Climate Change in Armenia

DEVELOPMENT OF ENERGY SECTOR IN PARALLEL WITH CLIMATE CONDITIONS

“EcoLur” Informational NGO | 2021

Contents

GENERAL SITUATION

Armenia is a landlocked mountainous country; its average altitude is 1800 m above sea level. It is located in the northeastern part of the Armenian Highlands, occupies most of the area between the Kura-Araks rivers. It borders Georgia to the north, Azerbaijan to the east, Iran to the south, and Turkey to the southwest. Its total area constitutes 29,743 square kilometers.

Around 9,500 small and medium rivers flow through the territory of Armenia with a total length of about 25 thousand km. The average annual flow of surface water is 6.8 billion m^3, whereas groundwater reserves make up about 4.0 billion m^3.

The territory of Armenia is characterized with high frequency and magnitude of hazardous hydrometeorological phenomena, which trigger droughts, landslides, mudflows, forest fires etc, thus causing significant losses to the population and the economy.

As of January 1, 2017, the population of Armenia constitutes 2,986,000 people.[1]

In the global climate system, Armenia accounts for 0.02% of global GHG emissions. In 2017, total GHG emissions amounted to 10,624 Gg CO^2_{eq}., and GHG net emissions amounted to 10,180 Gg CO^2_{eq}.[2]

Armenia is considered a vulnerable country in terms of climate change. Temperature rise in Armenia is higher than the global average. From 1929 to 2016 alone, the average annual temperature rose by 1.23 degrees (compared to 1961-1990).

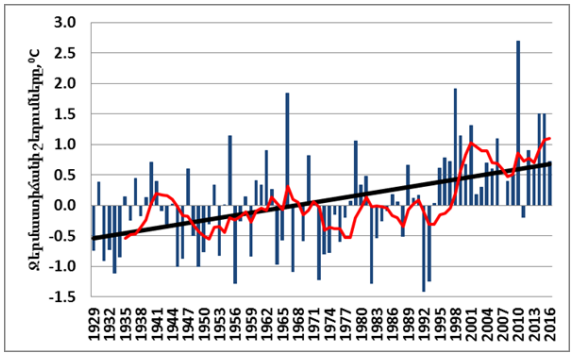

Fig 1. Temperature Deviations

In the period of 1935-2016, the average annual precipitation decreased by about 9% compared to the average for1960-1991. [3]

[1] FOURTH NATIONAL COMMUNICATION ON CLIMATE CHANGE UNDER THE UNITED NATIONS FRAMEWORK CONVENTION ON CLIMATE CHANGE (2020)

[2] https://www.e-gov.am/gov-decrees/item/36064/

[3] FOURTH NATIONAL COMMUNICATION ON CLIMATE CHANGE UNDER THE UNITED NATIONS FRAMEWORK CONVENTION ON CLIMATE CHANGE (2020)

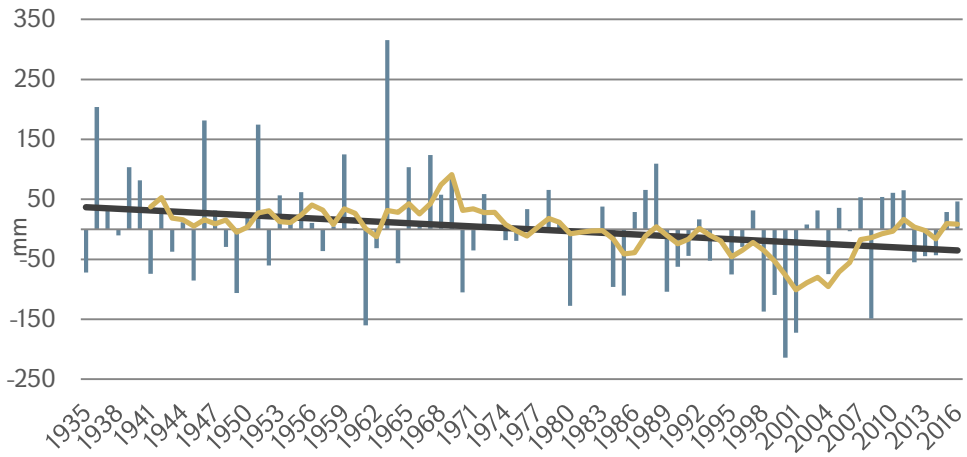

Fig 2. Deviation of average annual precipitation in the area of Armenia compared to the average for 1961-1990

The total assessed damage and losses from 1994 to 2014 becuase of natural disasters in the form of floods, earthquakes, droughts, hail, spring frosts and mudflows came to approximately US$1.5 billion dollars.[4]

CLIMATE FORECASTS

Under the Fourth National Communication on Climate Change, the average annual temperature across the territory of Armenia is projected to increase by up to 4.7◦ C by 2100 accompanied with a decline in average annual precipitation by 8.3%.

Based on the worst scenario, a decrease in the river flow by about 39% by 2100 is projected. The pessimistic (the worst) scenario suggests a decrease in the total river inflow into Lake Sevan by about 34% (265 million m^3) by 2100 as compared to the baseline conditions (1961-1990). According to forecasts, the following changes are expected in the field of agriculture as a result of the predicted climate change in Armenia in the course of upcoming 100 years:

- Expected high temperature will contribute to the increase in evaporation, which will result in the decrease in soil humidity by 10 to 30%, whereas moisture availability for various crops will decline by 7 to 13%[5].
- More common droughts and lower soil humidity levels will be accompanied with the lack of irrigation water: the water deficit of land will increase by 25 to 30%.
- Decrease in the river flow by 25% will lead to the reduction of the productivity of irrigable land areas by approximately 24%.
- Climate change scenarios forecast that, by 2030, total pasture yield will decrease between 4 and 10%. In the same time period, the productivity of the most valuable pastures, those in the sub-alpine and alpine zones, will decline by 19 to 22%.
- Grassland yield could potentially decrease by 7 to 10% which could reduce fodder production.
- By 2030 the expected unstable weather conditions, combined with strong storms, winds and downpours will damage crops, crop yield and will reduce the crop yield volume by 8-14%. Strong storms can also cause natural disasters, such as soil erosion,

[4] World Bank, 2017, Disaster Risk Finance Country Note: Armenia

[5] http://documents.worldbank.org/curated/en/260051468221982009/pdf/733320WP0ARMEN00Armenia0Jun20120Arm.pdf

mudflows and floods, which, in turn, may result in damage of agricultural lands and irrigation infrastructure.

According to forecasts, over the next 100 years vertical shift in the existing boundaries of main natural ecosystems will be observed. According to the features of mountain landscapes, they will shift upwards by 250-300 m. Climate change will lead to significant deterioration of fragile mountain ecosystem (soil erosion, productivity decrease of pastures and meadows, decline in the level of forests flexibility and productivity).

In humid forests of midmountainous zone some xerophytization processes will likely occur, as a result of which penetration of typical steppe, sparse forest and species characteristic to shiblyak may occur. Over time, the sub-alpine zone forests will be replaced by wet forests, upper boundary of the forest vegetation will shift vertically up.

As a result of extreme weather conditions and increase in the number of occurrences of dangerous hydrometeorological phenomena (heat waves, wildfires, floods), morbidity risks, including risks of injuries and mortalities (cases of intoxication, water drowning, etc.), will increase.

The morbidity rate conditioned by the water factor will rise, especially in territories, where there are already insufficient levels of water quality, sanitation and personal hygiene conditions.

ARMENIA'S CLIMATE POLICY

The Republic of Armenia ratified the United Nations Framework Convention on Climate Change in May 1993. In December 2002, Armenia ratified the Kyoto Protocol. In February 2017, it ratified the Doha Amendment to the Kyoto Protocol and the Paris Agreement. In May 2019, the Republic of Armenia ratified the Kigali amendment to the Montreal Protocol, committing itself to phasing out hydrofluorocarbons (HFA).

Paris Agreement

The Paris Agreement on Climate Change (PA) was adopted in Paris in December 2015, ratified by Armenia's National Assembly on February 8, 2017, and as a developing country, undertook quantitative commitments to limit greenhouse gas emissions.

The Armenian Government adopted the INDC and submitted in September 2015.

Armenia's position under the PA is formulated in the document entitled "Intended Nationally Determined Contributions", which was approved by RA Government Protocol Resolution № 41 dated on September 10, 2015[6], which was submitted to the UNFCCC Secretariat on September 22, 2015. Following the entry into force of PA in November 2016, the Intended Nationally Determined Contributions (INDC) submitted by the countries were considered to be the first NDCs.

On April 22, RA Government approved its resolution 610-L[7] "On Approving Nationally Determined Contribution (NDC) of the Republic of Armenia under the Paris Agreement on the UN Framework Convention on Climate Change for 2021-2030".

On 30 April, RA Environment Ministry presented its updated national climate pledge to the United Nations Framework Convention on Climate Change (UNFCCC), marking its renewed commitment for the period of 2021-2030 to the landmark Paris Agreement, by which world

[6] https://www.e-gov.am/protocols/item/544/
[7] https://www.e-gov.am/gov-decrees/item/36064/

leaders universally agreed to advance climate actions to limit temperature rise to well below 2 degrees Celsius, while pursuing efforts to limit to a safer 1.5 degrees.[8]

The key considerations taken into account by RA Government during the review of the NDC are the maintenance of national economic growth, poverty reduction, environmental protection, the achievement of sustainable development goals, while increasing national energy security, as well as providing clean energy supply.

Important components of Armenia new pledge are as follows:

- Under the reviewed NDC, the Republic of Armenia adopts a ten-year period of implementation of the NDC: January 1, 2021 - December 31, 2030;
- Reflect its mitigation goal, achieving per capita net emissions of 2.07 t CO^2_{eq} in 2050, in long-term low greenhouse gas emissions development strategies (LTS-LEDS). New mitigation plan to be implemented is equal to 40 per cent reduction from 1990 emission levels by 2030. Total GHG emissions 1990: 25,855, Gg CO^2_{eq}, net GHG emissions 1990: 25,118, Gg CO^2_{eq}, (NIR 1990- 2017);
- By 2030, Armenia is going to double its share of renewable energy in energy production;
- With the adoption of new National Forestry Programme, it is projected to increase forest cover to 12.9 per cent of the territory of Armenia by 2030;
- Define the progress of the implementation of the country's commitments under the Paris Agreement to monitor the improved transparency and accountability framework.
- Climate adaptation policy and measures have been valued.

In terms of the priority areas for adaptation in the mitigation actions of the revised NDC-2020 for Armenia, the main priority areas have remained as it was for NDC 2015. Sectors included in the mitigation contribution are as follows: a. Energy (Energy Production and Use) b. Industrial Processes and Product Use (Mineral Industry and F-gases) c. Agriculture (Enteric Fermentation, Direct and Indirect N2O Emissions from managed soils) d. Waste (Solid Waste management, Wastewater) e. Forestry (afforestation, forest protection) and Other Land Use.

CEPA: Armenia's Undertaken Commitments and Roadmap

Climate change and adaptation issues are also covered in Chapter 4 of the Comprehensive Extended Partnership Agreement (CEPA, 2017) signed between Armenia, the EU, the European Atomic Energy Community and their Member States.

The Roadmap for the Implementation of the Agreement (RA Prime Minister's Resolution N666-L dated on June 1, 2019) envisages clear actions aimed at ensuring the implementation of the provisions of Chapter 4 of the Agreement, including adaptation.

Under the CEPA Roadmap, Armenia stipulates:

- ✓ Development of an action plan for the implementation of the commitments arising under Paris Agreement;
- ✓ Establishment of a national system for inventory of greenhouse gas emissions (including aviation emissions) related to climate change, establishment of a national system of policies, means and forecasts and building relevant institutional capacities;

[8] http://nature-ic.am/en/news/The-Republic-of-Armenia-releases-updated-national-climate-pledge-under-Paris-Agreement/12737

- ✓ Regular development of biennial reports and national communications of national anthropogenic greenhouse gas emission cadastres;
- ✓ Establishment of a Measurement, Reporting and Verification (MRV) system, development of technologies aimed at solving climate change problems and formation of a transfer process;
- ✓ Implementation of measures for the replacement of ozone depleting substances, hydrochlorofluorocarbons, and their substitutes, hydrofluorocarbons;
- ✓ Amendment of Law on Ozone Depleting Substances and amending and supplementing bylaws on the use of ozone depleting substances and their substitutes;
- ✓ Development of a national program on the use of fluorinated greenhouse gases (with phase reduction);
- ✓ Establishment of a labeling system for those products and equipment that contain fluorinated greenhouse gases or their operation depends on those gases;
- ✓ Establishment of reporting systems for emission data from relevant sectors;
- ✓ Development of a concept paper on adaptation to climate change and a national action plan;
- ✓ Establishment of a ban on the production of hydrochlorofluorocarbons (HCFAs) until January 1, 2019, with the exception of special applications of substances subject to control.

Climate Change Adaptability National Plan

On May 13, 2021, RA Government adopted Resolution 749-L "On Approving National Climate Change Adaptation Action Plan (NAP) and List of Measures for 2021-2025"[9]

The following measures are planned for the implementation of the adaptation program for 2021-2025:

1. Development of RA draft governmental resolution "On Approving Climate Change Adaptation Program in Sector of Water Resources"
2. Development of RA draft governmental resolution "On Approving Concept Paper and Action Plan on Climate Change Adaptation in Sector of Agriculture"
3. Development of RA draft governmental resolution "On Approving Climate Change Adaptation Program in Sector of Energy”
4. Development of RA draft governmental resolution "On Approving Climate Change Adaptation Program in Sector of Healthcare"
5. Development of RA draft governmental resolution "On Approving Climate Change Adaptation Program in Sector of Tourism"
6. Development of RA draft governmental resolution "On Approving Climate Risk Management in Forest Management and Climate Change Adaptation Program"
7. Integration of Climate Change Factors into “Sevan” National Park Management Plan and Introduction of Adaptation Measures
8. Development of RA draft governmental resolution "On Approving Climate Risk Management in Sector of Transport Infrastructures and Climate Change Adaptation Program”
9. Development of Climate Change Adaptation Program for Shirak and Tavush Regions
10. Development of Climate Change Adaptation Programs for Eight Regions
11. Development and Implementation of National Strategic Approaches to Communication and Raising Awareness on NAP Process and Climate Change Adaptation

[9] https://www.e-gov.am/gov-decrees/item/36164/

12. Development of Resource Mobilization Approaches and Implementation Plan for NAP Process
13. Development of NAP Process Monitoring and Evaluation Guide,
14. Development of RA draft governmental resolution "On Approving Strategy for Introduction of Technologies Aimed at Climate Change Adaptation"
15. Analysis of Implementation of National Climate Change Adaptation Action Plan and List of Measures for 2021-2025
16. Development of RA draft governmental resolution "On Approving National Climate Change Adaptation Action Plan and List of Measures for 2026-2030"

PROJECTS IMPLEMENTED IN ARMENIA WITH GREEN FUNDING

This section presents the main projects that have received funding for energy efficiency, energy saving, and climate change adaptation projects.

- ✓ **"De-risking and Scaling-up Investment in Energy Efficient Building Retrofits"**

The Project seeks to systematically de-carbonise the existing building stock in Armenia to reduce greenhouse gas (GHG) emissions while achieving sustainable development benefits. The Project, addressing both public and residential buildings, focuses on creating a favourable market environment and a scalable business model for investment in energy efficiency retrofits by addressing market barriers.

The project will encourage private sector investment, thus scaling up investment in building modernization in Armenia. The project will lead to significant energy savings, resulting in a reduction in GHG emissions (from 5.1 to 5.4 million tonnes of CO^2 over a 20-year investment life).

The total cost of the project is $ 116 million, out of which $ 20,000,000 is Climate Green Fund grant, $ 420,000 is UNDP TRAC resources, and $ 1,000,000 is UNDP parallel funding. The amount of co-financing is provided in cash by Yerevan Municipality, RA Government, and the European Investment Bank.

The project contract was signed in July 2017 for a period of 6 years.[10]

This project is visible to everyone, as it has helped to increase energy efficiency and energy saving in community buildings. Thermal insulation works were carried out in public buildings, energy-saving lamps were used.

Ms. Diana Harutyunyan, UNDP Climate Change Program Coordinator, emphasized the long-standing cooperation with Yerevan Community in the field of energy efficiency, as well as the opportunities for the introduction of a community energy management system and an energy management information system.

The project facilitated the monitoring of energy consumption in buildings by serving as a tool for assessing energy efficiency in buildings, reducing greenhouse gas emissions. The UNDP also supported the involvement of KfW Bank in the implementation of the housing financing program by the National Mortgage Company in Armenia.

- ✓ **Armenia's National Adaptation Plan**

The aim of the project is to promote synergies between sectoral initiatives, as well as to improve coordination processes, strengthen institutional, operational and technical capacities, improve the

[10] http://www.nature-ic.am/Content/Projects/18/GCF%20PROJECT%20BRIEF%20ARM.pdf

knowledge and evidence base, contribute to more comprehensive and thorough assessments of climate risks, vulnerabilities and impacts. Monitoring capacity will be improved. Project duration: 2018- 2022

Funding: Green Climate Fund Grant: $ 2,999,593.00, Co-financing: UNDP: $ 300,000, Government of the Republic of Armenia (in kind): $ 260,000.[11]

The effectiveness of the national adaptation program can be assessed in the case of a real result, when the legislative and institutional reforms will not remain on paper, but will be implemented. One of the directions of the project is the development of Armenia's water sector adaptation program, one of the expected results of which is the introduction of a climate change component in strategies, programs, measures, short-term and long-term plans, basin management plans, hydropower development concept, and reservoir perspective program.

One of the directions of the project refers to the implementation of possible measures of adaptation to the impacts of climate change in several regions of Armenia and the incorporation of the climate change component in the regional development plans.

The project addresses the development of adaptation measures in the fields of agriculture, energy, healthcare, tourism and human settlements.

- ✓ **"EU4Climate" Project**

The objective of the project is to support the development and implementation of climate-related policies by the Eastern Partnership countries which contribute to their low emission and climate resilient development and their commitments to the Paris Agreement on Climate Change.

The following results will be achieved: (i) Finalized/up-dated nationally determined contributions and national mid-century strategies and communicated to the United Nations Framework Convention on Climate Change (UNFCCC), (ii) Improved inter-institutional awareness and coordination at political and technical level of the Paris Agreement and the corresponding national commitments, (iii) Established or strengthened measurement, reporting and verification (MRV) systems, with countries getting on track with Paris Agreement transparency requirements, (iv) Establishment of concrete sectoral guidelines for the implementation of the Paris Agreement in each of the Eastern Partners, especially in the field of energy (v) Advanced alignment with EU acquis as provided by bilateral agreements with EU and in the context of the Energy Community Treaty, (vi) Increased mobilization of climate finance, and (vii) Enhanced adaptation planning.

Duration: 2019-2022. Funding: EU - 8 million Euros, UNDP - 800,000 Euros[12].

This Project can be viewed as a tool for fulfilling Armenia's commitments under the UN Framework Convention on Climate Change, the Paris Agreement, the Armenia-EU Comprehensive Extended Partnership Agreement (CEPA) and the European Green Deal.

- ✓ **Building Armenia's National Transparency Framework under Paris Agreement**

This project follows from the commitments of the Government of Armenia under Paragraphs 7 to 10 of Article 13 of the Paris Agreement, which requires each Party to regularly provide a national inventory report, information necessary to track progress made in implementing and

[11] http://www.nature-ic.am/Content/Projects/1030/UNDP%20GCF%20Project%20%20Document_brief_ARM.pdf

[12] http://www.nature-ic.am/Content/Projects/1031/EU4Climate%20Description%20of%20Action%20for%20IW_ARM.pdf

achieving its nationally determined contributions (NDC), information related to the adaptation actions and support received.
Funding: GEF Trust Fund: $ 990,000, Co-financing: Ministry of Environment (in kind) - $ 400,000, UNDP (in kind) - $ 170,000. The duration of the project is 2020-2023. [13]
The effectiveness of this Project can be assessed in terms of expected outcomes of conscious planning to address projected vulnerabilities, achieving savings, improved public health and safety, disaster reduction, new business opportunities, greater investment security.

- ✓ **"Forest Sustainability of Armenia - Mitigation of Green Growth and Promotion of Adaptation in Rural Communities" project**

The program envisages expanding Armenia's forest cover by 2.5%, reducing the demand for firewood by 30% by increasing the efficiency of stoves, and strengthening the adaptive forest management toolkit. It will be implemented in Lori and Syunik Regions, Armenia, where 49% of the forest fund of Armenia is located. Three nurseries will be established, which will produce climate-resistant planting material. About 1,700 people will take some courses on climate change and reforestation.
Afforestation works will be carried out in 5700 hectares of forest area. National energy efficiency standards for the production of energy efficient stoves will be developed. The funding of the project is $ 18.7 million. Funding provided by the Green Climate Fund - $ 10 million, co-financed by the Austrian Development Agency, WWF, Torciano Community, Italy. The Armenian government participates by in-kind contribution. Project duration: 2021-2029.[14]

- ✓ **"EU4Sevan" Project**

The aim of EU4SEVAN project is to strengthen the capacity of Lake Sevan catchment water monitoring, management, and wastewater treatment solutions among public and private stakeholders. The project will also help improve ecosystem-friendly, water-saving land use and cultivation capacity. It is planned to raise awareness and access to information on the protection of Lake Sevan in the communities adjacent to the basin.
Lake Sevan ecosystem management component in Armenia will be implemented jointly with the UNDP.
The project is co-sponsored by the European Union Ministry, the Federal Ministry for Economic Cooperation and Development (BMZ), It is implemented by the United Nations Development Program (UNDP) and Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ). The financing of the project is equivalent to 5.7 million Euros in AMD. The duration of the project is 2020-2024.[15]

- ✓ **"Strengthening Land-Based Adaptation Capacity in Communities Adjacent to Protected Areas in Armenia" Project**

The objective of the project is to reduce the climate risk vulnerability of local communities living adjacent to "Khosrov Forest" and "Dilijan" National Park by strengthening the adaptive capacity of the agricultural sector and reinforcing their institutional and planning capacity for climate change adaptation.

[13] https://drive.google.com/file/d/1DmBvlCwdPwWWI__He4-Ta_dc-nFiZYsC/view
[14] https://www.greenclimate.fund/project/sap014
[15] http://mnp.am/news/pashtonapes-hastatvec-eu4sevan-cragiry

The aim of the project is to reduce socio-economic, environmental, agricultural, irrigation water conservation measures, high incomes of the population in Urtsadzor, Dilijan, Fioletovo and Margahovit Communities in Lori Region near "Khosrov Forest" State Reserve and "Dilijan" National Park will alleviate anthropogenic pressures on both SPANs and surrounding ecosystems.

The specific objectives of the project are:

Community based, climate smart agricultural practices implemented in degraded areas to reduce climate risks vulnerability of production systems and sustain protected areas.

Value chains for climate smart agriculture strengthened and climate smart technologies made accessible for vulnerable rural communities, including equally for women and men.

Awareness, planning, monitoring and resolution -making capacity on climate smart agriculture production methods and land degradation neutrality in target communities. [16]

The project is funded by the Adaptation Fund. Funding: $ 2,506,000. The duration of the project is 2021-2022.

- ✓ **"Management of Wastes and Floods in Non-operating Stone Pits in Artik Town" Pilot Project**

40 ha of the area surrounding the town and non-operating mines will be planted with trees and an up-to-date rest zone will be established, which is missing in the community. It is planned to improve plough lands, pastures and meadow lands for people dealing with agriculture. The slopes of two drainage systems running into the town will also be enhanced within the project ranges and a fast disaster response system will be introduced.

The Adaptation Fund has provided a grant of 1,435,100 USD. Project duration – 2019-2023.[17]

- ✓ **"Engaging Future Leaders: Digital Education Module on Adaptation Challenges and Best Practices for Youth" Project**

The project objective is to educate new generations of environmentally cultured young change-makers (with particular focus on climate adaptation) in developing countries, through design and introduction of replicable and sustainable digital education solution for high school students in Armenia.

The project is aimed at engaging future leaders, creating a digital education module on adaptation issues for young people and best practices.[18]

The project is funded by the Adaptation Fund. Funding - 231.250 USD. Project duration - 2020-2021.

ENERGY AND CLIMATE CHANGE

In 2017, the Energy Sector accounted for 66.7% of Armenia's total GHG emissions. The second largest source of emissions was AFOLU Sector (without Forestry and Other Land Use) with a share of 18.5%, followed by IPPU and Waste Sectors – 8.9% and 5.8%, respectively.

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[16] https://www.epiu.am/naxagcer/yntacik-naxagcer/%d5%a1%d5%a4%d5%a1%d5%ba%d5%bf%d5%a1%d6%81%d5%ab%d5%b8%d5%b6-%d5%b0%d5%ab%d5%b4%d5%b6%d5%a1%d5%a4%d6%80%d5%a1%d5%b4%d5%a8-%d5%b0%d5%a1%d5%bd%d5%bf%d5%a1%d5%bf%d5%a5%d5%ac-%d5%a7-%d5%b0%d5%a1/#more-2125

[17] https://www.adaptation-fund.org/project/artik-city-closed-stone-pit-waste-flood-management/

[18] https://www.adaptation-fund.org/project/engaging-future-leaders-digital-education-module-on-adaptation-challenges-and-best-practices-for-youth/

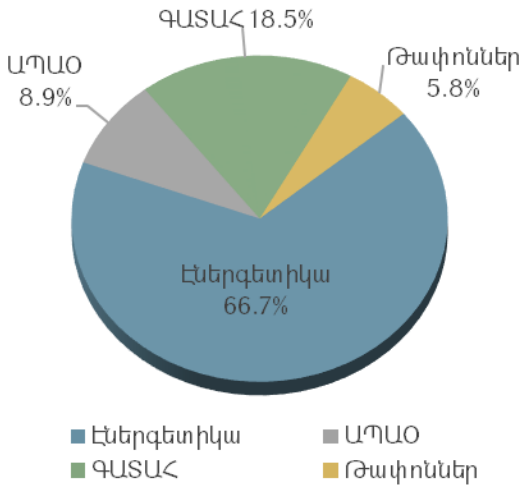

Fig. 3 Main Findings of GH Cadastre

Emissions from the Energy Sector consist of two main categories: fossil fuel combustion and fugitive emissions from natural gas. The majority of the sector's emissions (77%) results from fossil fuel combustion, whereas 23% constituted fugitive emissions from natural gas. Road transport generated 25% GHG of the Energy Sector emissions in 2017, Energy production – 18%, households accounted to 18 % as well.

Natural gas is the main consumed fuel in our country. Natural gas accounted for 61% of Armenia's TPES in 2017, 85% of the fossil fuel (including jet fuel) consumption. Over 83% of CO^2 emissions from fuel combustion (without international bunker) in 2017 originated from natural gas. Fugitive emissions from natural gas accounted for 77.47 Gg CH^4 in 2017.

With its resolution 48-L dated on January 14, 2021, RA Government adopted Strategic Program for Development of Energy Sector of the Republic of Armenia (until 2040)[19].

Under the strategic program, the main priorities for the development of the energy sector are as follows: renewable energy, energy efficiency, lifetime extension of the second power unit of the Armenian Nuclear Power Plant (ANPP), gradual development of the electricity market, liberalization, North-South transit corridor construction program, Armenia-Iran and Armenia-Georgia power transmission lines and infrastructures.

Nuclear Energy

The ANPP is located in Armavir Region, 28 km west of Yerevan, 16 km from the Turkish border. The ANPP consists of two power units with VVER-440 type V270 model) reactors. The first power unit of the ANPP was put into industrial operation in 1976.

The lifetime of the second power unit expired in 2016. However, the Armenian government decided to extend the life of the latter by 10 years until 2026. The share of the Armenian NPP in the total electricity production in the country constitutes 34-40%.

For the modernization of the second power unit, the Russian Federation provided a $ 270 million loan to Armenia and a $ 30 million grant. Out of this amount, $ 173.6 million was spent from the loan, $ 19.3 million from the grant, after which the Armenian government reached a resolution to give up the rest of the Russian loan on June 11, 2020, providing a budget loan of 63 billion 200

[19] https://www.e-gov.am/gov-decrees/item/35481/

million AMD from the state budget in order to to accomplish the modernization of “Armenian Nuclear Power Plant” CJSC.[20]

Out of this amount, 20 billion AMD have already been allocated for the works carried out at the ANPP with the participation of "Rusatom" service, Ministry of Territorial Administration and Infrastructure, and “ARMATOM Research Institute” CJSC.

According to the Armenian government, the main reasons for refusing the Russian loan are the following: postponing the dates of signing relevant contracts, deviation from the work schedule, tightening loaning conditions by the Russian side, establishing a monopoly position for Russian manufacturers and service providers.

Assessing the Russian side's proposal, the financial resources needed for the successful completion of the project are about $ 163 million, whereas under the Armenian party, the project could be completed with $ 123 million in funding, resulting in up to $ 29 million in savings, considering a $ 10.7 million grant loss.

On 15 May, 2021 the ANPP Unit 2 shutdown started and at 11:45 the unit was disconnected from the RA power grid. The nuclear power plant was shut down for annual outage-2021 which will last 141 days owing to an unprecedented large scope of activities of the final stage of the ANPP Unit 2 life extension program.

The following main activities are scheduled to be performed during outage-2021:

- reactor general overhaul with complete core unloading,
- activities on modernization of the sealing surfaces of the reactor facility upper unit,
- reactor vessel annealing,
- inspection of the reactor vessel metal prior to and after the annealing,
- maintenance of the spent fuel storage pond (2SFSP) and pressurizer (2Prz),
- general overhaul of the steam generators and eddy current testing of the steam generator tubing,
- inspection of the composite welds of steam generators,
- routine maintenance of the reactor coolant pumps,
- modernization of the emergency core cooling system,
- general overhaul of the pressurizer safety valves and steam generator safety valves,
- routine maintenance of turbines №3 and №4,
- intermediate maintenance of generator №3,
- general overhaul of generator №4,
- routine maintenance of autotransformer AT-1,
- modernization of the in-core monitoring system,
- replacement of instrumentation and control equipment complete sets, replacement of instrumentation cables within the boundaries of the steam generator compartment,
- installation of additional parameters of the computer information system.[21]

One of the goals of the modernization program of the second power unit of the ANPP is to double the lifetime of the second power unit. The lifetime extension of the second power unit of the ANPP after 2026 of Strategic Program for Development of Energy Sector of the Republic of Armenia (until 2040) is one of the main priorities of RA Government, and the construction of a new nuclear power plant is the main goal.

[20] https://www.primeminister.am/hy/press-release/item/2020/06/11/Cabinet-meeting/
[21] http://armeniannpp.am/hy/info/noroutyounner/pnv-2021-i-meknarky-trvac-e.html

If the safe operation of the second power unit of the ANPP after 2026 is substantiated as a result of relevant studies, the Armenian government intends to operate it at least until 2036, for which, according to forecasts, an additional investment of $ 150 million will be required.
If the safe operation of the second power unit of the ANPP after 2026 is substantiated as a result of relevant studies, the Armenian government intends to operate it at least until 2036, for which, according to forecasts, an additional investment of $ 150 million will be required.
The construction of the new ANPP is supported by "Strategic Program for Development of RA Energy Sector (until 2040)". However, apart from RA Law on Construction of New Nuclear Power Unit(s) in the Republic of Armenia adopted on October 27, 2009, there is no new document available on this issue. Moreover, the capacity of the new power unit, 1200 MW, approved under the law, is considered to be artificially overestimated. It is now preferable to build a smaller nuclear power plant with a capacity of up to 600 MW in the same area of the ANPP. But there are no investors yet.
In terms of reducing climate change and GHG emissions, the Strategy states: "The presence of an Armenian nuclear power plant in Armenia's energy system is viewed as an opportunity to achieve the lowest level of greenhouse gas emissions, which is in line with the government's long-term development goals for low-emission greenhouse gases."
Article 42 (g) of the CEPA Agreement covers Armenia's nuclear energy commitments, in particular, to increase nuclear safety, nuclear waste management, ensure the safe operation of nuclear power plants, the closure of the ANPP roadmap or action plan as soon as possible, and the need of the construction of a new power unit.
In 2021, the draft of the second roadmap for CEPA implementation was put into circulation, which envisages measures on radioactive waste and spent fuel.
As for the roadmap for ANPP closure, in response to EcoLur's inquiry, RA Deputy Minister of Territorial Administration and Infrastructure Hakob Vardanyan in his letter № HV/22.3/1757-2020 dated on 29.01.2020 particularly stated:
“…According to RA Law "On Safe Use of Nuclear Energy for Peaceful Purposes" (adopted on February 1, 1999), the activities of objects having significance in terms of security are subject to licensing.
According to Resolution No. 707 of RA Government dated on June 14, 2005 "On Procedure for Licensing and Approval of License for Decommissioning of Nuclear Plant Operations", the list of the documents to be submitted to the Regulatory Authority for obtaining a license of decommissioning is approved, including the most significant and relevant documents - Decommissioning Project, Security Analysis Report, Environmental Impact Report, as well as Environmental Impact Assessment Report issued by competent public authorities.
The abovementioned documents have also been developed in conjunction with other documents related to the decommissioning with the support of the Council of Europe, considering that the operation date of the Nuclear Power Plant expired in September 2016. The form and content of these documents are in accordance with the requirements of the applicable legislation, and in their absence the IAEA requirements/recommendations have been considered.
The conducted research indicates that the current regulatory requirements for staff, population and the environment will not be exceeded during the ANPP decomissioning. It should also be noted that all documents related to the extension of the operation of the secondnd power unit for 10 years are subject to review/updating for submission to the regulatory authority within the timeframe provided by the legislation.”

Renewable Energy

Solar Energy

Under the Strategic Program, the share of solar energy production in the energy system is planned to increase to 15% - 1.8 billion kWh by 2030. For this purpose, solar power plants with a total capacity of 1000 MW will be built, including autonomous power plants.

By July 2022, the construction of 55-megawatt Masrik-1 solar photovoltaic station in the territory of Mets Masrik Community, Gegharkunik Region, will be accomplished. Masrik-1 will produce 0.11 billion kWh of electricity per year. The investment in this program is estimated at $ 60 million. The financing will be provided by loans from the European Bank for Reconstruction and Development and the International Finance Corporation. The area of the station will cover 128.3 hectares.

"Masrik-1" solar photovoltaic (PV) power plant project has entered into an active phase by the resolution of RA Government № 1016-A dated on June 18, 2020. The EBRD and IFC will jointly provide a long-term loan of up to $ 35.4 million.

It should be noted that the winner of the competition for the construction of "Masrik-1" was recognized the consortium of companies - Fotowatio Renewable Ventures B.V. (Netherlands) and FSL Solar S.L. (Kingdom of Spain) with which RA Government signed a Government Support Agreement in 2018 on the organization and implementation of the Project.

Public hearings were held in Mets Masrik on the construction of "Masrik-1" solar station. However, the risks of the program have not been sufficiently discussed. In particular, the issue concerns the waste generated by the operation of the plant, the pastures taken from the community for the plant.

The construction of “Ayg-1” solar photovoltaic power plant with an installed capacity of 200 MW is planned to be completed in 2025. The plant will generate 0.32 billion kWh of electricity per year. The project is estimated at $ 170 million.

The accomplishment date of the construction of "Ayg-2" solar photovoltaic power plant with an installed capacity of 200 MW is still unclear. The station is projected to produce 0.32 billion kWh of electricity per year. An investment of $150 million is estimated for this project.

The construction of "Ayg-1" and "Ayg-2" solar photovoltaic stations is planned to be implemented within “Masdar Armenia Programs” investment project initiated by Abu Dhabi Future Energy Company (Masdar) founded in the United Arab Emirates and Armenia National Interest Fund (ANIF) established by the Government of Armenia.

It is planned to eliminate about 520 hectares of land for the first station from Talin, Dashtadem, Katnaghbyur and Yeghnik communities. For the second station, it is planned to take about 520 hectares of land from Yeghvard and Nor Yedesia communities.

RA Government is considering taking the lands in the form of a donation and has given a corresponding instruction to the Minister of Territorial Administration and Infrastructure.

In December 2024, it is planned to complete the construction of 5 solar photovoltaic power plants with a capacity of 120 MW. As a result, about 0.192 billion kWh of electricity will be produced annually. For these projects, it is planned to attract private investments on a competitive basis based on the lowest price offer.

In December 2029, it is planned to complete the construction of small solar stations with a total installed capacity of 315 MW (up to 5 MW), out of which 15 MW is planned for the construction of community solar stations. It is estimated that these plants will produce 0.326 billion kWh of electricity per year: $340 million in private investment is expected for this purpose.

In December 2023, it is planned to accomplish the construction of autonomous solar power plants, increasing the total installed capacity from 40 MW to 100 MW. These plants will produce about 0.16 billion kWh of electricity per year. $80 million is planned to be invested by the private sector for this purpose.
As of April 1, 2021, according to the licenses issued by RA Public Services Regulatory Commission, 43 solar stations and 1 wind farm are being built.
As of April 1, 2021, 4 wind farms, 1 biomass power plant, and 19 solar stations are in operation.
One of the disadvantages of the rapidly growing solar energy in Armenia is the use of agricultural land areas, as well as the problem of generated waste utilization.

Small Hydropower

The strategic plan envisages increasing the total installed capacity of small hydropower plants from 380 MW to 430 MW. The hydro resource for the construction of SHPPs is mainly considered exhausted, whereas the strategy includes the construction of those SHPPs only for which a construction license has been issued.
As of April 1, 2021, according to the license for the production of electricity (capacity) issued by RA Public Services Regulatory Commission, 24 small HPPs are under construction. 188 small HPPs are put into operation.
The hydropower sector is extremely vulnerable to climate change. Water flow is decreasing in Armenia every year and SHPPs are not able to operate at design capacity. There are a number of SHPPs that have not been operated for months due to lack of water, or are operating at the expense of the environmental flow.
Within Armenia's Water Sector Adaptability Program to Climate Change (WSAP) it is planned to review "Strategic Development Plan of RA Hydropower Sector (2011)" considering the vulnerability of water resources under climate change. It is also necessary to review long-term water use permits for hydropower considering the potential impact of climate change on water resources.
In order to reduce the burden of small hydropower plants on river ecosystems, RA National Assembly adopted Law on Making Amendments to RA Water Code on June 28, 2019, whereas its Article 30.1 stipulates cases of rejection of applications for water use permits for newly constructed small hydropower plants[22].
On 8 April 2021, the Armenian Government adopted resolution 488-N [23] "On defining the list of rivers prohibited for the construction of small hydroelectric power plants conditioned with being spawning sites for red-listed or endemic fish species or overloaded with derivation pipelines by 40% and over", which bans construction of SHPPs on 25 rivers.

Large Hydropower

The power system of Armenia includes the systems of two large hydroelectric power plants: Vorotan Hydropower Plant System and Sevan-Hrazdan Hydropower Complex providing 19% electricity balance.
The system of Vorotan hydropower plants consists of Tatev HPP, Spandaryan HPP and Shamb HPP, which are located on the tributaries of Vorotan River. The total installed capacity is 404.2 MW, the average annual design output is 1.16 billion kWh.

[22] http://www.parliament.am/legislation.php?sel=show&ID=6660
[23] https://www.e-gov.am/gov-decrees/item/35913/

The general scheme of hydropower plants in the system is as follows: the water from the main Spandaryan reservoir of the system reaches Spandaryan HPP through a pressure tunnel. Inside the HPP, Angeghakot dam is built, which forms Angeghakot reservoir.
From this reservoir, water is transported through a non-pressure tunnel to Tolors Reservoir formed on Sisian-Ayri tributaries. Water from Tolors reservoir through a pressure tunnel is supplied to Shamb HPP. Below the station, Tatev Reservoir is built with a rare pearl-shaped waterfall structure. Through the non-pressure tunnel from Tatev reservoir, the water reaches the daily regulation pool (DRP), from where it is connected to Tatev HPP via a turbine pipeline. Vorotan hydro cascade provides stability in the energy system.
Under RA Government resolution № 1496-A dated on 21.11.2013, the main part of the property complex of "Vorotan Hydroelectric Power Plant Complex" CJSC was alienated to "Contour Global HydroCascade" CJSC. The cost of Vorotan Cascade was set at US $ 180 million.
The deal caused public anger, as contrary to RA water legislation, the terms of the contract are such that a private company can pledge the dams in the hydro cascade, which means that the company can dispose of Armenia's strategic water resources at its own discretion.
Due to climate change, there will be a water famine in Armenia in 2021. In this situation, reservoir monitoring is very important for the targeted use of water resources. Unlike other large reservoirs, the fullness data of Vorotan hydrocomplex are not published and are closed to stakeholders.
The other large hydropower system is "Sevan-Hrazdan Cascade" with its seven HPPs: Sevan, Hrazdan, Argel, Arzni, Qanaqer, Yerevan-1 and Yerevan-3. The total installed capacity of these HPPs is 559.4 MW, and the annual design output is 2.32 billion kWh. The HPPs are located on the Hrazdan River, they use the natural flow of the river and the water released from the river.
Water outlet from from Lake Sevan is permitted for irrigation purposes, which is regulated by RA Law on Lake Sevan and RA Law on Approval of Annual and Comprehensive Program of Measures for Restoration, Preservation, Reproduction and Use of Lake Sevan Ecosystem.
Sevan Hrazdan Cascade became private in 2011 and was renamed into International Energy Corporation (IEC) CJSC. In 2019, it was resold to Tashir for 173 million rubles.
Sevan-Hrazdan Cascade cannot use the water of Lake Sevan for energy purposes unless water is released from the lake for irrigation. Additional water intake has been carried out from Lake Sevan 5 times in the last 10 years. The legislation on Lake Sevan was violated, as the lake had a negative balance, which led to the violation of the lake ecosystem, deterioration of water quality and activation of waterlogging processes.

Wind Farms

The strategy envisages the construction of small wind power plants with a capacity of up to 500 MW only in the presence of competitive tariff offers.

- **Thermal Power Plants**

Under Strategic Program, as of July 1, 2020, the thermal power plants are operating: HrazTPP - 410 MW, Hrazdan fifth power unit - 467 MW, Yerevan Combined Cycle Co-generation Power Plant (YCCPP) 1 power unit - 228.6 MW. Due to low efficiency, Hrazdan TPP is planned to be decommissioned after the commissioning of the Iran-Armenia 400 kV power transmission line, the newly constructed Yerevan 2nd HGH power unit. A 254 MW steam cycle power plant is currently under construction at the Yerevan Thermal Power Plant. Withdrawal from hot power

plants does not presuppose proven strategies, as they are included in the list of stable electricity producers in the energy system.
The abandonment of thermal power plants is not provided for by the approved strategy, since they are included in the list of the most stable electricity producers in the country's energy system.

- **Regional Energetic Cooperation**

Regional energy cooperation plays an important role in the development of the sector. On the one hand, it is the establishment of a common energy market of the Eurasian Economic Union, on the other hand, meeting the requirements within the framework of the Armenia-EU Comprehensive Extended Partnership Agreement. The latter is aimed at improving the normative base. Eventually, the construction of the Armenia-Iran and Armenia-Georgia energy bridge will lead to an increase in the role of the Armenian energy system in the development of cooperation with regional countries.

WATER

Preservation and reasonable use of water resources is an issue for Armenia today. In our country, water flows are decreasing year by year, precipitation is decreasing, temperature is rising due to climate change.
River flow is forecast to decrease by about 14% in the Republic of Armenia in 2040, river flow vulnerability is projected at around 28% in 2070 and at 39% in 2100. If the baseline river flow is about 7.1 billion cubic meters, then, according to estimates, it is predicted that the river flow will make 4.3 billion cubic meters in 2100.
The river flow entering Lake Sevan is projected to decrease by about 30-35% in 2100, which will have a negative impact on the lake's vital resources. Evaporation from Lake Sevan due to precipitation and temperature changes was also assessed. According to estimates, evaporation is projected to increase by about 10% of the lake surface in 2040, by 20-25% in 2070, and by 35% in 2100."
A decrease in the amount of river flow entering the reservoirs during spring floods is projected. According to Levon Azizyan, a decrease of 30-35% is forecasted for 2100 due to the fact that the temperature will increase and the amount of precipitation in the form of snow will decrease.
In the context of global climate change, the maximum filling of three major strategic reservoirs has been estimated. The biggest vulnerability is forecast for Aparan Reservoir. According to estimates, the filling of Aparan reservoir will be about 35-40 million cubic meters in 2100, Azat reservoir - 40-45 million, and Akhuryan reservoir - up to 300 million cubic meters.

CONCLUSION

Armenia is considered a vulnerable country in terms of climate change. The temperature rise in Armenia is higher than the global average.
With this in mind, Armenia must pursue an effective policy of mitigating the negative impact of climate change, promoting sustainable development, green economy, and green energy.
Within the latest developments governmental resolution 610-L "On Approving Nationally Determined Contribution (NDC) of the Republic of Armenia under the Paris Agreement on the

UN Framework Convention on Climate Change for 2021-2030" dated on 22 April, 2021, is of utmost significance.

With this resolution, Armenia is obliged to reduce GHG emissions by 40% in 2021-2030 compared to the level of emissions in 1990, to double the share of renewable energy by 2030, and to increase the forest cover by 12.9% of the territory of Armenia.

On May 13, 2021, RA Government adopted Resolution 749-L "On Approving National Climate Change Adaptation Action Plan (NAP) and List of Measures for 2021-2025", which stipulates developing and implementing 16 adaptation programs for different vulnerable sectors.

Climate change and adaptation issues are also covered in Chapter 4 of the Comprehensive Extended Partnership Agreement (CEPA, 2017) signed between Armenia, the EU, the European Atomic Energy Community and their Member States.

The Roadmap for the Implementation of the Agreement envisages clear actions aimed at ensuring CEPA implementation, including adaptation.

The actions and programs envisaged by the resolutions of RA Government have the financial support of "green" foundations. These programs mobilize the potential of professionals, technical resources, and influence reforms in various fields.

With its resolution 48-L dated on January 14, 2021, RA Government of the Republic of Armenia adopted Strategic Program for Development of Energy Sector of the Republic of Armenia (until 2040), where solar energy is a priority. Favourable environment is established for this purpose, which promotes involvement of new investments.

The reforms of RA Government in the field of small hydropower plants, which are aimed at preserving the biodiversity of river ecosystems, are positively assessed.

RA National Assembly adopted Law on Making Amendments to RA Water Code on June 28, 2019, whereas its Article 30.1 stipulates cases of rejection of applications for water use permits for newly constructed small hydropower plants.

On 8 April 2021, the Armenian Government adopted resolution 488-N "On defining the list of rivers prohibited for the construction of small hydroelectric power plants conditioned with being spawning sites for red-listed or endemic fish species or overloaded with derivation pipelines by 40% and over", which bans construction of SHPPs on 25 rivers.

The climate and energy policies implemented in Armenia have significant shortcomings, especially in the field of water security. Water management is poor: there is a large amount of water loss in irrigation systems, biological water treatment is not carried out, water resources are exposed to chemical pollution with industrial wastes. There is a problem of water security and water rights in Armenia in terms of climate vulnerability of water resources.

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