

“2019 Energy Balance of the Republic of Armenia”

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ABBREVIATIONS

CNG FS	Compressed natural gas fueling station
SC	Statistical Committee
CN FEA	Commodity Nomenclature of Foreign Economic Activity
HVEN	High Voltage Electric Networks
EU	European Union
EEAP	Energy Efficiency Action Plan
MTAI	Ministry of Territorial Administration and Infrastructures
EB	Energy Balance
HPP	Hydro Power Plant
AEB	Armenia Energy Balance
ENA	Electric Network of Armenia
PSRC	Public Services Regulatory Commission
RA	Republic of Armenia
WPP	Wind Power Plant
R2E2	Armenia Renewable Resources And Energy Efficiency Fund
M&A	Monitoring and assessment
IEA	International Energy Agency
TPP	Thermal Power Plant
RF	Russian Federation
UGS	Underground gas storage
OECD	Organization for Economic Cooperation and Development
ILCS	Integrated Living Conditions Survey
CJSC	Closed Joint Stock Company
PV	Photovoltaic
EDRC	Economic Development and Research Centre

Measurement units

mln.	Million
km	Kilometer
t	Ton
toe	ton oil equivalent
ktoe	kiloton oil equivalent (1000 toe)
m ³	cubic meter
mln. m ³	million cubic meter
W	Watt
kW	kiloWatt (10 ³ W)
MW	MegaWatt (10 ⁶ W)
Wh	Watt*hour
kWh	kiloWatt*hour (10 ³ Wh)
MWh	MegaWatt*hour (10 ⁶ Wh)
GWh	GigaWatt*hour (10 ⁹ Wh)
J	Joule
MJ	MegaJoule (10 ⁶ J)
TJ	TeraJoule (10 ¹² J)

1. INTRODUCTION

The given report was developed by the order of the United Nations Development Program (Armenia) under UNDP-GEF “Armenia’s Third Biennial Update Report to the UNFCCC” project.

Development of the RA Energy Balance is important for the assessment of the energy security level of the country, the diversification of power supply and the trends in greenhouse gas emissions, as well as for evaluation of the progress in achieving the targets of the United Nations Framework Convention on Climate Change.

Energy balance is one of the main sources for the collection of the initial data on greenhouse gases (GHG) emissions in the Energy sector. It serves as a ground for the development and implementation of mitigation measures addressing the environmental challenge of climate change. Implementation of the mitigation measures is of a great importance under the Paris agreement and commitments undertaken by the Republic of Armenia.

The Energy Balance of Armenia for 2019 was compiled by the support of the UNDP-GEF “Armenia’s Third Biennial Update Report to the UNFCCC” project following the request of the RA Ministry of Territorial Administration and Infrastructures. The Energy Balance was developed in cooperation with the GHG inventory compilation expert team.

Energy balance is a valuable instrument for the assessment, documentation and monitoring of the energy efficiency and renewable energy indicators in the country for the given year.

For the compilation of the Energy Balance following actions were undertaken:

- Collection of the SC official data;
- Business meetings and discussions have been organized to improve data collection, in particular: (a) for the assessment of the consumption volumes of liquid fuels by sectors; (b) for evaluation of biofuels consumption (particularly, firewood and manure);
- Methodology for the compilation of 2018 Energy Balance was analyzed;
- Collected data were analyzed, the balance indicators were calculated and the initial data were archived;
- 2019 Armenia Energy Balance was compiled and presented in Eurostat and International Energy Agency’s formats.

Compilation and publication of Armenia Energy Balance is defined by the RA Law on “Energy Efficiency and Renewable Energy”.

The guideline¹ published by the IEA, Eurostat and Organization for Economic Cooperation And Development (OECD) as well as the “Explanatory Note on Energy Balance of Armenia” developed by the Economic Development Research Centre (EDRC) serves as methodological base for the compilation of the 2019 Armenia Energy Balance. The main sources of the initial data and the major applied approaches for the compilation of the energy balance are reflected within the mentioned Explanatory Note.

During the compilation of the 2017 and 2018 Energy Balances, the “Scientific Research Institute of Energy” CJSC slightly upgraded the Excel program developed by the EDRC. Slight upgrades were also made in 2019 Energy Balance, in particular, the values of imported oil products imported in the RA SC by 10-digit classifier.

¹“Energy Statistics Manual”, OECD/IEA, 2007

2. SIGNIFICANCE OF THE ENERGY BALANCE

Energy balance is represented in the form of a standard spreadsheet format, which reflects amounts of the energy resources extracted, produced, imported, exported, stored, processed, converted, transported, distributed and used in various sectors in Armenia during the reporting period. The Energy balance of the country is presented in the Eurostat or IEA standard formats, which comply with the regulation No 1099/2008 of the European Parliament and of the Council of 22 October 2008 on energy statistics.

During the compilation of the energy balance, it is necessary to take into account the flows of energy carriers and all types of the energy by their generation, recycling, transformation, distribution, storage and final consumption cycles, as well as energy costs and possible losses for own needs.

According to the Eurostat requirements energy balances are composed using natural (TJ) units, and as for the IEA standards - the oil equivalent (1 ktoe equals to 41.868 TJ).

Collection and processing of the statistical data and compilation of the energy balance are the first steps for the analysis of the energy situation in the country allowing the assessment of the previous trends and formation of the future policy addressed to the development of the energy sector. Data in the energy balance enable the assessment of the energy efficiency level in the different sectors of the economy and households. It should be noted that emissions indicators are closely related to those of energy efficiency.

The role of clear and comprehensive information is constantly increasing and allowing to not only be limited to the qualitative conclusions, but also to reveal quantitative assessments for energy policy.

According to the IEA, in order to develop an energy policy it is necessary to have clear information about the final consumption, in particular:

- Information on the driving forces of the energy consumption,
- Information on the current energy consumption situation,
- Information about the responses on the implementation of the policy options.

Different models have been developed that enable the identification of the existing issues and the evaluation of the possible outcomes of the events taken. The "driving force – situation - reaction" is a key model, which was suggested by the Organization for Economic Co-operation and Development (OECD) in 1996.

All this makes an information environment, which is regularly updated and provides with a basis for the policy review and correction.

Amounts of the electricity produced by renewable sources (wind, solar, etc.) in different countries of the world still grow. The increase of their share in the energy balance ensures a reasonable level of energy independence of the country and the reduction of greenhouse gas emissions.

Development of the energy balance is necessary for:

- Assessment of the country's energy independence, including the power produced at the renewable energy sources in the energy balance;
- Study of the fuel and energy production and consumption structure;
- Study of the fuel and energy resources demand;
- Analysis of the fuel and energy balance structure for its improvement;

- Definition of the capital investments volumes for the development of the fuel and energy complex in the country;
- Identification of the export and import volumes of fuel and energy resources;
- Assessment of the energy efficiency potential;
- Identification of the greenhouse gases & other emissions volumes and the development of the measures to minimize their negative impacts on the environment, etc.

3. BALANCE COMPILATION AND APPLIED APPROACHES

This chapter presents the initial data of the main energy carriers included in the energy balance and the basic approaches applied for compilation of the balance.

3.1. Electricity Balance

General information and overview

Electric energy is one of the most developed areas in the economy of Armenia. There are both the traditional sources for electricity production that are NPP, TPP and HPPs, and the alternative sources. Recent governmental decisions contributed to the development of some alternative energy projects which includes installation of licensed and autonomous solar photovoltaic systems, solar water heaters, as well as wind power monitoring and geothermal energy research activities, etc.

Armenia exports electricity to Iran, Artsakh and to Georgia as well as imports electricity from the mentioned countries. Electricity export to Iran is realized on electricity-for-gas swapping agreement and was 94.5% of the overall exported electricity in 2019. The import from Iran amounted to 78.8 mln. kWh in 2019, which is mainly conditioned by the power system regimes. Electricity export to Georgia is mainly organized in the emergency switched off the 500 kW Caucasian power transmission line feeding the system from Russia and was 0.0005 mln. kWh in 2019. Power supply to the Northern parts of Armenia in high precipitation seasons is performed from Georgia in the isolated regime and amounted to 59.3 mln. kWh in 2019. In 2019, transmission of electricity to Artsakh was 68.8 mln. kWh and the import amounted to 154.4 mln. kWh. In 2019, total exports amounted to 292.6 million kWh, and imports amounted to 1251.1 million kWh.

Armenian NPP produced 2197.8 million kWh electricity in 2019 which is around 28.6% of the total production. These indicators increased against those of 2018 due to the maintenance activities undertaken for extension of the ANPP operation life time.

There are three big thermal power plants in Armenia, two of which although are combined cycle production capacities but operated in condensation mode in 2019. Stockpiles of "Yerevan TPP" CJSC, "Hrazdan-5" of "Gazprom Armenia" CJSC and "Hrazdan TPP" OJSC generated 1593.0 million kWh, 944.5 million kWh and 500.7 million kWh electricity in 2019, respectively. Production of "Gazprom Armenia" CJSC decreased by 58.5% compared to 2018. Shares of the mentioned plants in the total electricity production accordingly amount to 20.7%, 12.3% and 6.5%. Thus, the shares of "Hrazdan-5" TPP OJSC in the electricity production decreased and of "Hrazdan TPP" increased respectively compared to the generation in 2018. Some amount of electricity was also produced at small combined cycle power plants. Total electrical energy production of "Yerevan State Medical University after Mkhitar Heratsi" and "ArmRuscogeneration" CJSC cogeneration plants in 2019 amounted to 8.6 million kWh or 0.12% of the overall production.

Hydro energy of Armenia are presented by two major HPP cascades owned by “International Energy Corporation” CJSC and “Contour Global Hydro Cascade” CJSC, as well as by a number of small HPPs. The HPPs of “International Energy Corporation” and “Contour Global Hydro Cascade” produced 424.3 million kWh and 991.1 million kWh electricity in 2019, respectively, which accordingly amount to 5.5% and 12.9% of the total electricity production and are comparable to the indicators of 2018. According to the RA PSRC information, number of the small HPPs in 2019 was 186, with total installed capacity of 374.4 MW, and the supply of the actual useful electricity was 955.68 million kWh. The share of small HPPs in the total net electricity supply was 12.8% which is lower than in 2018.

Small amount of electricity was also produced at the wind and solar photovoltaic power plants. Total production of the wind farms amounted to 3.2 million kWh in 2019, which was 0.04% of the total electricity production. Introduction of solar PV sites has significantly developed in 2019. According to the PSRC, amount of the useful electricity transmitted from the license owned PV sites to the electric network was 13.1 million kWh in 2019, and electricity delivered by the autonomous producers amounted to 10.1 million kWh. Following to the information provided by the “ENA” CJSC, the total installed capacity of the autonomous producers was 39.44 MW which output, according to the expert assessments based on Solar Map of Armenia², amounted to 47.33 million kWh.

Electricity is transmitted and distributed by HVEN and ENA CJSCs wherein inevitable technical losses occur. Losses in 2019 amounted to 548.0 million kWh which was 10.37% less than in 2018.

Data Sources

Data on the production and the own needs of each of the plants, as well as on the losses in the transmission and distribution processes have been collected from the PSRC’s official website. Data on the electricity consumption by the industrial sectors has been provided by RA SC. Data on annual solar hours duration was taken from Solar Map of Armenia. Information on the electricity consumption in other sectors has been collected from the official website of the RA PSRC.

3.2. Natural Gas Balance

General Information and Overview

The supply and sale of the natural gas in the RA domestic market is realized by the “Gasprom Armenia” CJSC.

²http://minenergy.am/storage/hh_taracqum_arevayin_neruji_qartezner.pdf

The total length of the main gas pipelines and pipes' branches operated in the gas transportation system amounts to 1680.4 km. Transportation of the gas is carried out through the 1682.2 km length gas pipeline. Transportation of the gas carried out through the 1532.8 km length gas pipeline. Unused pipelines are in operational reserve mode.

The total length of the distribution of high, middle pressure operated in the gas distribution system amounts to 15981.6 km. In gas distribution system were operating 2617 gas regulating points, 7775 individual pressure regulators, 1430 head measuring nodes, as well as 328 chemical protection stations.

The underground gas storage (UGS) allocated in Abovyan is also used for the gas backup owned by "Gasprom Armenia" CJSC, wherein it is possible to store up to 135 million m³ natural gas. UGS has strategic importance since it ensures the reliability of the gas supply in the country while being used to cover the seasonal and peak demand of the gas. In 2019, 30,3 mil.m³ of gas was taken from the gas pipelines and UGS (70.3% less than in 2018), meanwhile, 11.7 mil.m³ was pumped into the UGS (49.7% less than in 2018).

Diversification of the gas supply to the Republic of Armenia is ensured by the gas imported from the Russian Federation and the Islamic Republic of Iran. According to the pending agreement with Iran it is planned to perform gas-for-electricity swapping. A two-circuit 400kV transmission line is now being constructed to ensure the contractual amounts of the gas imported from Iran.

In 2019, natural gas in amounts of 2166.9 million m³ (11.7% more than in 2018) and 378.5 million m³ (27.7% less than in 2018) were imported from the Russian Federation and Iran, respectively. Data on the imported gas are published in the annual report of the RA SC and posted on the PSRC's official website.

Following to the estimations of "Gazprom Armenia" CJSC, around 77% of the vehicles park in Armenia operates in compressed natural gas. Currently, Armenia has leading positions among the countries in the world that apply natural gas as an engine fuel. It is economically advisable compared to the other oil products and leads to the significant reduction of hazardous substances and greenhouse gas emissions in the atmosphere. Today, there are around 400 CNG fueling stations in Armenia. Transport sector consumed 577.2 million m³ of natural gas in 2019 which is 4.4% more than in 2018. Amounts of the natural gas consumption in the transport sector (577.2 million cubic meter) was less than consumption volumes of the population (668.7 million cubic meters) and are 3.4 times higher than the volume of the gas consumed in the industry for energy purposes (194.1 million m³).

Data Sources

Data provided by the RA PSRC, RA MTAI and RA SC served as the information source for the compilation of the natural gas balance. Information about the gas amounts imported and taken from the gas pipelines and UGS as well as data on the gas volumes pumped into the UGS, losses in transportation and distribution systems, transported gas amounts, own needs consumption, recovered gas volumes and consumption in the transportation sector were taken

from the RA PSRC's official website. Data on the natural gas used in the Industrial sector for energy purposes and in separate power plants were provided by the RA SC.

3.3. Thermal energy balance

General information and overview

Share of the thermal energy in the overall energy balance of Armenia is quite small. Thermal energy in Armenia is generated only for the domestic market.

In the beginning of 1990's, energy crisis occurred in Armenia caused by the irregular gas supply due to Armenia's low solvency and regular explosions of the gas pipeline. That was the reason for the collapse of the centralized heat supply systems. After the gas supply rehabilitation, individual equipment was widely used for preparation of hot water and heating.

Currently, centralized heat supply in Armenia is implemented by small combined cycle power plants. "Yerevan State Medical University after Mkhitar Heratsi" and "Lus Astkh" LLC produce heat energy for its own needs (According to the PSRC, electricity generation by "Lus Astkh" LLC made 0.01 mln.kWh in 2019), and "ArmRuscogenartion" CJSC realizes heat supply to Hovhannisyan, Varuzhan, Isahakyan, Tumanyan, Kuchak and Narekatsi blocks of Avan administrative area in Yerevan. There is no data on the thermal energy generated at the cogeneration station of the fund "Yerevan State Medical University after Mkhitar Heratsi". In 2019, amounts of the thermal energy produced "ArmRuscogenartion" were 27.4 thousand GJ, which is 14.2% higher than in 2018. Thermal energy losses remain high in the distribution which was 17 thousand GJ in 2019 (58% of the produced energy).

There was no heat supply from the main thermal power plants - Hrazdan 5 unit and Yerevan CCGT, and they operated in condensation mode.

There are some small capacity boiler houses in Armenia designed for the heating of one or several buildings.

Thermal **energy** sources also include solar water heaters and fruit drying equipment. There is no reliable information about the individual solar water heaters' areas and the volumes of their utilization in different sectors, particularly, in food industry and service sector. According to expert assessments, thermal energy generated by the solar equipment in 2019 was 60% higher than in 2018 taking into account the data of the Tax Service, but the share of that energy is insignificant and has been considered in the section "Renewable Energy Carriers Balance".

Data sources

The RA PSRC's official website publishes the data only on the electricity produced by the combined cycle and biogas operated power plants. Information about the thermal energy produced by the combined cycle power plants in 2019 was provided by the RA SC. The basis for data on the solar water heaters was the information available at the Tax Service.

3.4. Oil product balance

General information and overview

Data on the following oil products are presented in the oil product balance:

- Motor fuel types (engine gasoline, diesel fuel, petrol for jet engines, aviation kerosene)
- Liquid oil gases,
- Mazut and oil bitumen,
- Other oil products (other kerosene types, special types of gasoline, lubricants, paraffin and other oil products).

There is no oil extraction in the territory of Armenia and all the oil products are imported. Some types of the imported oil products are used in the limited amounts for the production of varnish, paints and the other products in Armenia. Imported bitumen and mazut are utilized for non-energy purposes either.

Engine gasoline is 99.96% consumed in the transport sector.

In 2019, the main volume of the diesel fuel in amount of 75.0% was consumed in the transport sector. Industrial sector used around 12.46% of the diesel fuel. Diesel fuel consumed by the industrial sector is utilized to operate different types of the mechanisms (drilling rigs, cranes, telescopic towers and other mechanisms). The major consumer of the industrial sector is the mining industry.

Around 11.4% of the diesel fuel was utilized by the agriculture sector (tractors, combines and other mechanisms).

In Household sector was consumed 0.3% of diesel fuel.

Insignificant amounts of diesel fuel are also consumed by the diesel generators which are reserve sources for power production. Data on this sector consumption aren't available.

Minor volumes of diesel fuel were also used for non-energy purposes in the chemical industry and other sectors. The share of diesel consumed for non-energy needs was 0.83% compared with total consumption.

In 2019, the main volumes of liquid petroleum gases, that are 83.2%, were used by the transport sector and exceeds the consumption of 2018 due to the increase of the liquid petroleum gas operated vehicles stock. The share of liquid petroleum gas consumption in the industry was only 0.7% which is around 2 times highest than in 2018. Consumptions of the liquid petroleum gases in the service sector and households were 14.9% and 0%, respectively.

Other oil products are consumed for non-energy purpose.

Data sources

Information on the imports and exports of oil products is provided by the RA SC and could be revised. The RA SC supplied data on the volumes of the oil products consumption in the industrial sector and the information about sowing and total harvesting areas of the

agricultural crops for 2019, as well as on fuel consumption in the agriculture sector are the expert assessment of the RA Ministry of Agriculture.

3.5. Coal Balance

General information and overview

The RA SC data on the imported coke, semi-coke, anthracite, peat and other coal types were used to compile the coal balance.

In 2019, the main volumes of the coal consumed for energy purposes, around 65.9%, were used by the service sector.

There are lignite mines in Jajur and Dilijan. They haven't got any industrial significance, and according to the expert estimations around 500 families collect the lignites manually. Therefore, consumption of the lignites in 2019 remained at the level fixed in 2018.

A certain amount of the imported coal is used for non-energy purposes, such as peat as fertilizer.

Data Sources

Information on the imports and exports of the coal types was provided by the RA SC and could be revised. The RA SC also supplied data on the volumes of the coal consumption in the industrial sector. Information about the export and consumption of the lignites was revealed using the expert assessments.

3.6. Balance of wood and other biofuels

General information and overview

Wood and other types of biofuel are renewable energy carriers.

Types of the biofuels are:

- Industrial wastes,
- Solid household wastes,
- Solid biomass (including charcoal),
- Biogases.

Firewood and timber in Armenia are revealed in the following ways:

1. Sanitary deforestation (solid biomass),
2. Illegal deforestation (solid biomass),
3. Fallen dry wood (solid biomass),
4. Wastes from woodworking and furniture manufacturing (industrial wastes),
5. Import.

Data on the timber products and firewood used for the energy purposes in the industrial sector are available and provided by the RA SC. It is more difficult to estimate the amounts of timber products and firewood consumed in the households, which are provided by the RA SC either are based on the surveys.

Official data on the individual biogas facilities isn't available. In Armenia, these technologies mainly use manure. Manure is also utilized for the energy purposes as a furnace fuel, mainly for the heating purposes. Data on the amounts of manure consumption are provided by the RA SC based on surveys.

Limited amounts of crude and other solid residues are also imported to Armenia.

Data sources

Data on the imports and exports of the wood and other biofuels have been provided by RA SC. The RA SC has also provided the data on the amounts of the wood and other biofuels consumption in the industrial and other sectors.

3.7. Renewable energy balance

General information and overview

This chapter observes hydro, wind, solar and geothermal energy.

Hydro energy is the most developed among the other renewable energy resources in Armenia.

Total installed capacity of seven HPPs owned by the "International Energy Corporation" CJSC amounts to 561.4 MW and the production in 2019 was 424.3 million kWh.

Total installed capacity of three HPPs owned by "Contour Global Hydro Cascade" CJSC amounts to 404.2 MW and the production in 2019 was 991.1 million kWh.

In 2019, 188 small HPPs were operated in Armenia which total installed capacity amounted to 371.8 MW and the actual annual useful supply was 934.8 million kWh.

Four wind power plants (WPP) operated in Armenia in 2019. Total supply of the useful electricity from the WPPs was 3.2 million kWh in 2019.

Armenia also has significant potential for solar energy production. Solar energy is represented by solar water heating and PV power plants. In 2019, amounts of the hot water and electricity produced by the solar technologies increased significantly compared to 2018 due to the policy realized by the RA Government. The net metering method was applied for the autonomous consumers in PV sector.

According to PSRC's official website, useful supply among the autonomous producers in the electricity exchange amounted to 10.1 million kWh, and delivery from solar PV plants was 13.1 million kWh. Since only a part of the electricity produced by the autonomous producers is delivered to the power system the amounts of primary production at the solar PV systems

couldn't be assessed. In 2019, total installed capacity of the autonomous PV systems amounted to 39.4 MW following the information provided by "ENA" CJSC.

Total generation of autonomous and utility scale solar PVs amounted to 60.7 million kWh. This indicator is about 3.1 times higher than those in 2018.

The Government of Armenia is implementing a promoting policy for the development of solar water heating technologies. The customs service data on the water heater technologies imported to Armenia in 2019 were analyzed

Share of the solar technologies in the gross domestic consumption of the renewable energy carriers significantly increased and was 4.35% in 2019.

Geothermal energy in Armenia is represented by several pilot installations which haven't been included in the energy balance due to their insignificant production volumes.

Data sources

Data on the WPP production amounts were taken from the RA PSRC's official website. Sources for the information on the solar technologies were the "ENA" CJSC, customs service and R2E2.

4. CONCLUSION

During the task implementation:

- Energy balances of Armenia for 2010, 2011, 2012, 2014, 2015, 2016, 2017 and 2018 have been analyzed,
- Collection of the official data from RA SC, PSRC, MTAI and R2E2 have been accomplished,
- Energy Balance of Armenia for 2019 has been compiled in the formats of Eurostat and International Energy Agency,
- Preliminary Energy Balance of Armenia for 2019 has been discussed with the specialists from RA SC and MTAI.
- Based on compiled balance the Fact sheet was developed.

