

**COUNTRY REPORT
ARMENIA**



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Lead by NAS RA, with the support of TTA

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Table of Contents

ABBREVIATIONS	3
CHAPTER 1: INTRODUCTION	4
CHAPTER 2: CURRENT ENERGY SITUATION IN THE COUNTRY	4
2.1 LEGAL FRAMEWORK IN THE FIELD OF ENERGY	6
2.1.1 Energy Law.....	6
2.1.2 Energy Efficiency and Renewable Energy Law.....	7
2.1.3 Water Code.....	7
2.1.4 Energy Security Concept.....	7
2.1.5 Energy debates	7
CHAPTER 3: CURRENT SITUATION WITH EE/RES	8
3.1 HYDROPOWER	10
3.2 WIND	10
3.3 BIOMASS	10
3.4 SOLAR	11
3.5 ENERGY EFFICIENCY	11
CHAPTER 4: INNOVATION SITUATION IN THE ENERGY SECTOR	11
CHAPTER 5: OVERVIEW OF CRITICAL STAKEHOLDERS	22
CHAPTER 6: ANALYSIS	24
REFERENCES	28

List of Tables and Figures

Figure 1: Primary Energy Supply In Armenia, 2008-2012	5
Table 1: Inogate Projects	21
Table 2: Swot Analysis Of The Innovation System In Armenia	27

Abbreviations

CDM = Clean Development Mechanism

EaP = Eastern Partnership countries

EBRD = European Bank for Reconstruction and Development

EE = Energy Efficiency

GWh = Gigawatt Hour

HPPs = Hydro Power Plants

IFC = International Finance Corporation

IMF = International Monetary Fund

KTOE = Kilotonne of Oil Equivalent

NPP = Nuclear Power Plant

R&D = Research and Development

RES = renewable energy sources

RTD = Research and Technological Development

S&T = Science and Technology

SMEs = Small and medium enterprises

Chapter 1: Introduction

The objective of this Country Report is to conduct the analysis of the energy sectors in Armenia and the identification of stakeholders as basic information for the initiation and stimulation of further innovation and research support activities for energy efficiency (EE) and renewable energy sources (RES) to be carried out within ener2i project. It will focus on existing potential in EE/RES and provide overview of available technologies and technology providers, opportunities and barriers and address relevant policies and energy strategies. This analysis will also constitute the basis for the formulation of policy recommendations and the definition of a joint roadmap to be addressed to the responsible public institutions. The analysis is carried out on the basis of common methodology developed within WP2 of ener2i project also to allow conducting a comparative analysis focused on the local energy innovation systems in Armenia, Belarus, Georgia and Moldova.

Chapter 2: Current energy situation in the country

Armenia, officially the Republic of Armenia, is a landlocked mountainous country in the Caucasus region of Eurasia. Located at the crossroads of Western Asia and Eastern Europe, it is bordered by Turkey to the west, Georgia to the north, the de facto independent Nagorno-Karabakh Republic and Azerbaijan to the east, and Iran and the Azerbaijani exclave of Nakhijevan to the south. A former republic of the Soviet Union, Armenia is a unitary, multiparty, democratic nation-state with an ancient and historic cultural heritage.

Armenia has no indigenous sources of oil, coal or natural gas. It imports and consumes 47,000 barrels of oil a day, most of which is imported from Russia. It also imports and consumes about 9 mln cubic meters of natural gas of which two-thirds is imported via pipelines from Russia that runs through Georgia, and one-third comes from Iran. In 2008, Armenia imported 2.2 bn cubic meters of gas from Russia. On December 23, 2009, Iran and Armenia reached an agreement for Armenia to import about 150 mln cubic meters of natural gas from Iran. Armenia was importing 1-1.5 mln cubic meters of natural gas, which it paid for by exporting electricity to Iran. Natural gas from Iran is imported via a 140 km pipeline that was completed in 2008. The pipeline is controlled by ArmRosGazprom (ARG), a Russian-Armenian joint venture that up until 2013 was 80% owned by Gazprom of Russia. In autumn 2013, Armenian Government announced the decision to hand over the state's remaining 20% stake in joint venture to Gazprom thus ceding almost total control of energy supplies to Russia.¹

Heavy reliance on imported fuels and the old and under-maintained transmission and distribution assets put Armenia at risk of supply interruptions, price fluctuations, and possible outages. The average age of the transmission lines is around 45 years and the transmission company did not make any substantial investments in rehabilitation of the lines. Moreover, Armenia is dependent on the imports of gas and nuclear fuel used to generate over two-third of the country's electricity.

Armenia currently has sufficient capacity to meet its demand. However, depending on the power demand growth scenarios, generation capacity shortage of 520-920 MW to meet the peak electricity demand is estimated to emerge after the planned shutdown of the existing nuclear power plant (if the construction of a new nuclear power plant is not implemented), and the phasing out of inefficient and old (>40 years) thermal power plants. The shortage is expected to reach 1,150 – 2,270 MW by 2020.

¹ <http://www.reegle.info/profiles/AM>

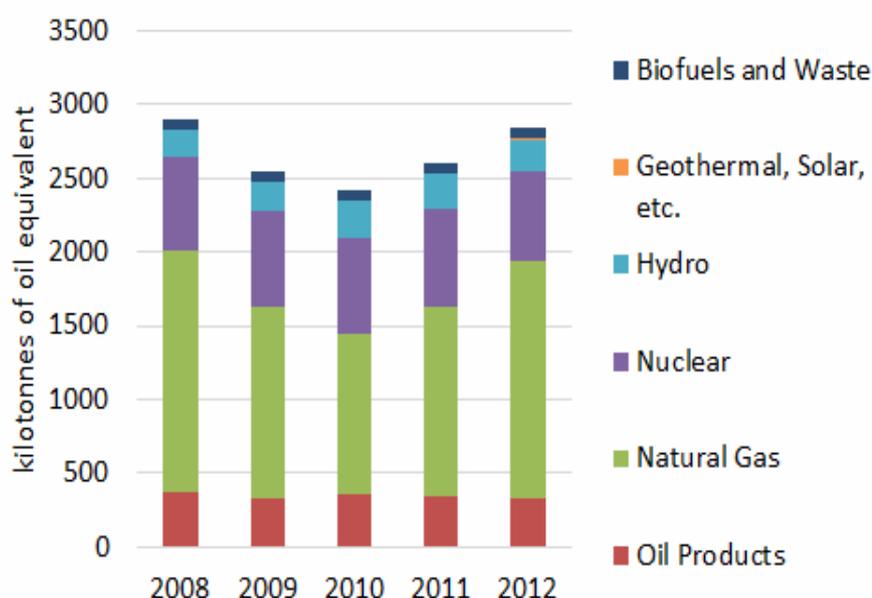


Figure 1: Primary Energy Supply in Armenia, 2008-2012²

Electricity consumption grew by an annual average of 2% from 2008 to 2012, with the distribution of consumption by customer category remaining largely the same. Out of a total annual primary energy supply of 2,586 thousand tonnes of oil equivalent (ktoe), 1,372 ktoe are from natural gas, 688 ktoe are from nuclear power, 394 ktoe from petroleum products, 157 ktoe from hydroelectricity plants, and 1 ktoe from RES. Wind power from Lori-1 WPP and other renewable energy projects such as the Lusakert biogas plant represented around 0.03% of electricity production in 2012. Although Armenia imports nearly all of the fuels needed to meet its primary energy needs, it is a net exporter of electricity, with net exports of 27 ktoe. Primary energy supply chart of the country is given in Figure 1.

Hydropower and nuclear power are the main indigenous sources of energy. There are 9 major hydro power plants. The largest is the Sevan Hrazdan Cascade plant, which is 90% owned by United Energy System (UES) of Russia. The second largest hydro plant, the Vorotan facility, was acquired by US energy company in January 2014. Under the takeover agreement signed with the Armenian government, the New York-based group Contour Global is to pay \$ 180 million and invest \$ 70 million in the three plants making up the Vorotan Hydro Cascade.³

The Meghri hydropower plan, a joint project of Iran and Armenia, is currently under construction. The USD 2.3 bn plant will have a capacity of 130-140 MW and will be built by Iranian companies. Construction is expected to be completed in 2015.

There is one nuclear power plant (NPP). The Metsamor NPP was built in 1979 and has an installed capacity of 815MW but only 1 of its 2 units is operational and stands for 407.5 MW. Nuclear fuel is flown in from Russia. Although the government owns the plant, UES signed an agreement in 2003 to operate the facility. The plant was scheduled to close in 2016, but in September 2013 Russia announced an agreement to extend the life of the plant by ten years, and in May 2014 Russia agreed to a \$300 million loan for upgrading the plant to enable life extension to 2026.

² **Source:** Preparation of SREP Investment Plan for Armenia, Task 1 and 2 Report, 26 September 2013 <http://www.azatutyun.am/content/article/25246857.html>

In 2007, Armenia adopted a new energy strategy focusing on security of supply through diversification and the use of nuclear energy as well as renewable energy sources. Later in 2007, the energy minister announced a feasibility study for a new unit at Metsamor, the investigation being carried out with assistance from Russia, the USA and the International Atomic Energy Agency. The new plant was then expected to go on line about 2016.

In February 2009, the government announced a tender for a new 1000 MWe unit, the Armenia New Nuclear Unit (ANNU). In May 2009, Australian company Worley Parsons was chosen to administer the project, and a \$460 million management contract was signed in June. Legislation providing for construction of up to 1200 MWe of new nuclear capacity at Metsamor from one or more reactors was passed in June 2009.

In December 2009, the government approved establishment of Metzamorenergoatom, a 50-50 Russian-Armenian joint stock company set up by the Ministry of Energy and Natural Resources with Atomstroyexport, with shares offered to other investors. This is to build a 1060 MWe AES-92 unit (with a VVER-1000 model V-392 reactor) with a service life of 60 years at Metsamor. It would have two natural-draft cooling towers. In March 2010 an agreement was signed with Rosatom to provide the V-392 reactor equipment for it. In March 2011 the environmental assessment report was presented to the Ministry of Nature Protection, and in [October 2012 Revision 1](#) following public consultation became available.

In August 2010, an intergovernmental agreement was signed to provide that the Russian party will build at least one VVER-1000 reactor, supply nuclear fuel for it and decommission it. Construction was to commence in 2013 and was expected to cost US\$5 billion. The customer and owner of new reactors, as well as electricity generated, will be Metzamorenergoatom, and Atomstroyexport will be the principal contractor. Armenia undertakes to buy all electricity produced at commercial rates, allowing investors to have their capital returned, for 20 years. CJSC Metzamorenergoatom is to fund not less than 40% of the construction, and early in 2012 Russia agreed to finance 50%, though in late 2013 this was reported as 35%.

In May 2014 the government approved construction of the new reactor, starting 2018.⁴

2.1 Legal Framework in the field of Energy

2.1.1 Energy Law⁵

"Energy Law of the Republic of Armenia" was adopted by the Armenian Parliament in April 2001, to regulate interrelations between legal entities involved in the energy sector, electricity, heating and natural gas consumers pursuant to the law and the state bodies. Currently, the Law guarantees the market for electricity produced by all small hydropower plants (SHPPs, total capacity up to 10 MW per plant) in Armenia. According to this Law (Article 59, Clause 1.c), *"All electricity (capacity) generated at small hydro power plants, as well as from renewable sources of energy within the next 15 years shall be purchased pursuant to the Market Rules"*.

Some of the basic principles of the state policies for energy sector stated in the Law are as follows

- Enhancement of competition and efficient operation in the energy sector.
- Regulation on energy sector operations.
- Protection and balance of interests between consumers and economic entities.

⁴ <http://www.world-nuclear.org/info/country-profiles/countries-a-f/armenia>

⁵ www.parliament.am/law_docs/210301HO148eng.pdf

- Efficient use of domestic and alternative sources of energy, and the creation of economic and legal mechanisms to serve that purpose.
- Encouragement of investments, safety and environmental protection in the energy sector.
- Encouragement of scientific-technical progress and employment of new energy-efficient and energy-saving technologies, as well as encouragement of personnel training and re-training.
- Separation of the generation, transmission, and distribution system operators, etc.

2.1.2 Energy Efficiency and Renewable Energy Law⁶

According to the Energy Efficiency and Renewable Energy Law, ratified in December 2004, the principles of Armenian policy in energy saving and renewable energy are:

- Increasing the level of supply of indigenous renewable energy carriers to satisfy the energy demand of the economy;
- Implementation of energy saving strategies, as well as development and enforcement of legal and economic mechanism for the promotion of renewable energy,
- Ensuring increasing usage of renewable energy resources as well as the application and development of new renewable energy technologies aimed at its promotion,
- Ensuring competitiveness of renewable energy resources and protection/enforcement of the rights of businesses engaged in the area of renewable energy,
- Ensuring high priority of issues of environmental protection and efficient (economic) usage of natural resources while implementing measures/activities aimed at the development of energy saving and renewable energy, etc.

2.1.3 Water Code⁷

This Code, which has been adopted on 4 June 2002, establishes procedures to obtain water permit for hydro power plants. According to this Code water permit for a hydro power plant is given for 3 years at the first, but once the plant is operational or even if it is under construction, then the permit is extended for a much longer period. The purpose of this provision is to prevent people getting a water permit and then not proceeding to construct the project. However, land lease for the project outlined in the Land Code dated 2 May 2001 is not in synch with this provision because there are not such time limits for the land lease.

2.1.4 Energy Security Concept⁸

The Energy Security Concept of the Republic of Armenia was approved by the President in October 2013, outlining the main directions of energy security arrangements and stipulating the development of the Action Plan 2014-2020 within a short period of time. The document mentions development of renewable energy sources and increasing energy efficiency as one of the directions of ensuring energy security in the country.

2.1.5 Energy debates

In Armenia, Japan's nuclear accident has raised a debate over the safety of Metsamor nuclear power station which is also situated on an earthquake-prone zone, and prompted the Armenian

⁶ <http://www.parliament.am/legislation.php?sel=show&ID=2119&lang=eng>

⁷ www.parliament.am/legislation.php?sel=show&ID=1310&lang

⁸ <http://www.minenergy.am/en/en/2013-12-18-11-49-40>

government to invite an IAEA inspection to the plant. Metsamor currently provides more than 40% of the electricity in Armenia. The country suffered from severe electricity shortages during the time Metsamor was closed. Therefore, the nuclear plant is very important for Armenia in terms of energy production. Armenia plans to replace Metsamor with a new nuclear power plant at the same location. Since 2007, the EU provides assistance in nuclear safety through the Instrument for Nuclear Safety Co-operation (INSC), and the Armenian Ministry of Energy receives Commission assistance for the decommissioning of the ageing Medzamor nuclear plant. Projects range from “on-site assistance” – for example, making sure the plant operates safely until shutdown – to the development of alternatives to nuclear energy, such as hydro power, electricity and gas.

Chapter 3: Current situation with EE/RES

Armenia passed through an energy crisis in 1991-1995 as the result of its energy security loss what was the consequence of a conflict in the region and following an economic and fuel blockade by Azerbaijan and Turkey, as well as low self-sufficiency by Armenia’s own energy resources. This has caused an economic decline, environmental disruptions, and a decrease in the quality of life. In order to overcome the created situation, the re-opening of the Armenian Nuclear Power Plant, which was decommissioned after the 1988 earthquake, was necessary.⁹

Generally, Armenia can meet only 35% of the total demand for energy with its domestic resources and it is thus highly dependent on imported energy resources. It produces, however, a significant share of about 40% of the annual production of electricity from hydropower (2010). Energy efficiency within the Armenian economy is much lower than that of developed countries in the region. Therefore, in order to secure the sustainable development of Armenia, priority has to be given to the development of domestic energy resources and widespread implementation of energy efficiency throughout the economy. During the last decades a number of studies, strategy papers and legal documents were adopted in Armenia to ensure sustainable development of the economy and energy sector based on increasing energy efficiency and renewables.¹⁰

Armenia's **Energy Law**, which was enacted in 1997 and revised by the National Assembly in 2001 states among others (Article 5) that the main principles of the state policy in the energy sector are:

- Efficient use of local energy resources and energy renewables and the application of relevant economic and legal measures for that purpose;
- Ensuring energy security;
- Promotion of the energy independence of the republic, including the diversification of local and imported energy resources and ensuring maximal use of capacities; and
- Ensuring environmental security.

Armenia’s commitment to promote renewable resources relates to its need to diversify its energy resource base and reduce energy imports. The country has taken concrete steps to make renewable energy development part of its energy law and energy strategy. In 2004 legislation was passed on the Law of the Republic of Armenia on Energy Efficiency and Renewable Energy. The Public Services

⁹ http://www.lumes.lu.se/database/alumni/01.02/theses/hovhannisyan_karen.pdf

¹⁰ http://r2e2.am/wp-content/uploads/2011/07/National_Program_eng.pdf

Regulatory Commission of Armenia has set high tariffs for newly constructed small hydro power plants operating on natural water flows and other renewables.

Law on Energy Efficiency and Renewable Energy was adopted on November 9, 2004. It was amended in 2011, and another round of amendment is currently underway. The objective of this law is to identify mechanisms of state policy principles for development of energy efficiency and renewable energy and the mechanisms of their implementation, targeted at:

- Strengthening the economic and energy independence of the RA,
- Raising the economic and energy safety, energy system reliability of the RA,
- Creation of new industries and organization of services to promote development of the energy efficiency and renewable energy.
- Decrease negative impact on environment and health of people.

Towards implementation of the provisions of the Law on Energy Efficiency and Renewable Energy, **Armenian Renewable Resources and Energy Efficiency Fund** was created in 2006 with a main mission to facilitate investments in energy efficiency and renewable energy and provide an array of comprehensive assistance to project developers, investors, banks, condominiums, researchers and other stakeholders. It provides professional expertise to the government in issues related to green energy development strategies and legislation. The Fund continuously analyses situation identifying barriers and proposing solutions to relevant government agencies. It also established financing mechanism through a revolving lending tool, which finances energy efficiency and renewable energy projects through the banks and credit organizations.

National Programme on Energy Saving and Renewable Energy of the Republic of Armenia was developed in 2007 by the Research Institute of Energy within a USAID funded project with the main aim of setting the targets for the energy saving and renewable energy development in the country and outlining mechanisms of its implementation.¹¹

Renewable Energy Roadmap for Armenia was developed in 2011 by Danish Energy Management A/S within Global Environmental Facility (GEF) and World Bank (WB) funded project to identify the economically and financially viable potential of renewable energy (RE) in Armenia. It defines short (2013), mid-term (2015), and long-term (beyond 2020) targets for the development of RE as well as outlines specific steps towards achieving those targets. It includes milestones to allow regular tracking of progress towards the established goals.

According to the main results of the Armenian RE Roadmap project, the contribution of the renewable electricity in Armenia can increase by fivefold in 2020 in comparison to the present energy production from RE. In 2010, RE production generated 310 GWh, and it is forecasted to generate 740 GWh in 2015, and 1500 GWh in 2020. It is important to emphasize that the achievement of targets is much more dependent on politically implemented measures than on technical capabilities.

The findings of a comprehensive review of RE potential in Armenia have ranked electricity from small hydropower plants (SHPP, up to 10 MW) and solar hot water heaters as the most advanced renewable energy technologies (RET) and the most economical for Armenia in the short to medium-term, followed by grid connected wind farms and the use of heat pumps.

Photovoltaics, geothermal power, and biofuels, especially bioethanol from cellulosic feedstock, are ranked as more costly in today's prices and are not expected to be commercially viable in the short

¹¹ http://r2e2.am/wp-content/uploads/2011/07/National_Program_eng.pdf

to medium-term, but may play a more important role in the longer term, and in the development of RE high-tech industry.

Biomass was also considered for both heat and electricity production for the short term, under several conditions, including replanting of harvested trees and biofuels using fractionation process. In addition, hydrogen was considered as a possible fuel for transportation in the longer term. Finally, although not strictly a renewable resource, municipal solid waste in landfills was considered a practical source for generating methane for power production near municipalities.¹²

All these activities are indicative of prioritization of EE/RES issues in the country at the highest decision-making level. It is also to be mentioned that in May 2010 the government adopted a resolution on Science and Technology Development Priorities for 2010-2014 where Renewable Energy & New Energy Sources is one of the 6 priority fields.

Below is the brief description of the situation and development potential in separate RES sectors.

3.1 Hydropower

The hydro potential of Armenia has been evaluated to be about 21.8 billion kWh/year, including 18.6 billion kWh from large and medium rivers and 3.2 billion kWh from small rivers. According to the Renewable Energy Armenia webpage, the economically feasible hydropower potential is about 3.6 billion kWh, with 1.5 billion kWh already utilized. The remaining hydropower potential is to be developed during the next 15 years. As of 2012, there were more than 110 commercial size small hydropower plants (SHPP) operating in Armenia. About 60 of these have been developed and constructed in the past decade. There are also numerous small units that are operated by individuals to satisfy their own electrical needs. The forecast is that SHPP generation would grow from its current 5% penetration level of the total electricity generation to 10% within the next 10 years.¹³

3.2 Wind

The average annual wind velocity in Armenia is distributed unevenly in the range of 1.0 to 8.0 meters per second. In some regions, particularly in the Ararat Valley, strong mountain valley winds are quite common. For instance, during the summer months the velocity of these winds often reaches 20 m/s or more. Despite a relatively attractive wind regime in many parts of the country, the only operational wind power facility in Armenia today is the 2.6 MW Lori-1 pilot wind power project comprised of four 660 kW Iranian-assembled Vestas wind turbines. A second one, the Iran-Armenia Wind Farm, is under construction.

3.3 Biomass

Biomass energy in Armenia has the potential to provide significant power, if utilized. Armenia has reasonable areas of land covered by forests and lands for agricultural industry, including farming of plants and animals. These areas can potentially produce residues which could be used as fuel for biomass combustion or gasification, as well as biogas production through anaerobic digestion. Forest residues (slash from forest thinning or waste wood from sawmills) can provide a concentrated resource to be used as fuel for energy production. Agricultural residues can provide a range of residues, including crop residues (corn stover, nutshells, fruit tree branches, etc.) and animal wastes. The Lusakert Biogas Plant (LBP) is the first industrial size state of the art biogas plant based on

¹² <http://r2e2.am/wp-content/uploads/2012/07/Renewable-Energy-Roadmap-for-Armenia.pdf>

¹³ <http://www.armenianweekly.com/2013/07/25/electricity-production-in-armenia/>

organic wastes from animal farming constructed 26 kms from Yerevan with a loan from the Danish Industrialization Fund for Developing Countries. It can process up to 220 tons per day of liquid poultry manure coming from the nearby Lusakert Pedigree Poultry Plant.

3.4 Solar

Armenia is rich in solar energy resources, the utilization of which will reduce the need for imports of other energy sources. The average annual solar radiation is approximately 1,720 kWh/m² compared to the average annual European solar radiation of 1,000 kWh/m². Over a quarter of the territory of the country has solar resources with an intensity of 1,850 kWh/m².

3.5 Geothermal

Recent geologic surveys, funded by the World Bank, show that on the Syunik volcanic plateau, the Jermaghbyur region presents the best region for extracting geothermal power. The water temperature at 2500-3000 m is about 250o C. Using single flash technology this site can produce approximately 25 MW of electric power. In addition to Jermaghpyur, two more geothermal sites, Karkar and Gridzor are being investigated with the WB/Geo-Fund.

3.6 Energy Efficiency

The need to promote EE in Armenia is going to increase due to the fact that the upcoming decommissioning of the nuclear power plant requires the country to develop RE. Additionally, Armenia has been associated to the Copenhagen Accords under UNFCCC, and has committed in increasing energy production based on RE sources and improving EE in all sectors of the economy, including buildings and construction. Better use of the potential of EE will limit the dependency of the country on imported fuel and will significantly contribute to energy security of the country.

According to the National Programme on Energy Saving and Renewable Energy (ESRE), the potential for energy efficiency (EE) savings in Armenia is large, including 40% in building sector, 35-40% in food industry, while optimization of lighting was estimated to save 475 million kWh over the next 10 years.

Under the project financed through the Asian Development Bank loan (2013) it is planned to rehabilitate and upgrade four of seven HPPs in Sevan-Hrazdan Cascade Hydropower System, rehabilitation of water outflow canals in three plants and replacement of electrical equipment in the plants respectively.

Under the Power Transmission Rehabilitation Project (2012) financed by the Asian Development Bank loan it is intended to improve the efficiency and power supply reliability of the power system of Armenia. The project includes two major components: extension of dispatching control and data collection system (SCADA), and rehabilitation of eight existing 220 kV substations with respective replacement of aged transformers, circuit breakers and other equipment.

Chapter 4: Innovation situation in the energy sector

In the 1950-80s, the powerful scientific-technical and industrial potential was established and functioned in Armenia practically in all basic industrial branches of the former Soviet Union: chemistry and chemical technologies, electrical engineering, radio electronics, machine-tool industry, instrumentation technologies, construction industry, textile industry, and also rock mining industry

and metallurgy. By its production volumes, assortment and extensive cooperation networks Armenia was among the four most industrial republics of the former Soviet Union.

After the collapse of the Soviet Union as a common economic area, transport blockade and energy crisis, the basic components of Armenian industry have been destroyed except for a few chemical factories, mining and processing industry, electrical engineering and construction industry (cement plants, natural stone, copper and molybdenum mining, and ferroconcrete structures manufacturing, etc.).¹⁴

After several years of double-digit economic growth, Armenia faced a severe economic recession with GDP declining more than 14% in 2009, despite large loans from multilateral institutions. Sharp declines in the construction sector and workers' remittances, particularly from Russia, led the downturn. The economy began to recover in 2010 with 2.1% growth, and picked up to 4.6% growth in 2011, before slowing to 3.8% in 2012. Under the old Soviet central planning system, Armenia developed a modern industrial sector, supplying machine tools, textiles, and other manufactured goods to sister republics, in exchange for raw materials and energy. Armenia has since switched to small-scale agriculture and away from the large agroindustrial complexes of the Soviet era. Armenia's geographic isolation, a narrow export base, and pervasive monopolies in important business sectors have made it particularly vulnerable to the sharp deterioration in the global economy and the economic downturn in Russia. Armenia has only two open trade borders - Iran and Georgia - because its borders with Azerbaijan and Turkey have been closed since 1991 and 1993, respectively, as a result of ongoing conflict of Azerbaijan with Armenian populated Nagorno-Karabakh region. Armenia is particularly dependent on Russian commercial and governmental support and most key Armenian infrastructure is Russian-owned and/or managed, especially in the energy sector. The electricity distribution system was privatized in 2002 and bought by Russia's RAO-UES in 2005. Natural gas is primarily imported from Russia but construction of a pipeline to deliver natural gas from Iran to Armenia was completed in December 2008, and gas deliveries expanded after the April 2010 completion of the Yerevan Thermal Power Plant. Armenia's severe trade imbalance has been somewhat offset by international aid, remittances from Armenians working abroad, and foreign direct investment. Armenia joined the WTO in January 2003. The government made some improvements in tax and customs administration in recent years, but anti-corruption measures have been ineffective and the economic downturn has led to a sharp drop in tax revenue and forced the government to accept large loan packages from Russia, the IMF, and other international financial institutions. Armenia will need to pursue additional economic reforms and to strengthen the rule of law in order to regain economic growth and improve economic competitiveness and employment opportunities, especially given its economic isolation from two of its nearest neighbors, Turkey and Azerbaijan.¹⁵

Armenia has a very liberal economy. According to the Heritage Foundation Index of Economic Freedom, Armenia's economic freedom score is 68.8, which ranks it 39th in the 2012 index. Compared to the 43 countries in the European region, Armenia is ranked 19th, putting its score above the world and the regional averages. According to the World Bank, Armenia is ranked 37 out of 189 economies in Doing Business 2014. The Doing Business indicator sheds light on how easy or difficult it is for a local entrepreneur to open or run a small to medium-size business when complying with relevant regulations.

¹⁴ <http://www.reegle.info/countries/armenia-energy-profile/AM>

¹⁵ <https://www.cia.gov/library/publications/the-world-factbook/geos/am.html>

The 2013 Global Innovation index ranks Armenia 59th among 142 countries. The country comes second in the lower-middle-income group of countries, topped by Moldova (45th).¹⁶

Innovation infrastructure is among the least competitive dimension of Armenia's overall competitiveness performance. According to the World Economic Forum *Global Competitiveness Report 2013* Armenia ranks above 100th place among 148 economies in terms of quality of research institutes (106), company spending on R&D (109), university industry collaboration in R&D (107) and government procurement of advanced technology products (111).

By government resolution as of September 2006, the Ministry of Economy was recognized as authorized body responsible for development and implementation of innovation policy, in co-operation and coordination with other concerned ministries and organizations. On 17 February, 2011, RA Government approved the Concept Paper on the Initial Strategy of the Formation of Innovation Economy which is based upon the projects implemented by the Ministry of Economy of RA directed to the development of the sphere, as well as legal, business, educational, financial and innovation infrastructure building measures aimed at developing the national innovation system.

"National Center of Innovation and Entrepreneurship" (NCIE) among the operating organizations in the system of the Ministry of Economics plays an important role in the formation of an innovative policy of economy of the Republic. The NCIE realizes the incubation process of innovative ideas development, supporting the realization of necessary preparatory works for their commercialization, and also provides scientific-technical information and library services.¹⁷

The Ministry of Education and Science of RA elaborates and implements the policies of the Republic of Armenia Government in the education and science sectors.¹⁸ To improve the policy-making and better coordination in the field of S&T, in October 2007 the government made a decision on the creation of the State Committee of Science empowered to carry out integrated S&T policy in the country. This structure is subordinated to the Ministry of Education and Science, but with wider power of independent activity.¹⁹

In May 2010, the Government adopted the Strategy on Development of Science in Armenia, which outlined the state policy towards development of science in 2011-2020.

Based on this strategy, the Action Plan 2011-2015 was approved by the government in 2011 on the development of science in Armenia which incorporates the following targets for the stated period as follows:

- Improving the S&T management system and ensuring adequate conditions for sustainable development;
- Measures on increasing the number of young and talented specialists involved in research, education and technological development, upgrading of research infrastructure;
- Creating adequate conditions for the development of integrated science, technology and innovation system;
- Developing international cooperation in RTD.

One of the main positive aspects in the latest adopted policy documents is the existence of quantitative targets to measure the success of implementation of envisaged measures.

¹⁶ <http://www.globalinnovationindex.org/content.aspx?page=GII-Home>

¹⁷ <http://www.mineconomy.am>

¹⁸ <http://www.edu.am>

¹⁹ <http://scs.am/eng.php>

In May 2010, the government issued a resolution on Science and Technology Development Priorities for 2010-2014 in the Republic of Armenia. These priorities are stated to be as follows:

- Armenian Studies, Humanities and Social Sciences;
- Life Sciences;
- Renewable Energy, New Energy Sources;
- Advanced technologies, Information Technologies;
- Space, Earth Sciences, Sustainable Use of Natural Resources;
- Basic research promoting applied research of vital importance²⁰;

The National Academy of Sciences of Armenia (NAS RA) with around 35 affiliated research institutes and centers, and around 2000 research staff remains to be main R&D performing organization in Armenia. The Academy promotes and carries out fundamental and applied research in different scientific fields, as well as coordinates basic research carried out throughout Armenia.

The new Statute of the National Academy of Sciences of Armenia was approved by the government in May 2011, based on the Law on the National Academy of Sciences of Armenia, allowing the Academy to carry out wider business activities towards commercialization of R&D outcomes and creation of spin-offs. Decision was made on optimization of the NAS structure and creation of scientific/technological/production centers through amalgamation of institutes involved in close research activities to promote innovation.

In 2007, Science Development Foundation was created within the NAS RA with the main objectives:

- Supporting research projects with innovative potential;
- Supporting commercialization of research outcomes;
- Supporting infrastructure modernization projects;

In total there are around 90 research institutes in Armenia subordinated to the Academy and various ministries.

The higher education system in Armenia consists of 22 public institutions of higher education (IHEs) and over 70 private IHEs. From 2000 on, the system of higher education in the country started to reform itself along the lines of the European models as per the Bologna agreement. Unfortunately, there are no statistical data on the dynamics of R&D intensity in the university sector to analyze trends during recent years. However, based on general observations and personal interviews, it can be stated that university R&D, particularly in leading state universities, is increasing. The universities are more flexible in redirecting revenues from tuition fees to modernization of research laboratories and funding research activities.

Dramatic downsizing of R&D intensity, starting from the early-1990s after the collapse of the former Soviet Union, mostly affected branch and enterprise research institutes, which were mostly involved in applied research and were subordinated to local or Moscow-based industries or ministries. The vast majority of these enterprises have been privatized during last decades, and stopped or reoriented their activities by shutting down RTD divisions.

There are also a number of small enterprises involved in innovative R&D and high-tech production activities. Such enterprises could play an essential role in economic development of the country, but they face a number of problems, such as: 1) shortage of qualified specialists in the field of technology

²⁰ <http://www.scs.am/>

transfer, commercialization, and management, and lack of innovation support intermediary organizations; 2) low awareness in intellectual property related issues among businessmen involved in technological development; 3) lack of financial institutes and venture capital funds providing loans on acceptable conditions.²¹

The Ministry of Energy and Natural Resources of RA is the highest executive authority to elaborate and implement the policies in the energy sector. The Ministry includes in its structure the Research Institute of Energy with the main activity directions to be as follows:

- Research and development in power engineering,
- Design Engineering,
- Design of occupational safety laboratories,
- Development projects on operation of power systems,
- Development of optimization methods for power network and energy system operation,
- Development of power supply plans,
- Energy loss calculation in power networks,
- Energy saving projects,
- Forecast services for power engineering development of Armenia,
- Preparation of standard documents in power engineering,
- Research in power engineering,
- Research in renewable energy.

By the decision of the government, Armenian Renewable Resources and Energy Efficiency Fund was created in 2006 with a main mission to facilitate investments in energy efficiency and renewable energy and provide an array of comprehensive assistance to project developers, investors, banks, condominiums, researchers and other stakeholders.

During the last years the Armenian Government adopted several conceptual and legislative documents directed to the creation of the innovation system, though these measures can be considered as initial steps towards the development of a legislative framework and improvement of the information support and institutional basis of the innovation system. The issues of effective management of innovative resources, modernization of S&T basis, introduction of incentives for innovative companies, and attraction of private investments need to be still addressed adequately. The adopted legislative measures need to be supported by adequate concrete actions and programmes directed towards forming the national innovation system. Up until recently they had more of a declarative and fragmented character and were not supported by adequate financial commitments and tailor-made decisive actions consistent with general economic development trends.

It is to be mentioned that R&D intensity (GERD/GDP ratio) has decreased dramatically in Armenia since the collapse of the former Soviet Union, dropping from 2.5% in 1990 to around 0.25% in 2012. This decline is reflected also in the number of researchers and research institutes, which decreased nearly fourfold and twofold, respectively. Though, while speaking about last years it can be mentioned that some stabilization and diversification of R&D funding has taken place via

²¹ INNO-Policy TrendChart - Policy Trends and Appraisal Report, Armenia, EC

implementation of the following national funding mechanisms, implemented via State Committee of Science:

- Basic funding;
- Thematic (project based) funding;
- Goal oriented project funding;

Among recent initiatives to promote research-industry cooperation, a new funding programme for research projects, launched by the SCS RA in 2011, with a requirement for research institutes to build partnership with an industrial enterprise in a project proposal and 15% co-funding by this industry partner could be mentioned. In 2013, the industrial partner co-funding was increased up to 25%.

New Young Researchers Support and Infrastructure Programmes have also been launched recently which reflect the positive tendencies in S&T and Innovation system.

Unfortunately, no statistics are available on business expenditure on R&D in Armenia, though from personal considerations and various reports it can be estimated to be very low and insignificant.

There are no specific programmes focusing only on energy sector, but all these programmes are open for energy research as well, including RES. Screening of funded national research projects for 2010-2013 showed that there have been very few projects in energy field which is indicative that prioritization of RES as research topic doesn't imply any specific support mechanism.

Amongst other government initiatives towards creating favorable business environment it can be mentioned the establishment of the Armenian Development Agency (ADA) in 1998 to facilitate foreign direct investments and promote exports. ADA acts as "one-stop-shop" agency for investors assisting them in setting up their business in Armenia, helping in project implementation, performing a liaison role with the Government, providing information on investment opportunities in the country, as well as investment related regulations and laws. In its export promotion activities, ADA helps to find markets for products, undertakes market studies and seeks out partners for joint ventures aimed at increasing the volume of exports and development of Armenian enterprises. ADA coordinates the work of the Secretariat of the Business Support Council, which provides an effective mechanism to channel issues of concern in the Business Community to the Government, and the Secretariat of IT Development Support Council of Armenia. The Business Support Council of Armenia was established in 2001 and focuses on issues of investment promotion and assistance to entrepreneurship, developing measures aimed at the elimination of administrative barriers, and supporting the formation of a favorable legislative framework for the business environment.

Another major structural initiative of the government was the establishment of Small and Medium Entrepreneurship Development National Centre of Armenia (SME DNC of Armenia) in 2002. The SME DNC of Armenia was the first national body created to implement state support to small and medium-sized enterprises (SMEs) and programmes directed towards the development of the sphere, as well as to facilitate links between SMEs and other state support organizations. The main goals of the SME DNC are as follows:

- Providing support to start-up and operating SMEs;
- Increasing the efficiency and competitiveness of SMEs;
- Expanding the financing opportunities for SMEs;
- Promoting innovations and support to new technologies introduction;
- Encouraging external economic activities of SMEs;

SME DNC of Armenia provides support to SMEs through the following programs: 1) Loan guarantees provision; 2) Partial subsidizing of credit interest rates; 3) Information and consulting support; 4) Goods and services market promotion; 5) Start-up business support; and 6) Programme for implementation of R&D activities for introducing innovations, new technologies and products.

As a private initiative, the establishment of Viasphere Technopark, a state-of-the-art technology park, operating in Yerevan since 2001 can be mentioned. It provides infrastructure to technology companies worldwide looking to extend their core development offshore. Viasphere Technopark is currently hosting several successful US-based subsidiaries developing advanced software in a variety of fields. In Armenia, Viasphere Technopark interacts with technical universities and institutes in areas of advanced research.²²

The shortage of intermediary organizations – such as technology transfer centers, business incubators and technoparks aiming to bridge public RTD and business communities as well as support knowledge commercialization activities – is one of the major bottlenecks of the Armenian innovation system. The existing scientific system of Armenia does not encourage scientific research outcomes to be utilized. Some technology assessment and offer development activities are carried out by ADA and SME DNC. A few technoparks have been created and decisions have been adopted to create further ones during recent years under state or private initiatives, which mainly provide infrastructure for start-ups and do not focus on support to commercialization of R&D outcomes.

A number of civil society organizations, including non-governmental organizations and various associations, try to get involved and influence innovation policy development activities. Amongst the most active ones can be mentioned the Union of Manufacturers and Businessmen (Employers) of Armenia, whose mission is to represent and protect the collective interests of businessmen, and improve the business and legal environment in the country.

The Intellectual Property Agency of the Republic of Armenia was established in 2002 through the merger of the Patent Office and the National Copyright Agency. Currently, intellectual property related matters in Armenia are regulated by the Civil Code, law on copyright and neighboring rights, law on patents, law on trademarks, service marks and appellations of origin, law on protection of topographies of integrated circuits, law on protection of the economic competition as well as by a number of international treaties. Armenian legislation on intellectual property has been harmonized with the requirements of the Agreements on Trade Related Aspects of Intellectual Property Rights (TRIPS Agreements). Since 2003, Armenia is a member of the World Trade Organization (WTO).

A further instrument to support innovation in a broader sense is the approach of Free Economic Zones (FEZ). The overall aims of the FEZ is the promotion of foreign investments, the development of new and advanced technologies, the increase of exports from Armenia, and the generation of employment and economic growth. Armenia's first FEZ opened in July 2013 based in the Yerevan Computer Research and Development Institute (YCRDI) and the Mars motors manufacturing company. The FEZ is an example of a combined approach of supporting inward-investment, export-orientation and high-tech development. A special technological focus of FEZ Mars and YCRDI is on R&D and innovation in the fields of electronics, precision engineering, pharmaceuticals and biotechnology, ICT, alternative energy, industrial design, and telecommunications. "One-stop-shop" services are offered to all zone residents who can enjoy tax benefits, exemption from import and

²² <http://viasphere.com/technopark/tenants.htm>

export duties, profit tax, property tax, etc. As far as this is a relatively new approach in Armenia, it would be difficult to assess the economic effects of this initiative.

Granatus Ventures (GV), the first venture capital fund in Armenia, was launched in 2013. It is focused on investing in and helping start-ups achieve success by leveraging international value chains, the Armenian diaspora, and a global network of advisors, mentors, and partners.

All these innovation support initiatives and structures are also not energy specific but surely cover energy, and in particular, EE/RES priorities as well.

All the policy and strategy documents adopted during last decades directed to the regulation and the development of S&T and Innovation in Armenia, stress the importance of the development of international cooperation in the field of sciences and technology, and better positioning of the country in the international research and development environment.

In particular, the Law on Scientific and Technological Activity, the Strategy on Development of Science and Action Plan 2011-2015 on the development of science in Armenia include the development of international cooperation in RTD as one of the main challenges.

As of February 2013, a total of 146 eligible proposals were submitted in response to 381 EU FP7 calls for proposals involving 159 applicants from Armenia. A total of 45 proposals were retained for funding from Armenia requesting EUR 3,2 million EC financial contribution. None of these projects were in the field of energy. Within FP7 Research to Innovation call for proposals another project focusing on energy efficiency was retained for funding (INNOVER-EAST: Building a more effective pathway leading from research to innovation through cooperation between the European Union and Eastern Partnership countries in the field of energy efficiency) where Science Development Foundation of NAS RA is a partner from Armenia. Surely, there are good opportunities for synergy and cooperation between ENER2I and INNOVAR-EAST Projects.

During the last decade a number of EE/RES oriented projects have been implemented in the country by various stakeholders in partnership with international organizations. Below are brief descriptions of such projects:

The Renewable Energy Project (REP), bearing TF-053910 index of Global Environmental Facility (GEF) and World Bank (WB), started in 2007 by Renewable Resources and Energy Efficiency Fund. REP consisted of two main components – credit and grant components. REP financial funds were provided for supporting the construction of Small scale Hydro Power Plants (SHPP-s) in Armenia. The total REP credit package made about USD 15 mln. of which WB portion made USD 5 mln. Another amount of USD 3 mln. made the portion of Gafeschyan Family Fund (USA) and USD 7 mln. was the portion of EBRD. At the expense of these funds 26 SHPP construction projects have been carried out with 43 MW total capacity and about 160 thousand kWh annual production. Already 12 power plants out of the mentioned are in operation at present and the rest are in construction and licensing stages. The successful implementation of REP credit component set a good example for the start of several similar projects in Armenia: Armenian-German Fund, ArmCEEF European Project, IFC Project etc., studies of fundamental importance in RE sector, studies on resources, evaluation of various RE technology potentials and perspective availability, etc. Upon the start of the works about 20 separate expensive international projects and special studies have been implemented within the frame of REP for most various directions of renewable energy (RE) in Armenia. Around 124 leading experts, of which 105 local and 19 foreign experts (from USA, Denmark, Switzerland, Sweden, Russia) have participated in these works. The conducted studies include such RE sectors like: SHPP-s, solar photovoltaic energy, bio-ethanol production, geothermal energy, development of norms and

standards for some technologies of this sector, development of RE geographical-informative system, assessment of peak electricity potential and hydro-accumulative station perspective availability for Armenian and regional markets, etc. The following studies implemented within REP framework were of special applicative importance, such as: development of the microprocessor-based relay protection system for energy absorption increase from RE sources, development of its estimated methodology and norms/standards (Project “Support to energy system regulation and protection in Armenia for energy absorption from RE sources”), as well as development of the Project for Emergency systemic automatics securing the safety of RE stations and reliability and efficiency of the works in the Armenian 2010-2016 energy system.²³

Armenia Renewable Resources and Energy Efficiency Fund started the WB supported Energy Efficiency Project on August 10, 2012, the objective of which is to reduce energy consumption in public and municipal buildings and in street lighting systems. Within the project energy saving measures have been implemented in schools and other educational institutions, kindergartens, hospitals, administrative, cultural and residential buildings.

The Fund is involved in BSBEPP-Black Sea Buildings Energy Efficiency Plan Project (2013-2015) within EU funded Black Sea Joint Operation Programme with the overall objective of strengthening the administrative capacity of local authorities and exchange good practice knowledge in energy efficiency in buildings.²⁴

The European Bank for Reconstruction and Development (EBRD) initiated Armenian Sustainable Energy Financing Facility (ArmSEFF) project to assist in the realization of renewable energy project ideas. This credit line is meant for Armenian private businesses of all scale and sectors as well as individuals who intend to invest in EE/RE projects.²⁵

Since November 2010, a four-year East-Invest project is being implemented which is a regional investment and trade facilitation project for the economic development of the Eastern Neighborhood region, launched in the framework of the European Eastern Partnership initiative. It targets Business support organizations and SMEs from the 6 Eastern Partnership countries (Armenia, Azerbaijan, Belarus, Georgia, Republic of Moldova, Ukraine), who have potential for developing mutual cooperation and investment relations with the European Union. One of the six thematic focuses of the initiative is the alternative energy. Its main objectives are:

- To promote and facilitate investment and economic cooperation at large between the EU and Eastern Partnership countries, and also between the 6 target countries.
- To create the “East Alliance”, mobilizing business organizations from both sides to engage in a sustainable partnership and dialogue both within the private sector and towards the public authorities.
- To develop concrete activities that will generate immediate results for SMEs in the region.²⁶

The Institute of Geological Sciences of NAS RA is a partner in “CO2 Capture and Storage” Caucas-CCS Project together with Karlsruhe Institute of Technology (Germany) and Tbilisi State University (Georgia) which started in 2012. The project was funded within FP7 BS-ERA Net Project Pilot Joint Call for proposals.

²³ <http://r2e2.am/en/2011/06/potential-by-regions/>

²⁴ <http://bsbeep.com/activities/ga-2/>

²⁵ <http://armseff.org/>

²⁶ <http://www.east-invest.eu/en/about-east-invest>

UNDP is supporting the Ministry of Nature Protection in preparation of the National Communications under UN Framework Convention on Climate Change including the development and publication of Greenhouse gases inventory of Armenia, which is essential for assessment of mitigation potential and attraction of foreign investments and technology transfer in energy sector. UNDP supported Ministry in calculating and publishing the national electrical grid emission factor for 2009, 2010, 2011, 2012, which is important data for Clean Development Mechanism Projects under implementation in Armenia (3 small hydroelectric plants, biogas plant, and landfill gas)²⁷.

UNDP assisted Ministry of Energy and Natural Resources in assessment of national needs and gaps under “Sustainable Energy for All” Initiative of UN Secretary General thus allowing Armenia to join this Initiative among 58 other countries before the Rio+20 Summit.

Starting from 2005 UNDP is assisting Ministry of Nature Protection in implementation of three large scale projects with Global Environment Facility funding (USD 5,75 mil.) aimed at the promotion of energy efficiency in heating, building and lighting sectors. More than 12 million direct foreign investments were attracted in the energy efficiency projects initiated so far.

Starting from 2010 under coordination of the RA Ministry of Nature Protection and RA Ministry of Urban Development the GEF financed “Improving Energy Efficiency in Buildings” Project. Project has supported Armenia in the development and promotion of the energy efficient building technologies, building materials and construction practices. The support being provided by the project aims at development of new regulations (EE building codes and standards) the training of professionals, demonstration of integrated building design approach and stimulating manufacturing of new EE materials and equipment.

Benefits of energy efficient design were demonstrated on the example of 3 pilot buildings. Energy efficiency and building thermal physics laboratories were established in Armenia as well as support was provided for testing and certification of the locally produced insulation materials.

The UNDP-GEF “Green Urban Lighting Project” started in 2014 is aimed at state of the art technology transfer to Armenian municipalities and demonstrating benefits of modern illumination technologies and contributing to the reduction of municipal energy costs related to street lighting. UNDP in cooperation with other donors assisted the **Energy Strategy Center** of the Research Institute of Energy in organization of International Conferences on Renewable Energy and Energy Efficiency. Starting from 2002 five conferences were organized and the last one organized in October 2013. The Conferences provide opportunity to scientists, business and policy makers to exchange opinions and present developments in the sector. The Proceedings of the Conferences were published.

Several EE/RES projects have been implemented through EU funded INOGATE Programme – an international energy cooperation programme between the EU and partner countries of Eastern Europe, the Caucasus and Central Asia. The partners involved agreed to work together toward achieving the following four major objectives:

- Converging energy markets on the basis of the principles of the EU internal energy market taking into account the particularities of the involved countries;
- Enhancing energy security by addressing the issues of energy exports/imports, supply diversification, energy transit and energy demand;

²⁷ www.nature-ic.am

- Supporting sustainable energy development, including the development of energy efficiency, renewable energy and demand side management;
- Attracting investment towards energy projects of common and regional interest.

Below is the list of INOGATE Projects implemented during the last years with Armenian participation:

Project Title	Project Period	Energy Theme	Countries
Energy Saving Initiative in the Building Sector in the Eastern European and Central Asian Countries (ESIB)	01/01/2010 - 01/02/2014	Renewable Energy, Sustainable Energy Development, Investment Attraction	Armenia, Azerbaijan, Belarus, Georgia, Kazakhstan, Kyrgyzstan, Moldova, Tajikistan, Turkmenistan, Ukraine, Uzbekistan
Supporting Participation of Eastern European and Central Asian Cities in the 'Covenant of Mayors'	20/09/2011 - 20/07/2015	Energy Efficiency, Renewable Energy	Armenia, Azerbaijan, Belarus, Georgia, Kazakhstan, Kyrgyzstan, Moldova, Russian Federation, Tajikistan, Turkmenistan, Ukraine, Uzbekistan
INOGATE Technical Secretariat and integrated programme in support of the Baku Initiative and the Eastern Partnership energy objectives	01/02/2012 - 31/01/2015	Oil, Gas, Electricity, Energy Efficiency, Renewable Energy, Climate Change, Convergence of Energy Markets, Energy Security, Sustainable Energy Development, Investment Attraction	Armenia, Azerbaijan, Belarus, Georgia, Kazakhstan, Kyrgyzstan, Moldova, Tajikistan, Turkmenistan, Ukraine, Uzbekistan

Table 1: INOGATE Projects²⁸

Generally, lack of financial resources restricts mobility programmes for Armenian researchers, as well as the attraction of foreign scientists. Weak infrastructure is another major barrier, both from the point of view of up-to-date research equipment, and housing and working conditions for researchers from abroad. Many Armenian researchers and innovators have also emigrated, attracted by access to modern infrastructure and higher salaries. While this weakens the innovative capacities in the country, it also creates opportunities for cooperation between the scientific diaspora and researchers in Armenia. Language is to some extent still a barrier, but the younger generation possesses the required language skills for international cooperation.

²⁸ Source: <http://www.inogate.org>

Chapter 5: Overview of critical stakeholders

The **Ministry of Energy and Natural Resources of RA** is the highest executive authority to elaborate and implement the policies in the energy sector including system planning and investment planning for state-owned entities. The Ministry objectives include also provision of energy efficiency and renewable energy sector policy development and implementation, provision of the state policy of state technical control in the power sector and energy consumption, conducting supporting research, and obtaining and facilitating support from international organizations.²⁹

The **Public Services Regulatory Commission (PSRC)** performs regulatory operations in energy, water and telecommunication sectors, including:

- Regulating tariffs, service quality and licensing
- Overseeing compliance with licensee obligations
- Mediating disputes between licensees and customers
- Defining electricity market rules
- Setting, monitoring and enforcing service quality standards³⁰

The **Ministry of Nature Protection of RA** is the highest executive authority for coordination of implementation of the activities aimed at meeting the commitments of the Republic of Armenia under UN Framework Convention on Climate Change.

As a Non-Annex I party to the UNFCCC Armenia does not have quantitative commitments for reducing GHG emissions. However, being a party to the convention and supporting its objectives, as well as taking into account that the mitigation activities are in line with the economic, energy and environmental objectives of the country, Armenia has declared willingness to take certain quantitative limitations in greenhouse gas emissions by consistently reducing energy intensiveness of its GDP in case adequate financial and technical assistance will be provided under Convention mechanisms.³¹

The **Armenian Renewable Resources and Energy Efficiency Fund** was created in 2006 with a main mission to facilitate investments in energy efficiency and renewable energy and provide an array of comprehensive assistance to project developers, investors, banks, condominiums, researchers and other stakeholders.³²

The Ministry of Energy and Natural Resources includes in its structure the **Research Institute of Energy** with the main mission of carrying out applied and analytical studies. The **Energy Strategy Center within the Institute** aims to promote and expedite the implementation of projects and activities in the energy sector. Areas of expertise: Advice on specific energy issues, energy auditing, promotion of technology, dissemination of information, implementation of RES projects, consulting, support in project implementation for energy efficiency, CHP, small wind farms, solar energy, biomass.³³

The **National Academy of Sciences of Armenia** (NAS RA) with around affiliated 35 research institutes and centers is the main R&D performing organization in Armenia. The Academy promotes and carries

²⁹ <http://www.minenergy.am>

³⁰ <http://www.psrc.am/am>

³¹ <http://www.mnp.am>

³² <http://www.r2e2.am/enversion>

³³ <http://www.energinst.am/eng/enrazkentr.htm>

out fundamental and applied research in different scientific fields, as well as coordinates basic research carried out throughout Armenia. Renewable and alternative energy related research is being carried out in several research institutes of the NAS RA.³⁴

Energy related research is being carried out in some departments and laboratories of **Yerevan State University** (Department of Physics of Semiconductors and Research Center of Semiconductor Devices and Nanotechnologies), **State Engineering University of Armenia**, **American University of Armenia**, and **Armenian-Russian (Slavonic) University**.

The **National Competitiveness Foundation of Armenia** is a public-private partnership (drawing on international business executives of Armenian descent) with the objective to attract FDI supporting economic development and international competitiveness.³⁵

The main mission of the **Chamber of Commerce and Industry of Armenia** is carrying out activities towards improving general business environment, promotion of export and investments, as well as competitive product manufacturing, and support to SMEs.³⁶

The activities of the **Union of Manufacturers and Businessmen (Employers)** of Armenia are directed to the promotion of the private sector, the creation of favourable conditions for business development, and the support to creation of market infrastructures.³⁷

Republican Union of Employers of Armenia is another business support non-governmental organization aiming at improving the business environment and advocacy of business community.³⁸

Armenian Development Agency (ADA) acts as a “one-stop-shop” agency for investors assisting them in setting up their business in Armenia, helping in project implementation, performing a liaison role with the Government, providing information on investment opportunities in the country, as well as investment related regulations and laws. In its export promotion activities, ADA helps to find markets for products, undertakes market studies and seeks out partners for joint ventures aimed at increasing the volume of exports and development of Armenian enterprises.³⁹

Small and Medium Entrepreneurship Development National Centre of Armenia (SME DNC) provides support to SMEs through the following programs: 1) Loan guarantees provision; 2) Partial subsidizing of credit interest rates; 3) Information and consulting support; 4) Goods and services market promotion; 5) Start-up business support; and 6) Programme for implementing R&D activities for introducing innovations, new technologies and products.⁴⁰

Engineering Academy of Armenia (EAA) was established in 1992 and is a non-governmental organization with a main mission of promoting research and innovation in applied science fields including energy.⁴¹

ECOATOM LLC is a company created in 1991 involved in research and development of industrial technologies in various fields, including renewable energy sources, hydrometallurgy, processing of nuclear wastes and recycling of industrial wastes.

³⁴ <http://sci.am>

³⁵ <http://www.cf.am/eng/index.php>

³⁶ <http://www.armcci.am/>

³⁷ <http://www.umba.info.am/>

³⁸ <http://www.employers.am/>

³⁹ <http://www.ada.am/>

⁴⁰ <http://www.smednc.am/>

⁴¹ <http://www.eaa.academy.am>

CONTACT-A LLC is a private renewable energy company, established in 1993 on a basis of former Yerevan Solar Institute having experience in research, development and implementation of various photovoltaic (PV) cells, modules, and systems for autonomous and grid connected applications as well as in manufacturing of solar collectors and implementation of solar water heating systems.⁴²

BARVA Innovation Center was established in 2005 specializing in R&D and manufacturing of various high-tech innovative products for different industry sectors, including agriculture, energy, utilities, etc. The Center is involved in R&D and manufacturing of renewable energy systems such as biomass briquetting equipment (straw, cane, wood chips, etc.), high efficiency biomass boilers, mini thermal co-generation power plants on syngas from biomass, parabolic trough concentrated solar power systems for waste heat applications and generation of electricity and heat.⁴³

Transistor Plus Ltd, an engineering company involved in clean energy technologies. It carries out design, installation and maintenance of renewable energy systems including bioenergy, solar thermal and PV. It also manufactures components for solar energy systems (PV modules, DC to AC power inverters, solar tracking systems, UPS).

Viasphere Technopark is a state of the art commercial technology park in Yerevan, providing infrastructure to local start-ups and companies worldwide looking to extend their core development offshore. In addition to providing a vital bridge to Silicon Valley, USA, Viasphere Technopark provides the facilities, infrastructure and support services to companies for cost effective speed-to-market and scalability.

Chapter 6: Analysis

Armenia has adopted a policy of sustainable economic development, which assumes harmonized growth for each branch of the economy. Under these conditions, the energy sector is the most important sector for growth of the society as its qualitative and quantitative development determines the degree of Armenia's level of development and wellbeing of citizens.

Armenia can meet only 35% of the total demand for energy with its domestic resources, thus it is highly dependent on imported energy resources. In addition, energy efficiency within the Armenian economy is much lower than that of developed countries. Therefore, in order to secure the sustainable development, priority must be given to the development of domestic energy resources and widespread implementation of energy efficiency throughout the economy.

Under these circumstances, the government's strong interest in developing renewable sources of energy is evident. Renewable energy cannot completely substitute for the contributions of nuclear and thermal energy, but they can be an increasingly important component of the electricity mix. As such the Law on Renewable Energy and Energy Efficiency established a legal framework to facilitate development of RES, and specified that all renewable energy produced is to be purchased by the electricity distribution company. The regulator for the power industry, the Public Service Regulatory Committee (PSRC) has set attractive tariffs for newly constructed SHPPs, and wind and biomass plants, and has stipulated that the electricity off-take and these tariff rates will apply for 15 years from the date of issue of an operating license for a new plant.

Armenia has renewable energy resources that can already compete with conventional resources in the generation of electricity. Most of the viable projects implemented so far are in small hydropower

⁴² <http://www.contact-a.am/index.html>

⁴³ <http://www.barva.am/>

sub-sector. As of 2012, there were more than 110 commercial size small hydropower plants (SHPP) operating in Armenia. About 60 of these have been developed and constructed in the past decade. There are also numerous small units that are operated by individuals to satisfy their own electrical needs. The forecast is that SHPP generation would grow from its current 5% penetration level of the total electricity generation to 10% within the next 10 years.

Despite a relatively attractive wind regime in many parts of the country, the only operational wind power facility in Armenia today is the 2.6 MW Lori-1 pilot wind power project, comprised of four 660 kW Iranian-assembled Vestas wind turbines. A second one, the Iran-Armenia Wind Farm, is under construction. The national target for wind power is 500MW of grid connected capacity by 2025.

Lusakert Biogas Plant (LBP) is the first industrial size state of the art biogas plant based on organic wastes from animal farming constructed at 26 km distance from Yerevan under the loan from the Danish Industrialization Fund for Developing Countries. It can process up to 220 ton per day of liquid poultry manure coming from nearby Lusakert Pedigree Poultry Plant. Total energy production can amount for up to 14 GWh per year. It is one of few projects in Armenia formally certified by UNFCCC under the Clean Development Mechanism (CDM).⁴⁴

Innovative research in the field of development of new energy sources is underway in several Armenian institutions.

At Yerevan State University (Department of Physics of Semiconductors and Research Center of Semiconductor Devices and Nanotechnologies-DPS&NT) a team of scientist has been involved in photovoltaic research for many years and manufactured a PS layer as the appropriate antireflection coating (ARC) on common (industrial) solar cells instead of conventional ZnS ARC and compared their parameters.⁴⁵

Improved hydro-wind power system with higher efficiency is suggested by the researchers at the Institute of Radio-Physics and Electronics (IRPhE) of NAS RA. Researchers of the IRPhE also carry out research on development of thin film CIGS solar cells on specially synthesized non-conducting perlite glass-ceramic substrates.

The Institute of Geological Sciences and the Institute of Geophysics and Engineering Seismology of NAS RA are involved in studies on identification of geothermal sites in Armenia. Researchers at the Institute of Geological Sciences have started studying the possibility of using the method of biodiesel production from microalgae.

In the Institute of Chemical Physics of NAS RA high efficiency technological processes for synthesis of hydrides of transition metals are developed. Self-propagation high-temperature synthesis (SHS) method of hydride production has essential advantages: it is low energy consuming, quick, single stage, wasteless, safe and environmentally pure process.

“Ecoatom” Company developed a simple method for obtaining hydrogen to be used in car engines by magnesium and water. A chemical reaction of mixing magnesium and water results in the production of hydrogen, magnesia and heat. This method is well known, but the revolutionary difference is the relatively low cost of magnesium produced by a new technology.⁴⁶

⁴⁴ <http://www.lbp.am/index.php>

⁴⁵ http://www.r2e2.am/documents/english/solar_task1_eng.pdf

⁴⁶ www.ada.am/files/98/publications/Armenwal.pdf

Specialists of BARVA Innovation Center and Engineering Academy of Armenia (EAA) are involved in research to develop a co-generation plant using syngas produced from biomass or other organic wastes. It makes possible to re-purpose the carbon content in biomass and conventional solid waste products into syngas, and then it can be turned into electricity at a low cost with zero CO₂. Research is also underway on the development of parabolic trough concentrated solar thermal (CSP) power station (150-300KW). CSP plants use steam to produce energy like conventional steam power plants. The difference is that CSP plants use emission-free clean solar radiation to produce heat instead of fossil or nuclear fuel.

Among other innovative research projects suggested by EAA, the design and construction of solar pond for solar energy storage with application of new method of thermal energy conversion into electric power could be mentioned which has been elaborated and patented by the authors.

The study carried out by Danish Energy Management in the frame of GEF funded Renewable Energy project "Development of PV Industry Potential in Armenia" (August 2008) states that there is an extensive experience in PV technology in Armenia but at the moment there is no significant practical activity in this area.

A large number of R&D tasks have to be undertaken to meet the common targets across all PV technologies for the short term (up to 2013) and medium term (up to 2020).

Short-term: In the present economical and global PV market situation Armenia should exploit business opportunities along the supply chain, e.g. gases (trichlorsilane and others) or parts for equipment manufacturers. In parallel Armenia has to develop their human basis, especially on the R&D side to sustain future local business development in PV. Establish collaboration through joint activities with European partners from R&D and industry to develop a local industry. By joining forces and competencies the collaborations enable a critical mass for manufacturing and surviving in the PV business.

Medium-term: In the next two to four years Armenia can gather important know-how and collaborations to understand and identify their position for establishment of the future highly profitable and fast growing PV business.

Long-term: PV should become part of the future national energy policy, with respect to its future contribution to energy security and environmental and social benefits. A commitment from the Government and a clear long-term strategy will develop a local market and create local business opportunities, which help to learn and build up the capacity necessary for the local enterprises.

Most importantly the following should be addressed:

- to involve all relevant stakeholders and decision makers;
- to have continuity and long-term action plan;
- to improve technology transfer;
- to focus and coordinate R&D efforts in a national PV R&D roadmap;
- to roll out a capacity building programme to emphasize manufacturing issues and market development;
- to develop human resource basis through dedicated education programs;
- to improve funding/incentives for R&D and PV business start-ups;
- to provide attractive incentives for PV business start-ups; and
- to establish a National PV Industry Association responsible for lobbying Government

- and to coordinate a national PV industry and market roadmap.⁴⁷

At present, the existing support mechanisms for EE/RE projects are mainly funds provided by donor agencies for on-lending to small hydro or wind power facilities.

Based on the aforementioned, below we tried to make a SWOT analysis of the innovation system with some focus on local energy sector and its innovative capacities.

Strengths	Weaknesses
<ul style="list-style-type: none"> • Adoption of several legal and strategic documents towards creation and development of innovation system and the promotion of EE/RES • Creation of innovation and EE/RES promotion structures (SME DNC, RREEF, etc.) 	<ul style="list-style-type: none"> • Poor development of innovation support infrastructure and intermediaries • Extremely low level of R&D expenditure and negligible level of share of business sector in it • Limited role of business subsystem in the innovation process • Lack of incentives for the stimulation and growth of innovative and science-intensive SMEs and spin-offs
Opportunities	Threats
<ul style="list-style-type: none"> • Launching of new programmes to promote research-industry cooperation • Strong Diaspora ready to bring new knowledge and investments in case of favourable conditions 	<ul style="list-style-type: none"> • Adopted innovation policy documents and measures are not based on the strategic economic development priorities of the country • R&D system and infrastructure remain nearly unchanged and far away from real economic and social needs of the country • Environmental regulation and enforcement is not uniform for all RE technologies

Table 1: SWOT analysis of the innovation system in Armenia

Ener2i project with a planned wide range of activities, including analytical reports on the research and innovation situation and players in EE/RES in EaP countries, and further expert workshops with the participation of representatives of concerned stakeholders are surely to contribute to highlighting the existing barriers and derive recommendations for tackling them. Moreover, the innovation voucher scheme, brokerages, expert workshops and twinning between EaP and EU partners could be a good tool for local start-ups and innovative SMEs to raise awareness on available innovative research/technologies, to find partners for joint projects and to make a step forward to commercialization of available research outcomes.

⁴⁷ http://www.r2e2.am/documents/english/solar_task1_eng.pdf

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