This project is co-funded by
the European Union

Armenia
Energy Profile

International
Energy Agency

INTERNATIONAL ENERGY AGENCY

The IEA examines the full spectrum of energy issues including oil, gas and coal supply and demand, renewable energy technologies, electricity markets, energy efficiency, access to energy, demand side management and much more. Through its work, the IEA advocates policies that will enhance the reliability, affordability and sustainability of energy in its 30 member countries, 8 association countries and beyond.

IEA member countries:

Australia
Austria
Belgium
Canada
Czech Republic
Denmark
Estonia
Finland
France
Germany
Greece
Hungary
Ireland
Italy
Japan
Korea
Luxembourg
Mexico
Netherlands
New Zealand
Norway
Poland
Portugal
Slovak Republic
Spain
Sweden
Switzerland
Turkey
United Kingdom
United States

The European Commission also participates in the work of the IEA

IEA association countries:

Brazil
China
India
Indonesia
Morocco
Singapore
South Africa
Thailand

Please note that this publication is subject to specific restrictions that limit its use and distribution. The terms and conditions are available online at www.iea.org/t&c/

Source: IEA. All rights reserved.
International Energy Agency
Website: www.iea.org

Table of contents

Armenia Energy Profile

Country overview

The Republic of Armenia (Armenia) is a landlocked country in the southern Caucasus region between the Black and Caspian seas, bordered by Turkey on the west, Georgia to the north, Azerbaijan on the east and Iran to the south. The country is approximately 29 800 km^2 with a population of 2 963.3 million. Yerevan, the capital, is the largest city with 1 082 million inhabitants (www.armstat.am/file/article/nasel_01.01.2019.pdf).

Armenia's economy has undergone numerous reforms since the economic crisis of the early to mid-1990s. It has evolved from having a Soviet-era centralised structure to a partially market-oriented economy, with privatisation of most enterprises. An influx of foreign capital and funding from donors since the early 2000s has contributed to healthy economic growth, and Armenia's real GDP increased 5.72% per year from 2002 to 2018 (measured in US dollars at PPP 2011 prices). Real GDP per capita was USD 9 178 in 2018, two and half times more what it was in 2002 (http://api.worldbank.org/v2/en/country/ARM?downloadformat=excel).

Armenia's reliance on export-oriented industries and high remittances from the Armenian diaspora (remittances accounted for 12% of GDP in 2018 [http://api.worldbank.org/v2/en/country/ARM?downloadformat=excel) exposes the economy to price and demand fluctuation risks. During the latest global financial crisis, the country's real GDP fell 15% and poverty rose from 27% in 2008 to 35% in 2011. However, targeted social expenditures and pension increases have induced economic growth, and the poverty level was reduced to 23.5% as of 2018 (https://armstat.am/file/article/poverty_2019_a_2.pdf).

Lacking indigenous resources, Armenia imports natural gas and oil for most of its energy needs (78% of total energy supply in 2018), mainly from the Russian Federation (hereafter, "Russia"). Natural gas is imported from Russia via pipeline through Georgia, but also from Iran through a barter agreement under which it exports electricity in exchange.

IEA. All rights reserved.

Electricity is also traded with Georgia, though volumes are low since the countries' networks are not synchronised. Energy interconnections with Azerbaijan and Turkey are currently inactive for political reasons.

Prompted by a severe electricity supply crisis in the mid-1990s, Armenia has revamped its energy sector over the past 20 years. Parts of the sector have been privatised, some companies have been restructured, most households now have access to gas, and cost-reflective tariffs have been introduced. This has led to ample investment in capacity and networks, which has considerably improved reliability; funding came mainly from the donor community, upon which Armenia still relies for support.

Energy policy is now focused on developing indigenous energy sources, mainly renewables, and on extending the lifetime of the nuclear reactor that supplies nearly one-third of the country's electricity. The government has begun to pay more attention to energy efficiency issues, and the second National Energy Efficiency Action Plan (NEEAP-2) was developed in 2020.

Armenia's regional policy focuses on strengthening its position and broadening market integration. The European Union and Armenia completed negotiations for the Association Agreement and the Deep and Comprehensive Free Trade Area in July 2013; soon after, however, implementation was suspended because Armenia expressed strong interest in joining the Eurasian Customs Union with Belarus, Kazakhstan and Russia (http://ec.europa.eu/trade/policy/countries-and-regions/countries/armenia/). Armenia became a member of the Eurasian Economic Union in January 2015 with Belarus, Kazakhstan and Russia, and Kyrgyzstan joined in August 2015. It has been an observer to the Energy Community since 2011 and a member of the Eastern Partnership since 2009.

Key energy data

- Armenia's energy demand averages above 3 Mtoe (3.40 Mtoe in 2019), comparable to that of Moldova or Tajikistan.
- Natural gas dominates the energy mix (63% of total primary energy supply in 2019). Armenia's electricity mix is more diversified.

Production

- Although Armenia does not produce any fossil fuels, it manages to cover 24% of energy demand with domestic energy production. This production (0.67 Mtoe in 2019) comes mostly from nuclear and hydro energy.

IEA. All rights reserved.

- In 2019, Armenia produced 7.7 TWh of electricity, of which natural gas covered 40% (3.0 TWh), hydro 31% (2.4 TWh) and nuclear 29% (2.2 TWh). In the Caucasus region, Armenia is the only country producing nuclear energy.

Imports/exports

- All fossil fuels are imported: natural gas represents over 80% of Armenia's energy imports (2.1 Mtoe out of 2.6 Mtoe in 2019), followed by oil products (0.5 Mtoe in 2019).
- Russia is its predominant supplier of natural gas (85% in 2019), the rest coming from Iran.
- Armenia is a net exporter of electricity, although most of it is in exchange from natural gas from Iran.

Demand

- Energy consumption (final consumption excluding transformation) more than doubled between 2000 and 2019 (+122%), and heavily outpaced the global demand in the same period (43%).
- Total final consumption (TFC) in 2019 was 2.7 Mtoe. Residential and transport consumption were on par in 2019 with both consuming 0.81 Mtoe (33% of the TFC). Households consume mainly natural gas and electricity, whereas transport consumption consists of natural gas and oil products. In recent years, transport has also been the main driver of demand growth.

Renewables

- Renewables, including hydro, represented 8.8% of Armenia's energy mix in 2019. Almost a third (32% in 2019) of the electricity generation came from renewable sources.

Energy sector governance

Executive

The **Ministry of Territorial Administration and Infrastructure (MTAI)** is responsible for developing and implementing energy policy. It develops relevant primary and secondary legislation, as well as investment plans for state-owned enterprises.The regulator for nuclear energy is the State Nuclear Safety Regulatory Committee.

IEA. All rights reserved.

The **Ministry of Nature Protection** oversees the protection and conservation of natural resources and is responsible for environmental impact assessments. It is the designated national authority for projects under the Kyoto Protocol's Clean Development Mechanism.

The **Public Services Regulatory Commission (PSRC)** is an independent body responsible primarily for tariff methodology and review, licensing procedures and import/export regulation. The PSRC also regulates water, waste, telecommunications and rail transport.

Armenia does not have a dedicated agency for renewable energy policies, so the **Renewable Resources and Energy Efficiency (R2E2) Fund** is responsible for implementing renewable energy and energy efficiency projects.

Legislative

Armenia's primary energy legislation is the Law on Energy (2001): included in its legislation are provisions for market rules and ownership structure. The Law on Energy Saving and Renewable Energy (2004) defines the policy principles for renewables and energy savings, and efficiency licensing and tariffs are regulated mainly by the PSRC's laws on licensing and energy.

The Law on the Construction of New Nuclear (2009) legislated construction of a new 1 000 MW nuclear unit and decommissioning of the operating plant. However, for electricity supply security reasons, in 2012 a ten-year extension to 2026 was granted to Unit 2 of the existing plant (commissioned in 1980), provided that rehabilitation work is carried out.

Judiciary

Armenia has a three-tiered judicial system consisting of courts of first instance, courts of appeal and a Supreme Court. Courts of first instance include the courts of general jurisdiction and the Administrative Court. Courts of general jurisdiction examine all civil and criminal cases, whereas administrative cases are heard by the Administrative Court.

Decisions of the courts of general jurisdiction and the Administrative Court can be appealed to the courts of appeal; these include the Civil Court of Appeal, the Administrative Court of Appeal and the Criminal Court of Appeal. The Supreme Court can review and revise rulings of the courts of appeal.

IEA. All rights reserved.

Also within the judicial system is the Constitutional Court of Armenia, the country's highest body of constitutional justice. The Constitutional Court primarily settles disputes, assesses the conformity of laws and regulations with the Constitution, resolves election-related disputes, and assesses compliance of international treaties with the Constitution.

Disputes between foreign investors and the Republic of Armenia must be resolved in Armenian courts through the application of domestic legislation, according to the Law on Foreign Investment. In cases of mutual consent, businesses may opt to settle disputes through commercial arbitration either in Armenia or abroad. Arbitration is regulated by the Law on Commercial Arbitration, which provides a sound framework for conducting both domestic and international commercial arbitration in Armenia, and for enforcing awards made in other countries in Armenian courts of arbitration.

The government always honours arbitration judgements, and other dispute resolution procedures such as mediation, mini-trials and neutral negotiation are also available in Armenia. The Permanent Arbitration Body of the Chamber of Commerce and Industry was established in 2007 based on the Law on Commercial Arbitration, and Armenia is a signatory to the 1958 Convention on the Recognition and Enforcement of Foreign Arbitral Awards. It is also a signatory to the International Convention on Investment Disputes.

Regulatory framework

Armenia's power sector is regulated by the Energy Law adopted in 2001. The Energy Law provides basic principles for national policy, but does not specify the authority of the government or MTAI to make policy decisions, nor does it define MTAI's role in the power sector. At the same time, it describes in detail the authority granted to the PSRC, which is generally in compliance with international best practice. The regulator issues licences for wholesale power market participants, for both import and export transactions; sets the tariffs for generation, transmission and distribution, including end-user tariffs and service fees for the system operator and Settlement Centre; sets the market rules in co-operation with MTAI; and determines the distribution rules, including connection rules. The regulator also sets the tariffs for imported electricity (www.minenergy.am/storage/files/pages/pg_7791595395722_3.2_Gap_Analysis_Armenia_Final_Eng.pdf).

IEA. All rights reserved.

Key policies

Armenia relies on imports of natural gas and oil for most of its energy needs, which exposes it to supply risks and dependence on a single supplier. As the government considers energy security and the development of indigenous sources to be of prime importance for the energy sector, renewables and efficiency measures are key areas. To satisfy expected demand growth while increasing reliability, the government aims to increase capacity and promote domestic energy sources.

In 2013, the government developed a National Energy Security Concept that outlines strategies for fuel diversification mainly through renewables and nuclear power, building fuel reserves and increasing power generation capacity. In 2014, the government approved the Schedule of Activities for 2014-2020 for implementing the security concept. The security concept complements previous energy sector development strategies as part of the 2005 Context for Economic Development to 2025, including the National Program on Energy Saving and Renewable Energy (2007) and MTAI's Action Plan (2007). The Long-Term (up to 2036) Development Pathways programme for Armenia's energy sector, approved in December 2015, outlines possible least-cost strategies to develop the whole energy system.

These strategies and action plans are the main energy policy documents. They set out targets and objectives for the energy sector, in line with the following principles:

- Make full use of the economically and environmentally sound potential of renewables and energy efficiency across the whole economy.
- Develop nuclear power for electricity supply.
- Integrate Armenia into regional energy markets and participate in regional projects.
- Diversify supply sources of primary energy resources.

In 2014, the government developed the Scaling-Up Renewable Energy Program Investment Plan. It is an update of the Renewable Energy Road Map developed in 2011 and includes comprehensive analyses of renewable energy potential, costs and benefits, and the viability of specific technologies. It also sets targets and objectives for renewables to 2025, including a plan for financing. The investment plan describes the first geothermal and solar PV projects, which are being developed by the government and serve as examples for other investors. Nuclear energy accounts for nearly one-third of the electricity supply and is of strategic importance; therefore, although the existing reactor is old, its service life has been extended to 2026, by which time the government hopes to have secured financing to build a new reactor of 1 000 MW.

IEA. All rights reserved.

The government's ambitious plan to increase renewables to 28% of the power generation mix by 2036 (from 7% in 2012) includes small hydro, wind, solar PV and geothermal, but excludes biofuels. To reach this target, Armenia will need to have 634 MW of new renewable energy capacity installed by 2036. Estimated projected capacity additions comprise 148 MW of small hydro and 266 MW of large hydro, 150 MW of wind, 30 MW of geothermal, and 40 MW of solar PV.

Energy efficiency measures are based on the second NEEAP, which involves setting energy efficiency targets for all sectors up to 2020. The R2E2 Fund, established in 2006 within the framework of the Energy Efficiency Project with the support of the Armenian government, the World Bank and revolving fund financing, has initiated energy efficiency measures in schools, kindergartens, universities, hospitals, and other social and administrative buildings, as well as for municipal street lighting systems.

Regulatory reform has supported achievements in the power sector since the mid 1990s. A commitment to cost-recovery tariffs has facilitated investment in infrastructure and attracted substantial private-sector investment, resulting in improved reliability, service quality and operational efficiency in the sector.

Strengthening regional integration is also a key component of Armenia's energy policy. In addition to having political disagreements with two of its neighbours, Armenia's electricity interconnection with Georgia is not fully functional because their systems are asynchronous, and its connection with Iran is operating under limited conditions. Armenia plans to increase its electricity production to sell more to Georgia and Iran during the summer months, and to rely on electricity imports in the winter if necessary. To synchronise its system with those of its neighbours, and to provide electricity at competitive prices, Armenia will have to open its relatively closed electricity market.

Energy statistics

The National Statistical Service of the Republic of Armenia (ArmStat) is the government institution responsible for collecting and validating energy data. Two statisticians of ArmStat's industry division dedicate part of their time to energy statistics, and the MTAI compiles an energy balance from data provided by ArmStat and other sources.

Survey data for energy consumption in the transport, industry and construction sectors, as well as for households, are available from 2015 onwards (although a

IEA. All rights reserved.

test survey was conducted in 2014). Supply data are collected directly from the data providers (customs, main electricity companies).

Armenia's first official energy balance was produced for 2015 (although an experimental balance was released for 2014). In February 2017, the official energy balance became available on the websites of both ArmStat and MTAI. It is published in Armenian, English and Russian, and its layout follows United Nations (UN) International Recommendations for Energy Statistics. Methodological documentation with a description of the key data is also available on the MTAI website.

ArmStat shares annual data with the International Energy Agency (IEA) through five joint IEA/Eurostat/UN Economic Commission for Europe questionnaires. All data for Armenia published by the IEA have come directly from ArmStat since 2014, but consumption data were previously estimated by the IEA Secretariat. ArmStat also shares energy data with the Eurasian Economic Commission and the Interstate Statistical Committee of the Commonwealth of Independent States and participates in the Joint Organisations Data Initiative (JODI) oil database.

The priority in energy data collection is to continue producing and publishing energy balances despite staff constraints, and to further consolidate raw data.

IEA. All rights reserved.

Chapter 1. Energy security

Resource endowment

Armenia has no proven reserves of natural gas or oil, and hard coal deposits are a modest 154 Mt, with resources of 163 Mt and further potential of 317 Mt (www.bgr.bund.de/EN/Themen/Energie/Downloads/energiestudie_2013_en.pdf?__blob=publicationFile&v=2). There are six known coalfields and some shale oil deposits, but the economic viability of mining these deposits has not been determined. There is currently no coal or shale oil production in the country (www.geni.org/globalenergy/library/national_energy_grid/armenia/country_overview.shtml).

Given its more than 400 mostly small, steep mountain rivers of at least 10 km in length, Armenia's small hydropower potential is significant. Although small hydro has been the focus of considerable development in recent years, the government is also assessing the potential of other forms of renewables.

Energy security and diversification

Energy security in Armenia has greatly improved since the gas and power supply crisis in the early to mid-1990s. During the crisis, energy sector management was dysfunctional, losses were extremely high, and the collection rate was below 50%. This resulted in acute supply shortages, with households receiving only a few hours of power per day. Since then, increased natural gas heating, investment in new generation capacity and the network, and improved operational management have restored a consistent and uninterrupted supply of electricity and gas.

Electricity and gas demand is expected to continue growing as living standards rise and poverty is reduced. Significant investment will be needed to meet these rising energy needs, as large portions of the electricity and gas networks date to the Soviet era, and infrastructure modernisation is needed to maintain and improve supply reliability. In its Energy Security Concept, the government estimates approximately 1 000 MW will be retired by 2026, so new investments will be required to satisfy growing demand if the country does not want to become even more reliant on imports. The proposed new 1 000 MW nuclear plant accounts for planned new capacity, but financing has not been secured.

IEA. All rights reserved.

The sustainability and reduced import dependency offered by renewable energy makes its increased contribution (28% by 2036) a priority, with additional capacities of 414 MW of hydro (small and large), 150 MW of wind, 30 MW of geothermal and 40 MW of solar PV required to meet this target. According to the government, small hydro capacity was 328 MW in 2016, and 71 MW was planned or under construction.

In electricity, regional integration and supply diversity is advancing, with a 400 kV double-circuit high-voltage interconnection with Iran under construction, as well as a high-voltage interconnection with Georgia with back-to-back high-voltage direct current connection. These interconnections will strengthen regional integration, expand the market and improve supply reliability, and could serve as additional sources of electricity in cases of shortage.

Energy infrastructure and investment

Electricity

Installed generation capacity is 4 147.2 MW, but available capacity is lower due to the age and condition of plants: approximately 50% of the capacity is more than 40 years old. The Yerevan thermal power plant was retired in 2010, and the government plans to retire the oldest units at the Hrazdan plant in 2021. Significant investment will therefore be needed to modernise power system assets over the next 10 to 20 years.

Baseload electricity is produced from the 407 MW Armenian Nuclear Power Plant (ANPP). The plant was scheduled for retirement by 2016, but its service life has been extended by ten years because of insufficient replacement capacity. Approximately USD 300 million is required to keep the reactor operating until 2026, and rehabilitation is under way. Financing for the new 1 000 MW replacement plant remains a challenge, and no concrete progress has been made to date.

Output from thermal power plants covers peak periods and baseload power when the nuclear plant is offline for maintenance. Part of the electricity generated by the Hrazdan-5 Unit, and all the electricity generated by the Yerevan combined-cycle gas turbine plant, is exported under the gas-for-electricity barter agreement with Iran.

IEA. All rights reserved.

Hydropower (including small hydro) from the Hrazdan and Vorotan rivers and from other dams is a stable component of Armenia's electricity system and provides daily load regulation with installed capacity of 1 200 MW.

Construction of the Megri hydropower plant (HPP) (110 MW) is postponed with no exact commissioning date. Contracted and financed by Iran, it will be operated by Iran for 15 years and then ownership will be transferred to Armenia under the build own-operate-transfer model.

Wind power, at 4.23 MW, is a relative newcomer in the power supply system.

A 65 km, 220 kV line and 54.8 km of 110 kV lines connect Armenia with Georgia, and construction of a 400 kV line is planned to commence in 2021. The interconnection with Iran consists of more than 80 km of 220 kV lines, and a high voltage 400 kV line is also under construction and expected to be operational by early 2021. Armenia also has idle connections with Azerbaijan and Turkey.

Because much of the electricity network is aged and inefficient, significant investment in rehabilitation is needed. Improvements in grid infrastructure are carried out as part of government-authorised programmes supported through loans from international donors and investment programmes of individual utilities approved by the PSRC. The electricity network reconstruction programme was partially completed by 2012 with donor support, but further work was suspended due to lack of financing.

Natural gas

The gas transmission network comprises 1 682 km of pipelines, a Soviet-era connection with Russia through Georgia, and a 2.3 bcm connection with Iran built in 2009 to barter gas imports for electricity. An additional pipeline connection with Azerbaijan exists but is not in operation.

The gas distribution network includes 15 990 km of high-, medium- and low pressure gas pipelines delivering to about 717 000 customers. Gazprom Armenia has spent approximately USD 900 million since 2007 on large projects to increase consumer access to gas, boosting the connection rate from 20% in 2002 to 96.4% in 2019. It also rehabilitated the Abovyan underground gas storage facility, almost doubling its capacity to 135 mcm in 2016, and invested USD 215 million in a new gas unit at the Hrazdan-5 power station, which began operations in March 2013.

IEA. All rights reserved.

System reliability

Energy system reliability in Armenia is now considered adequate, as investments in electricity and gas infrastructure, increased residential access to gas, and operational improvements since the mid-1990s have led to significant declines in outages and losses.

Network losses in both the gas and electricity sectors are in line with international standards. In the gas sector in 2019, transmission losses were 3.39% and distribution system losses 1.11%; losses are kept relatively low by modern metering devices and a supervisory control and data acquisition system.

Closed joint stock company (CJSC) Electric Networks of Armenia (ENA) has been installing automated metering and data acquisition systems in the 110/35 kV portions of the network since 2003 to improve operations and monitoring, and in 2019 electricity transmission losses amounted to 1.6% while distribution losses were 7.1%.

Emergency response

Emergency response in relation to nuclear power has received increased attention since the Fukushima accident in 2011. Armenia is a party to the Non-Proliferation Treaty, has an Additional Protocol with the International Atomic Energy Agency (IAEA) and has ratified the Comprehensive Nuclear Test Ban Treaty. In 2011, the IAEA inspected its nuclear power station for operational safety, deeming the plant acceptable (www-pub.iaea.org/MTCD/Publications/PDF/cnpp2018/countryprofiles/Armenia/Armenia.htm).

Armenia also works closely with the United States in managing nuclear safety. In 2013, the US National Nuclear Security Administration (NNSA) conducted two emergency response training sessions in Armenia, with 28 participants from relevant authorities, civil protection agencies and other specialised parties. The NNSA also provides direct emergency management assistance to Armenia and other countries.

Also in 2013, Armenia signed an agreement with Belarus on information exchange and co-operation in nuclear safety and radiation protection. Belarus commissioned its first nuclear power plant (NPP) in 2021, and a number of activities were carried out within the framework of Armenia's agreement to assist Belarus.

IEA. All rights reserved.

According to a 2008 Energy Charter report, Armenia's oil product storage facilities are of adequate capacity, as requirements far exceed annual consumption. Up to 1.2 Mt of light oil products and 0.9 Mt of fuel oil can be stored, but most depots do not comply with modern standards and many need repairs. Meanwhile, upgrades to the Abovyan underground gas storage facility in 2012 doubled its capacity to 135 mcm.

Armenia is not under any international obligation to hold oil stocks. Requirements are legislated by the former Soviet laws, and most of the time stock availability is determined by the country's financial situation rather than by strict adherence to the legislation.

IEA. All rights reserved.

Chapter 2. Market design

National market structure

Electricity

Armenia's electricity market operates under the single-buyer model and includes six large generation companies (private and state-owned), more than 205 small power producers and one transmission system operator (TSO). Generation and transmission operations are unbundled.

There is no competitive wholesale electricity market. The one distribution system operator has the exclusive right to buy electricity from the generators at regulated prices and to sell to final consumers.

The state-owned power system operator is the TSO and is financially and legally unbundled. At the wholesale level, the state-owned CJSC Settlement Center provides control and metering services and CJSC High-Voltage Electric Networks is the state owner and operator of the transmission network. ENA is the only retailer in the country, and it is owned by the open joint-stock company (OJSC) Inter-RAO UES.

Oil

The oil product market is completely privatised and prices are based on demand and supply.

Gas

The natural gas sector is owned and operated by one vertically integrated operator, Gazprom Armenia (previously ArmRusGazprom). Since January 2014, it has been fully owned by Russia's Gazprom, which purchased the Armenian government's remaining 20% share. No unbundling or opening of the market is envisaged.

IEA. All rights reserved.

Coal/peat

N/A.

Nuclear

ANPP is a government-owned company. Commissioned in 1980, its operating capacity is 385 MW (installed capacity is 440 MW); annual generation is approximately 2 400 GWh, covering 37% of domestic supply. The plant was scheduled for a USD 300 million rehabilitation in 2017-2018 to prepare it for a service life extension to 2026.

Large hydro

Vorotan Cascade power generation complex, commissioned 1970-1989 and operated by the private company ContourGlobal Hydro Cascade CJSC, has an operating capacity of 404 MW (installed capacity is also 404 MW). Annual generation is approximately 1 000 GWh from three HPPs, covering 15% of domestic supply. Vorotan Cascade's assets are aged and require extensive upgrades; a short-term rehabilitation plan at a cost of EUR 51 million is under development.

The privately owned Sevan-Hrazdan Cascade complex of hydroelectric plants is operated by International Energy Corporation CJSC at an operating capacity of 552 MW (installed capacity is 561 MW). It was commissioned over the 1940-1962 period, and annual generation is approximately 450 GWh, or 6% of domestic supply. Various upgrades have been performed since the early 2000s, and one of the seven HPPs (Yerevan HPP) is currently under reconstruction at a cost of USD 40 million.

Renewable energy

The foundation of the renewable energy system as of 1 January 2020 was 188 small, private HPPs (under 30 MW), mostly constructed since 2007. Installed capacity is approximately 375 MW for annual generation of 973 GWh, covering 14% of domestic supply. There are also several small wind power (4.23 MW), bioenergy (0.835 MW) and solar power plants (10 MW) that have a limited impact on system supply.

IEA. All rights reserved.

Energy efficiency

Energy efficiency is crucial to Armenia's economy. Given the country's extreme dependence on imports for fossil fuel supplies, any energy conserved by citizens, businesses and infrastructure translates into financial savings, reduced pollution and greater energy security. The potential for energy efficiency in all sectors has been repeatedly assessed as high, despite the relatively low energy intensity of the economy. Although the government has taken legal action to promote efficiency through various programmes and policies, the potential for efficiency improvements remains largely untapped.

Development and adoption of the next revision of the NEEAP is one of the steps on the pathway to energy efficiency that was initiated in 2004 with Armenia's first Law on Energy Saving and Renewable Energy.

Regulatory framework

The PSRC is an independent body that from September 2018 has been primarily responsible for determination of regulated tariffs, their calculation methodology and review, licensing and import/export regulation, determination of market norms and rules etc. The PSRC also regulates gas, water, electronic communications and thermal energy. Although energy companies may have more than one licence, the Law on Energy prescribes certain limitations on the size of shareholdings.

Tariffs

Electricity and natural gas tariffs are regulated by the PSRC on a cost-plus basis that allows a set rate of return for the operators after accounting for fixed and variable costs. The government applies a cost-recovery policy on tariffs, but in recent years the increasing cost of electricity services and government concern about affordability have led to a departure from cost-recovery tariffs, and subsidies and below-cost pricing have increased.

The tariff-setting procedure is fully transparent. An operator applies for a tariff review on the official PSRC website, which is then subject to consultation with consumer protection organisations and other interested parties. The PSRC reviews the matter and makes its decisions available on its website; it is expected to take a decision within 80 working days from the date of application for most operators, and 25 working days for small hydropower and other renewable generators.

IEA. All rights reserved.

For electricity generators participating in the balancing market controlled by the power system operator, the tariff structure has two components (energy and capacity) for payments; for other generators, a one-part tariff is applied. The gas supply system uses a single tariff structure.

At the retail level, electricity rates for residential consumers increased 70% from 2009 to 2019, and natural gas rates rose by 172% from 2005 to 2019. In 2016, the import gas price was reduced from USD 165 per 1 000 m^3 to USD 150 per 1 000 m^3 under the purchase agreement for Gazprom Armenia. The current gas price at the border is USD 165 per 1 000 m^3. The PSRC gas tariffs set in 2017 and remaining in force are presented in the table below.

№	Categories of consumers by consumption level and period of time	Measurement unit	Tariff
1.	Socially insecure families		
1.1	For up to 600 m^3 of natural gas annually	Armenian drams (AMD) per 1 000 m^3	100 000.0
1.2	For more than 600 m^3 of natural gas annually	AMD/1 000 m^3	139 000.0
2.	Greenhouse farms in agriculture		
2.1	For period from 1 November to 31 March inclusively	USD equivalent of AMD/1 000 m^3	212.0
2.2	For period from 1 April to 31 October inclusively		
a.	For consumption of up to 10 000 m^3 per month.	AMD/1 000 m^3	139 000.0
b.	For consumption of 10 000 m^3 per month and more	USD equivalent of AMD/1 000 m^3	242.1
3.	For individuals performing agricultural processing: preserves, beverages and dairy product producers	USD equivalent of AMD/1 000 m^3	212.0
4.	For consumption of up to 10 000 m^3 per month, except for those covered in points 1-3	AMD/1 000 m^3	139 000.0

IEA. All rights reserved.

№	Categories of consumers by consumption level and period of time	Measurement unit	Tariff
5.	For consumption of 10 000 m^3 per month and more, except for those covered in points 1-3	USD equivalent of AMD/1 000 m^3	242.1

Electricity rates have a time-of-day element for metered consumption. The introduction of an automated metering and data acquisition system and computerised customer billing have significantly improved collection rates since the mid-2000s. In 2019, collection rates were 100.3% for electricity and 100.1% for gas.

Feed-in tariffs

Under the Law on Energy, small HPPs and other plants generating electricity from renewables are afforded feed-in tariffs for a period of 15 years from their licence date. The tariffs are specified on an annual basis to account for exchange rate fluctuations between the Armenian dram and a foreign currency (USD or EUR). Feed-in tariffs were introduced in 2007, and since then until January 2020, 375 MW of small hydropower, 4.23 MW of wind power and 10 MW of solar PV have come on line.

Technical rules

Armenia uses state standards for technical applications. They are aligned with the directives of the International Organization for Standardization (ISO), the International Electrotechnical Commission and the European Committee for Standardisation (CEN). With a government resolution in 2012, Armenia was on its way to harmonising its standards with those of the European Union. The National Institute of Standards had worked out an action plan for 2013-2015, including a schedule of harmonisation up to 2020, but Armenia instead joined the Customs Union with Belarus, Kazakhstan, Kyrgyzstan and Russia. This is likely to result in a different set of standards for harmonisation.

IEA. All rights reserved.

Regional markets and interconnections

Electricity

Government policy to enhance energy security in the power sector is directed towards strengthening regional integration to increase trade flows. For instance, during the spring and summer when hydro generation is high, Armenia could increase exports of electricity to Georgia, which could subsequently pass it on to the Turkish market because Georgia often has surplus electricity during the summer. Alternatively, Georgia could supply Armenia with low-cost electricity from hydropower when markets are favourable. In addition, when Armenia's new NPP is operational, it may offer further trade opportunities. More electricity trade would lead to the opening of the market and greater competition in the Armenian electricity sector.

Armenia's electricity network is connected to Georgia's by 110 kV and 220 kV lines, and with Iran's by 220 kV lines. Electricity trading is currently limited, however, as Georgia and Armenia have asynchronous systems and the market in Armenia is mostly closed. Electricity trade with Iran is based on a barter agreement, whereby much of the gas imported from Iran is used in power generation at the Yerevan power plant, which in turn exports the power to Iran. According to the PSRC, in 2019 Iran bartered around 0.379 bcm of gas for 1.14 TWh of Armenian electricity. Interconnections with Azerbaijan and Turkey exist but are not active.

The governments of Armenia and Georgia are co-operating to build a 400 kV interconnection: in 2012, the utilities in both countries signed an agreement for parallel operation of their power systems, including the organisation of operational dispatch management and a contract for power supply in emergency situations. The feasibility study was completed in 2013 and construction began in 2017.

Collaboration with Iran on electricity market integration is focused on fully developing the existing interconnection via a 220 kV transmission line and a new 400 kV line. With construction beginning in 2017, the interconnection is expected to be operational by 2021. In the long term, Armenia plans to be actively involved in developing a Black Sea power ring and north-south synchronised operation relations (involving Armenia, Georgia, Iran, Russia and other countries).

IEA. All rights reserved.

Natural gas

Nearly all gas consumed in Armenia is imported from Russia by pipeline through Georgia. Metering of the gas is carried out on Georgian territory, but import controls are done in Armenia. The National Agency of Georgia, responsible for standards, technical regulations and measurements, carries out annual metrological controls and supervises gas metering.

In January 2014, Russia's Gazprom purchased ArmRusGaz's remaining 20% share of the company through a deal that forgave ArmRusGaz's debts to Gazprom and reduced the price of gas from USD 270 per 1 000 m^3 to USD 150 per 1 000 m^3. The current gas price from Russia is USD 165 per 1 000 m^3 at the border.

IEA. All rights reserved.

Chapter 3. Sustainable development

Renewable energy

Small hydro

Constructing small hydropower plants (HPPs) is the favoured course of action for developing the renewable energy sector and securing energy independence in Armenia. Most designated, under-construction or operational small HPPs are derivational stations on natural water flows. According to licences issued as of 1 January 2020, 26 more small HPPs are under construction, with total projected capacity of 60 MW and 203 million kWh of electricity supply annually (http://psrc.am/images/docs/sectors/electric/Karuc_Artad%20VER%2001.04.20.xlsx).

According to Protocol Decision No. 3 adopted in January 2009, the scheme for developing small HPPs was approved and recommended to possible investors (www.minenergy.am/storage/files/SHPPs_technical__RA_eng.doc).

Solar

Armenia has significant solar energy potential: average annual solar energy flow per square metre of horizontal surface is 1 720 kWh (the European average is 1 000 kWh), and one-quarter of the country's territory is endowed with solar energy resources of 1 850 kWh/m^2 per year.

Solar thermal energy is therefore developing rapidly in Armenia. Because solar water heating systems not only ensure energy savings but have become cost-effective, they have been installed in nurseries, residential homes and medical facilities through charitable programmes with international funding.

Various low-capacity PV demonstration modules have also been installed: polymeric photoelectric inverters with 9.8 kW capacity and total surface area of 200 m^2 have been assembled on the roof of the Armenian American

IEA. All rights reserved.

Wellness Center, and solar power plants have been installed on the roof of the UN office as well as in Spitak. At the Caritas organisation's Gyumri Day Care Center for Children & Youth with Multiple Disabilities, a solar PV power plant with 100 kW installed capacity was also built.

The Renewable Energy Investment Plan for Armenia was approved within the framework of the Scaling-Up Renewable Energy Program (SREP) of the Climate Investment Funds, in accordance with which SREP resources have been allocated to develop up to 110 MW of utility-scale solar PV (http://minenergy.am/en/page/466).

Currently, wide implementation of solar PVs is in progress. As of 1 January 2020, around 10 MW of solar PV up to 1 MW each are in operation. Another bunch of grid-connected PV power plants amounting to 172.6 MW are under construction, the biggest one of which will be Masrik solar PV station with 55 MW of installed capacity. Moreover, more than 1 400 autonomous (auto) electricity producers with 21 MW of total installed capacity are connected to the distribution grid. (http://psrc.am/images/docs/sectors/electric/Karuc_Artad%20VER%2001.04.20.xlsx).

Wind

According to the Armenian Wind Atlas developed in 2002-2003 by the US National Renewable Energy Laboratory in collaboration with SolarEn of Armenia, the most favourable areas for grid-connected wind power are classified as 4 to 7 (good to excellent) for wind power resources.

These sites are limited, however, and are located mostly on remote mountain passes at high elevations (2 000 m and higher) with restricted access, resulting in above-average transportation and turbine installation costs. Of the prospective areas, only class 4 (upper level of "good" class) and class 5 (lower level of "excellent" class) sites can be considered as realistic for the construction of wind power plants. The total cost of installing wind turbines of up to 195 MW on sites within these two categories was assessed at EUR 1.3 million/MW to EUR 1.6 million/MW in 2006-2007 by several local developers and international vendors (http://r2e2.am/en/2011/06/wind/).

As of 1 January 2020, wind energy in Armenia has limited implementation. In addition to already operating wind farms with total installed capacity of 4.23 MW, only one more is under construction with design capacity of 4 MW (http://psrc.am/images/docs/sectors/electric/Karuc_Artad%20VER%2001.04.20.xlsx).

IEA. All rights reserved.

Geothermal

Investigations have revealed the precise sites of geothermal energy sources for construction of geothermal power plants. At the Jermaghbyur site, geological and geophysical explorations have found that high-pressure (20 25 atmospheres) hot water (up to 250°C) is available at a depth of 2 500 m to 3 000 m. If these data are confirmed, it would be possible to construct Armenia's first geothermal power plant with 25 MW capacity in this area (http://minenergy.am/en/page/467).

Biomass

Biomass is not widely used as a power or gas source in Armenia. Annual biogas potential of around 135 mcm is just beginning to be exploited, and the Renewable Energy and Energy Efficiency Fund recently produced an Assessment of Bioethanol Production, Potential Utilization and Perspectives in Armenia exploring possibilities for bioethanol production and presenting the concept to investors (http://minenergy.am/en/page/468). Currently, only one company with 835 kW of installed capacity is producing electricity from biomass (http://psrc.am/images/docs/sectors/electric/Karuc_Artad%20VER%2001.04.20.xlsx).

Waste

A contract between the municipality of Yerevan and Japan's Shimizu Corporation was signed in 2005 to implement the Nubarashen Solid Waste Landfill Gas Capture and Power Generation Clean Development Mechanism Project in Yerevan. According to Shimizu Corporation calculations, implementation of each phase will result in CO_2 emissions reductions equal to at least 56 000 tonnes (http://minenergy.am/en/page/468).

Energy efficiency

Last evaluated by the government in 2015, Armenia's potential for energy efficiency is high. Estimates in the second National Energy Efficiency Action Plan (NEEAP) for sectoral energy efficiency potential (indicative revised estimated cumulative energy saving targets for 2020) are:

- cross-sectoral: 91.5 ktoe
- industry: 291.6 ktoe
- transport: 109.5 ktoe

IEA. All rights reserved.

- residential: 51.4 ktoe
- agriculture: 10.7 ktoe
- service sector: 215.3 ktoe.

Energy efficiency policies and measures have been in place in Armenia since at least 2004, when the first comprehensive legislation on energy efficiency was adopted as part of a law on Energy Saving and Renewable Energy. This was followed in 2007 by a National Programme on Energy Savings and Renewable Energy, and an NEEAP in 2010. In 2012, the European Bank for Reconstruction and Development also assisted the former Ministry of Energy and Natural Resources to develop a Sustainable Energy Action Plan, which aimed at developing legislation to promote energy efficiency investments across the economy.

In 2021, several parallel efforts are under way to create a comprehensive policy framework for energy efficiency in Armenia[1]. A new National Programme on Energy Saving and Renewable Energy covering the period 2021-2030 is expected to be adopted by the government in 2021. It will include the main energy efficiency policies and targets of Armenia until 2030, based on an analysis of data available for the period 2007-2020, and will incorporate a revised NEEAP.

Efforts are under way to complete the regulatory framework for energy efficiency in Armenia aligned with the strategy, including a new national programme, and a revised NEEAP. The government is also working to align with policies and market protocols set out by the European Union, as well as the Eurasian Economic Union, where Armenia is a treaty member. Indeed, international partners, including development agencies and lenders, play an important role in shaping the policy agenda for energy efficiency in Armenia.

Impacting on these efforts are several important barriers to energy efficiency policy making in Armenia. These include gaps in the availability of data as well as concerns about the quality of available data, limited administrative capacity to develop provisions and enforce compliance, and generally low levels of public awareness on the benefits of energy efficiency. Major political developments, notably the 2018 revolution and the Covid-19 pandemic, have also delayed or disrupted several ongoing energy efficiency policy initiatives.

The legislative framework for organising **energy audits** is set out under the Law on Energy Savings and Renewable Energy (2004) along with the amendments and supplements dated 2016, 2017 and 2018, and the

[1] It is important to note that the Covid-19 pandemic has slowed the progress of and focus on energy efficiency policy making in Armenia, with some funding streams initially earmarked for efficiency programmes diverted to pandemic response.

IEA. All rights reserved.

Regulation on Conducting Energy Audits (2006). The government devised a methodology for conducting voluntary energy audits of buildings, and is developing an Energy Audit Institute. Training and advancement of energy auditors was supported by technical assistance from international organisations such as the UN Development Programme, the Global Environment Facility and the INOGATE Programme. Energy efficiency certificates for existing buildings should be issued based on energy audits.

In the period 2013-2016, two national standards were developed in order to support the improvement of buildings energy performance, enabling the implementation of important instruments such as the building energy passports and energy audits:

- AST 362-2013, “Energy conservation. Building energy passport. Basic rules. Standard form”
- AST 371-2016, “Methodology for performing energy audit in residential and public buildings”.

The construction norm RACN 24-01-2016 “Thermal Protection of the Buildings” (mandatory building code based on Russian norms), approved in 2016, also tightens the requirements for energy efficiency through requirements for the heat transfer resistance of building structures, the characteristics of energy efficiency of buildings, the class of energy efficiency of buildings and the energy passport of a building.

The amendments in the Law on Energy Saving and Renewable Energy in 2016, as well as Governmental Resolution No. 426-N, dated 12 April 2018 established the technical regulation for energy savings and energy efficiency in newly constructed multi-apartment buildings, as well as objects constructed (reconstructed/renovated) by state funds.

The norm-setting legal act that regulates energy audits in Armenia is the Procedure for Energy Audit. This procedure has been approved by Armenian Government Decree 1399-N on 31 August 2006 and revised by Decree 1105-N on 4 August 2011 and Decree 1026-N on 10 September 2015.

It is multisector (intended primarily for production enterprises) and evaluates the use of fuel and energy resources in a building. Based on the Governmental Decision No. 1399-N, energy audits should be implemented by an energy auditor certified by an accredited conformity assessment body.

IEA. All rights reserved.

Fuel switching

From 2002 to 2009, Armenia reduced the share of fuelwood- and electricity based heating in multi-apartment residential buildings from 90% to 26% and increased gas-based heating from 13% to 71%.

The switch to more efficient and affordable heating was driven by key activities of the government's Urban Heating Strategy (UHS) and was financed by donor support. In 2001, urban households relied almost entirely on fuelwood and electricity for heating, so in 2002 the government adopted the UHS as a first step towards efficient, clean, safe and affordable heating. The UHS provided the strategic framework for short-, medium- and long term development of an affordable and environmentally sustainable urban heating sector. The key factors motivating the rapid switch of urban households to gas-based heating (primarily individual gas boilers) were an improved legal and regulatory framework to support the introduction of gas based heating; mobilisation of the private sector to provide heat supply equipment and services; financing for consumers to invest in heat supply systems and capital grants for the poor for gas service connection; and rapidly expanding access to gas throughout the country (http://documents.worldbank.org/curated/en/500811468116363418/pdf/796160PUB0REPL00Box377374B00PUBLIC0.pdf, p. 13, Box 2.4, Fuel switching in Armenia).

There have also been significant developments in the use of natural gas vehicles (NGVs); in fact, Armenia is one of the leading countries in transport sector natural gas use. The benefits of NGVs are both economic and environmental, owing to their low GHG emissions. As of the beginning of 2020, more than 80% of vehicles in Armenia run on natural gas and there are 379 gas-charging stations in the country (https://armenia.gazprom.ru/about/today/).

As Armenia has switched to mainly natural gas consumption across multiple sectors, the potential for further fuel switching is minimal. Residential heating and transport rely heavily on natural gas, as mentioned above. However, the development of renewable energy sources, solar in particular, could allow for switching to renewable electricity in both heating and transport in the future. Solar is a cost-effective choice and there is strong potential for future investment, as outlined above.

IEA. All rights reserved.

Environmental protection

Four main laws cover priorities and objectives for environmental protection and the rational use of natural resources: the Law on Ambient Air (1994); the Law on Environmental Impact Assessment (1994); the Law on Environmental Fee Rates (2000); and the Law on Environmental Inspectorate (2005). Furthermore, environmental impact assessments are required for specific projects under the Law on Expert Testing of Environmental Impacts (1995). Information on public hearings is published on the Ministry of Nature Protection website.

The Law on Atmosphere, the Law on Waste, the Water Code, the Land Code, the Law on Environmental Impact and Expertise, the Tax Code, etc. have been developed and are in different stages of adoption. The rates of environmental tax and nature utilisation payments will be completely revised and raised.

The Law on Environmental Impact Assessment and Expertise is also being amended. Within the framework of the newly developed draft law, the administration part has been simplified, especially for cases when the planned activity is aimed at reducing the pressure on the environment and eliminating the negative effects. It is planned to involve internationally qualified experienced professionals, which will allow environmental impact assessments to be carried out more comprehensively, objectively and effectively.

According to the draft amendments to the Law on Environmental Impact Assessment, all small hydropower plants, regardless of their size, will become subject of an environmental impact assessment.

Climate change

Armenia has signed and ratified numerous international environmental conventions:

- the Doha Amendment to the Kyoto Protocol (February 2017)
- the Paris Agreement of the UN Framework Convention on Climate Change (UNFCCC) (February 2017), which entered into force 22 April 2017
- the UNFCCC (1994) and its Kyoto Protocol (2005)
- the Basel Convention on the Control of Transboundary Movement of Hazardous Wastes and their Disposal (1992)
- the Convention on Environmental Impact Assessment in a Transboundary Context (1991)

IEA. All rights reserved.

- the Montreal Protocol on Substances that Deplete the Ozone Layer (1989)
- the Convention on Long-Range Transboundary Air Pollution (1983).

Armenia ratified the Kyoto Protocol in 2005 as a non-Annex I Party and has implemented a number of Clean Development Mechanism projects. The energy sector accounts for 70.3% of CO_2-equivalent emissions according to Armenia's First Biennial Update Report to the UNFCCC (http://nature-ic.am/Content/announcements/7280/BUR-Report-eng.pdf). As part of the UNFCCC Copenhagen Accord in 2009, the Ministry of Nature Protection prepared a list of priority climate change mitigation measures such as investment in renewable energy; modernisation of thermal power plants; energy efficiency improvements; reduced fugitive emissions of methane from gas distribution and supply systems; electric transport development and greater use of natural gas as engine fuel; reduced methane emissions from solid municipal waste; and restoration of degraded forests, reforestation, reduced logging and conservation.

Armenia's energy-related emissions of CO_2 totalled 6.6 Mt in 2016 – one third the emissions of 1990, mainly owing to a strong decline after the dissolution of the Soviet Union. Transport accounts for 25.1% of energy related CO_2 emissions, followed by power generation (17.9%), households (17.7%), commercial (7.4%), manufacturing (6.7%) and agriculture (1.2%). There are also 24% of fugitive emissions from natural gas (http://nature-ic.am/Content/announcements/10603/GHG%20Inventory%202016_ENG_Final_Web.pdf).

Technology research, development and deployment

Research and development (R&D) in energy technology and innovation in Armenia is not significant, though it is becoming more important. The government's plan to develop new renewable energy technologies will increase the need for technology and innovation funding, and for skilled human resources. Greater R&D activity will benefit from the country's highly skilled labour force, particularly in the fields of science and information technology.

Approximately 63 research institutes and universities were involved in state financed programmes and projects in Armenia in 2018. According to the government, its R&D priorities are in the social sciences and humanities, life sciences, renewable and new energy sources, information technologies,

IEA. All rights reserved.

space and earth sciences, and applied research (www.armstat.am/file/doc/99516758.pdf).

IEA. All rights reserved.