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# Armenia Energy Profile

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# Overview

## Country overview

The Republic of Armenia (Armenia) is a landlocked country in the southern Caucasus region between the Black and Caspian seas, bordered by the Republic of Türkiye (Türkiye) on the west, Georgia to the north, Azerbaijan on the east and Iran to the south. The country is approximately 29 800 km<sup>2</sup> with a population of 2.969 million. Yerevan, the capital, is the largest city with 1.092 million inhabitants.

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 2021 (measured in US dollars at 2017 PPP prices). Real GDP per capita was USD 4 670 in 2021, roughly six times what it was in 2002.

Armenia's reliance on export-oriented industries and high remittances from the Armenian diaspora (which accounted for 10.5% of GDP in 2021) expose 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 had fallen to 27.0% in 2020.

Lacking indigenous resources, Armenia imports natural gas and oil for most of its energy needs (78.6% of total energy supply in 2020), 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.

Armenia also trades electricity with Georgia, though volumes are low since the countries' networks are not synchronised. Energy interconnections with Azerbaijan and Türkiye 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 an 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. Armenia subsequently 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.

## Energy supply and demand

### Production

- Although Armenia's energy demand averages more than 3 Mtoe (3.59 Mtoe in 2020) and the country does not produce any fossil fuels, it manages to cover 27% of energy demand with domestic energy production. This production (0.96 Mtoe in 2020) comes mostly from nuclear and hydro resources.
- Natural gas dominates the energy mix (59.6% of total energy supply in 2020), but the electricity mix is more diversified.
- In 2021, Armenia produced 7.7 TWh of electricity, of which natural gas covered 44% (3.4 TWh), hydro and other renewables 30% (2.3 TWh) and nuclear 26% (2.0 TWh). In the Caucasus region, Armenia is the only country producing nuclear energy.

### Demand

- Armenia's energy demand averages more than 3 Mtoe (3.59 Mtoe in 2020).
- Energy consumption (final consumption excluding transformation) more than doubled between 2000 and 2020 (+136%), and heavily outpaced global demand in the same period (+36%).
- Total final consumption (TFC) in 2020 was 2.61 Mtoe. Residential and transport consumption were on a par in 2020, with both sectors consuming 0.86 Mtoe (33% of TFC). Households use 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.

## Imports/exports

- All fossil fuels are imported: natural gas represents over 80% of Armenia's energy imports (2.147 Mtoe out of 2.8 Mtoe in 2020), followed by oil products (0.63 Mtoe in 2020).
- Russia is its predominant supplier of natural gas (87.7% in 2021), the rest coming from Iran.
- Armenia is a net exporter of electricity, although most of it is exchanged for natural gas from Iran.

## 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. Then, in 2014 it approved a Schedule of Activities for 2014-2020 for implementing its 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 Programme on Energy Saving and Renewable Energy (2007) and the Ministry of Territorial Administration and Infrastructure (MTAI) Action Plan (2007). The latest energy sector development documents approved by the government of Armenia on 14 January 2021 are the [Republic of Armenia Energy Sector Development Strategic Programme to 2040](#) and [the Action Plan to Ensure Implementation of the Republic of Armenia Energy Sector Development Strategic Programme](#), which outlines the government's vision for least-cost strategies to develop the entire energy system and the measures necessary to implement this strategy.

This strategy and its accompanying action plan are Armenia's main energy policy documents. Their targets and objectives aim for an energy sector that is:

- free, competitive and non-discriminatory
- inclusive and diversified, and energy-independent at the highest level
- clean and energy-efficient, with development that is sustainable

- of regional significance
- reliable and safe
- digitalised and innovative, science-based and highly technological
- predictable and transparent
- accessible and fair for everyone, including vulnerable groups, and attractive for investors.

In 2014, the government developed the Scaling-Up Renewable Energy Programme Investment Plan. It is an update of the Renewable Energy Roadmap 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 renewable energy 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 lifetime has been extended to 2026, at which time the government intends to extend its lifetime once again to at least until 2036. This second extension is forecast to require an additional USD 150-million investment.

The government's ambitious plan to increase renewables to 66% of the power generation mix by 2036 (from 7% in 2012) includes small hydro, wind and solar PV resources, but excludes biofuels. To reach this target, Armenia will need to have 2 185 MW of new renewable energy capacity installed by 2036. Estimated projected capacity additions comprise 50 MW of small hydro and 141 MW of large hydro, 500 MW of wind, and 950 MW of solar PV.

Energy efficiency measures are based on the government decision of 24 March 2022 on Approving the Programme on Energy Saving and Renewable Energy for 2022-2030, the Action Plan Ensuring Implementation of the First Phase (2022-2024) of the Programme on Energy Saving and Renewable Energy for 2022-2030. Financial assistance from the R2E2 Fund (established in 2006 within the framework of the Energy Efficiency Project with Armenian government support), the World Bank and revolving fund financing, has been used to initiate energy efficiency measures in schools, kindergartens, universities, hospitals and other social and administrative buildings, as well as in municipal street lighting.

Regulatory reforms have supported power sector advances 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.

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 provide electricity at competitive prices, Armenia will have to open its relatively closed electricity market.

## 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.

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 it 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.

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 2001 Energy Law regulates the power sector. The Energy Law provides [basic principles for national policy](#), but it 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 tariffs for imported electricity.

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 make 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.

For electricity generators participating in the balancing market controlled by the power system operator, the tariff structure has one- or two-part components (energy or both 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 77% from 2009 to 2021, and natural gas rates rose by 178% from 2005 to 2021. In 2016, the import gas price was reduced from USD 165 per 1 000 m<sup>3</sup> to USD 150 per 1 000 m<sup>3</sup> under the purchase agreement for Gazprom Armenia. The current gas price at the border is USD 165 per 1 000 m<sup>3</sup>. The table below presents PSRC gas tariffs in force as of 1 April 2022 (inclusive of 20% VAT).

## Consumer gas tariffs in Armenia

Consumer category	Time frame	Consumption	Measurement unit	Tariff
1. Socially insecure families		For up to 600 m <sup>3</sup> per year	Armenian drams (AMD) per 1 000 m <sup>3</sup>	100 000.0
		For more than 600 m <sup>3</sup> per year	AMD/1 000 m <sup>3</sup>	143 700.0
2. Greenhouse farms in the agriculture sector	For 1 November to 31 March inclusive		USD/1 000 m <sup>3</sup>	233.9
	For 1 April to 31 October inclusive	For up to 10 000 m <sup>3</sup> per month	AMD/1 000 m <sup>3</sup>	143 700.0
		For consumption of 10 000 m <sup>3</sup> and over per month	USD/1 000 m <sup>3</sup>	265.81
3. Agricultural processing involving preserves, beverages and dairy products			USD/1 000 m <sup>3</sup>	233.9
Consumers not covered in points 1-3			AMD/1 000 m <sup>3</sup>	139 000.0
		For up to 10 000 m <sup>3</sup> per month	AMD/1 000 m <sup>3</sup>	143 700.0
		For 10 000 m <sup>3</sup> and over per month	USD/1 000 m <sup>3</sup>	265.81

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 2021, collection rates were 100.0% for electricity and 100.6% for gas.

## Feed-in tariffs

Under the Law on Energy, small hydropower plants (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 by January

2022, 389 MW of small hydropower, 4.23 MW of wind power and 56 MW of solar PV had 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 Standardization (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.

## 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 test survey was conducted in 2014). Supply data are collected directly from data providers (the Customs Service of the Republic of Armenia and the main electricity companies).

Armenia's first official energy balance following international methodology was produced for 2015 (although an experimental balance was released for 2014). [ArmStat](#) and [MTAI](#) co-ordinated its preparation and dissemination.

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 it 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.

# 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. It has 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.

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 for other forms of renewable energy.

## Energy security and diversification

Armenia's energy security 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 consistent and uninterrupted supplies of electricity and gas.

Electricity and gas demand are 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.

The sustainability and reduced import dependency offered by renewable energy makes its increased contribution (66% by 2036) a priority, with additional capacities of 191 MW of hydro (small and large), 500 MW of wind and 950 MW of solar PV required to meet this target. According to the government, small hydro capacity was 380 MW in 2020, and 50 MW was planned or under construction.

In electricity, regional integration and supply diversity are 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 during shortages.

## 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 2021, transmission losses were 2.68% and distribution system losses 1.18%; 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 2021 electricity transmission losses amounted to 1.43% while distribution losses were 6.03%.

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. At the beginning of 2022, more than 80% of vehicles in Armenia were running on natural gas and the country had [358 gas-charging stations](#).

As Armenia has switched to mainly natural gas consumption across multiple sectors, 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, particularly solar, could allow for switching to renewable electricity in both heating and transport in the future. Solar energy is a cost-effective choice and there is strong potential for future investment, as outlined above.

## 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](#).

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.

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.

## 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 a 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 (see [Tajikistan's Winter Energy Crisis](#), p. 13, Box 2.4, Fuel Switching in Armenia).

## Electricity

### Electricity generation

Installed generation capacity is 4 147.2 MW, but available capacity is lower (2 878.7 MW) due to the age and condition of plants: approximately 50% of Armenia's 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 of the Hrazdan plant in 2023. 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 was invested to keep the reactor operating until 2026, and rehabilitation has been completed. Securing financing for the new 1 000-MW replacement plant remains a challenge, so the government intends to continue operating the existing plant until at least 2036, which will require an additional investment of USD 150 million according to forecasts.

Output from thermal power plants covers demand at peak periods and baseload power generation 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.

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 1 345.6 MW.

Construction of the Megri HPP (110 MW) has been 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.

At just 4.23 MW, wind power is a relative newcomer in Armenia's power supply system.

## Cross-border interconnections

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 hydropower 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 opening of the market and greater competition in the Armenian electricity sector.

Armenia's electricity network has several cross-border linkages including connections to Georgia and Iran. Electricity trading is currently limited, however, as Georgia and Armenia have asynchronous systems and Armenia's market 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 2021 Iran bartered around 0.3446 bcm of gas for 1.034 TWh of Armenian electricity. Interconnections with Azerbaijan and Türkiye exist but are not active.

A 65-km, 220-kV line and 54.8 km of 110-kV lines connect Armenia with Georgia. 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 focuses on fully developing the existing interconnection via over 80 km of 220-kV transmission lines and a new 400-kV line. With construction beginning in 2017, the interconnection is expected to be operational by 2023. 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). Armenia also has idle connections with Azerbaijan and Türkiye.

Because much of the electricity network is old and inefficient, significant investment in rehabilitation is needed. Grid infrastructure improvements are carried out as part of government-authorized programmes supported by loans from international donors and investment programmes of individual utilities approved by the PSRC. Five substations have been completely reconstructed in recent years with support from the World Bank and Germany's Kreditanstalt für Wiederaufbau (Credit Institute for Reconstruction, KfW), and five others were under reconstruction in 2021.

## Market structure

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 Centre 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 Inter-RAO UES.

The government [amended the Law on Energy in 2017](#) to encourage greater market liberalisation. Changes will be phased in, and during the transition a hybrid model will continue to prevail. Energy supplies will be guaranteed based on existing power purchase agreements, and generators selling on the market will be obligated to pay electricity networks for distribution only. New amendments to the law also aim to create competition among electricity suppliers, which will reduce ENA's control over distribution throughout the country.

Changes to this law will also allow consumers to purchase electricity from other suppliers. Large wholesale consumers will be able to enter the market to purchase and consume electricity generated outside Armenia. Mechanisms to implement the amendments went into gradual effect on 1 February 2022, and in the first stage, qualified customers are being given the right to choose their supplier.

## Natural 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. This deal forgave ArmRusGaz's debts to Gazprom and reduced the price of gas from USD 270 per 1 000 m<sup>3</sup> to USD 150 per 1 000 m<sup>3</sup>. The current gas price from Russia is USD 165 per 1 000 m<sup>3</sup> at the border. No unbundling or opening of the market is envisaged.

The gas transmission network comprises 1 683 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 19 350 km of high-, medium- and low-pressure gas pipelines delivering to about 737 000 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% in 2021. 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.

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.

## Oil

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

## 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's USD 300-million rehabilitation in 2017-2018 to extend its service lifetime to 2026 has been fully implemented. The government intends to operate the existing ANPP until at least 2036, requiring an additional USD 150-million investment according to forecasts.

# Energy system transformation

## Renewable energy

Renewable energy resources, including hydro, represented 7.1% of Armenia's energy mix in 2020. Almost one-third of the country's electricity generation (30% in 2021) came from renewable sources.

Forming the [foundation of Armenia's renewable energy system](#) as of 6 January 2022 were 189 small, private HPPs (under 30 MW), mostly constructed since 2007. Installed capacity is approximately 389 MW for annual generation of 943 GWh, covering 14% of domestic supply. Several small plants also produce wind power (4.23 MW), bioenergy (0.835 MW) and solar power (56 MW), with limited impact on system supplies.

## Large hydro

Vorotan Cascade power generation complex, commissioned during 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 ageing, however, and require extensive upgrades; a short-term EUR 51-million rehabilitation plan is therefore under development.

Meanwhile, International Energy Corporation CJSC operates the privately owned Sevan-Hrazdan Cascade complex of hydroelectric plants, with an operating capacity of 552 MW (installed capacity is 561 MW). It was commissioned during 1940-1962, 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.

## Small hydro

Constructing small HPPs is Armenia's favoured course of action to develop the renewable energy sector and secure energy independence. Most designated, under-construction or operational small HPPs are derivational stations on natural water flows. According to licences issued as of 1 January 2022, [20 more small HPPs](#) are under construction, with total projected capacity of 39.3 MW supplying 136.7 million kWh of electricity annually.

According to Protocol Decision No. 3 adopted in January 2009, the [scheme to develop small HPPs](#) was approved and recommended to possible investors.

## 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<sup>2</sup> 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 of capacity and total surface area of 200 m<sup>2</sup> have been assembled on the roof of the Armenian American Wellness Centre, and solar power plants have been installed on the roof of the UN office as well as in the town of Spitak. A solar PV power plant with 100 kW of installed capacity was also built at the Caritas organisation's Gyumri Day Care Centre for Children and Youth with Multiple Disabilities.

The Renewable Energy Investment Plan for Armenia was approved within the framework of the Climate Investment Funds' Scaling-Up Renewable Energy Programme (SREP), which has allocated resources to develop up to [110 MW of utility-scale solar PV](#) generation.

Wide implementation of solar PV systems is currently in progress. As of 1 July 2022, around 102.8 MW of solar PV installations (of up to 5 MW each) were in operation. Another batch of grid-connected PV power plants totalling 176.7 MW are under construction, the largest being the Masrik solar PV station with [55 MW of installed capacity](#). Moreover, more than [6 940 autonomous electricity producers](#) with 136.1 MW of total installed capacity are connected to the distribution grid.

## 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 in 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 sites classified as 4 (upper level of the “good” class) and 5 (lower level of the “excellent” class) can be considered realistic for the construction of wind power plants. In 2006-2007, several local developers and international vendors assessed the total cost of installing wind turbines of up to 195 MW on sites within these two categories as [EUR 1.3-1.6 million/MW](#).

As of 1 January 2020, wind energy implementation in Armenia was limited. In addition to already-operating wind farms with total installed capacity of 4.23 MW, only one more is under construction with a [design capacity of 4 MW](#).

## Geothermal

Investigations have revealed precise geothermal energy source sites for the [construction of geothermal power plants](#). At the Jermaghbyur site, geological and geophysical explorations have found that high-pressure hot water (20-25 atmospheres, up to 250°C) is available at a depth of 2 500-3 000 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.

## 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. Currently, only [one company](#) with 835 kW of installed capacity is producing electricity from biomass.

## Waste

In 2005, the municipality of Yerevan and Japan’s Shimizu Corporation signed a contract 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<sub>2</sub> emissions reductions equal to at least 56 000 tonnes.

## 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 economy’s relatively low energy intensity.

Although the government has taken legal action to promote efficiency through various programmes and policies, potential for efficiency improvements remains largely untapped.

On 24 March 2022, the government of Armenia adopted a decision on Approving the Programme on Energy Saving and Renewable Energy for 2022-2030, the Action Plan Ensuring Implementation of the First Phase (2022-2024) of the Programme on Energy Saving and Renewable Energy for 2022-2030. This is an important step on the pathway to energy efficiency initiated by Armenia in 2004 with its first law on Energy Saving and Renewable Energy.

Last evaluated by the government in 2022, Armenia's potential for energy efficiency is high. Cumulative energy savings for total final energy consumption will amount to 931 ktoe. Estimates for sectoral energy efficiency potential in the Programme on Energy Saving and Renewable Energy for 2022-2030 are:

- industry: 19 ktoe
- transport: 744 ktoe
- residential: 92 ktoe
- agriculture: 34 ktoe
- service sector: 42 ktoe.

Following adoption of its first comprehensive legislation on energy efficiency as part of its 2004 law on Energy Saving and Renewable Energy, Armenia approved a National Programme on Energy Savings and Renewable Energy in 2007 and a National Energy Efficiency Action Plan in 2010. In 2012, the European Bank for Reconstruction and Development also helped the former Ministry of Energy and Natural Resources develop a Sustainable Energy Action Plan aimed at developing legislation to promote energy efficiency investments across the economy.

In 2021, several parallel efforts were under way to create a comprehensive policy framework for energy efficiency in Armenia.<sup>1</sup> The government's new National Programme on Energy Saving and Renewable Energy for 2021-2030 (adopted 24 March 2022) includes Armenia's main energy efficiency policies and targets to 2030, based on analysis of available 2008-2020 data.

The government is working to align its policies and market protocols with those of the European Union and of the Eurasian Economic Union, of which Armenia is a treaty member. Indeed, international partners, including development agencies and lenders, play an important role in shaping Armenia's energy efficiency policy agenda.

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<sup>1</sup> It is important to note that the Covid-19 pandemic has redirected attention away from energy efficiency policy making in Armenia and slowed progress in this area, with some funding streams initially earmarked for efficiency programmes diverted to pandemic response.

Impacting these efforts are several important barriers to energy efficiency policy making in Armenia. Obstacles include gaps in data availability 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 in the Law on Energy Savings and Renewable Energy (2004) and its amendments and supplements of 2016, 2017 and 2018, and in the Regulation on Conducting Energy Audits (2006). The government has devised a methodology for conducting voluntary energy audits of buildings and is also developing an Energy Audit Institute. Energy auditor training and advancement have had technical assistance support 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.

To enable the implementation of important instruments such as energy passports and energy audits for buildings, three national standards were developed during 2013-2021 to support better energy performance of buildings:

- AST 362-2013, on energy conservation, energy passports for buildings, and basic rules
- AST 371-2016, on the methodology for performing energy audits on residential and public buildings
- AST ISO/CIE 20086-2020, on lights and lighting, and the energy performance of lighting in buildings.

Furthermore, construction norm RACN 24-01-2016 on thermal protection for buildings (a mandatory building code based on Russian norms), approved in 2016, also tightens energy efficiency requirements. It contains building-specific stipulations for heat transfer resistance; energy efficiency characteristics; energy efficiency classes; and energy passports.

Amendments to the law on Energy Saving and Renewable Energy in 2016, as well as Government Resolution No. 426-N of 12 April 2018, established the technical regulations for energy-saving and energy efficiency in newly constructed multi-apartment buildings, as well as for structures reconstructed/renovated with state funds.

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

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

## 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 Assessment and Expertise, the Tax Code, etc. have been developed and are in different stages of adoption. Environmental tax rates 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 administrative portion has been simplified, especially for cases in which the planned activity aims to reduce pressure on the environment and eliminate negative effects. Internationally qualified, experienced professionals are expected to be involved so that environmental impact assessments will be carried out more comprehensively, objectively and effectively.

According to draft amendments to the Law on Environmental Impact Assessment, all small hydropower plants, regardless of their size, will be subject to 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)
- 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 69.8% of CO<sub>2</sub>-equivalent emissions according to Armenia's [Third Biennial Update Report](#) to the UNFCCC.

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 investing in renewable energy; modernising thermal power plants; improving energy efficiency; reducing fugitive emissions of methane from gas distribution and supply systems; developing electric transport and increasing the use of natural gas as an engine fuel; curtailing methane emissions from solid municipal waste; and enforcing degraded forest restoration, reforestation, reduced logging and conservation.

Armenia's energy-related CO<sub>2</sub> emissions totalled [7.1 Mt in 2017](#) – one-third (31.2%) the emissions of 1990, mainly owing to a strong decline after dissolution of the Soviet Union. Transport accounts for 25% of energy-related CO<sub>2</sub> emissions, followed by power generation (18%), the residential sector (18%), the commercial sector (8%), manufacturing (7%) and agriculture (1%). There are also 23% fugitive emissions from natural gas.

## 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 65 research institutes and universities were involved in state-financed programmes and projects in Armenia in 2020. According to the government, its [R&D priorities](#) are in the social sciences and humanities, life sciences, renewable and new energy sources, information technologies, space and earth sciences, and applied research.

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