

Armenia



Investment Opportunities in Energy and Mining



TABLE OF CONTENTS

Economic overview of Armenia.....	2
Investment Climate.....	3
Overview of the Energy Sector Regulatory Framework.....	4
Investment opportunities in nuclear power.....	6
Investment opportunities in thermal power	8
Investment opportunities in hydro power generation.....	10
Investment opportunities in renewable energy.....	12
Investment opportunities in mining sector.....	20

ECONOMIC OVERVIEW OF ARMENIA

Armenia's economy has undergone a profound transformation since independence. Sustained growth, ambitious reforms, as well as inflows of capital and remittances have created a market-oriented environment. However, the global financial crisis impacted significantly the market of the country.

Double digit growth rates of pre-crisis period were replaced by a 4.0 percent rate after the crisis. Since 2010 the Armenian economy on average grew by 4.4%. Real growth in 2013 reached 3.5% and so the pre-crisis real GDP level is finally recovered and exceeds 2008 levels by 1.9%. In exception of construction, all major sectors of the economy exceed their pre-crisis levels. Bulk of the acceleration has come from the service sector which grew by 26%.

Accordingly, structural adjustments of the economic structure in Armenia continue as the construction sector continues to shrink and some smaller economic sectors such as the hotel and catering and services sectors experience high growth rates.

Exports in dollar terms grew by 8.6% and reached 15% of the GDP which is quite high for Armenia. In contrast, imports grew only by 0.2% and equaled 34% of the GDP. As a result the current account balance improved by 1.6 percentage points of the GDP.

The global economic outlook is more positive as the global economy is expected to grow faster in the coming years. WB and IMF project about 3.4–3.6% growth in global output which exceeds actual growth rates of the last two years. The key challenge for the government is to mitigate the economic and social impacts of the global crisis for the midterm, while continuing policy and institutional reforms essential for recovery and long-term development. Increasing the economy's resilience to external shocks and creating new opportunities for development are important priorities.

As of January 1, 2015 Armenia is a full member of Eurasian Economic Union (EAEU), an international organization aimed at regional integration. It ensures the free movement

ARMENIA

Geography

The Republic of Armenia is a small land-locked country, located at the crossroads of Europe and Asia, between the Black and Caspian seas. Together with Georgia and Azerbaijan, Armenia is situated in the South Caucasus. The country occupies an area of 29,800 square kilometers (km²).

Armenia shares borders with Turkey to the west, Georgia to the north, Azerbaijan to the east, Nakhichevan (Azerbaijan) to the south-west, and Iran to the south. The climate of Armenia is continental. Summer is dry and sunny, lasting from June to mid-September. Winter is short and quite cold with plenty of snow.

Armenia has no fossil fuel resources, but has deposits of copper, iron, molybdenum, gold, lead, silver, clay, limestone and zinc, as well as semi-precious and ornamental stones. Armenia is also rich in natural mineral waters. There are hundreds of natural wells in the country, as well as 10 natural lakes, 5 canyons, and numerous springs and torrents. Armenia's rivers have considerable hydro power potential. Lake Sevan is the world's largest highland freshwater lake. It is located at 1,916 m above sea level. The country's highest peak is Mount Aragats 4,090 m.

Population

Armenia's 3.3 million population breaks down ethnically as Armenian 97.9%, Yezidi 1.3%, Russian 0.5%, other 0.3%. The official language is Armenian, spoken by about 97.7% of the population. The religion is predominantly Christian.

The population is relatively young and concentrated in cities. The urban population represents 64% of the total. Average age of the population is 35 years, with about 20% of the population 15 years and under. Life expectancy is 71 years for men and 77 years for women. The level of education is high, and continues to be one of the main values in Armenian society. Combination of graduates and the unemployment rate means that there is a huge supply of highly qualified people available in Armenia. Armenia worldwide diaspora comprising more than 5 million Armenians.

of goods, services, capital and labour under its framework. One of the most important pillars of the EAEU is trade regulation and adjacent areas, in particular, creation of a Customs Union. Liberalization in tariff regulation, reduction of customs administration and transaction expenses also have the power to contribute to trade creation. In addition to these, there are also other factors possible which can contribute to trade creation and result in positive production effect. These in the first place relate to increased

competition and economic effects in the internal market.

Production increase and trade development is among others also possible due to creation of production cooperatives and increased cooperation. These are considered more dynamic development effects. From the perspective of consumption effect, the limitation of energy price rise can be highlighted as a positive factor, particularly natural gas which plays an important role in this regard.

INVESTMENT CLIMATE

The Government of Armenia has been successfully progressing with institutional and structural reforms aimed at liberalizing the energy sector which has led to a better investment climate for investors. Armenia has a well-established and functioning energy sector with stable energy supply and services extended to the population and economy sectors. The implemented reforms have created a solid basis for future development. Over the last five years, domestic and foreign investment in larger-scale energy infrastructure has been increasing. Both national gas supply and electricity networks have been improving since the beginning of power sector reform.

The recent improvements in the investment climate include establishment of a one-stop-shop system for business registration which significantly reduced bureaucratic procedures for investors. The national authorities continue to deregulate the economy and strengthen competition. Reduction of red tape and the implementation of

inspection reform enabled the country to continue to improve its ranking in international business environment surveys.

International donors provide assistance to the country to facilitate reforms aimed at simplifying procedures of paying taxes, enforcing contracts and improving trading across borders. The Government plans to introduce the Electronic Guillotine, a comprehensive database of legislation and business processes, which in addition to providing a consolidated electronic database will promote transparency in relations with the state authorities.

Armenia is ranked 37th out of 189 economies in the international assessment Doing Business 2014 prepared by the World Bank. The country has a very positive assessment regarding starting a new business and protecting investors. More reforms are needed to improve the country's ranking in the area of paying taxes, trading across the borders, enforcing contracts etc.

OVERVIEW OF THE ENERGY SECTOR REGULATORY FRAMEWORK

Energy Law

The Law was adopted on March 7, 2001. It regulates the relationships between the government bodies, legal entities of the energy sector operating under this Law, and consumers of electricity, thermal energy and natural gas in the Republic of Armenia.

- Is the foundation for electricity sector regulation in Armenia
- Established the Armenia Energy Regulatory Commission (AERC) as an independent regulator

a tariff reduction, a license suspension, or a license revocation. The licensee can appeal a penalty at a commission hearing.

- Defining electricity market rules. The PSRC is in charge of defining rules for the relationship between Licensees operating in the sector
- Mediating disputes between licensees and customers. Licensed operators must submit all customer complaints to PSRC. The PSRC has the authority to rule on disputes
- Setting quality of service requirements. The PSRC must set service quality standards for all electricity services provided to customers.

Law on the Regulatory Body for Public Services

The Law was adopted in 2004. AERC was renamed as the Public Services Regulatory Commission (PSRC) and expanded its regulatory responsibilities to water, natural gas and heating sectors. In 2005, responsibilities were further expanded to include telecommunications

The regulator's responsibilities include:

- Issuing licenses. All generation, transmission, and distribution operators must obtain a license from the PSRC. The PSRC sets conditions for obtaining a license and has discretion over all procedures and terms of the licensing application process
- Setting tariffs. The PSRC sets and reviews tariffs for generation, transmission, dispatch and distribution
- Overseeing compliance with licensee obligations. The PSRC reviews the operation of licensees and can penalize operators for not fulfilling license requirements through one of four methods—a warning,

2004 - Law on Energy Saving and Renewable Energy

This law is the main legal act regulating sustainable energy in Armenia. It aims to:

- Strengthen economic and energy independence and security of Armenia
- Increase the reliability of energy systems in Armenia
- Establish and develop industrial infrastructure and service organizations for promoting energy saving and RE
- Reduce adverse impacts on the environment and human health as a result of technological developments

Regulatory Framework for Renewable Energy

The following regulations provide incentives for investment in renewable energy generation:

- Electricity Purchase Agreements. The Energy Law mandates that, during the first

20 years of operations, 100 percent of electricity produced from new renewable energy systems (15 years for SHPP) must be purchased at tariff levels set by the PSRC

- **Tariff Incentives.** The PSRC supports renewable energy investments through fixed-rate feed-in tariffs. Information about tariffs is available at www.psrc.am and www.r2e2.am.

- Loan service costs
- Costs related to environmental standards
- Mothballing and preservation costs
- Costs of the safe keeping of the utilized nuclear fuel and requisite allocations to the Nuclear Plant Decommissioning Fund
- Technical and commercial losses
- Other justified costs as provided by Legislation.

The tariff should also provide the operator with the opportunity to make a reasonable profit.

Tariff Setting Methodology

The PSRC establishes the procedures for setting and reviewing tariffs. According the Energy Law, the PSRC can either set the specific monetary value of the tariff or establish a clear formula for calculating the tariff based on parameters defined in the Energy Law. According to the Energy Law, a tariff should cover:

- Justified operation and maintenance costs

The PSRC or the Licensee can request a tariff review every six months. Once requested, a tariff review must be submitted within 90 days. The PSRC is authorized to set long term tariffs for more than six-months if it is considered necessary to provide investment security. Once a tariff is set, licensees cannot appeal the level of a tariff. The only recourse for altering an assigned tariff is to petition the PSRC's tariff methodology.



Figure 1. Tatev Hydro Power Plant

INVESTMENT OPPORTUNITIES IN NUCLEAR POWER

The energy security of Armenia is historically linked to nuclear power, since the country imports about 97% of its primary energy resources. The Government of Armenia initiated the construction process for a new nuclear power plant and adopted an action plan which stipulates start of construction works in 2018 and commissioning in 2026.

The ANNU will be constructed on the ANPP site originally prepared for additional Units 3 and 4.

With the engagement of international and local experts the preliminary activities for the construction of a new nuclear unit began in 2009. Assessment of the seismic safety of the operating unit, modelling of different incidents and emergency situations reveal that the plant's seismic safety factor corresponds to international standards. In addition, another site examination of the ANPP facilities and surrounding areas was conducted in regards to seismic safety, volcanology and geophysics. The Technical Task for seismic re-evaluation of the ANPP was developed and agreed with IAEA. The results of the seismic re-evaluation were submitted for expert review to IAEA in August 2010. In September 2011 the second review of the seismic re-evaluation was returned with positive feedback from IAEA.

In accordance with the provisions of international conventions and the legislation of Armenia, discussed and endorsed during public hearings, an Environmental Impact Assessment was conducted. The special report "Seismic and volcanic hazard assessment for the site of the new nuclear power unit" was developed under the EIA.

In order to invite investors and provide sufficient data and information, a Bankable Feasibility Study was prepared by "Worley Parsons".

According to a Government Decree dated December 3, 2009, based on the analysis of BFS, the Russian AS-92 design (capacity – 1060 MW; operating life – 60 years) was approved for the "nuclear island" of the new NPP. It has a certificate of conformity to the requirements of European Utilities (certificate dated 24 April 2007). Other

HISTORICAL REMARK

One third of power generated in Armenia is from the Armenian Nuclear Power Plant (ANPP). It is situated at an elevation of 930m on the semi-desert landscape of the western part of the Ararat Valley. It was originally planned to accommodate four units of WWER-440 reactors, with Units 3 and 4 to be situated to the west of Units 1 and 2. Preliminary site clearance for Units 3 and 4 was conducted in the early 1980s; however construction of further units at ANPP was not started. ANPP consists of two power units with 407.5 MW designed capacity of each. Planned lifetime is 30 years.

ANPP was the first nuclear power plant in the USSR intended to be constructed in a region of high seismicity, for which significant changes were made in the VVER-440 (V-230 project) design. The reactor was assigned with the new identification – V-270. Currently only one unit of ANPP is operational. It produces 2.5 billion kWh electricity in the base-load regime, which is about 35% of total balance of country's power generation.

After the 1988 earthquake, although the Armenian Nuclear Power Plant was not damaged, the Council of Ministers of the USSR decided shut down the ANPP as a precautionary measure. The ANPP was decommissioned in 1989 without any substantial reasons. The units were not decommissioned but kept in prolonged shut down condition. This caused the severe energy crisis that brought about not only the collapse of the economy, but also an ecological catastrophe due to mass deforestation and the decrease in water level of Lake Sevan due to hydropower generation volume. In fact, Armenia became very sensitive to the energy security threats. After independency in 1995, Unit 2 of the ANPP was restarted and Unit 1 remained in a stand-still regime.

The operation of the second unit of ANPP still continues and according to the Government's decision, it will be decommissioned after putting the new nuclear power unit into operation.

components of the project, i.e. turbine island and I&C systems, are subject to negotiations with international suppliers selected through tender.

In December 2009, the GoA established a joint Armenian-Russian company “METSAMORENERGOATOM”, open to investors. Taking into account the lack of financing and limitations for sovereign guarantee, the GoA invites potential investors to take part in the construction and operation of the new nuclear power plant.

A power purchase agreement will be signed with investors in accordance to the legislation of Armenia. The PPA will guarantee the adequate return of investments.

Armenia is committed to the proper implementation of its obligations under International Conventions.

Documents and references (www.minenergy.am)

Bankable Feasibility Study (Worley Parsons 2010)
Environmental Impact Assessment Report. 2010
Seismic and Volcanic Hazard Assessment for New NPP 2010

The Law on Construction of new nuclear power unit in Republic of RA, adopted in 27 October 2009



Figure 2. Armenian Nuclear Power Plant in Metsamor

INVESTMENT OPPORTUNITIES IN THERMAL POWER

The historic threats to supply security and affordability are expected to continue in Armenia. Therefore, the Government's commitment to developing new generation capacities remains as strong as before and there is now more urgency, given a looming gap between supply and demand. Demand grew at an average annual rate of roughly 4 percent between 2004 and 2013, and is expected to continue to grow at a rate of around 2 percent per year. New supply will be needed since 50 percent of available capacity is more than 40 years old and from installed

capacity of 3949 MW the operational is only 1910 MW. In addition, one of the largest generating units in the system, the nuclear unit at ANPP is in urgent need of investments. It's retirement has been postponed twice, most recently from 2021 until commissioning of the new nuclear power plant (expected in 2026) because of the difficulty in securing financing for it. If Metsamor is retired in 2026, Armenia can expect a supply gap of roughly 830 MW, considering the base-case forecast average annual peak demand growth of roughly 2 percent per year.



Figure 3. Yerevan Thermal Power Plant, 1965

Although Armenia is promoting energy efficiency and renewable energy development, however thermal power will be needed to cover base load generation needs.

Therefore the Action Plan for Implementation of the Energy Security Concept of the RA approved by the Government on 31 July 2014, envisages construction of new thermal power unit (units) with 250–450 MW capacity to be commissioned by 2018.

The new power unit will replace the old one which operates at high cost and tariff due to low efficiency, such as the old 200 MW power units of Hrazdan TPP.

The similar activity was installation of Yerevan Combined Cycle Power Unit with 250 MW capacity that commissioned in 2010, which was financed from the concessional loan provided by the Japan Government under sovereign guarantee. Currently the modernization of electrical substation are ongoing at the Yerevan TPP.

The existing site of Yerevan TPP is very suitable for construction of additional power unit (units) with 250–450 MW capacity due to the available land and well-established infrastructures.

The Government of Armenia invites interested private companies to build, own and operate

thermal power planned. All interested parties can contact the Ministry of Energy and Natural Resources to obtain data and information, access to the proposed site and organize necessary meetings with experts and officials.

It is envisaged to sign a PPA with total generation take-off guarantee.



Figure 4. Yerevan Combined Cycle Power Unit, 2010

Information is available on www.minenergy.am

INVESTMENT OPPORTUNITIES IN HYDRO POWER GENERATION

Armenia has significant hydro resources. Total capacity of all hydropower systems is 1,032 MW. Plants on the Hrazdan and Vorotan rivers generate the majority of the country's hydroelectric power. The Sevan-Hrazdan cascade consists of six power plants with a total capacity of 561 MW. The Vorotan cascade consists of three power plants with a total capacity of 404 MW. The Sevan-Hrazdan system is owned by a subsidiary of RAO-UES of Russia, RAO Nordic. The Vorotan Cascade is owned by the Government of Armenia. There are currently 102 small hydropower plants in operation, with a combined installed capacity of 132 MW. Dzoraget HPP is the largest, with 10 mini-hydro units having 26 MW of installed capacity.

- Loriberd HPP. The engineering firm Fichtner completed a feasibility study of the Loriberd HPP in 2003-2004, and in 2007 updated the cost estimates. The plant will have an installed capacity of 66 MW, and a utilization factor of roughly 12 percent. Construction has not begun on this project.
- Shnokh HPP. This plant is estimated to have installed capacity of 75 MW and utilization factor is expected to be similar to Loriberd's.

The Action Plan for Implementation of the Energy Security Concept of the RA approved by the Government on 31 July 2014, envisages start of con-



Figure 5. Yerevan HPP

The Government of Armenia and the Government of Iran are partnering on the construction of two hydropower plants along the Arax River, near the border town of Meghri. Armenia's plant is expected to have an installed capacity of 140 MW.

There are also two new medium-sized hydro plants planned for Armenia:

struction of Shnokh and Loriberd Hydro Power Plants in 2023. The Shnokh and Lori-Berd HPPs will be constructed in the northern part of Armenia, where does not exist the large generation capacities. This will facilitate electricity exchange with Georgia.

Below are some data on proposed HPPs.

Lori-Berd HPP

Construction of the Lori-Berd HPP will be on the Dzoraget river. In 2003–2004, in the framework of the EU TACIS program the Fichtner prepared a feasibility study for construction of the above

mentioned plant. In 2007 the same company updated the cost estimates of the project, as a result of which 15% increase in prices has been observed due to the equipment' price increase globally.

Item	Lori-berd HPP, with storage	Lori-berd HPP	Tashir SHPP
Design head, m	343	311.75	47.5
Design discharge, m ³ /s	25	20	2
Installed Power Capacity, MW	65.3	54.3	0.7
Annual Energy Production, mln. kWh	202.9	208.3	3.9
Capital expenses, mln. USD	121.614	112.692	1.256

Shnokh HPP

The Shnokh Hydro Power Plant will be located in northern Armenia, on the Debed River. The site is upstream of the existing Dzoraget Hydropower Station, which has been in operation since 1936.

The characteristics of the Shnokh HPP plant without construction of Armanis reservoir are as follows:

1	Catchments Area	km²	4080
2	Design head	m	247.3
3	Length waterway tunnels	km	22
4	Design discharge	m ³ /s	37
5	Installed Power Capacity	MW	76
6	Annual Energy Production	Mln.kWh	291.4
7	Storage basin	thous. M ³	450
8	Capital expenses, without VAT	mln.USD	120
9	Construction period	years	8

The last update of the original engineering design of the Shnokh HPP implemented in 1993.

Construction of the Armanis reservoir with 130 mln. m³ design discharge will allow to construct power plant with 120 MW installed capacity and 460 mln. kWh annual power generation.

The Government of Armenia invites all interested private companies to invest in this attractive projects. The long term PPA with full cost recovery tariff is guaranteed for investors.

All interested investors may obtain further information on the potential projects from the Ministry of Energy and Natural Resources of RA.

INVESTMENT OPPORTUNITIES IN RENEWABLE ENERGY

Armenia has significant indigenous renewable energy resources, and an educated workforce with extensive scientific and engineering expertise. Furthermore, the Government has taken proactive steps in recent years to craft laws and regulations designed to reform the power sector to enable private sector involvement in renewable energy sector development. Nonetheless, Armenia's renewable energy sector still faces some important barriers to renewable energy deployment, primarily related to the availability of financing, sometimes relatively higher capital cost of renewable energy technologies and public awareness of the potential benefits of renewable energy in general. The donor community in Armenia plays an important role in promoting development of renewable energy through investment and technical assistance to improve the legal and regulatory framework, as well as through a number of projects including resource assessment and mapping.

Recently the Government of Armenia requested a Scaling-Up Renewable Energy Program in Low Income Countries (SREP) under the Climate Investment Funds to support development of viable renewable energy technologies and projects, for several of which

detailed technical assessments, pre-feasibility or feasibility studies are available. The objective of the SREP is to pilot and demonstrate the economic, social and environmental viability of low carbon development pathways in the energy sector by creating new economic opportunities and increasing energy access through the use of renewable energy. In June 2014 the SREP board has approved provision of 40 million USD in concessional funding for Armenia, which will leverage about 5 times more investments.

One of the important incentives for investments in the renewable energy is the guaranteed off-take of all electricity produced for 20 years at all types of grid-connected renewable energy generations (for SHPPs 15 years) from the moment of commissioning.

For most of RE technologies the feed-in-tariff was established, which is subject for annual adjustment to reflect inflation and exchange rate fluctuations.

The resource assessment is also important to provide information on potential for certain technology resource to the investors.

Renewable Energy Resource Potential in Armenia by Technology

Technology	Capacity (MW)	Generation (GWh _t /yr)
Wind	795	1,640
Utility scale solar PV	835–1,169	1,735–2,118
Concentrating solar power	1,169	2,400
Distributed solar PV	93	128
Geothermal power	31–54	244–436
Landfill gas	2.3	20
Small hydro power	91	334
Biogas	3.3	26
Biomass	29	228
Solar thermal hot water	200	254
Geothermal heat pumps	3,500	4,423

Source: Ministry of Energy and Natural Resources

Small Hydro Power Plants (SHPP)

In the renewable energy sector Armenia has mostly developed small hydro power plants (SHPP). Typically plants with less than 30 MW of installed capacity are considered SHPP. As of

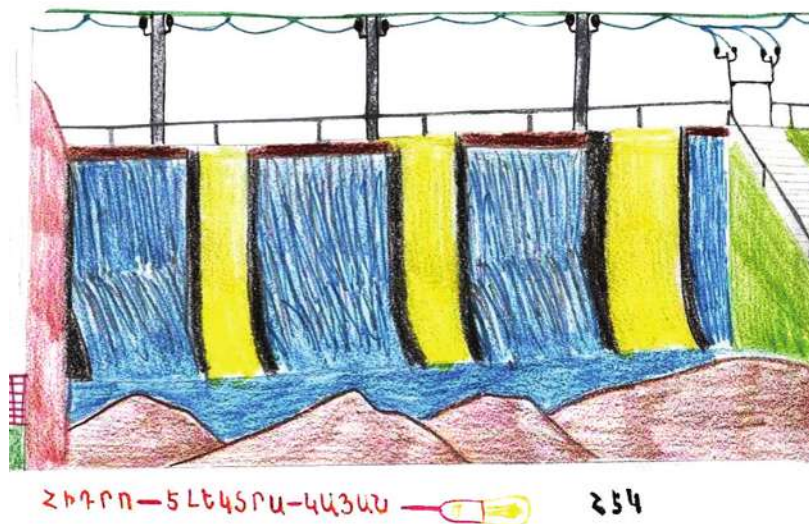


Figure 6. Hrach Arzumanyan

January 1, 2015, there are 165 SHPPs with annual installed production capacity of 853 million kWh electricity. Another 59 SHPPs are under construction.

The table below summarizes the potential for additional SHPP development in Armenia over the next 10 years, and is based on data presented in a recent study prepared by the Armenian Renewable Resources and Energy Efficiency Fund (R2E2).

Potential Remaining SHPP Capacity in Armenia¹

Mid and Long Range	Capacity (MW)	Output (GWh)	Needed Investment (mln. \$)
Resource: Possible max	305	1 118	366
Resource: Possible min	252	774	303
2015 (forecast)	179	517	214–225
2020 (forecast)	216	626	259–270

Over the past five years, those SHPPs that were approved for licensing and were constructed faced and overcame a number of issues related mainly to the long term financing. It is important

to attract private foreign capital investment to develop new small hydro capacity and qualitatively develop the existing capacity.

Wind Power

Armenia has a number of areas with promising wind resources. The most promising areas that have been identified and characterized to date are Zod Pass, Karakach Pass, Pushkin Pass, Sisian Pass and the Fontan region. Together these sites are estimated to have 800 MW of developable resource potential, with estimated capacity factors ranging from 21 to 31 per cent, depending on the site. The private companies Zodwind and Arenergy have completed feasibility studies for wind plants in Armenia. Two other private companies, SolarEn and MVV-Decon, have conducted wind measurement projects. However, to date no private companies have moved forward with wind plant development in Armenia. Armenia's



Figure 7. Lori 1 wind plant. Ashot Mkryan, 11 years

¹ The values are average annual energy output number with the maximum peak occurring during spring runoff, and the minimum occurring during winter months when stream flows are at their lowest



Figure 8. Potential wind power sites

only operating wind project is the 2.64 MW Lori-1 plant. Lori-1 was built in December 2005 under a grant from Iran. Nonetheless, there is a growing interest in this sector with more entrepreneurs willing to take the risk. The main challenge was the availability of long term financing, which for a time is solved in cooperation with Germany KfW bank.

The first wind power atlas of Armenia was developed by ECOTECH Scientific Association in 1989-90. Synoptic data from 37 hydro-meteorological stations of the Republic was analyzed, and corrections of air density and on openness of all considered meteo-stations were carried out. According to obtained results theoretical wind power potential of the Republic was assessed as 2426 – 4418 MW for two zones of the republic. In 2002-03, The United States Department of Energy (DOE) sponsored a project to help accelerate the widespread use of wind energy technologies in Armenia through the

development of a wind energy resource atlas of Armenia. DOE's National Renewable Energy Laboratory (NREL) led the project in collaboration with SolarEn International Corporation, and its Armenian subsidiary SolarEn LLC. The primary goals of the project were to develop detailed wind resource maps for all regions of Armenia and produce a comprehensive wind resource atlas documenting the results and establish a wind monitoring program to identify prospective sites for wind energy projects and help validate some of the wind resource estimates.

Biogas

Armenia has the potential for biogas-based power production at livestock farms, at the Nubarashen landfill (in the city of Yerevan) and at the Aeratsia waste water treatment plant (in the city of Yerevan). In 2010, the GEF/UNDP identified three livestock farms as potential candidates for biogas-to-energy projects, with a combined resource potential of 3.3 MW. These plants would be similar to the Lusakert biogas plant, which is Armenia's only operating industrial-scale biogas-to-energy plant, located at the Lusakert poultry farm.

In 2001, a consortium of Japanese companies studied the potential for a landfill gas-to-energy plant at the Nubarashen landfill. Although eventually the consortium installed a methane gas flare plant instead of an energy project, more recent assessments have identified the potential for building up to a 2.5 MW landfill gas-to-energy plant at the facility.

The other potential source of biogas energy in Armenia is the Aeratsia waste water treatment plant. The plant is currently dilapidated and largely non-functioning, but if the plant were to undergo significant rehabilitation and anaerobic digesters were installed at the facility, it is expected that a 3 MW cogeneration plant could be constructed at the facility.

There is also a potential for investment for micro scale biogas equipment production for the use in the villages of Armenia. Building a sustainable agricultural practices is the core of Armenia's agricultural policy and biogas has a potential to play a significant role in it.

Solar Photovoltaic Power

Armenia has good solar PV resources, with annual average global horizontal irradiation (GHI) ranging from 1,490 kWh/m² to over 2,100 kWh/m². By comparison, average annual GHI in Europe is 1,000 kWh/m². According to the study done in 2012, the total resource potential for utility-scale solar PV is over 6,500 MW. Assuming polycrystalline solar PV modules mounted at a fixed angle to the sun are deployed in ground-mounted utility-scale plants, solar PV systems could achieve capacity factors of 20 to 24 in Armenia (dependent on location). If single-axis tracking solar PV technology is deployed, capacity factors could be as high as 30 per cent.



Figure 9.

High investments costs that result in high tariffs and Armenia's limited solar research and technical experience have hampered widespread deployment. But, utility-scale solar PV is now analysed to be cost-competitive with other power generation options available to Armenia given recent technological advancements combined with

continued drastic cost declines globally. Armenia will benefit from developing its capacity to scale-up PV technology and take advantage of the cost reductions as they happen.

Financing from the World Bank and Asian Development Bank (ADB) will be blended with concessional financing from the Strategic Climate Fund (SCF) under the Scaling up Renewable Energy Program for Low Income Countries to bring down solar PV generation cost closer to grid parity and address viability and affordability concerns. The combination of funds will catalyse private investment in the first new plants and demonstrate commercial deployment of solar PV. Site-specific solar resource assessments and project development assistance, institutional capacity building, knowledge management activities, and, transaction advisory services under the technical assistance will support financial sustainability, cost reductions and scaling up due to market learning. It was envisaged to build at least 30 MW solar PV plants by 2018, but due to the cost reductions globally, Armenia may be able to afford much more then.

In addition to utility-scale solar PV, distributed solar PV mounted on building rooftops could also be deployed throughout Armenia. Solar PV deployment in Armenia to date has been limited to relatively small-scale rooftop-based installations at schools, hospitals, office buildings and municipal sites throughout Armenia. Armenia is now improving its "net-metering" scheme (the capacities up to 150 kW are not regulated and the net-metering is applied if requested) and is negotiating with financial institutions to have financial tools available for autonomous/rooftop energy production.

Although Armenia has good resources for solar PV, Armenia receives relatively low direct normal irradiation (DNI) compared to most of the locations where concentrating solar thermal power (CSP) is successfully deployed. Armenia's annual DNI ranges from 1,410 kWh/m² to 2,453 kWh/

m². The minimum DNI level threshold for viability for CSP plants that is generally accepted in the industry is 2,200 kWh/m². Only one area in the south-eastern corner of Lake Sevan receives DNI

above this threshold. However, overall Armenia has rather poor resources for CSP and for that reason this technology is not considered a viable option for development.

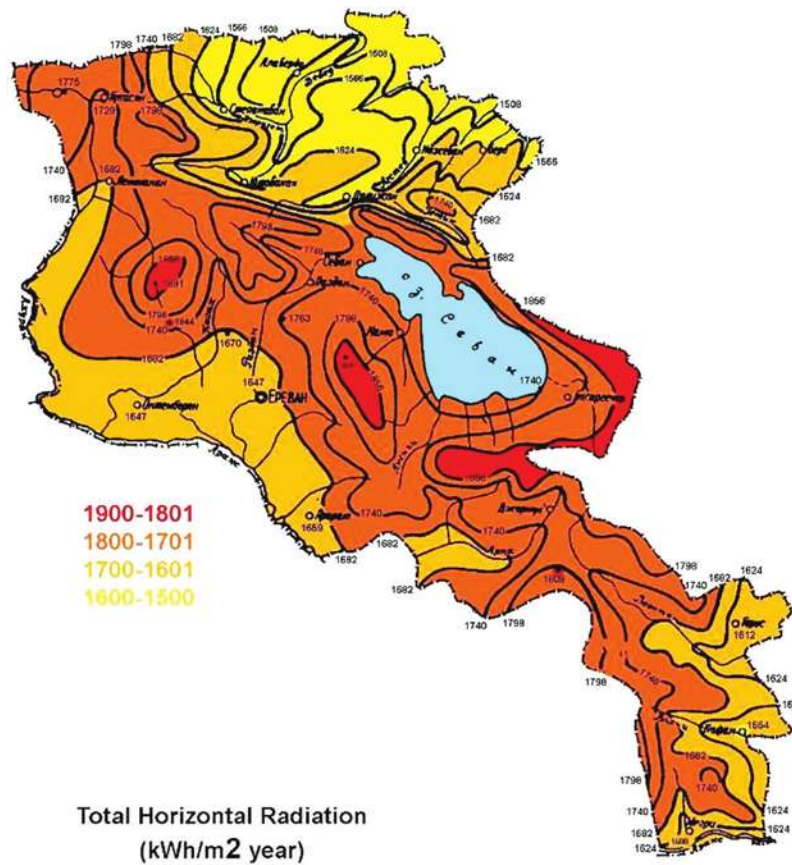


Figure 10. Solar resources of Armenia

Geothermal Power

Armenia has no installed geothermal power plants, but comprehensive geo-technical studies suggest that geothermal resources suitable for power production may exist at a number of sites, including the most promising Karkar, Jermaghbyur, and Grizor sites, as well as along the Armenian–Georgian border. In 2009–2011, comprehensive surface investigation works were conducted for the Karkar site. Results of the studies indicate that a geothermal resource exists at the

site, and can only be confirmed through exploratory drilling. The key conclusions and recommendations of those studies were also reviewed by a third party – Iceland Geosurvey (ISOR) – that confirmed the robustness of the methodology for the above studies and the key conclusion that exploratory drilling is needed to confirm the resource and its characteristics. In order to reduce the risk of potential investors associated with the resource confirmation and necessary

infrastructure, the Government has requested and received funding from Climate Investment Funds Scaling up Renewable Energy Program in Low Income Countries to complete exploratory drilling and transaction structuring. The GoA intends to invite private investors to build, own and operate the plant, when adequate resources are confirmed. The total geothermal resource potential of three geothermal sites that were explored

to some extent has been estimated to be at least 150 MW. However, it is important to note that because of the limited exploratory activities and information about Armenia's geothermal resources, this is a very rough estimate, which relates only to three potential sites for which information was available, and the actual geothermal resource potential could be much larger.



ARMENIA RENEWABLE RESOURCES AND ENERGY EFFICIENCY FUND

Armenia Renewable Resources and Energy Efficiency Fund (Fund) has been established by the Government of Armenia.

The mission of the Fund is to facilitate investments in energy efficiency and renewable energy in Armenia. Under the umbrella of one organization, the Fund provides an array of comprehensive assistance to renewable energy and energy efficiency project developers, investors, bankers, experts, researchers, etc. It is professional expertise for government in issues related to the sustainable energy development strategy and legislation. The Fund continuously analyses the situation, identifying barriers and proposing solutions to the Government's responsible agencies.

The Fund also established a financing mechanism through a revolving lending tool, which finances energy efficiency and renewable energy projects through the banks or credit organizations, as well as directly, using ESCO mechanism.



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Energy Efficiency

Armenia has significant potential for energy efficiency and can recoup economic benefits through utilization of this potential. While Armenia is one of the less energy intensive economies in the region, largely due to the structural changes of the economy, large potential remains for further efficiency improvements. The energy efficiency potential is not realized due to several informational, knowledge, financing and legal obstacles.

The Energy Sector Strategy and the Sustainable Development Program of the Government recognize these challenges and continuous improvement of energy efficiency policy contribute to addressing of the above challenges. The increase of the power supply reliability and improvement of energy security are among the key strategic objectives of the sector. To that end, the Government prioritizes realization of economically viable energy efficiency potential as means for achieving the above strategic objectives.

The Government has taken important steps to encourage realization of the energy efficiency potential. In 2005, the National Assembly passed the Law on Energy Savings and Renewable Energy, creating a legal basis for implementation of energy efficiency measures in Armenia. In 2007 the Government also adopted the National Program on Energy Savings and Renewable Energy, which identifies the sectors with the largest energy efficiency potential and provides an outline of technical measures/solutions to be taken to realize the identified technically viable potential. Additionally, in 2010 adopted a time-bound Energy Efficiency Action Plan directed to plan and implement long term energy efficiency activities by 2020 in different phases. Several programs aiming at improved energy efficiency are already implemented and under implementation. All these activities will lead to the dynamic development of Energy Serving Companies (ESCOs) in Armenia. Being open to changes and understanding the sheer necessity of energy efficiency, the Government has the political will to implement any reform necessary to develop this sector. International ESCOs are encouraged to start business in Armenia.

INVESTMENT OPPORTUNITIES IN MINING SECTOR

The mining sector is a key contributor to the national economy of Armenia. The mining, ore processing and final product are classified as main economic driving forces.

The importance of the mining industry was mostly manifested during the economic crisis, when it became one of the few sources of stable income. The Republic of Armenia has abundant and diverse natural resources. Efficiency of mining in terms of environmental safety has special importance; as the deterioration of the environment including land degradation, consumption of underground water resources, operational inefficiency, high-energy intensity of technologies and low productivity are still obstacles to the sustainable development of the mining industry.

State policy regarding the mining sector aims to encourage the industry towards the most rational

use of natural resources, taking into account global environmental and social concerns.

The Ministry of Energy and Natural Resources of RA invites interested companies to invest in the mining sector of Armenia and bring with them the best international practices.

Currently the mining sector is regulated by the following legal acts:

- 1) Mining Code of RA, 2011
- 2) Law on Environmental and Natural Resources Using Fees, 1998
- 3) Law on Environmental Supervision, 2005
- 4) Law on Waste, 2004
- 5) Law on Promoting of State Regulation of Technical Security, 2005
- 6) Law on Environmental Impact Assessment and Environmental Expertise, 2014
- 7) Civil Code of RA, 1998



- 8) Water Code of RA, 2002
- 9) Land Code of RA, 2001
- 10) Code on Administrative Offences, 1985 and also sub-set regulations, as well as international conventions.

Over 850 construction material and aggregate mineral mines are registered in the state balance sheet of the Mineral Resources, including 38 base metal and precious metal mines, 45 underground fresh water mineral mines and 25 underground mineral water mines. 497 licenses were provided for the extraction/production of mineral resources, including 27 licenses for metallic minerals, 442 for non-metallic minerals and 29 for underground mineral waters.

There are 87 licenses provided to geological exploration of the lithosphere for the extraction of mineral resources, including 53 licenses for metallic deposits, 33 for non-metallic deposits, 1 for underground water, and 3 licenses for the detection of gas and oil.

Among base metal and precious metal deposits located in Armenia, there are 8 copper-molybdenum mines, 3 copper mines, 13 gold and gold-polymetallic mines, 2 poly metal lie mines, 2 iron ore mines, 1 aluminum and 1 magnesium silicate and chromite rock mines.

As the production capacity is expanded, the longevity of the above mines has been calculated as follows:

1. Copper and molybdenum ores – almost 100-120 years,
2. Gold ores – almost 25-30 years,
3. Lead-zinc ore – almost 20-25 years.

The longevity of resource security is based upon the major mines, as it is assumed that by that period the resources of the small and medium scale mines will be exhausted. This will lead to a reduction in the total product of

the mining industry. To avoid further problems a reproduction of the mining base.

In addition to the base metals registered in the state inventory above, scattered traces of other elements have also been discovered, including rhenium, selenium, tellurium, cadmium, indium, helium, thallium and bismuth. Technological and geological exploration has proven the possibility of extracting of these components and the industrial significance this could have.

The concentrates are considered as a final product with a high content of copper, molybdenum, zinc, in some cases gold and silver, which does not allow full use of the economic potential of the mine in Armenia. The processing of metal minerals in its entirety, from the extraction to the creation of the final product, will add value and increasing GDP of the country.

Inspection of the current situation of metallic mineral mines shows a 30% loss of registered resources that arise due to complexities in the extraction and processing of the minerals. The profit from the sales of extracted ore is significantly higher than the amount of money invested in production, but the negative impact on the environment is greater than that provided by the accumulation of financial resources for the implementation of environmental measures in order to ensure the fees or operating system.

There are 21 tailings in Armenia built to store the left over materials of the mining industry (11 in the Syunik Province, 7 in the Lori Province, 2 in the Aragatsotn Province, 1 in the Ararat Province), covering a total of 700 hectares. These residue dumps contain large amounts of useful metals that have not yet been processed

There is need for a comprehensive study into the materials accumulated in the tailings,

reassess their contents and begin exploiting them as «man-made mines», as defined by the terms of the Mining Code of RA.

The Republic of Armenia is a global leader in terms of the abundance and diversity of non-metallic minerals. Nearly all forms of mineral rocks known throughout the world exist within its territory. Mountainous rocks, formed as a result of volcanic processes, are of special value and significance. The following abundant non-metallic useful minerals are registered in the state balance sheet:

Tuff – including volcanic tuff, volcanic slag, felsitic tuff. Deposits of 540-mln cub. meters have been confirmed. Around 310-mln cub. meters are currently under exploitation.

Basalt – including basalt, melano-basalt, andesite basalts, andesite, andesite dacite, dacite and others. Deposits of 355-mln cub. meters have been confirmed. Around 117-mln cub. meters are currently under exploitation.

Perlite, obsidian – Deposits of 150-mln cub. meters have been confirmed. Around 110-mln cub. meters are currently under exploitation.

Pumice – Deposits of 195-mln cub. meters have been confirmed. Around 90-mln cub. meters are currently under exploitation.

Zeolite – Deposits of 510-mln cub. meters have been confirmed. Around 275-mln cub. meters are currently under exploitation.

Volcanic slag – Deposits of 350-mln cub. meters have been confirmed. Around 60-mln cub. meters are currently under exploitation.

Granite – including granite, granodiorite, syenite, gabrinite, monzonite. Deposits of 65-mln cub. meters have been confirmed. Around 20-mln cub. meters are currently under exploitation.

Nepheline Syenite – confirmed deposits are about A+B+C-457.0 mln t.

Marbles – including clay, marlstone, dolomite, marble, travertine, koglomerats. Deposits of 80-mln cub. meters have been confirmed. Around 50-mln cub. meters are currently under exploitation.

There are also numerous quartzite and quartzite-sand, ultra-alkaline rocks (dunite, serpentinite, peridotite and pyroxene), clays, bentonite, gypsum, natural abrasives and raw coloring materials.

The greatest amount of high quality in the world is in Armenia. The confirmed deposits of Aragats-perlite in Armenia amount to 150-mln cub. meters, and the total amount of projected deposits could be as high as 3-blm cub. meters. More than 100 basalt and andesite mines are mapped in the territory of Armenia, some of which are unique in their composition. Our goal is the extraction of minerals as well as the development of efficient processing of natural resources.

Many non-metallic minerals in Armenia have a wide use and demand in the world: The products with the best perspective are common within the chemical and food industries, construction materials and cable industry, electrical engineering, construction industry, agriculture, and energy production and efficiency technologies.

In order to promote further development of non-metallic mineral processing the Government of Armenia proposes to select the most profitable and important industrial products for the economy by

1. Organizing their production, taking into account domestic and international market demand,
2. Importing new technologies,

3. Implementing marketing strategies for identifying the markets for new products with special emphasis on competitive products in domestic and international markets,
4. Driving forward the processing industries of non-metallic minerals in the Republic of Armenia.

Experts and business associates have developed business proposals addressing the high world-wide demand for these products. The usage and processing industry of non-metallic mineral resources has a solid future, and the development of such an industry will guarantee sustainable benefits.

Digitized versions of the specialized maps are the standard today, so there must be a system in

place to automatically record and manage mineral deposits.

Negotiations to join the Extractive Industries Transparency Initiative (EITI) with the World Bank are in progress, to ensure the transparency of the mining sector, and make information about the fixed and forecasted reserves of natural resources available.

The Ministry of Energy and Natural Resources of RA is open to and encourages discussion with interested investors about the possibility of introducing new, efficient, environmentally friendly technologies in the mining sector. This will guarantee proper extraction of metal and non-metal raw materials, the most efficient and complete processing and recycling of mineral resources, and reduce the environmental impact and over-exploitation of the valuable elements.

