line, which is the average of the upper and lower lines.

The following comparison of poverty data for 2020-2024 is available in the report of the Statistical Committee and the "Centre for Economic Development and Research".

Table 1. Main poverty indicators in Armenia, (%)

Indicators	2020	2021	2022	2023	2024
Poverty level	27.0	26.5	24.8	23.7	21.7
Extreme poverty level	0.7	1.5	1.2	1.1	0.6

Table 2. Poverty rate by gender, (%)

Indicators	2020	2021	2022	2023	2024
Among men	26.3	25.8	24.7	23.7	22.5
Among women	27.9	27.3	25.0	23.8	19.4
In children (up to 5 years old)	34.1	36.7	32.3	32.2	30.2

Table 3. Poverty rate by education level, (%)

Indicators	2020	2021	2022	2023	2024
Elementary and lower	32.7	39.9	35.1	30.4	32.8
Incomplete secondary school	34.4	33.4	33.7	31.0	28.1
Secondary general school	29.5	30.0	26.0	23.8	22.7
Secondary vocational school	24.0	21.8	19.4	21.0	18.9
Higher	16.6	12.5	14.9	14.5	13.4

Table 4. Poverty level by some regions of Armenia, (%)

Indicators	2020	2021	2022	2023	2024
Total	27.0	26.5	24.8	23.7	21.7
Gegharkunik	48.1	49.1	33.9	35.4	27.6
Shirak	42.9	46.9	41.6	43.1	43.0
Syunik	6.1	2.8	5.4	7.0	6.2
Tavush	37.5	38.2	37.4	37.2	39.9

Table 5. Extreme poverty level by some regions of Armenia, (%)

Indicators	2020	2021	2022	2023	2024
Total	0.7	1.5	1.2	1.1	0.6
Gegharkunik	1.9	4.7	2.5	3.1	0.4
Shirak	2.2	3.1	3.6	4.0	2.4
Syunik	0.0	0.0	0.6	0.0	0.0
Tavush	0.7	1.3	5.0	2.6	2.0

Main poverty indicators in Armenia

Source: by the Statistical Committee

The poorest region in Armenia is Shirak, where 43% of the population is poor. Tavush follows with a poverty rate of 39.9%.

Poverty levels are also higher than average in Vayots Dzor, Gegharkunik, Armavir, and Kotayk.

The lowest poverty rates were recorded in Aragatsotn and Syunik.

Source: link

According to the RA 2014-2025 Strategic Development Program approved by the Appendix to the RA Government Decision No. 442-A of 27.03.2014, the main factors for poverty reduction will be the increase in the labour income of the population due to economic growth, including the progressive increase in the labour income of the poor population, as well as the increase in state expenditures on social insurance and social assistance and their targeting.

Table 6. Key target indicators for poverty reduction

Indicators	2010	2011	2012	2017	2021	2025
Poor, percent of population	35.8	35.0	32.4	23.7	18.1	13.0
Extremely poor, percent of population	3.0	3.7	2.8	2.4	2.1	1.8
Memorandum articles						
Upper general poverty threshold/line, AMD/month	33,517	36,158	37,044	43,218	48,642	54,747
Extreme poverty line, AMD/month	19,126	21,306	21,732	25,354	28,536	32,118

According to the RA Government Program (2021-2026), approved by the Appendix to the RA Government Decision N 1363-A of 18.08.2021, an annual GDP growth of more than 7% is necessary in the RA to halve poverty by 2026. By ensuring this growth rate, the quality of people's lives will significantly improve, incomes will increase, jobs will be created, and the poverty level will be reduced. The government will take steps to eliminate extreme poverty by 2026. Through the development of the capabilities and skills of poor and disadvantaged families, through the provision of employment and self-employment funds, and the application of phased poverty reduction models, families will emerge from poverty.

According to the planned measures, Armenia should implement: a) Adoption of a legal act on energy poverty taking into account the specificities of the Republic of Armenia, with the definition of characteristic indicators, b) Establishment of a mechanism for assessment and collection of gender-disaggregated data, c) Collection and assessment of gender-disaggregated data, d) Registration of energy poor energy consumers by gender, household and mapping.

All measures proposed within the framework of the SECAP are also aimed at reducing energy poverty in the community. Perhaps the most effective measure is 9.2.3.4. Restoration of thermal insulation layers of attic roofs of private houses.

If the specific cost of GHG emissions as a result of the implementation of all mitigation measures proposed within the framework of the Program (depending on the selected target year) is 3.17-3.33 thousand euros/tCO_2, and in the residential sector - 1.07-1.16 thousand euros/tCO_2, then in the case of the mentioned measure the specific cost of GHG emissions is 0.62 thousand euros/tCO_2, therefore it is also the most affordable in the context of reducing energy poverty.

1.8. About gender sensitivity

Women are among the most vulnerable groups in terms of energy poverty. Climate change-induced instability of the energy system, potential disruptions in energy supply, and problems with access to energy services may increase the burden on women.

The Gender Strategy of Armenia for 2025–2028 sets out national priorities aimed at promoting equality in all areas. Priority 6 focuses on developing gender-sensitive and gender-responsive approaches to climate change. This priority highlights the importance of ensuring inclusive principles and raising awareness of the differential consequences of climate change impacts for women, men and vulnerable groups. In the context of climate adaptation and mitigation programmes, it is necessary to integrate gender considerations into policies and programmes, promote equal participation of men and women in decision-making processes and recognize women as key agents of change.

Within a coherent national framework, this document takes into account the importance of gender-responsive approaches to climate change and emphasizes the commitment to integrating inclusive principles into current and future adaptation and mitigation processes, contributing to resilience and sustainable development.

Chapter 2. Brief description of the Akhuryan community

Akhuryan community of Shirak region is located in the central part of the Shirak plain, to the north is Shirak, and to the south is the Pambak mountain range. It is about 1-5 km east of the regional centre Gyumri, and 126 km northwest of the capital Yerevan. The community borders the communities of Gyumri, Arevik, Karnut, Basen and Kamo. The average altitude above sea level is 1536-1560 m, in some places 2100 m.

The name Akhuryan is very old, it originated from the name of the Akhuryan region near Sarighamish, the "Land of Etiun" mentioned in the Van inscriptions. It is known that as early as the 8th century BC, King Argishti founded a city named Akhuryan in Basen, after which the nearby river was named Akhuryan.

One of the versions of the origin of the name Akhuryan is as follows: a farmer, embittered by frequent droughts and disasters, looked at the river flowing through the gorge and sighed: “akh ur”, “akh ur” (“oh where”, “oh where”). The sigh mixed with the sound of flowing water and the stream received the name Akhuryan.

Akhuryan Gorge

by Valen1988- Own work under CC BY-SA 3.0
https://hy.wikipedia.org/wiki/wiki/Պատկեր:Ախուրյանի_կիրճը.jpg#/media/Պատկեր:Ախուրյանի_կիրճը.jpg

Panorama of Akhuryan village

by GeoO - Own work under CC BY-SA 4.0
source:
https://commons.wikimedia.org/wiki/File:Գյուղ_Ախուրյան.jpg#/media/File:Գյուղ_Ախուրյան.jpg

The village of Akhuryan, which is now in its present form, was founded in 1828-1829 by Armenians deported from the Basen, Kars, Sebastia, and Alashkert provinces of Western Armenia. The founders of the village were from the Chanchurian, Baghdiyan, and Matosyan families.

Source: https://hy.wikipedia.org/wiki/Մարմաշենի_վանք

The Marmashen Monastery complex is located about 2 km northwest of the village of Marmashen in Shirak province, on the left bank of the Akhuryan River. Marmashen was first mentioned by Armenian historians in the 10th century. The next historian who provides valuable information about Marmashen is the 10th-11th century author Samvel Anetsi. He mentions that it was built by Vahram Pahlavuni.

The Armenian Apostolic **Church of St. Stepanos** in the village of Azatan was built in 1460, renovated in 1865 and in 1999 was transformed into the Church of St. Harutyun. Now both names are used: St. Harutyun and St. Stepanos. The bell gong preserved from the village's old Apostolic church of the 7th century is kept in the Church of St. Stepanos. Not far from the Armenian Apostolic Church is also a chapel of the sanctuary built in the 18th century. The chapel now houses a giant metal cross, which belonged to the belfry of the old church of the community. Currently, both churches have been renovated and are in operation.

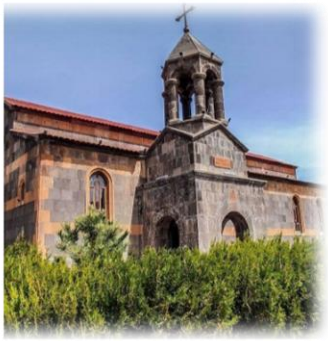
Source: https://hy.wikipedia.org/wiki/Սուրբ_Ստեփանոս_եկեղեցի_(Ազատան)

2.1. Historical and cultural monuments

After the renaming of foreign nomads, by the decision of the Supreme Council of the Armenian SSR in 1945, the village was again renamed Akhuryan/Akhuryan, after the Akhuryan River, which originates from Lake Arpi and is the right tributary of the Araks River.

Akhuryan has the 13th-14th century St. Nshan Church and the "Srbategh" chapel, the St. Astvatsatsin Church, the Marmashen Monastery, the St. Stepanos Armenian Apostolic Church in the village of Azatan, the Bazilik Church in the village of Karnut, etc. The "St. Nshan" domed church in the village of Akhuryan was built in 1858, then rebuilt in 2008. The Black Fortress is not that far away. There is a megalithic structure near Azatan.

Holy Mother of God Church of Akhuryan



Source: https://akhuryan.tilda.ws/church

The Holy Mother of God Church in Akhuryan, which, according to local residents, was built by Armenians who migrated from the village of Vazili in Sarighamish in 1858. On the initiative of a person named Terter, is considered one of the important representatives of Armenian architecture. It is built of local tuff stone, using a cross-shaped plan and a central dome, which symbolizes the spiritual connection with God. The church is characterized by moderate and beautiful decorative solutions, which complete its sacred appearance. The church suffered partial collapses in 1926, completely collapsed in 1988. During the catastrophic Spitak earthquake and was thoroughly rebuilt in 2007-2008.

Source: https://www.aliqmedia.am/2025/07/29/191123/

Hole Stone (TsakKar) - The Saint of the Seven Brothers .

The pilgrimage site "Tsakkar" or "Yot Akhpor Surb" (The Saint of the Seven Brothers) is located about 1 km northeast of the Hatsik settlement of the enlarged Akhuryan community of Shirak province, in the Karmrakar settlement, where there are early Christian khachkars.

"Yot Akhpor Surb" consists of several small underground chambers.

It was probably a natural cave that was later turned into a chapel. There is a story that seven brothers lived in the cave, who constantly fought against enemies and protected the area. After their death, the locals buried four of the brothers inside the cave, and three outside. This is where the name of the pilgrimage site "Seven Holy Brothers" came from. The brothers had a sister who was killed by nomadic tribes. Her relics are buried a little above the sanctuary, on the mountain. Not far from the chapel, on the slope of the valley, there is a huge, oval stone with a round hole, which is better known as the "Tsak Kar". According to tradition, in ancient times, barren women came to this place to make a pilgrimage in the belief that they would have children. According to another version, when you pass through the hole in the stone, you seem to be reborn and cleansed of your sins and illnesses.

Mayisyan Holy Mother of God Church

In the center of the village of Mayisyan in Shirak province, stands the 7th century Tiranavor, now Surb Astvatsatsin Church, built of polished tuff and decorated with numerous cross carvings. In 1926-1927, the church was destroyed by the earthquake, leaving only flagstones. Based on the memories of the villagers, part of the church walls has been restored.

Source: https://www.aliqmedia.am/2025/07/29/191123/

The church is a cross-domed type with a centralized plan. Local tuff was used, which with its colours and durability provides the church with a unique appearance. The walls are decorated with khachkars and traditional Armenian patterns. The dome is high, and the windows inside create natural lighting. There are old khachkars and graves around the church.

After the establishment of the Soviet regime, from 1920 to 1924, Akhuryan was part of the Alexandropol province of the Yerevan province. Until 1930, along with Ani, Amasia, Akhuryan, Azatan, and Talin, it was included in the Leninakan province, and after the abolition of the provinces, it was included in the Leninakan region.

As a result of the local government elections held in December 2021, the community was enlarged and today it already includes 35 settlements.

2.2. Local governance structure

The Council of Elders is the highest representative body of local self-government in the Akhuryan community, which exercises control over the activities of the Akhuryan community leader and the implementation of decisions made by him.

The bodies of the Council of Elders are: the Head of the Community, his first deputy and deputy, the members of the Council of Elders, and the fractions of the Council of Elders. The Council of Elders consists of 21 members, who are elected for a five-year term.

The Council of Elders adopts decisions concerning the interests of the Community, and on issues beyond its jurisdiction, it may adopt messages addressed to the community population, the community leader, the regional governor, or other state bodies.

Structurally, the staff of the Akhurian Municipality consists of the following departments:

- Department of Urban Planning and Land Development,
- Agriculture and Environmental Protection,
- Financial and Economic, Revenue Accounting, Collection and Procurement,
- Department of Development Programs, Tourism, Trade, Service and Advertisement,
- Secretariat, Personnel Management, Information Technology Department.

There are also civil works and maintenance personnel, community discretionary and administrative (staff) positions.

Brief information about the other 34 out of all 35 rural settlements of Akhuryan community is provided below.

Azatan **rural area/settlement**

Source: https://www.aniarc.am/2021/05/23/azatan-pokr-gharakilisa-1831-1931-korkotian/

The village was founded in the 5th-6th centuries. Azatan community is located 5 km southwest of Gyumri city, 110 km from Yerevan city. It has an altitude of 1,510 m above sea level. The community is geographically foothill, bordering the communities of Gyumri, Akhuryan, Arevik, Aygabats, Beniamin, Bayandur, Yerazgavors, Getk and Gharibdjanian. The Gyumri-Yerevan national highway passes through the community.

Most of the community's land is black soil and is of agricultural importance, while pastures are few and poor. The community is located in a seismic zone.

Akhurik rural area/settlement

Source: https://www.facebook.com/Akhurik/posts/867612447327425/ https://www.facebook.com/photo?fbid=867612397327430&set=a.453536056792745

The community was founded in 1922 by immigrants from Western Armenia. The village is located in the northwestern part of the Republic of Armenia, near the Armenian-Turkish border. Although the distance from the Armenian-Turkish border is 1 km, the community does not have border status. There are remains of 7th-century border control churches in the community. The community is 12 km from the regional center and its altitude is 1,428 m.

Akhuryan kayarani rural area/settlement

It is included in the Akhuryan rural settlement.

Source: https://gdb.rferl.org/72DA36D5-E957-4C1B-94B0-3A8D86D1B3BC_mw800_s.jpg

Aygabats rural area/settlement

Source: https://www.aniarc.am/2021/06/06/aygabats-population-1831-1931/

The village was founded in the 1830s by residents who migrated from the village of Verin Patchvank in Western Armenia. Aygabats was renamed in 1948. The community has had a school since the 1920s and was called the Teachers' Forge.

Aygabats community is located in the southern part of Gyumri city, at an altitude of 1,500-1,600m above sea level. It borders the administrative territories of Azatan, Arevik of Akhuryan region and Vardakar, Meghrashen of the Artik region.

The climatic conditions are variable and unfavourable for agriculture. The fields are mostly not irrigated and yields depend heavily on annual precipitation. Winters are cold. Summers are cool, sometimes hot and dry.

Arapi rural area/settlement

Source: https://epress.am/tag/Առափի

The village is located in the valley of the Akhuryan River at an altitude of 1,500 m above sea level. The western part of the village is surrounded by low mountains. It borders the villages of Mar-mashen, Voskehask, Haykavan, Gharibjanyan and the city of Gyumri. Sometimes the amount of precipitation is 250-300 mm. The village is located in a seismic zone. There are landslides. The settlement was founded in 1720. Most of the population moved from the Kars and Mush regions of Western Armenia.

Arevik rural area/settlement

Source: https://armtimes.com/hy/article/179543

Arevik village was founded in 1815-20. The village is located southeast of the regional center Gyumri, at an altitude of 1,500 m above sea level. The distance from the regional center is 7 km. The duration of winter is 6 months, the weather is severe, the average winter temperature is 25°C. Winds are characteristic in spring and autumn, the average amount of precipitation is 200-250 mm. The village has a reserve of drinking water, which is supplied to the population through deep pumps.

Bayandur rural area/settlement

Source: By Narek75 - Uploader's own work, CC BY-SA 4.0, https://commons.wikimedia.org/w/index.php?curid=45368990

The village is 1,539 m above sea level. The village was renamed after Prince Bayandur. The heroic spirit of the Bayandur people was expressed in the 1853 Russian-Turkish battle and during World War II. There are cuneiform inscriptions in the village of Bayandur. To the northwest of Bayandur are Armenian and Greek churches. There are also St. Pap and "Mariam Mam" chapels in the village. It is 16 km from the regional center.

Basen rural area/settlement

Source: https://www.aravot.am/wp-content/uploads/2020/10/basen-gyugh-1.jpg

The village of Basen was founded in 1813-1817 by Armenians displaced from the Basen, Mush, Kars, Sebastia, and Alashkert provinces of Western Armenia. The community of Basen is located 16 km east of Gyumri, on the western slopes of the Pambak mountain range. To the east and north of the village are the Harsnasar, Artapa, and Chanaghasar mountains of the Pambak mountain range with their cold springs and flowery meadows, and to the west are the Ispiri, Topkar, and Gharavultapa mountains. It is 1,600 m above sea level, located in a strong seismic zone. The duration of winter is up to four months.

Beniamin rural area/settlement

Source: https://hushardzan.am/archives/10007#iLightbox[gallery-1]/0

The village was founded in the 19th century, and in 1945 it was renamed in honour of the village hero Beniamin Gaystyan. The distance from the capital is 110 km, from the regional centre is 15 km, and from the Yerevan-Gyumri highway is 1 km.
The Karkachun River flows through the administrative territory of the village. Tomb fields and territories have been discovered, which, according to archaeologists, are attributed to the 2nd to 1st centuries BC.

Getk rural area/settlement

Source: http://shirak.mtad.am/files/docs/25027.pdf

Getk community is located in the southwestern part of the Shirak plain on the Armavir-Gyumri highway. The distance from the capital is 125 km, from the regional center is 10 km. It is connected by inter-settlement roads to the communities of Gharibdjanian, Yerazgavors, and Azatan. The climatic conditions are variable and unfavourable for agriculture.
The fields are mainly not irrigated and the yield depends largely on the annual precipitation. Winter is cold, summer is cool, and sometimes hot and dry.

Yerazgavors rural area/settlement

Source: https://www.facebook.com/TSAYGlTV/videos

The community was founded in 1926. The main part of the population immigrated from the Mush and Kars provinces of Western Armenia. The village was renamed Yerazgavors in 1947. The community is not rich in historical and cultural monuments. Yerazgavors borders Turkey. It is 1,520 m above sea level. The distance from the center is 12 km. The village is in a moderately cold, moderately humid zone. The community borders the administrative territories of Bayandur, Getk and Akhurik communities.

Lernut rural area/settlement

Source: https://www.azatutyun.am/a/32572254.html

The rural community is located in the northern part of Shirak region, at an altitude of 1,930 m above sea level. The climate is temperate, the landscape is mountain-steppe, which is favorable for farming and cattle breeding. The settlement of the village has a very ancient history. This is evidenced by the pagan graves located in the village cemetery. The distance from the regional center is 20 km.

Kamo rural area/settlement

Source: https://www.shantnews.am/news/view/953278.html

The village was founded in 1772 by Armenian families who migrated from Mush. 1.5 km south of the village is an ancient settlement and burial ground, dating back to the 2nd-1st millennium BC. It is 1700 m above sea level. It is 13 km from the regional centre Gyumri, 9 km from Akhuryan, and 130 km from the capital.

Kaps rural area/settlement

Source: By Armenak Margarian - Բեռնողի սեփական աշխատանք, CC BY-SA 4.0, https://commons.wikimedia.org/w/index.php?curid=61096804

The village of Kaps was founded in 1820, when Armenians who migrated from the villages of Tigor and Akrak in Bayazet, Western Armenia, settled here. They were engaged in animal husbandry and fishing. There was clay in the area of Kaps, from which women made containers and used it for various purposes.
The annual precipitation in the community is 600-700 mm. The lowest temperature was -35°C, and the highest was + 33 °C.
Kaps community is located in the western part of the regional centre of Gyumri, near the Kaps reservoir. The settlement is located 23 km from the community centre, 16 km from the regional centre, and 132 km from the capital. The Gyumri-Amasia national road passes through the settlement.

Karnut rural area/settlement

Source: https://mamul.am/am/news/65195/

The rural community of Karnut is located in the north-eastern part of the region, at the foot of the Pambak mountain range, at an altitude of 1,550 m above sea level. The climate is temperate, the landscape is mountain-steppe, which is favourable for farming and cattle breeding. The settlement of the village has a very ancient history. The history begins as early as the Bronze Age, as evidenced by the Bronze Age settlements excavated at the western foot of the mountain called "Surb Minas".
Evidence of the antiquity of the settlement are the pagan and medieval cemeteries; there is a basilica church built in the 4th century.
The village was last inhabited in 1828-1829 by Armenians who migrated from the Basen province of Western Armenia. In 1946, the village was renamed Karnut. The name was based on the thorn variety called Kar, which grows lushly and tall in the area of the settlement.

Karmrakar rural area/settlement

Source: https://hetq.am/hy/article/167254

Karmrakar village was founded in 1829 by the refugees from Akhsa village in Basen province of Western Armenia. The village has a cemetery, a monument, a chapel and a church.
Karmrakar village is located in the north-eastern part of Gyumri city, at an altitude of 1,700-1,730 m above sea level. The distribution of seasons is uneven. The duration of winter is 5-6 months. It is not very hot in summer. The community borders the settlements of Mets Sariar, Lernut, Shirak, Hatsik, Mayisyan, Keti and Pokrashen of Akhuryan community.

Krashen rural area/settlement

Source: https://www.facebook.com/photo/?fbid=2756772647872851&set=a.683922557079421

The rural community of Krashen is located in the northern part of the region, at an altitude of 1,970 m above sea level. The climate is temperate, the landscape is mountain-steppe, favorable for agriculture and cattle breeding. The settlement of the village has a very ancient history. This is evidenced by the pagan graves located in the village cemetery. In 1948. the village was named Krashen, probably referring to the white clay buildings. In 1920, Armenians from the Bulanghi region of Msh province resettled in the village. The distance from the regional centre is 15 km, from the community centre - 20 km. The village borders the villages of Mets Sariar, Jajuravan and Jajur.

Haykavan rural area/settlement

Source: https://www.aniarc.am/2021/03/04/haykavan-population-1886-1931-shirak/

The village is the last village in the northwestern part of the Akhuryan community. As a settlement, it has a history of about five thousand years. In the northwestern part of the village, a settlement from the early pagan period, a burial ground, was discovered, in the area of the current cemetery, the foundations of a chapel from the early Christian period have been preserved, and in the eastern part there is a settlement dating back to the Middle Ages Arab period.

In the 1920s, it was resettled by Armenians who had survived the Genocide and migrated from various provinces of Western Armenia. Previously, the village was part of the Alexandrapol province of Yerevan province. On December 7, 1945, by the decision of the Supreme Council of the Armenian SSR, it was renamed Haykavan.

Hatsik rural area/settlement

Source: https://www.facebook.com/photo/?fbid=591895406704814&set=pcb.591895716704783

The ancient history of the community is evidenced by the Stone Age finds discovered during construction work. In the 1890s, a basilica-type church was built in the village, which was damaged by the 1988 earthquake.

After the operation of the Shirak Canal in 1924, when the arable lands of the village became irrigated, the village spread downwards. The village is located 3.5 km northeast of the regional centre. The new history of the village begins in 1815-1820, when Western Armenians migrated from Mush, Erzrum, and Basen and settled here. In 1946, the village was renamed Hatsik due to the abundance of grain crops in the village.

Hatsikavan rural area/settlement

Source: By Armenak Margarian - Uploader's own work, CC BY-SA 4.0, https://commons.wikimedia.org/w/index.php?curid=45176131

The village of Hatsikavan is located about 1 km northwest of the village of Hatsik. It has a station, which was built in 1898, and was renamed Hatsikavan on July 4, 2006.

Hovit rural area/settlement

Source: https://www.aliqmedia.am/2023/08/17/118557/

The village of Hovit in the Shirak region of the Republic of Armenia was founded in the 1830s by residents who migrated from Western Armenia. It was renamed Hovit in 1936.

Hovuni rural area/settlement

Source: https://hetq.am/hy/article/86314

The community of Hovuni was founded in 1926. The main part of the population immigrated from the Mush and Kars provinces of Western Armenia. Hovuni was renamed in 1948. Currently, the church built in the 1980s has been preserved.

Hovuni is located between the Kaps and Shirak canals. The village is located at an altitude of 1,730 m above sea level. The distance from the centre is 14 km.

Gharibdjanian rural area/settlement

Source: https://www.facebook.com/photo/?fbid=910458709709465&set=pcb.910458789709457

The village was founded in 1873. The village is located 4 km south of Gyumri city. It is located on the left bank of the Akhuryan River at an altitude of 1,600 m above sea level.

Mayisyan rural area/settlement

Source: By Valen1988 - Uploader's own work, CC BY-SA 4.0, https://commons.wikimedia.org/w/index.php?curid=38259111

Mayisyan village is located in the northern part of Gyumri city, 1 km away. The village borders five other villages and the administrative territory of Gyumri city. The Gyumri-Ashotsk-Georgia central road and the Yerevan-Tbilisi railway pass through here. The Shirkanal River passes near the village, which allows for full irrigation of the community's lands. The village is 1,640 m above sea level.

Marmashen rural area/settlement

Source: https://hetq.am/hy/article/83276

Marmashen village was founded in 1830, where immigrants from the villages of Tigor and Akrak Terjyani of Bayazet settled. The villagers are engaged in cattle breeding and farming. Marmashen community is located in the western part of Gyumri city, near the Kaps reservoir, its land area borders the settlement of Vahramaberd in the south, and the settlement of Hovuni in the north. The village has a rugged relief. Above sea level: 1,660 m.

Mets Sariar rural area/settlement

Source: Ara Vardanyan
https://www.instagram.com/p/DDZFJ5voiFy/?img_index=2

The village was founded in the 1820s. Since its foundation, the village has been called Sariar. It is located on the N. side of Gyumri city, at an altitude of 1,800-1,900 m above sea level. It borders the administrative territories of Krashen, Jajuravan, Lernut and Arpen settlements. Climatic conditions are variable and not favourable for agriculture. The fields are not irrigated and the yield depends largely on the annual precipitation. Winter is cold. Summer is cool, sometimes hot and dry.

Shirak rural area/settlement

Source: By Anyutos - Uploader's own work, CC BY-SA 3.0,
https://commons.wikimedia.org/w/index.php?curid=33504774

The village was founded in 1827 by a person named Mghdos, who designed the village area. The Shirak rural settlement is located in the northern part of the region, at an altitude of 1,965 m above sea level. The climate is temperate, the landscape is mountain-steppe, which is favourable for farming and cattle breeding. The settlement of the village has a very ancient history. This is evidenced by the pagan graves located in the village cemetery.

Voskehask rural area/settlement

Source: https://www.aniarc.am/2022/01/31/voskehask-population-karapapakhs/

Renamed Voskehask in 1946. The community is located on the right bank of the Akhuryan River, in the Shirak Plain, at an altitude of 1,500 m above sea level. It has a cold climate, little precipitation. There are strong winds, fogs and snowstorms are frequent. Summer is hot, relatively humid. Annual precipitation is 450-500 mm. Natural landscapes are black soil mountain steppes. The village was affected by the earthquake of December 7, 1988.

Jajur rural area/settlement

Source:By User:Alex alex - Jajur at Armenian Wikipedia, CC0,
https://commons.wikimedia.org/w/index.php?curid=27749316

The Jajur community of Shirak province was founded in 1827 by refugees from the villages of the Khnus provinces of Western Armenia and partly from the villages of the Ghars province in 1915-1920. From the moment of its foundation to this day, the village has been called Jajur. The name of the village is derived (according to tradition) from the words "jan jur" and "joj ureni". The village is famous for its rich reserves of drinking water and cold springs. The population of the village is only Armenians.

Jajuravan rural area/settlement

Source: By ArMu2025 - Uploader's own work, CC BY-SA 4.0 https://hy.wikipedia.org/wiki/Ջաջուռավան#/media/Պատկեր:Jajuravan.jpg

The village is located about 10 km northeast of the regional centre Gyumri. Jajuravan was renamed on July 4, 2006. Initially, it was a workers' settlement adjacent to the Jajur railway station, which was founded in 1928, immediately after the construction of the lime factory. The lime factory was built in 1927 with the funds of an Armenian tycoon from Tbilisi, by Greek and German specialists. The population of the community is exclusively Armenians, who came from the neighbouring villages of Kamo, Jajur, Krashen, Sariar, Lernut, to work at the lime factory and permanently settle in the settlement.

Jrarat rural area/settlement

Source: Ara Vardanyan https://www.instagram.com/p/DDegdvDouXE/?img_index=4

Jrarat village was founded in 1828, is located at the foot of Arevot and Harsnasar mountains. It is considered a mountainous-peripheral village. The village is also located in the upper reaches of the Jrarat River, at an altitude of 1,900-2,000 m above sea level, 140 km from the capital, and 20 km from the regional centre. The remains of a village site and a Cyclopean fortress, a chapel have been preserved in the vicinity. In the north-east of the village are the ruins of the 7th century St. Minas Church.

Vahramaberd rural area/settlement

Source: https://www.1lurer.am/hy/2025/11/08/1/1412360

The village is located 10 km northwest of Gyumri, on the left bank of the Akhuryan River. Renamed in 1946 in honor of the medieval Armenian general Vahram Pahlavuni, whose tombstone is preserved in the vestibule of the Marmashen Monastery.

It is 1,650 m above sea level. The climate is cold, with little precipitation.

Pokrashen rural area/settlement

Source: Ara Vardanyan https://www.instagram.com/p/DBtTMIAopjz/?img_index=5

Pokrashen village is located on the 14th km of the Yerevan-Gyumri-Bavra main highway, bordering the villages of Toros, Mets Sariar, Arpeni, Karmrakar and Keti.

The village was founded in 1827 at its current location, the population migrated from the village of Akha in the Basen province. The geographical location of the village is mountainous.

Pokrashen community is located at an altitude of 2,000m above sea level, 15 km NW of Akhuryan, 12 km from Gyumri.

Keti rural area/settlement

Keti village is located in the southern part of the Shirak mountain range. It borders Mayisyan in the south, Hoghmik, Goghovit, Torosgyugh and Pokrashen in the north, Karmrakar and Hatsik in the east, and Hovuni and Mayisyan in the west.

The annual precipitation is 350-450 mm. The lowest temperature was -35°C, and the highest was +33°C. The village has a rugged relief. It is 1,720 m above sea level.

Source: https://www.aliqmedia.am/2024/09/24/169287/

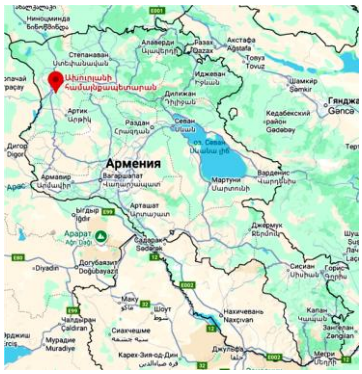
2.3. Geography

The settlement and community of Akhuryan in the Shirak region of the Republic of Armenia are located in the north-west of the Republic of Armenia, in the central part of the Shirak plain, in the north of Shirak, and in the east is the Pambak mountain range. The community borders the regional centre of Gyumri, from which Akhuryan village is 1-5 km to the east, and the village is 126 km to the north-west of the capital Yerevan. The community borders the communities of Gyumri, Arevik, Karnut, Basen and Kamo. The average altitude above sea level is 1,536-1,560 m, in some places 2,100 m.

The climate of Akhuryan village is cold. Precipitation is scarce: their average annual amount is 500 mm. The highest point of Akhuryan community is Mount Yeznasar (2,256 m). The surface is flat, forestless. The geographical location of the community is foothill, the mountain-steppe landscape prevails. It is rich in mineral building materials; there is also brown coal. The climate of the community is temperate, moderate, with long hot summers and cold winters. The absolute air temperature varies in the range of + 38 ° C ... -36 ° C, the average temperature in January is from -8 °C to 10 °C, in July - 12-20 °C, the annual amount of precipitation is 450-550 mm (average 528 mm), the vegetation period is 140-170 days. Winds from the east with a speed of 3.5-5.0 m/s prevail. The thickness of the snow cover is 62 cm, the pressure is 70 kg/cm^2. The freezing point of the soil reaches 92 cm. From a mountaineering point of view, the area is located on the northwestern slope of Mount Aragats and represents a flat-wave tuff plain.

The lands suitable for cultivation have a black soil structure. The community is located in a strong seismic zone. The border Akhuryan River flows through the west. The right-bank Akhuryan, Shirak, Kaps canals, Karnut and Zajur reservoirs are in operation. There are hydroelectric power plants and pumping stations on the Akhuryan River.

The Akhuryan highway and the interstate and republican highways M1-Yerevan-Gyumri-Bavra and M7-Gyumri-Spitak pass through the community. Gyumri Shirak International Airport is located nearby, and there are railway stations. The Akhuryan sugar factory operates.

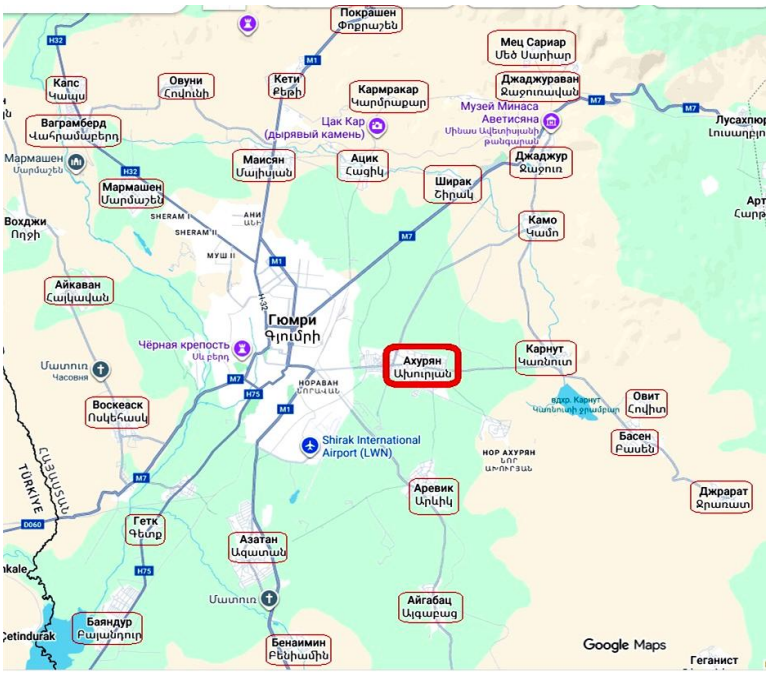


Source: GoogleMaps

Source: https://hy.wikipedia.org/wiki/Ախուրյան_(Շիրակի_մարզ)

Akhuryan community on the maps of Armenia and Shirak region

The Akhuryan enlarged community includes the following 35 rural settlements: Akhuryan, Azatan, Akhurik, Akhuryan Station/kayarani, Aygabats, Arapi, Arevik, Bayandur, Basen, Beniamin, Getk, Yerazgavors, Lernout, Kamo, Kaps, Karnut, Karmrakar, Krashen, Haykavan, Hatsik, Hatsikavan, Hovit, Hovuni, Gharibdjanian, Mayisyan, Marmashen, Mets Sariar, Shirak, Voskehask, Jajur, Jajuravan, Jrarat, Vahramaberd, Pokrashen, Keti.



Akhuryan village and some rural settlements of Akhuryan community on the map of Armenia (Source: google maps ®)

The table below shows the administrative area of the enlarged Akhuryan community in hectares by settlement, as well as the territorial share (in %) of each settlement in the total administrative area of the enlarged community.

Settlement	Area		Settlement	Area	
	ha	(%)		ha	(%)
Akhuryan (+Akhuryan kayarani (Akhuryan Station) / Nor Akhuryan)	2,846.38	5.09%	Haykavan	1,588.31	2.84%
Azatan	3,856.87	6.89%	Hatsik+Hatsikavan	1,213.42	2.17%
Akhurik	918.00	1.64%	Hovit	1,642.00	2.93%
Aygabats	1,857.10	3.32%	Hovuni	846.45	1.51%
Arapi	1,516.60	2.71%	Gharibdjanian	750.00	1.34%
Arevik	1,580.52	2.82%	Mayisyan	2,062.73	3.69%
Bayandur	1,143.00	2.04%	Marmashen	1,400.76	2.50%
Basen	4587.46	8.20%	Mets Sariar	2,326.05	4.16%
Beniamin	860.54	1.54%	Shirak	1,673.77	2.99%
Getk	921.00	1.65%	Voskehask	1,694.40	3.03%
Yerazgavors	971.90	1.74%	Jajur	2,416.21	4.32%
Lernut	879.60	1.57%	Jajuravan	26.11	0.05%
Kamo	2,418.08	4.32%	Jrarat	5,622.18	10.05%
Kaps	812.44	1.45%	Vahramaberd	819.62	1.46%
Karnut	1,936.24	3.46%	Pokrashen	746.16	1.33%
Karmrakar	941.24	1.68%	Keti	1,753.05	3.13%
Krashen	1,340.30	2.39%	-		

2.4. Community history

The name Akhuryan is very old, it originated from the name of the Akhuryan region near Sarighamish, the "Land of Etiun" mentioned in the Van inscriptions. It is known that as early as the 8th century BC, King Argishti founded a city named Akhuryan in Basen, after which the nearby river was named Akhuryan.

The territory of Akhuryan was part of Armenia in ancient times, during the reigns of the Yervandunis (570-201 BC) and the Artashesians (189-1 BC). Later, the territory of the Akhuryan region formed part of the Ashotsk province of the Gugark province of Greater Armenia. From the end of the 9th century, it entered the Bagratuni kingdom, then the Zakarian principality. In the 14th-16th centuries, it was invaded and occupied by foreign nomads.

During Persian rule, the Akhuryan region was part of the Yerevan Governorate. After Eastern Armenia joined Russia, it became part of the Kars region, and after the establishment of Soviet rule in Armenia, it became a district of the Leninakan province.

In 1828-1829, the present-day village of Akhuryan was founded by Armenians deported from the Basen, Kars, Sebastia, and Alashkert provinces of Western Armenia. The founders of the village were from the Janjuryan, Baghdiyan, and Matosyan families.

There are remains of a Cyclopean fortress (Tsoghamarg) and traces of a 3000-year-old settlement (Lernagyugh) in the area. Other notable historical monuments include the Urartian fortress of Vahramaberd, the Basilica Church of Karnut (4th-5th centuries), the Church of Jrarat (7th century), and the Monastery of Marmashen (10th-13th centuries).

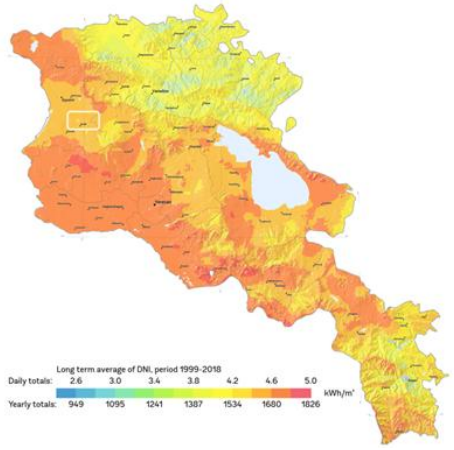
In 1831, Akhuryan had 456 inhabitants, in 1873 - 1061, in 1897 - 1635, in 1926 - 2447, in 1939 - 2320, in 1959 - 2966, in 1970 - 3812, in 1979 - 6364, in 1989 - 6730, in 2001 - 9696 inhabitants, according to 2011 data, the population was 7113 people. According to the data of the community administration, today the permanent population of the community is 45908 people.

According to the data of the National Statistical Service (NSS), the population of the enlarged Akhuryan community in 2014-2024 by settlements is presented in **Table 3.** According to the data provided on the official website[9] of the Akhuryan Municipality for 2025, the village has 30 general secondary schools, 2 primary schools, 1 senior school, 1 elementary school, 1/2/[10] art schools, 2 music schools and 1 sports school, 7 libraries, 19/13/ kindergartens, 11 culture houses and 2 sports and cultural centres.

2.5. Climatic conditions

The settlement and community of Akhuryan in the Shirak region of the Republic of Armenia are located in the north-west of the Republic of Armenia, in the central part of the Shirak plain, with the Pambak mountain range in the north and the Shirak Mountains in the south. The average altitude above sea level is 1,536-1,560 m, in some places 2,100 m.

[9] https://akhuryan.am/Pages/CustomPage/?CustomPageID=722b890c-cc0b-4c5d-bdf2-30fbebab4291
[10] The numbers marked in the brackets is according to the five-year development plan of Akhuryan community for 2022-2026: https://akhuryan.am/upload/DocFlow/Projects/Mo232131223402110187_2022-2026.pdf



According to the RACN 22-01-2024 "Construction Climatology" Construction Norms", the annual solar radiation is around 1,371.92 hours, with a maximum in July of 187.6 hours[11].

The total radiation of the horizontal surface under average cloudiness is 1,608.5 kWh/m^2, which is slightly lower than the average indicator for the republic.

https://globalsolaratlas.info/download/armenia

The calculated characteristics, beginning, end and duration of the heating period in Akhuryan community are given in **Tables 1 and 2.**

Table 1. Calculation characteristics of the heating period

Coldest five-day mean air temperature (^{0}C)	Average temperature with average daily temperature for the period: not higher than, °C			Degree-days of heating period at indoor temperature (+20°C)		
with 98% probability of occurrence	(0)	(≤ 8°C)	(≤ 10°C)	115	187	205
-18 (°C)	-5.6 (°C)	-1.7 (°C)	-0.7 (°C)	2944	4057.9	4243.5

Table 2. Start, end and duration of the heating period

Multi-year daily mean air temperature transition	Beginning*	End*	Duration* (days)
Heating period (stable transition of air temperature to 0°C in spring and autumn)	24 November	18 March	115
Heating period (≤ 8°C)	21 October	25 April	187
Heating period (≤ 10°C)	13 October	5 May	205

* Assessed according to the data provided for the settlement of Gyumri in the RACN 22-01-2024 "Construction Climatology" construction norms

2.6. Economy

Shirak region is located in the north-west of Armenia. It borders Turkey to the west, Georgia to the north, Lori to the east, and Aragatsotn to the south. In 2023, the shares of the main sectors of the regional economy in the total volume of the corresponding sectors of the RA economy were: ➢ industry 5.4 %, ➢ agriculture 9.8 %, ➢ construction 5.0 %, ➢ retail trade 3.9 %, ➢ services 1.9 %. The leading industries of Shirak region are food and beverage production and non-metallic mineral products. Akhuryan and Ani tuff and pumice are well-known. Freight and passenger transportation in the region is carried out by road. The Shirak airport and the Bavra customs point are located in the region. The main railway and highway connecting Armenia with Georgia pass through the region. The railway and highway networks of Armenia and Turkey connect here.

The population of Akhuryan community is engaged in field farming, beet farming, animal husbandry, vegetable and melon crops, potato cultivation, fruit growing, poultry farming, and beekeeping. The Akhuryan sugar factory operates.

[11] https://pvgis.com/en

The territory includes the Leninakan Hydroelectric Power Plant and a number of pumping stations, the Akhuryan Right Bank, Shirak, Kaps canals, Karnut and Zajur reservoirs. There is a branched railway with its own infrastructure. The Gyumri Shirak International Airport is located nearby.

The total area of the community's land fund is 55,889.73 ha, of which 44,675.2 ha are agricultural lands. Agricultural lands owned by citizens are used as arable land. State-owned agricultural lands are used as arable land, grasslands and pastures, amounting to 23,252.85, 811.86, 18,594.56 hectares, respectively. The total area of perennial plantations, including orchards, is 37.93 ha.

Although the majority of the irrigable lands of Shirak region are located in Akhuryan community, in some settlements of the community, for example, Karnut, Basen, Jrarat, there are no irrigable lands at all. Akhuryan region is considered the black soil region of Shirak. Multi-branch agriculture is developed here: grain crops (wheat, barley, etc.), potatoes, fodder crops (alfalfa, corn), vegetables (cabbage, cauliflower, table beets, carrots). The villages with potato fields and engaged in potato cultivation are Azatan, Akhuryan, Hatsik, Mayisyan, Karnut and Arevik communities. The villagers in this region are also engaged in small and large cattle breeding and pig breeding. The number of cattle is 17,813, the number of small cattle is 16,998, and the number of pigs is 2,962. The number of farms is 10,838 with 27 tractors and 12 combines.

Among the community's key issues, the construction of irrigation water pipelines, the repair and asphalting of intra-community roads, the renewal of night lighting systems on streets, gasification, the improvement and landscaping of parks, the construction of preschool institutions and sports schools are of great importance. The repair of cultural monuments is also considered a priority. Subsidy programs and other sources are expected to be involved in solving all of these.

2.7. Population

Armenians who migrated from the Erzurum and Kars provinces of Western Armenia in 1826-1828 also resettled in Akhuryan. In particular, in 1828-1829, Armenians deported from the Basen, Kars, Sebastia, and Alashkert provinces of Western Armenia founded the present-day village of Akhuryan, and a new period of prosperity began for the settlement. The founders of the village were from the Chanchuryans, Baghdiyans, and Matosyans.

In 1831, Akhuryan had 456 inhabitants, in 1873 - 1061, in 1897 - 1635, in 1926 - 2447, in 1939 - 2320, in 1959 - 2966, in 1970 - 3812, in 1979 - 6364, in 1989 - 6730, in 2001 - 9696, according to 2011 data, the population was 7113 people. According to the data of the community administration, today the permanent population of the community is 45908/42051[12] people.

According to the NSS data, the population of the Akhuryan enlarged community in 2014-2024 by settlements is presented in **Table 3**. The change in the total population of the Akhuryan enlarged community and the total indicators of the rural settlements of the community in the period 2014-2024 is presented in **Chart 1**, and the age composition of the permanent population of the community is presented in **Chart 2**.

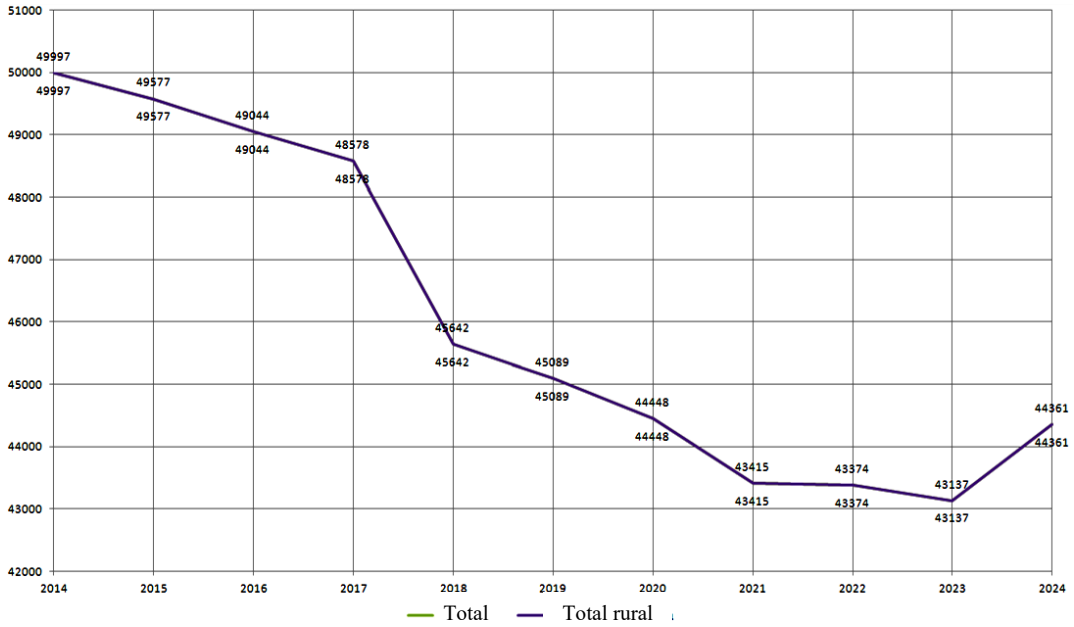
Table 3. Population of the Akhuryan enlarged community in 2014-2024

Settlement	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
Akhuryan	9884	9664	9682	9613	9238	9370	9208	9239	9194	9235	9839
Azatan	5728	5792	5801	5676	5688	5744	5908	6008	5841	5837	5676
Akhurik	1243	1243	1243	1234	1126	1119	1106	1130	1124	1094	1093
Akhuryan kayarani/Station	-	-	-	-	-	17	18	19	17	15	14
Aygabats	827	804	810	806	811	767	745	761	756	758	762
Arapi	1984	1994	1796	1917	1704	1704	1692	1693	1697	1702	1705
Arevik	1837	1852	1860	1851	1832	1805	1809	1814	1895	1929	1905

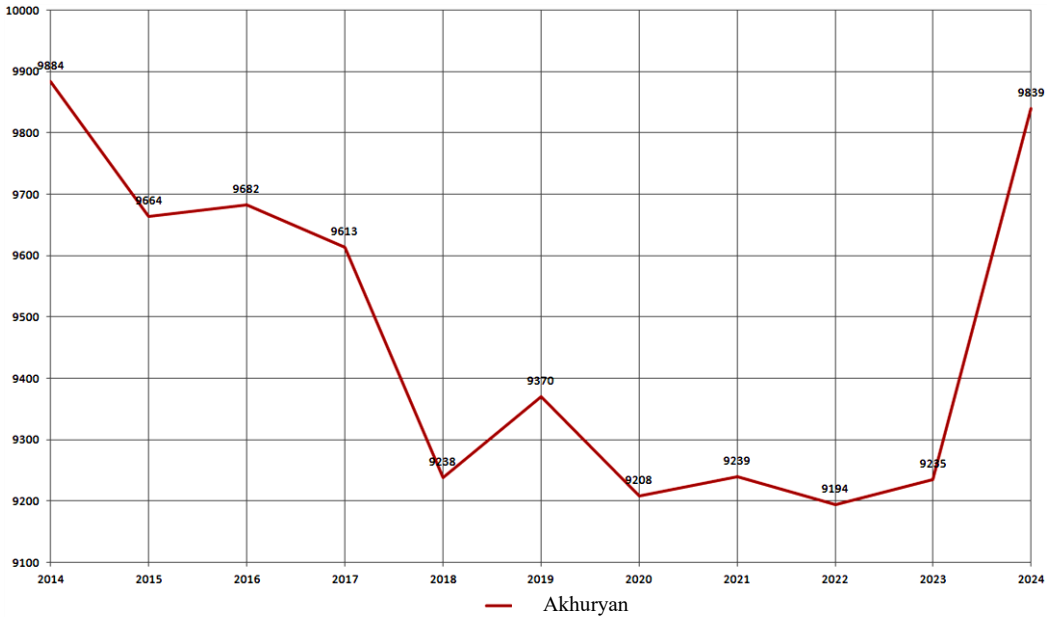
[12] https://akhuryan.am/Pages/CustomPage/?CustomPageID=722b890c-cc0b-4c5d-bdf2-30fbebab4291

Bayandur	775	714	733	735	715	719	713	704	717	735	838
Basen	1778	1775	1787	1780	1421	1299	1280	1275	1250	1226	1167
Beniamin	752	760	739	720	709	724	691	696	602	531	540
Getk	618	663	612	596	614	581	603	588	633	617	608
Yerazgavors	1664	1650	1652	1665	1587	1568	1554	1420	1300	1300	1345
Lernut	198	150	158	156	159	159	169	136	147	138	127
Kamo	1554	1510	1505	1508	1519	1489	1483	1489	1488	1480	1477
Kaps	1022	1020	1015	926	694	731	623	625	640	645	640
Karnut	1185	1199	1085	1134	1052	998	988	998	1143	1053	1013
Karmrakar	49	50	50	44	46	43	46	36	42	38	31
Krashen	291	295	295	282	252	263	256	206	211	231	207
Haykavan	1537	1538	1539	1538	1275	1268	1263	1258	1270	1258	1268
Hatsik	1051	1023	1019	1010	1063	997	1086	1032	882	871	785
Hatsikavan	-	-	-	-	-	56	42	42	56	43	60
Hovit	585	585	586	512	537	463	557	553	562	578	600
Hovuni	730	689	716	698	648	624	624	640	651	652	579
Gharibdjanian	1052	1060	1052	1042	1022	992	983	976	995	989	989
Mayisyan	2003	2021	1989	1955	1641	1627	1651	1357	1332	1297	1230
Marmashen	2196	2177	2188	2077	1902	1408	1404	1378	1770	1645	1605
Mets Sariar	402	400	406	410	393	380	402	319	315	343	304
Shirak	1139	1138	1146	1156	1208	1191	1192	900	906	949	1012
Voskehask	2134	2113	2115	2156	1799	2041	2041	2006	2006	1977	2702
Jajur	1009	949	826	827	768	740	620	686	656	660	849
Jajuravan	243	245	213	218	217	217	216	173	173	177	173
Jrarat	1270	1272	1214	1158	1089	1095	981	985	971	997	1021
Vahramaberd	1908	1909	1906	1895	1704	1608	1227	1045	904	893	928
Pokrashen	237	233	234	227	215	218	200	203	198	216	239
Keti	1112	1090	1072	1056	994	1064	1067	1025	1030	1028	1030
Total	**49997**	**49577**	**49044**	**48578**	**45642**	**45089**	**44448**	**43415**	**43374**	**43137**	**44361**
Total rural areas	**49997**	**49577**	**49044**	**48578**	**45642**	**45089**	**44448**	**43415**	**43374**	**43137**	**44361**

The Shirak region of the Republic of Armenia is relatively sparsely populated, with a population density of 91 people/km^2. The birth rate is low, which is due to the large number of people leaving for work abroad. The number of marriages has decreased. According to the data provided on the official website of the municipality, the number of registered births is 485, the number of deaths is 315, the number of marriages is 160, the number of divorces is 22, the number of households is 10,958, of which the number of households receiving family benefits is 1,189.



a. Population change of Akhuryan community 2014-2024



b. Population change of Akhuryan village from 2014 to 2024

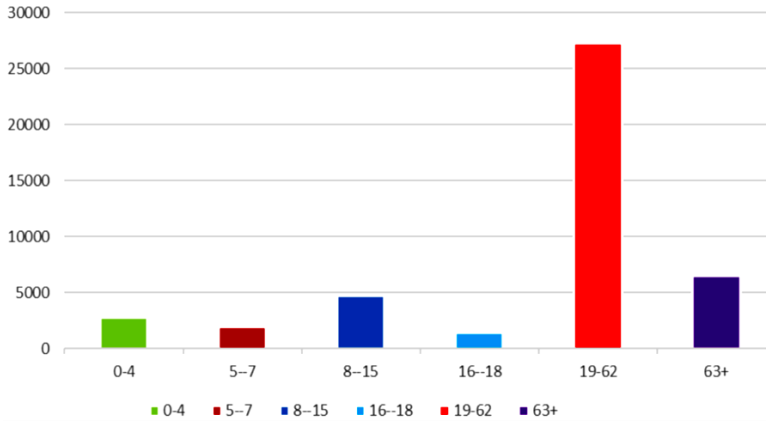
Chart 1. Population change of Akhuryan community 2014-2024

Table 3 shows that the population of Akhuryan village made up only 22.179% of the community population in 2024. The other large rural settlement is Azatan. 12.8% in 2024. Akhurik, Arapin, Arevik, Basen, Yerazgavors, Kamo, Karnut, Haykavan, Mayisyan, Marmashen, Shirak, Voskehask, Jrarat and Keti are among the villages with more than 1,000 inhabitants. The villages of Akhuryan Station (Nor Akhuryan), Karmrakar, Hatsikavan have less than 100 inhabitants. In particular, the indicators of Nor Akhuryan and Hatsikavan settlements were taken into account in the corresponding indicators of adjacent large villages.

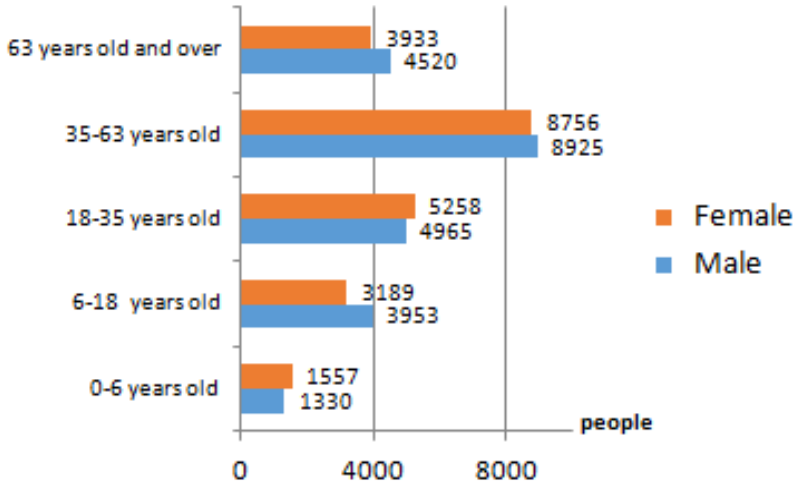
In most settlements of Akhuryan community, a decrease in population was recorded during 2014-2024, with the minimum population number observed in 2021 and 2022, after 2022, a certain increase was recorded until today. Compared to 2014, as of January 1, 2024, a population increase was recorded in the villages of Arevik, Bayandur, Hovit and Voskehask. After a decrease in population compared to 2014, a population increase was also recorded in the village of Akhuryan.

Chart 1 shows that the population of Akhuryan village decreased by 0.45% between 2014 and 2024, with a larger decrease observed in 2018, 2020 and 2022 (up to 6.98%). The total population of Akhuryan

community and rural settlements decreased by 11.3% between 2014 and 2024. The reasons include the difficult socio-economic situation, high unemployment, and the presence of war casualties and missing persons.



a.



b.

Chart 2. The age composition of the community's permanent population, according to the data provided in the community's 2022-2026 five-year development plan (a[13]) and the community's 2025 annual work plan (b[14])

48.9% of the community's population is women, 51.1% is men. There are 1,139 beneficiaries, 2,432 people with disabilities, 6,904 pensioners, 17 refugees, 11,224 unemployed. There are 90 homeless families, and 633 families living in temporary shelters.

2.8. Employment of the community population

Employment and job creation are key issues for the Akhuryan community. There are people leaving for work abroad and an outflow of young people to the capital or abroad.

The number of factories or workshops operating in the community is small, the population can find work mainly in the community hall, non-profit organizations and non-profit organizations, and can go to military units for contract service. The Municipality and the «World Vision Armenia» organization support orphaned, disabled, and socially vulnerable and difficult children.

The community has a well-developed multi-branch agriculture: grain crops (wheat, barley, etc.), potatoes, fodder crops (alfalfa, corn), vegetables (cabbage, cauliflower, table beets, carrots). The villagers are also engaged in small and large cattle breeding and pig breeding.

The five-year development plan for 2022-2026 plans to overcome unemployment and the difficult social situation by studying the labor market, assisting in the professional orientation of residents, guiding and

[13] https://akhuryan.am/upload/DocFlow/Projects/Mo2321312234021101 87_2022-2026.pdf
[14] https://akhuryan.am/upload/DocFlow/Projects/Tu251141713574110234_301-.pdf

retraining, supporting agriculture and entrepreneurial activities, and introducing social assistance services, and opening new craft workshops.

2.9. Community housing stock

The total number of households in Akhuryan community is 11,437. The community's housing stock includes 13 multi-apartment buildings [9 in Akhuryan (105 apartments) and 4 in Vahramaberd settlement (48 apartments)].

In 2024, the total number of private houses was 11,437 (9,094 in rural settlements and 2,343 in Akhuryan).

The number of existing multi-apartment buildings in the community by storeys, external wall materials, and roof shape is presented in **Table 4**, and the types of buildings in the community's residential stock are presented in **Figure 1**.

Table 4. Number of existing MABs in Akhuryan community by storeys, external wall materials, and roof shape

The MABs of Akhuryan community in 2024	Number of buildings	Number of apartments	including			Roof shape	
			stone	panel	reinforced concrete cast	tilted	flat
In Akhuryan community, in total, of which	13	153	9	4	-	9	4
In Akhuryan, in total	**9**	**105**	**9**	**-**	**-**	**9**	**-**
5 -storey	-		-	-	-	-	-
4 -storey	4	60	4	-	-	4	-
3 -storey	5	45	5	-	-	5	-
2 -storey	-	-	-	-	-	-	-
1 -storey	-	-	-	-	-	-	-
In Vahramaberd settlement, in total	**4**	**48**	**-**	**4**	**-**	**-**	**4**
5 -storey	-	-	-	-	-	-	-
4 -storey	-	-	-	-	-	-	-
3 -storey	4	48	-	4	-	-	4
2 -storey	-	-	-	-	-	-	-
1 -storey	-	-	-	-	-	-	-

Source: Data provided by Akhuryan Municipality

The number of private houses in Akhuryan community in 2022-2024 by Akhuryan village and rural settlements is given in **Table 5.**

Table 5. Number of private houses in rural areas of Akhuryan village and community in 2022-2024 .

Community settlements	Quantity (pcs)			%, 2024
	2022	2023	2024	
Akhuryan private houses	2,287	2,315	2,343	20.5%
Azatan village	1,325	1,342	1,359	11.9%
Akhurik village	263	272	281	2.5%
Aygabats village	179	182	185	1.6%
Arapi village	410	424	438	3.8%
Arevik village	448	450	452	4.0%

Bayandur village	182	183	184	1.6%
Basen village	429	430	431	3.8%
Beniamin village	171	181	191	1.7%
Getk village	149	151	153	1.3%
Yerazgavors village	388	391	394	3.4%
Lernut village	36	37	37	0.3%
Kamo village	368	369	370	3.2%
Kaps village	179	182	185	1.6%
Karnut village	253	254	253	2.2%
Karmrakar village	10	10	10	0.1%
Krashen village	64	67	70	0.6%
Haykavan village	307	316	325	2.8%
Hatsik village	253	257	261	2.3%
Hatsikavan village	8	9	9	0.1%
Hovit village	139	140	141	1.2%
Hovuni village	155	163	171	1.5%
Gharibdjanian village	249	249	249	2.2%
Mayisyan village	402	414	426	3.7%
Marmashen village	475	479	483	4.2%
Mets Sariar village	97	97	97	0.8%
Shirak village	266	268	270	2.4%
Voskehask village	491	491	491	4.3%
Jajur village	191	193	195	1.7%
Jajuravan village	46	48	50	0.4%
Jrarat village	261	261	261	2.3%
Vahramaberd village	354	360	366	3.2%
Pokrashen village	54	54	53	0.5%
Keti village	239	246	253	2.2%
In Akhuryan community, in total	11,128	11,285	11,437	100.0%
Growth index	100%	101%	103%	
Including rural areas	8,841	8,970	9,094	79.5%

Source: Data provided by Akhuryan Municipality

According to the Akhuryan community's 2022-2026 five-year development plan, the most important issues for the community are:

- To improve the building and property conditions of the municipality and administrative representatives
- To improve the quality of drinking water supply services
- To provide community residents and tourists with pleasant conditions for organizing and communicating
- To have well-maintained parks and playgrounds

The "Akhuryan Communal Service and Improvement" and "Marmashen Technical Service Center" non-profit organizations carry out the repair of community-owned drinking water pipes, leveling of inter-field roads and streets in settlements that do not have a pavement, garbage collection, sanitary cleaning, maintenance of buildings without a management body for multi-apartment buildings, operation of the street lighting system, replacement of light fixtures, etc.

Figure 1. Types of buildings in the community's housing stock ©CCGE

Stone MAB-s (4-storey), in Akhuryan (4 units), tilted roof

Stone MAB-s (3-storey), tilted roof (5 units), in Akhuryan, panel MAB-s, tilted roof, in Vahramaberd (4 units)

Total number of private houses in Akhuryan community: 11,437, in Akhuryan village (2,343), in rural settlements (9,094)

2.10. Community-owned structures

According to the report on the implementation of the 2024 annual work plan of the Akhuryan community of the Shirak region of the Republic of Armenia (approved by the Appendix to the decision No. 38-A of the Akhuryan community council of March 14, 2025), a number of important programs and initiatives aimed at the development of the community were implemented in the community in 2024.

With joint state-community investment, 14 subsidy programs consisting of 19 sub-programs have been launched in the Akhuryan community.

With state-community co-financing, 8 kindergartens were built in the Akhuryan enlarged community in 2024, of which 5 were put into operation.

It is planned to create a youth centre in Akhuryan community, the direct beneficiaries of which will be the teenagers and young people of the community.

Below, **Figure 2** presents pictures of the buildings of the preschool education institutions (PEI) operating in the Akhuryan community, **Table 6** presents data on the types of PEI buildings, number of floors, condition, gasification and heating, and **Figure 3** presents pictures of other community-owned structures.

Figure 2. The existing PEI-s in Akhuryan community ©CCGE



«Hekiat» (Fairytale) kindergarten



«Shushan» kindergarten



Leo named Kindergarten


Arapi kindergarten


Aygabats's kindergarten

Hatsik's kindergarten

Basen's kindergarten

Jajur's kindergarten

Arevik's kindergarten

Kamo's kindergarten

Marmashen's kindergarten

Haykavan's kindergarten

Vahramaberd's kindergarten

Mayisyan's kindergarten

Azatan's kindergarten

Karnut's kindergarten

Jajuravan's kindergarten

Jajur's kindergarten

Source: Data provided by Akhuryan Municipality

As can be seen from the information presented in **Table 6** by the administrative heads of the settlements of Akhuryan community, about 70% of kindergartens are gasified and heated by systems equipped with natural gas boilers, and 15% have autonomous photovoltaic stations.

Table 6. Data on preschool organizations (NGOs)

	Name of the NGO	Building type	Number of storeys	Building usage/operation/	Year of construction	Condition	Heating system
1.	**Shushan Kindergarten**	stone-built	1	full	1995	good	Gas boiler
2.	**Hekiat Kindergarten**	Prefabricated sandwich panels	1	full	1991	good	Gas boiler, PV
3.	**Leo named Kindergarten**	Prefabricated sandwich panels	1	full	1991	good	Gas boiler
4.	**Azatan's** Kindergarten	stone-built	2	full	2014	good	Gas boiler
5.	**Akhurik's** Kindergarten	stone-built	2	full	1988	good	Electric boiler
6.	**Aygabats's Kindergarten**	stone-built	1	full	1986	satisfactory	Gas boiler
7.	**Arevik's Kindergarten**	stone-built	1	full	2015	good	Gas boiler,
8.	**Bayandur's** Kindergarten	stone-built	1	full	2024	good	Gas boiler, PV
9.	**Kamo's*** Kindergarten	stone-built	2	partial	2021	good	Gas boiler
10	**Karnut's** Kindergarten	stone-built	1	full	2023	good	PhotoVoltaic
11	**Haykavan's** Kindergarten	stone-built	1	full	1990	good	Electric heater
12	**Hatsik's** Kindergarten	stone-built	1	full	2024	good	Gas boiler
13	**Mayisyan's** Kindergarten	sandwich panels	1	full	1990	վատ	Gas boiler
14	**Shirak's** Kindergarten	stone-built	1	full	2025	good	Gas boiler
15	**Voskehask's** Kindergarten	stone-built	1	partial	1970	good	Electric heater
16	**Jajur's** Kindergarten	stone-built	1	full	1995	good	Electric heater
17	**Jajuravan's *** Kindergarten	stone-built	2	full	2018	good	Electric heater

18	**Jrarat's** Kindergarten	stone-built	1	full	2024	good	Electric heater
19	**Vahramaberd's** Kindergarten	stone-built	2	full	2014	good	Gas boiler
20	**Keti's** Kindergarten	sandwich panels	1	full	1992	good	Electric heater

* Used in conjunction with the administrative head's office

To achieve the community's defined vision, the community's strategic objectives include:

- Construction of kindergartens with state-community co-financing,
- Creation of a youth centre, the direct beneficiaries of which will be the teenagers and young people of the community,
- In 2024, the annual program for the management of community-owned buildings and structures was drawn up and, in accordance with it, 8 community-owned kindergarten buildings were renovated, overhauled and constructed,
- The total number of employees in preschool educational institutions is 271, of which 113 are pedagogical workers and teacher assistants,
- To organize concerts, festive events, choir concerts, master classes, meetings with renowned artists in art and music schools,
- "Akhuryan Sports and Cultural Center" Non-profit organization implements extracurricular education in the field of music education and culture. It carries out library work in the Akhuryan, Vahramaberd, Beniamin, Kaps, Aygabats, Marmashen, Hatsik settlements of the community (91,233 books):

Pictures of community-owned structures in Akhuryan community are provided in **Figure 3.**

Akhuryan community community-owned structures, non-profit organizations ©CCGE

Akhuryan Municipality

Sports and cultural centre

Sports school

Azatan settlement House of Culture

Figure 3. Community-owned structures

The immediate goals of the Akhuryan community's 2022-2026 five-year development plan are:

- To have well-maintained and well-lit roads and streets within the settlement
- To improve the quality of services provided in the field of preschool education
- To expand and improve the irrigation water supply network
- To update the machinery and tractor fleet
- To have a community with a clean environment, without violating the sanitary and hygienic state of nature and the environment, and to avoid diseases and epidemics
- To make the community more interesting, attractive and comfortable for tourists
- To activate the cultural life of the community
- To have well-maintained and functioning sports infrastructures equipped with gymnastics equipment
- Efficiently use of irrigation water resources
- To facilitate agricultural work by having paved inter-field roads
- To organize events to manage and reduce disaster risks and to cope with disasters

Table 7 presents data on the types of buildings, number of floors, condition, gasification and heating of community-owned structures, cultural institutions located in Akhuryan community.

Table 7. Data on community-owned structures

	Name of community-owned structure	Building type	Number of storeys	Building usage/operation/	Year of construction	Condition	Heating system type
1	Akhuryan Municipality	stone-built	3	full	1980	good	Gas boiler
2	House of Culture	stone-built	1	Not being used	1960	bad	Not heated
3	Sports and cultural centre	stone-built	3	full	1980թ	good	Gas boiler
4	Sports school	stone-built	2	full	1980թ	good	Gas boiler
5	Azatan settlement House of Culture	stone-built	2	full	1970	good	Gas boiler

6	Beniamin Settlement House of Culture*	stone-built	2	full	1973	good	Gas boiler
7	Vahramaberd settlement House of Culture*	stone-built	2	full	2014	good	Gas boiler

* Used in conjunction with the administrative head's office.

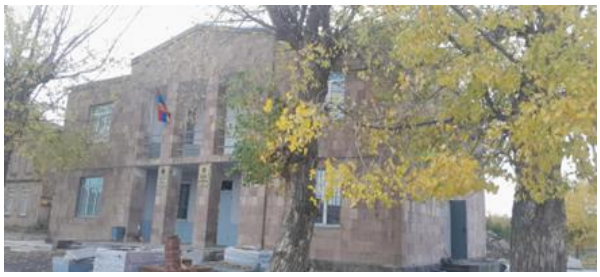
As can be seen from the information provided, all community-owned buildings of Akhuryan and village cultural institutions (except of one, which is not in operation) are gasified and heated by heating systems equipped with natural gas boilers.

The offices of the administrative heads of rural settlements are mainly stone, one- or two-story buildings, the condition of which is currently assessed as satisfactory. They are mainly 1970-1980. structures and some are used partially, about 60% as of 2024 are not gasified and are heated by electricity (according to data provided by the municipality, heating with firewood, coal or manure and other fuels is not carried out).

Pictures of the offices of the administrative heads of rural settlements under community control are presented in **Figure 4**. **Table 8** presents data on the types of office buildings, number of floors, condition, gasification and heating.

Pictures of the offices of the administrative heads of the rural settlements of the community, NGO's ©CCGE

Azatan Administrative Office



Arevik Administrative Office

Aygabats Administrative Office

Bayandur Administrative Office

Getk Administrative Office

Yerasgavors Administrative Office

Hatsik Administrative Office

Haykavan Administrative Office

Jajur Administrative Office

Pokrashen Administrative Office

Jrarat Administrative Office

Karnut Administrative Office

Shirak Administrative Office

Kaps Administrative Office

Gharibdjanian administrative office

Karashen Administrative Office

Keti administrative office

Vahramaberd Administrative Office

Kamo Administrative Office

Figure 4. Offices of the administrative heads of rural settlements of Akhuryan community

Table 8. Data on the offices of administrative heads of rural settlements of Akhuryan community

	Name of community-owned structure	Building type	Number of storeys	Building usage/operation/	Year of construction	Condition	Heating system type
1.	**Azatan** administrative head's office	stone-built	2	full	1980	good	Gas boiler
2.	**Aygabats** administrative head's office	stone-built	2	full	1986	bad	Gas boiler
3.	**Arapi** administrative head's office	stone-built	1	full	1985	satisfactory	Electric heater
4.	**Arevik** administrative head's office	stone-built	2	full	1980	good	Gas boiler
5.	**Bayandur** administrative head's office	stone-built	2	full	1970	good	Photovoltaic plant
6.	**Basen** administrative head's office	stone-built	2	full	1986	good	Photovoltaic plant

7.	**Beniamin** administrative head's office*	stone-built	2	full	1973	good	Gas boiler
8.	**Getk** administrative head's office	stone-built	1	full	1990	good	Electric heater
9.	**Yerazgavors** administrative head's office	stone-built	2	full	1979	satisfactory	Electric heater
10.	**Lernut** administrative head's office	stone-built	3	full	1970	good	Photovoltaic plant
11.	**Kamo** administrative head's office**	stone-built	2	partial	2021	good	Gas boiler
12	**Kaps** administrative head's office	stone-built	2	partial	1978	satisfactory	Gas boiler
13	**Karnut** administrative head's office	sandwich panels	1	full	1989	bad	Electric heater
14	**Hatsik** administrative head's office	stone-built	2	full	1968	bad	Gas boiler
15	**Hovit** administrative head's office	stone-built	1	full	2019	good	Electric heater
16	**Hovuni** administrative head's office	stone-built	2	partial	1960	bad	Electric boiler
17	**Gharibdjanian** administrative head's office	stone-built	2	partial	1972	good	Photovoltaic plant
18	**Mayisyan** administrative head's office	stone-built	1	full	2014	good	Gas boiler
19	**Marmashen** administrative head's office	stone-built	2	full	2020	good	Gas boiler
20	**Mets Sariar** administrative head's office	stone-built	1	full	1985	good	Electric heater
21	**Shirak** administrative head's office	stone-built	2	partial	1995	good	Electric heater
22	**Voskehask** administrative head's office	stone-built	2	partial	1970	bad	Electric heaters
23	**Jajuravan** administrative head's office **	stone-built	2	full	2018	good	Electric heaters
24	**Jrarat** administrative head's office	stone-built	2	full	1970	good	Electric heaters
25	**Vahramaberd** administrative head's office *	stone-built	2	full	2014	good	Gas boiler
26	**Pokrashen** administrative head's office	stone-built	1	full	2020	good	Electric heaters
27	**Keti** administrative head's office	sandwich panels	1	full	1991	good	Electric heaters

* used in conjunction with the cultural centre,

** used in conjunction with kindergarten.

Chapter 3. Energy consumption assessment in Akhuryan community

The energy sources used in the Akhuryan community are electricity, natural gas, including compressed natural gas (CNG) as a motor fuel, coal and manure, liquid motor fuels: gasoline and diesel fuel, and liquefied petroleum gas (LPG).

As in the entire territory of the Republic of Armenia, the supply of electricity and natural gas to consumers in the Akhuryan community is also carried out by centralized service providers " Electric Networks of Armenia" (ENA) and " Gazprom Armenia" CJSC. The companies operate in a regulated market, and the tariffs for the services provided are set by the Public Services Regulatory Commission of the Republic of Armenia (PSRC).

The tariffs for electricity sold to consumers by "Electric Networks of Armenia" CJSC, effective at the time of preparation of this report (entered into force on February 1, 2022), in accordance with the Decision No. 478-N of the Public Services Regulatory Commission of the Republic of Armenia dated December 29, 2021, are:

Voltage	Monthly consumption	Tariff (VAT included)	
		Daytime	Nighttime
Population			
0.38 kV	under 200 kWh	46.48 AMD/kWh	36.48 AMD/kWh
0.38 kV	201- 400 kWh	48.48 AMD/kWh	38.48 AMD/kWh
0.38 kV	over 400 kWh	53.48 AMD/kWh	43.48 AMD/kWh
0.38 kV	Socially vulnerable families *	29.99 AMD/kWh	19.99 AMD/kWh
Other consumers (except population)			
0.38 kV		53.48 AMD/kWh	43.48 AMD/kWh
6 - 110 kV voltage-powered consumers			
6 (10) kV		50.48 AMD/kWh	40.48 AMD/kWh
35 kV		44.48 AMD/kWh	40.48 AMD/kWh
110 kV		41.98 AMD/kWh	37.98 AMD/kWh

* Socially vulnerable families are defined in accordance with the RA Government Decision No. 1122-N of 03.11.2016.

It is necessary to note that the tariffs for electricity sold to consumers by the ENA are set by the PSRC in order to promote energy saving: with an increase in monthly consumption indicators, the tariff also increases.

At the same time, the principle of subsidy and cross-subsidy is absent during tariff formation: with the reduction of voltage in the network and, accordingly, the increase in operating costs, the tariff also increases, and consumers of 0.38 kV voltage, including the population, pay the highest tariff.

Perhaps, there are only discounts determined by the social factor: a) the establishment of discounted tariffs for ENA and “Gazprom Armenia” CJSC by the RA Social Insurance Institution for socially vulnerable families, and b) the partial compensation by the government of the fees for electricity (50% of the annual consumption of 1,440 kWh) and natural gas (50% of the annual consumption of 360 m^3) consumed in border communities.

Electricity tariff changes are presented from 2016 to the present, for the period that includes the 2020-2024 period considered for selecting the baseline year in this SECAP.

Monthly consumption	Since 01.08.2015	Since 01.08.2016	Since 01.02.2017	Since 01.02.2019	Since 01.02.2021	Since 01.02.2022 up to now
Daytime (7:00 -23:00) tariff (VAT included), population 0.38 kV						
Under 200 kWh	48.78	46.20	44.98		44.98	46.48
Under 400 kWh						48.48
400 kWh and more					47.98	53.48
Socially vulnerable families *			40.00	29.99		
Nighttime (23:00 - 7:00) tariff (VAT included), population 0.38 kV						
Under 200 kWh	38.78	36.20	34.98		34.98	36.48
Under 400 kWh						38.48

400 kWh and more					37.98	43.48
Socially vulnerable families*			30.00	19.99		19.99
Average daily tariff (including VAT), population – 0.38 kV.						
Average, under 200 kWh	45.45	42.87	41.647		41.647	43.15
Average, under 400 kWh						45.15
Average, 400 kWh and more					44.647	50.15
Average, socially vulnerable families*			36.667	26.657		26.66

* Annual consumption up to 1440 kWh

According to the Decision No. 83-N of the Public Services Regulatory Commission of the Republic of Armenia dated March 1, 2022, the following tariffs have been established for natural gas sold to consumers by Gazprom Armenia CJSC (from April 1, 2022).

Consumer groups			Tariff (VAT included)
Socially vulnerable families*		Annual consumption up to 600 cubic meters	100,000 AMD/ thousand cubic meters
		Annual consumption exceeding 600 cubic meters	143,700 AMD/ thousand cubic meters
Greenhouse farms	From November 1 to March 31		233.9 USD (equivalent AMD)/thousand cubic meters
	From April 1 to October 31	Monthly consumption up to 10,000 cubic meters	143,700 AMD/ thousand cubic meters
		Exceeding 10,000 cubic meters per month	265.81 USD (equivalent AMD)/thousand cubic meters
Canned goods, beverages and dairy manufacturers			233.9 USD (equivalent AMD)/thousand cubic meters
Other consumers not included in the above groups (including the population)		Monthly consumption up to 10,000 cubic meters	143,700 AMD/ thousand cubic meters
		Exceeding 10,000 cubic meters per month	265.81 USD (equivalent AMD)/thousand cubic meters

* Socially vulnerable families are defined in accordance with the RA Government Decision No. 1122-N of 03.11.2016.

The changes in the natural gas tariff from 2016 to the present are as follows:

Monthly consumption	Unit of measure	Since 07.07. 2013	Since 01.07. 2016	Since 01.01. 2017	Since 01.08. 2018	Since 01.08. 2019	Since 19.07. 2020	Since 01.04.2022 till now
Monthly consumption up to 10,000 cubic meters	AMD/thousand cubic meters	156,000	146,700	139,000				143,700
Socially vulnerable families *				100,000	80,000	100,000		
Exceeding 10,000 cubic meters per month	USD (equivalent AMD)/thousand cubic meters	276.98	257.56	242.1			255.91	265.81
Canned goods, beverages and dairy manufacturers				212.0			224.0	233.9

* Annual consumption up to 600 cubic meters

The gasoline, diesel, and LPG markets are not regulated by the PSRC due to their non-monopoly nature. However, the Commission for the Protection of Competition (CPC) of the Republic of Armenia monitors energy prices to prevent cartels, entry barriers, and excess profits in different market segments.

Official publications of the RA energy balances for 2020, 2021, 2022 and 2023 were also studied.

The community energy balance was compiled using data obtained from energy supply companies and/or developed based on data provided by communities and available from other open sources.

In the absence of accurate statistical data, some indicators, in particular, for example, the consumption volumes of firewood, manure or liquid petroleum fuels, have been assessed at an expert level, based on the information provided by the municipality, the results of studies conducted in relevant sectors and other available data.

Reliable and credible information on the energy consumption volumes ensuring the vital activity of the community has been collected for the Akhuryan community for the period 2020-2024. The selection of the base year for the community's BIE (the year to which the volume of emission reduction in the target year is compared) was made from this period, guided by the methodological requirements of the Covenant, 2024 was selected as the base (baseline) year.

The availability and dynamics of the number of population and apartments (households, HHs) in the community also make it possible to assess the specific energy consumption indicators [per capita or per apartment (household)] in various spheres of life. The latter, in turn, makes it possible to assess the most effective, affordable and expedient areas in terms of measures aimed at increasing energy efficiency, and to consider investment priorities accordingly.

Detailed information on the annual consumption of energy carriers by the population, community institutions, motor transport and street lighting in Akhuryan community during the mentioned period is presented and analysed in the relevant sections of this report.

The physical quantities of energy carriers given in the above sections are expressed in energy units using the coefficients recommended in the guidelines published by the European Commission Joint Research Centre (JRC) Institute for Energy and Transport (IET) or the normative indicators adopted in the Republic of Armenia, which are summarized in **Table 9**.

Table 9. Energy conversion factors and indicators

Energy carrier	Value	Unit of measure	Comment
Natural gas *	9.42	kWh/m^3	Corresponds to a net calorific value (NCV) of combustion of gas of 8,100 kcal/m^3
Gasoline	9.2	kWh/l	or 12.3 kWh/kg, (density is assumed to be 0.75 kg/l)
Diesel fuel	10	kWh/l	or 11.9 kWh/kg, (density is assumed to be 0.84 kg/l)
LPG	7.3	kWh/l	13.1 kWh/kg, (density is assumed to be 0.555 kg/l)
Firewood	2.476	MWh/m^3	Corresponds to the NCV of combustion of firewood equal to 3,000 kcal/kg. The volumetric mass of firewood is assumed to be 710 kg/m^3.
Manure	3.2	kWh/kg	Corresponds to the NCV of combustion of manure equal to 2.771 kcal/kg.
Anthracite	7.4	kWh/kg	Corresponds to the NCV of combustion of anthracite equal to 26.7 MJ/kg
Brown coal	3.3	kWh/kg	Corresponds to the NCV of combustion of brown coal equal to 11.9 MJ/kg

* The CNG conversion factors and indicators are identical.

Chapter 4. Energy consumption in residential sector

The population of Akhuryan community uses electricity, natural gas, firewood, as well as LPG, manure (dung) and coal. Electricity is used for lighting, household appliances, heating (the latter mainly in non-gasified households), cooking, natural gas for heating, hot water supply, and cooking, firewood is also mainly in non-gasified households (HH) for heating (also for hot water supply, and cooking), LPG is used mainly for cooking in non-gasified settlements, and coal and manure, the latter in limited quantities, are used only in rural communities for heating.

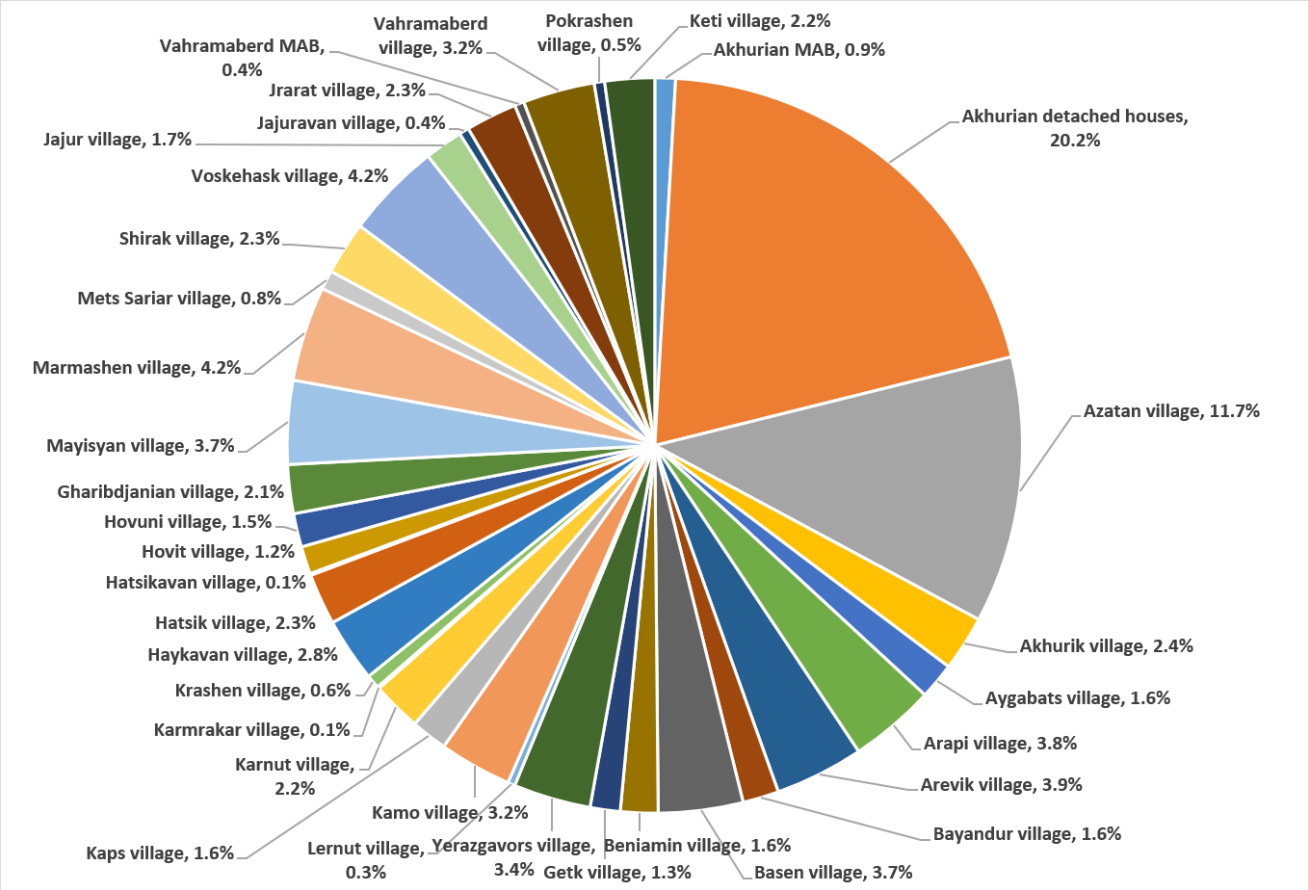


Chart 3. The structure of apartments and private/detached houses (households)

In fact, according to 2024 data, there are only 153 (105 in Akhuryan and 48 in Vahramaberd) apartments in 13 MABs of Akhuryan community (on average, about 12 apartments per building), which makes up only 1.3% of the total households (HHs) in the community.

Detached houses make up 98.7% of the total HHs: in Akhuryan - 20.2%, in Azatan - 11.7%, in Marmashen and Voskehask - 4.2% each, etc. In private/detached houses, natural gas, firewood, manure and electricity are used for heating purposes. If the volumes of natural gas and electricity consumption are presented by energy supply organizations, then the volumes of firewood and manure consumption can only be estimated at an expert level, based on approximate information provided by the administrative heads of settlements.

4.1. Electricity consumption by the population

The annual amounts of electricity consumption by the population of Akhuryan community in 2020-2024 are presented in accordance with the ENA letter No. LO-4600 dated 14.10.2025 provided by the relevant department of the community municipality and are presented in **Table 10.**

Table 10. Annual electricity consumption in the residential sector

Multi-apartment buildings, private houses, households	Unit of measure	Annual electrical energy consumption					Remarks
		2020	2021	2022	2023	2024	
Multi-apartment buildings in Akhuryan*	MW·h	416.08	386.22	376.95	371.92	383.10	
	%	100%	92.8%	90.6%	89.4%	92.1%	Consumption index
Specific consumption in MAB	kW·h/year	2,719	2,524	2,464	2,431	2,504	Per apartment
Private houses in Akhuryan	MW·h	2,768.24	2,669.92	2,648.51	2,680.55	2,691.48	
	%	100%	96.4%	95.7%	96.8%	97.2%	Consumption index
Specific consumption in private houses	kW·h/year	1,181	1,140	1,130	1,144	1,149	single family house
Total in Akhuryan	MW·h	3,184.31	3,056.14	3,025.47	3,052.47	3,074.57	
	%	100%	96.0%	95.0%	95.9%	96.6%	Consumption index
Specific consumption of household	kW·h/year	1,276	1,224	1,212	1,223	1,232	per household
Private houses in rural settlements	MW·h	13,951.2	13,327.4	13,240.8	13,503.5	13,501.8	
	%	100%	95.5%	94.9%	96.8%	96.8%	Consumption index
Specific consumption of Private houses	kW·h/year	1,534	1,466	1,456	1,485	1,485	single family house
Total in rural settlements	MW·h	13,951.2	13,327.4	13,240.8	13,503.5	13,501.8	
	%	100%	95.5%	94.9%	96.8%	96.8%	Consumption index
Specific consumption of household in rural settlements	kW·h/year	1,534	1,466	1,456	1,485	1,485	per household
MAB-s in community	MW·h	416.1	386.2	377.0	371.9	383.1	
	%	100%	92.8%	90.6%	89.4%	92.1%	Consumption index
Specific consumption in MAB	kW·h/year	2,719	2,524	2,464	2,431	2,504	Per apartment
Private houses in community	MW·h	16,719.4	15,997.3	15,889.3	16,184.0	16,193.3	
	%	100%	95.7%	95.0%	96.8%	96.9%	Consumption index
Specific consumption of Private houses	kW·h/year	1,462	1,399	1,389	1,415	1,416	single family house
Total in community	MW·h	17,135.5	16,383.6	16,266.2	16,555.9	16,576.4	
	%	100%	95.6%	94.9%	96.6%	96.7%	Consumption index
Specific consumption of household	kW·h/year	1,478	1,414	1,403	1,428	1,430	per household

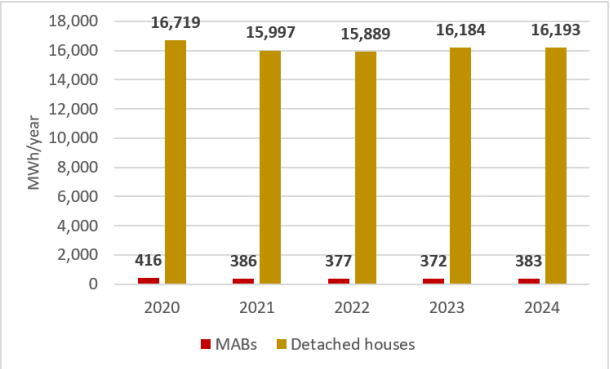
* The data of the 4 existing MABs in Vahramaberd are included, since separate data was not provided in the reference submitted by ENA CJSC.

In the MABs of Akhuryan community, the volumes of electricity consumption by the population have been stable over the five years under review, in 2024 making up 96.7% of the consumption level in 2020. In private houses, over the same period, electricity consumption decreased by about 3.1%, in apartments - by 7.9%. At the same time, the specific consumption indicators in apartments are higher than in private houses, by years, respectively: in 2020 - 46.2%, in 2021 - 44.6%, in 2022 - 43.6%, in 2023 - 41.8%, in 2024 - 43.5%. The latter has been discussed with the responsible employees of the community municipality and is considered

normal, since electricity is used in apartments also for heating purposes, while in private houses, natural gas, firewood, coal and manure are mainly used for heating.

During the observed five-year period, a reduction in the absolute value of electricity consumption of about 3.3% is recorded.

The absolute and specific indicators of electricity consumption in households for the period 2020-2024 are presented in the charts below.



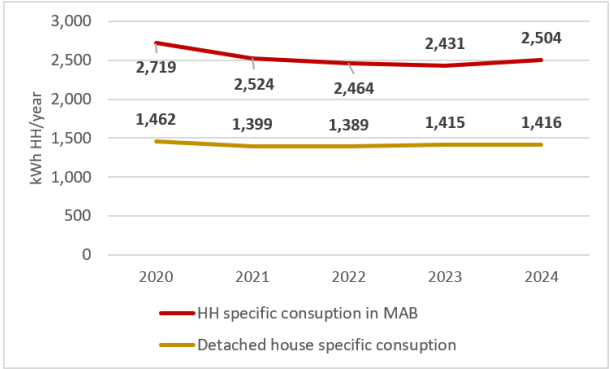


Chart 4. Absolute and specific indicators of electricity consumption of apartments and private houses for 2020-2024

The average monthly specific indicators of electricity consumption in MABs and private houses (in drams (AMD)) for 2024 are: in apartments of Akhuryan community - 9,421 drams/month, and in private houses 5,327 drams/month. On average, the cost of each household is 5,381 drams/month or 64,575 drams/year.

The calculated average monthly/specific AMD/month indicators are considered reasonable. It should also be taken into account that the data are monthly average for the year, calculated at the average daily tariff set for 2024 (average consumption up to 400 kWh per month), and empty/unoccupied apartments and private houses (which amounted to 5-7% in 2024) are not taken into account.

4.2. Natural gas consumption by the population

The Republic of Armenia is considered one of the most gasified countries in the world, 96.6% of settlements are considered gasified, while the settlements of Akhuryan community are gasified by only 55.9%, out of 34 rural communities, only 19 settlements are gasified. However, natural gas is one of the main energy carriers for the energy supply of the population of gasified settlements. The annual quantities of natural gas consumption by the population of Akhuryan community in 2020-2024 are presented in accordance with the letter of "Gazprom Armenia" CJSC No. 04/28/7379-2025 dated 07.10.2025 provided by the relevant department of the municipality and are presented in **Table 11.**

Table 11. Natural gas consumption in the residential sector

Multi-apartment buildings, private houses, and households	Annual consumption, thousand m^3/year					Annual consumption, MW·h/year				
	2020	2021	2022	2023	2024	2020	2021	2022	2023	2024
Multi-apartment buildings in Akhuryan *	237	241	245	249	272	2,231	2,268	2,304	2,349	2,564
Consumption index %	100%	101.6%	103.3%	105.3%	114.9%	100%	101.6%	103.3%	105.3%	114.9%
Specific consumption of apartment	1,548	1,574	1,599	1,630	1,779	14,584	14,822	15,060	15,352	16,757
	(nm^3/year)					(kW·h/year)				

Private houses in Akhuryan	1,541	1,658	1,761	1,851	1,926	14,515	15,620	16,590	17,432	18,146
Consumption index %	100%	107.6%	114.3%	120.1%	125.0%	100%	107.6%	114.3%	120.1%	125.0%
Specific consumption of Private house	658	708	752	790	822	6,195	6,667	7,081	7,440	7,745
	(nm^3/year)					(kW·h/year)				
Total in Akhuryan settlement	1,778	1,899	2,006	2,100	2,198	16,746	17,888	18,895	19,781	20,709
Consumption index %	100%	106.8%	112.8%	118.1%	123.7%	100%	106.8%	112.8%	118.1%	123.7%
Specific consumption of HH in Akhuryan	712	761	804	841	881	6,709	7,167	7,570	7,925	8,297
	(nm^3/year)					(kW·h/year)				
Private houses in rural settlements	3,547	3,653	3,962	4,171	4,509	33,411	34,407	37,325	39,287	42,477
Consumption index %	100%	103.0%	111.7%	117.6%	127.1%	100%	103.0%	111.7%	117.6%	127.1%
Specific consumption of Private house	652	672	729	767	829	6145	6328	6865	7226	7813
Total in rural settlements	3,547	3,653	3,962	4,171	4,509	33,411	34,407	37,325	39,287	42,477
Consumption index %	100%	103.0%	111.7%	117.6%	127.1%	100%	103.0%	111.7%	117.6%	127.1%
Specific consumption of HH in rural settlements	652	672	729	767	829	6,145	6,328	6,865	7,226	7,813
	(nm^3/year)					(kW·h/year)				
MABs in community	237	241	245	249	272	2,231.4	2,267.8	2,304.2	2,348.9	2,563.8
Consumption index %	100%	101.6%	103.3%	105.3%	114.9%	100%	101.6%	103.3%	105.3%	114.9%
Specific consumption of apartment in MAB	1,548	1,574	1,599	1,630	1,779	14,584	14,822	15,060	15,352	16,757
	(nm^3/year)					(kW·h/year)				
Private houses in community	5,088	5,311	5,724	6,021	6,436	47,926	50,027	53,916	56,719	60,623
Consumption index %	100%	104.4%	112.5%	118.3%	126.5%	100%	104.4%	112.5%	118.3%	126.5%
Specific consumption of Private house	654	683	736	774	827	6,160	6,430	6,930	7,290	7,792
	(nm^3/year)					(kW·h/year)				
Total in community	5,325	5,551	5,968	6,270	6,708	50,157	52,295	56,220	59,068	63,187
Consumption index %	100%	104.3%	112.1%	117.8%	126.0%	100%	104.3%	112.1%	117.8%	126.0%
Specific consumption of HH	518	540	581	610	653	4,881	5,089	5,471	5,748	6,149
	(nm^3/year)					**(kW·h/year)**				

* Data on the 4 existing MABs in Vahramaberd are included, as separate data was not provided in the reference submitted by "Gazprom Armenia" CJSC.

The conversion from physical volumes of natural gas to energy values was made using the average value of the net calorific value (NCV) of combustion of natural gas, 9.42 kWh/m^3, which corresponds to approximately 8,100 kcal/m^3.

In the MABs of Akhuryan community, the volumes of natural gas consumption by the population (total households) have recorded a continuous increase (compared to 2020) over the five years under review: by 4.3% in 2021, by 12.1% in 2022, by 17.8% in 2023, and by 26.0% in 2024. A slightly more dynamic trend is recorded in the community's private houses than in apartments.

At the same time, the specific consumption of natural gas in community apartments is consistently higher than in private houses, and by year is: 57.8% in 2020, 56.6% in 2021, 54.0% in 2022, 52.5% in 2023, and 53.5% in 2024. The latter was also discussed at the community's municipality and is explained by the fact that no other fuel (firewood, coal, or manure) is used for heating in apartments. The difference is due to the use of other auxiliary/secondary sources of heating (electricity, firewood, manure, or coal), as well as the level of comfort (surface of heated area, actual duration of heating, and indoor air temperature), which greatly affect the assessment of their exact ratio.

The number of private houses in the residential sector of the community is 98.7%, with 79.5% of private houses being located in rural areas, where the poverty rate is higher, which leads to energy poverty: during the heating season, the family concentrates in one room, which is heated mainly by firewood stoves, at insufficient temperatures and for non-normative periods.

The absolute (thousand m^3/year and MW·h/year) and specific (nm^3/year household and kW·h/year household) indicators of natural gas consumption in households for the period 2020-2024 are presented in the charts below.

Chart 5. Absolute and specific consumption of natural gas in MABs' apartments and private houses of the community in 2020-2024

In Akhuryan community, natural gas consumption in 2024 amounted to: 6.436 million m^3 (or 60.623 GWh) in 11,437 private houses, and 0.272 million m^3 (2.564 GWh) in 153 apartments.

The specific indicators of natural gas consumption in MABs and private houses (in drams) for 2024 are: in community apartments - 255.6 thousand drams per year, or an average of 21,301 drams per month, and in private houses - 118,867.5 thousand drams per year, or an average of 9,906 drams per month (for all private houses in gasified settlements).

The average monthly/specific indicators calculated for the Akhuryan community are considered reasonable. It should be taken into account that these data are averages for the year, calculated at a rate of 143.7 drams/nm^3, and the calculations do not take into account empty/unoccupied apartments and private houses [which constitute a significant number, up to 6-8%, according to **Table 14**].

4.3. Consumption of firewood, manure, LPG, and coal by the population

Among other energy sources, the residential sector mainly uses firewood, in rural areas also manure, in non-gasified households, for cooking, LPG (propane-butane mixture) and coal (anthracite and brown coal). If previously the use of coal was insignificant, then in 2024 cases of coal use are already observed. Since there is no reliable system for recording the consumption of the mentioned fuels, the assessment of the consumption of firewood, manure, LPG and coal was carried out at the expert level.

According to the 1990-2019 report of the National Greenhouse Gas Inventory of the Republic of Armenia and the Energy Balance, data on the quantities of firewood consumed in the Republic of Armenia vary. Research and surveys by some international organizations are also available as a guide.

Data on firewood in energy balances are obtained based on household researches/surveys conducted by the Statistical Committee of the Republic of Armenia (SC), and in GHG inventory calculations, based on references provided by "Hayantar".

The consumption of firewood, manure and LPG by the population in Akhuryan community was assessed by settlement based on information provided by the relevant subdivision of Akhuryan community administration and the offices of the administrative heads of rural communities (see **Table 14**).

The results of the calculations are summarized in **Table 12.**

Settlements	Total number of existing HHs	Fuel used							
		Firewood		Manure		LPG		Coal	
		m^3/year	Number of HHs	m^3/year	Number of HHs	kg/year	Number of HHs	kg/year	Number of HHs
Akhuryan MABs	153	-	-	-	-	-	-	-	
Akhuryan Private houses	2,343	1,874	234	-	-	52,718	351	-	-
Azatan village	1,359	1,087	136	-	-	28,539	190	-	-
Akhurik village	281	2,445	163	-	-	2,645	84	28,100	14
Aygabats village	185	148	19	-	-	-	-	-	-
Arapi village	438	986	66	-	-	3,285	22	-	-
Arevik village	452	362	45	-	-	-	-	-	-
Bayandur village	184	147	18	-	-	-	-	-	-
Basen village	431	2,586	259	-	-	-	-	-	-
Beniamin village	191	153	19	-	-	-	-	-	-
Getk village	153	918	92	-	-	-	-	-	-
Yerazgavors village	394	2,364	236	-	-	17,730	118	-	-
Lernut village	37	148	15	222	11	1,665	11	-	-
Kamo village	370	296	37	-	-	-	-	-	-
Kaps village	185	148	19	-	-	-	-	-	-
Karnut village	253	1,518	152	-	-	-	-	-	-
Karmrakar village	10	40	4	60	3	450	3	-	-
Krashen village	70	336	28	-	-	2,100	21	42,000	21
Haykavan village	325	1,300	130	-	-	29,250	195	-	-
Hatsik village	261	209	26	-	-	-	-	-	-
Hatsikavan village	9	63	6	-	-	405	3	1,800	1
Hovit village	141	987	99	-	-	6,345	42	28,200	14

Hovuni village	171	137	17	-	-	-	-	-	-
Gharibdjanian village	249	2,092	174	-	-	7,470	75	49,800	25
Mayisyan village	426	341	43	-	-	-	-	-	-
Marmashen village	483	386	48	-	-	-	-	-	-
Mets Sariar village	97	815	68	-	-	-	-	77,600	39
Shirak village	270	486	41	-	-	5,400	54	-	-
Voskehask village	491	1,964	196	-	-	-	-	589,200	95
Jajur village	195	1,170	117	-	-	8,775	59	-	-
Jajuravan village	50	350	35	-	-	2,250	15	-	-
Jrarat village	261	1,827	183	-	-	11,745	78	-	-
Vahramaberd village	366	293	37	-	-	-	-	-	-
Pokrashen village	53	127	11	-	-	2,120	21	-	-
Keti village	253	1,822	152	-	-	10,120	101	-	-
Total	11,590	29,923	2,923	282	14	203,012	1,444	816,700	408
HH-s' %	11437		25.2%		0.1%		12.5%		3.5%

Table 12. Consumption of firewood, manure and LPG in the residential sector by settlement for 2022

According to the estimates, out of the 11,590 households in the community (11,437 private houses and 153 apartments), only 25.2% (or 2,923 households, the indicator is close to the national average, the average annual household consumption is 10.2 m^3/year) use firewood, only 0.1% (or 14 households, the indicator is lower than the national average, the average annual household consumption is 20.0 m^3/year) use manure, and only about 12.5% (or 1,444 households, the indicator is higher than the national average, the average annual household consumption is 140.6 kg/year) use LPG, only 3.5% (or 408 households, the indicator is higher than the national average, the average annual household consumption is 2.0 t/year) use coal (mainly anthracite).

Thus, the annual consumption of firewood by households in the community is 29,923 m^3 or 21,245 t, the consumption of manure is 282.0 m^3 or 176.25 t, the consumption of LPG is 203,012 kg or 203 t, and the consumption of coal is 816,700 kg or 816.7 t[15] . These data are taken as a basis for the baseline year, 2024. The indicators for the four years preceding that year are conditionally adjusted in proportion to the population.

The results of the calculations are presented in **Table 13**, in which the energy equivalents of fuels are calculated based on their characteristics.

The values and densities of the net calorific value (NCV) of combustion of firewood, manure, coal and LPG are presented below. The values indicated for LPG are accepted provided that the propane/butane ratio is 70/30, and the average temperature of the liquid mixture is 15°C. At the same time, since, in the case of the population, the accounting and sale of LPG and coal is carried out in weight units, the questionnaire was filled out and the calculations were made accordingly. Meanwhile, in the case of manure, volumetric units are indicated in the questionnaire (for easy visual assessment), and weight units are used in the calculations.

- NCV of firewood, 3,000 kcal/kg or 3.488 kWh/kg, or 2.476 MWh/m^3 (3,488 x 710/1000)
- Volumetric mass of firewood 710 kg/m^3,
- NCV of manure 2,771 kcal/kg or 3.2 kWh/kg, or 2.0 MWh/m^3 (3,200 x 625/1000)
- Volumetric mass of manure 625 kg/m^3,
- NCV of LPG 7.3 kWh/l or 13.14 kWh/kg,
- Volumetric mass of LPG 0.555 kg/l,
- NCV of anthracite: 26.7 MJ/kg or 7.4 kWh/kg.

[15] According to the 2023 Energy Balance of the Republic of Armenia, the volumes of coal imported into the Republic of Armenia amounted to: brown coal 0.7 ktoe (8,141 MWh or 2,467 t) and anthracite 12.3 ktoe (143,409 MWh or 19,331 t)

Table 13. Consumption of firewood, manure, coal and LPG in the residential sector of the community

Fuel type	Unit of measure	Annual fuel consumption				
		2020	2021	2022	2023	2024
Firewood	m^3/year	29,982	29,285	29,257	29,098	29,923
	MWh/year	74,235.1	72,509.9	72,441.4	72,045.6	74,089.8
Manure	t/year	176.6	172.5	172.3	171.4	176.3
	MWh/year	565.1	552.0	551.5	548.4	564.0
LPG	t/year	203.4	198.7	198.5	197.4	203.0
	MWh/year	2672.8	2610.7	2608.2	2594.0	2667.6
Coal	t/year	818.3	799.3	798.5	794.2	816.7
	MWh/year	6,055.4	5,914.7	5,909.1	5,876.8	6,043.6

It is noticeable that fuel consumption is mainly stable for the mentioned years (similar to the fluctuation of the population in the community). From the point of view of climate mitigation, coal burning is undesirable, but due to its price and advantages compared to other types of solid fuel, it is quite applicable in rural areas of the community. Manure is used mainly in settlements where livestock farming is developed. Manure, like firewood generated by natural growth of timber, is considered a renewable resource and emissions from its combustion are assumed to be zero (0 tons CO_2/MWh). The GHG emission factor of the LPG is assumed to be 0.227 tons CO_2/MWh in accordance with the IPCC guidelines. The topic related to emissions will be discussed in detail in the relevant section of this report.

In the case of firewood, according to the Guidelines for the Development of the SECAP, the emission factor of the main greenhouse gas, carbon dioxide, resulting from combustion depends on the nature of the origin of the wood. If it is a product of natural forest growth, this factor is taken as 0 t CO_2/MWh, if it is a product of direct deforestation, then 0.403 t CO_2/MWh[16].

It is extremely difficult to assess the sources of origin and supply of firewood in the Republic of Armenia. In this regard, at the expert level, it is conventionally accepted that about 70% of the firewood used is brought from other regions or neighbouring countries and is a product of natural forest growth, and 30% is a result of direct deforestation. When compiling the BIE, emission factors for firewood used will be applied to the volumes obtained according to this ratio.

The ratio of firewood (renewable and non-renewable), manure, coal and LPG used by the population in the community in the base year is presented in **Chart 6.**

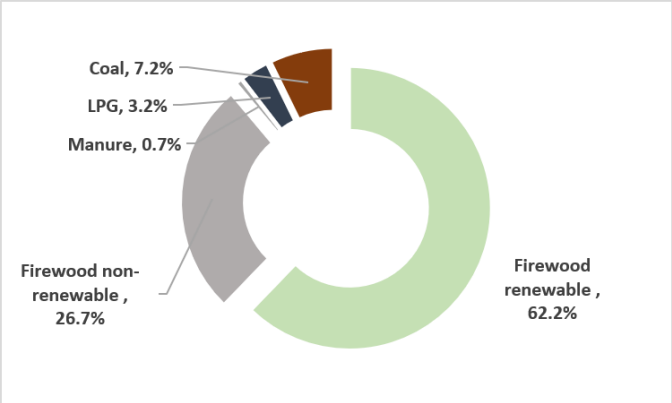


Chart 6. Consumption of firewood (renewable and non-renewable), coal, LPG and manure in the community, 2024 (MWh, %)

[16] Source: How to Develop a Sustainable Energy Action Plan (SEAP) in Eastern Partnership and Central Asian Cities - A Guide, Part 2, Baseline Emissions Inventory, 2014.

4.4. Total energy consumption of the community population

In order to have more accurate information on the consumption of energy carriers by the population in Akhuryan community in 2024, and at the same time to observe the dynamics of consumption in 2022-2024, relevant questionnaires were sent to the offices of the administrative heads of Akhuryan village and other rural communities. The responses received are presented below in **Table 14**. The responses to the questionnaires were analysed and the average indicators obtained were used in the calculations.

Settlements	What proportion of households are connected to gas? %		What proportion of households use firewood for heating and cooking? %			What proportion of households use manure for heating and cooking? %			What proportion of households use liquefied petroleum gas for cooking? %			What proportion of households use coal for heating and cooking? %			Number of uninhabited households	
	2022	2024	2022	2024	Consumption per average household m^3/year	2022	2024	Consumption per average household m^3/year	2022	2024	Consumption per average household kg/year	2022	2024	Consumption per average household kg/year	2022	2024
Akhuryan MABs	100%	100%	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Akhuryan Private houses	80%	80%	10%	10%	8մ3	0	0	0	15%	15%	150	0	0	0	5%	5%
Azatan	80%	80%	10%	10%	8 մ3	0	0	0	14%	14%	150	0	0	0	5.8%	5.8%
Akhurik	0%	0%	58%	58%	15 մ3	0	0	0	30%	30%	150	5%	5%	2,000	3.5%	3.5%
Aygabats	100%	100%	10%	10%	8 մ3	0	0	0	0	0	0	0	0	0	2.8%	2.8%
Arapi	80%	80%	15%	15%	15 մ3	0	0	0	5%	5%	150	0	0	0	2%	2%
Arevik	100%	100%	10%	10%	8 մ3	0	0	0	0	0	0	0	0	0	10%	10%
Bayandur	100%	100%	10%	10%	8 մ3	0	0	0	0	0	0	0	0	0	8%	8%
Basen	0%	0%	60%	60%	10 մ3	0	0	0	0	0	0	0	0	0	8%	8%
Beniamin	100%	100%	10%	10%	8 մ3	0	0	0	0	0	0	0	0	0	7%	7%
Getk	0%	0%	60%	60%	10 մ3	0	0	0	0	0	0	0	0	0	8%	8%
Yerazgavors	0%	0%	60%	60%	10 մ3	0	0	0	30%	30%	150	0	0	0	5%	5%
Lernut	0%	0%	40%	40%	10 մ3	30%	30%	20 մ3	30%	30%	150	0	0	0	8%	8%
Kamo	100%	100%	10%	10%	8 մ3	0	0	0	0	0	0	0	0	0	7%	7%
Kaps	100%	100%	10%	10%	8 մ3	0	0	0	0	0	0	0	0	0	10%	10%
Karnut	0%	0%	60%	60%	10 մ3	0	0	0	0	0	0	0	0	0	6%	6%
Karmrakar	0%	0%	40%	40%	10 մ3	30%	30%	20 մ3	30%	30%	150	0	0	0	7%	7%
Krashen	0%	0%	40%	40%	12 մ3	0	0	0	30%	30%	100	30%	30%	2,000	7%	7%
Haykavan	0%	0%	40%	40%	10 մ3	0	0	0	60%	60%	150	0	0	0	7%	7%
Hatsik	100%	100%	10%	10%	8 մ3	0	0	0	0	0	0	0	0	0	5%	5%
Hatsikavan	0%	0%	70%	70%	10 մ3	0	0	0	30%	30%	150	10%	10%	2,000	6%	6%
Hovit	0%	0%	70%	70%	10 մ3	0	0	0	30%	30%	150	10%	10%	2,000	6%	6%
Hovuni	100%	100%	10%	10%	8 մ3	0	0	0	0	0	0	0	0	0	7%	7%
Gharibdjanian	0%	0%	70%	70%	12 մ3	0	0	0	30%	30%	100	10%	10%	2,000	5%	5%
Mayisyan	100%	100%	10%	10%	8 մ3	0	0	0	0	0	0	0	0	0	5%	5%
Marmashen	100%	100%	10%	10%	8 մ3	0	0	0	0	0	0	0	0	0	7%	7%
Mets Sariar	0%	0%	70%	70%	12 մ3	0	0	0	0	0	0	40%	40%	2,000	6%	6%
Shirak	40%	100%	15%	15%	12 մ3	0	0	0	40%	20%	100	0	0	0	8%	8%
Voskehask	0%	0%	40%	40%	10 մ3	0	0	0	0	0	0	60%	60%	2,000	8%	8%
Jajur	0%	0%	60%	60%	10 մ3	0	0	0	30%	30%	150	0	0	0	7%	7%
Jajuravan	0%	0%	70%	70%	10 մ3	0	0	0	30%	30%	150	0	0	0	4%	4%
Jrarat	0%	0%	70%	70%	10 մ3	0	0	0	30%	30%	150	0	0	0	7%	7%
Vahramaberd	100%	100%	10%	10%	8 մ3	0	0	0	0	0	0	0	0	0	8%	8%
Pokrashen	40%	100%	40%	20%	12 մ3	0	0	0	40%	40%	100	0	0	0	4%	4%
Keti	40%	40%	60%	60%	12 մ3	0	0	0	40%	40%	100	0	0	0	5%	5%

Table 14. About electricity supply, gasification, use of firewood, LPG, manure, coal and uninhabited households in the community

If 100% of households are electricity subscribers, then as can be seen from the table, more than half of the settlements are not gasified, 25% of households use firewood, 12.5% - LPG, 3.5% - coal, and manure is used in insignificant quantities. Uninhabited households (in 2024) make up 6% of the total or 697 households, this phenomenon is considered temporary, therefore it is not taken into account in the calculations of specific consumption of energy carriers.

The total energy consumption of the population, of course, is expedient to present it in energy units (the most understandable and convenient unit is kWh and/or 10^3 kWh = 1 MWh, if necessary, it can be converted to other energy units, the conversion factors are presented at the beginning of the report, in the Units of Measurement section). The given physical quantities of energy carriers are expressed in energy equivalents, using the coefficients indicated in **Table 9**. The consumption volumes of energy carriers in the residential sector of Akhuryan community for 2020-2024 are summarized in **Table 15**.

Table 15. Population energy consumption data for 2020-2024

Energy carrier	Type of buildings	Energy consumption, MWh				
		2020	2021	2022	2023	2024
Electrical energy	MABs	416.1	386.2	377.0	371.9	383.1
	Private houses	16,719.4	15,997.3	15,889.3	16,184.0	16,193.3
Natural gas	MABs	2,231.4	2,267.8	2,304.2	2,348.9	2,563.8
	Private houses	47,925.6	50,027.2	53,915.9	56,718.8	60,622.9
Firewood	MABs	0	0	0	0	0
	Private houses	74,235.1	72,509.9	72,441.4	72,045.6	74,089.8
Manure	MABs	0	0	0	0	0
	Private houses	565.1	552.0	551.5	548.4	564.0
LPG	MABs	0	0	0	0	0
	Private houses	2,672.8	2,610.7	2,608.2	2,594.0	2,667.6
Coal	MABs	0	0	0	0	0
	Private houses	6,055.4	5,914.7	5,909.1	5,876.8	6,043.6
Total	MABs	2,647.4	2,654.0	2,681.2	2,720.8	2,946.9
	Private houses	148,173.5	147,611.8	151,315.4	153,967.6	160,181.2

In Akhuryan community, MABs account for only 1.3% of total households, while private houses account for 98.7%, of which 79.5% are located outside the community centre.

The structure of energy consumption in MABs is very different from that of private houses. **Chart 7** presents the structure of energy consumed by MABs and private houses for 2024.

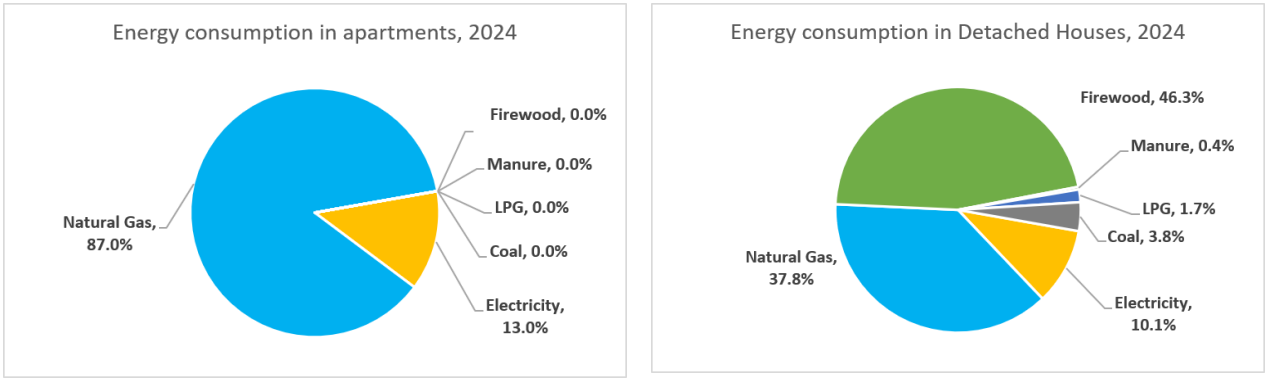


Chart 7. Structure of energy consumption in the residential sector of the community (apartments and private houses), in %

As in almost all community settlements of the Republic of Armenia, in Akhuryan community, natural gas consumption dominates in MABs (87.0%) and private houses (37.8%), while the role of firewood is greater in private houses (46.3%).

The structure of energy consumption in the residential sector by energy carriers and household units in the community, as well as the structure of total energy consumption in the residential sector of the community, is presented in **Chart 8**.

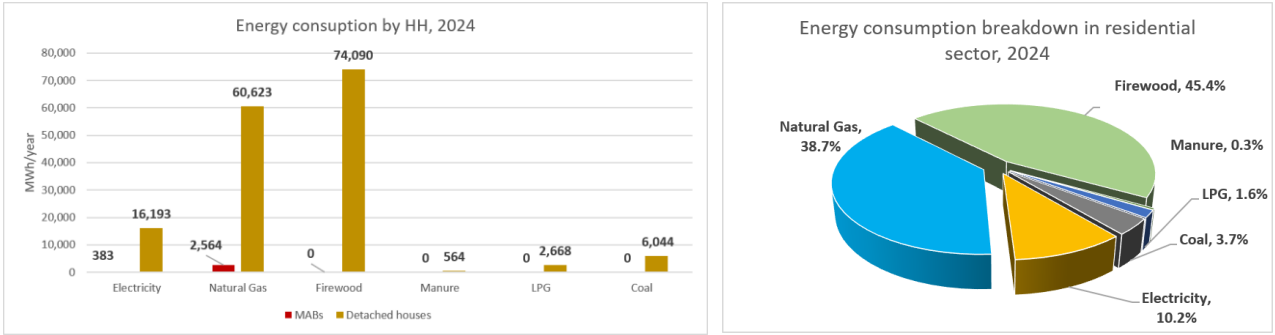


Chart 8. The structure of population energy consumption in 2024

Chapter 5. Energy consumption of municipal institutions

Institutions and organizations under the jurisdiction of Akhuryan community and financed from the community budget cover their energy demand mainly through electricity and natural gas. According to the submitted references, the use of other fuels: firewood, LPG, coal and manure was not recorded during the observed years. As of 2024, the rural settlements of the community were gasified by only 55.9%, which is a very low indicator by the scale of the Republic of Armenia.

According to the data presented for 2024, administrative offices, preschool educational institutions, and cultural centres mainly use electric energy for heating purposes - 58.7%, and natural gas accounts for 41.3% of the energy used by them, which is a low indicator. The above is due to the presence of photovoltaic panels in municipal buildings for their own needs, but it should also be taken into account that under current energy carrier tariffs, 1 kWh of useful thermal energy produced using natural gas (assuming the efficiency of the heating device is 85-92%) is about 2.5-2.7 times cheaper than the useful thermal energy obtained using electric heaters, and the reduction in CO2 emissions (in the case of the coefficients used within the framework of this report) will be 1.4-8.9%.

Below is an analysis of the energy sources used in all municipal (community-owned) institutions.

5.1. Electricity and natural gas consumption in municipal institutions

Electricity consumption by community institutions

The annual electricity consumption data for community-funded educational institutions, cultural, sports and other institutions and organizations, as well as the Municipality of the Akhuryan community and the offices of the administrative heads of the community's rural settlements for the period 2022-2024 are presented in **Table 16**.

Table 16. Electricity consumption by municipal institutions in 2022-2024 (MWh/year)

No	Institution name	Annual electricity consumption, MWh/year		
		2022	2023	2024
1	Akhuryan village municipal institutions, including: Akhuryan Municipality, Shushan, Hekiat and Leo PEIs, Sport-Cultural Centre and Sports School	183.951	237.647	237.996
In total in Akhuryan		**183.951**	**237.647**	**237.996**
Consumption index, %		100%	129.19%	129.38%
2	Offices of Administrative Heads	384.087	477.446	426.025
3	Kindergartens in rural areas	266.357	309.688	329.010
4	Cultural centres in rural areas	64.363	93.184	96.968
In total in rural settlements		714.807	880.318	852.003
Consumption index, %		100%	123.15%	119.19%
In total in Akhuryan community		898.759	1,117.965	1,090.000
Consumption index, %		100%	124.39%	121.28%

Electricity consumption has been increasing over the years (with some minor exceptions) both in the community centre and in rural organizations. In 2024, the total electricity consumption in Akhuryan community increased by about 21.3% compared to 2022. It accounts for about 6.6% of the population's electricity consumption, which is a high indicator compared to other communities.

As is clear from the data presented by the municipality, electricity is also used as an auxiliary energy source for heating in almost all organizations, and as of 2024, 50% of offices of administrative heads (as well as kindergartens and cultural/art centres) that are not connected to gas use only electricity for heating.

Electricity consumption for 2022-2024 in Akhuryan village, rural settlements and the Akhuryan community is depicted in **Chart 9**.

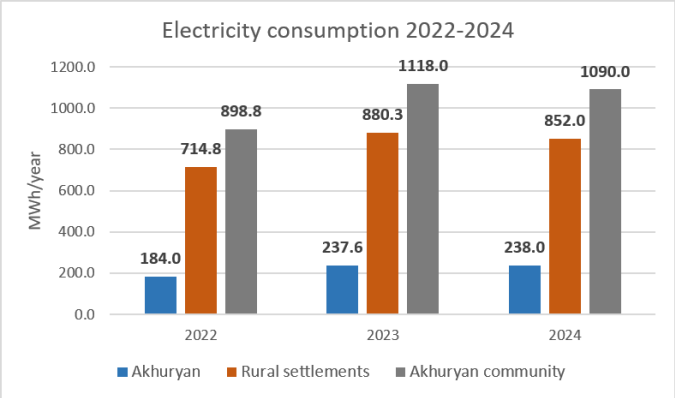


Chart 9. Structure of electricity consumption by municipal institutions

The electricity and natural gas costs spent by all community-owned (municipal) organizations of Akhuryan community (offices of administrative heads of settlements and kindergarten buildings, culture houses and/or clubs included in them, art or music schools, as well as in cases of their joint or separate use) were accepted according to the data actually consumed and recorded by meters presented by the relevant specialists of the community administration[17].

Natural gas consumption by community institutions

Some of the budgetary institutions of Akhuryan community are also natural gas subscribers and consumers. The annual volumes of natural gas consumption by community institutions in physical units (nm^3) and energy equivalents (MWh) are presented in **Tables 17** and **18**, respectively.

Table 17. Physical volumes of natural gas consumption in CNPOs in 2022-2024 (nm3/year)

No	Name of institution or organization	Natural gas consumption, m^3/year		
		2022	2023	2024
1	Akhuryan village municipal institutions, including: Akhuryan Municipality, Shushan, Hekiat and Leo PEIs, Sport-Cultural Centre and Sports School	12,761	8,501	11,503
In total in Akhuryan		**12,761**	**8,501**	**11,503**
Consumption index, %		100%	66.61%	90.14%
2	Offices of Administrative Heads of settlements	26,069	29,292	29,995
3	Kindergartens in rural areas	13,995	16,882	17,963
4	Cultural centres in rural areas	20,564	21,092	21,934
In total in rural settlements		**60,628**	**67,266**	**69,892**
Consumption index, %		100%	110.95%	115.28%
In total in Akhuryan community		**73,389**	**75,767**	**81,395**
Consumption index, %		100%	103.24%	110.91%

The combination of data in **Tables 16** and **18** somewhat explains the ratio of energy costs of (municipal) organizations subordinate to the municipality during the indicated years.

Natural gas consumption is increasing over the years in rural community organizations, but decreasing in institutions located in Akhuryan. In Akhuryan community, the total consumption of natural gas in 2024 increased by about 11% compared to 2022. This indicates the current gasification rates in the community. However, in absolute terms, it accounts for about 1.2% of the population's natural gas consumption.

As mentioned, firewood and other fuels are not used for heating in community-owned buildings.

[17] Electricity generated in own solar photovoltaic plants and consumed for own needs are not included in the calculations of consumed electricity.

A conversion factor of 9.42 kWh/m^3 was used to estimate the energy equivalents of the physical volumes of natural gas given in **Table 17**. This corresponds to a Net calorific value (NCV) of combustion of natural gas of 8,100 kcal/m^3. These data are summarized in **Table 18** below.

Table 18. Energy equivalents of natural gas consumption in CNPOs in 2022-2024 (MWh/year)

No	Name of institution or organization	Natural gas consumption, MWh/year		
		2022	2023	2024
1	Akhuryan village municipal institutions, including: Akhuryan Municipality, Shushan, Hekiat and Leo PEIs, Sport-Cultural Centre and Sports School	120.210	80.075	108.358
In total in Akhuryan		**120.210**	**80.075**	**108.358**
Consumption index, %		100%	66.61%	90.14%
2	Offices of Administrative Heads of settlements	245.567	275.931	282.557
3	Kindergartens in rural areas	131.831	159.030	169.212
4	Cultural centres in rural areas	193.715	198.685	206.615
In total in rural settlements		**571.1**	**633.6**	**658.4**
Consumption index, %		100%	110.95%	115.28%
In total in Akhuryan community		**691.3**	**713.7**	**766.7**
Consumption index, %		100%	103.24%	110.91%

Natural gas consumption by Akhuryan, rural areas of the community, and the whole Akhuryan community is depicted in **Chart 10.**

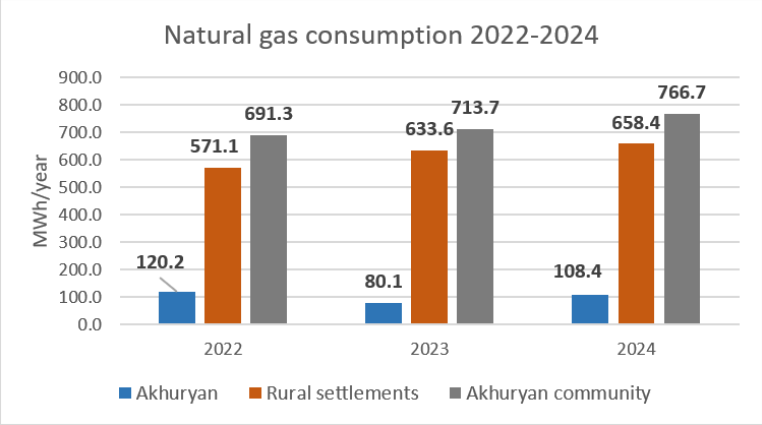


Chart 10. Structure of natural gas consumption by municipal institutions

Despite the fact that almost half of the community-owned buildings in rural communities are not gasified (as of 2024), there is an 11% increase in natural gas consumption in 2024 compared to 2022, the latter being explained by the construction and expansion of heating systems, the transition from electric to natural gas heating, and weather conditions.

5.2. Total energy consumption of community institutions

The overall energy consumption indicators by community/municipal institutions for 2022-2024 are given in **Table 19.**

Table 19. Total energy consumption of community institutions

No	Name of institution or organization	Energy consumption, MWh/year		
		2022	2023	2024
1	Akhuryan village municipal institutions, including: Akhuryan Municipality, Shushan, Hekiat and Leo PEIs, Sport-Cultural Centre and Sports School	304.161	317.722	346.354
In total in Akhuryan		**304.161**	**317.722**	**346.354**
Consumption index, %		100%	104.00%	122.40%

2	Offices of Administrative Heads of settlements	629.654	753.377	708.581
3	Kindergartens in rural areas	398.188	468.718	498.222
4	Cultural centres in rural areas	258.078	291.869	303.583
In total in rural settlements		**1,285.920**	**1,513.964**	**1,510.387**
Consumption index, %		100%	117.73%	117.46%
In total in Akhuryan community		**1,590.081**	**1,831.686**	**1,856.741**
Consumption index, %		100%	115.19%	116.77%

The dynamics of energy consumption (electricity + natural gas) by Akhuryan, rural settlements of the community, and the overall Akhuryan community is depicted in **Chart 11.**

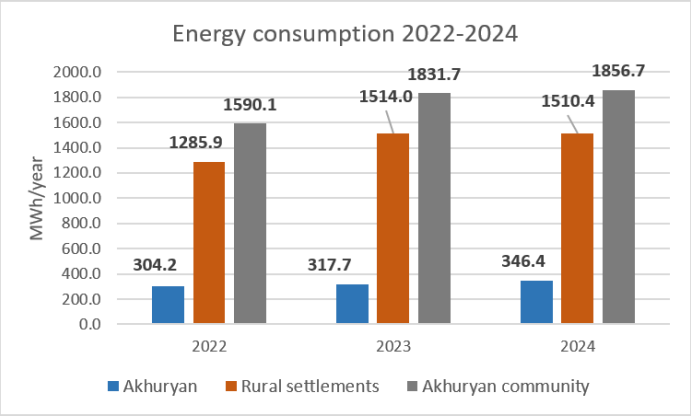


Chart 11. Structure of energy consumption by municipal institutions

The tabular data shows that; however, the summary consumption of energy carriers is more stable. There is a continuous growth of energy carriers, about 17%, compared to 2022, which also speaks of financial improvements in municipal budgetary organizations.

Energy (electricity + natural gas) consumption by energy carrier for Akhuryan, rural settlements of the community and the overall Akhuryan community is depicted in **Chart 12.**

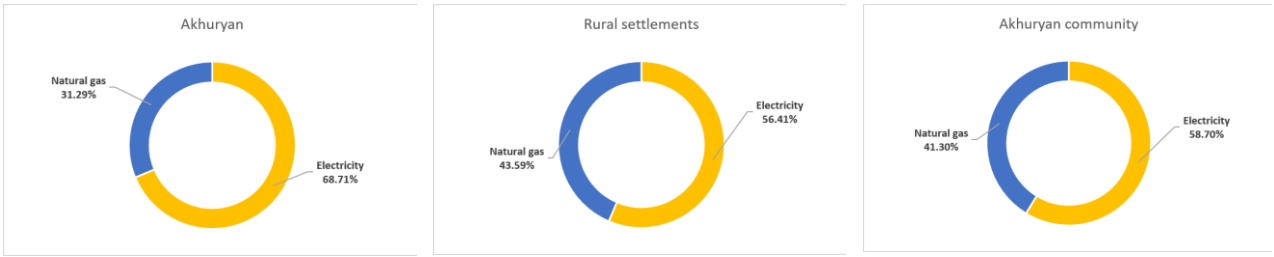


Chart 12. Consumption structure of municipal institutions by energy carriers, 2024

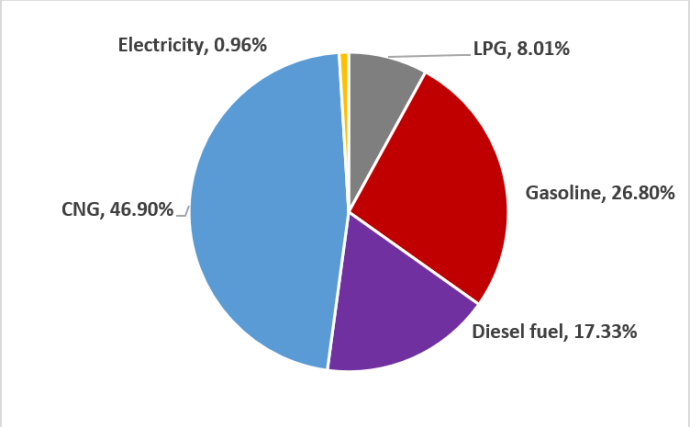
Analysing the annual energy consumption indicators of buildings under the Akhuryan community's Municipality jurisdiction for the base year 2024, it can be concluded that electricity is dominant in different proportions in both urban and rural areas.

All data presented in the analysis are actual consumption data and are provided by the relevant department of the Akhuryan community's Municipality administration.

Chapter 6. Energy consumption in road transportation

The automobile sector includes municipal, public, private, and commercial transport. As in other settlements in the Republic of Armenia, the primary motor fuel in Akhuryan is compressed natural gas (CNG), and there are no electrified ground vehicles as of 2022.

It is assumed that the structure of fuel consumption in the transport sector of Akhuryan community will be comparable to the average statistical indicators recorded in other communities of the Republic of Armenia and on a national scale.



According to the energy balance of the Republic of Armenia, in 2022, 887.5 thousand tons of oil equivalent (ktoe) of final energy was used in the transport sector in the Republic of Armenia. The types of energy/fuels consumed are: CNG, gasoline, diesel fuel, LPG and electricity. Their structure is presented in **Chart 13.**

Chart 13. Structure of fuel consumed in the road transport sector in Armenia in 2022

The objective difficulties in assessing the energy consumption of vehicles [lack of clear information on average annual mileage, specific fuel consumption (l/100km or kg/100km), number of vehicles retrofitted with CNG, etc.] were overcome thanks to joint expert discussions.

Information about the community's trucks and passenger vehicles from the responsible department of the municipality is presented in the tables below.

To express the costs of motor fuels used in vehicles in energy units, supporting guidelines developed by a professional body of the European Commission were used, which propose appropriate conversion factors for different types of motor fuels[18].

Energy consumption indicators were assessed for all main types of vehicles included in the transport sector: light passenger cars, light and heavy trucks, as well as buses and other specialized vehicles.

The number of vehicles in the community by fuel type (gasoline, diesel fuel, CNG, LPG) and other technical indicators (annual mileage, specific fuel consumption, etc.) were estimated through joint expert discussions, as a result of averaging the indicators presented by Akhuryan and the settlements and applying proportional calculation methods.

6.1. Energy consumption of public and community automobile transport

In Akhuryan community, the automobile transport sector consists of public, community, private and commercial vehicle subsectors. The functions of the public transport subsector are carried out by vehicles of the two mentioned subsectors, mainly by means of owners with the status of physical persons or individual entrepreneurs. Public motor (automobile) transport provides intra-community and inter-community transport services (mainly in the regional centre). The number of vehicles involved is quite limited and includes medium-capacity buses, minibuses and taxis. According to the presented data, no serious changes have occurred in the composition of motor transport in recent years.

[18] Guidebook "How to develop a SECAP in the Eastern Partnership Countries", EC, Ispra, 2018, JRC113659

In Akhuryan community, 28 minibuses operated in 2022-2024, mainly from Gyumri to the settlements of Akhuryan community. In the public transport subsector, in 2022-2024, mainly compressed natural gas (CNG) was used, and in the case of taxis, also liquefied petroleum gas (LPG). Electric vehicles were not available in those years.

The quantitative and technical indicators of public transport vehicles in the mentioned years are presented in **Table 20.**

Table 20. Technical indicators of public transport

Type of motor transport	Quantity: pcs	Fuel	Mileage, km/car	Annual fuel consumption		
				m^3/100 km l/100 km	10^3 m^3 10^3 l	MWh
Minibuses (Akhuryan communities – Gyumri)	28	CNG	36,500	16	163.5	1,540.4
Taxis (intra-community)	35	CNG	12,000	12	50.4	474.8
	25	LPG	12,000	14	42.0	306.6
Total	88					2,321.7

Source: data provided by Akhuryan Municipality.

In the tables, the energy value of CNG and LPG, as well as gasoline, has been estimated according to the energy conversion coefficients and indicators given in **Table 9**.

- CNG: 9.42 kWh/m^3 or 12.9 kWh/kg, density: 0.7278 kg/m^3,
- LPG: 7.3 kWh/l or 13.1 kWh/kg, density: 0.555 kg/l.

The public transport subsector uses (as of 2022-2024) the most affordable and appropriate motor fuels in the Republic of Armenia: CNG (86.8%) and LPG (13.2%), which is typical for other communities in the Republic of Armenia as well.

The fleet of municipal vehicles, in addition to vehicles serving institutions, also includes vehicles providing special services and a certain number of mechanisms. The quantitative, technical and energy indicators of vehicles and mechanisms of this subsector for 2022-2024 are presented in **Table 21**. In the table, the energy values of liquid motor fuels are estimated according to the coefficients recommended in the EC directives[19], the values of which are:

- gasoline: 9.2 kWh/l or 12.3 kWh/kg, density: 0.75 kg/litre,
- diesel fuel: 10.0 kWh/l or 11.9 kWh/kg, density: 0.84 kg/litre.

Table 21. Energy consumption of municipal transport in 2024

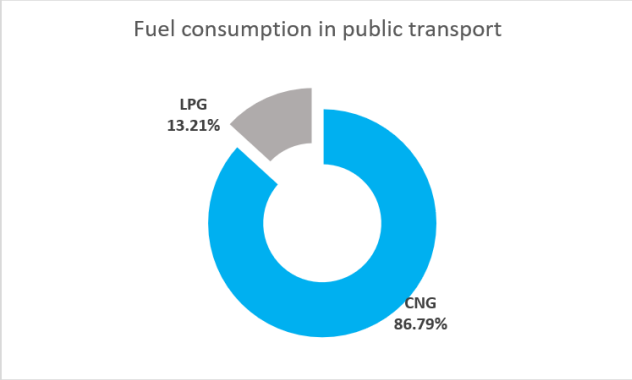
Type of motor transport	Year of production	Quantity, pcs.	Fuel type	Mileage, km/car	Motor fuel consumption		
					m^3/100 km, l/100 km	10^3 m^3 or 10^3 l	MWh
Passenger cars							
«GAZ 3105-100» Gasoline 10%, CNG 90%	2006	1	Gasoline	1,200	12	0.14	1.32
			CNG	10,800	12	1.30	12.21
«INFINITI QX4 3.5» Gasoline 10%, CNG 90%	2002	1	Gasoline	1,200	13	0.16	1.44
			CNG	10,800	13	1.40	13.23
«LEXUS RX 350» Gasoline 10%, CNG 90%	2007	1	Gasoline	1,200	13	0.16	1.44
			CNG	10,800	13	1.40	13.23

[19] How to Develop a Sustainable Energy Action Plan (SEAP) in Eastern Partnership and Central Asian Cities - A GUIDE. Part II, Baseline Emissions Inventory, 2014.

«KIA OPTIMA 2.0» Gasoline 10%, CNG 90%	2009	2	Gasoline	1,200	12	0.29	2.71
			CNG	10,800	14	1.51	13.91
«CHEVROLET NIVA» Gasoline 10%, CNG 90%	2018	1	Gasoline	1,200	12	0.14	1.32
			CNG	10,800	12	1.30	12.21
«CHEVROLET NIVA 212300» Gasoline 10%, CNG 90%	2016	1	Gasoline	1,200	13	0.16	1.44
			CNG	10,800	13	1.40	13.23
«FORD FUSION 2.5» Gasoline 10%, CNG 90%	2015	1	Gasoline	1,200	12	0.14	1.32
			CNG	10,800	12	1.30	12.21
«VAZ 21214» Gasoline 10%, CNG 90%	2007	1	Gasoline	1,200	13	0.16	1.44
			CNG	10,800	13	1.40	13.23
«VAZ 212140» Gasoline 10%, CNG 90%	2006	1	Gasoline	1,200	13	0.16	1.44
			CNG	10,800	13	1.40	13.23
«VAZ 2123» Gasoline 10%, CNG 90%	2010	1	Gasoline	1,200	13	0.16	1.44
			CNG	10,800	13	1.40	13.23
«VAZ 212140» Gasoline 10%, CNG 90%	2016	1	Gasoline	1,200	13	0.16	1.44
			CNG	10,800	13	1.40	13.23
«GAZ 3110» Gasoline 10%, CNG 90%	1998	1	Gasoline	1,200	14	0.17	1.55
			CNG	10,800	15	1.62	15.26
«HYUNDAI TUCSON 2.0» Gasoline 100%	2022	1	Gasoline	20,000	14	2.80	25.76
«TOYOTA RAV 4 2.5» Gasoline 100%	2021	1	Gasoline	20,000	12	2.40	22.08
Passenger cars total, by motor fuel			Gasoline			8.40	77.65
			CNG			15.62	147.11
			Total			24.03	224.76
Garbage truck	1998	1	Diesel fuel	40,000	15	6.00	60.00
Small truck UAZ236325-105	1998	1	Gasoline	20,000	22	4.40	40.48
Truck Kamaz KO 806	2005	1	Diesel fuel	30,000	38	11.40	114.00
Trucks, special vehicles by motor fuel			Gasoline			4.40	40.48
			Diesel fuel			17.40	174.00
			Total trucks			21.80	214.48
Total municipal, by motor fuel			Gasoline			**12.80**	**118.13**
			CNG			**15.62**	**147.11**
			Diesel fuel			**17.40**	**174.00**
			Total			**45.83**	**439.24**

The share of CNG in the community transport subsector is 33.49%, which is typical for other communities of the Republic of Armenia as well, considering that special vehicles mainly run on diesel fuel. The energy consumption of community automobile transport was assessed according to the average data provided by the community administration.

The proportion of fuel consumed in the public and community transport sector of Akhuryan community is presented in **Chart 14.**



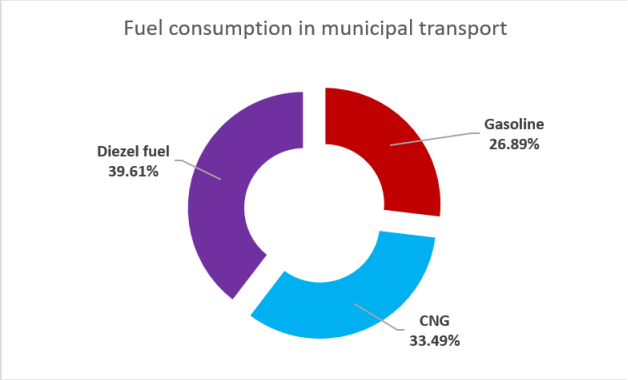


Chart 14. Structure of fuel consumed in public and community transport sectors

As a rule, the fuel consumed by municipal/community motor vehicles constitutes 2-3% of the total consumption in community's transport sector, the largest share in the sector belongs to the private and commercial subsector, in order to accurately estimate energy costs in this sector, the list of municipal property (vehicles) and the detailed property tax (for vehicles) report submitted by the Akhuryan Municipality were taken into account.

6.2. Energy consumption of private and commercial automobile transport

The Municipality has submitted data on the number of private and commercial (individuals and legal entities) cars available and alienated in Akhuryan and all settlements of the community by type (passenger vehicles with up to and more than 10 seats, trucks (freight and passenger vehicles), specialized, etc.) for 2022-2024. However, taking into account the insignificant change in the indicators, this report presents the indicators for the base year 2024.

The proportion of vehicles by fuel type was determined based on joint expert assessments.

In practice, the numbers of cars in relatively active operation are estimated using an approximate expert method, assuming their share to be within 60-80% of the total number of registered cars.

The physical quantities and technical indicators characterizing the energy intensity/content of liquid and gaseous motor fuels consumed by active, in-service vehicles of the private and commercial subsector for the baseline year 2024 are summarized in **Table 22**. The energy equivalents corresponding to the natural volumes of fuel are calculated according to the conversion factors given in **Table 9**.

Table 22. Energy consumption of private and commercial transport

Type of cars	Fuel type	Quantity, pieces	Factor	Mileage, km/car	Motor fuel consumption		
					l or m^3/ 100 km	l or m^3/year	MWh
Passenger vehicles with up to 10 seats	CNG	7,882	0.8	6,000	10	3,783,456	35,640
	Gasoline	3,284	0.7	5,000	10	1,149,488	10,575
	Diesel fuel	920	0.7	5,000	11	354,042	3,540
	LPG	1,051	0.8	6,000	15	756,691	5,524
Total		13,137					55,280
Trucks (+passenger vehicles with more than 10 seats)	CNG	758	0.7	5,000	30	795,690	7,495
	Gasoline	632	0.6	4,000	25	378,900	3,486
	Diesel fuel	1,010	0.6	4,000	32	775,987	7,760
	LPG	126	0.7	5,000	30	132,615	968
Total		2,526					19,709
Total fleet		**15,663**					**74,989**

In the baseline year 2024 energy consumption balance of vehicles in this subsector, the role of compressed natural gas is the highest at 57.5%. This indicator is very close to the average indicator of the

republic. Then, CNG is followed by gasoline at 18.8%, diesel fuel at 15.1% and liquefied petroleum gas (LPG) at 8.7%.

Despite the growth in vehicles using LPG by 2024 (as a result of competitive LPG prices in recent years), the absolute dominant role of CNG in motor transport still remains.

The proportion of fuel consumed in the private and commercial passenger and freight transport sector in Akhuryan Community is given in **Chart 15** and the proportion of total fuel consumed in the private and commercial transport sector in the Community is given in **Chart 16**.

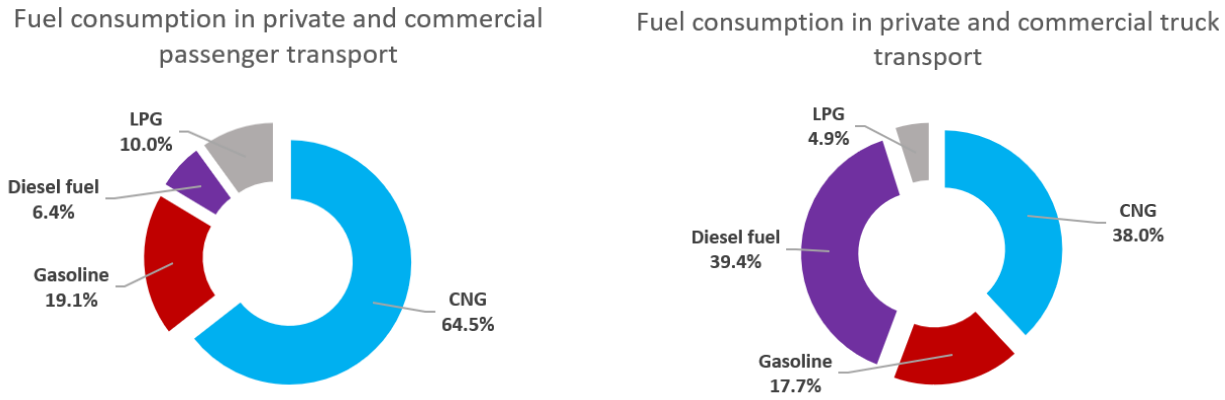
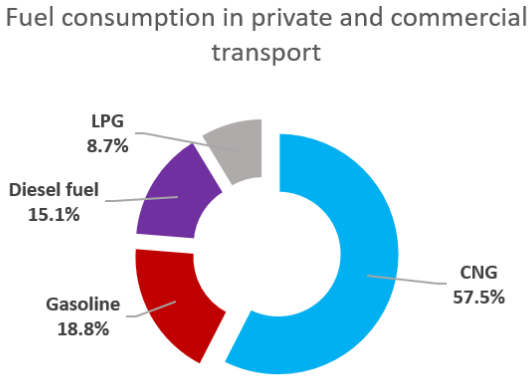


Chart 15. Structure of fuel consumed in private and commercial, passenger and freight transport in 2024



The community uses all fossil fuels used in the Republic of Armenia. Despite the economic and environmental advantages of CNG (more affordable price and lower emission coefficient compared to other fossil fuels), this report proposes the idea of introducing electric vehicles and developing a fleet of electric vehicles, both in terms of financial feasibility and GHG emission reduction, with the presentation of relevant calculations and justifications.

Chart 16. Structure of fuel consumed in private and commercial transport in 2024

6.3. Total energy consumption of the transport sector

Combining the data obtained for the three subsectors allows us to estimate the total energy consumption of the community in the transport sector and to identify the share of each subsector in the total energy consumption. The energy consumption of the transport sector by subsectors and by type of motor fuels is presented in **Table 23**. The table also summarizes the structure/proportion of energy consumption in the transport sector by sub-sectors and fuel types.

The structure of energy consumption by type of motor fuel is reflected in the last row of **Table 23**, and the structure by subsectors is reflected in the last column of the table. It follows from the data in the table that the most energy-intensive is the private and commercial transport subsector, at 96.45%, and the most widely used motor fuel is compressed natural gas, with a share of 58.26%.

Table 23. Energy consumption structure of the transport sector

Transport subsector	Annual consumption of transport motor fuels, MWh/year				Total consumption	
	Gasoline	Diesel fuel	CNG	LPG	MWh/year	%
Community/Municipal	118	174	147	0	439	**0.56%**
Public	0	0	2,015	307	2,322	**2.99%**
Private and commercial	14,061	11,300	43,136	6,492	74,989	**96.45%**
Total, MWh	**14,179**	**11,474**	**45,298**	**6,799**	**77,750**	**100.00%**
Total, %	**18.24%**	**14.76%**	**58.26%**	**8.74%**	**100.00%**	

The structure of energy consumption in the transport sector of Akhuryan community by fuel type is presented in **Chart 17**, and by sub-sectors in **Chart 18**.

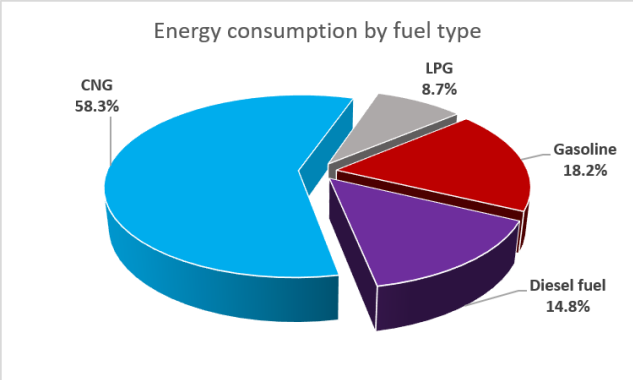


Chart 17. Structure of fuel consumed in the transport sector

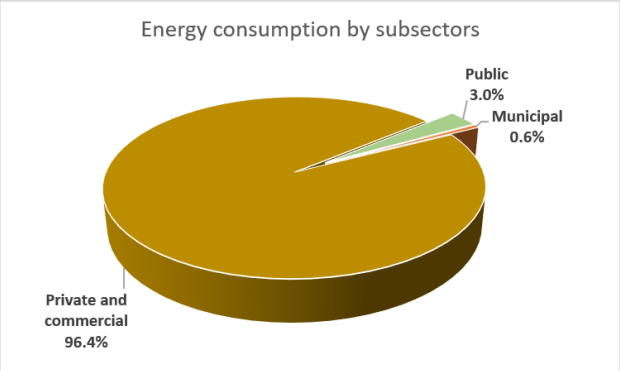


Chart 18. Energy consumption structures by subsectors

The quantities of natural gas supplied to the community's CNG filling stations in 2020-2024 are given in **Chart 19.**

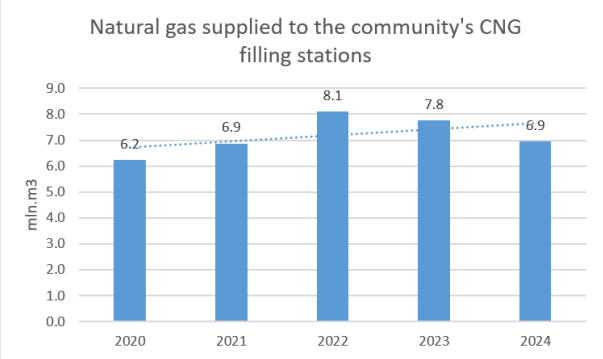


Chart 19. The quantities of natural gas supplied to the community's CNG filling station in 2020-2024

Chart 19 shows the demand for CNG in the community's CNG filling station, which is also determined by the geographical location of the community. The growth in CNG demand in 2020-2022 and the decreasing trend in 2022-2024 are obvious. The latter is characteristic for all roadside gas stations in all communities of the Republic of Armenia.

Chapter 7. Electricity consumption in the street lighting system

The street lighting system of Akhuryan community is an object of community budget financing. The system does not include advertising, information, traffic regulation, architectural and other types of lighting installations.

The main technical data and annual operation and maintenance indicators of the street lighting system of Akhuryan community for 2024 are presented in **Table 24**[20]**.**

Table 24. Technical characteristics and annual electricity consumption indicators of the street lighting system of Akhuryan community

Characteristic name	Unit of measurement	The value of the indicator in 2024		
		Akhuryan	Rural areas	Community
Street light poles	piece	1,204	3,473	4,677
Number of lights	piece	1,204	3,473	4,677
including incandescent lamps	piece	1,204	1,452	2,656
	W	100	84	91
including fluorescent (CFL) lamps	piece	-	-	-
	W	-	-	-
including sodium lamps	piece	-	-	-
	W	-	-	-
including LED lamps	piece	-	2,021	2,021
	W	-	64	64
Total length of illuminated streets	km	48.2	138.9	187.1
System installed capacity	*kW*	120.4	252	372.4
Annual electricity consumption	MWh	216.7	419.5	636.2
Annual working hours	*h/year*	1,800	1,665	1,709

The community is working to expand, modernize, and increase energy efficiency and comfort of the street lighting system, in particular, one thousand LED lamps/light fixtures have already been installed in rural areas by 2024.

Replacing incandescent and fluorescent lighting with LED lamps, increasing the number of lighting fixtures, improving the level of lighting comfort (as well as increasing annual operating hours), and lighting previously dark streets can lead to a certain increase in the electrical installed capacity of the system and a reduction in specific electricity consumption.

The data presented in **Table 25** on the street lighting systems of all settlements in Akhuryan community were provided by the offices of the administrative heads of the settlements.

2024	U/M	Akhuryan	Azatan	Akhurik	Aygabats	Arapi	Arevik	Bayandur	Basen	Beniamin	Gelk	Yerazgavors	Lernut	Kamo	Kaps	Karnut	Karmrakar	Krashen	Haykavan
Street light poles	piece	1,204	500	0	55	177	155	220	133	62	72	100	22	54	91	80	15	60	60
Number of lights	piece	1,204	500	0	55	177	155	220	133	62	72	100	22	54	91	80	15	60	60
including incandescent lamps	piece	1,204	50	0	45	157	105	108	6	0	62	73	18	19	50	55	0	10	10
	W	100	80	0	100	80	60	100	80	0	100	80	60	100	80	60	0	80	60
including fluorescent (CFL) lamps	piece	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	W	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
including sodium lamps	piece	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	W	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
including LED lamps	piece	0	450	0	10	20	50	112	127	62	10	27	4	35	41	25	15	50	50
	W	0	75	0	50	50	75	60	50	75	60	50	75	60	50	75	60	50	75
Total length of illuminated streets	km	48.2	20.0	0.0	2.2	7.1	6.2	8.8	5.3	2.5	2.9	4.0	0.9	2.2	3.6	3.2	0.6	2.4	2.4

[20] Source: Reference from the relevant department of Akhuryan Municipality

System installed capacity	*kW*	120.4	37.8	0.0	5.0	13.6	10.1	17.5	6.8	4.7	6.8	7.2	1.4	4.0	6.1	5.2	0.9	3.3	4.4
Annual electricity consumption	MWh	216.7	62.3	0.0	9.0	22.4	14.5	31.5	11.3	6.7	12.2	11.9	2.0	7.2	10.0	7.5	1.6	5.4	6.3
Annual working hours	*h/year*	1,800	1,650	1,440	1,800	1,650	1,440	1,800	1,650	1,440	1,800	1,650	1,440	1,800	1,650	1,440	1,800	1,650	1,440
2024	U/M	Hatsik	Hatsikavan	Hovit	Hovuni	Gharibdjanian	Mayisyan	Marmashen	Mets Sariar	Shirak	Voskehask	Jajur	Jajuravan	Jrarat	Vahramaberd	Pokrashen	Keti	Total rural settlements	Total in Akhuryan community
Street light poles	piece	48	0	115	43	100	147	225	41	100	350	105	14	55	126	33	115	3,473	4,677
Number of lights	piece	48	0	115	43	100	147	225	41	100	350	105	14	55	126	33	115	3,473	4,677
including incandescent lamps	piece	31	0	85	0	50	0	89	24	60	230	18	0	15	42	0	40	1,452	2,656
	W	100	0	60	0	80	0	100	80	60	100	80	0	100	80	0	100	84	91
including fluorescent (CFL) lamps	piece	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-	-
	W	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-	-
including sodium lamps	piece	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-	-
	W	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-	-
including LED lamps	piece	17	0	30	43	50	147	136	17	40	120	87	14	40	84	33	75	2,021	2,021
	W	60	50	75	60	50	75	60	50	75	60	50	75	60	50	75	60	64	64
Total length of illuminated streets	km	1.9	0.0	4.6	1.7	4.0	5.9	9.0	1.6	4.0	14.0	4.2	0.6	2.2	5.0	1.3	4.6	138.9	187.1
System installed capacity	*kW*	4.1	0.0	7.4	2.6	6.5	11.0	17.1	2.8	6.6	30.2	5.8	1.1	3.9	7.6	2.5	8.5	252.0	372.4
Annual electricity consumption	MWh	7.4	0.0	10.6	4.6	10.7	15.9	30.7	4.6	9.5	54.4	9.6	1.5	7.0	12.5	3.6	15.3	419.5	636.2
Annual working hours	*h/year*	1,800	1,650	1,440	1,800	1,650	1,440	1,800	1,650	1,440	1,800	1,650	1,440	1,800	1,650	1,440	1,800	1,665	1,709

Table 25. Technical characteristics and annual electricity consumption indicators of street lighting systems in Akhuryan community settlements for 2024

Some missing data reported by some settlements were accepted based on averaging the available indicators and used to obtain the overall data for rural settlements and the community.

Electricity consumption data for community street lighting is presented in **Chart 20.**

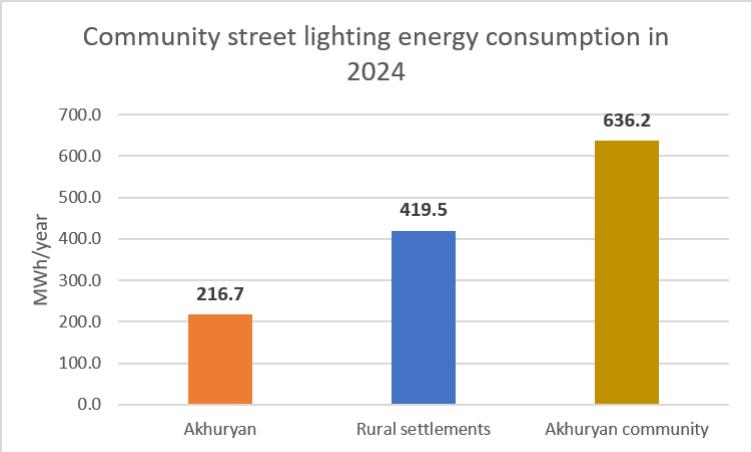


Chart 20. Structure of electricity consumption by street lighting system for Akhuryan village, all other rural settlements and Akhuryan community

The annual electricity consumption by the street lighting systems of Akhuryan community is 636,220 kWh/year.

Chapter 8. Development of a baseline GHG emissions inventory

The year 2024 is selected as the baseline year for the development of the Akhuryan community's SECAP. Reliable and credible information on the energy consumption volumes ensuring the vital activities of the Akhuryan community has been collected and analysed for 2020-2024. The base year was selected based on the methodological requirements of the Covenant.

The choice of the base year 2024 is reasonable and representative also for the following reason: some data for years prior to 2022 are due to the 2019–2020 coronavirus pandemic and the 44-day war and their consequences.

8.1. Main sources of GHG emissions

In the energy sector, of the three greenhouse gases emitted by the combustion of fossil fuels: carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O), this program only accounts for the first, which accounts for the vast majority (up to 98%) of total emissions associated with fuel combustion. Fugitive emissions of methane are also not included in the calculations. CO_2 emissions in the sectors under consideration are generated by the combustion of fuels (natural gas, firewood, manure, gasoline, diesel fuel, LPG and coal).

The baseline emissions inventory takes into account only those sources of CO_2 emissions that are included in the Sustainable Energy and Climate Action Plan of the Akhuryan community. These sources are:

- ✓ Municipal institutions whose work activities are accompanied by the use of electricity, as well as GHG emissions resulting from the combustion of natural gas.
- ✓ The residential sector, which is a major consumer of electricity, natural gas and firewood, their use is also associated with CO_2 emissions.
- ✓ Automobile transport, where carbon dioxide and other greenhouse gases are produced and released into the atmosphere as a result of the combustion of liquid and gaseous motor fuels used.
- ✓ The municipal street lighting system, which is an object of municipal budget financing, in which the production of electricity used is accompanied by the generation of CO_2.

After specifying the sources of GHG emissions, the emission volumes are calculated based on the emission factors for various energy carriers, which were developed by the IPCC and are considered pan-European norms. The numerical values of these factors for the Republic of Armenia are given below[21]:

- Electrical energy: 0.241 tons of CO_2/MWh
- Natural gas: 0.202 tons of CO_2/MWh
- Compressed natural gas (CNG): 0.202 tons of CO_2/MWh
- Motor gasoline: 0.249 tons of CO_2/MWh
- Diesel fuel: 0.267 tons of CO_2/MWh
- Liquefied petroleum gases: 0.227 tons of CO_2/MWh
- Firewood (non-sustainable)[22] 0.403 tons of CO_2/MWh
- Firewood (sustainable)[23] 0 tons of CO_2/MWh
- Manure (sludge, dung): 0 tons of CO_2/MWh

[21] Source: How to Develop a Sustainable Energy Action Plan (SEAP) in Cities in the Eastern Partnership and Central Asia – A Guide. Part II – Baseline Emissions Inventory. 2014.

[22] Firewood resulting from unsustainable forest management (when deforestation rates exceed natural forest growth rates), which is a non-renewable resource and whose combustion results in carbon dioxide emissions.

[23] Firewood generated through natural growth of timber, which qualifies as a renewable resource resulting from sustainable forest management (when, on average, forest growth equals or exceeds deforestation volumes) and in calculations, emissions from the combustion of timber classified in this group are considered zero, in accordance with the requirements of the Covenant's methodological guidelines.

- Anthracite: 0.354 tons of CO_2/MWh
- Brown coal: 0.364 tons of CO_2/MWh

To estimate GHG emissions in the base year, the quantitative indicators of energy consumption recorded in each sector [expressed in energy units (MWh)] are multiplied by the corresponding GHG emission factors:

Carbon dioxide emissions (tons of CO_2) =

Energy consumption (MWh) x CO_2 emission factor (tons of CO_2/MWh)

Based on these factors, the following section 8.2 calculates the volumes of GHG emissions and identifies the target obligations of the community in terms of reducing GHG emissions.

8.2. Baseline GHG emissions inventory

The GHG BIE is developed for the baseline year 2024. The baseline emissions inventory includes the absolute energy consumption indicators of all sectors listed in the previous section 8.1. The quantities of energy carriers used in the baseline year by specific sectors and areas are presented in **Table 26.**

Table 26. Energy carrier consumption volumes for the baseline year 2024

Energy carrier	Unit of measurement	Energy carrier consumption volumes				Total consumption	
		Municipal	Population	Transport	Street lighting*	**10^3 m^3, 10^3 l or MWh**	**%**
Electrical energy	MWh	1,090.0	16,576.4	-	636.2	**18,302.6**	**7.5%**
Natural Gas	10^3 m^3	81.4	6,707.7	-	-	**6,789.1**	
	MWh	766.7	63,186.7	-	-	**63,953.4**	**26.3%**
Compressed Natural Gas	10^3 m^3	-	-	4,808.7	-	**4,808.7**	
	MWh	-	-	45,297.8	-	**45,297.8**	**18.6%**
Firewood (non-sustainable)	10^3 m^3		9.0	-	-	**9.0**	
	MWh	-	22,227.0	-	-	**22,227.0**	**9.1%**
Firewood (sustainable)	10^3 m^3		20.9	-	-	**20.9**	
	MWh	-	51,862.9	-	-	**51,862.9**	**21.3%**
Manure	10^3 tons	-	0.176	-	-	**0.2**	
	MWh	-	564.0	-	-	**564.0**	**0.2%**
LPG in HHs	10^3 tons	-	0.203	-	-	**0.2**	
	MWh	-	2,667.6	-	-	**2,667.6**	**1.10%**
Coal	10^3 tons		0.8			**0.8**	
	MWh		6,043.6			**6,043.6**	**2.48%**
Gasoline	10^3 l	-	-	1,541.2	-	**1,541.2**	
	MWh	-	-	14,179.3	-	**14,179.3**	**5.8%**
Diesel fuel	10^3 l	-	-	1,147.4	-	**1,147.4**	
	MWh	-	-	11,474.3	-	**11,474.3**	**4.7%**
LPG in transport	10^3 l	-	-	931.3	-	**931.3**	
	MWh	-	-	6,798.5	-	**6,798.5**	**2.8%**
Total	**MWh**	**1,856.7**	**163,128.0**	**77,749.9**	**636.2**	**243,370.9**	**100.0%**
	%	**0.8%**	**67.0%**	**31.9%**	**0.3%**	**100.0%**	

* In the community street lighting system, only external lighting data is presented in the electricity consumption.

The dominant role in the structure of energy consumption included in the GHG inventory belongs to the population, with a share of 67.0% in the base year. The transport sector occupies the second place in the baseline inventory, with a share of 31.9%.

The ratio of energy carrier consumption in the Akhuryan community in the base year by final consumption sectors is presented in **Chart 21**, and **Chart 22** depicts the ratio of energy carrier consumption in the community in the base year by energy carrier types.

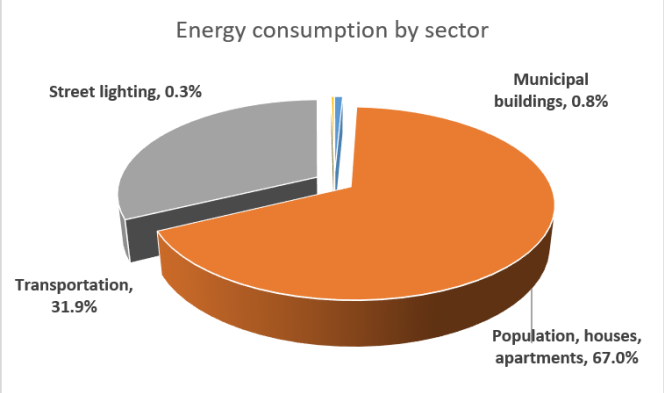


Chart 21. Energy carrier consumption breakdown in the base year by final consumption sectors

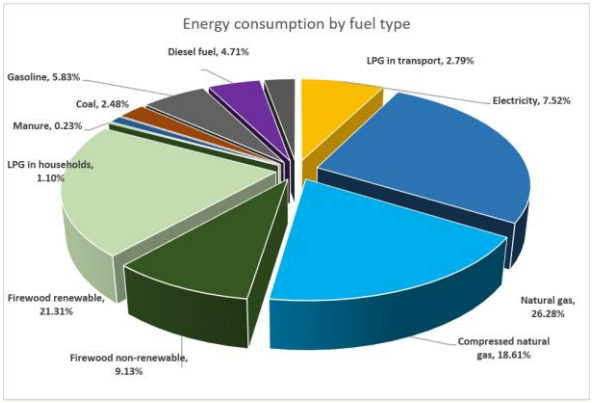


Chart 22. Energy carrier consumption breakdown in the base year by energy carrier type

The dominance of natural gas over other fuels is obvious - 26.3%, and together with CNG - 44.9%. According to the latest energy balances of the Republic of Armenia - 2022 and 2023, this situation is also typical for the republic. The dominance of firewood over other fuels is also noticeable - 21.3% (30.4% when including non-renewable firewood), which is also typical especially for rural areas of the Republic of Armenia. The third is electricity with 7.5%, a significant share of which is produced in thermal power plants, also using natural gas. The share of coal in the total is 4.7%, the use of which has increased significantly in rural areas in recent years. Coal has the highest emission factor of all existing fossil fuels, therefore its replacement with another fossil fuel with a lower emission factor would be considered a mitigation measure.

To calculate greenhouse gas emissions, it is necessary to multiply the net energy consumption volumes of energy carriers (expressed in energy units) given in **Table 26** by the corresponding CO_2 emission factors. The factors were developed by the IPCC and their numerical values are given in Section 7.1 of this chapter.

In the Republic of Armenia, it is extremely difficult to assess the sources of origin and supply of firewood. In this regard, at the expert level, it is conventionally accepted that about 70%[24] of the firewood used is a product of natural forest growth (under conditions of sustainable forest management, when an average forest growth is equal to or exceeds the volume of deforestation and firewood is considered a renewable resource generated at the expense of natural growth of timber), the emissions from the combustion of which are considered zero (0 t CO_2/MWh).

Meanwhile, firewood resulting from unsustainable forest management (when deforestation rates exceed natural forest growth rates) is a non-renewable resource, with a GHG emission factor of 0.403 t CO2/MWh. Therefore, replacing 30% of the firewood used with other fossil fuels with lower emission factors will also be proposed as a mitigation measure.

The results of calculating the quantities of greenhouse gas emissions (only CO2 - carbon dioxide) resulting from the use of energy carriers involved in the BIE are presented in **Table 27.**

[24] Similar to programs that have been implemented in the past for other communities in Armenia.

Table 27. GHG emissions in baseline 2024 year

Energy carrier	GHG emissions, t CO_2				Emissions	
	Municipal	Population	Transport	Street lighting	t CO_2/year	%
Electrical energy	262.7	3,994.9	-	153.3	**4,410.9**	**9.52%**
Natural gas	154.9	12,763.7	-	-	**12,918.6**	**27.89%**
CNG	-	-	9,150.2	-	**9,150.2**	**19.75%**
Firewood non-renewable	-	8,957.5	-	-	**8,957.5**	**19.34%**
Firewood renewable	-	-	-	-	**-**	**0.00%**
Manure	-	-	-	-	**-**	**0.00%**
LPG in households	-	605.5	-	-	**605.5**	**1.31%**
Coal		2,139.4	-	-	**2,139.4**	**4.62%**
Gasoline	-	-	3,530.6	-	**3,530.6**	**7.62%**
Diesel fuel	-	-	3,063.6	-	**3,063.6**	**6.61%**
LPG in transport	-	-	1,543.3	-	**1,543.3**	**3.33%**
Total, tons of CO_2/year	**417.6**	**28,461.0**	**17,287.7**	**153.3**	**46,319.6**	**100 %**
Total, %	**0.90%**	**61.44%**	**37.32%**	**0.33%**	**100 %**	

The table shows that the population and transport maintain their leading positions in the emissions balance. By fuel type, natural gas, CNG and non-renewable firewood have the highest emission values.

Thus, in the Akhuryan community of the Shirak region of the Republic of Armenia, as a result of the population and economic activity, **46,319.6 tons of CO_2** were emitted in the baseline year 2024. This value is the baseline for assessing the target commitments of the community within the framework of the Covenant of Mayors. The community voluntarily assumed these commitments by becoming a participant in the Covenant initiative.

The ratio of CO_2 emissions in the base year is given in the graphs.

It is obvious from **Chart 23** that the dominant role in the structure of GHG emissions in the community belongs to the population, whose share in the total CO_2 emissions balance of the base year is 61.44%, and the share of transport is 37.32%.

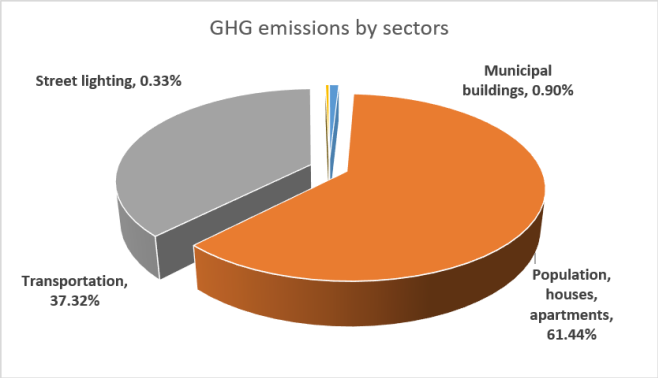


Chart 23. GHG emissions in the base year by consumption sectors

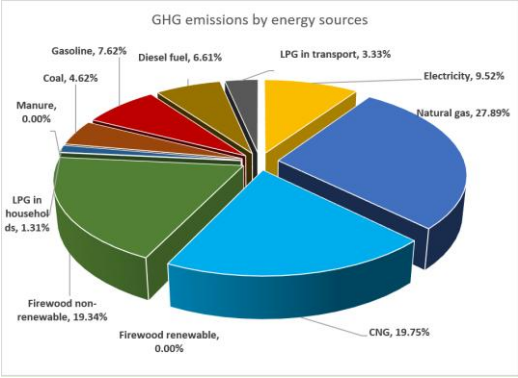


Chart 24. GHG emissions in the base year by energy carrier

Chart 24 shows that natural gas emissions together with CNG make up 47.6% (27.89+19.75), and non-renewable firewood emissions make up 19.34%. The third source of CO_2 emissions in the community is electricity - 9.52%, which is also a result of the combustion of exclusively natural gas in RA thermal power plants. The total share of liquid fuels used in motor transport is 17.6%, and emissions from coal combustion are 4.62%.

8.3. Target amounts of GHG emissions reduction

According to the Covenant procedures, local governments of the Eastern Partnership countries are authorized to independently decide on the approaches to estimating the target amounts of GHG emission reductions, based on one of the following two scenarios proposed by the European Commission:

- **Baseline year scenario,** in which the target emission reduction volume by 2050 is determined based on the estimated value of emissions in the baseline year.
- **Business as usual (normal development) scenario,** in which the target amount of emission reductions by 2050 is determined by taking into account the expected inevitable increase in GHG emissions by 2050 due to community development (e.g. population growth, economic development, expansion of street lighting and transport systems, etc.).

In the second approach, depending on the duration of the period from the baseline year to the target year 2050, a coefficient is introduced that takes into account the development of the community during that period and, naturally, the increase in emissions.

Over the past few years, the volumes of energy (energy carrier) consumption in the Akhuryan community have been variable: no stable growth or decrease trends have been recorded, which can be confirmed by studying, for example, **Tables 10-16**. The same can be said about the population size. Taking these circumstances into account, for the assessment of the target volumes of greenhouse gas emission reduction in the community in 2050, it is expedient and realistic to orientate ourselves with the first of the proposed scenarios, taking as a basis the BIE data for 2024.

Therefore, in the case of the adopted option, the volume of target obligations for reducing GHG emissions in the Akhuryan enlarged community by 2050 is:

46,319.6 x 0.4 = 18,527.86 t CO_2/year

In order to reduce the level of GHG emissions recorded in the base year by 18,527.86 tons of CO_2/year in the target year (2050), this SECAP proposes appropriate measures to reduce GHG emissions, which are summarized in **Chapter 9**. An interim target will also be set: to reduce GHG emissions by 30% in 2030 compared to the base year:

46,319.6 x 0.3 = 13,895.89 t CO_2/year

Upon the completion of the full implementation of this Program, aimed at increasing the efficiency of energy use, promoting the development of energy conservation and renewable energy, and ultimately mitigating climate change, GHG emissions will be reduced by **18,662.76 t CO_2** (**14,008.82 t CO2** in 2030), which slightly exceeds the target commitments.

The financial investments required for the implementation of the project amount to approximately **59.2 million euros** (**46.6 million euros** in 2030). It should be noted that the total investment package does not include expenses for measures not directly related to energy efficiency, such as organizational measures, expansion of forested areas, etc.

Considering the fact that the residential sector is the clear leader in terms of GHG emission reduction potential and, consequently, obligations, the Akhuryan Municipality should consistently carry out work to inform the population and introduce incentive mechanisms. Only with the active involvement of the residential sector can the implementation of this Program be realistic.

The implementation of the expected GHG emission reductions in the transport sector assumes the active participation of the private and commercial sectors in terms of organizing the work and financial investments (otherwise, the implementation of the Project may be jeopardized).

With the active involvement, joint work, and targeted funding of members of the Akhuryan Municipality Council of Elders, offices of administrative heads of the settlements, residents of Akhuryan village and rural communities, private and commercial entities, the implementation of this SECAP can be realistic and contribute to the further sustainable development of the community.

Chapter 9. "Sustainable Energy and Climate Action Plan" Measures

In order to fulfil its obligations under the Covenant, the Akhuryan Enlarged Community is implementing measures aimed at reducing the volume of GHG emissions recorded in 2024 by 40% by 2050 (a 30% reduction option by 2030 is also being considered). Measures to reduce GHG emissions are planned in four different areas and are aimed at encouraging energy saving and energy efficiency, and expanding the use of renewable energy resources.

The main part of the measures proposed in the section of this SECAP aimed at reducing GHG emissions are investment, so-called "hard" measures, which mainly provide for thermal modernization of buildings, development of a fleet of electric vehicles in transport, local energy production from renewable sources, etc. The implementation of these actions requires certain investments and ensures the full fulfilment of the community's commitment to reducing GHG emissions.

The other part of the proposed measures is of an organizational, "soft" nature and is mainly aimed at raising awareness and strengthening the capacities of target groups of society, relevant specialists of community structures and other stakeholders in the implementation of the community strategy in the context of emission reduction, including through the creation and improvement of an energy management system in the community.

9.1. Organizational "soft" measures

The active participation of local governments and the organizational skills of community structures are of great importance for the implementation of horizontal/soft measures of the Action Plan and for proper communication of the benefits. The implementation of measures of this nature, as a rule, does not require the involvement of significant financial resources and is designed to contribute to raising the level of awareness of the community population, institutional leaders, businessmen and individual entrepreneurs about the need for energy saving and climate mitigation. For this reason, this group of measures is called awareness-raising and also “Soft”.

It is often difficult to provide an accurate quantitative assessment of the energy or environmental effectiveness of "soft" measures; however, such assessments have been made on the basis of expert assessments, with certain reservations.

The latter are advisory in nature and are not included in the summary table of the SECAP. Consistent implementation of such measures is highly encouraged.

Measure 9.1.1. Implementation of a Municipal Energy Management System (MEMS)

The introduction of a MEMS in the Akhuryan community and the appointment of an energy manager will greatly contribute to the systematic and constant monitoring and management of energy flow parameters (technological, economic, social and environmental) within the community.

The Guide for the Implementation of the Energy Management System and the Institute of Energy Manager in RA Communities, the main goal of which is to assist RA communities in organizing energy consumption management in community-owned and community-managed buildings, was also provided to the RA Ministry of Territorial Administration and Infrastructure in 2020.

The energy management department will carry out an inventory of municipal and public MAB buildings in the community, compile a database of their thermal technical indicators, classifying the buildings according to previously developed criteria. The introduction of the MEMS also aims to ensure the sustainability of the energy management of the Akhuryan community and will provide significant economic benefits as a result of prudent management of the community budget.

The primary goals of the energy manager should be to carry out the following tasks:

- Create a list of work tasks and targets for the energy management department, define and plan practical steps to achieve the targets.
- Establish criteria and mechanisms for selecting buildings for modernization from the point of view of energy-efficiency.
- Organize the implementation of energy audits and monitoring of municipal buildings and public MABs under community jurisdiction, in order to identify and control the main energy indicators of buildings.
- Provide calculation and analysis of key indicators of thermal and energy efficiency of buildings, including baseline energy consumption, specific energy consumption, comfort level, etc.
- Assess the necessary investments, energy saving potential, GHG emission reduction and other energy and financial and economic indicators for buildings subject to modernization.

It is expected that as a result of the introduction of MEMS, at least a 10% reduction in energy consumption and GHG emissions can be achieved in community-owned structures.

The implementers	Cost, 10^3 euros	Energy conservation/saving, MWh/year		Reduction of CO_2 emissions, t/year	Years of implementation
		Electrical energy	Natural gas		
Akhuryan MP	12.0	109.0	76.7	41.757	2026

Calculation of GHG reduction by electricity and natural gas components:
$E_{el.en.}$ = 1,090.0 MWh/year x 0.1 x 0.241 t CO_2/ MWh = 26.269 tons of CO_2/year,
B_{gas} = 766.7 MWh/year x 0.1 x 0.202 t CO_2/ MWh = 15.488 tons of CO_2/year.

Measure 9.1.2. Participation in events organized by international organizations on climate and energy

International organizations such as the World Bank (WB), the United Nations Development Programme (UNDP), the German Agency for International Cooperation (GIZ) and others regularly organize events on climate mitigation and adaptation, promoting energy efficiency and the use of renewable energy sources. It is expected to ensure the active participation of municipal employees and the population in such events. For example, participation in the global event "Earth Hour". This is a global movement organized by the World-Wide Fund for Nature (WWF). The event is held annually (usually at the end of March), encouraging individuals, communities and businesses to turn off non-essential electrical lighting and other energy-consuming devices for one hour from 8:30 PM to 9:30 PM, as a symbol of commitment to the planet.

The event is designed to demonstrate the effectiveness of saving electricity for just one hour a year. The average hourly values of electricity consumption are estimated by assuming that:

- 80% of the population's daily consumption occurs within 10 hours,
- 90% of the municipal institutions' daily consumption: within 8 hours.

In that case, the energy efficiency of the measure will be determined as:

- in the residential sector: E= 0.8 x 16,576.38 /365/10 = 3.633 MWh/year
- in municipal institutions: E= 0.9 x 1,090.0 /260/8 = 0.472 MWh/year.

The implementers	Cost, 10^3 euros	Energy conservation/saving, MWh/year		Reduction of CO_2 emissions, t/year	Years of implementation
		Electrical energy	Natural gas		
Akhuryan MP	1.2	4.105	-	0.989	2026–2030

Another such event is participation in the EU Sustainable Energy Week (ESEW), the largest annual event organized by the European Commission and dedicated to the effective use of renewable energy in Europe.

Measure 9.1.3. Optional climate change mitigation courses in schools

Instilling energy-efficient behaviour and education in children can contribute to reducing the consumption of fossil fuels. Young people, and especially schoolchildren, can greatly contribute to solving the energy and climate problems of the community. The goal of the event is to instil a caring attitude towards energy carriers among schoolchildren, as well as to realize the advantages of using renewable energy sources. It is accepted that if a part of school-age children, remembering the knowledge acquired during classes, manages to turn off an unnecessarily turned-on light or gas stove at least once a day, we can expect a reduction in annual consumption by about 0.8%. The results are presented in the table below.

The implementers	Cost, 10^3 euros	Energy conservation/saving, MWh/year		Reduction of CO_2 emissions, t/year	Years of implementation
		Electrical energy	Natural gas		
Akhuryan MP and schools	3.50	132.611	505.493	134.069	2026–2027

Measure 9.1.4. Involving young people in the sustainable energy development process of the community

The implementation of the program's goals largely depends on the level of population involvement. It is necessary to encourage the participation of the community's proactive youth and active population in the implementation of the mentioned programs.

It is very important to consistently ensure the participation of employees of the municipality and offices of the administrative heads of settlements in events regularly organized by international organizations on the topics of climate mitigation and adaptation, energy efficiency, and renewable energy sources.

It is assumed that within the framework of this event, informational and educational materials on energy saving and energy efficiency will be distributed among youth and, in particular, schoolchildren, as a result of which, thanks to the active promotion of green and sustainable development ideas by schoolchildren involved in this process, a certain part of the population of Akhuryan community (schoolchildren's families) will initiate and implement energy-saving measures in apartments and houses, including the installation of PV panels, the purchase of electric cars, energy-saving household appliances, energy-efficient renovation, etc.

The daily consistent work of the entire staff of the municipal council members and the offices of the heads of administrative settlements is expected to ensure the effective implementation of the measure. As a result of daily targeted work, an annual reduction of about 0.5% in all areas of energy consumption can be expected, also as a result of behavioural changes. The results are estimated in the table below.

The implementers	Cost, 10^3 euros	Energy conservation/saving, MWh/year								Reduction of CO_2 emissions, t/year	Years of implementation
		Electrical energy	Natural gas	CNG	Firewood non-renewable	Gasoline	Diesel fuel	LPG	Coal		
Akhuryan MP	12.0	91.5	319.8	226.5	111.1	70.9	57.4	47.3	30.2	231.6	2026 – 2030

Similar organizational measures can be expanded as needed, in accordance with the wishes, abilities and capabilities of the municipality. The funding volume of the proposed 4 soft measures is 28.7 thousand euros, the total estimated energy savings are 2,403.5 MWh/year, and the reduction of GHG emissions is 408.4 t CO_2/year.

9.2. "Hard" investment measures

Under the Covenant of Mayors, Akhuryan Municipality has committed to reduce CO_2 emissions by 40% by 2050 (and a parallel option of 30% by 2030), while contributing to the mitigation of global climate

change. In order to meet this ambitious commitment, this section presents investment-requiring measures that are expected to deliver the above-mentioned CO_2 emission reduction results. Mitigation measures are proposed for the main sectors included in the SECAP BIE: municipal buildings, residential buildings, transport and outdoor lighting.

When proposing measures, the development directions of low-carbon and green technologies that have gained momentum in Armenia in recent years were taken into account, in particular, the installation of autonomous solar power plants, the thermal modernization of the external envelope of buildings, and the import of electric vehicles.

The presented measures are consistent with the provisions of the documents defining the energy and climate strategies of the Republic of Armenia, mentioned above in the SECAP, as well as with decisions and development programs adopted at the national and local levels.

The above-mentioned trends and development rates in the Republic are also paramount for the development of the Sustainable Energy and Climate Action Plan of the Akhuryan community.

The following subsections present the main activities of the SECAP in various areas of community life. These activities, which require the investment of significant financial resources, ensure the full implementation of target commitments.

9.2.1 Measures at community-owned structures

The measures proposed in municipal buildings are consistent with the provisions of the RA Government Resolution No. 1504-N of 25.12.2014 "On the application of measures aimed at increasing energy saving and energy efficiency in facilities being constructed (reconstructed, renovated) at the expense of state funds".

The following measures are being considered to reduce the volume of thermal and electrical energy consumption in buildings, reduce their operating costs, and ensure regulatory comfort conditions:

- Thermal insulation of external envelope structures- external walls, attic floors, basements, with certified thermal insulation construction materials;
- Application of volumetric layout solutions that ensure the minimum possible surfaces of external cladding structures;
- Use/replacement of energy-efficient windows and entrance doors;
- Use of energy-efficient systems and equipment for heating, ventilation, air conditioning, hot water supply and lighting;
- Use of solar water heating and photovoltaic equipment and heat pumps.

Energy efficiency measures implemented in community-owned/municipal institutions must be economically justified and ensure savings of community budget funds. Financial savings accumulated from year to year are encouraged to be invested in the community revolving fund, to the extent possible, and used to expand energy efficiency measures, involving new streets and buildings, and implementing energy efficiency improvement programs.

Measure 9.2.1.1 Partial savings in electrical and thermal energy in municipal buildings through simple energy saving measures

The implementation of simple energy saving (ES) measures requires the mobilization of administrative resources and the active participation of all employees of the municipality. These measures are considered a priority in terms of time. The planned measures are not related to large investments. The measure envisages the following types of work:

- installation of radiant heat flow reflectors in the rear parts of heating system heaters,

- thermal "sealing" of windows and exterior doors using silicone, foam rubber, insulating foams or other modern materials (replacement of sealing rubbers of aluminium and metal-plastic, euro windows and doors, adjustment of handles),
- adjustment of heating and hot water supply modes, thermal insulation of external pipes,
- installation of light thresholds (tambours) for entrance doors of buildings,
- installation of motion sensors and automatic electrical power switches:

The measures in the CNPOs (NGOs) can be implemented as soon as possible, by 2027. It is estimated that as a result, annual electricity savings of 2% and natural gas savings of 4% can be achieved in the buildings of institutions financed from the community budget [including natural gas equivalent to saved thermal energy (calculated COP/efficiency 92%)]. In the baseline year, community institutions consumed 1,090.0 MWh/year of electricity and 766.7 MWh/year of natural gas.

The results of the calculations performed are applied to the two considered options (**Target 1: 40% in 2050 and Target 2: 30% in 2030**) and are summarized in the table below.

The implementers	Cost, 10^3 euros	Energy conservation/saving, MWh/year		Reduction of CO_2 emissions, t/year	Years of implementation
		Electrical energy	Natural gas		
Akhuryan MP	24.00	21.800	33.335	11.987	2026-2027

Measure 9.2.1.2 Restoration of thermal insulation layers in attics of municipal buildings

The thermal insulation layers in the attics of some of the buildings of the CNPOs have deteriorated, disappeared or are missing. It is planned to restore the thermal insulation layers in all buildings under community control within the next 1-2 years.

The thickness of the planned thermal insulation layer is assumed to be 16 cm (blankets made of local raw materials, expanded perlite or mineral wool), the coefficient of thermal conductivity is 0.045 W/(m2°C), the thermal resistance of the roof structure of the last floors of the buildings is assumed to be 0.65 m^2°C/W, which increases by 3.556 due to the insulation layer, thus making 4.206 m^2°C/W. The average attic area of the building is assumed to be 140 m^2, the temperature coefficient of the attic is 0.75. Since there are buildings in the community that are heated with electric energy, it is estimated that 15% of the consumed electricity is used for heating purposes. And to calculate the expected savings in useful thermal energy from the transition to final energy, natural gas, the average COP/efficiency of heating boilers and furnaces is taken to be 90%. From an economic point of view, this measure is very attractive, as it requires minimal initial investments for one unit of GHG reduction.

The results are summarized in the table below and are applicable to the two options/targets considered.

The implementers	Cost, 10^3 euros	Energy conservation/saving, MWh/year		Reduction of CO_2 emissions, t/year	Years of implementation
		Electrical energy	Natural gas		
Akhuryan MP	45.520	32.700	170.378	42.297	2026-2030

In particular, it is planned to create a youth centre in the Akhuryan community and the German International Cooperation Agency (GIZ) is considering the implementation of thermal insulation of the centre's roof.

Measure 9.2.1.3 Renovation of municipal buildings

According to the decision of the Akhuryan Community Council of Elders No. 38-A dated 14.03.2025, 14 subvention programs consisting of 19 sub-programs have been launched in Akhuryan community with joint state-community investment. Annual programs for the management of buildings and structures owned by the community have been drawn up. In accordance with the latter, community-owned buildings are being renovated, overhauled and constructed.

In particular, the 2024 annual work plan of Akhuryan community provides for 37.7 million drams for increasing the energy efficiency of community-owned municipal buildings (including 31.7 million drams of donor organizations' investment and 6.0 million drams of community investment).

It is difficult to estimate the exact energy savings and GHG emissions reductions resulting from the renovation of municipal buildings. However, it is accepted that energy-efficient renovations in municipal buildings can be expected to result in energy consumption improvements of around 10% for electricity and natural gas.

The results of the measure are summarized in the table below and are applicable to both options/targets considered.

The implementers	Cost, 10^3 euros	Energy conservation/saving, MWh/year		Reduction of CO2 emissions, t/year	Years of implementation
		Electrical energy	Natural gas		
Akhuryan MP	84.5	109.0	76.67	41.756	2026-2030

Measure 9.2.1.4 Installation of solar water heaters in kindergartens

All preschool educational institutions in Akhuryan community consume about 23.7 thousand m^3 of natural gas annually. The transition to solar water heating in these preschools is beneficial both from the point of view of economic, reducing CO_2 and GHG emissions, as well as instilling a caring attitude towards energy and nature in children.

It is assumed that favourable technical conditions can be created in kindergartens for the installation of solar collectors. Each system with an absorption surface of about 30 m^2, together with a hybrid gas heater, will be able to produce the necessary useful thermal energy for hot water supply. If we assume that about 30% of the 233.4 MWh of natural gas consumed annually is used for domestic hot water, then the installation of solar water heaters can save about 7.1 thousand m^3 of natural gas, the energy equivalent of which will be about 67.0 MWh/year. The expected energy and GHG emission reduction benefits from the implementation of this measure are presented in the table below.

The results of the measure are applicable to both observed targets.

The implementers	Cost, 10^3 euros	Energy conservation/saving, MWh/year		Reduction of CO_2 emissions, t/year	Years of implementation
		Electrical energy	Natural gas		
Akhuryan MP	115.2	-	67.0	13.537	2026-2028

Measure 9.2.1.5 Replacing inefficient lamps with LED lamps in community-owned organizations

Incandescent and other inefficient lamps are still used in the internal lighting systems of municipal institutions as of 2024. Replacing these lamps with modern energy-efficient LED lamps available on the local

market can achieve up to a fivefold reduction in the required electricity consumption without reducing the luminous flux.

There is a need to replace low-efficiency incandescent or fluorescent lamps in indoor lighting systems in Akhuryan community institutions with modern energy-efficient LED lamps. From an economic perspective, this measure is very attractive, as it requires minimal initial investments for one unit of GHG reduction.

The measure plans to replace an average of 20 incandescent lamps (100 W) with LED lamps in all municipal buildings. The operating hours of the lamps in these facilities are assumed to be 4.5 hours/day and 260 days/year, and the incandescent lamps to be replaced are replaced with LED lamps of about 18 W. The annual amount of electric energy saved will be:

$$E = 260 \times 58 \times 20 \times (100-18) \times 4.5/10^6 = 111.29 \text{ MWh/year}$$

The results of the measure are applicable to both observed targets.

The implementers	Cost, 10^3 euros	Energy conservation/saving, MWh/year		Reduction of CO2 emissions, t/year	Years of implementation
		Electrical energy	Natural gas		
Akhuryan MP	5.2	111.29	-	26.821	2026-2028

Measure 9.2.1.6 Installation of PV modules in municipal institutions

Solar radiation indicators in Akhuryan conditions - the total radiation of a horizontal surface under average cloudiness is 1,608.5 kWh/m^2. According to the current regulations, individuals and legal entities can install autonomous solar power plants with a capacity of up to 150 kW to meet their own electricity needs. In recent years, this green technology has been developing in Armenia with almost geometric progression.

It is also known that with appropriate orientation of PV modules, each kW of peak power is capable of producing about 1,500 kWh of electricity per year in Akhuryan conditions. It is proposed to allocate 40-50 m^2 of sunlit area for installing PV modules in community-owned institutions that do not have PV modules. That is, the installed capacity in each building will be about 6.5 kW on average (only 227.5 kW for 60% of 58 organizations), each of which will produce about 9.75 MWh of electricity per year.

The results of the event are applicable to both observed targets.

The implementers	Cost, 10^3 euros	Energy conservation/saving, MWh/year		Reduction of CO_2 emissions, t/year	Years of implementation
		Electrical energy	Natural gas		
Akhuryan MP	170.625	341.25	-	82.241	2026-2028

In particular, the German Agency for International Cooperation (GIZ) is considering: a) the installation of a 30-kW solar station, heat pump and recuperator at the Voskehask Sports School, b) a 10 kW (up to 20 kW if funds are available) solar station at the Arevik Kindergarten, and c) a 20-kW solar station at the Akhuryan Youth Centre.

9.2.2 Local production of electrical energy

The Akhuryan enlarged community, in order to ensure sustainable development, intends to cooperate with international organizations, promoting low-carbon development, increasing energy efficiency and the use of renewable energy resources.

In the current conditions of liberalization of the electricity market, the Akhuryan community plans to build a 0.6 MW community commercial PV power plant equipped with batteries. This system is intended for 24-hour operation, during sunny weather they accumulate excess energy, which is also used in case of possible outages or accidents.

9.2.2.1 Construction of a community commercial PV power plant

Within the framework of this measure, it is planned to build and operate a 0.6 MW community commercial PV power plant (equipped with storage and rechargeable batteries) in Akhuryan community during 2026-2030, with an annual production of approximately 900 MWh.

The implementation of the measures will require 576,000 euros. Sources of financing may include the municipal budget, subsidy programs or financial support provided by foundations and international organizations. The results of the calculation of renewable energy production and GHG emission reduction are presented in the table below.

The results of the measure are applicable to both observed targets.

The implementers	Cost, 10^3 euros	Energy conservation/saving, MWh/year		Reduction of CO_2 emissions, t/year	Years of implementation
		Electrical energy	Natural gas		
Akhuryan MP	576.0	900.0	0	216.9	2026-2030

9.2.3 Measures in the residential sector

The residential sector of Akhuryan community is a major consumer of energy, using mainly electricity, natural gas, and firewood, as well as relatively small amounts of coal, liquefied petroleum gas, and manure.

This sector is the main one of the four that are included in the BIE and the list of mitigation measures according to the Covenant methodology. The potential for reducing energy consumption in the residential sector and the resulting reduction in GHG emissions are of key importance for achieving the set targets.

The population accounts for the majority of energy consumption in the community: 67.0%, and the volume of GHG emissions: 61.4%, therefore the main share/potential for GHG emission reductions should also be expected from the residential sector. The role of the population in fulfilling the community's target obligations cannot be underestimated.

The multi-apartment building stock of Akhuryan, like other communities, was mainly built during the Soviet era, with very low regulatory requirements for thermal protection of buildings typical of that period, largely ignoring the issues of energy saving and energy efficiency, which became a priority as a result of the increase in energy prices.

The MAB sector has significant energy saving potential, and energy efficiency measures implemented here can significantly reduce GHG emissions. The buildings in Akhuryan village were built with tuff stone, and in the Vahramaberd settlement they are panelled, and in both cases the thermal resistances of the buildings do not meet the thermal protection requirements in force in Armenia.

In general, the same characteristic can be given to private houses, which are also built without thermal insulation of external enclosing structures (walls, attic roofs). In the case of private houses, along with the potential for energy efficiency, the use of solar energy is also promising, both in terms of local production of electrical and thermal energy. Among the negative phenomena in the sector are the factor of "energy poverty" and the inability of households to provide a normative level of heating comfort, along with other social problems.

The low baseline level of energy consumption significantly reduces the energy saving potential of the proposed measures. And the implementation of measures to increase the energy efficiency of buildings often does not lead to a reduction in energy consumption, but instead contributes to an improvement in the level of comfort. The mentioned factors reduce the business attractiveness of such projects, as well as the actual impact on climate mitigation.

A complete package of thermal modernization measures in buildings can require significant investments and long payback periods. Therefore, all these factors need to be taken into account during the planning and implementation of measures.

At the same time, the municipality does not have direct leverage over the implementation of energy saving measures by owners of private houses and apartments. However, the residential sector is included in the BIE and, accordingly, in the list of mitigation actions of the SECAP, taking into account the social, energy and climate benefits of the measures proposed here.

Taking into account the above circumstances, the members of the Akhuryan Municipality Council of Elders and the entire staff are ready to consistently implement large-scale campaigns to raise public awareness about the commercial and social benefits of energy efficiency and to ensure active participation of community residents in the implementation of such events.

According to the RACN 24-01-2016 "Thermal Protection of Buildings", RACN II-7.02-95 "Construction Thermophysics of Building Enclosing Structures" and RACN 24-01-2024 "Construction Climatology", the thermal resistances (R-values) of building enclosing structures in Akhuryan community (number of degree-days 4,058) for residential buildings must provide the following values:

Exterior building envelope	Required values $(m^2 \cdot °C)/W$
Roofing and weatherproofing	4.28
Cold basement and attic covers	3.98
Exterior walls	3.08
Exterior windows and doors	0.45

In the stone-built MABs of Akhuryan community, it is proposed to implement partial thermal modernization works of the buildings within the framework of the State Subvention Program, co-financed by the UNDP-GCF Project.

Since similar works have not been carried out in the community before, below are examples of similar works carried out in other communities in a similar climatic zone.

Address: Gyumri, Mush district, 7/1

Thermally modernized in 2022. Energy saving 66%

Annual energy savings: 434,104x3 kWh (calculations are presented for heating and ventilation, assuming that the building provides 100% comfort level)
Energy performance before: 215, after: 74 kWh/m² year. **Project cost: 96.3x3 million AMD.** Energy efficiency class: before: E, after: B+.

24 apartments each, 3x3 entrance, built in the 1990s, 4-storey with load-bearing walls, 2,157x3 m². 80% of the installed windows are metal-plastic windows, and 20% are old wooden windows. The external walls are made of 500 mm thick stone load-bearing walls, the covering is 220 mm thick reinforced concrete round-hole slabs, for which thermal insulation was not provided.
Work carried out: a) thermal insulation of the external walls of the building with an 80 mm thick extruded polystyrene foam layer, b) thermal insulation of the upper floor with 200 mm thick expanded perlite sand bags, c) thermal insulation of the first floor from the basement with an 80 mm thick extruded polystyrene foam layer, d) restoration/replacement of the doors and windows of the staircase and landings.

Address: Alaverdi, Sanahin Sarahart 1/20

Partially thermally modernized in 2023. Energy saving 25%

Annual energy savings: 223,666 kWh (calculations are presented for heating and ventilation, assuming that 100% comfort level is ensured in the building)
Energy performance before: 156, after: 96 kWh/m² year. **Project cost: 31.0 million AMD.** Energy efficiency class: before: E, after: D.

The building has a frame-panel construction solution, 4 floors and 2 entrances, a total area of 2,380 m², 24 apartments and 84 residents, a sloping roof. The external walls are made of 500 mm thick tufa midis. The roof is made of 220 mm thick reinforced concrete round-hole slabs.
Work carried out: a) restore/replace the doors and windows of the staircase and landings, b) repair the damaged walls and ceilings, c) perform thermal insulation of the attic floor with a 200 mm thick thermal insulation layer with expanded perlite bags, completely repairing the roof.

Address: Vedi, Kasyan 26/1

Thermally modernized in 2021. Energy saving 66%

Annual energy savings: 225,589 kWh (calculations are presented for heating and ventilation, assuming that 100% comfort level is ensured in the building)
Energy performance before: 151, after: 52 kWh/m² year.
The cost of the project is 40.6 million AMD. Energy efficiency class: before: E, after: B**.**

30 apartments, 114 residents, built in the 1970s, frame-panel, 5-story, total area: 2,272 m², sloping roof. 60% of the installed windows are metal-plastic windows, and 40% are old wooden windows.

The external walls are made of 300 mm thick panels, for which no thermal insulation was provided. The covering is made of 220 mm thick reinforced concrete slabs with round holes.

Implemented works: a) Thermal insulation of the external walls of the building with a 50 mm thick extruded polystyrene foam layer. The sequence of layers of the multilayer cladding construction (from the outer layer to the inner layer) will be as follows: waterproof facade paint, primer, fiberglass reinforced adhesive layer, extruded polystyrene foam layer, adhesive layer, panel, gypsum plaster, b) implement a thermal insulation layer with 100 mm thick rigid mineral wool slabs on the upper floor, c) restore/replace the doors and windows of the stairwell and landings. Vestibules (tambours) will be built at the entrances of the building.

In the mentioned buildings, the current condition of the external envelope structures of the buildings prior to thermal modernization is identical to the 3- and 4-storey multi-apartment buildings of Akhuryan community, also in terms of the equipment used for heating the apartments.

It is recommended to implement identical thermal modernization measures. Calculations are made on the principle of proportionality.

Measure 9.2.3.1 Partial thermal modernization of 4 4-storey and 5 3-storey stone-built multi-apartment buildings in Akhuryan community

Following the example of the successful thermal modernization of MABs implemented within the framework of the state subvention program (co-financed by the UNDP-GCF Project), it is proposed to gradually implement partial thermal modernization works of the existing 4-storey (4 units) and 3-storey (5 units) stone-built buildings during 2026-2030:

- Thermal insulation of attic floors and repair/replacement of roof coverings,
- Replacement of entrance doors and windows with new energy-efficient windows and doors,
- Installation of automatic interior lighting systems in entrances and stairwells.

It is expected that the energy savings in the partially insulated MAB will amount to about 69.9 MWh/year[25] in 4-storey stone buildings and about 41.9 MWh/year in 3-storey stone buildings, i.e., the total (useful energy) annual savings will amount to 279.6 MWh/year in 4 4-story buildings and 209.7 MWh/year in 5 3-story buildings (useful energy).

For the conversion from useful to final energy (as the latter is needed for GHG emissions calculations), the average energy efficiency of natural gas, heating boilers/stoves used in buildings is assumed to be 85%. Based on the survey[26] results, it is assumed that families living in buildings spend on average 80% natural gas and 20% electricity on heating their apartments, therefore, the calculation of GHG emissions reduction within the framework of this measure will be carried out in the same proportion.

The implementation of the measures will require the following investments: 173.8 thousand euros for 4 4-storey buildings and 130.3 thousand euros for 5 3-storey buildings, a total of 304.1 thousand euros.

The results of the energy savings and GHG emission reduction calculations are presented in the table below. The results of the measure are applicable to both targets considered.

The implementers	Cost, 10^3 euros	Energy conservation/saving, MWh/year		Reduction of CO_2 emissions, t/year	Years of implementation
		Electrical energy	Natural gas		
Akhuryan MP	304.119	97.854	460.489	116.602	2026-2030

[25] According to energy audits and calculations conducted by UNDP-GCF project experts, the average energy efficiency of these buildings, under regulatory conditions, is estimated at around 60-141 (kWh/m^2 year). Considering that the BIE includes actual energy consumption data, and the comfort level of these buildings is not more than 40-50%, the actual energy efficiency of the buildings is estimated accordingly.

[26] Results of a survey on heating in rural areas conducted within the framework of the UNDP-GCF project.

Measure 9.2.3.2 Complete thermal modernization of 4 3-storey panel MABs in the Vahramaberd settlement

It is proposed to implement complete thermal modernization works for 4 3-story panel MABs located in the Vahramaberd settlement:

- Thermal insulation of external walls,
- Replacement of entrance doors and windows with new energy-efficient windows and doors,
- Installation of automatic interior lighting systems in entrances and stairwells,
- Flat roof insulation,
- In case of a basement, thermal insulation of the upper floors.

It is expected that the energy savings in a fully insulated MAB will amount to about 45.12 MWh/year[27], in one 3-storey building, or, the total (useful energy) annual savings will amount to 180.47 MWh/year in 4 3-storey buildings, (useful energy).

To obtain the final energy, the approaches of measure 8.2.3.1 are applied.

The results of the energy savings and GHG emission reduction calculations are presented in the table below. The results of the measure are applicable to both targets considered.

The implementers	Cost, 10^3 euros	Energy conservation/saving, MWh/year		Reduction of CO2 emissions, t/year	Years of implementation
		Electrical energy	Natural gas		
Akhuryan MP	145.663	36.094	169.855	43.009	2026-2030

Measure 9.2.3.3 Partial thermal modernization of MABs and private houses through simple energy saving measures

The event is essentially a repetition of event 8.2.1.1 for residential buildings. The nature of the work to be carried out, cost indicators, implementers, etc., have the same substantive and volume characteristics as those characteristics of event 8.2.1.1.

Given the modest number of financial resources required, 40% of the MAB apartments and private houses (for the 30% GHG reduction target by 2030) and 60% (for the 40% GHG reduction target by 2050) will be able to participate in this measure. It is also assumed that the implementation of the measure will save 7% of the natural gas and firewood consumed by the population in the base year, and 3% of the electricity[28]. The cost of the measure was estimated at 60 euros per apartment in the MAB and 100 euros per private house.

For the calculation of final energy, the following efficiency ratios for heating equipment are used for natural gas and firewood, respectively: 85%, 70%. The results of the calculation of energy savings and GHG emission reductions are presented in the tables below.

Table 1. By 2030, 30% GHG reduction target

The implementers	Cost, 10^3 euros	Energy conservation/saving, MWh/year			Reduction of CO_2 emissions, t/year	Years of implementation
		Electrical energy	Natural gas	Firewood*		
MP&HH	461.16	198.9	2,081.4	2,963.6	826.689	2026-2030

[27] Proportional calculation, comfort level is assumed to be around 50%

[28] Domestic liquefied petroleum gas (LPG) consumption by population was not considered because it is not used for heating purposes, greenhouse gas emissions for manure are zero, and coal replacement is considered a separate measure.

Table 2. By 2050, a 40% GHG reduction target

The implementers	Cost, 10^3 euros	Energy conservation/saving, MWh/year			Reduction of CO_2 emissions, t/year	Years of implementation
		Electrical energy	Natural gas	Firewood *		
MP&HH	691.72	298.4	3,122.2	4,445.4	1,240.033	2026-2050

* 30% of the specified amount is non-renewable firewood, the GHG emission factor of which is 0.403 t CO_2/MWh, and the remaining 70% is renewable and the GHG emissions are equal to 0.

Measure 9.2.3.4 Restoration of thermal insulation layers of attic roofs of private houses

Restoration of thermal insulation layers of attic floors is the most effective measure for thermal modernization of buildings in terms of investment/savings. The measure requires relatively small financial resources, and the specific result is better.

The community's private houses were mainly built and put into operation many years ago, when they were not thermally insulated or were not sufficiently insulated. Currently, as a rule, in the attics of a significant part of residential buildings, due to the deterioration or absence of thermal insulation layers, heat losses from the ceilings of the last floors many times exceed the regulatory indicators.

For this purpose, locally produced thermal insulation materials/structures can be used. The main prerequisite is to keep the thermal insulation layer free from moisture. The thickness of the layer is 18-20 cm, the thermal conductivity coefficient of the material is 0.045 W/(m^2°C). The thermal resistance of the last floor covering is assumed to be 0.75 m^2°C/W. With insulation with the specified parameters, it increases by at least 3.32 and is about 3.98-4.02 m^2°C/W.

The attic area of each private house is assumed to be 80 m^2, the attic temperature coefficient is 0.7 and the comfort coefficient is 0.7. It is assumed that 35% or about 4,002 private houses (**by 2030: 30% GHG reduction target**) and 40% or about 4,575 private houses (**by 2050: 40% GHG reduction target**) will participate in the measure. As a result of the measure, the energy savings used for heating will amount to:

Target 1` Q=4,003x80x (20+1.7) x187 x 24 x (1.33-0.25) x0.7x0.7x10^{-6}= 16,504.71 MWh/year.

Target 2` Q=4,575x80x (20+1.7) x187 x 24 x (1.33-0.25) x0.7x0.7x10^{-6}= 18,863.12 MWh/year.

The calculation of GHG emission reduction is carried out taking into account that the share of electricity among the energy carriers used for heating in private homes is 20%, and the proportion of thermal energy produced as a result of burning natural gas and firewood used to obtain thermal energy (for the remaining 80%) (on a community scale, corresponding to the quantities consumed in private homes) is as follows:

Total consumption in private houses of Akhuryan community		
Natural gas	Firewood	Total
60,623	74,090	134,713
45.00%	55.00%	100.00%

The efficiency indicators of the equipment for the transition from useful energy to final energy are assumed: for gas boilers, stoves and water heaters- average 85%, and for wood stoves- 70%. The cost of thermal insulation of 1 sq.m. of the attic floor (for example, with expanded perlite blankets) is estimated at around 6.73 euros (3,000 AMD).

The results of the energy savings and GHG emission reduction calculations are presented in the tables below.

Table 1. By 2030, 30% GHG reduction target

The implementers	Cost, 10^3 euros	Energy conservation/saving, MWh/year			Reduction of CO_2 emissions, t/year	Years of implementation
		Electrical energy	Natural gas	Firewood*		
MP&HH	2,154.3	3,300.9	6,990.5	10,374.1	3,461.832	2026-2030

Table 2. By 2050, 40% GHG reduction target

The implementers	Cost, 10^3 euros	Energy conservation/saving, MWh/year			Reduction of CO_2 emissions, t/year	Years of implementation
		Electrical energy	Natural gas	Firewood*		
MP&HH	2,462.1	3,772.6	7,989.4	11,856.5	3,956.503	2026-2040

*30% of the specified amount is non-renewable firewood, the GHG emission factor of which is 0.403 t CO_2/MWh, and the remaining 70% is renewable and the GHG emissions are equal to 0.

Measure 9.2.3.5 Installation of energy-efficient lamps in the residential sector

Incandescent lamps have been rapidly phased out of use in recent years, but inefficient lamps are still used for indoor lighting in community apartments and private houses as of 2024. Replacing them with LEDs is economically feasible in current conditions in terms of specific investment (euro/t CO2 ratio).

It is planned that about 30% of the households of Akhuryan community, i.e. about 46 apartments and 3,431 private houses (**30% GHG reduction target by 2030**) and about 60%, i.e. about 92 apartments and 6,962 private houses (**40% GHG reduction target by 2050**) will participate in the measure. It is planned that the participants' 100 W lamps will be replaced with 18 W LED lamps. In total, the number of LED lamps to be replaced is: in the apartments of the MABs: 4 each: **Target I**: 184 pieces (**Target II**: 368), and in the private houses: 5 each: **Target I**: 17,155 pieces (**Target II**: 34,310).

The annual electricity savings and GHG emission reduction calculation results are presented in the tables below[29]:

Target 1` Q= (184+17,155) x (100+18) x4.5 x 350x10^{-6}= 2,239.3 MWh/year.

Target 2` Q= (368+34,310) x (100+18) x4.5 x 350x10^{-6}= 4,478.7 MWh/year.

Table 1. By 2030, 30% GHG reduction target

The implementers	Cost, 10^3 euros	Energy conservation/saving, MWh/year			Reduction of CO2 emissions, t/year	Years of implementation
		Electrical energy	Natural gas	Other		
MP and HH	77.8	2,239.3	-	-	539.679	2026-2028

Table 2. By 2050, a 40% GHG reduction target

The implementers	Cost, 10^3 euros	Energy conservation/saving, MWh/year			Reduction of CO2 emissions, t/year	Years of implementation
		Electrical energy	Natural gas	Other		
MP and HH	155.5	4,478.7	-	-	1,079.358	2026-2038

[29] It is estimated that the lamps work 350 days a year, 4.5 hours a day, and the cost of one lamp is 2,000 drams.

Measure 9.2.3.6 Installation of energy-efficient windows in residential MA buildings

The specific investments for replacing windows and doors are very large, unlike, for example, the thermal insulation of an attic. Energy-efficient windows are quite expensive (about 30,000 AMD per 1 m^2). Installing new metal-plastic or aluminium windows has more aesthetic and comfort purposes, but at the same time contributes to the reduction of GHG emissions.

It is planned to involve about 50% of the 70% of the apartments in the MABs (apartments whose windows are still old as of the base year), up to 54 apartments (**Target I**) and about 80%, up to 86 apartments (**Target II**). The thermal resistances of the existing and energy-efficient windows are assumed to be 0.28 and 0.45 K•m^2/W, respectively, the light-transmitting area of one window is 1.8 m^2, the average number of new windows installed per apartment is 3, and the average comfort level in apartments is 50%. The use of new windows will also improve natural lighting.

The annual saving of thermal energy is determined by the following formula:

Target I Q = 3 x 54 x 1.8 x (20+ 1.7) x 187 x 24 x (1/0.28 -1/0.45) x $0.5/10^6$ = 19.158 MWh/year,

Target II Q = 3 x 86 x 1.8 x (20+ 1.7) x 187 x 24 x (1/0.28 -1/0.45) x $0.5/10^6$ = 30.511 MWh/year,

There is no burning of firewood and manure for heating in MABs. : The electricity consumption for heating is estimated at 20%. The final and useful energy transfer coefficient, COP/efficiency, for natural gas equipment (wall, gas boiler and stove) is 85%, for electric heating equipment - 100%.

Table 1. By 2030, 30% GHG reduction target

The implementers	Cost, 10^3 euros	Energy conservation/saving, MWh/year			Reduction of CO2 emissions, t/year	Years of implementation
		Electrical energy	Natural gas	Other		
MP and HH	19.62	3.832	18.031	-	4.566	2028-2030

Table 2. By 2050, 40% GHG reduction target

The implementers	Cost, 10^3 euros	Energy conservation/saving, MWh/year			Reduction of CO2 emissions, t/year	Years of implementation
		Electrical energy	Natural gas	Other		
MP and HH	31.24	6.102	28.716	-	7.271	2038-2040

Measure 9.2.3.7 Installation of energy-efficient windows in private houses

The measure is a repeat of the previous one for private houses. The thermal characteristics of existing old, wooden-framed (sometimes with single-pane glass) and new windows in private houses are assumed to be the same: 0.28 and 0.45 K·m^2/W, the number of windows to be renovated in each house is 4, and the translucent area of each window is 1.8 m^2. It is assumed that within the framework of **Target I**, 40% of 70% of private houses (of those houses whose windows are still old as of the base year) will be involved in the measure implementation, 3,202 houses will be involved (over five years), starting from 2026, 640 houses each year until 2030, and within the framework of **Target II**, 80% of the same 70% of private houses will be involved (as of the base year), starting from 2026, 256 private houses each year until 2050, i.e., a total of about 6,405 houses (over twenty-five years). It is assumed that the comfort level in private houses is 70%, the cost of 1 m^2 of energy-saving windows is 30,000 AMD, and the Euro/Armenian dram exchange rate is 1/445.96 (the average rate of the Central Bank of RA for January 2026). The results of the calculation are presented below:

Target I Q = 4 x 3,202 x 1.8 x (20+ 1.7) x 187 x 24 x (1/0.28 -1/0.45) x $0.7/10^6$ = 2,120.761 MWh/year,

Target II Q = 4 x 6,404x 1.8x (20+ 1.7) x 187 x 24 x (1/0.28 -1/0.45) x $0.7/10^6$ = 4,241.521 MWh/year.

The calculation of GHG emission reduction is carried out taking into account that the share of electricity used for heating in private houses is 20%, and it is also taken into account that the proportion of natural gas and firewood used to obtain thermal energy (for the remaining 80%) is 45.0%/ 55.0% respectively.

For the transition from useful energy to final energy, the following equipment efficiency indicators are adopted: for gas boilers, water heaters, and stoves, the COP/efficiency is 85%, and for firewood stoves, it is 70 %:

The results of the energy savings and GHG emission reduction calculations are presented in the tables below.

Table 1. By 2030, 30% GHG reduction target

The implementers	Cost, 10^3 euros	Energy conservation/saving, MWh/year			Reduction of CO_2 emissions, t/year	Years of implementation
		Electrical energy	Natural gas	Firewood *		
MP and HH	1,551.06	424.152	898.2	1097.8	416.383	2026-2030

Table 2. By 2050, 40% GHG reduction target

The implementers	Cost, 10^3 euros	Energy conservation/saving, MWh/year			Reduction of CO_2 emissions, t/year	Years of implementation
		Electrical energy	Natural gas	Firewood *		
MP and HH	3,102.12	848.304	1,796.4	2,195.6	832.765	2026-2050

*30% of the specified amount is non-renewable firewood, the GHG emission factor of which is 0.403 t CO_2/MWh, and the remaining 70% is renewable and the GHG emissions are equal to 0.

Measure 9.2.3.8 Installation of solar water heaters in the apartments of the MABs

In the MABs of Akhuryan community, it is possible to install solar water heaters in apartments that are natural gas subscribers (at least those on the top floors). It is estimated that at least 20% of the community's MABs, a total of about 31 apartments (6 apartments per year over 5 years), have the technical capabilities to install and operate solar/gas hybrid water heaters.

It is planned to install combined water heaters with an absorption area of 2.7 m^2 (as 1 stage of sequential heating) in each of the selected apartments. The solar component of the hybrid system will be able to produce up to 800-850 kWh/(m^2·year) of useful thermal energy. As a result of operation, thermal energy and equivalent natural gas savings will amount to:

$$Q = 31 \times 2.7 \times 850/1000 = 71.15 \text{ MWh/year},$$

$$B = 71.15 / 0.85 = 83.7 \text{ MWh/year}.$$

The results of the calculations are summarized in the table below:

The implementers	Cost, 10^3 euros	Energy conservation/saving, MWh/year			Reduction of CO_2 emissions, t/year	Years of implementation
		Natural gas	Firewood	Other		
R2E2, MP and HHs	26.784	83.7	-	-	16.907	2026-2030

Measure 9.2.3.9 Installation of solar water heaters in the private houses

With the same justification as in the event 9.2.3.8, it is planned to install solar water heaters with an absorption surface of 3.0 m^2 in 600 private houses using natural gas every year in the five-year period 2026-2030. In total, 3,000 private houses or 26.2% of the total will participate in the measure implementation. The

annual savings in terms of thermal energy and natural gas (the efficiency of the gas water heater is assumed to be 85%), will be:

$$Q = 3,000 \times 3.0 \times 850/1000 = 5,100.0 \text{ MWh/year},$$

$$B = Q/0.85 = 5,100.0 /0.85 = 6,000.0 \text{ MWh/year (final energy)}$$

The results of the calculations are summarized in the table below.

The implementers	Cost, 10^3 euros	Energy conservation/saving, MWh/year			Reduction of CO_2 emissions, t/year	Years of implementation
		Natural gas	Firewood	Other		
R2E2, MP and HHs	2,592.0	9,000.0	-	-	1,818.0	2026-2030

Measure 9.2.3.10 Installation of photovoltaic systems in private houses

According to **Table 10**, the average specific annual electricity consumption in private houses in Akhuryan community in 2024 is 1,430 kWh/year, i.e. a 1.5 kW peak PV capacity, which would require about 9-12 m^2 of space and produce about 2,250 kWh per year, is on average sufficient for an average private house.

Within the framework of this measure, it is planned to install PV modules with a peak power of 1.5 kW each in private houses to meet the private houses' own electricity demand. The panels can operate with "ENA" CJSC on the "Net metering" principle, as well as with a hybrid system (with the presence of accumulators), according to the regulatory acts of the RA PSRC.

Within the framework of **Target I**, it is assumed that for a capacity of 1.5 kW, at least 20.0% of private houses or 2,287 private houses (an average of 457 houses per year) can have a sun-exposed area on the roof that is not shaded during the entire daylight hours; and within the framework of **Target II**, 40.0 % or 4,575 private houses (an average of 183 houses per year). Under the conditions of Akhuryan, each kW of peak photovoltaic capacity can produce at least 1,500 kWh of electricity per year. Therefore, by the end of the target periods, we can expect:

Target I $Q = 2,287 \times 1.5 \times 1,500/1000 = 5,146.7$ MWh/year,

Target II $Q = 4,575 \times 1.5 \times 1,500/1000 = 10,293.3$ MWh/year.

The results of the energy savings and GHG emission reduction calculations are presented in the tables below.

Table 1. By 2030, 30% GHG reduction target

The implementers	Cost, 10^3 euros	Energy conservation/saving, MWh/year			Reduction of CO_2 emissions, t/year	Years of implementation
		Electrical energy	Natural gas	Other		
MP and HHs	3,293.9	5,146.7	-	-	1,240.343	2026-2030

Table 2. By 2050, 40% GHG reduction target

The implementers	Cost, 10^3 euros	Energy conservation/saving, MWh/year			Reduction of CO_2 emissions, t/year	Years of implementation
		Electrical energy	Natural gas	Other		
MP and HHs	6,587.7	10,293.3	-	-	2,480.685	2026-2050

Measure 9.2.3.11 Use of natural gas in private houses instead of firewood resulting from unsustainable forest management

According to the Covenant's methodological guidelines, 30% of the burned firewood, is estimated to be firewood resulting from unsustainable forest management, which is a non-renewable resource (whose GHG emission factor is assumed to be 0.403 t CO_2/MWh).

Many households in the Akhuryan community, including those that are natural gas subscribers, heat their private houses with firewood.

In the context of this measure, it is proposed that, as a result of expanding gasification in settlements, increasing the number of subscribers, and improving people's well-being, the aforementioned firewood generated as a result of unsustainable management of the forest will be replaced with natural gas.

Heating, hot water supply, and cooking with natural gas are naturally much more convenient than using other fuels (firewood, etc.).

Firewood generated through natural forest growth is considered a renewable resource and the emissions from burning that firewood is zero.

The measure applies only to that firewood, which is considered a non-renewable resource and is used by the population.

According to **Table 26**, the non-renewable, non-sustainable portion of the firewood burned in the base year is 9.0 thousand m^3, or expressed in energy units, it is 22,227.0 MWh/year, the emissions of which are 8,957.5 t CO_2/ year (according to **Table 27**).

It is recommended to undertake consistent work and replace at least 50 % (within **Target I**) and 70 % (within **Target II**) of non-renewable firewood with natural gas, which is quite realistic due to the availability of gasification in the community and the consistent fight against illegal logging of firewood.

Within the framework of **Target I**, if the final energy of non-renewable firewood, 11,113.476 MWh/year (22,227.0 x 50% = 11,113.476, the emission of which is 4,478.731 t CO_2/ year), is used in the form of natural gas, 1,179.775 thousand m^3 of natural gas will be used, from which 2,244.922 t CO_2/ year will be emitted (1,179.775 thousand m^3 x 9.42 kWh/m^3 x 0.202 t CO_2/MWh).

Therefore, replacing the specified amount of non-renewable firewood (by final energy) with natural gas at zero energy savings results in a reduction of 2,233.809 t CO_2/year in GHG emissions [30].

Accordingly, within the framework of **Target II**, if the final energy of non-renewable firewood, 15,558.867 MWh/year (22,227.0 x 70% = 15,558.867, the emission of which is 6,270.223 t CO_2/ year) is used in the form of natural gas, 1,651.684 thousand m^3 of natural gas will be needed, from which only 3,142.891 t CO_2/ year will be emitted (1,651.684 thousand m^3 x 9.42 kWh/m^3 x 0.202 t CO_2/ MWh).

Therefore, replacing the specified amount of non-renewable firewood (by final energy) with natural gas, assuming zero energy savings, results in a reduction of 3,127.332 t CO_2/ year in GHG emissions.

The investment in this measure will be implemented by the residents and will amount to approximately 876.900 thousand euros (within **Target I**) and 1,227.660 thousand euros (within **Target II**). The costs of the participants in this measure (in case of new gasification) are connection to the gas pipeline (or replacement of the in-house gas pipeline) and purchase of gas-consuming equipment: boiler or furnace and water heater, gas stove, etc. According to the analytical calculation, 15.0 % of households (using firewood) in the community, or approximately 438 (within **Target I**) and 21.0 % of households, or approximately 614 (within **Target II**), should participate in the measure, each of which will contribute approximately 2,000 euros.

[30] The calculation is carried out at the final energy level. If recalculated to useful energy, the indicator will increase accordingly, since the efficiency of natural gas-fired equipment (boiler, gas stove, water heater) (85-92%) is higher than the efficiency of a wood-fired stove (65-70%).

The results of the energy savings and GHG emission reduction calculations are presented in the tables below.

Table 1. By 2030, 30% GHG reduction target

The implementers	Cost, 10^3 euros	Energy conservation/saving, MWh/year			Reduction of CO_2 emissions, t/year	Years of implementation
		Firewood	Natural gas	Other		
MP and HHs	876.900	11,113.476	-11,113.476	-	2,233.809	2026-2030

Table 2. By 2050, 40% GHG reduction target

The implementers	Cost, 10^3 euros	Energy conservation/saving, MWh/year			Reduction of CO_2 emissions, t/year	Years of implementation
		Firewood	Natural gas	Other		
MP and HHs	1,227.660	15,558.867	-15,558.867	-	3,127.332	2026-2050

Measure 9.2.3.12 Use of natural gas in private houses instead of coal

In recent years, there has been a noticeable increase in coal use in the community, particularly in private houses. In the base year, coal consumption (mainly anthracite, but also brown coal) in the community's energy balance is about 2.5% or 6,043.6 MWh/year. As is known, coal has the highest emission coefficient (0.354 t CO_2/MWh) among existing fossil fuels, therefore replacing coal use for heating with more environmentally friendly fuels is considered a mitigation measure.

It is recommended to replace coal use with natural gas (emission coefficient: 0.202 t CO_2/MWh). At the same time, natural gas is much more convenient for heating, hot water supply and cooking than coal.

According to **Table 26**, the coal burned in the base year is 0.817 thousand tons, or 6,043.6 MWh/year, the emissions of which are 2,139.4 tons of CO_2/year, or 4.62% (according to **Table 27**).

It is recommended to consistently reduce coal consumption by at least 40% (within **Target I**) and 80% (within **Target II**) and replace it with natural gas, which is quite realistic due to the availability of gasification in the community.

Within **Target I**, replacing 3,021.790 MWh/year of coal (6,043.6 x 50% = 3,021.790, the emission of which is 1,069.714 t CO_2/year) with natural gas will require 320.785 thousand m^3 of natural gas, from which 610.402 t CO_2/year will be emitted (320.785 thousand m^3 x 9.42 kWh/m^3 x 0.202 t CO_2/MWh).

Therefore, replacing the specified amount of coal (by final energy) with natural gas results in a reduction of 459.312 t CO_2/year in GHG emissions even at zero energy savings[31].

Accordingly, within the framework of **Target II**, if the final energy of 4,834.864 MWh/year of coal (6,043.6 x 80% = 4,834.864, the emission of which is 1,711.542 t CO_2/year) is used in the form of natural gas, 513.255 thousand m^3 of natural gas will be required, from which 976.643 t CO_2/year will be emitted (513.255 thousand m^3 x 9.42 kWh/m^3 x 0.202 t CO_2/MWh).

Therefore, replacing the specified amount of coal (by final energy) with natural gas results in a reduction of 734.899 t CO_2/year in GHG emissions at zero energy savings.

The investment in this measure will be implemented by residents and will amount to about 408.0 thousand euros (within the framework of **Target I**) and 652.8 thousand euros (within the framework of **Target II**). The costs of the participants in this measure are (in the case of new gasification): connection to the gas pipeline (or replacement of the in-house gas pipeline) and purchase of gas-consuming equipment: boiler or

[31] The calculation is carried out at the final energy level. If recalculated to useful energy, the indicator will increase accordingly, since the efficiency of natural gas-fired equipment (boiler, gas stove, water heater) (85-92%) is higher than the efficiency of a coal-fired stove (70-80 %).

furnace and water heater, gas stove, etc. According to the analytical calculation, 50.0% of households using coal in the community, or about 204 (within the framework of **Target I**) and 80.0% of households, or about 326 (within the framework of **Target II**), should participate in the measure, investment for each of them is about 2,000 euros.

The results of the energy savings and GHG emission reduction calculations are presented in the tables below.

Table 1. By 2030, 30% GHG reduction target

The implementers	Cost, 10^3 euros	Energy conservation/saving, MWh/year			Reduction of CO_2 emissions, t/year	Years of implementation
		Coal	Natural gas	Other		
MP and HH	408.0	3,021.790	- 3,021.790	-	459.312	2026-2030

Table 2. By 2050, 40% GHG reduction target

The implementers	Cost, 10^3 euros	Energy conservation/saving, MWh/year			Reduction of CO_2 emissions, t/year	Years of implementation
		Coal	Natural gas	Other		
MP and HH	652.8	4,834.864	- 4,834.864	-	734.899	2026-2050

The considered option is the most realistic, but the results of the measure would be much better if the use of coal were replaced with an equivalent amount of renewable energy (solar photovoltaic, biomass - renewable firewood, manure, etc.) according to the recommendation of the community energy manager and available opportunities.

Note. As a result of the implementation of the proposed measures **9.2.3.11 and 9.2.3.12**, one fossil fuel is replaced by another, more environmentally friendly fuel, the energy-neutral result ensures a significant reduction in GHG emissions. The presented proposals are assessed as the most realistic in the current conditions.

In terms of social problems and investment reduction, it should be noted that many households, already being natural gas subscribers (therefore, connection costs are not required), prefer the use of non-renewable firewood (illegal logging, etc.) or coal (seemingly/supposed low price). At the same time, to organize natural gas heating, it is also possible to implement much more affordable stove heating instead of water-circulation heating (many have stoves but do not use them).

Naturally, the use of renewable energy (solar photovoltaic, wind, biomass, renewable firewood, manure, local production of biofuels from agricultural residues, etc.) instead of natural gas is undoubtedly more appropriate.

Therefore, below are also presented (for future energy managers and decision-makers of the community) options where non-renewable firewood or coal is replaced by renewable energy and provide the same results in reducing GHG emissions.

Measure 9.2.3.11 Use of renewable energy sources in private houses instead of firewood generated by unsustainable forest management

*According to **Table 26**, the non-renewable, non-sustainable part of the firewood burned in the base year is 9.0 thousand m^3, or expressed in energy units, it is 22,227.0 MWh/year, the emissions of which are 8,957.5 t CO^2/year (according to **Table 27**).*

*It is recommended to undertake consistent work and replace at least 25% (within **Target I**) and 35% (within **Target II**) of non-renewable firewood with renewable energy sources.*

*Within the framework of **Target I**, if the final energy of non-renewable firewood, 5,542.950 MWh/year (22,227.0 x 25% = 5,542.950, the emission of which is 2,233.809 t CO_2/year), is used in the form of renewable energy sources, 5,542.950 MWh/year will be required, but 0 t CO_2/year will be emitted.*

Therefore, replacing the specified amount of non-renewable firewood (by final energy) with renewable energy sources results in a reduction of 2,233.809 t CO2/year in GHG emissions even under zero energy savings.

*Accordingly, within the framework of **Target II**, if the final energy of 7,760.130 MWh/year (22,227.0 x 35% = 7,760.130, the emission of which is 3,127.332 t CO_2/year) of non-renewable firewood is used in the form of renewable energy sources, 7,760.130 MWh/year will be saved, but 0 t CO_2/year will be emitted.*

Therefore, replacing the specified amount of non-renewable firewood (by final energy) with renewable energy sources results in a reduction of 3,127.332 t CO_2/year in GHG emissions even under zero energy savings.

*According to calculations, 6.0% of households (using firewood) in the community, or about 175 (within **Target I**) and 8.4% of households, or about 245 (within **Target II**), should participate in the event.*

Measure 9.2.3.12 Use of renewable energy sources instead of coal in private houses

*According to **Table 26**, the coal burned in the base year is 0.817 thousand tons, or 6,043.580 MWh/year, the emissions of which are 2,139.427 tons of CO_2/year (according to **Table 27**).*

*It is recommended to consistently reduce coal consumption by at least 21% (within **Target I**) and 34% (within **Target II**) by replacing it with renewable energy sources.*

*Within **Target I**, replacing 3,568.295 MWh/year of coal (6,043.580 x 21% = 1,297.492, the emission of which is 459.312 t CO_2/year) with renewable energy sources will require 3,568.295 MWh/year, from which 0 t CO_2/year will be emitted.*

Therefore, replacing the specified amount of coal (by final energy) with renewable energy sources results in a reduction of 459.312 t CO_2/year in GHG emissions even under zero energy savings.

*Accordingly, within the framework of **Target II**, if the final energy of 2,075.987 MWh/year of coal (6,043.580 x 34% = 2,075.987, the emission of which is 734.899 t CO_2/year) is used in the form of renewable energy sources, 2,075.987 MWh/year will be required, but 0 t CO_2/year will be emitted.*

Therefore, replacing the specified amount of coal (in terms of final energy) with renewable energy sources results in a reduction of 734.899 t CO_2/year in GHG emissions even under zero energy savings.

*According to calculations, 21.5% of households (using coal) in the community, or about 88 (within **Target I**) and 34.4% of households, or about 140 (within **Target II**), should participate in the event.*

Measure 9.2.3.13 Implementation of photovoltaic lighting in common areas of MABs

Lighting of common areas of MABs, such as courtyards, front entrance, stairwells /staircases, stairways/, etc., with PV converters is economically feasible and realistic. In the climatic conditions of the community, about 1,500 kWh of electricity can be expected to be produced annually from 1 kW of peak power. A system of PV installations with a peak power of 1 kW each can be envisaged for 9 of the 13 community MABs (30% of the total), which will be capable of producing the following amount of electricity annually:

$$E = 9 \times 0.25 \times 4 \times 1{,}500/10^3 = 13.5 \text{ MWh/year.}$$

The implementers	Cost, 10^3 euros	Energy conservation/saving, MWh/year		Reduction of CO_2 emissions, t/year	Years of implementation
		Electrical energy	Natural gas		
MP, R2E2, HH	8.55	13.5	-	3.254	2026-2030

9.2.4 Measures in the transport sector

According to the 2024 BIE of the Akhuryan community, the transport sector is the 2nd largest consumer of energy (31.9 %) and the 2nd largest source of GHG emissions (37.2 %).

In the transport sector of Akhuryan community, GHG emissions were calculated in three subsectors: municipal vehicles (share of energy consumption in transport 0.6 %), public transport (3.0 %) and private and commercial (96.4 %) transport.

Vehicles operating in the community run on the following fuels: CNG (share of energy consumption in transport: 58.3 %), gasoline (18.2 %), diesel fuel (14.8 %) and LPG (8.7%). Mitigation measures have been considered in all three subsectors.

Five-Year Development Program of Akhuryan Community of Shirak Region of the Republic of Armenia 2022-2026 (Approved by the Resolution of the Council of Elders of Akhuryan Community of Shirak Region of the Republic of Armenia N 218-A dated 17.11. 2022), it is planned to implement works that will contribute to the reduction of GHG emissions in the transport sector:

- Programs implemented by the state and in cooperation with international organizations in the administrative territory of the community
- Renovation of relevant sections of the Gyumri - Kaps - Amasia (M-1) national highway
- Renovation of sections of the Shirak-Kamo regional highway
- Major renovation of the road leading to the Marmashen Monastery Complex and improvement of the adjacent area
- Major renovation of the Gyumri – Hatsik-Karmrakar (S-7-45) highway section
- Internal roads of the community, in the case of the majority of settlements, need repair/maintenance, asphalting.

The transition of gasoline-powered vehicles to CNG was not considered as a measure. The measures mainly concern the replacement of existing fossil-fuel passenger cars with electric vehicles.

To encourage the use of electric vehicles, certain incentive actions should be taken by the Akhuryan Municipality, in collaboration with relevant stakeholders and partners:

- Organization of preferential (free) parking spaces for electric vehicles in central parts of the city.
- Construction of community charging stations for electric vehicles, or provision of suitable preferential terms for private charging stations.
- Make the construction of electric vehicle charging stations a prerequisite for issuing construction permits, etc.

A modern electric car consumes about 12-16 kWh of electricity per 100 km. Taking into account the complex terrain, weather conditions and other factors (service life, etc.) that affect the energy consumption of electric vehicles, the calculations assume a value of 20-25 kWh/100 km for passenger cars, and 30-40 kWh/100 km for minibuses and buses.

Below is an example of replacing an average fossil fuel (CNG) car with an electric car [32].
A passenger car with an internal combustion engine (ICE) consumes an average of 10 m^3 of CNG (or 7.2 kg of CNG or about 94.2 kWh of energy) or an equivalent amount of other fossil fuels per 100 km, while an electric car consumes about 20.0 kWh of electricity per 100 km, or 94.2 kWh /20.0 kWh = 4.71 times less final energy.

The final energy savings and CO2 emission reductions of an CNG-powered vehicle with an average annual mileage of 10,000 km can be calculated as follows:

$$E=[1{,}000(m^3/\text{year}) \times 9.42(\text{kWh}/m^3) - 10{,}000(\text{km}) \times 20(\text{kWh}/100\ \text{km})/100]/1000 = 7{,}420\ \text{kWh/year}$$

$$E = 9.420\ \text{MWh/year} - 2.000\ \text{MWh/year} = 7.420\ \text{MWh/year (or 78.8 \%)}$$

and reduction of CO_2 emissions will be:

$$F = [9{,}420(\text{kWh}) \times 0.202(\text{kg } CO_2/\text{ kWh}) - 2{,}000(\text{kWh}) \times 0.241(\text{kg } CO_2/\text{ kWh})]/1000 = 1.421\ \text{t/year}$$

$$F = 1{,}902.8\ \text{kg } CO_2/\text{year} - 482.0\ \text{kg } CO_2/\text{year} = 1{,}420.8\ \text{kg } CO_2/\text{ year (or 74.7 \%, or 3.95 times)}$$

Therefore, the implementation of these measures is very effective in terms of reducing GHG emissions, and at the same time very profitable from a financial perspective.

[32] This calculation (also for other fossil fuels) will be used in the evaluation of all transport sector measures.

Measure 9.2.4.1 Partial replacement of municipal passenger vehicles with electric passenger vehicles

Taking into account the factor of reducing the prices of electric vehicles and making them more accessible, within the framework of this measure, it is envisaged to replace municipal passenger cars with electric vehicles within the framework of two targets.

According to the presented data, municipal passenger cars run on CNG and gasoline and have an annual mileage of 12-20 thousand km. Taking into account the existing privileges for the import of electric vehicles, as well as their favourable impact on the environment, it is envisaged within the framework of this measure:

Within the framework of **Target I**, from 2026 to 2030 (in 5 years), 2 gasoline-powered and 3 CNG-powered passenger cars under municipal jurisdiction will be replaced with electric vehicles (electromobiles-EM) (one vehicle per year). The cost of a light passenger car is estimated at up to 20,000 euros.

Table 1. By 2030, 30% GHG reduction target

Fuel	km/year	l/100 km, m^3/100 km	kWh/ 100km	l/year, m^3/year	kWh/l, kWh /m^3	MWh/year	$kgCO_2$/kWh	tCO_2/year
Gasoline (2 cars)	40,000	13		5,200.0	9.2	47.8	0.249	11.91
CNG (3 cars)	36,000	20		4,320.0	9.42	40.7	0.202	8.22
Total (5 cars)	76,000					88.5		20.13
EM (5 cars)	76,000		25			19.0	0.241	4.58
Savings (5 cars)						69.5		15.55

Within the framework of **Target II**, from 2026 to 2040 (in 15 years), 2 gasoline-powered and 13 CNG-powered passenger cars under municipal jurisdiction will be replaced with electric vehicles (one vehicle per year). The vehicle values are estimated to be the same.

Table 2. By 2050, 40% GHG reduction target

Fuel	km/year	l/100 km, m^3/100 km	kWh/ 100km	l/year, m^3/year	kWh/l, kWh /m^3	MWh/year	$kgCO_2$/kWh	tCO_2/year
Gasoline (2 cars)	40,000	13		5,200.0	9.2	74.8	0.249	11.91
CNG (13 cars)	156,000	20		18,720.0	9.42	176.3	0.202	35.62
Total (15 cars)	196,000					224.2		47.53
EM (15 cars)	196,000		25			49.0	0.241	11.81
Savings (15 cars)						175.2		35.72

The results of the calculation of Energy Savings and CO_2 Emissions Reduction as a result of the implementation of the measure are presented in the tables below.

Table 1. By 2030, 30% GHG reduction target

The implementers	Cost, 10^3 euros	Energy conservation/saving, MWh/year					Reduction of CO_2 emissions, t/year	Years of implementation
		Electrical energy	CNG	Gasoline	Diesel fuel	LPG		
MP	100.0	- 19.0	40.7	47.8	-	-	15.553	2026-2030

Table 2. By 2050, 40% GHG reduction target

The implementers	Cost, 10^3 euros	Energy conservation/saving, MWh/year					Reduction of CO_2 emissions, t/year	Years of implementation
		Electrical energy	CNG	Gasoline	Diesel fuel	LPG		
MP	220.0	-49.0	176.3	47.8	-	-	35.724	2026-2040

Measure 9.2.4.2 Partial replacement of minibuses and taxis in public transport with electric vehicles

The use of electric vehicles in public transport should be encouraged through the implementation of the above-mentioned incentive actions. Investments in the measure are made by route operators, private companies, and individuals, which is a good example of private-community cooperation.

Within the framework of **Target I**, it is proposed to consider 9 replacing 9 intra-community and inter-city (medium capacity) minibuses with electric small vehicles of the same capacity (about 32% of the transport operating in the base year) and their operation on the corresponding routes, over a period of five years (about 2 units per year). The new minibuses will replace vehicles operating on CNG, and at least 18 intra-community and city taxis operating on gas fuel (CNG and LPG) will also be replaced with electric vehicles (about 30 % of the vehicles operating in 2024, or 3-4 units per year).

Within the framework of **Target II**, it is proposed to consider and encourage the replacement of 14 minibuses (about 50%) and 30 taxis (about 50%) with electric equivalent vehicles.

The results of the calculation of the expected energy savings and CO_2 emission reductions in public transport as a result of the implementation of the measure are presented in the tables below.

Table 1. By 2030, 30% GHG reduction target

The implementers	Cost, 10^3 euros	Energy conservation/saving, MWh/year					Reduction of CO_2 emissions, t/year	Years of implementation
		Electrical energy	CNG	Gasoline	Diesel fuel	LPG		
MP, entities	630.0	- 206.55	617.20	-	-	110.38	99.95	2026-2030

Table 2. By 2050, 40% GHG reduction target

The implementers	Cost, 10^3 euros	Energy conservation/saving, MWh/year					Reduction of CO_2 emissions, t/year	Years of implementation
		Electrical energy	CNG	Gasoline	Diesel fuel	LPG		
MP, entities	1020	- 243.30	973.65	-	-	183.96	179.80	2026-2050

Measure 9.2.4.3 Partial replacement of private and commercial passenger transport vehicles with electric vehicles

The dynamics of imports of electric vehicles in Armenia during 2018-2022 demonstrate their demand. If in 2020 354 vehicles were imported (in 2018: 5, in 2019: 149), then in 2022 3,833 purely electric vehicles were imported, and in 2024 the quota for import of 8,000 units at 0% customs duty by the decision of the Eurasian Economic Commission (EEC) Council and excluding VAT was consumed/ exhausted. The import of plug-in hybrid vehicles is also large.

Taking into account the factor of reducing the prices of electric vehicles and making them more affordable for the population and commercial organizations, within the framework of **Target I** of this measure, it is envisaged that by 2030, about 15% of the existing car fleet will be updated by private and commercial entities of the community and old cars will be replaced: 1,816 cars or about 302 cars per year (for 2026-2030), and within the framework of **Target II** - by 2050 - 18% cars or 1,816 cars or 73 cars per year (during 2026-2050).

The replacement of passenger cars (powered by CNG, LPG, gasoline, and diesel) with equivalent electric vehicles is being considered.

Calculations were made based on the indicators given in **Table 23:**

Before the measure **(Target I)**

Fuel	Quantity, pcs	Mileage, km/car	l or m^3/ 100 km	10^3 l, 10^3 m^3/ year	MWh/ year	t CO_2/ year
CNG	946	6,000	10	567.5	5,345.9	1079.9
Gasoline	345	5,000	10	172.4	1,586.2	395.0
LPG	126	6,000	15	113.5	828.6	188.1
Diesel fuel	97	5,000	11	53.1	531.3	141.9
Total	1,513				8,292.0	1,804.8

After the measure **(Target I)**

Fuel	Quantity, pcs	Mileage, km/car	kWh/ 100 km	kWh/ year	MWh/ year	t CO_2/ year
El. energy	946	6,000	20	1,135,008	1,135.0	273.5
El. energy	345	5,000	20	344,820	344.8	83.1
El. energy	126	6,000	20	151,344	151.3	36.5
El. energy	97	5,000	20	96,600	96.6	23.3
Total	1,513				1,727.8	416.4

Before the measure **(Target II)**

Fuel	Quantity, pcs	Mileage, km/car	l or m^3/ 100 km	10^3 l, 10^3 m^3/ year	MWh/ year	t CO_2/ year
CNG	1,135	6,000	10	681.0	6,415.1	1,295.8
Gasoline	414	5,000	10	206.9	1,903.4	473.9
LPG	151	6,000	15	136.2	994.3	225.7
Diesel fuel	116	5,000	11	63.8	637.6	170.2
Total	1,816				9,950.4	2,165.7

After the measure **(Target II)**

Fuel	Quantity, pcs	Mileage, km/car	kWh/ 100 km	kWh/ year	MWh/ year	t CO_2/ year
El. energy	1,135	6,000	20	1,362,010	1,362.0	328.2
El. energy	414	5,000	20	413,784	413.8	99.7
El. energy	151	6,000	20	181,613	181.6	43.8
El. energy	116	5,000	20	115,920	115.9	27.9
Total	1,816				2,073.3	499.7

The share of private and commercial transport in the total is large, therefore, to ensure the implementation of this measure, the municipality must carry out consistent work among the population and business people.

The results of the calculation of the expected energy savings and CO_2 emission reductions in public transport as a result of the implementation of the measure are presented in the tables below.

Table 1. By 2030, 30% GHG reduction target

The implementers	Cost, 10^3 euros	Energy conservation/saving, MWh/year					Reduction of CO_2 emissions, t/year	Years of implementation
		Electrical energy	CNG	Gasoline	Diesel fuel	LPG		
MP, entities	30,260	- 1,727.8	5,345.9	1,586.2	531.3	828.6	1,388.384	2026-2030

Table 2. By 2050, 40% GHG reduction target

The implementers	Cost, 10^3 euros	Energy conservation/saving, MWh/year					Reduction of CO_2 emissions, t/year	Years of implementation
		Electrical energy	CNG	Gasoline	Diesel fuel	LPG		
MP, entities	36,320	- 2,073.3	6,415.1	1,903.4	637.6	994.3	1,666.061	2026-2050

As can be seen from the above calculations, replacing a fossil fuel-powered vehicle with an equivalent electric vehicle, depending on many factors, can provide an average reduction in GHG emissions of about 75% (or 2-3 t CO_2/year), while ensuring a significant reduction in fuel consumption and financial feasibility.

Measure 9.2.4.4 Asphalting, improvement of community streets, installation and marking of traffic signs and information boards

As stated in the five-year development plan of the Akhuryan community, one of the main common problems facing the community is the implementation of improvement and asphalting works on intra-community roads. The existing poor and dilapidated roads in the community are inconvenient and dangerous for pedestrians and vehicles. More than 1,000.0 million drams have been allocated from various financial sources for the capital renovation of intra-community roads.

Thanks to the repair and asphalting works, the operating modes of motor transport will be improved and the duration of idling modes of vehicles will be reduced, the probability of operating with low gear ratios and, consequently, driving with excessive fuel consumption will decrease, etc.

It is practically impossible to quantify the expected energy savings as a result of the implementation of the measure. However, it is estimated that about 60% of the annual energy consumption of the community's vehicle fleet falls on the repaired roads and as a result, fuel consumption is reduced by about 5.0%. The results are applicable to both targets. The amount of fuel savings according to the base year statistics is given below and in the table.

- In gasoline-powered vehicles: $\Delta E = 0.05 \times 14{,}179.3 \times 0.6 = 425.4$ MWh/year,
- In diesel-powered vehicles: $\Delta E = 0.05 \times 11{,}474.3 \times 0.6 = 344.2$ MWh/year,
- In CNG-powered vehicles: $\Delta E = 0.05 \times 45{,}297.8 \times 0.6 = 1{,}358.9$ MWh/year,
- In LPG-powered vehicles: $\Delta E = 0.05 \times 6{,}798.5 \times 0.6 = 204.0$ MWh/year.

The implementer	Cost, 10^3 euros	Energy conservation/saving, MWh/year					Reduction of CO_2 emissions, t/year	Years of implementation
		Electrical energy	CNG	Gasoline	Diesel fuel	LPG		
MP	2,242.4	0	1,358.9	425.4	344.2	204.0	518.631	2026-2028

Measure 9.2.4.5 Creating cycling infrastructure

Cycling infrastructure (cycling paths, bicycle parking lots, etc.) does not require particularly large investments. It is important to choose the right bicycle parking lots that will make cycling for business or personal purposes attractive. They should be created near large shopping centers, universities, budgetary and administrative institutions, and service facilities, within the field of view of municipal transport surveillance cameras.

Quantifying the effectiveness of the measure is a rather complex task. The program tentatively assumes that fuel efficiency will be expressed as a reduction of approximately 1.0% of total annual consumption:

- In gasoline-powered vehicles: $\Delta E = 0.01 \times 14{,}179.3 = 141.8$ MWh/year,
- In diesel-powered vehicles: $\Delta E = 0.01 \times 11{,}474.3 = 114.7$ MWh/year,
- In CNG-powered vehicles: $\Delta E = 0.01x\ 45{,}297.8 = 453.0$ MWh/year,
- In LPG-powered vehicles: $\Delta E = 0.01 \times 6{,}798.5 = 68.0$ MWh/year.

The implementation of the measure will also be facilitated by cycling races that have recently become more popular in Armenia.

The implementer	Cost, 10^3 euros	Energy conservation/saving, MWh/year					Reduction of CO_2 emissions, t/year	Years of implementation
		Electrical energy	CNG	Gasoline	Diesel fuel	LPG		
MP	30.0	0	453.0	141.8	114.7	68.0	172.877	2026-2029

9.2.5 Measures in the street lighting system

According to the 2022-2026 five-year development plan for the Akhuryan community of the Shirak region of the Republic of Armenia, the immediate goals of the community's development are:

- to have well-maintained and well-lit roads and streets within the settlement,
- expansion of the lighting network in settlements and addition of night lighting fixtures,
- repair and improvement of inter-settlement and intra-settlement roads and streets and the installation, expansion, enlargement and maintenance of outdoor lighting systems (funding source mainly from the community budget).

Measure 9.2.5.1. Replacing incandescent lamps with LED lamps

In Akhuryan community, street lighting in 2022-2024 is implemented using LED, but about 2,656 incandescent lamps (average power 91 W) are still in operation on the streets. Replacing them with 30 W (average) LED lamps can significantly reduce annual electricity consumption and at the same time increase lighting comfort by about 2 times.

It is assumed that all existing low-efficiency luminaires are replaced with 30 W LED luminaires and the operating modes of 2024 are maintained. Under these conditions, the annual electricity savings in the system will be determined as follows:

$$\Delta E = 1{,}709 \times 2656 \times (91-30)/10^6 = 276.885 \text{ MWh/year}$$

The implementers	Cost, 10^3 euros	Energy conservation/saving, MWh/year		Reduction of CO_2 emissions, t/year	Years of implementation
		Electrical energy	Natural gas		
MP, R2E2	11.91	276.885	-	66.729	2026-2028

Measure 9.2.5.2. Expansion of the outdoor lighting network in the community

The five-year development program of the Akhuryan community envisages further expansion of the street lighting network and Increasing night lighting with high-efficiency LED lights.

According to the information provided, in the base year, only 4,677 luminaires are operated in the community, of which 2,021 (64 W average power) are LED luminaires. It is assumed that LED luminaires will increase by 20% or 936 (current average power). The installation of LED luminaires is planned for 2026-2028 period, also in place of missing luminaires. New luminaires do not replace inefficient lamps, but are installed additionally. The results of the effectiveness of the measure are presented in tabular form.

The implementers	Cost, 10^3 euros	Energy conservation/saving, MWh/year		Reduction of CO_2 emissions, t/year	Years of implementation
		Electrical energy	Natural gas		
MP, R2E2	4.68	-102.376	-	-24.673	2026-2030

The implementation of this measure will greatly contribute to the fulfilment of the community's commitments under the five-year plan, in particular, to the expansion of outdoor lighting systems and the expansion of the night lighting network, despite the negative impact in terms of reducing GHG emissions.

Measure 9.2.5.3. Construction of an autonomous PV station powering the street lighting system of the city of Akhuryan

The use of solar power is considered as a reliable and promising solution for the street lighting network. It is assumed that the installation of a PV plant will reduce the amount of electricity purchased from the distribution network and mitigate the impact of GHG emissions on the climate.

The installed electrical capacity of the Akhuryan external street lighting network in 2024 was about 120.4 kW, the annual consumption of electrical energy was 216.7 MWh/year. Taking into account the prospects for network expansion in the coming years, it is assumed that the total installed capacity of PV installations can be envisaged at 150 kW (equipped with storage batteries). In case of excess electricity produced, it is proposed to direct it to electric vehicle charging stations. Maintaining the mode indicators of the baseline year of the lighting system, the expected annual savings values are presented in the table below.

The implementers	Cost, 10^3 euros	Energy conservation/saving, MWh/year		Reduction of CO_2 emissions, t/year	Years of implementation
		Electrical energy	Natural gas		
MP, R2E2	127.5	225.0	-	54.225	2026-2030

Measure 9.2.5.4. Construction of autonomous PV stations powering street lighting systems in rural areas of the community

Taking into account the continuous improvement of street lighting systems in rural areas, it is advisable to build autonomous PV power plants that power street lighting systems.

The installed electrical capacity of the lighting networks in 2024 amounted to about 252.0 kW, the annual consumption of electrical energy was 419.5 MWh/year. Taking into account the prospects for the expansion of the network in the near future, it is assumed that the installed total capacity of the PV plant should be 280 kW (equipped with storage batteries). In case of excess electricity produced, it is proposed to direct it to electric vehicle charging stations.

The number and locations of autonomous solar power plants will be determined based on the logic of ensuring their most efficient operation. The implementation of the measure will allow to zero out GHG emissions from street lighting in rural settlements of the community by 2030. The implementation of the measures will require an investment of about 238.0 thousand euros and a total area of about 2,000 m^2.

The administrative heads of the community and rural settlements are responsible for implementation of the proposed measure.

The results of the calculation of renewable energy production and GHG emission reduction are presented in the table below.

The implementers	Cost, 10^3 euros	Energy conservation/saving, MWh/year		Reduction of CO_2 emissions, t/year	Years of implementation
		Electrical energy	Natural gas		
MP, R2E2	252.0	420.0	-	101.220	2026-2030

9.2.6 Development of green spaces

The five-year development plan of the Akhuryan community envisages increasing green areas in all settlements, creating a necessary and attractive environment for recreation and tourism, and sustainable development of green agriculture and innovative tourism.

It is often difficult to provide quantitative assessments of environmental effectiveness within the scope of this section; however, such assessments have been made based on expert assessments, with certain reservations, which are not included in the summary table of the two measures of SECAP (for main Target II and intermediate Target I), but can be calculated and taken into account when assessing SECAP performance.

The environmental effectiveness of the measures is aimed at mitigating the negative impact of global warming on the climate.

Measure 9.2.6.1 Expansion of forested areas

Depending on the tree species, each hectare of forested area absorbs about 120-280 kg of carbon dioxide (on average 200 kg) from the atmospheric air during one sunny day and releases 180-200 kg of oxygen. A significant part of the total area of the community is of agricultural importance. It is possible to envisage an increase in forest cover of 0.7 ha per year, starting from 2026 until the end of the target year.

CO2 absorption, which is equivalent to the same amount of GHG emissions reduction, will be equal to:

$$M_{CO2} = 0.7 \times 5 \times 200 \times 250 = 175.0 \text{ t } CO_2\text{/year (Target I) and}$$

$$M_{CO2} = 0.7 \times 25 \times 200 \times 250 = 875.0 \text{ t } CO_2\text{/year (Target II)}$$

Green space development measures will contribute to the development of tourism based on the historical and cultural monuments of the Akhuryan community, which have been repeatedly mentioned in the five-year community development plan.

Measure 9.2.6.2 Expansion of green areas

According to reliable sources, urban green lawns are able not only to clean the air from dust, but also absorb carbon dioxide during the day, producing oxygen. Moreover, 1 acre of green lawn can provide 11-12 kg of CO2 absorption per year. Thus, thanks to 1 ha of green lawn, 1.1-1.2 tons of CO2 absorption can be achieved annually, which is equivalent to the same amount of GHG emissions reduction.

It is proposed to restore and expand at least 100 acres of green areas every year until 2050.

In that case, over a 5-year period, we can expect about 6 tons of CO_2 absorption in the years following the baseline year, and over a 25-year period, about 30 tons.

Chapter 10. Summary of measures to reduce GHG emissions

Within the framework of the Akhuryan Community SECAP, the list of measures aimed at reducing GHG emissions by the community authorities by 2050 (also by 2030) includes costly/cost-intensive and non-costly/non-cost-intensive measures. The implementation of 29 measures of the first group will allow reducing baseline emissions by **18,662.76 t** CO_2/year in 2050 (also in 2030), (**14,008.82 t CO_2/year** in the case of 2030), which is 0.73% (0.81%) higher than the commitments undertaken[33].

Thus, investments totalling approximately **59.2 million Euros** (**46.6 million Euros** in 2030) can ensure the fulfilment of the quantitative commitments undertaken by the community within the framework of the Covenant, namely the reduction of the volume of BIE registered in the baseline year by at least 40% (30%).

The tables below present GHG emissions in the main sectors included in the BIE, both in the baseline (2024) and target years 2050 (2030).

Table 28. GHG emissions in 2024 and 2050 by target sectors

	Greenhouse gas emissions, t CO_2/year					
	Municipal buildings	**Residential sector**	**Transport**	**Street Lighting**	**Local energy production**	**Total**
BIE, 2024	417.6	28,461.0	17,287.7	153.3	0	46,319.64
Reductions as a result of measures	218.64	15,456.62	2,573.09	197.50	216.90	18,662.76
	1.17%	82.82%	13.79%	1.06%	1.16%	100.00%
Emissions in the target year: 2050	198.9	13,004.4	14714.6	-44.2	-216.9	27,656.9
Reduction, %	52.36%	54.31%	14.88%	128.81%		40.29%

Table 29 GHG emissions in 2024 and 2030 by target sectors

	Greenhouse gas emissions, t CO2/year					
	Municipal buildings	**Residential sector**	**Transport**	**Street Lighting**	**Local energy production**	**Total**
BIE, 2024	417.6	28461.0	17287.7	153.3	0	46,319.64
Reductions as a result of measures	218.64	11,180.38	2,195.40	197.50	216.90	14,008.82
	1.56%	79.81%	15.67%	1.41%	1.55%	100.00%
Emissions in the target year: 2030	198.9	17,280.7	15092.3	-44.2	-216.9	32,310.8
Reduction, %	52.36%	39.28%	12.70%	128.81%		30.24%

The largest share of GHG emission reductions is naturally envisaged to come from the residential sector: 82.82 %- of the total CO_2 reductions in the community (Target I: 79.81%), then from transport: 13.79 % (Target I: 15.67%), the total share of reductions in the community/municipal buildings, street lighting and local energy production sectors is 3.39% (Target I: 4.52%).

GHG emission reductions in the Street Lighting and Local Energy Production sectors also take into account the increase in electricity demand for intra-community purposes: expansion of lighting systems, construction of community charging stations for electric vehicles, etc.

The ratios of energy savings and GHG emission reductions (**Target II: 2050)** by consumption sectors and energy carriers are presented in **Charts 25 and 27** (%, in MWh), **26 and 28** (%, in t CO_2).

[33] The summary table does not include "soft" measures and Green Space Development measures.

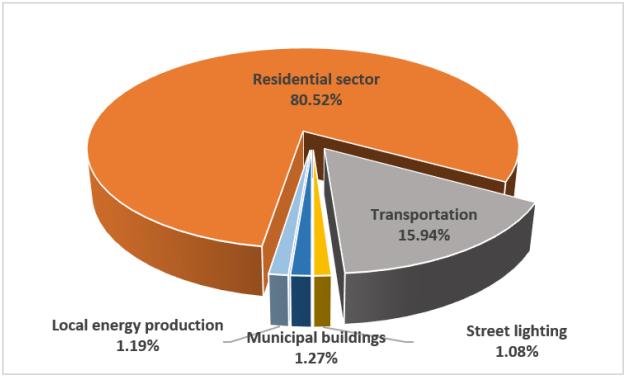


Chart 25. Structure of energy savings by sector (Target II: 2050)

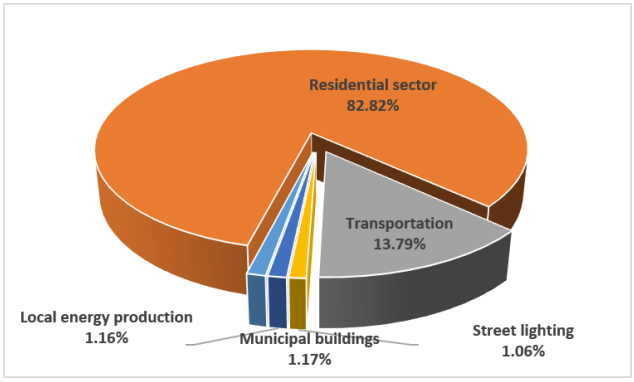


Chart 26. Structure of GHG emission reductions by sector (Target II: 2050)

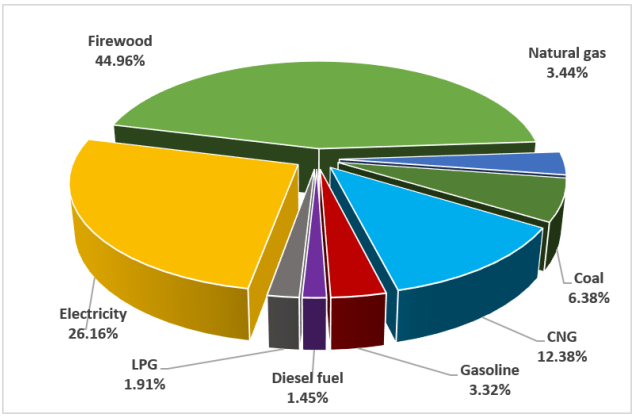


Chart 27. Structure of energy savings by type (Target II: 2050)

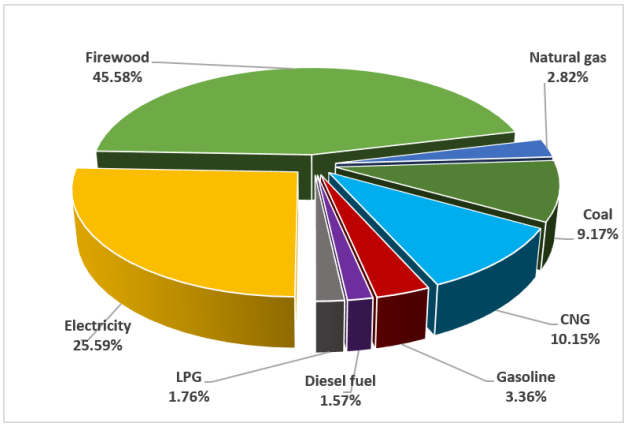


Chart 28 Structure of GHG emission reductions by energy carrier (Target II: 2050)

The largest sector for energy savings is naturally the population (80.52% of the projected reduction), then transport (15.94%). The same applies to the reduction of GHG emissions, 82.82% and 13.79%, respectively.

By energy carriers, the largest savings are expected from firewood resulting from unsustainable forest management: 44.96 %, electricity: 26.16 %, CNG: 12.38 %, coal: 6.38 %, natural gas: 3.34 %, the total share of LPG, diesel fuel and gasoline is 6.69 %.

The largest reduction in GHG emissions from energy/fuel combustion is expected from firewood resulting from unsustainable forest management: 45. 58 %, electricity: 25.59 %, CNG: 10.15 %, coal: 9.17 %, natural gas: 2.82 %, the total share of LPG, diesel fuel and gasoline is 6.69 %.

A comparison of GHG emissions by sector and energy carrier in the base (2024) and target (2050) years is presented in **Charts 29 and 30.**

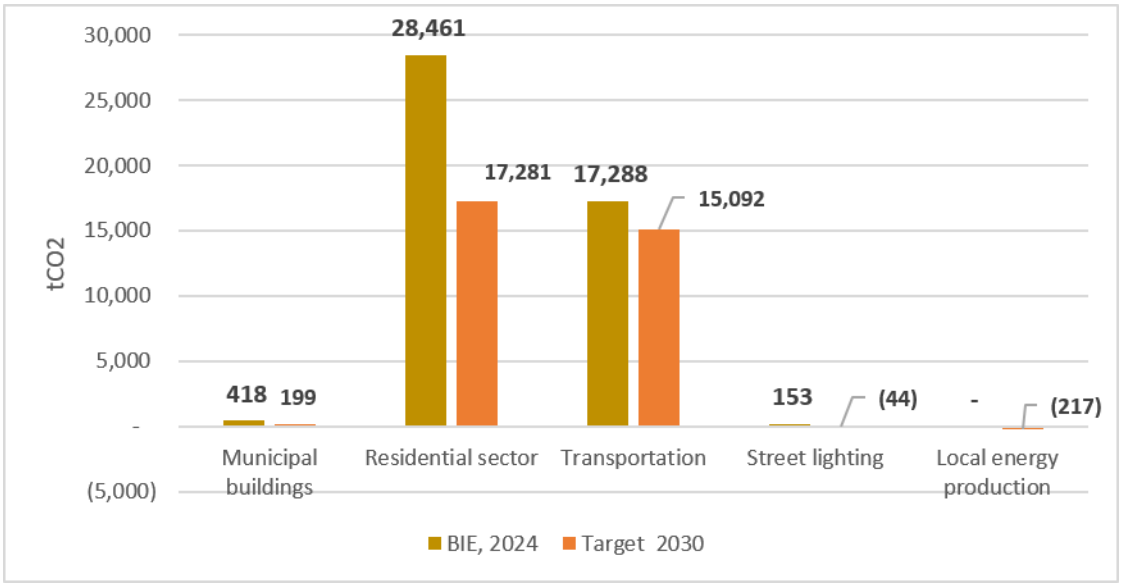


Chart 29. Comparison of baseline and target (2050) emissions by sector (tCO2/year)

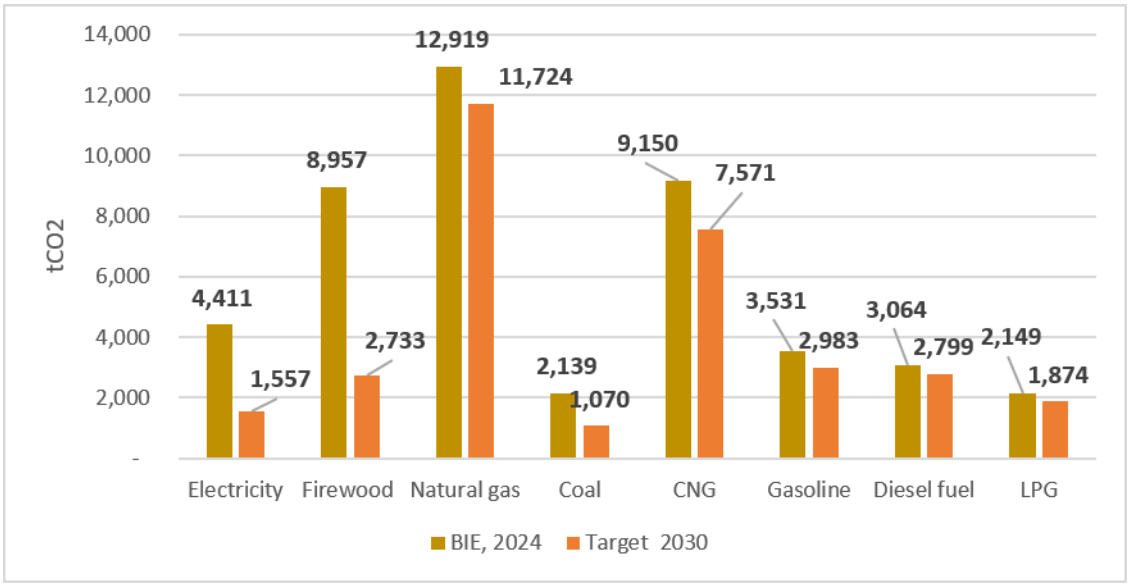
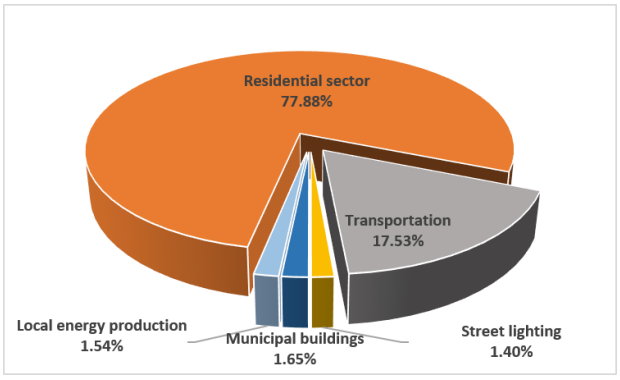


Chart 30. Comparison of baseline and target (2050) emissions by energy carrier (tCO2/year)

The ratios of energy savings and GHG emission reductions (**Target I: 2030)** by consumption sectors and energy carriers are presented in **Charts 32 and 34** (%,by MWh), **33 and 35** (%,by t CO2).



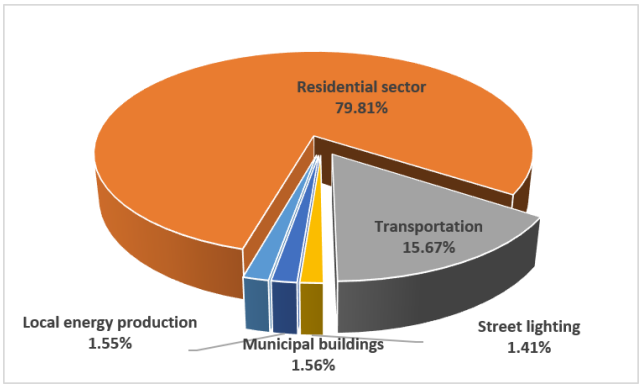


Chart 31. Structure of energy savings by sector (Target I: 2030)

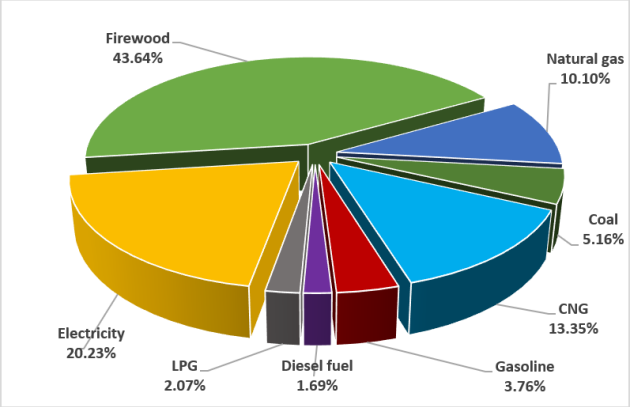


Chart 32. Structure of GHG emission reductions by sector (Target I: 2030)

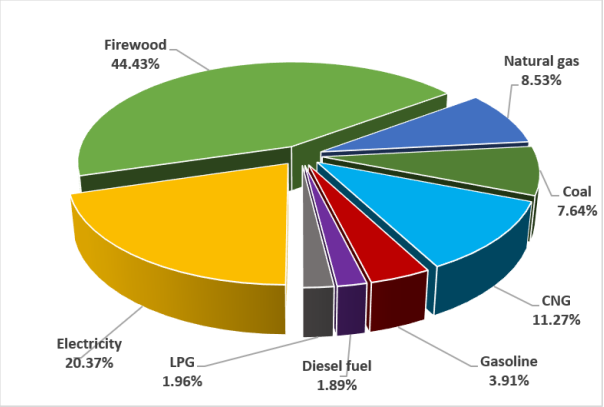


Chart 33. Energy saving structure by type (Target I: 2030)

Chart 34. Structure of GHG emission reductions by energy carrier (Target I: 2030)

The largest sector of energy savings is naturally the population (77.88% of the projected reduction), then transport (17.53%). The same applies to the reduction of GHG emissions, respectively 79.81% and 15.67%.

By energy carriers, the largest savings are expected from firewood resulting from unsustainable forest management: 43.64 %, from electricity: 20.23 %, from CNG: 13.35 %, from natural gas: 10.10 %, from coal: 5.16 %, the total share of LPG, diesel fuel and gasoline is 7.52 %.

The largest reduction in GHG emissions from energy/fuel combustion is expected from firewood resulting from unsustainable forest management: 44.43 %, from electricity: 20.37 %, from CNG: 11.27 %, from coal: 7.64 %, from natural gas: 8.53 %, the total share of LPG, diesel fuel and gasoline is 7.76 %.

A comparison of GHG emissions by sector and energy carrier in the base (2024) and target (2030) years is presented in **Charts 35 and 36.**

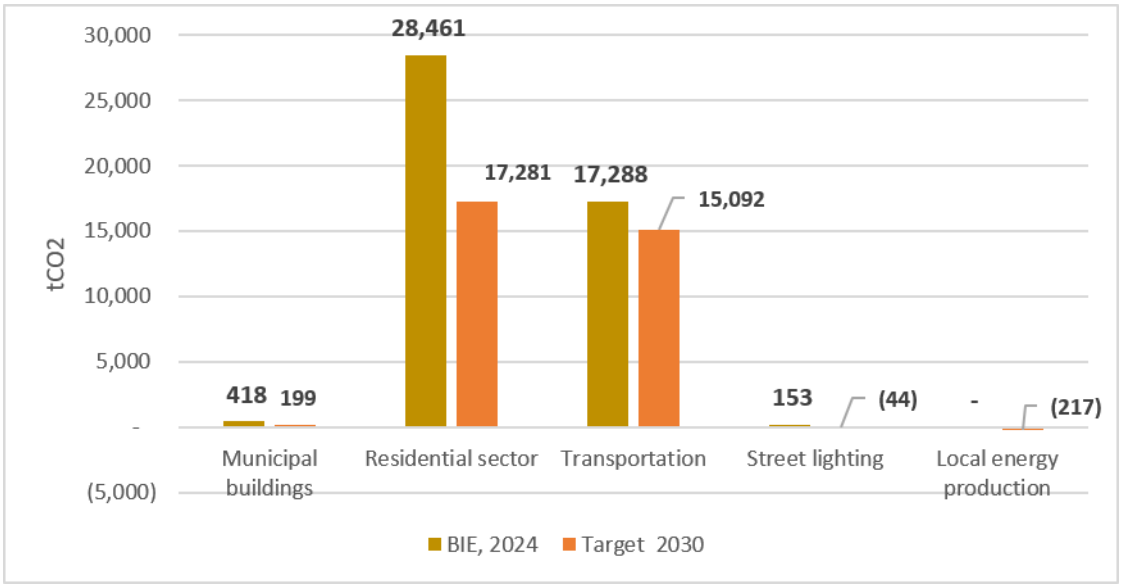


Chart 35. Comparison of baseline and target (2030) emissions by sector (tCO2/year)

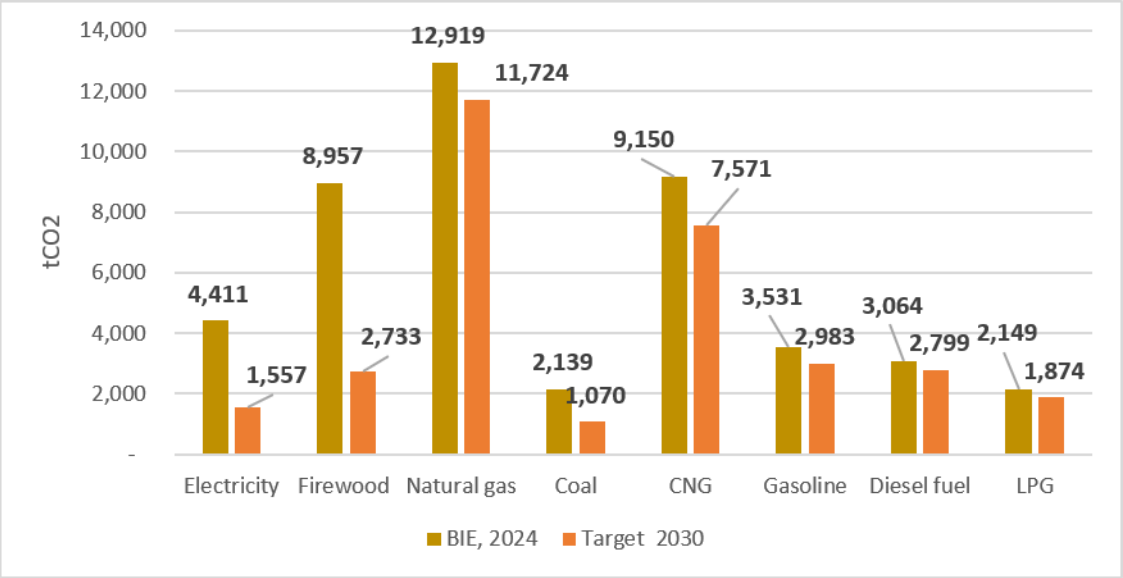


Chart 36. Comparison of baseline and target (2030) emissions by energy carrier (tCO2/year)

The financial investments required for the implementation of the proposed (**Target II: 2050**) mitigation investment "hard" measures aimed at reducing GHG emissions in the SECAP and the specific values of GHG emission reduction by sectors are presented in **Table 30.**

As mentioned, the "soft" organizational measures regularly organized by the municipality are not associated with large financial costs and are considered as activities that contribute to the implementation of mitigation measures.

Table 30. Financial investments required for the implementation of mitigation measures and specific values of GHG emissions (Target II: 2050)

Sector	Investments		Specific cost of reducing 1 ton of CO_2
	1,000 euros	%	1,000 euros/t CO_2
Municipal buildings	445.08	0.75%	2.04
Local energy production	576.00	0.97%	2.66
Residential sector	17,987.99	30.37%	1.16
Transport	39,832.35	67.24%	15.48
Street lighting	396.09	0.67%	2.01
TOTAL	**59,237.52**	**100.00%**	**3.17**

According to the table, an investment of 59.2 million euros is required to ensure the reduction of 18,662.76 t CO_2 emissions as a result of the implementation of the SECAP. According to the table, the cost of reducing 1 kg of CO_2 is 3.17 euros on average.

The most expensive specific cost mitigation measures are in the transport sector (15.48 euros/kg CO_2) due to the high costs of measures, including street renovation, asphalting, and the purchase of electric vehicles.

In MABs and private houses, it is recommended to first implement measures to increase energy efficiency, and then use renewable energy sources to fully or partially meet the already reduced energy demand.

The summary table of measures envisaged in the Akhuryan community's SECAP (**Target II: 2050)** is presented in **Table 32.**

The table also suggests the timeframes for implementing the measures, which will probably be set by the municipality, taking into account the availability of necessary financial resources and many other factors.

The financial investments required for the implementation of the proposed in the SECAP (**Target I: 2030)** mitigation investment "hard" measures and the specific values of GHG emission reductions, by sectors, are presented in **Table 31.**

Table 31. Financial investments required for the implementation of mitigation measures and specific GHG emissions (Target I: 2030)

Sector	Investments		Specific cost of reducing 1 ton of CO_2
	1,000 euros	%	1,000 euros/t CO_2
Municipal buildings	445.08	0.96%	2.04
Local energy production	576.00	1.24%	2.66
Residential sector	11,919.74	25.58%	1.07
Transport	33,262.35	71.38%	15.15
Street lighting	396.09	0.85%	2.01
TOTAL	**46,599.27**	**100.00%**	**3.33**

According to the table, an investment of 46.6 million euros is required to ensure the reduction of 14,008.82 t CO_2 emissions as a result of the implementation of the SECAP. According to the table, the cost of reducing 1 kg of CO_2 is 3.33 euros on average.

The most expensive specific cost mitigation measures are in the transport sector (15.15 euros/kg CO_2) due to the high costs of measures, including street renovation, asphalting, and the purchase of electric vehicles.

The summary table of measures envisaged under the Akhuryan community's SECAP (**Target I: 2030)** is presented in **Table 33.**

Table 32. Summary table of cost-intensive measures planned under the Akhuryan Community's SECAP (Target II: 2050)

No	Brief description of the measure	Financing volume, thousand euros	Energy conservation/savings, MWh/year					GHG emissions reduction, t CO_2/year					Years of implementation
			EE	FW	NG	Other	Total	EE	FW	NG	Other	Total	
9.2 "Hard" investment measures													
9.2.1 Community-owned structures													
9.2.1.1	Partial savings in electrical and thermal energy in municipal buildings through simple energy saving measures	24.00	21.800	-	33.335	-	55.135	5.254	-	6.734	-	11.987	2026-2027
9.2.1.2	Restoration of thermal insulation layers in attics of municipal buildings	45.52	32.700	-	170.378	-	203.078	7.881	-	34.416	-	42.297	2026-2030
9.2.1.3	Renovation of municipal buildings	84.54	109.000	-	76.670	-	185.670	26.269	-	15.487	-	41.756	2022-2026
9.2.1.4	Installation of solar water heaters in kindergartens	115.20	-	-	67.017	-	67.017	0.000	-	13.537	-	13.537	2026-2028
9.2.1.5	Replacing inefficient lamps with LED lamps in community-owned organizations	5.20	111.290	-	-	-	111.290	26.821	-	-	-	26.821	2026-2028
9.2.1.6	Installation of PV modules in municipal institutions	170.63	341.250	-	-	-	341.250	82.241	-	-	-	82.241	2026-2028
Total 9.2.1		**445.08**	**616.04**	**-**	**347.40**	**-**	**963.44**	**148.47**	**-**	**70.17**	**-**	**218.64**	**1.17%**
9.2.2 Local production of electrical energy													
9.2.2.1	Construction of a community commercial PV power plant	576.00	900.00	-	-	-	900.000	216.900	-	-	-	216.900	2026-2030
Total 9.2.2		**576.00**	**900.00**	**-**	**-**	**-**	**900.00**	**216.90**	**-**	**-**	**-**	**216.900**	**1.16%**
No	**Brief description of the measure**	**Financing volume, thousand euros**	**Energy conservation/savings, MWh/year**					**GHG emissions reduction, t CO_2/year**					**Years of implementation**
			EE	**FW**	**NG**	**Coal**	**Total**	**EE**	**FW**	**NG**	**Coal**	**Total**	
9.2.3 Residential sector													
9.2.3.1	Partial thermal modernization of 4 4-storey and 5 3-storey stone-built multi-apartment buildings in Akhuryan community	304.12	97.854	-	460.5	-	558.3	23.583	-	93.019	-	116.602	2026-2030

9.2.3.2	Complete thermal modernization of 4 3-storey panel MABs in the Vahramaberd settlement	145.66	36.094	-	169.9	-	205.9	8.699	-	34.311	-	43.009		2026-2050
9.2.3.3	Partial thermal modernization of MABs and private houses through simple energy saving measures	691.72	298.37	4,445.39	3,122.16	-	7,865.9	71.908	537.45	630.677	-	1,240.033		2026-2050
9.2.3.4	Restoration of thermal insulation layers of attic roofs of private houses	2,462.10	3,772.62	11,856.5	7,989.37	-	23,618.5	909.202	1,433.5	1,613.853	-	3,956.503		2026-2040
9.2.3.5	Installation of energy-efficient lamps in the residential sector	155.5	4,478.66	-	-	-	4,478.7	1,079.36	-	-	-	1,079.358		2025-2038
9.2.3.6	Installation of energy-efficient windows in residential MA buildings	31.24	6.1	-	28.7	-	34.8	1.471	-	5.801	-	7.271		2028-2030
9.2.3.7	Installation of energy-efficient windows in private houses	3,102.12	848.304	2,195.61	1,796.41	-	4,840.3	204.441	265.45	362.875	-	832.765		2026-2050
9.2.3.8	Installation of solar water heaters in the apartments of the MABs	26.784	-	-	83.70	-	83.7	-	-	16.907	-	16.907		2026-2030
9.2.3.9	Installation of solar water heaters in the private houses	2,592.00	-	-	9,000.0		9,000.0	-	-	1,818.0	-	1,818.0		2026-2030
9.2.3.10	Installation of photovoltaic systems in private houses	6,587.71	10,293.3	-	-	-	10,293.3	2,480.69	-	-	-	2,480.685		2024-2050
9.2.3.11	Use of natural gas in private houses instead of firewood resulting from unsustainable forest management	1,227.66	-	15,558.9	-15,558.9	-	-	-	6,270.2	-3,142.9	-	3,127.332		2026-2030
9.2.3.12	Use of natural gas in private houses instead of coal	652.80	-	-	-4,834.9	4,834.9	-	-	-	-976.6	1,711.54	734.899		2026-2030
9.2.3.13	Implementation of photovoltaic lighting in common areas of MABs	8.55	13.5	-	-	-	13.5	3.254	-	-	-	3.254		2026-2030
Total 9.2.3		**17,987.99**	**19,844.8**	**34,056.3**	**2,256.97**	**4,834.86**	**60,992.99**	**4,782.6**	**8,506.6**	**455.91**	**1,711.5**	**15,456.62**		**82.82%**
No	**Brief description of the measure**	**Financing volume, thousand euros**	**Energy conservation/savings, MWh/year**						**GHG emissions reduction, t CO2/year**						**Years of implementation**
			EE	**CNG**	**Gasoline**	**Diesel**	**LPG**	**Total**	**EE**	**CNG**	**Gasoline**	**Diesel**	**LPG**	**Total**	
9.2.4 Transport sector															
9.2.4.1	Partial replacement of municipal passenger vehicles with electric vehicles	220.00	-49.0	176.34	47.84	-	-	175.18	-11.809	35.621	11.912	-	-	35.724	2026-2040

9.2.4.2	Partial replacement of minibuses and taxis in public transport with electric vehicles	1,020.00	-243.3	973.65	-	-	183.96	914.3	-58.635	196.68	-	-	41.759	179.801	2026-2050
9.2.4.3	Partial replacement of private and commercial passenger transport vehicles with electric vehicles	36,320.00	-2,073.3	6,415.1	1,903.4	637.56	994.33	7,877.0	-499.67	1,295.8	473.948	170.23	225.71	1,666.06	2026-2050
9.2.4.4	Asphalting, improvement of community streets, installation and marking of traffic signs and information boards	2,242.35	-	1,358.93	425.38	344.23	203.96	2,332.5	-	274.51	105.919	91.909	46.298	518.631	2026-2028
9.2.4.5	Creating cycling infrastructure	30.00	-	452.98	141.79	114.74	67.99	777.499	-	91.502	35.306	30.636	15.433	172.877	2026-2029
Total 9.2.4		**39,832.35**	**(2,365.6)**	**9,376.97**	**2,518.42**	**1,096.53**	**1,450.23**	**12,076.5**	**(570.12)**	**1,894.2**	**627.09**	**292.77**	**329.20**	**2,573.1**	**13.79%**
No	**Brief description of the measure**	**Financing volume, thousand euros**	**Energy conservation/savings, MWh/year**						**GHG emissions reduction, t CO2/year**						**Years of implementation**
			EE	**FW**	**NG**	**Other**	**Total**		**EE**	**FW**	**NG**	**Other**	**Total**		
9.2.5 Sector of street lighting system															
9.2.5.1	Replacing incandescent lamps with LED lamps	11.91	276.89	-	-	-	276.89		66.7	-	-	-	66.729		2026-2028
9.2.5.2	Expansion of the outdoor lighting network in the community	4.68	-102.38	-	-	-	-102.38		-24.673	-	-	-	-24.673		2025-2026
9.2.5.3	Construction of an autonomous PV station powering the street lighting system of the city of Akhuryan	127.50	225.0	-	-	-	225.0		54.225	-	-	-	54.225		2026-2030
9.2.5.4	Construction of autonomous PV stations powering street lighting systems in rural areas of the community	252	420.0	-	-	-	420.0		101.220	-	-	-	101.220		2026-2030
Total 9.2.5		**396.09**	**819.51**	**-**	**-**	**-**	**819.51**		**197.50**	**-**	**-**	**-**	**197.50**		**1.06%**
TOTAL		**59,237.5**											**18,662.76**		**100%**

Table 33. Summary table of cost-intensive measures planned under the Akhuryan SECAP (Target I: 2030)

No	Brief description of the measure	Financing volume, thousand euros	Energy conservation/savings, MWh/year					GHG emissions reduction, t CO2/year					Years of implementation
			EE	FW	NG	Other	Total	EE	FW	NG	Other	Total	
9.2 "Hard" investment measures													
9.2.1 Community-owned structures													
9.2.1.1	Partial savings in electrical and thermal energy in municipal buildings through simple energy saving measures	24.00	21.800	-	33.335	-	55.135	5.254	-	6.734	-	11.987	2026-2027
9.2.1.2	Restoration of thermal insulation layers in attics of municipal buildings	45.52	32.700	-	170.378	-	203.078	7.881	-	34.416	-	42.297	2026-2030
9.2.1.3	Renovation of municipal buildings	84.54	109.000	-	76.670	-	185.670	26.269	-	15.487	-	41.756	2022-2026
9.2.1.4	Installation of solar water heaters in kindergartens	115.20	-	-	67.017	-	67.017	0.000	-	13.537	-	13.537	2026-2028
9.2.1.5	Replacing inefficient lamps with LED lamps in community-owned organizations	5.20	111.290	-	-	-	111.290	26.821	-	0.000	-	26.821	2026-2028
9.2.1.6	Installation of PV modules in municipal institutions	170.63	341.250	-	-	-	341.250	82.241	-	0.000	-	82.241	2026-2028
Total 9.2.1		**445.08**	**616.04**	**-**	**347.40**	**-**	**963.44**	**148.47**	**-**	**70.17**	**-**	**218.64**	**1.56%**
9.2.2 Local production of electrical energy													
9.2.2.1	Construction of a community commercial PV power plant	576.00	900.00	-	-	-	900.000	216.900	-	-	-	216.900	2026-2030
Total 9.2.2		**576.00**	**900.00**	**-**	**-**	**-**	**900.00**	**216.90**	**-**	**-**	**-**	**216.900**	**1.16%**
No	**Brief description of the measure**	**Financing volume, thousand euros**	**Energy conservation/savings, MWh/year**					**GHG emissions reduction, t CO2/year**					**Years of implementation**
			EE	**FW**	**NG**	**Coal**	**Total**	**EE**	**FW**	**NG**	**Coal**	**Total**	
9.2.3 Residential sector													
9.2.3.1	Partial thermal modernization of 4 4-storey and 5 3-storey stone-built multi-apartment buildings in Akhuryan community	304.12	97.854	-	460.5	-	558.3	23.583	-	93.019	-	116.602	2026-2030

9.2.3.2	Complete thermal modernization of 4 3-storey panel MABs in the Vahramaberd settlement	145.66	36.094	-	169.9	-	205.9	8.699	-	34.311	-	43.009		2026-2050
9.2.3.3	Partial thermal modernization of MABs and private houses through simple energy saving measures	461.16	198.92	2,963.6	2,081.4	-	5,244.0	47.939	358.3	420.451	-	826.689		2026-2030
9.2.3.4	Restoration of thermal insulation layers of attic roofs of private houses	2,154.27	3,300.9	10,374.1	6,990.5	-	20,665.5	795.527	1254.2	1,412.08	-	3,461.832		2026-2030
9.2.3.5	Installation of energy-efficient lamps in the residential sector	77.8	2,239.3	-	-	-	2,239.3	539.679	-	-	-	539.679		2026-2028
9.2.3.6	Installation of energy-efficient windows in residential MA buildings	19.62	3.8	-	18.0	-	21.9	0.923	-	3.642	-	4.566		2028-2030
9.2.3.7	Installation of energy-efficient windows in private houses	1,551.06	424.152	1,097.8	898.20	-	2420.2	102.221	132.73	181.437	-	416.383		2026-2030
9.2.3.8	Installation of solar water heaters in the apartments of the MABs	26.784	-	-	83.70	-	83.7	-	-	16.907	-	16.907		2026-2030
9.2.3.9	Installation of solar water heaters in the private houses	2,592.00	-	-	9,000.0		9,000.0	-	-	1,818.0	-	1,818.0		2026-2030
9.2.3.10	Installation of photovoltaic systems in private houses	3,293.86	5,146.6	-	-	-	5,146.7	1,240.3	-	-	-	1,240.343		2024-2030
9.2.3.11	Use of natural gas in private houses instead of firewood resulting from unsustainable forest management	876.90	-	11,113.5	-11,113.5	-	-	-	4,478.7	-2,244.9	-	2,233.809		2026-2030
9.2.3.12	Use of natural gas in private houses instead of coal	408.00	-	-	-3,021.8	3,021.8	-	-	-	-610.4	1,069.7	459.312		2026-2030
9.2.3.13	Implementation of photovoltaic lighting in common areas of MABs	8.55	13.5	-	-	-	13.5	3.254	-	-	-	3.254		2026-2030
Total 9.2.3		**11,919.7**	**11,461**	**25,549**	**5,567**	**3,022**	**45,598.96**	**2,762.**	**6,224**	**1,124.5**	**1,069.7**	**11,180.38**		**79.81%**
No	**Brief description of the measure**	**Financing volume, thousand euros**	**Energy conservation/savings, MWh/year**						**GHG emissions reduction, t CO2/year**					**Years of implementation**
			EE	**CNG**	**Gasoline**	**Diesel**	**LPG**	**Total**	**EE**	**CNG**	**Gasoline**	**Diesel**	**LPG**	**Total**
9.2.4 Transport sector														
9.2.4.1	Partial replacement of municipal passenger vehicles with electric passenger vehicles	100.00	-19.00	40.694	47.84	-	-	69.53	-4.579	8.220	11.912	-	-	15.553	2026-2030

9.2.4.2	Partial replacement of minibuses and taxis in public transport with electric vehicles	630.00	-206.55	617.20	-	-	110.376	521.0	-49.779	124.67	-	-	25.06	99.951	2026-2030
9.2.4.3	Partial replacement of private and commercial passenger transport vehicles with electric vehicles	30,260.0	-1,727.8	5,345.9	1,586	531.30	828.61	6,564.2	-416.4	1,079.9	394.957	141.9	188.1	1,388.4	2026-2030
9.2.4.4	Asphalting, improvement of community streets, installation and marking of traffic signs and information boards	2,242.35	-	1,358.93	425.38	344.23	203.96	2332.5	-	274.51	105.919	91.909	46.298	518.631	2026-2028
9.2.4.5	Creating cycling infrastructure	30.00	-	452.98	141.79	114.74	67.99	777.499	-	91.502	35.306	30.636	15.433	172.877	2026-2029
Total 9.2.4		**33,262.35**	**(1,953.3)**	**7,815.7**	**2,201.2**	**990.27**	**1,210.9**	**10,264.7**	**(470.75)**	**1,578.8**	**548.09**	**264.40**	**274.88**	**2,195.4**	**15.67%**
No	**Brief description of the measure**	**Financing volume, thousand euros**	**Energy conservation/savings, MWh/year**						**GHG emissions reduction, t CO2/year**						**Years of implementation**
			EE	**FW**	**NG**	**Other**	**Total**		**EE**	**FW**	**BG**	**Other**	**Total**		
9.2.5 Sector of street lighting system															
9.2.5.1	Replacing incandescent lamps with LED lamps	11.91	276.89	-	-	-	276.89		66.7	-	-	-	66.729		2026-2028
9.2.5.2	Expansion of the outdoor lighting network in the community	4.68	-102.38	-	-	-	-102.38		-24.673	-	-	-	-24.673		2025-2026
9.2.5.3	Construction of an autonomous PV station powering the street lighting system of the city of Akhuryan	127.50	225.0	-	-	-	225.0		54.225	-	-	-	54.225		2026-2030
9.2.5.4	Construction of autonomous PV stations powering street lighting systems in rural areas of the community	252	420.0	-	-	-	420.0		101.220	-	-	-	101.220		2026-2030
Total 9.2.5		**396.09**	**819.51**	**-**	**-**	**-**	**819.51**		**197.50**	**-**	**-**	**-**	**197.50**		**1.06%**
TOTAL		**46,599.3**											**14,008.82**		**100%**

Conclusions on the mitigation component of the SECAP

Local government bodies can significantly contribute to the efficient use of energy resources and the resolution of climate protection issues at the local and national levels. It is necessary for community authorities to develop a strategy that identifies the main energy consumers in various sectors of life, assesses the annual volumes of energy consumption and greenhouse gas emissions.

Recognizing the importance of the strategic plan being developed, the Akhuryan Community Council of Elders decided to join the EU's "Covenant of Mayors" initiative, which aims to support communities in Europe and the Eastern Partnership countries in implementing a sustainable energy policy, reducing communities' dependence on fossil fuels and contributing to the mitigation of global climate change.

This Sustainable Energy and Climate Action Plan represents the energy development strategy of the Akhuryan community, the implementation of which will ensure the fulfillment of the target commitments undertaken by the community within the framework of the CoM. The plan may be periodically reviewed and supplemented with new economically and technically justified measures.

The existence of the SECAP, approved by the Akhuryan Community Council of Elders and accepted by the Joint Research Center of the European Commission, provides the community with an opportunity:

- to join the "club" of advanced and developed European cities and get the opportunity to use EU information and regulatory sources and expert support;
- take advantage of preferential loan or grant funds provided by EU financial institutions and donor organizations to communities that are members of the CoM;
- to become closely acquainted with modern leading energy technologies, the peculiarities of their use, and to participate in experience exchange activities;
- to contribute to raising awareness among the community population and other stakeholders and implementing energy-saving measures;
- to create new jobs during the implementation of the measures.

An assessment of climate hazards, risks, and vulnerabilities specific to the community was also conducted for the enlarged community of Akhuryan, based on which initial adaptation measures were proposed to reduce or eliminate the identified risks.

Chapter 11. Climate Change Vulnerability Assessment of the Akhuryan Community and Adaptation Measures

11.1. The Adaptation Component in the Covenant

Climate change adaptation, together with mitigation measures, became one of the "cornerstones" of the EU's "Covenant of Mayors for Climate and Energy" initiative in 2015. As a result, starting from that year, communities joining the pact, have committed to developing adaptation measures aimed not only at reducing GHG emissions, but also at mitigating identified climate risks.

In terms of adaptation, community action plans should include measures in those areas and sectors that are most vulnerable in the context of the projected impacts and climate change risks (hazards).

Vulnerable areas can vary significantly from community to community, encompassing sectors such as buildings, transport, energy, waste management, land use planning, etc. For this reason, having a deep understanding of climate hazards and vulnerabilities by local governments can be of paramount importance in developing appropriate adaptation strategies.

11.2. Armenia's policy on climate change

Within the framework of the UNDP – Green Climate Fund "National Adaptation Plan to Advance Medium- and Long-Term Adaptation Planning in Armenia" project, the National Climate Change Adaptation Plan (NAP) and the list of measures for 2021-2025 were developed in 2021 and approved by the RA Government's Decision No. 749-L dated 13.05.2021.

The document guides the implementation of adaptation goals and aims to combine the efforts of the government, regional administrations, local governments, civil society and academic institutions, business, and the international community to strengthen the country's capacity to adapt to climate change in 2021-2025.

In essence, the main objective of the NAP process is to contribute to climate risk reduction and management in Armenia by identifying the most important hazards, implementing mitigation and adaptation measures that eliminate the negative impacts of these hazards, reducing socio-economic vulnerabilities and avoiding losses and damages caused by climate change. At the same time, there is a goal to ensure the coordination of adaptation measures implemented in different sectors and levels in order to optimize their effectiveness. All these processes are fully consistent with the goals of the Covenant and the commitments undertaken by communities under the initiative.

The NAP is a constituent and most important component of the regions in planning and implementation of measures to increase the climate resilience of communities. In this context, the following are of utmost importance for Armenia: identification of climate change risks by communities, as well as community strategies and adaptation measures developed to minimize the negative impact of these risks on the population's livelihoods and various sectors of the economy.

11.3. Akhuryan Climatic Conditions

The Akhuryan multi-residential community was formed as a result of the unification of communities under the RA Law 328-N on Amendments and Supplements to the Law "On Administrative-Territorial Division of the Republic of Armenia" adopted by the National Assembly of the Republic of Armenia on September 24, 2021. The presentation of climate change trends, forecasts and scenarios for the Akhuryan enlarged community is summarized based on relevant available data related to climate change in the regional center of Gyumri, bordering Akhuryan, and the Jajur settlement of the community.

Climate hazards, risk and vulnerability assessments, as well as proposed adaptation measures, are summarized for the Akhuryan enlarged community.

The Shirak plain, located on the left bank of the Akhuryan River, is surrounded by the Jajur and Kamkhut mountains and borders the slopes of Mount Aragats in the southeast, the Shirak mountain range in the north, the Ararat Valley in the south, and the Pambak mountain range in the east. It is surrounded by the Cherkes, Jajur, Shirak, and other gorges.

Figure 5. Akhuryan River (https://www.hatis.am/akhuryan-river/)

Shirak region has a continental climate. According to the norms of the RA Construction Code 22-01-2024, the Akhuryan region is located in the "cold-C" construction climate zone, with cool summers, cold winters, an average annual air humidity level of 72 percent, and a favorable wind regime (average annual speed: 1.3 m/s, average monthly speeds: 0.6-2.1 m/s). Winter is long, lasting 115 days, with constant snow cover. On average, it begins in early November and ends in mid-April. The average temperature in January is -9.0^{0}C, and the absolute minimum reaches -36^{0}C. The weather is stable in winter. The average temperature in July and August is 19.5^{0}C, and the absolute maximum is 38^{0}C. In the driest months, July and August, precipitation reaches 40-47 mm, and relative humidity is 60-62 percent. Autumn is cool, with changeable weather. Early autumn frosts begin in late September or early October. The average annual precipitation is 498 mm. Thus, the main climatic indicators indicate mainly favorable conditions for residence, recreation, and agriculture.

Below table characterize the climatic regime of the Akhuryan community according to the averaged data of meteorological stations located near the community. The table used data from the Construction Climatology Norms of the Armenian Construction Code (ACC) 22-01-2024.

Table 34. The climate regime of the Akhuryan community **(Construction Climatology, ACC 22-01-2024)**

Air temperature

Settlement	**Monthly average**											
	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
Akhuryan	-8.2	-6.7	1.1	6.0	10.9	14.7	18.4	18.5	14.5	8.4	1.7	-4.9
Average annual temperature, °C			**The absolute minimum, °C**					**The absolute maximum, °C**				
6.1			-36.0					38.0				

Average and observed minimum air temperature (°C)

	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Year
Average	-13.6	-12.3	-5.4	0.9	5.4	9.1	13.1	12.9	7.9	2.0	-3.8	-9.5	0.5
Observed	-36.0	-35.0	-27.7	-16.0	-7.6	-3.6	0.3	1.9	-3.7	-12.5	-23.0	-30.0	-36.0

Average and observed maximum air temperature (°C)

	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Year
Average	-2.7	-0.8	5.9	13.8	18.7	23.3	27.1	27.1	27.5	23.8	16.7	8.5	13.5
Observed	9.2	14.0	21.5	26.8	29.3	33.1	38.0	37.0	35.1	27.4	20.2	17.6	38.0

Average values of extreme air temperatures (°C)

(average maximum: a.m, average minimum: n.m)

	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Year
a.m.	3.9	6.1	14.0	20.9	24.7	29.0	32.6	32.8	29.7	23.8	15.5	7.8	33.6
n.m.	-23.9	-22.7	-16.0	-6.5	0.9	3.1	7.0	7.0	1.5	-4.7	-11.8	-19.9	-26.0

Relative humidity

Settlement	Relative monthly humidity (%)											
	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
Akhuryan	79	77	72	67	68	65	62	60	61	66	74	79

Average annual	Average monthly hours at 3 p.m.	
	Coldest month, %	Hottest month, %
70	70	41

Precipitation and snow cover

Settlement	Precipitation (monthly average/daily maximum) mm											
	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
Akhuryan	23/16	25/26	32/24	61/30	88/53	70/42	49/88	36/41	28/36	41/30	29/25	25/32

Annual	Snow cover		
	Maximum decadal height, sm	Number of days with snow cover per year	Maximum amount of water in snow, mm
507/88	61	94	129

Wind

Month of the year	Wind directions repeatability, % Average wind speed (m/s) by direction							
	N	NE	E	SE	S	SW	W	NW
I	15/0.7	18/0.6	8/0.5	3/0.6	13/0.8	19/0.5	10/0.5	14/0.5
IV	14/1.8	17/1.4	11/1.9	4/1.6	12/1.7	19/1.7	12/1.5	11/1.5
VII	19/1.9	39/1.9	24/2.2	2/1.6	2/1.4	4/1.4	5/1.2	5/1.6
X	18/0.8	20/0.7	9/0.7	2/0.6	12/0.8	17/0.6	13/0.6	9/0.7

	Recurrence of disturbances%	Average monthly speed in m/s	Average annual speed in m/s	Number of days with strong winds (>15 m/s)	Estimated wind speed (m/s): which is possible once in "n" years		
					25	50	100
I	85	0.6	1.2	28	25	27	29
IV	61	1.7					
VII	56	2.1					
X	79	0.8					
Average annual atmospheric pressure, (hPa)							846.6

Number of days with strong winds, monthly average

I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Year
0.9	1.3	3.5	3.5	3.6	3.4	2.8	3.7	2.0	1.1	1.0	0.8	28

Heat capacity (enthalpy), monthly average value, KJ/kg

I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
-3.7	-1.5	8.2	19.4	29.1	37.9	46.6	45.5	35.6	23.4	11.4	1.4

Climatic parameters of the warm period of the year (22-01-2024)

Settlement	Air temperature, ^{0}C				
	hottest of the day		Absolute maximum	hottest of the month average maximum	hottest average of the month daily fluctuation
	0.95	0.99			
Akhuryan	27	28	38	13.8	24.7

Climatic parameters of the cold season (22-01-2024)

Settlement	Air temperature, ^{0}C								
	On the coldest day			The coldest five days			Coldest time-period average	Absolute minimum	Average daily variation of the coldest month
	0.98	0.95	0.92	0.98	0.95	0.92			
Akhuryan	-26	-23	-23	-24	-22	-21	-6.7	-36	11.1

11.4 Climate change in Akhuryan

11.4.1. Observed climate change in Akhuryan

The results of the localization of regional climate change scenarios, and the vulnerability of various sectors of the Armenian economy and natural ecosystems under these scenarios, have been assessed and included in the four national communications of the Republic of Armenia under the UNFCCC, which were published in 1998, 2000, 2015 and 2020.

Main trends of change

The analysis of the climate situation was carried out based on data published by the "Hydrometeorology and Monitoring Center" SNCO of the Ministry of Environment of the Republic of Armenia (Environmental Bulletins of the Republic of Armenia), which clearly confirms the existence of the alarming phenomenon of climate change.

Observations of climate indicators record the steadily changing process of the climate in the republic. The amount of precipitation is regularly decreasing year by year, the average air temperature and relative humidity are increasing, which are associated with an increase in the average air temperature and surface evaporation. According to the Fourth National Communication of the Republic of Armenia on Climate Change, during the period of 1935-2020, the average annual precipitation in the republic has decreased compared to the baseline (592 mm, 1961-1990) by 14% (Figure 37), and the annual average air temperature has increased above normal (5.5^{0}C, 1961-1990) by 1.38^{0}C (Figure 38). The climate is becoming quite worrying and the available statistical data allow us to draw certain conclusions.

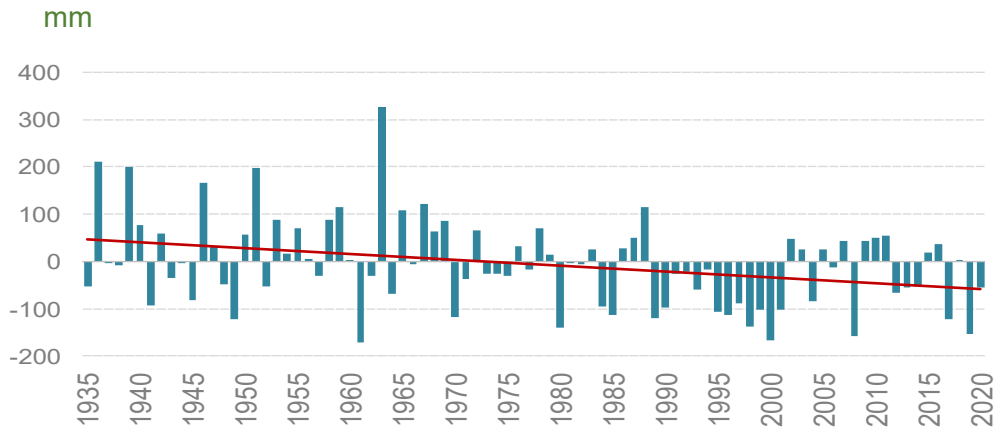


Chart 37. Change in the annual average precipitation in Armenia for the period of 1935-2020.

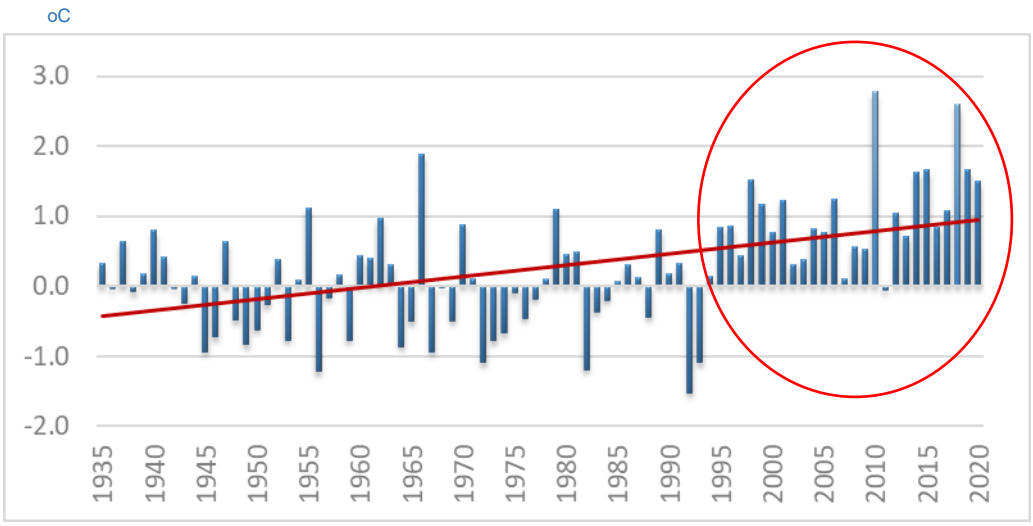
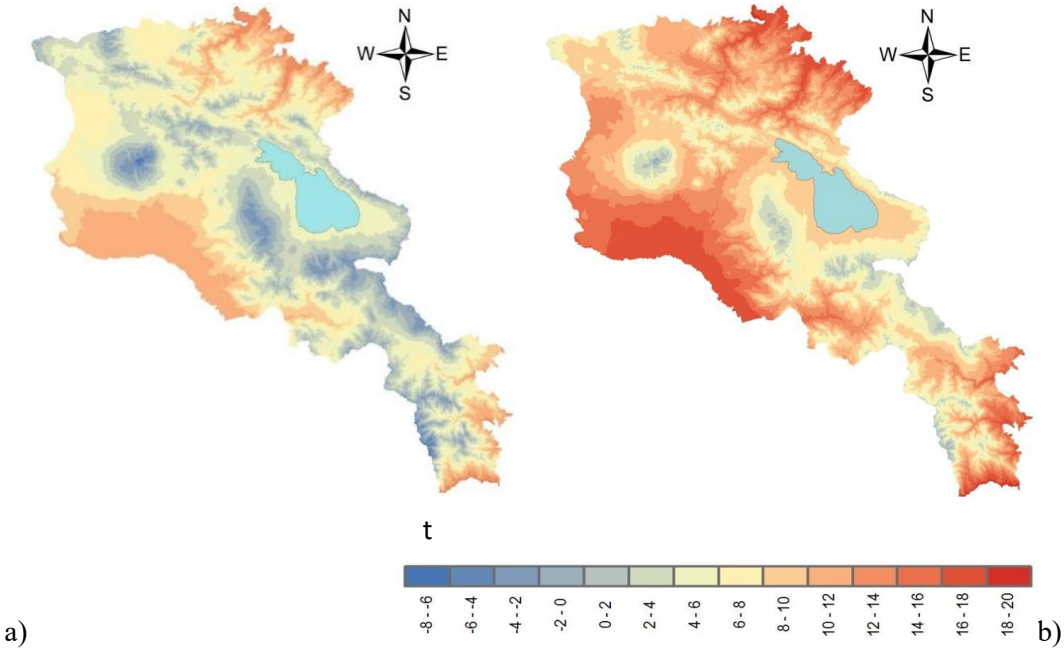


Chart 38. Change in average annual air temperature in Armenia for the period of 1935-2020.

Projected change in annual temperature and precipitation according to regional METRAS model

Implementing METRAS high resolution regional model, it is possible dynamically localize global models results for Armenia, by using the model with resolution and agreed mistakes, taking into account the conditions of Armenia's complex mountainous terrain. Thus, expected changes of the temperature and atmospheric precipitation are modeled by METRAS with the results according to pessimistic RCP 8.5 scenario according to the 2020 4th National Communication on Climate Change. Using the results of the METRAS model, projected average annual temperature (T, °C) and precipitation values up to 2100 were estimated (**Figure 6**).

According to the air temperature distribution in **Figure 6**, in the regions of Armenia during the baseline period and after 50-80 years, it can be seen that the average annual air temperature in the Shirak region is 6-8^{0}C for 1961-1990 (Fig. 2-a), and in 2071-2100 according to the RCP8.5 scenario it will reach 12-14^{0}C (Fig. 2-b).



a) b)

Figure 6. Distribution of annual average air temperature values in Armenia
a) under the baseline and b) under the RCP 8.5 scenario for 2071-2100. (4th National Communication on Climate Change)

Factors of climate extremes

The increase in the frequency of extreme climatic events is one of the main manifestations of climate change. Extreme climatic conditions can have a significant impact on various sectors of the community economy and the normal life of the population, therefore information about them is extremely important for identifying vulnerable sectors and planning adaptation measures aimed at mitigating climate risks in these sectors.

For the entire territory of Armenia, according to the data from 45 operating meteorological stations, about 27 indices proposed by the World Meteorological Organization have been evaluated for the period of 1935-2016, which can be applied in a number of areas: healthcare, agriculture, water resources, etc.

The indices were calculated for each station based on their observation data sets. The number of summer days (Tmax>25°C) increased at all altitudes during the observed period (1935-2016). The number of cold days decreased by 1 during the same period, 4-3 by 5 days/10 years, and the number of frost days

has been reduced to 0.4-2.3 days/10 years. The duration of heat waves has increased accordingly by 2.0-7 for 6 days.

The following coefficients characterizing climatic extreme conditions were also evaluated according to altitudes: number of consecutive dry days, number of wet days, duration of rainless period. The number of consecutive dry days during the observed period, 1935-2016, increased by 0.3-1. By 6 days/10 years, the number of days with heavy precipitation (R10mm) at altitudes up to 2000 m has increased by 0 for 7 days.

The indices of the number of consecutive days with precipitation less than 1 mm (CDD) and the number of days with temperature above 25°C (SU25) were estimated for all meteorological stations in Armenia using data from 1935-2016. The results were mapped and presented in Figure 7.

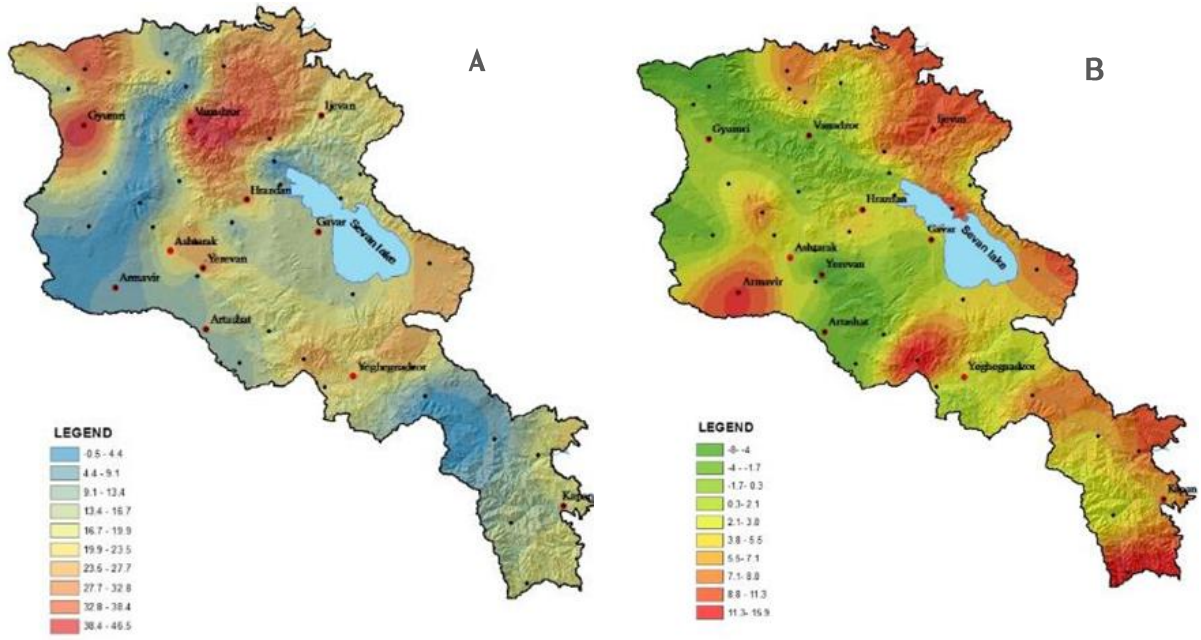


Figure 7. Spatial distribution of changes in a) SU25 and b) CDD indices in Armenia during 1935-2016.

The results of the analysis show that during 1935-2016, the above indices have increasing trends throughout the territory of the republic. These indices are very characteristic of the increase in the frequency of droughts, which in turn are caused by thermal depression, and can also lead to forest fires and desertification.

11.4.2. Climatic and other natural hazards and risks threatening the Akhuryan community, extracted from existing studies

Armenia is located in a high-risk zone for natural hazards. The World Bank has included Armenia in the list of 60 countries prone to hazards. The probability of a hazard and its severity are high. The main threats include storms, hail, floods, and landslides.

In order to study trends related to hazardous meteorological phenomena in the territory of Armenia, an analysis of the most frequently observed hazardous phenomena in the territory of the country during 1975-2016, including frost, hail, strong winds, and heavy precipitation, was conducted within the framework of the 4th National Communication on Climate Change.

During 1975-2016, the total number of dangerous phenomena in the territory of Armenia increased by about 40 cases compared to 1961-1990 average, which is 23.5% of the multi-year average value (Figure 39).

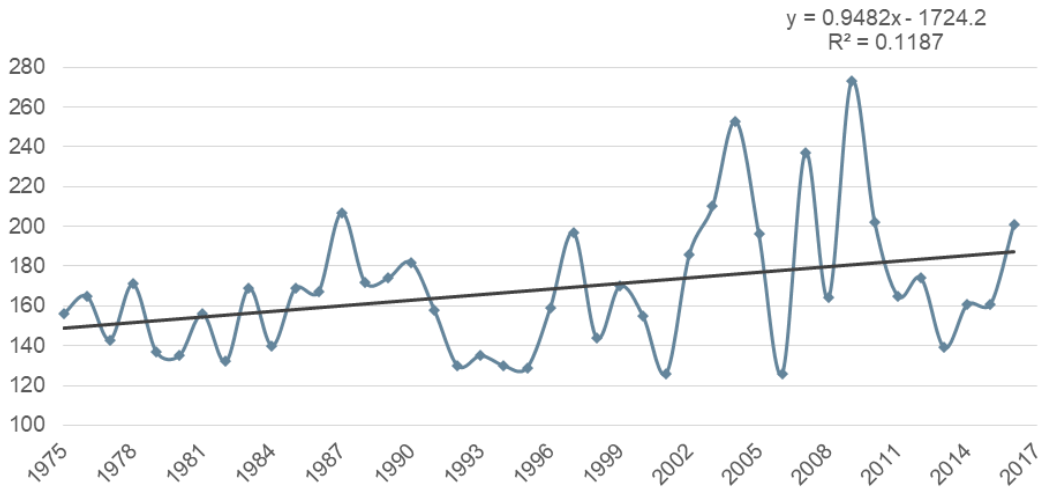
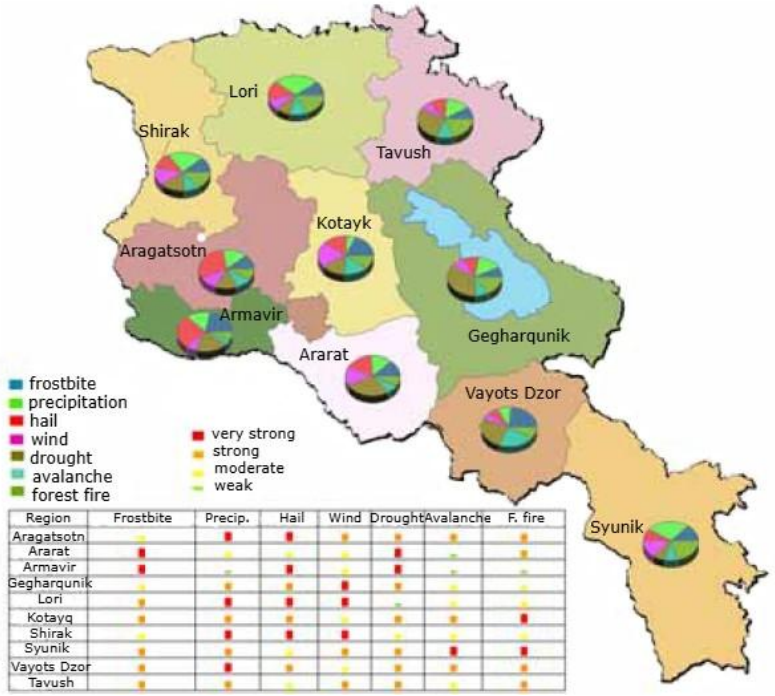


Chart 39. Cumulative number of hazardous events: frost, hail, strong wind and heavy precipitation, observed in the territory of Armenia during 1975-2016. (4th National Communication on Climate Change)

According to climate change scenarios, the frequency of unstable weather accompanied by thunderstorms and hail is likely to increase in spring and summer. In this case, the agricultural plains of the middle mountainous belt of the northern and southern regions of Armenia will be most vulnerable.[34] The vulnerability of Armenia's regions to hydrometeorological hazardous events (HMEs) according to their hazard level is presented in Figure 8. Among HMEs, precipitation, hail, and wind have a very high hazard level for Shirak region, while frost, drought, avalanches, and forest fires have a medium hazard level.[35]



[34] Climate Risk Management in Armenia: Report. (https://nature-ic.am/), 2013.
[35] Fourth National Communication on Climate Change, 2020.

Figure 8. Vulnerability of Armenia's regions to HMEs (https://nature-ic.am/)

The overall hydrometeorological vulnerability map of Armenia was calculated according to individual factors, such as maximum and minimum air temperatures, precipitation, maximum wind speed, and river flow velocity, which were based on daily data collected from 35 stations over the past 30 years, and is presented in Figure 9.[36]

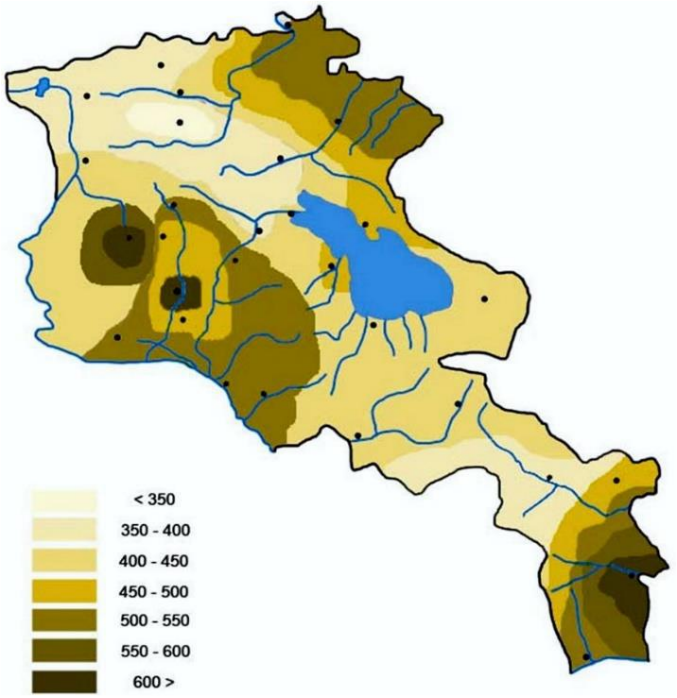


Figure 9. Spatial distribution map of hydrometeorological vulnerability of Armenia (UNDP)

Droughts are observed almost every year in the lowlands of the republic, and the recurrence of droughts in the foothills is about 50%. During 2000-2017, the duration of droughts increased by about 33 days compared to 1961-1990 (the average duration of drought during 1961-1990 was 87 days). In recent years, the upper boundary of the drought zone has expanded to include mountainous regions.

About 80% of the territory of the Republic of Armenia is subject to varying degrees of desertification, which has occurred both as a result of anthropogenic activities and is conditioned by the influence of natural factors and geomorphological features. According to the Strategy to Combat Desertification in the Republic of Armenia, Shirak region is located in a zone of desertification risk or potential risk (Figure 10).

[36] Current status and development prospects of climate services in Armenia. State Hydrometeorological and Monitoring Service of the Republic of Armenia, Report "Creating favorable conditions for the preparation of Armenia's third national communication under the United Nations Framework Convention on Climate Change" within the framework of the UNDP-GEF/00060737 Project: Lusabats Publishing House, 2013, 64 pages.

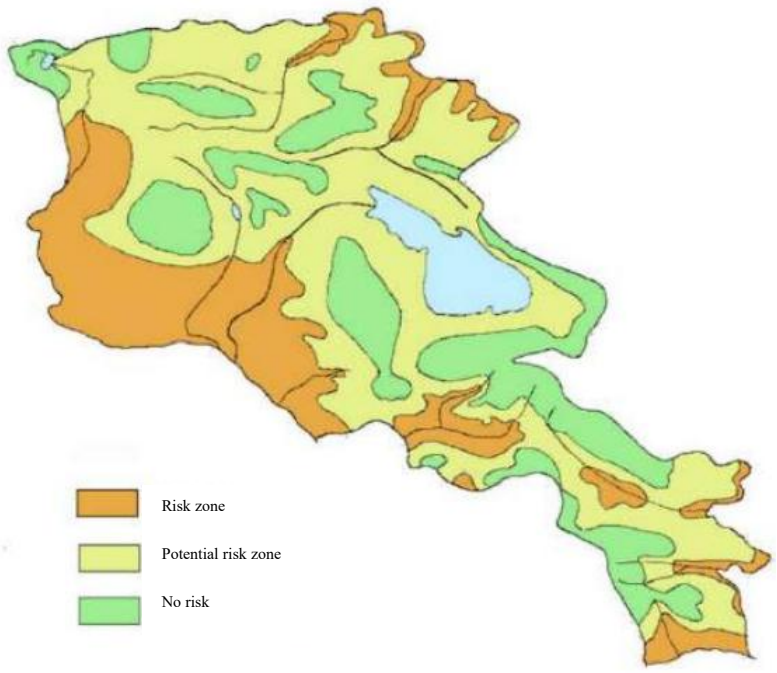


Figure 10. Desertification risk zone of Armenia, according to the Strategy and National Action Plan to Combat Desertification in the Republic of Armenia, 2015

The 2022 "Development of Adaptation Plans for Tavush and Shirak Regions" project was implemented within the framework of the "National Adaptation Plan to Advance Medium- and Long-Term Adaptation Planning in Armenia" UNDP project with the financial support of the Green Climate Fund and concerns the analysis of issues related to climate change adaptation in Shirak region, the general description of the region from the point of view of climate sensitivity.

The study undertook a comprehensive assessment of risks arising from natural hazards. The risk values associated with the hazards of hail, frost, mudflows, landslides and others (a total of 11 types) were assessed, together with environmental, social and economic vulnerability indicators (a total of 16). The risk of natural hazards was assessed as a result of potential hazards and vulnerabilities. As a result of the assessment, four hydrometeorological vulnerability zones were identified in Shirak region (Figure 11). And in the natural hazard risk map developed for Armenia in Figure 12, Shirak region is in the highest risk group after Lori region.

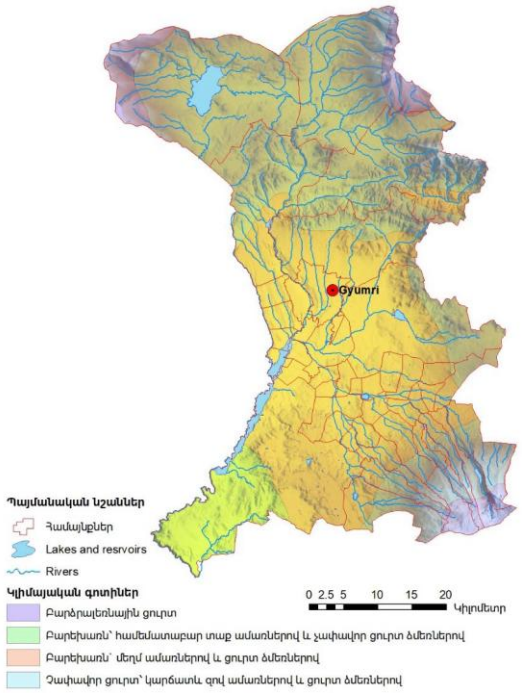


Figure 11. Climatic zones of Shirak region (UNDP, 2022)

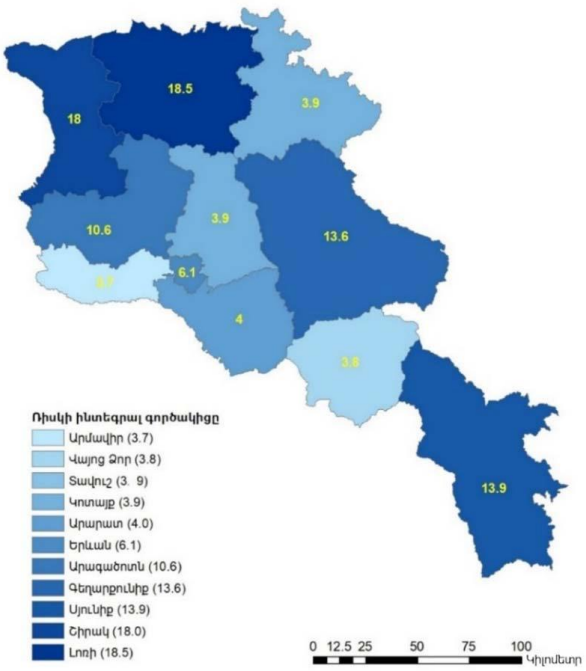


Figure 12. Comprehensive Natural Hazard Risk Assessment Map of Armenia by Region (UNDP, 2022)

The mentioned study also presents data from the RA Ministry of Emergency Situations, statistics on natural phenomena that have occurred in Shirak region in recent years, etc. (Table 35).

Table 35. Statistical data on natural disasters in Shirak region for 2015-2020 (Ministry of Emergency Situations of the Republic of Armenia)

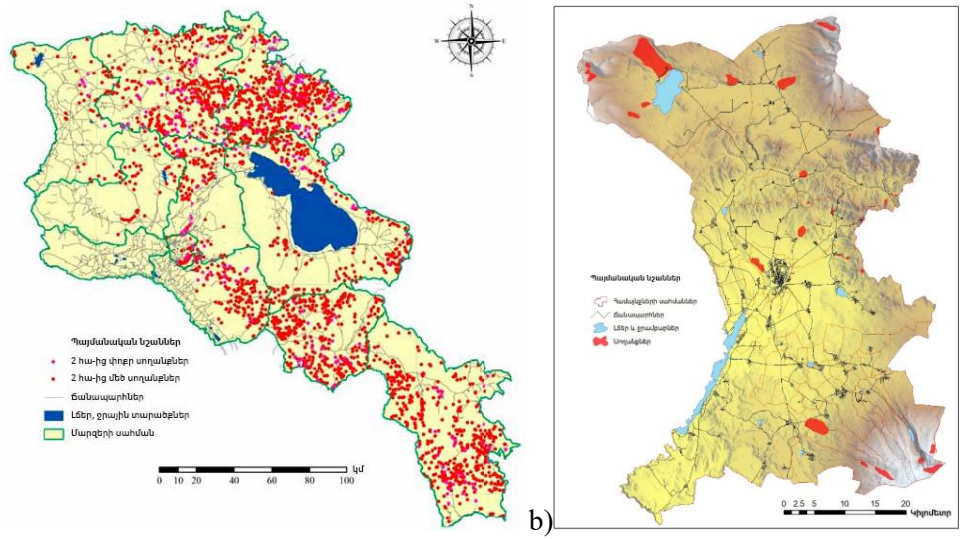
N	**Hazard**	**Number of natural hazards in Shirak region**	**Number of natural hazards in Armenia**
1	Rockfall	2	248
2	Strong wind, storm	88	856
3	Black ice	-	18
4	Heavy snowfall	-	10
5	Snowstorm	-	7
6	Flood	2	62
7	Collapse	2	19
8	Hail	70	402
9	Thunderstorm	3	13
10	Landslide	1	33
11	Flood	-	13
12	Water logging	1	8
13	Heavy rain	8	42
14	Earthquake	22	82
15	Frostbite	-	3
16	Windy, stormy	1	1
17	Avalanche	-	1
	Total:	200	1819
Estimated direct losses caused by natural hazards in Shirak region in 2018 and 2019			
2018			

RA Government Decision #1405-N, November 29, 2018.	
Number of natural hazards:	26
Damaged area (ha):	2376.16
Amount of damage (million drams):	2683.1
Compensation amount (million drams):	123.9
2019 RA Government Decision #1835-N, December 13, 2019.	
Number of natural hazards:	35
Damaged area (ha):	7091.98
Amount of damage (million drams):	5139.8
Compensation amount (million drams):	243.3

The data show that the total number of hydrometeorological hazards significantly exceeds external hazards (earthquakes, landslides, rockfalls). A study of the number of natural hazards for 2010, 2015 and 2020 revealed trends in the frequency of floods, waterlogging, river overflows, and flash floods in Shirak region, but the number of extensive rains is increasing.

Floods, river overflows, mudflows, landslides, strong winds, rockfalls, and avalanches have been identified as dangerous natural phenomena caused by climatic features that threaten settlements and infrastructure in the Shirak region.[37] These natural phenomena can not only cause great destruction and damage to settlements, roads, nearby structures, and infrastructure located in their area, but also cause human casualties.

Of the mentioned hazards, landslides are especially widespread in mountainous and foothill regions, where mountain rocks slide under the influence of gravity on steep slopes, due to frequent heavy precipitation and over-moistening of the slopes. In Shirak province, landslides are mainly widespread in the upper reaches of the Karkachun, Mantash and Jajur rivers of the Aragats massif, as well as near the Yeghnajur and Ellarget rivers flowing into the Arpi Lake reservoir and in the Ashotsk and Ghazanchi river basins. Landslides are not active, the danger level is not high, but there are some active landslide areas around the settlements of Arap and Marmashen.[38] Landslide prevalence maps in Armenia and Shirak region are presented in **Figure 13**.



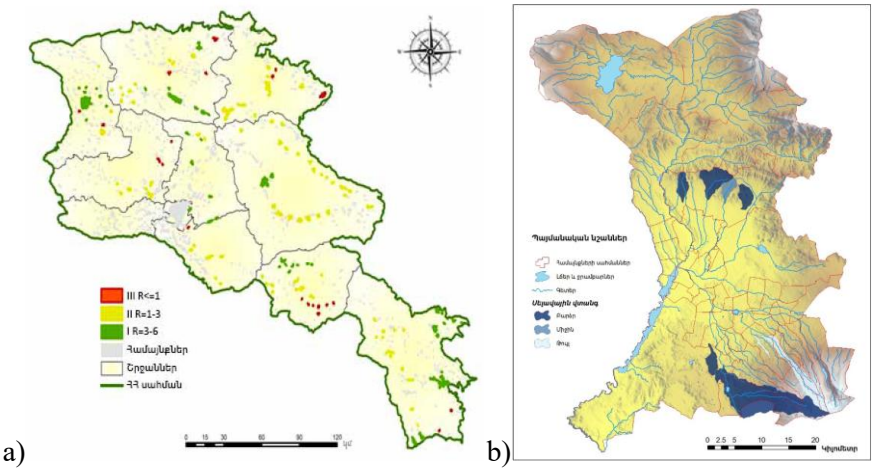
a) b)

Figure 13. a) The spread of landslides in the territory of the Republic of Armenia[39], b) Landslide hazard map of Shirak region[40].

[37] Shirak Region Adaptation Plan. "National Adaptation Plan to Advance Medium- and Long-Term Adaptation Planning in Armenia" Project. UNDP, 2022.
[38] Akhuryan River Basin Management Plan, 2016.
[39] 4th National Communication on Climate Change, 2020.
[40] The study on landslide disaster management in the Republic of Armenia. Final report, Vol. IV, KOKUSAI KOGYO CO., LTD. and NIPPON KOEI CO., LTD., Yerevan, 2006.

Due to heavy and prolonged rains, mudflows are often formed in a number of small rivers of the Akhuryan River Basin, which sometimes cause disasters. The most famous mudflows are mainly spread on the southern slopes of the Shirak mountain range. Here, the most mudflow-prone tributaries are Gyumri, Hatsik, Jajur, Musayelyan, Kamo, and Hovit, especially due to heavy summer rains. The frequency of mudflows is 3-5 years.[41] There is a low to medium risk of mudflows between Lake Arpi and the Akhuryan Reservoir.[42]

Mudflows, like floods, cause great material damage and can also be accompanied by human casualties. Maps of mudflow-prone settlements in Armenia and Shirak region are presented in Figure 14.



a) b)

Figure 14. a) Flood-prone settlements in Armenia by risk level (RI-III)[43], b) Flood-prone areas of Shirak region[44].

The number of communities affected by natural hazards as of 2014 by region and their area of coverage are summarized in Table 36.

Table 36. Number of communities affected by hazards by region and their area of coverage.[45]

N	Region	Region surface	Total amount of communities	Communities with hazards																	
				Hail		Flooding		Mudflow		Landslide		Strong wing		Extensive precipitation		Frost		Drought		Rockfall	
				Number of communities	Community surface %	Number of communities	Community surface %	Number of communities	Community surface %	Number of communities	Community surface %	Number of communities	Community surface %	Number of communities	Community surface %	Number of communities	Community surface %	Number of communities	Community surface %	Number of communities	Community surface %
1	Yerevan	22.78	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2	Aragatsotn	329.69	113	100	94.0	48	37.2	29	39.5	3	1.9	66	54.2	7	7.3	21	20.8	46	34.3	7	4.6
3	Ararat	964.66	89	53	66.5	24	32.3	18	39.7	4	21.0	20	40.3	1	0.8	3	7.6	9	34.5	4	6.1
4	Armavir	135.17	93	56	74.1	9	10.2	12	11.7	0	0.0	20	26.3	5	8.4	0	0.0	3	2.1	0	0.0
5	Gegharqunik	111.46	92	50	62.0	57	63.3	17	25.2	5	6	48	51.2	61	66.4	19	31.6	3	2.9	3	3.4
6	Lori	801.79	112	95	84.3	37	30.9	16	16.8	8	7.7	60	58.0	15	14.4	22	20.9	51	45.1	15	12.6
7	Kotayq	082.49	64	14	15.1	18	33.7	8	22.6	3	4.3	20	26.2	5	8.6	1	3.3	3	1.6	10	19.1
8	Shirak	674.80	118	84	69.1	30	26.0	26	25.1	3	2.9	78	64.1	7	6.0	4	2.2	1	1.0	0	0.0
9	Syunik	264.38	105	31	28.8	11	10.2	12	8.7	6	4.4	50	45.0	10	15.0	1	2.0	60	48.2	14	12.2
10	Vayots Dzor	300.00	43	38	81.4	26	56.3	17	39.8	10	18.3	33	70.7	11	25.2	11	22.5	1	6.4	12	23.5
11	Tavush	705.48	60	40	67.5	22	39.9	2	7.7	17	33.1	8	24.9	4	7.8	14	14.3	2	3.2	6	15.6
	Total	8592.70	890	561	63.4	282	35.7	157	23.7	59	10.2	403	48.6	126	19.8	96	14.2	179	21.1	71	10.5

[41] Akhuryan River Basin Management Plan, 2016.
[42] Environmental and Social Impact Assessment (ESIA) Report Preparation Consultancy Services, Akhuryan River Integrated Water Resources Management (IWRM), Construction of Kaps Reservoir and Gravity Irrigation System. Final version of the main Environmental and Social Impact Assessment Report. Yerevan, 2020.
[43] 4th National Communication on Climate Change, 2020.
[44] R. Ter-Minasyan: RA mudflow hazard map, 2007. https://sustainable-caucasus.unepgrid.ch/layers/geonode:mudflow_arm
[45] Climate Change Risk Analysis and Assessment: TAVUSH. SUMMARY "Mitigating Climate Change Risks in Rural Communities through Improved Local Development Planning" UNDP, 2014.

The UNDP study of Shirak region also presents an assessment of the region's vulnerability to climate change, presented in terms of the share of the weights of different sectors (Figure 15), from which it follows that the most important sectors in terms of vulnerability of Shirak region are water resources and agriculture, followed by settlements, energy and healthcare.

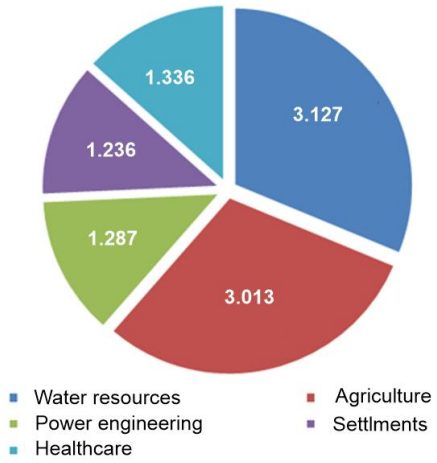
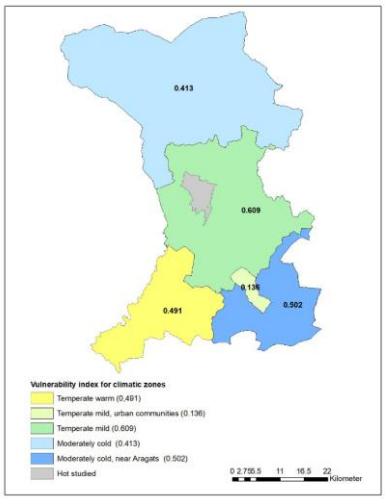


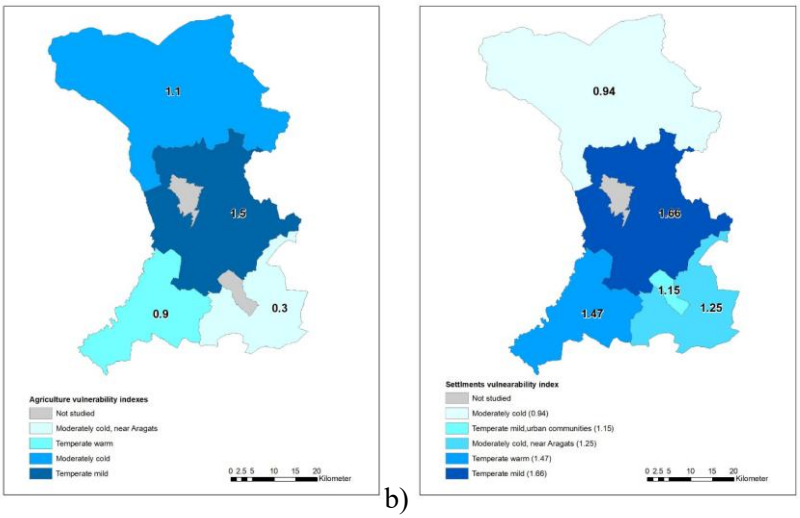
Figure 15. Weights of the sectors of Shirak region, with a distribution of 10 points[46]

The generalized vulnerability of Shirak regions by climatic zones is presented in Figure 16, and Figure 17 shows the vulnerability maps of a) agricultural sector and b) settlements.



a)

Figure 16. Shirak region vulnerability map (UNDP)



b)

Figure 17. Shirak region a) agriculture, b) settlements vulnerability maps (UNDP)

According to the maps of climate and related natural hazards and risks developed for Shirak and Lori regions, implemented within the framework of the UNDP "National Adaptation Plan to Advance Medium- and Long-Term Adaptation Planning in Armenia" project in 2022, the following climate hazards can be distinguished: extreme heat, drought, hail, late spring and early autumn frosts, heavy rains, forest fires, mudflows, and strong winds.

From the aforementioned study, Figure 18 below presents: a) absolute values of maximum temperatures and their repeatability for 5 years, b) maps of meteorological drought repeatability and variance, c) maximum number of days with dangerous and intense hail, its variance and repeatability for 5 and 10 years, and d) maps of strong wind gusts and maximum speed repeatability.

[46] Shirak Region Adaptation Plan. "National Adaptation Plan to Advance Medium- and Long-Term Adaptation Planning in Armenia" Project. UNDP, 2022.

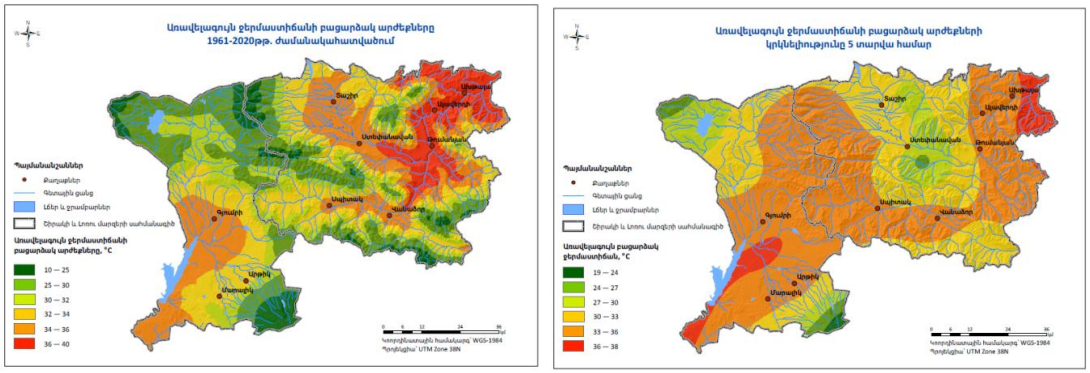


Figure 18a. Absolute values of maximum temperature during 1961-2020 and repeatability for 5 years (UNDP, 2022)

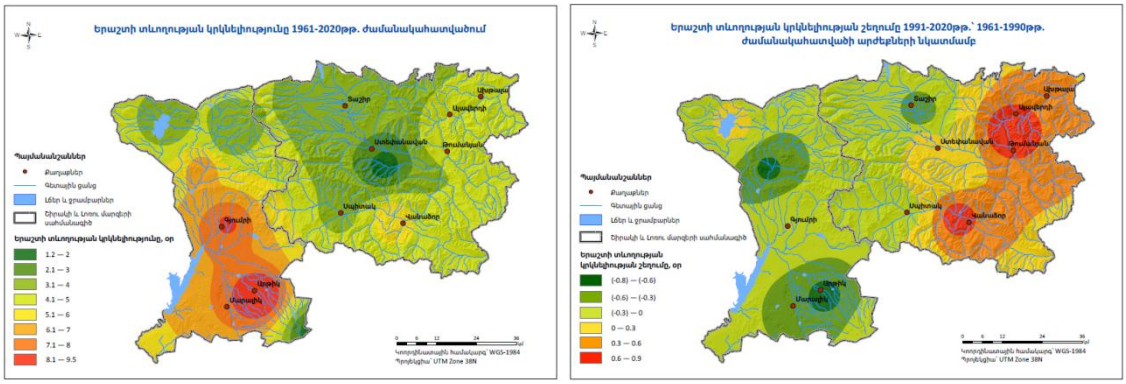


Figure 18b. Drought duration repeatability during 1961-2020 and the deviation of drought duration repeatability in 1991-2020 from the values during 1961-1990 (UNDP, 2022)

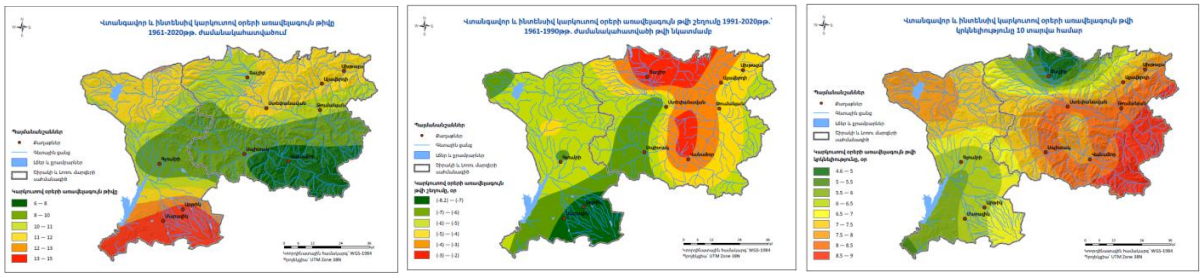


Figure 18c. Maximum number of days with dangerous and intense hail during1961-2020, its deviation from the number during 1991-2020 to the number during 1961-1990, and repeatability for 10 years (UNDP, 2022)

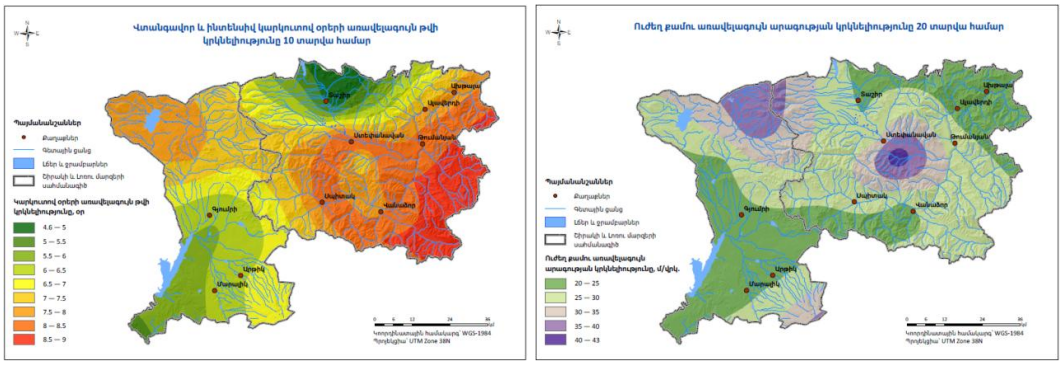


Figure 18d. Strong wind gusts during 1961-2020 and the repeatability of maximum strong wind speeds for 20 years (UNDP, 2022)

Shirak region is one of the regions of Armenia with high vulnerability to disaster-prone and extreme climatic events. The most dangerous natural hazards here are earthquakes, strong winds, hail, landslides and slides, mudflows, spring floods, frost, black ice, snowstorms, arid climatic conditions and drought, which cause significant damage to various sectors of the region's economy, having a significant negative impact on the socio-economic situation of the population.

Shirak region is the most hail-prone region in Armenia. According to the data of long-term observations of the anti-hail station previously operating in the Akhuryan region, the number of hail days in the region is 20-25 days. According to the data of the Ministry of Agriculture of the Republic of Armenia for 2004-2008, the average annual damage caused by hail in Shirak region is about 3 billion drams. Like other regions of Armenia, Shirak region has repeatedly suffered from strong winds and previously almost unheard-of tornadoes over the past two decades, which mainly caused great damage to settlements and infrastructure.

Over the past two decades, arid climatic conditions and drought have had a significant negative impact on the Shirak region, which are further exacerbated and deepened by the presence of constant winds characteristic of the region's climate, which increases evaporation and contributes to the dehydration and rapid drying of plants in arid croplands and pastures.

In 2023, UNICEF and the Disasters Risk Reduction National Platform foundation implemented the “Local Level Climate Risk Evaluation" project. The report presents schematic images of emergency cases recorded in Shirak region and their development trends over the last decade, built on the basis of data from the National Crisis Management Centre of the Ministry of Emergency Situations (Figures 40 and 41).

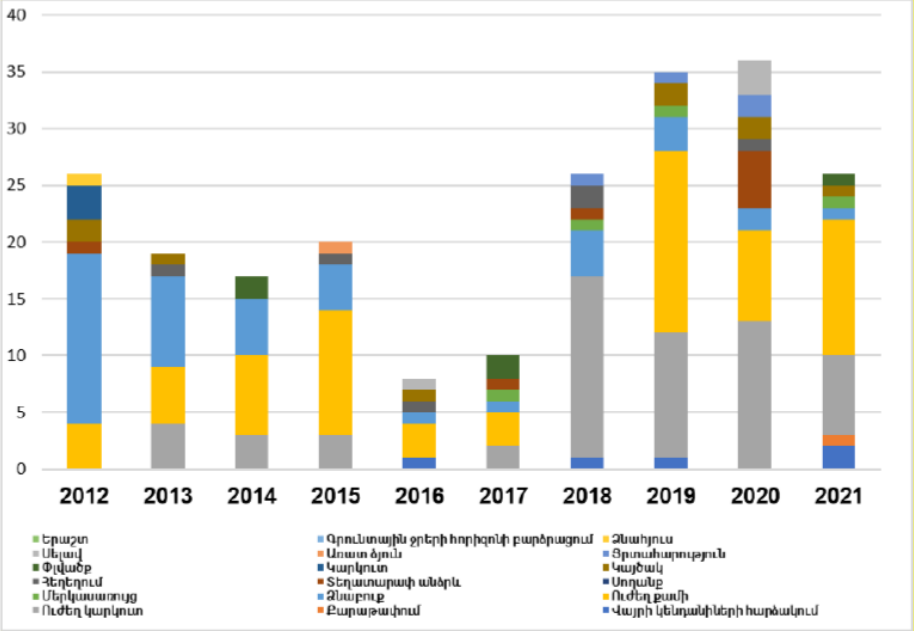


Chart 40. Total number of emergencies caused by natural hazards in Shirak province by year, 2012-2021.

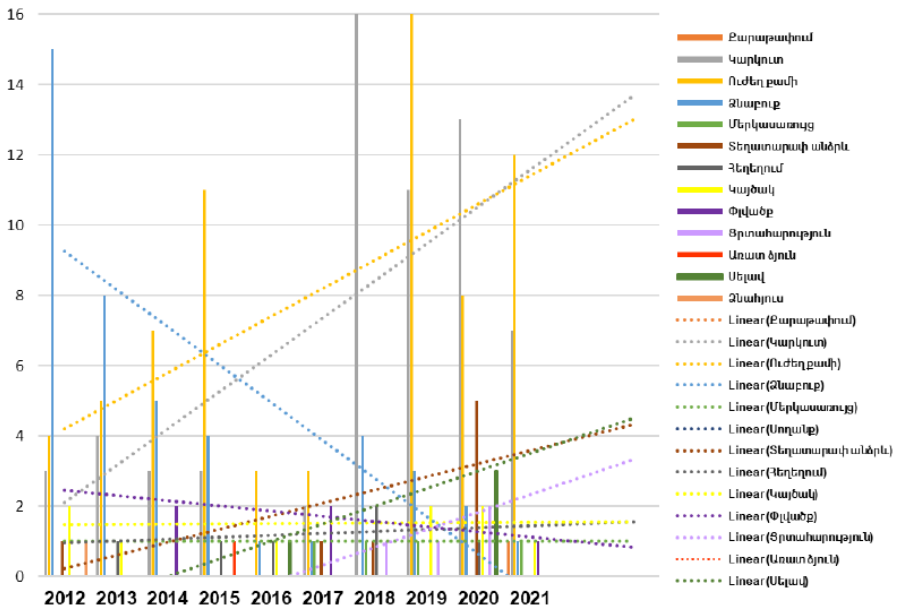


Chart 41. Development trends of individual hazards arising from the statistics of emergency cases recorded in Shirak region, 2012-2021.

From the data provided, the main causes of emergency cases registered in the region during the observed period are hydro-meteorological hazards and geological hazards caused by their impact (mudflow, flooding, landslide, rockfall). The provided graphs also show that the number of emergency cases caused by hydro-meteorological hazards has increased during the observed period and their number has increased significantly during 2018-2021 (the number of cases has doubled compared to the average for the period of 2012-2017).

Thus, it can be stated that based on the existing studies results, the following climatic hazards, typical for the region, can be identified for the Akhuryan community: **strong wind**, **hail**, **drought**, **mudflow**, **prolonged intense heat**, **continuous and heavy rain**, **frostbite** and **forest fire.**

11.4.3. Natural hazards and risks identified in the Akhuryan enlarged community as a result of surveys

In order to identify the climatic and other natural hazards and risks specific to the Akhuryan enlarged community, in addition to studying the existing analyses mentioned above, the expert team organized surveys of relevant stakeholders, within the framework of which, through a pre-developed questionnaire, the respondents' opinions were revealed regarding the climatic hazards specific to the community, their frequency and impact, as well as the vulnerability of key sectors.

The questionnaire was sent to the relevant stakeholders via e-mail. 33 settlements of the Akhuryan enlarged community participated and responded to the survey.

The most common climate hazards identified by the surveys are: hail, droughts and water shortages, extreme heat and storms, followed by heavy snowfall, heavy rains and forest fires. All identified hazards are presented in Table 37.

Table 37. Number of mentions of climate hazards in the Akhuryan enlarged community

	Climate risk	Community
1	Hail	31
2	Droughts and water scarcity	29
3	Extreme hot	20
4	Storm	15
5	Disease transmitted through air/water	10
6	Heavy snow	7
7	Heavy rains	6
8	Forest fire	5
9	Extreme cold	3
10	River flooding	1
11	Landslide	1
12	Rockfall	1
13	Waterborne diseases	1
14	Communicable diseases	1

11.4.4. Climate change risk assessment

Summarizing the results of calculations of observed atmospheric precipitation and temperature characteristic indices, the available information on observed climate hazards for the last 15 years, and the hazards identified by the Akhuryan community, each climate hazard was assigned a risk level, which should guide the planning and implementation priorities of further work.

Thus, the risk level was determined based on the combination of the probability and consequences of a given hazardous event, through which the overall risk of a given hazard was assessed.

Refraining from using different terminology, the risk assessment was conducted for hail, frost, forest fire, storm, heavy rainfall, mudflow, as well as extreme heat and drought hazards, brief definitions of which are presented in Table 38 below.

Table 38. Definitions of climate hazards

Hazard	Definition
Hail	5-50mm in diameter of transparent, or partly or completely opaque particles of ice precipitation, falling in irregular of ball form.
Frostbite	A decrease in air or soil surface temperature below 0°C during the growing season.
Forest fire	An uncontrolled fire in a forest/woodland area, which can be caused by lightning, extreme hot weather conditions, spontaneous combustion of dried plants, etc.
Storm	An atmospheric disturbance that may be characterized by strong winds and accompanied by rain, snow, or other precipitation, and by thunder and lightning.
Heavy precipitation	A significant precipitation event that occurs over a period of 1h, 3h, 6h, 12h, 24h, or 48h, where the total amount of precipitation exceeds a certain threshold defined for a given location.
Flood	A large flow of water caused by heavy rainfall, containing large amounts of debris and other materials, and can cause damage to settlements, industrial facilities, highways, irrigation systems, etc.
Extreme hot	A significant warming of the air or an intrusion of very hot air over a large area that lasts from several days to several weeks.
Drought	A complex of meteorological factors, combined with high air temperature and reduced humidity with a prolonged absence of precipitation, which leads to a disruption of the water balance of plants and their destruction (atmospheric and soil droughts are distinguished).

The likelihood and consequences of the hazards have been assessed according to the scale below and taking into account the results of all available analyses.

Table 39. Hazard assessment scale

N	Probability		Consequences
1	Low	The threat is unlikely to occur.	A hazard represents a low level of potential concern for the community. If it occurs, it will result in some consequences for the community, but these will have little or no significance for daily life.
2	Medium/ Moderate	The emergence of danger is likely.	The hazard represents a medium level of potential concern for the community. If it occurs, it will result in consequences for the community, but these will be of medium significance for daily life.
3	High	The threat is highly likely to occur.	A hazard represents a high (or highest) level of potential concern for a community. If it occurs, it will have extremely serious consequences for the community and daily life.

Based on the assessment of the probability and consequences of hazardous phenomena, risks were calculated (*risk = probability x consequence*) and a risk matrix was developed (Figure 42), according to which storms, hail, drought and heavy rainfall represent a high level of risk for the Akhuryan enlarged community, as well as frostbite, extreme heat and mudflows have a moderate level of risk.

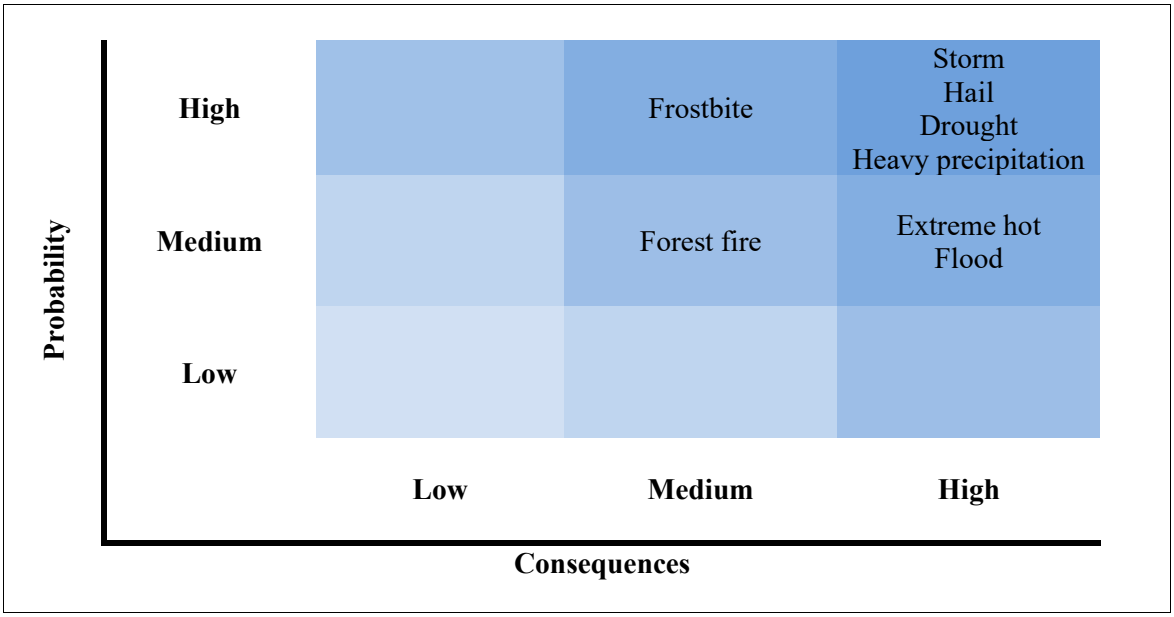


Chart 42. Akhuryan Community Risk Matrix

For all of the above-mentioned significant climate hazards and risks, their impact on various sectors was studied, which was a key component for the vulnerability assessment.

11.4.5. Climate change impact and vulnerability assessment

Climate change is evident in the territory of the Republic, which may theoretically and directly be related to the intensification of natural dangerous climatic phenomena in recent years.

Thus, according to the observations of the "Armhydromet" SNCO, over the past decades, as a result of climate change, the frequency and intensity of such hydrometeorological phenomena as severe frost, heavy rains and hail, droughts, and heat waves have increased significantly in the republic.

The number of cases of rapid snowmelt, as well as unseasonal river flooding, has increased, which in turn contributes to more intense occurrence of floods and mudflows.

The negative impacts of climate change are already being felt in human health, infrastructure, agriculture, and a number of other sectors.

The adverse impact of climate change on the health of the population may be due to an increase in extremely high and low temperature days and sharp fluctuations in atmospheric pressure, heat waves, which are a risk factor for various diseases, especially cardiovascular diseases.

The assessment of current and future climate hazards (risks) specific to the community was carried out in accordance with the Covenant of Mayors methodology and the Covenant Reporting Guidelines, based on the summarized climate hazards and risks, available information[47], as well as survey results from settlements.

Table 40 below summarizes the indicators of frequency, impact and intensity of hazards, which were obtained taking into account the analysis of information extracted from relevant sources. From the entire complex of identified risks mentioned above, only those hazards/risks for which the level of hazard/risk is high or moderate have been included in this table.

Table 40. Akhuryan community's present and future climate hazards

Climate risk	The current risk of hazard occurring		Future threats		
	Probability of hazard	The impact of the threat	Expected change in hazard intensity	Expected change in hazard frequency	Terms
Storm	High	High	Unchanged	Unchanged	Short-term
Hail	High	High	Unchanged	Unchanged	Short-term
Drought	High	High	Unchanged	Growth	Medium term
Heavy precipitation	High	High	Unchanged	Growth	Medium term
Frostbite	High	Moderate	Unchanged	Unchanged	Short-term
Extreme hot	Moderate	High	Unchanged	Growth	Medium term
Flood	Moderate	High	Growth	Unchanged	Medium term

The vulnerability assessment for the Akhuryan community was carried out taking into account the levels of their impact on the community economy and other sectors, and vulnerability to the increase in the number of diseases and energy risks was also emphasized.

[47] Including the Shirak Region Adaptation Plan developed by UNDP in 2022.

The socio-economic, physical and environmental vulnerabilities typical of the Akhuryan enlarged community are summarized in Table 41.

Table 41. Socio-economic, physical and environmental vulnerabilities typical for the Akhuryan community

Vulnerability type	Vulnerability description
Socio-economic	Hail and heavy rainfall will negatively impact the community's agriculture, cause material damage and raising food and nutrition security issues. Damage to road infrastructure due to flash floods will have a negative impact on passenger and freight transportation and, as a result, on the economic development of the community. Storms will contribute to damage to housing infrastructure and social tensions. Prolonged dry weather will threaten people's lives and health and contribute to the deterioration of sanitary and hygienic conditions.
Physical and environmental	During heavy rains, large amounts of silt and topsoil are washed into the river, and prolonged dry weather will contribute to the deterioration of agricultural lands. The mudflows will endanger the environment, as well as increase the safety risk for the community's population. Due to precipitation and mudflows, intra-community roads become impassable. Strong winds mainly threaten building roofs and power lines. Hailstorms damage military bases, buildings, and cars.

Sectoral vulnerability assessment

Based on the climate hazards identified in Table 39, their impact, intensity and frequency, the impact of the most typical hazards on the community economy and target sectors was assessed by vulnerability level (Table 42).

Table 42. Vulnerable sectors of the Akhuryan community according to vulnerability level

N	The most common hazards	Vulnerable sectors by vulnerability level				
		I	II	III	IV	V
1	**Storm**	Buildings	Agriculture	Energy	Environment and biodiversity	Civil defense and state of emergency
2	**Hail**	Agriculture	Buildings	Transport	Energy	Environment and biodiversity
3	**Drought**	Agriculture	Land use planning	Water Resources	Healthcare	Environment and biodiversity
4	**Heavy precipitation**	Transport	Energy	Civil defense and state of emergency	Agriculture	Buildings
5	**Extreme Cold**	Agriculture	Land use planning	Environment and biodiversity	Energy	Healthcare
6	**Extreme hot**	Water Resources	Agriculture	Buildings	Energy	Healthcare
7	**Flood**	Agriculture	Transport	Environment and biodiversity	Tourism	Land use planning

Taking into account all available studies, the impact of the above-mentioned most dangerous phenomena on various sectors is summarized in Table 43 by degree of impact (high: Levels I and II, and moderate: Levels III and IV).

Table 43. Potential vulnerability of key sectors in the Akhuryan community to selected climate hazards

Sector	Description
STORM	
Buildings and structures	Damage or demolition of roofs of buildings and structures and the need for related restoration work.
Agriculture	Deterioration of agricultural lands.
Energy	Damage to power lines, increase in the number of accidents, decrease in the reliability of power supply.
Environment and biodiversity	Environmental pollution: the spread of elevated dust around residential areas, air pollution.

Sector	Description
HAIL	
Agriculture	Deterioration of agricultural lands.
Buildings and structures	Damage to roofs and windows of buildings and structures, as well as infrastructure.
Transport	Reduced visibility.
	Difficulty and slowing of movement.
	Increase in the number of accidents.
Energy	Damage to power lines and substations, possible power outage.

Sector	Description
DROUGHT	
Agriculture	Decline in agricultural productivity.
	Significant increase in financial and labor costs related to seeds, fertilizers, sowing, as well as crop insurance.
	Deterioration/degradation of agricultural lands.
Land use planning	Increase in land areas exposed to climate hazards.
	Risk of reduced yield levels.
Water resources	Increased load on the irrigation system.
Healthcare	Deterioration of sanitary and hygienic conditions, threat to people's life and health.

Sector	Description
HEAVY PRECIPITATION	
Transport	Reduced visibility.
	Difficulty and slowing of movement.
	Increase in the number of accidents.
Energy	Damage to power lines, increase in the number of accidents, decrease in the reliability of power supply.
Civil defense and emergency situations	Increase in the frequency, severity and complexity of extreme weather events and emergencies.
Agriculture	Increased extreme rainfall, soil erosion, and crop damage due to more intense rainfall.
	Difficulty grazing on overly wet soils and reduced forage production in the event of increased precipitation.

Sector	Description
EXTREME COLD	
Agriculture	Deterioration of soil conditions during the growing season.
Land use planning	Increase in land areas exposed to climate hazards.
Environment and biodiversity	Decrease or deterioration in the quality of ecosystem services.
Energy	Damage to power lines, increase in the number of accidents, decrease in the reliability of power supply.

Sector	Description
EXTREME HEAT	
Water resources	Increased load on the irrigation system.
Agriculture	Decline in household and agricultural productivity.
	Deterioration/degradation of agricultural lands.
Buildings and structures	Increased demand for summer cooling (air conditioning) of buildings and structures and associated energy consumption.
	An increase in the number of buildings and structures that do not meet climatic conditions (do not provide comfort conditions): an increase in the demand for thermal insulation and ventilation of such structures.
Energy	possible power outage.

Sector	Description
MUDFLOW	
Agriculture	Decline of the agricultural and food industries.
Transport	Damage to the quality of road surface, flooding of roads and deterioration of traffic safety conditions.
	Significant damage to roads and other transportation infrastructure.
Environment and biodiversity	Plant damage. Accelerated habitat degradation for some species of animals and plants.
Tourism	Poor condition of roads/routes.

Summarizing in the context of climate change of Akhuryan, the results of the analysis of the impact of climate and other natural hazards on the community economy and target sectors should also mention the main factors contributing to the increase in the negative impact of climate risks, which should be taken into account when developing a concept for increasing the climate resilience of any community.

Such factors include:[48]

- Inadequate management of water resources, sanitation systems, and solid waste, leading to disease outbreaks, as well as floods and landslides.
- The degradation of ecosystems due to human activities, such as deforestation, overgrazing, construction, environmental pollution, the use of wetlands, and unsustainable resource extraction, which threaten the ability to provide essential services.
- Deteriorated infrastructure and a stock of emergency state buildings, which could lead to the collapse of structures.

[48] МСУОБ ООН (2012) Improving the resilience of cities to disasters - Handbook for the heads of municipalities and local authorities. Geneva, Switzerland. International strategy of the UN to reduce the danger of disasters.

- The adverse effects of climate change, which could lead to sharp (extreme) increases or decreases in temperature and precipitation (depending on the situations of countries), which will affect the frequency, intensity and spread of floods and other climate-related hazards.

Vulnerable groups of the population

The poor are among the most vulnerable groups to climate change. The adaptive capacity of poor citizens is severely limited, as they lack the resources to protect themselves from crises and their consequences, and the places where they live are most vulnerable to climate hazards.

In Armenia, as in the rest of the world, the poverty rate among women is higher than among men. There are a number of reasons for the latter, including the more often informal employment of women, and consequently the instability of income. It is noteworthy that poverty among women is higher, as they spend more time on housework and raising children.

In terms of vulnerability to the negative impacts of climate change, the elderly can also be noted. Although the poverty rate in the age group over 60 in the Republic of Armenia is below average[49], but climate change may have a greater negative impact on the health of older people.

According to the World Health Organization[50], the elderly are more vulnerable to prolonged extreme heat and cold weather conditions, air pollution, and the spread of infectious diseases, as they have a harder time adapting to such conditions and have weaker immune systems.

One of the issues related to infrastructure and services is the limited mobility, which hinders the mobility of the population, and in particular women. The availability of safe and accessible public transport systems increases women's mobility and expands opportunities for time use and economic empowerment.

Table 44 below presents the population vulnerability to each of the most important or significant climatic and other natural hazards.

Table 44. Vulnerable population groups

Climatic or other natural hazard	Vulnerable groups	Vulnerability level
Storms	Residents of the community and visitors.	High
Hail	Residents of the community and visitors, all persons living or working in remote areas, low-income households.	High
Drought (and water scarcity)	Those living or working in affected areas, especially the elderly, chronically ill, children, those working outdoors in the heat, those with mobility issues, athletes, and the homeless.	Moderate
Heavy precipitation	All persons living or working in the affected areas, especially the elderly, chronically ill, children, outdoor workers, people with limited mobility, athletes, homeless people, etc. Those living around the Debed River are particularly vulnerable.	Moderate
Frostbite	Elderly, children, low-income households.	Moderate
Flood	Residents of the community and visitors.	Moderate
Extreme hot	Elderly, children, low-income households.	Moderate

[49] https://armstat.am/file/article/poverty_2021_a_2..pdf
[50] https://cdn.who.int/media/docs/default-source/decade-of-healthy-ageing/decade-connection-series-climatechange.pdf?sfvrsn=e926d220_3&download=true

Adaptive capacity

Adaptability or adaptive capacity is the possibility of the ecosystems, institutions, people and other organisms to respond to the probable damages or use the consequences to adapt.

In other words, adaptive capacity can be described as the ability of a person or system to adapt to climate change (including climate variability and extremes), reduce potential damages, take advantage of opportunities, or cope with consequences. Adaptive capacity is a function of available financial resources, human resources, and adaptation options. Capacities may vary depending on climate hazards and target sectors. For example, a region or community that is well-prepared to withstand floods may be extremely vulnerable to a heat wave.

From this perspective, it is very important to conduct the adaptation assessment in the context of specific risks and sectors, which can be the subject of a separate detailed study.

According to a report by the United Nations Office for Disaster Risk Reduction, Cities or communities are considered sustainable[51]:

- where the risk of hazards is minimized, as the population lives in houses and regions equipped with the necessary engineering infrastructure and built according to reasonable construction standards, where illegal construction is not carried out, especially in coastal areas and on steep slopes;
- where there is a competent and responsible city government, representing broad segments of the population, which is interested in sustainable urban development processes and is ready to allocate the necessary funds for the development of its own capacities to solve managerial and organizational problems before, during and after natural hazards;
- where local authorities and residents are aware of existing risks and create a local information base on the damages caused by natural hazards, as well as threats and risks, also indicating the most vulnerable groups of the population;
- where people have the opportunity to participate in decision-making and the development of their communities, together with local authorities;
- Where measures are taken to prevent or mitigate the consequences of disasters, monitoring and early warning technologies are implemented to protect infrastructure, residents' property, cultural values, as well as natural and economic resources.
- where it is possible to minimize material and social damage caused by extreme weather events and hazards caused by human activity;
- where there are opportunities for rapid response and implementation of measures for the immediate restoration of vital services, as well as social, organizational and economic activities, after each emergency;
- where people recognize that all of the above measures also play an important role in strengthening community resilience to the impacts of adverse natural phenomena, including GHG emission reduction and adaptation.

According to the Covenant of Mayors Reporting Guidelines[52], the following five factors of adaptive capacity are defined, which describe the current ability of a community in a given area to adapt to the impacts of climate change:

[51] МСУОБ ООН (2012) Improving the resilience of cities to disasters - Handbook for leaders municipalities and local government bodies. Geneva, Switzerland. UN International Strategy reducing the danger of disasters.
[52] Reporting Guidelines, Covenant of Mayors - Europe Office in March 2020

- **Service availability:** access to basic services (e.g. healthcare, education, etc.).
- **Socio-economic:** interaction between the economy and society, combined with the presence of relevant assets (e.g. economic health, employment, poverty, immigration), as well as the level of social awareness and cohesion.
- **Governmental and institutional:** the existence of the institutional environment, regulations and policies (e.g. laws on restrictions, preventive measures, urban development policies), the leadership and competences of local government bodies, the capacities of staff and existing organizational structures (e.g. knowledge and skills of staff, the level of interaction between relevant departments and bodies of municipalities), the existence of a sufficient budget for climate (adaptation) actions.
- **Physical and environmental:** availability of resources (e.g. water, land, environmental services) and their management practices, availability of physical infrastructure and conditions for its use and maintenance (e.g. green-blue infrastructures[53], health and educational institutions, emergency response facilities).
- **Knowledge and innovation:** availability of data and knowledge (e.g. methodologies, guidelines, assessment and monitoring frameworks), availability and access to technologies and technical applications (e.g. meteorological systems, early warning systems, flood control systems) and the skills and capacities needed to use them, and innovation potential.

Each community should have the opportunity to assess its sectoral adaptive capacity to climate change, taking into account the factors mentioned above.

The main branches of economic development of the Akhuryan community are agriculture, in particular, animal husbandry and farming, as well as small and medium-sized enterprises. Steps are being taken to develop the above-mentioned sectors through the budgets of state, community, donor institutions, and private investments, which can contribute to strengthening the community's adaptive capacity to climate change.

Despite the fact that the adaptive capacity of the Akhuryan community is very low, it is worth noting the community's capabilities and factors for coping with climate change, which are:

- ***Access to basic services***: Akhuryan community has access to information sources and means of communication, inter-community roads, access to education, availability of health facilities, availability of banks and credit organizations.
- ***Physical and environmental:*** Akhuryan community has a favourable economic and geographical location, access to drinking water, natural springs, etc., which, if properly used and managed, will contribute to the development of agricultural activities.

11.5. Climate change adaptation measures

Thus, based on the vulnerabilities of the main sectors of Akhuryan community to climate and other natural hazards listed in Table 43, as well as taking into account the “Shirak Region Adaptation Plan” developed

[53] Green-blue infrastructures: natural and semi-natural territories strategically planned as systems, which have environmental features, which Ecosystems are created and maintained services wide to provide a framework, such as water cleaning, air quality control, reduced heat stress, rest areas, as well as climate change mitigation and adaptability. Green (land) and blue (aquatic) territories are the systems that can improve surrounding environment conditions and, therefore, residents of communities health and life quality. It also support green economy, creation of jobs opportunities and contribute biodiversity. At the local (community) level, green infrastructure practices include rainwater-irrigated gardens, permeable pavements, green roofs, water infiltration systems, trees and tree boxes, and rainwater harvesting systems, etc. Blue infrastructure usually refers to urban water infrastructure, including ponds, lakes, rivers, streams, as well as rainwater and stormwater removal, storage, and use systems.

in 2022 and the proposed priority solutions for climate change adaptation, the specialists of the community municipality and the Project experts have developed a short-term (until 2030) and medium-term (until 2050) adaptation plan. The list of adaptation measures to be implemented is summarized in Table 45.

It should be noted that the vulnerability of sectors to climate risks in the Akhuryan enlarged community, as well as the identification of targeted adaptation measures, is the subject of a separate, detailed and comprehensive study. Within the framework of the SECAP, the main climate hazards have been identified and initial adaptation measures have been proposed, which will subsequently require separate studies to make more objective decisions on their prioritization, implementation approaches, and funding volumes and sources.

The included programs are planned to be implemented with investments from the community and state budgets, local and international donor organizations, private companies, etc.

The SECAP also includes activities of priority/key importance for the community, for the implementation of which the community seeks funding sources in the absence of clear funding sources.

Table 45. List of adaptation measures to be implemented by 2050 within the framework of the Akhuryan Community SECAP

Description	Risks / hazards	Responsible / beneficiaries	Possible source of funding	Terms	Social, economic and environmental benefits
BUILDINGS AND STRUCTURES					
1.1. When designing new buildings and structures in the community, consider construction standards under climate change, as these structures must be operated in conditions of heavy rainfall, strong winds, and hail.	• storms • heavy rainfall • hail	Municipality, design organizations, developers and owners, supervisory bodies.	Community budget, state budget, international projects, private sector.	2026-2050	Reduces damage from climate hazards and ensures the safe operation of structures, increasing the social protection of communities, promoting the sustainability of the livelihoods of women and vulnerable groups, and reducing economic losses.
1.2. Study the physical condition of residential homes and buildings, while assessing the actual level of negative impacts of climate change and developing work plans aimed at reducing losses.	• storms • heavy rainfall	Municipality, design organizations, developers and owners, supervisory bodies.	Community budget, state budget, international projects, private sector.	2026-2030	Enable the development of loss reduction plans that ensure social protection of the population, reduce economic losses, and promote the formation of resilient and environmentally responsible communities, emphasizing the needs of women and vulnerable groups.
1.3. Regular inspection of community-owned buildings, inventory of buildings with defects and damaged foundations, repair and/or waterproofing.	• heavy rainfall • flooding • mudflow	Municipality, residents, service organizations, condominiums.	Community budget, state budget, residents' funds, other sources.	2026-2030	Reduce damage from climate hazards, ensure social protection of the population and the safety of vulnerable groups, reduce economic losses, and contribute to the long-term sustainable operation of structures.
1.4. Inspection of roofs of multi-apartment buildings, inventory of roofs vulnerable to heavy rainfall, hail and strong winds, repair of	• storms • heavy rainfall • hail	Municipality, residents, service organizations, condominiums.	Community budget, state budget, residents' funds, other sources.	2026-2030	Reduces damage from climate hazards and ensures the safe operation of structures, increasing the social protection of the

vulnerable roofs, replacement of roof coverings (e.g. with galvanized sheet metal), reinforcement of supporting structures/bearing structures, replacement of worn-out timber, modernization of the drainage system. *			(Required investment: approximately 1 million euros)		population, the sustainability of the livelihoods of vulnerable groups and women, reducing economic losses, and promoting the resilience of communities.

*Note: * Key action.*

Description	Risks / hazards	Responsible / beneficiaries	Possible source of funding	Terms	Social, economic and environmental benefits
TRANSPORT					
2.1. Monitoring the quality of road surface, timely and proper ongoing repair of damaged sections in order to prevent infrastructure deterioration and deterioration of traffic safety during heavy rainfall, hail and mudflows.	• hail • heavy rainfall • mudflow	Municipality, road construction organizations.	Community budget, state budget.	2026-2030.	Preventing infrastructure degradation and deteriorating traffic safety by ensuring social protection for the population, reducing economic losses, and promoting community resilience to climate hazards.
2.2. During the design and construction of major road infrastructure renovations and new roads, consideration shall be given to the possibility of operating these infrastructures in heavy rainfall, hail, mudflow and other conditions and the use of appropriate materials.	• heavy rainfall • hail • mudflow • flooding	Municipality, design organizations, developers and supervisory bodies, etc.	Community budget, state budget.	2026-2050	Prevent rapid deterioration of infrastructure and deterioration of traffic safety by ensuring social protection of the population, reducing infrastructural and economic losses, promoting the resilience of communities to climate hazards, and contributing to environmental protection through the use of sustainable and durable materials.
2.3. Ensuring the smooth operation, proper cleaning, prevention and repair of stormwater and stormwater	• heavy rainfall • mudflow	Municipality, road construction and operating organizations,	Community budget, state budget,	2026-2050	Reduce the damage caused by climate hazards, ensure social protection of the population and

drainage systems and stormwater drains in order to prevent road blockages due to flooding, as well as to ensure traffic safety.	• flooding	etc.	international projects, donors, etc.		the security of vulnerable groups, reduce infrastructural and economic losses, and contribute to the long-term resilience of communities.

Description	Risks / hazards	Responsible / beneficiaries	Possible source of funding	Terms	Social, economic and environmental benefits
ENERGY					
3.1 Ensuring the reliability of community (especially residential sector and healthcare facilities) energy supply systems in the context of climate hazards.	• climate extremes	Municipality, "ENA" CJSC, "Gazprom-Armenia" CJSC, other organizations	Community budget, state budget, private sector, donors.	2026-2050	Ensures social protection of the population and the sustainability of the livelihoods of vulnerable groups by reducing risks arising from energy disruptions, reduces infrastructural and economic losses, promotes the resilience of communities to climate hazards, and contributes to environmental sustainability by ensuring the efficient and clean operation of energy supply systems.
3.2. In emergency situations, ensuring alternative energy sources for uninterrupted energy supply to facilities of strategic importance to the community.	• heavy rainfall • storms • hail	Municipality	Community budget, state budget, donors.	2026-2050	Ensures the uninterrupted operation of strategically important facilities in emergency situations, reducing social risks and security threats to vulnerable groups, prevents infrastructural and economic losses, promotes the resilience of communities to climate hazards, and contributes to environmental sustainability

					through the effective use of alternative energy sources.
3.3. Planning and implementation of programs and activities aimed at community energy efficiency and energy saving.	• storms • hail	Municipality	Community budget, state budget, donors.	2026-2050	Reduces energy costs and dependence on external sources, ensuring social protection of the population and the sustainability of livelihoods of vulnerable groups, promotes the long-term resilience of communities to climate hazards, and contributes to environmental sustainability through the implementation of energy efficiency and energy saving measures.
3.4. Large-scale use of renewable energy resources for energy supply of community-owned structures. *	• climate extremes	Municipality	Community budget, state budget, donors. (Required investment: approximately 0.5 million euros)	2026-2030	Reduces economic costs and energy dependence, ensures social protection of the population and the sustainability of the livelihoods of vulnerable groups, especially women, as well as promotes environmental sustainability by reducing emissions and contributing to the formation of a clean environment.
3.5. Development of a program to optimize energy consumption in municipal buildings during periods of extremely high and low temperatures.	• extreme hot • extreme cold	Municipality	Community budget, state budget, international organizations.	2026-2030	Reduces excessive energy consumption and economic costs in extreme temperatures, ensures social protection of the population and the sustainability of livelihoods of vulnerable groups, promotes the resilience of communities to climate hazards, and contributes to environmental

					sustainability by reducing emissions and contributing to the formation of a clean environment through optimal energy consumption.

Note: * *Key action*.

Description	Risks / hazards	Responsible / beneficiaries	Possible source of funding	Terms	Social, economic and environmental benefits
WATER RESOURCES					
4.1. Study of existing irrigation and drinking water pipelines and water supply systems and identification of deficiencies, repair of damaged infrastructure or, if necessary, construction of new pipelines.	• drought	Municipality, water supply companies.	Community budget, state budget, private sector, international projects, donors, etc.	2026-2050	Ensure social protection of the population and the sustainability of the livelihoods of vulnerable groups, especially women, reduce economic losses and contribute to the long-term resilience of communities to climate hazards.
4.2. Organization of information campaigns on reducing water consumption and saving and using water economically.	• drought	Municipality, water supply companies, NGOs, donors.	Community budget, private sector.	2026-2030	Raise awareness among the population, ensure social protection and inclusive participation of vulnerable groups, especially women, reduce economic losses, and contribute to the effective and environmentally sustainable management of water resources.

Description	Risks / hazards	Responsible / beneficiaries	Possible source of funding	Terms	Social, economic and environmental benefits
LAND USE PLANNING					
5.1. Monitoring of natural water bodies, water catchments, ponds, ecological buffer zones existing in the community and development of a program to prevent their reduction.	• drought	Municipality, NGOs, international programs, private sector, RA Ministry of Environment.	Community budget, state budget, donors, international projects, other sources.	2026-2050	Prevents the reduction of natural water bodies and ecological buffer zones, ensuring social protection of the population and the safety of vulnerable groups, reduces infrastructural and economic losses, promotes the long-term resilience of communities to climate hazards, and contributes to environmental sustainability by preserving aquatic ecosystems and contributing to the formation of a clean environment.
5.2. Creation of community green zones or restoration, expansion of existing zones and recreational areas, parks and gardens, provision and maintenance of water supply. *	• drought	Municipality, NGOs, international programs, private sector.	Community budget, state budget, donors, international projects, other sources. (Required investment: approximately 0.5 million euros)	2026-2030	Ensures the social protection of the community population and the safety of vulnerable groups by preventing the loss of green zones and recreational areas, reduces infrastructural and economic losses, promotes the long-term resilience of communities to climate hazards, and contributes to environmental sustainability by preserving and expanding green spaces, improving air quality, and contributing to the formation of a clean and healthy environment.

Note: * *Key action*.

Description	Risks / hazards	Responsible / beneficiaries	Possible source of funding	Terms	Social, economic and environmental benefits
AGRICULTURE					
6.1. Apply vegetated windbreaks in areas frequently affected by strong winds.	• storms	Municipality, international companies, agricultural enterprises, individuals	Community budget, state budget, donors, international projects, other sources	2026-2050	Reduces agricultural losses and ensures crop stability, contributing to food security, protecting the livelihoods of women and vulnerable groups, as well as the economic resilience of rural communities.
6.2. Ensuring sufficient irrigation of agricultural lands and the use of drought-tolerant crops in the context of climate hazards.	• drought	Municipality, water supply companies, agricultural enterprises, RA Ministry of Territorial Administration and Infrastructure.	Municipality, water supply companies, agricultural enterprises, RA Ministry of Territorial Administration and Infrastructure.	2026-2050	Reduce crop losses and increase food security by ensuring the sustainability of the livelihoods of women and other vulnerable groups, reducing poverty risks, and contributing to the economic resilience of rural communities.
6.3. Installation and use of anti-hail measures, development and use of an information and warning system.	• hail	Municipality, international companies, agricultural enterprises, individuals.	Community budget, state budget, donors, international projects, other sources	2026-2030	Reduce agricultural losses and ensure crop stability, increasing food security, promoting the protection of women and vulnerable groups, and reducing poverty risks.

Description	Risks / hazards	Responsible / beneficiaries	Possible source of funding	Terms	Social, economic and environmental benefits
ENVIRONMENT AND BIODIVERSITY					
7.1. Development and implementation of measures to destroy the population of invasive plants and pests.	• drought	Municipality, RA Ministry of Environment,	Community budget, international projects and other sources.	2026-2050	Reduces social and health risks to the community population by preventing damage caused by the spread of invasive plants and

		environmental organizations.			pests, contributes to environmental sustainability by preserving biodiversity and contributing to the formation of a clean and healthy environment.
7.2. Conservation of unlicensed landfills and prevention of their emergence and spread.	• Extreme heat • storm	Municipality, public organizations, international programs, private sector, RA Ministry of Environment.	Community budget, state budget, donors, international projects, other sources.	2026-2030	Reduce health and social risks, ensure the protection of communities and the sustainability of the livelihoods of vulnerable groups, especially women, reduce economic losses, and contribute to environmental sustainability by promoting the creation of a clean and safe environment.

Description	Risks / hazards	Responsible / beneficiaries	Possible source of funding	Terms	Social, economic and environmental benefits
CIVIL DEFENSE AND EMERGENCIES					
8.1 Introduction of an early warning system for the population about extreme climatic phenomena and hazards and informing them about appropriate measures, as well as the creation of assistance centres operating during such phenomena, especially for representatives of vulnerable groups of the population.	• heavy rainfall • drought • storms • flooding • hail	Municipality, RA Ministry of Territorial Administration and Infrastructure, NGOs, international projects.	Community budget, state budget, international projects, donors.	2026-2030	Ensures the social protection of the population and the safety of vulnerable groups, especially the elderly and children, by reducing the risks arising from extreme climatic events, promotes the long-term resilience of communities to climate hazards, and contributes to environmental sustainability by ensuring clean, safe, and healthy living conditions through early warning and assistance centres.

8.2. Ensuring uninterrupted operation of rainwater and stormwater drainage systems, proper cleaning, prevention of blockages, as well as modernization and expansion (see also measure 2.3).	• heavy rainfall • flooding • mudflow	Municipality, water supply companies, etc.	Community budget, state budget, international projects, private sector donors.	2026-2050	Reduces damage from climate hazards by ensuring social protection of the population and the safety of vulnerable groups, promotes environmental sustainability through the uninterrupted operation, modernization and expansion of rainwater and stormwater systems, which ensure a clean and safe environment.
8.3. Raising awareness and training of young people on the consequences, hazards, adaptation of climate change, as well as providing first aid to vulnerable groups of the population (e.g. the elderly) in emergency situations.	• climate extremes	Municipality, RA Ministry of Territorial Administration and Infrastructure, international projects.	Community budget, state budget, international projects, donors.	2026-2030	Ensures the social protection of the population and the safety of vulnerable groups, especially the elderly, by raising the level of awareness and preparedness of young people, forms conscious behaviour, and supports the maintenance of a clean and healthy environment.

Description	Risks / hazards	Responsible / beneficiaries	Possible source of funding	Terms	Social, economic and environmental benefits
HEALTHCARE					
9.1. Introduction of an early warning system for the population about extreme climatic phenomena and hazards, as well as the creation of assistance (help) centres operating during such phenomena, especially for representatives of vulnerable groups of the population.	• storms • drought • heavy rainfall • hail	Municipality, RA Ministry of Territorial Administration and Infrastructure, NGOs, international projects.	Community budget, state budget, international projects, donors.	2026-2030	Ensures social protection of the population and the security of vulnerable groups by reducing risks arising from extreme climatic events, promotes environmental sustainability by ensuring clean, safe and healthy living conditions through early

					warning systems and support centres.
9.2. Informing the population about the impact of climate on health through the media, internet resources, and methodological literature.	• climate extremes	Municipality, Ministry of Health of the Republic of Armenia, international projects.	Community budget, state budget, donors.	2026-2030	Ensures social protection and health security of the population by raising awareness about climate impact, promotes environmental sustainability by shaping conscious behavior and supporting the maintenance of a clean and healthy environment.

Description	Risks / hazards	Responsible / beneficiaries	Possible source of funding	Terms	Social, economic and environmental benefits
TOURISM					
10.1. Planning and implementation of work aimed at preventing and averting danger in hazardous areas in cooperation with relevant structures.	• climate extremes	Municipality, RA Ministry of Economy, NGOs, international projects.	Community budget, state budget, international projects, donors.	2026-2050	Reduces social and health risks to the population by preventing potential damage in hazardous areas, promotes the long-term resilience of communities to climate hazards, and contributes to environmental sustainability by preserving the natural environment through preventive measures and ensuring clean and safe living conditions.

Conclusions - Climate change adaptation

The impacts of climate change already pose a serious challenge for almost all cities around the world: they threaten to increase vulnerability to climate hazards, reduce access to natural resources and weaken ecosystem functionality, limit citizen safety, reduce business, hinder socio-economic development, etc. Therefore, adaptation to climate change is increasingly becoming an important priority for cities.

As a result of this analysis, an assessment of climate hazards, risks, and vulnerabilities specific to the community was conducted for the Akhuryan enlarged community, based on which initial adaptation measures were proposed to reduce or eliminate the identified risks.

Thus, based on international and local best practices, as well as taking into account existing information and available methodologies, the vulnerability of the Akhuryan community has been assessed as high for storms, hail, drought and heavy rainfall, and moderate for frost, mudflows and extreme heat risks.

27 measures (of which 3 are key) have been proposed for the community to adapt to identified climate risks, the feasibility and priority of which should be determined by the municipality within the framework of a more detailed study and development of a more comprehensive climate strategy, taking into account the financial and technical capabilities of the community, as well as the opinions of beneficiaries and community residents.

The measures in the indicated quantities were proposed according to the following main areas:

- Buildings and structures: 4
- Transport: 3
- Energy: 5
- Water resources: 2
- Land use planning: 2
- Agriculture: 3
- Environment and Biodiversity: 2
- Civil defense and emergency situations: 3
- Healthcare: 2
- Tourism: 1

Since the assessment of financial resources required for the implementation of adaptation measures is generally a rather complex and time-consuming process that may require a separate study, the financial volumes of adaptation measures in this program are presented as approximate amounts only for key actions.