AMERICAN UNIVERSITY OF ARMENIA

ENERGY SECURITY OF ARMENIA: CHALLENGES AND OPPORTUNITIES

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Table of Contents

List of Tables

List of Abbreviations

AEN	Armenian Electricity Network
AGRI	Azerbaijan, Georgia, Romania Interconnection
AMD	Armenian Dram
AUA	American University of Armenia
CDM	Clean Development Mechanism
CIS	Commonwealth of Independent States
CJSC	Closed Joint Stock Company
EU	European Union
GW	Gigawatt
HPP	Hydropower Plant
IAEA	International Atomic Energy Agency
IEA	International Energy Agency
IMB PRC	International Maritime Bureau's Piracy Reporting Center
IOC	International Oil Company
LBP	Lusakert Biogas Plant
LLC	Limited Liability Company
MW	Megawatt
NATO	North Atlantic Treaty Organization
NIORDC	National Iranian Refining and Oil-products-distribution Company
NOC	National Oil Company
NPP	Nuclear Power Plant
NREL	National Renewable Energy Laboratory

OECD	Organization for Economic Co-operation and Development
OPEC	Organization of the Petroleum Exporting Countries
PSRC	Public Services Regulating Committee
RA	Republic of Armenia
SHPP	Small Hydropower plant
SOCAR	State Oil Company of Azerbaijan Republic
TPP	Thermal Power Plant
UES	Unified Energy System
UK	United Kingdom
UNFCCC	United Nations Framework Convention on Climate Change
U.S.	Untites States
USAID	United States Agency for International Development
USD	United States Dollar
VAT	Value Added Tax

Abstract

Energy security constitutes a key element of national security of any state. This claim is of particular importance for the states that lack their own energy resources. Armenia, which ensures its energy security mainly through the import of energy carrier, falls into this category. Such energy dependence of Armenia is fraught not only with political dependence on the energy-exporting countries, but threatens the energy security of the Republic in case of different force-majeure situations as well. For the purpose of overcoming these challenges and ensuring a certain level of energy self-sufficiency of Armenia, the authorities of the Republic should extensively develop renewable energy simultaneously with the development of available components of energy system.

Introduction

The topic of the study, "Energy Security of Armenia: Challenges and Opportunities", is highly relevant, since energy security is the integral and essential element in the structure of national security overall. It is no coincidence that in the National Security Strategy of Armenia, adopted in 2007, is stated that "ensuring the reliability, security and safety of energy, transport and communication infrastructure" is one of the fundamental values of national security of the Republic.[1] In the document energy dependence is considered as one of the main threats to the energy security: "Armenia, with a scarcity of natural resources, is dependent on external energy supplies".[2] In other words, energy security of Armenia depends to a large extent on external factors. This means that despite the fact that Armenia fully ensures its energy security for the current period, the Republic must be prepared for new external challenges in this area the latter not being dependent on it. Apart from global energy crisis, different force majeure situations can serve as sources for these challenges. For the purpose of enhancing energy security of our country, according to the National Security Strategy, Armenia identifies the need for "diversification of energy supplies and production, the creation of new sources of energy, including nuclear energy, and the development of a stable and reliable export-oriented energy system".[3]

Along with these measures, in order to achieve energy self-sufficiency of our country the development of renewable energy becomes highly relevant. Realizing the importance of this sector of energy, in the Law of the Republic of Armenia on Energy Saving and Renewable Energy, adopted in 2004, is stated that policy aimed at increasing the level of utilization of renewable energy should be developed and implemented by the government.[4]

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[1] National Security Strategy of the Republic of Armenia, Official Bulletin of Republic of Armenia, 2007.02.15/11 (535).

[2] Ibid.

[3] Ibid.

[4] National Assembly of the Republic of Armenia. The Law of the Republic of Armenia on Energy Saving and Renewable Energy (2004). (Webpage: http://www.parliament.am/legislation.php?sel=show&ID=2119&lang=eng).

However, unfortunately, it is noteworthy that within these eight years the authorities of the RA have not undertaken sufficient steps aimed at the development of the sector. In this context it should be mentioned that even Azerbaijan, which is rich in energy resources, emphasizes the high need for the development of alternative energy sources in its National Security Concept.

This paper aims at examining the current level of energy security of Armenia and analyzing the challenges and opportunities for the energy security of the Republic.

The current study consists of the following parts: introduction, methodology, literature review, two parts, conclusion, list of references and appendices. The introduction presents the relevance of the topic, purpose of the study, the research questions and hypothesis. The First Part addresses the main components of energy security of the three South-Caucasian republics and the challenges of energy security of Azerbaijan and Georgia. This part of the essay starts with the discussion of the concept of "energy security", reveals the relationship between global and national energy security, and throws light upon the problems of energy security of the South Caucasian republics. The Second part analysis the challenges of energy security of Armenia and discusses the opportunities for overcoming these challenges. In particular, the problems of Armenia's energy security dependence on the supply of energy resources from Russia and Iran, and the opportunities of ensuring energy security of Armenia are presented. In conclusion the main findings are summarized. The essay also provides the list of the experts that have been interviewed (Appendix A) and the questionnaire (Appendix B) that was used during the interviews.

Based on the literature review, the research questions for this study are as follows:

Research Question #1: Which definition of "energy security" concept can be applied to the Armenia case?

Research Question #2: What sources of energy can ensure national security of energy-importing countries in case of a global energy crisis?

Research Question #3: What are the key elements ensuring energy security of Azerbaijan and what are the threats to the energy security of the Republic and measures to overcome them?

Research Question #4: What are the key elements ensuring energy security of Georgia and what are the threats to the energy security of the Republic and measures to overcome them?

Research Question #5: What are the potential challenges of Armenia's energy security dependence on the supplies of gas from Russia and Iran?

Research Question #6: What are the opportunities of ensuring energy security of Armenia?

The Master's Essay will test the following hypothesis:

Hypothesis: Armenia's energy security is vulnerable because of disproportional development and import-based nature of energy system.

Methodology

For the purpose of answering the research questions and testing the hypothesis, as well as acquiring a deeper overview of the current state, challenges and threats of energy security of Armenia, both secondary and primary data were collected and analyzed. Within the framework of primary data in-depth interviews with the representatives of relevant institutions and experts were carried out. In order to have multi-sided perspectives over the issue, the selection of the interviewees was based on purposive sampling method. A questionnaire was formulated composed of 9 open-ended questions. Each interview lasted from 25-30 minutes. The responses were later translated and inputted for the purpose of analysis. Moreover, relevant national and international documents were reviewed. As for the secondary data scholarly literature was reviewed. Due to the time constraints the interviewees that had to be conducted with the representatives of the Ministry of Energy and Natural Resources were not carried out.

Review of the Literature

The concept of "energy security" in the modern sense has been formulated for the first time in 1973 as a result of OPEC Oil Embargo.[5] As mentioned by Kovalevich[6] and Samuel Van Vactor,[7] originally, this concept was understood in the national context and was restricted to an adequate energy supply of national economy and national defense. However, with the growing complexity of international economic relations the concept of energy security became more integrated and global. According to Kovalevich[8] and Fortov et al.,[9] globalization and increasing interdependence of energy market actors contributed to the establishment of a more inclusive paradigm of energy security.

The study of specialized literature shows that there is no single definition of the term "energy security" and every author puts his own thoughts into the concept. Thus, Mironov[10] and Tippe[11] emphasize that the interpretation of energy security depends on whether the country is an exporter or an importer of energy resources. At the same time, each of the scholars discusses the peculiarities of the formulation of the concept from their own perspective. Another group of authors consider that the level of economic development of the country plays a decisive role in the interpretation of energy security. For example, Yergin[12] and Denchev[13] argue that the developing countries mostly associate energy security

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[5] James D. Hamilton, Historical Oil Shocks (February 1, 2011). Department of Economics University of California, San Diego, pp. 10-11. (Webpage: http://dss.ucsd.edu/~jhamilto/oil_history.pdf).

[6] Dmitry Kovalevich, The Electric Safety and the Geography of the World Electric-Power Industry (*in Russian* - Energeticheskaya Bezopasnost i Geografiya Mirovoy Elektroenergii) (2012), pp. 2-4.

[7] Samuel Van Vactor, Energy Security and National Security (Wellington, 2007), pp. 1-3. (Webpage: http://www.econ.com/EnergySecurity0702.pdf)

[8] Dmitry Kovalevich, The Electric Safety and the Geography of the World Electric-Power Industry (2012), pp. 2-4.

[9] Vladimir Fortov, Aleksey Makarov, and Tatyana Mitrova, Global Energy Security: Problems and Solutions (*in Russian* - Globalnaya Energeticheskaya Bezopasnost: Problemi i Resheniya), The Herald of the Russian Academy of Science, vol. 77, #2 (2007), pp. 99-107.

[10] Nikolay Mironov, International Energy Security (Mejdunarodnaya Energeticheskaya Bezopasnost) (2003), pp. 10-12.

[11] Bob Tippe, Defining Energy Security, Oil and Gas Journal (23 Janruary, 2012). (Webpage: http://www.ogj.com/articles/print/vol-110/issue-1c/regular-features/journally-speaking/defining-energy-security.html).

[12] Daniyel Yergin, Ensuring Energy Security, Foreign Affairs, Vol.85, # 2 (March-April, 2006), pp. 70-72. (Webpage:http://www.un.org/ga/61/second/daniel_yergin_energysecurity.pdf).

[13] Kamen Denchev, World Energy Security: History and Perspectives (Mirovaya Energeticheskaya Bezopasnost: Istoriya i Perspektivi) (2010), pp. 16-18 (Webpage: http://www.hist.msu.ru/Journals/NNI/pdfs/Denchev_2010.pdf).

with the stability of energy prices. Also, Atje and Hapsari in the study "Energy Security: An Indonesian Perspective" emphasize that the developing countries are rather inclined to link energy security with the neither too low nor too high prices of supplied energy resources.[14]

Totally different perspective in interpretation of energy security is provided by Charles Ebinger. In the article, "The Meaning of Energy Security Depends on Who You Are", the author argues that the formulation of the paradigm is determined by ones position in the society, that is, whether it reflects the interests of the government, private citizen, poorest population, urban areas, or the basic level.[15] While in the report, "The New Energy Security Paradigm", another group of actors, the interests of which are reflected in the conceptualization of energy security, is presented. The study particularly emphasizes the difference of perspectives among oil producing countries, power companies, policymakers, consumers, and energy-intensive industries.[16]

Other authors mostly consider issues related to energy security as threats at individual, societal and state levels. For example, according to Milov,[17] for consumers of all levels energy security presupposes the minimization of energy supply's interruption danger and assurance of combination of reasonable prices and good quality of energy resources. While Winzer argues that there is a common concept behind all energy security definitions; the absence of, protection from or adaptability to threats that are caused by or have an impact on the energy supply chain form the backbone of energy security paradigm.[18]

It is worth mentioning that different authors prioritize different threats to energy security that exist at global level today. Thus, Shah in the article "Energy Security" discusses the depletion of

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[14] Raymond Atje and Indira Hapsari, Energy Security: An Indonesian Perspective (Beijing, 2008). (Webpage: http://www.rsis-ntsasia.org/activities/conventions/2008-beijing/atje.pdf).

[15] Charles K. Ebinger, The Meaning of Energy Security Depends on Who You Are (10 October, 2011). (Webpage: http://www.brookings.edu/opinions/2011/1010_energy_security_ebinger.aspx).

[16] World Economic Forum: The New Energy Security Paradigm (2006), pp. 8-10. (Webpage: https://members.weforum.org/pdf/Energy.pdf).

[17] Vladimir Milov, Global Energy Agenda. Russia in Global Affairs, vol.3 #4, (October-December, 2005).

[18] Christian Winzer, Conceptualizing Energy Security. Economic and Social Research Council (July, 2011), pp. 8-10. (Webpage: http://www.econ.cam.ac.uk/dae/repec/cam/pdf/cwpe1151.pdf).

fossil energy resources as the main concern for the humanity.[19] In contrast, Mironov argues that the hydrocarbon reserves' reduction probability is exaggerated and that the constant investment in the investigation of new reserves would not allow the shortage of fossil energy carriers to emerge.[20] At the same time, many authors give special consideration to the growing population of the world, constantly increasing demand for energy resources and to the shift of energy demand centers, as a result of which the whole configuration of the global energy market undergoes substantial changes.[21]

Another group of authors consider tense relations between consumers and producers,[22] conflict and instability,[23] support of dictatorial regimes,[24] as well as terrorism, piracy, nationalization of energy industry infrastructure and natural disasters[25] as main challenges for global energy security. Thus, Peter Johnstone examining one of the most acute threats to global energy security of 21st century, terrorism, brings the examples of targets most frequently chosen by terrorists.[26]

Various international organizations[27] and individual experts[28] consider the development of renewable energy as the best option for not only solving the environmental issues, but as a solution to the problem of fossil fuel depletion, as well as for the creation of a more stable, reiliable and diversified

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[19] Anup Shah, Energy Security (May, 2011). Global Issues. (Webpage: http://www.globalissues.org/article/595/energy-security).

[20] Nikolay Mironov, International Energy Security (2003), pp. 15-16.

[21] Jorge Blázquez and José María Martín-Moreno, The Rise of Emerging Markets and Its Impact on Global Energy Security (May, 2012). ESADEgeo, Center for Global Economy and Geopolitics, p. 25. (Webpage:http://itemsweb.esade.edu/research/esadegeo/The%20rise%20of%20emerging%20markets%20impact%20security.pdf).

The New Energy Security Paradigm (Spring, 2006). World Economic Forum in partnership with Cambridge Energy Research Associates, pp. 14-20. (Webpage: https://members.weforum.org/pdf/Energy.pdf).

Anup Shah, Energy Security (May, 2011). Global Issues..

[22] Robert F. Winchester, European Energy Security: Wrestling the Russian Bear For Caspian Natural Gas (2007). United States Department of State, pp. 8-10. (Webpage: http://www.dtic.mil/cgi-bin/GetTRDoc?AD=ada471533).

[23] Raymond Atje and Indira Hapsari, Energy Security: An Indonesian Perspective (Beijing, 2008), pp. 1-2.

[24] Thomas L. Friedman, The First Law of Petropolitics (May-June, 2006). Foreign Policy, pp. 28-36; (Webpage: http://aphrodite.aua.am:2061/ehost/pdfviewer/pdfviewer?sid=79a9d9ac-3a0f-4052-a591-e9436349584d%40sessionmgr10&vid=2&hid=21).

[25] Peter Johnstone, Energy Security Threats (June, 2011). The Technical Cooperation Program, pp. 35-37. (Webpage: http://drdc-rddc-gc.academia.edu/PeterJohnston/Papers/840169/Energy_Security_Threats).

[26] Ibid.

[27] Renewable Energy, European Commission. (Webpage: http://ec.europa.eu/energy/renewables/targets_en.htm).

[28] Paul Belkin, The European Union's Energy Security Challenges (January, 2008). Congressional Research Service. Report for Congress, pp. 25-27 (Webpage: http://www.fas.org/sgp/crs/row/RL33636.pdf).

energy supply system. Even countries that have no lack of reserves of energy resources and have completely ensured their energy security, attach a high importance to the development of renewable energy sector. For example, Azerbaijan realizing the vulnerability of its energy infrastructure has included the development of renewable energy, particularly, wind, sun, biomass, and hydropower in the National Security Concept.[29] An identical position towards the development of renewable energy is stated in the National Security Concept of Georgia. As precisely put in the document "among the main priorities of Georgia's energy policy are the development of energy infrastructure, the more efficient use of hydropower, and research into other clean-energy resources. Georgia actively cooperates with foreign investors on developing renewable energy resources".[30] Moreover, governmental program "On the expansion of the use of non-conventional energy sources in Georgia"[31] was approved in Tbilisi, which proves the importance attached to the renewable energy sector in the country.

Among the first steps towards the development of renewable energy in our Republic Energy Law of the Republic of Armenia,[32] adopted in 2001, and the Law of the Republic of Armenia on Energy Saving and Renewable Energy,[33] adopted in 2004, should be mentioned. The former particularly contributed to the development of the hydropower energy of the Republic, while the latter defined the principles of the state policy on development of the energy saving and renewable energy overall. Equally important is the "Energy Sector Development Strategies in the Context of Economic Development in Armenia", adopted by the Government of Armenia in 2005. The document emphasizes the interdependence between the development of renewable energy and energy security of the country and

[29] National Security Concept of the Republic of Azerbaijan (May, 2007), p. 20. (Webpage: http://www.un.int/azerbaijan/pdf/National_security.pdf).

[30] National Security Concept of the Republic of Georgia (2005), p. 24. (Webpage: http://www.nsc.gov.ge/files/files/National%20Security%20Concept.pdf).

[31] In-depth Review of Policies and Programmes in the sphere of Energy Efficiency in Georgia (2006). Energy Charter Secretariat, pp. 37-38. (Webpage: http://www.allbeton.ru/bibliotek/).

[32] Ministry of Energy and Natural Resources of Armenia. (Webpage: http://www.minenergy.am/hy/en/laws).

[33] National Assembly of the Republic of Armenia. The Law of the Republic of Armenia on Energy Saving and Renewable Energy (2004)..

discusses the potential of renewable energy to contribute to the Republic's energy independence.[34] Another document that stressed upon the high need for the development of domestic energy resources for the purpose of securing the sustainable development of Armenia is the "National Program on Energy Saving and Renewable Energy of the Republic of Armenia" [35] prepared by the Energy Research Institute of Armenia in 2007. Thus, if Armenia is to achieve sustained economic growth, besides increasing efficiency in all energy consuming sectors, it must develop renewable energy as well.[36]

It should be mentioned that most of the energy sector documents of Armenia mainly examine five sectors of renewable energy that have development potential in the Republic. One of the traditional sources of energy that has been utilized in Armenia is hydropower. As was already mentioned, the Energy Law of the Republic of Armenia played a decisive role in the development of small hydro power sector in the country by guarantying the purchase of electricity generated by the latter within 15 years[37] and establishing tariffs higher than average electricity tariffs by Public Services Regulating Committee of the Republic of Armenia[38]. The fact is that different studies were aimed at the assessment of theoretical, technically available, and economically feasible hydropower resource potential in Armenia.[39] It is noteworthy that just after the collapse of the Soviet Union the initiative to investigate the available water

[34] Government of Armenia. Energy Sector Development Strategies in the Context of Economic Development in Armenia. N1 resolution of N 24 protocol (Yerevan, 2005). (Webpage: http://unpan1.un.org/intradoc/groups/public/documents/apcity/unpan042544.pdf)/

[35] USAID. National Program on Energy Saving and Renewable Energy of Republic ofArmenia (2007), pp. 2-4. (Webpage:http://www.renewableenergyarmenia.am/download/National_Program_English_Draft_Part_1.pdf).

[36] Ibid.

[37] Ministry of Energy and Natural Resources of Armenia. The Energy Law of the Republic of Armenia (2001). (Webpage: http://www.minenergy.am/hy/en/laws).

[38] Public Services Regulatory Commission of the Republic of Armenia. (Website: http://resolutions.psrc.am/view.php?rid=1501).

[39] Vahe Odabashian and Susanna Khachatryan, Renewable Energy in the Republic of Armenia (2008). "21-st CENTURY", № 1 (3), pp. 110-112.

USAID. National Program on Energy Saving and Renewable Energy of Republic of Armenia (2007). (Webpage:http://www.renewableenergyarmenia.am/download/National_Program_English_Draft_Part_1.pdf).

Ara Marjanyan, The Future We Must Not Miss (June, 2011). "21-st CENTURY", № 2 (3).

resources in the Republic was undertaken by Yerevan.[40] And already today the electricity generated by the SHPPs accounts for about 6 % of the total power production of the Republic.[41]

However, the hydropower is not the only sector where the assessment projects were implemented. Thus, the studies "Use of Renewable Energy Sources in the World and Armenia: Through Innovations to Clear Technologies"[42] and "Armenia: Follow-up Review of the Investment Climate and Market Structure in the Energy Sector",[43] as well as experts[44] in the field of renewable energy stress the significant potential of the RA to utilize wind energy. Whereas, the "Wind Energy Resource Atlas of Armenia"[45] specifies the land areas with moderate-to-excellent wind resource potential in Armenia. The same set of documents, taking into consideration the geographic location and natural climatic conditions of our Republic, also emphasizes the potential of the RA to develop solar energy sector. While another group of authors introduces the possibility of usage of uncultivated lands and the exploitation of buildings for the production of solar energy,[46] particularly for the installation of solar water heaters[47] and solar photovoltaic stations.[48] With regard to the latter option, it is noteworthy that Armenia, being rich in raw material resources, has the opportunity to organize full-circle production as well. Thus, the experts concluded that

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[40] Use of Renewable Energy Sources in the World and Armenia: Through Innovations to Clear Technologies (2010), pp. 55-56. (Webpage: http://www.nature-ic.am/res/publications/brochures/Final_RE_Eng_Dec16.pdf) (Accessed January 12, 2012).

[41] Ibid.

[42] Ibid.

[43] Armenia: Follow-up Review of the Investment Climate and Market Structure in the Energy Sector. Energy Charter Secretariat (2008), pp. 90-92. (Webpage: http://www.encharter.org/fileadmin/user_upload/Publications/Armenia_ICMS_2008_ENG.pdf).

[44] Ara Marjanyan, Independence, Invulnerability, and Ecological Compatibility of Energy System (June, 2011). "21-st CENTURY", № 2 (3).

Vahe Odabashian and Susanna Khachatryan, Renewable Energy in the Republic of Armenia (2008).

[45] Dave Elliott, Marc Schwartz, G Scott, Steve Haymes, Donna Heimiller, R George, Wind Energy Resource Atlas of Armenia (2003). National Renewable Energy Laboratory (NREL), pp. 1-2. (Webpage: http://www.nrel.gov/docs/fy03osti/33544.pdf).

[46] Karen Hovhannisyan, Sustainable Development and Energy Security in Armenia: a Step Towards Dilemma (2003). Lund University, p. 33. (Webpage: http://www.lumes.lu.se/database/alumni/01.02/theses/hovhannisyan_karen.pdf).

[47] Armen Gharibyan, Towards Eastern Partnership Civil Society Forum. The Need for Developing Alternative Energy Resources in the Context of Armenia-EU Relations Based on the Example of Introducing Solar Water heaters. (Yerevan, 2011) Eurasia Partnership Foundation. Europe Program, pp. 2-4.

[48] Ara Marjanyan, Independence, Invulnerability, and Ecological Compatibility of Energy System (June, 2011). "21-st CENTURY", № 2 (3).

the creation of a new branch of industry, from mining to marketing and sales of solar modules, is possible and economically feasible.[49]

As for the remaining two sectors of renewable energy, biomass and geothermal, preliminary assessment studies were organized in these fields as well. Thus, in Armenia biomass can particularly be used for the production of bio-ethanol, biogas and hydrogen, which are considered as the most viable options for the Republic. For example, "A Preliminary Feasibility Assessment of the Preferred Alternative For Implementing Commercial Scale Bio-Ethanol Fuels Program For Armenia in the Near to Mid Term" report, implemented in frames "Assistance to the Bio-Ethanol Production Development in Armenia" in 2008, highlighted the main possibilities of the RA to produce bio-ethanol.[50] Moreover, as mentioned by Marjanyan, the efficiency of bio-ethanol production and, consequently, the possibility of its export much depend on the technology used.[51] As for the potential of development of hydrogen economy[52] and construction of biogas plants,[53] a series of research projects were undertaken throughout Armenia, most of which are presented in various studies.

The potential of development of the last sector of renewable energy, geothermal energy, should not be underestimated. The investigations of this energy sector started already in the Soviet times[54] and

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[49] Ara Marjanyan, Independence, Invulnerability, and Ecological Compatibility of Energy System (June, 2011).

[50] A Preliminary Feasibility Assessment of the Preferred Alternative For Implementing a Commercial Scale Bio-Ethanol Fuels Program For Armenia in the Near to Mid Term: Assistance to the Bio-Ethanol Production Development In Armenia (2003), Renewable Resources and Energy Efficiency Fund of Armenia, pp. 23-34.

[51] Ara Marjanyan, Independence, Invulnerability, and Ecological Compatibility of Energy System (June, 2011).

[52] Other Renewables in Armenia: Hydrogen Economy in Armenia. (Webpage: http://www.renewableenergyarmenia.am/index.php?option=com_content&task=view&id=28&Itemid=120).

Emil Danielyan, U.S. To Fund Hydrogen Energy Research In Armenia (August, 2004). (Webpage: http://hyeforum.com/index.php?showtopic=9739).

Vahe Odabashian and Susanna Khachatryan, Renewable Energy in the Republic of Armenia (2008), p. 118.

[53] USAID. National Program on Energy Saving and Renewable Energy of Republic ofArmenia (2007). (Webpage:http://www.renewableenergyarmenia.am/download/National_Program_English_Draft_Part_1.pdf).

Tamara Babayan, Areg Gharabegian, Artak Hambarian, Morten Søndergaard, and Kenell Touryan, Renewable Energy in Armenia (December, 2011).

Use of Renewable Energy Sources in the World and Armenia: (2010), pp. 40-43. (Webpage: http://www.nature-ic.am/res/publications/brochures/Final_RE_Eng_Dec16.pdf) (Accessed January 12, 2012).

[54] Vahe Odabashian and Susanna Khachatryan, Renewable Energy in the Republic of Armenia (2008), p. 117.

continued with the establishment of the independent Republic,[55] as a result of which a number of areas with moderate to high potential were identified.

Based on the above-mentioned material, it can be firmly stated that the concept of "energy security" has no single definition. It is obvious that it is a dynamic concept, which throughout the whole history of its usage required reappraisal and broadening. The interpretation of the term depends on various economic, political and social factors on a state level. At the same time, the expansion and deepening of the level of political and economic globalization dictates the need for an adequate response to the existing and potential threats to energy security on an international level, which, in its turn, predetermines to a large extent the formulation of a more inclusive concept of energy security, where renewable energy starts to occupy a significant niche.

Armenia: Follow-up Review of the Investment Climate and Market Structure in the Energy Sector. Energy Charter Secretariat (2008), p. 93. (Webpage: http://www.encharter.org/fileadmin/user_upload/Publications/Armenia_ICMS_2008_ENG.pdf).

[55] Use of Renewable Energy Sources in the World and Armenia: Through Innovations to Clear Technologies (2010), p. 53. (Webpage: http://www.nature-ic.am/res/publications/brochures/Final_RE_Eng_Dec16.pdf) (Accessed January 12, 2012).

Vahe Odabashian and Susanna Khachatryan, Renewable Energy in the Republic of Armenia (2008), p. 117.

Part 1. The Main Components of Energy Security of the Three South-Caucasian Republics

Part 1.1 The Concept of "Energy Security"

The primary objective of any state is to guarantee security, which consists of numerous components, like economic, industrial, environmental, military, energy secutiry, etc. The security paradigm and the concepts of each of its elements have undergone many conceptual modifications since their emergence in the policy agendas of various states.

"Energy security" is one of the most widely used concepts in both economic and political spheres. For the first time the concept of "energy security" has been used in the modern sense in 1973 as a result of OPEC Oil Embargo. This was the first energy crisis, which affected most of the Western European countries.[56]

This was a history-making period, which brought the concept of national energy security forward. As Kovalevich mentions, originally, the concept of "energy security" was understood in the national context, that is, on a scale of one country. The author also states that in some cases, the term was restricted to an adequate energy supply of the national economy or to the country's energy self-sufficiency.[57] In his article "Energy Security and National Security" Samuel Van Vactor emphasizes that traditionally energy security was regarded as a "straightforward strategic objective aimed at ensuring fuel for national defense".[58] Thus, according to the author there was a direct link between secure oil supplies and national security.[59] The exploration and the analysis of the changes, which have occurred to the "energy security" concept since oil crises of the 1970s, were also undertaken by the World Economic Forum and Cambridge Energy Research Associates and were reflected in "The New Energy Security Paradigm" semiannual report. The authors extend the scope of the concept by enumerating five traditional

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[56] Andrey Gafurov, The Essence of "Energy Security" Concept and its Place in the Whole Structure of Security (*in Russian* - Sushnost Kategorii "Energeticheskoy Bezopasnosti" i eyo Mesto v Obshey Strukture Bezopasnosti) (2010), pp. 178-182.

[57] Dmitry Kovalevich, The Electric Safety and the Geography of the World Electric-Power Industry (*in Russian* - Energeticheskaya Bezopasnost i Geografiya Mirovoy Elektroenergii) (2012), pp. 2-4.

[58] Samuel Van Vactor, Energy Security and National Security (Wellington, 2007), pp. 1-3. (Webpage: http://www.econ.com/EnergySecurity0702.pdf)

[59] Ibid.

elements of energy security – demand centers, supply sources, geopolitics, market structures and institutions, all of which have changed over the past 30 years.[60]

The transformation of "energy security" from a narrow and highly specialized term to a more inclusive paradigm took place along with the increase of economic interdependence between states. As mentioned by Kovalevich globalization had a huge impact on the change in the perception of energy security as a more multidimensional concept. As a result, the comprehensive term included not only the availability of resources in the physical sense, but also other economic, social and environmental aspects of energy security, and the relationships between them.[61] According to Fortov et al. due to the qualitative change of world economy and energy, the concept of energy security became more integrated and global, increasing the interdependence of energy market actors.[62] The energy security of the European Union or the South Caucasian region can serve as vivid examples of interconnection and interdependence that exist between the countries. The combination of all these factors contributed to the establishment of a firm link between national, regional and global energy security.

As the study of specialized literature shows, there is no specific definition of the term "energy security", and different authors interpret it differently. The evolution of this term depended on many internal and external factors. Therefore, there was a high need to formulate a new definition of energy security as a respond to the change in the environment.

As mentioned in the leading petroleum industry weekly publication "Oil and Gas Journal" energy security means different things in different places. The difference in the interpretation of energy security can be based on the status of the country, that is, whether the latter is an exporter or an importer of energy resources. While the former is mainly concerned about the security of demand, the latter's basic concern

[60] World Economic Forum: The New Energy Security Paradigm (2006), pp. 8-10. (Webpage: https://members.weforum.org/pdf/Energy.pdf).

[61] Dmitry Kovalevich, The Electric Safety and the Geography of the World Electric-Power Industry (*in Russian* - Energeticheskaya Bezopasnost i Geografiya Mirovoy Elektroenergii) (2012), pp. 2-4.

[62] Vladimir Fortov, Aleksey Makarov, and Tatyana Mitrova, Global Energy Security: Problems and Solutions (*in Russian* - Globalnaya Energeticheskaya Bezopasnost: Problemi i Resheniya), The Herald of the Russian Academy of Science, vol. 77, #2 (2007), pp. 99-107.

is the security of supply.[63] The International Energy Agency (IEA) broadly defines energy security as secure supply of energy at affordable prices. The Agency also provides a more profound differentiation in the priorities of formulation of energy security between supplying and consuming states. In particular, for the importing countries energy security encompases the following crucial elements: ensurance of a reliable supply, diversification of supply sources, ensurance of security of the energy infrastructure, utilization of new technologies to reduce dependence of energy imports. With regard to the second group of states, the components of energy security differ considerably. The consolidation on strategic markets with economically competitive prices, provision of necessary investments for the development of infrastructure and for the investigation of new energy sources are the components of long-term energy security and form the basis of energy policies of exporting countries.[64] A more comprehensive list of priorities, presenting diverging foundation of the definition of energy security of exporting and importing countries, was developed by Mironov. According to the scholar the definition of energy security differs between the two groups of states due to the nature of the goals they set up in the field of energy. The importing countries prioritize the accelerated development of domestic conventional and alternative sources to decrease the dependence on imported resources; the reduction of energy consumption by improving its efficiency; the development of clean energy technologies. As for the energy exporting countries, the protection of the energy sovereignty, promotion of the economic development of the state and minimization of the damage to the environment are among the most widely stated goals of energy security.[65] An example of energy exporting countries was analyzed by Yergin. Thus, for Russia, the aim is to reassert the state control over "strategic resources" and gain primacy over the main pipelines and market channels through which it ships its hydrocarbons to international markets.[66] As mentioned by Atje and Haspari the Saudis define energy security as "maintaining and enhancing access to where the oil

[63] Bob Tippe, Defining Energy Security, Oil and Gas Journal (23 Janruary, 2012). (Webpage: http://www.ogj.com/articles/print/vol-110/issue-1c/regular-features/journally-speaking/defining-energy-security.html).

[64] Kamen Denchev, World Energy Security: History and Perspectives (2010), pp. 20-24.

[65] Nikolay Mironov, International Energy Security (2003), pp. 10-12.

[66] Daniyel Yergin, Ensuring Energy Security, Foreign Affairs, (March-April, 2006), pp. 70-72. (Webpage:http://www.un.org/ga/61/second/daniel_yergin_energysecurity.pdf).

exists in obvious abundance".[67] In contrast to exporting countries, energy security is regarded from a totally opposite perspective in European countries. The major concern for this part of the world is how to manage dependence on imported natural gas and to develop such energy policies that will enhance their energy security.[68]

As Yergin and Denchev mention the definition of energy security may also depend on the level of economic development of the country. The authors highlight that the main concern for the developing countries is how changes in energy prices may affect their balance of payments. In such rapidly developing countries, like China and India, energy security is first of all understood as the ability of the country to adjust to the changes in the global markets, on which they are highly dependent.[69] This ability to react promptly to sudden changes in supply and demand is defined as a short-term energy security by IEA.[70] Another example of developing country's definition that focuses on energy security from economic perspective is provided by Atje and Hapsari. As mentioned by the authors China "defines energy security as the acquisition of the sufficient energy supplies to protect the China core objectives at prices that are neither too high nor too low to undermine those objectives".[71] On this occasion, the OECD Competition Committee's definition of energy security can be mentioned. The interpretation of energy security much depends on what a nation is accustomed to. If low energy prices predominated in the economic history of the country, then a high energy price is considered as a threat to energy security. In case the nation is used to a stable and sustainable energy supply, then, a disruption on energy supply will be considered as threat to energy security.[72] With regard to developed countries, each of them has their own specificities in the development of energy policy, thus, in the formulation of energy security as well.

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[67]Raymond Atje and Indira Hapsari, Energy Security: An Indonesian Perspective (Beijing, 2008). (Webpage: http://www.rsis-ntsasia.org/activities/conventions/2008-beijing/atje.pdf).

[68] Daniyel Yergin, Ensuring Energy Security, Foreign Affairs, (March-April, 2006), pp. 70-72. (Webpage:http://www.un.org/ga/61/second/daniel_yergin_energysecurity.pdf).

[69] Ibid.

Kamen Denchev, World Energy Security: History and Perspectives (2010), pp. 16-18.

[70]International Energy Agency (IEA). Energy Security. (Website: http://www.iea.org/subjectqueries/keyresult.asp?KEYWORD_ID=4103).

[71] Raymond Atje and Indira Hapsari, Energy Security: An Indonesian Perspective (Beijing, 2008). (Webpage: http://www.rsis-ntsasia.org/activities/conventions/2008-beijing/atje.pdf).

[72] Ibid.

Yergin states that for Japan energy security means offsetting its stark scarcity of domestic resources through diversification, trade, and investment. The other example presented by the author is the U.S., which has to accommodate itself to the contemporary structure of the energy field and to realize the inappropriateness of "energy independence" it strived to achieve.[73]

The framework suggested by Ebinger regards the concept of "energy security" as dependent on ones position in the society. The author analyzes five possible definitions of energy security, each considered from different perspectives. At the most basic level, energy security implies uninterrupted "access to the requisite volumes of energy at affordable prices"[74] From the perspective of a government, energy security means energy policies and standby measures (for example, energy supply diversification, volume of energy stock) that can be implemented in the event of a supply disruption, and at a cost that its citizens consider reasonable. As for a private citizen, although the definition of the term still hinges on access to readily available resources in sufficient volume at affordable prices, but now it is more nuanced. In this case energy security is applied to individuals and small enterprises (farmers, businesses, local industry, etc.). For urban areas energy security simply means having access to electricity. Finally, from the perspective of the poorest population energy security is mainly about guaranteeing access.[75]

This approach to the study of the concept of "energy security" from various perspectives can be supplemented by another group of perspectives proposed in the "The New Energy Security Paradigm" report. The first group consists of consumers and energy-intensive industries, which are interested in reasonably-priced energy on demand and worry about disruptions. Major oil producing countries present the next group, according to which security of revenue and of demand constitute the foundation for ensuring energy security. Access to new reserves, ability to develop new infrastructure, and stable investment regimes form the basis of energy security for oil and gas companies. With regard to the power companies, the main concern is the integrity of the entire network. The last group, policymakers, regards

[73] Daniyel Yergin, Ensuring Energy Security, Foreign Affairs, (March-April, 2006), pp. 70-72. (Webpage:http://www.un.org/ga/61/second/daniel_yergin_energysecurity.pdf).

[74] Charles K. Ebinger, The Meaning of Energy Security Depends on Who You Are (10 October, 2011). (Webpage: http://www.brookings.edu/opinions/2011/1010_energy_security_ebinger.aspx).

[75] Ibid.

energy security as the absence of threats to the supply of energy resources and to the infrastructure, which can be caused by acts of terrorism, war or natural disasters.[76]

Thus, given the variety of perspective in interpretation of "energy security" concept, the development of a holistic approach that will consider to the highest extent possible the interest of all involved parties becomes a necessity. As mentioned in the research "Energy Security" done by Matthew H. Brown et al., energy system is a complex, interconnected web, in which a disruption in one part of the infrastructure can easily cause disruptions elsewhere in the system.[77] Equally important in understanding energy security is the policy analysis "Energy Security as Multidimensional Concept" done by Florian Baumann. According to the author only an integrated approach that combines all different aspects of energy security, economic, political and security measures, can be successful.[78]

The significance of such an approach is doubled, taking into account that energy security is an integral part of the whole system of national security. As McCaskill mentioned viewing energy security as an integral part of national security is crucial to the continued growth of the national power of the United States. From this perspective, energy is intertwined with economic, diplomatic and military powers. As a result, the nexus between National Security Strategy and Energy Policy is established. Thus, according to the author the definition of energy security emphasize the usage of a combination of national means for the achievement of a stable and reliable energy portfolio.[79] The idea of considering energy security as one of the crucial components of naitonal security is supported by many American politicians, among which Senator John Forbes Kerry can be mentioned. In one of his speeches the official compared

[76] World Economic Forum: The New Energy Security Paradigm (2006), pp. 8-10. (Webpage: https://members.weforum.org/pdf/Energy.pdf)

[77] Matthew H. Brown, Christie Rewey, and Troy Gagliano, Energy Security. National Conference of State Legislatures. The Forum for America's Ideas (2003), pp. 9-12. (Webpage: http://www.oe.netl.doe.gov/docs/prepare/NCSLEnergy%20Security.pdf).

[78] Florian Baumann, Energy Security as Multidimensional Concept Research Group on European Affairs. CAP Policy Analysis (2008), pp. 4-9. (Webpage: www.cap.lmu.de/download/2008/CAP-Policy-Analysis-2008-01.pdf).

[79] John R. Mccaskill, Energy Security: The Nexus of National Security Strategy and Energy Policy (2007), pp. 4-5. (Webpage: http://www.dtic.mil/cgi-bin/GetTRDoc?AD=ADA471527).

energy security with the national security of the Unites States.[80] So, energy security has a significant, if not a decisive role in determining the level on national security. It is no coincidence that the main priorities of energy policies of states are highlighted in National Security Strategies.

Armenia is not an exception. Thus, greater energy independence through a diversification of energy supplies and production, the creation of new sources of energy, including nuclear energy and the development of a stable and reliable export-oriented energy system are in the list of priorities stated in the National Security Strategy of the Republic of Armenia.[81] It is worth mentioning that in the "Energy Sector Development Strategy in the Context of Economic Development in Armenia", approved by the government of Armenia "energy security" is defined as a guarantee of stable and reliable fuel and energy resources at affordable prices sufficient to completely meet the demand of the country and its citizens, the society and economy and to provide electric generation, adequate to preserve the public's health and Armenia's environment in normal conditions as well as in emergencies.[82]

It should be also mentioned that the issues related to energy security are frequently regarded as threats at individual, societal and state levels. In one of the most widely used interpretations, proposed by the scientists of the Energy Systems Institute after L.A. Melentiev, energy security is understood as a condition for securing the vital interests of an individual, society and state from the threat of shortage of affordable fuel energy resources of an acceptable quality.[83] Milov discusses the concept of energy security as an attempt by energy customers to protect themselves from interruptions that could endanger supply of energy as a result of an accident, terrorism, insufficient investment in energy infrastructure or insufficient

[80] John F. Kerry, Energy Security is American Security. Center for National Policy Ronald Reagan Building (22 January, 2002). (Webpage: http://commons.wvc.edu/jminharo/pols206/Article%20to%20Choose%20From/Energy%20Security%20is%20American%20Security.pdf).

[81] National Security Strategy of the Republic of Armenia, Official Bulletin of Republic of Armenia, 2007.02.15/11 (535).

[82] The Government of Armenia, Energy Sector Development Strategy in the Context of Economic Development in Armenia. Session N 1, Resolution of N 24 protocol (23 June, 2005), p. 13. (Webpage: http://unpan1.un.org/intradoc/groups/public/documents/apcity/unpan042544.pdf).

[83] Vladimir Ryasin, Energy Security of the Region as a Backbone Factor of Energy Security (Energeticheskaya Bezopasnost Regiona kak Sistemoobrazuyushiy Faktor Ekonomicheskoy Bezopasnosti) (2005).

organization of the energy markets.[84] A definition of a more general nature is brought forward by Winzer, according to whom the common concept behind all energy security definitions is the absence of, protection from or adaptability to threats that are caused by or have an impact on the energy supply chain.[85] The definition, formulated by International Atomic Energy Agency (IAEA) that considers energy supply security as a matter of both domestic policy and international relations, specifies the possible threats to energy security. According to the Agency, perceived and real threats may be economic or logistic, politically motivated or the result of war or natural causes. They may be source, technology or transport related, specific to a facility or a function of system structure, due to sabotage or to inadequate investment or maintenance, or result from pricing or regulatory policies.[86]

Thereby, from the above presented multifarious interpretations of "energy security" the IEA's and Mironov's definitions formulated from the perspective of an energy-importing country particularly correspond to the Armenian reality. The fact is that before the collapse of the Soviet Union, in Armenia energy security was percieved as a component part of the energy security of the USSR overall. So, Armenia was under the unified All-Union energy policy. The electricity generated by Armenian Power Plants joined the Transcaucasian Energy System.[87] Still in late 1980s structural changes in the energy industry of Armenia took place due to the shut down of both power-generating units of Metsamor Nuclear Power Plant. As a result, energy security of the Armenian SSR started to be associated with stable fuel oil supplies necessary for the operation of the Hrazdan and Yerevan thermal power plants, which had to carry most of the burden for electricity production.[88]

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[84] Vladimir Milov, Global Energy Agenda. Russia in Global Affairs, vol.3 #4, (October-December, 2005).

[85] Christian Winzer, Conceptualizing Energy Security. Economic and Social Research Council (July, 2011), pp. 8-10. (Webpage: http://www.econ.cam.ac.uk/dae/repec/cam/pdf/cwpe1151.pdf).

[86] Analyses of Energy Supply Options and Security of Energy Supply in the Baltic States, International Atomic Energy Agency (February, 2007), p. 4. (Webpage: http://www.iaea.org/OurWork/ST/NE/Pess/assets/TE_1541_balticstudyFeb07.pdf).

[87] Armenia: Country Profile (2011). International Atomic Energy Agency, Scientific and Technical Publications. (Webpage: http://www-pub.iaea.org/MTCD/Publications/PDF/CNPP2011_CD/countryprofiles/Armenia/Armenia2011.htm).

[88] Sevak Sarukhanyan, Energy Security of RA: Main Achievements and Challenges (2011) N2. Yerevan: 21st Century, p. 30.

Thus, given that Armenia's energy security still to a large extent depends on external energy supplies, when defining the essence of the energy security of our Republic one should proceed from the fact that the country is an importer of energy resources. Moreover, taking into consideration the fact that energy security of Armenia, apart from numerous elements that are typical for an energy-importing country, also comprises the development of domestic conventional and renewable sources of energy, the level of development of the latter should be reflected in the definition of "energy security of Armenia".

Part 1.2 The Relationship Between Global and National Energy Security

While energy is the most important sector of economy in majority of countries, its security is predetermined not only by the internal, but by the external factors as well. Globalization, the result of internationalization of world economy, has a huge impact on the development of international economic relations. The fact is that global and regional economy, as well as economic development of a single state much depends on the production and consumption of energy resources. Thus, nowadays, energy security is at the top of global political agenda and is prioritized by the majority of states, and is considered as one of the security sectors together with military, political, economic, societal and environmental security sectors.[89]

The recognition of the universal nature of energy security led to the unification of efforts and development of a comprehensive strategy. Global Energy Security Principles agreed to at the St. Petersburg G8 summit in 2006 can be considered as the most important step towards the enhancement of global energy security. Based on these principles, the St. Petersburg Action Plan on Global Energy Security was adopted by the G8 leaders on 16 July same year.[90] According to the agreement all states will promote the introduction of innovative technologies for efficient production of hydrocarbons and the

[89] Mikko Palonkorpi, Energy Security and the Regional Security Complex Theory (Helsinki, 2006). University of Helsinki, Finnish Centre for Russian and Eastern European Studies, p. 1. (Webpage: http://busieco.samnet.sdu.dk/politics/nisa/papers/palonkorpi.pdf)

[90] Kenji Iwata, The G-8 Summit in St. Petersburg and Russia (Tomsk, 2007). School for International Development and Cooperation, Hiroshima University, Herald of Tomsk State Pedagogical University, vol. 1, pp. 47-51.

reduction of environmental impacts via utilization of renewable energy sources. It was also stated that solar, wind, geothermal, hydro, and biomass gain price competitiveness relative to conventional fuels and massive development of renewable energy could contribute to the diversification of energy sources and to global energy security overall.[91]

The concept of security of energy supply appeared back in 1914, on the eve of the First World War. The First Lord of the Admiralty, Winston Churchill made a historic decision: in order to make the Royal Navy faster than its German counterpart, he proposed to switch the power source from coal to oil. Coal was produced in Wales, while oil was produced in Persia. As a result, securing the oil supply became a key element of the UK's national security strategy. Churchill stated that "safety and certainty in oil lie in variety and variety alone".[92] Thus, this is the time when the main guiding principle of ensuring energy security, diversification of energy supplies, was determined.

The post-World-War-II events also played a great role in the evolution of the concept of energy security. The major oil shocks, such as, for example, Suez Crisis (1956-1957), OPEC Oil Embargo (1973-1974), and Iranian revolution (1978-1979), influenced the awareness of the importance of energy security as a component of national security greatly.[93]

With regard to the recent events that proved the extreme volatility of energy prices, which is one of the main risks for the world economy today, the crucial role that energy security has in the modern society and high need for healthy cooperation within the international community, for example, the civil war in Libyan 2011 and the tensions in the Straits of Hormuz in early 2012 are worth mentioning. The armed conflict in the North African state forced the IEA to engage in collective action for the purpose of softening its impact on the global economy. As a result, some of the Agency's members released 60 million barrels of oil (or petroleum products) in the market, which was to prevent the further rise in oil

[91] International Energy Agency, St. Petersburg Plan of Action: Global Energy Security. IEA Evaluation of G8 Countries' and European Commissions Progress on the 7 Key Action Areas (2009). (Webpage: http://www.g8italia2009.it/static/G8_Allegato/StPETERSBURG,0.pdf)

[92] Daniyel Yergin, Ensuring Energy Security, Foreign Affairs, Vol.85, # 2 (March-April, 2006), pp. 69-70. (Webpage:http://www.un.org/ga/61/second/daniel_yergin_energysecurity.pdf).

[93] James D. Hamilton, Historical Oil Shocks (February 1, 2011). Department of Economics University of California, San Diego, pp. 10-11. (Webpage: http://dss.ucsd.edu/~jhamilto/oil_history.pdf)

prices.[94] The high necessity for preserving stability in the global energy market was also sharply felt during the tensions that escalated over the energy system's main chokepoint, Straits of Hormuz (according to the IEA, around 17 million barrels of oil and 2 million barrels of petroleum products cross the Straits daily, accounting for 20% of world oil production).[95] The Western countries', particularly EU's, ban on the Iranian oil imports, vital to Iran's besieged economy, has sharpened tensions in the Persian Gulf. In response, Tehran has threatened to block the strategic Strait of Hormuz in case new sanctions are imposed.[96]

Starting from the first oil crisis up to date, issues related to energy security define the international political agenda. While, if traditionally energy security was primarily associated with oil disruption in the oil-producing world, with particular focus on the Middle East, the paradigm has enlarged greatly as a response to the developments in the international arena. The fact is that the five traditional elements of energy security – demand centers, supply sources, geopolitics, market structures and institutions – have all changed over the past forty years.[97] For example, the current global energy security agenda besides stressing upon the risks associated with oil production and transportation, frequently refers to the challenges of natural gas industry, particularly, to the issue of high prices of this energy source, increasingly becoming a global commodity. Moreover, international terrorism and climate change were not on the agenda in 1970s. Finally, globalizaton had a huge impact on the the nature of relations between the producing and consuming countries. So, what is obvious is that the 1970s model is no longer appropriate due to the fact that the economic and political environment, which determines the framework of global energy security has changed greatly.

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[94] Jorge Blázquez and José María Martín-Moreno, The Rise of Emerging Markets and Its Impact on Global Energy Security (May, 2012). ESADEgeo, Center for Global Economy and Geopolitics, pp. 4-5.

[95] Tobias Vanderbruck, Iran, Oil and Strait of Hormuz (February, 2012). (Webpage: http://www.oil-price.net/en/articles/iran-oil-strait-or-hormuz.php).

[96] EU Ban on Iranian Oil Hikes: Strait of Hormuz Tensions (May, 2012). (Webpage: http://www.upi.com/Business_News/Energy-Resources/2012/01/05/EU-ban-on-Iranian-oil-hikes-Strait-of-Hormuz-tensions/UPI-79861325784664/).

[97] The New Energy Security Paradigm (Spring, 2006). World Economic Forum in partnership with Cambridge Energy Research Associates, p. 4. (Webpage: https://members.weforum.org/pdf/Energy.pdf).

For a better understaing of contemporary and future state of global energy security the main concerns of the international community and threats to the sector should be analized. The awareness of a potential threat may contribute to a more or less timely and adequate response from state and regional or international actor to prevent or at least to decrease the damage to be caused or to finding an alternative solution to the upcoming problem beforehand.

The fear that has started to dominate over the others is that the world is quickly using up the vast but finite amount of fossil fuels. According to the estimations of the experts, humanity has already peaked in fossil fuel extraction and production.[98] The fact is that the development of world economy takes place in parallel with the continuous rise in global energy production. For example, from 1960 up to 2010 the production of crude oil in the world increased from about 20 mb/d to 74 mb/d.[99] If the growth rate of world oil consumption observed in the last decade continues, the reserves of this raw material proven to date, will be exhausted by about 80% during the period 2020-2030 . In contrast, another group of authors argue that instead of a fixed amount of resources we have to deal with the flow rate of reserves. That is, one the one hand, humanity consumes oil that decreases the reserves of the resource, on the other hand, the investments made in the geological investigations could explore new oil reserves.[100] Though these investigations may cover the expenses, it cannot be stated firmly whether the newly found reserves would be sufficient to satisfy the demands for energy resources of growing population of the world. In this context another subject of international controversy should be mentioned. The issue is whether it is population growth or economic choices (patterns of consumption, production, etc.) that drive resource depletion and energy needs. The former implies countries like China and India are major causes of problems, and the latter implies that economic policies, perhaps even fundamental economic ideologies may be major problems. The fact is that the rich countries blame the developing world for the global

[98] Anup Shah, Energy Security (May, 2011). Global Issues. (Webpage: http://www.globalissues.org/article/595/energy-security).

[99] Transportation Energy Data Book, U.S. Department of Energy. (Webpage: http://cta.ornl.gov/data/chapter1.shtml)

[100] Nikolay Mironov, International Energy Security (*in Russian* - Mejdunarodnaya Energeticheskaya Bezopasnost) (2003), pp. 15-16.

problems, arguing that defending the right to development may appear to promote bad policies that are not sustainable for the environment. Yet, the enormous waste of resources in global economic system by the industrialized countries is rarely discussed.[101]

It is noteworthy that the western nations form a small percentage of the world population but consume far more resources. Problems such as climate change and energy depletion are thus largely caused by these nations. However, as the developing countries, like China and India, also grow rapidly there is a fear that these countries' demands for energy and resources will very quickly see the world's natural resources stripped away even more quickly given their large population sizes.[102] The fact is that the emerging economies started to play a significant role in the world economy and, particularly in the energy industry. Moreover, their share in the global economy will increase in the future. It can be anticipated that nearly half of global oil demand growth over the next ten years will occur in the Asia Pacific.[103] While already by 2030 the energy demand from non-OECD economies will be twice as much as the OECD's.[104] Although the oil demand growth will be focused in China and India, the countries of Latin America, the Middle East and Africa will see substantial growth in oil demand over the next decade as well. Thus, both the supply sources and the demand centers for oil are shifting, with direct implications for energy security issues.[105]

These substantial changes in the structure of global enegry security should be reflected in the policy of IEA. The matter is that the countries that have started paving their way towards the inclusion in the industrialized world are not members of the Agency. Thus, a new scenario, which will stress upon the high need for active cooperation between developed countries and new emerging powers, should be

[101] Anup Shah, Energy Security (May, 2011). Global Issues. (Webpage: http://www.globalissues.org/article/595/energy-security).

[102] Ibid.

[103] The New Energy Security Paradigm (Spring, 2006). World Economic Forum in partnership with Cambridge Energy Research Associates, pp. 12-16. (Webpage: https://members.weforum.org/pdf/Energy.pdf).

[104] Jorge Blázquez and José María Martín-Moreno, The Rise of Emerging Markets and Its Impact on Global Energy Security (May, 2012). ESADEgeo, Center for Global Economy and Geopolitics, p. 25.

[105] The New Energy Security Paradigm (Spring, 2006). World Economic Forum in partnership with Cambridge Energy Research Associates, pp. 14-20. (Webpage: https://members.weforum.org/pdf/Energy.pdf).

developed. Only in case of inclusion of both sides the stability of global energy security will be guaranteed and the creation of an efficient global energy security policy will become possible.

The increasing demand for sources of energy by the emerging economies will not only result in a greater participation of the states in the global economy, but in the world politics as well. This is one of the major concerns of the developed world. According to some scholars, the clash of interests in ensuring secure access to energy between the two groups of countries can even result in new geopolitical cold war.[106] From this perspective, what could present even a greater threat is the possible support of dictatorships, which can be justified to the home population as being for the "national interest".[107] The link between the form of the government and global energy was studied by Thomas L. Friedman. As mentioned by author, there is a negative correlation between the global oil price and the level of freedoms in the oil producing states with weakly developed institutions. This phenomena was called "the first law of petropolitics", the main characteristic of which is the following: "… higher the average global crude oil price rises, the more free speech, free press, free and fair elections, an independent judiciary, the rule of law, and independent political parties are eroded".[108] According to Friedman increase in oil prices creates favourable conditions for the oil-exporting states to resist external and domestic pressures for more political freedoms. This can be explained by the fact that countries become less dependent on the foreign investments. Moreover, these additional oil revenues allow the regimes to support larger security structures.[109] In this context, another serious threat to the global energy security, terrorism, can be discussed. Throughout the history the energy sector facilities have frequently become the targets for terroristic organizations. As stated by Peter Johnstone, the vulnerabilities include the pipelines, refining and storage facilities, shipping chokepoints, and loading facilities, which were being chosen in terrorist

[106] Anup Shah, Energy Security (May, 2011). Global Issues. (Webpage: http://www.globalissues.org/article/595/energy-security).

[107] Ibid.

[108] Thomas L. Friedman, The First Law of Petropolitics (May-June, 2006). Foreign Policy, pp. 28-36; (Webpage:http://aphrodite.aua.am:2061/ehost/pdfviewer/pdfviewer?sid=79a9d9ac-3a0f-4052-a591-e9436349584d%40sessionmgr10&vid=2&hid=21).

[109] Ibid.

attacks of both regional and international scope.[110] Today terrorism cannot be discussed separately from piracy, which has gained momentum in the late 20th and early 21st centuries. According to 2011report issued by the International Maritime Bureau's Piracy Reporting Center there has been a steady increase in reported piracy incidents worldwide in recent years. There were a total of 445 incidents reported, 217 of which were attributed to Somali pirates. Some of the attacks were directed against vessels of petroleum industry, which resulted in the disruption of the supply chain.[111].

It should be noted that the threats posed to the global energy security do not exist in isolation; they depend on each other and one can cause the formation or exacerbation of the other. Thus, the possible future depletion of natural resources could result in a harsher and more severe struggle for the control of the energy resources, increasing the number and enlarging the scope of terrorist attacks. This could be done with the purpose of not only having an access to energy sources, but for using the ownership and control of energy resources as a political weapon. The exclusive possession of energy resources in a particular region can determine the relations between consumers and producers to a large extent. The case of Russia is a vivid example of the usage of energy as a tool of foreign policy, posing a threat to EU's energy security. Taking into consideration the fact that Europe's natural gas needs are predicted to double over the next 25 years with simultaneous decline in the domestic production, the EU's energy security will much depend on the development of an integrated approach to energy policy.[112]

In most of the developed and in some of the developing courtries energy policy and environmental policy go hand in hand. The issue of climate change has affected the perception of energy security greatly. The high need for meeting the environmental concerns was reflected in major environmental conventions of the previous and current centuries. Today, China and India are urged to decrease the greenhouse gas emissions into the atmosphere, while the latters emphasize that they have a

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[110] Peter Johnstone, Energy Security Threats (June, 2011). The Technical Cooperation Program, pp. 38-40. (Webpage: http://drdc-rddc-gc.academia.edu/PeterJohnston/Papers/840169/Energy_Security_Threats).

[111] Ibid.

[112] Robert F. Winchester, European Energy Security: Wrestling the Russian Bear For Caspian Natural Gas (2007). United States Department of State, pp. 8-10. (Webpage: http://www.dtic.mil/cgi-bin/GetTRDoc?AD=ada471533).

right to development, and they have not been the ones wastefully pumping greenhouse gases into the atmosphere for as many decades.[113]

The fact is that much more options are available today than it was in 1970s, not only from the perspective of finding a solution to the environmental issues or to the problem of fossil fuel depletions, but for the creation of a more stable, reiliable and diversified energy supply system. Many experts consider the development of renewable energy as an optimum long-term strategy that may solve all these problems. For example, as mentioned by A. Marjanyan Armenia survived during the severe energy crisis of the 90s only thanks to the fact that the Republic had developed renewable energy, particularly hydropower sector in due time. The fact is that this sector of energy was not subjected to "blockade".[114] It is no coincidence that in March 2007 EU member states agreed to a legally binding target mandating that 20% of total European energy consumption be fueled by renewable energy sources by 2020. Today hydro, wind, solar and bio-mass energy account for less than 7% of Europe's total energy consumption and 15% of its electricity generation. For the purpose of promoting the use of energy from renewable sources, the European Commission proposed individual national renewable energy target, which will based on the natural and geographic conditions of the states.[115] For instance, Austria and Latvia promote hydro power, while the Czech Republic and Portugal have committed financial support to large solar energy facilities. Germany, Sweden and the UK are home to major wind farms off their coasts. Bio-mass and biofuel programs are becoming more attractive.[116]

With regards to the share of renewable power in global energy consumption, it reached 1.3% in 2010, up from 0.6% in 2000. Renewables accounted for 2.2% of OECD energy consumption in 2010, compared to 0.6% in the non-OECD. While the aggregate shares remain low, for some individual

[113]Anup Shah, Energy Security (May, 2011). Global Issues. (Webpage: http://www.globalissues.org/article/595/energy-security).

[114] Ara Marjanyan, The Future We Must Not Miss (June, 2011). "21-st CENTURY", № 2 (3).

[115]Renewable Energy, European Commission. (Webpage: http://ec.europa.eu/energy/renewables/targets_en.htm).

[116] Paul Belkin, The European Union's Energy Security Challenges (January, 2008). Congressional Research Service. Report for Congress, pp. 25-27

countries renewable power now contributes a significant share of primary energy consumption. Eight countries have a renewables share of more than 5%, led by Denmark with 13.1%.[117]

The utilization of renewable energy has many advantages[118] compared to the conventional energy, but this does not mean that the world can shift to the clean energy in one day. Alternatives should be phased-in gradually, where the role of the government's support and encouragement is crucial (for example, in the form of subsidies and tax incentives or legislative initiatives). However, some scholars argue that the development of renewable energy is contrary to the interests of the governments. The development of clean energy technology could give individuals, communities, cities, and countries overall energy independence, which could be considered as a threat by oppressive central governments. Moreover, this could also pose a threat to oil producing countries, lessening their ability to manipulate oil prices for political purposes and substantially damaging their oil depending economies[119] Nevertheless, as the number of oil-exporting regions that are prone to conflicts increases (if in the 1970s the risks were limited to the Middle East, in the past few years the scope of politically unstable regions, where a large fraction of known reserves of oil and gas is located, has increased dramatically. Today, Central Asian, African (Nigeria and Sudan) and Latin American (Venezuela) countries, as well as Iraq and Iran present serious problems for oil importing countries and are considered as a threat to energy security)[120], which is considered as one of the major threats for oil-importing countries, the idea of more active utilization of renewable energy sources becomes embedded.

Another major threat to the global energy security that was discussed by Peter Johnstone is the nationalization of energy industry infrastructure. This is defined as a practice of taking over the operations of international oil companies or exploiting previously underdeveloped resources through a state-owned oil company. The ratio of national oil companies (NOCs) to international oil companies (IOCs) has

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[117] Renewable power consumption grew by 15.5% in 2010, the fastest rate of expansion since 1990. British Petroleum. (Webpage: http://www.bp.com/sectiongenericarticle800.do?categoryId=9037716&contentId=7069274)

[118] For more information see Part 2.3, p. 65

[119] Anup Shah, Energy Security (May, 2011). Global Issues. (Webpage: http://www.globalissues.org/article/595/energy-security).

[120] Raymond Atje and Indira Hapsari, Energy Security: An Indonesian Perspective (Beijing, 2008), pp. 1-2. (Webpage: http://www.rsis-ntsasia.org/activities/conventions/2008-beijing/atje.pdf).

changed dramatically since 1970s, so that in 2008 about 92% of total global reserves were held by nationalized companies. This trend has a negative impact on the security of energy supply. Firstly, the author mentions that IOCs usually operate more effectively than NOCs. Secondly, the revenue from the operations is not reinvested back into the industry, but rather is used for the support of various non-productive programs (to sustain arm races, to support terrorists), which not only decreases the amount of oil available in the market, but also can lead to domestic security challenges.[121] As result, the global security of energy supply finds itself in jeopardy and the oil-importing states become even more vulnerable.

Apart from the threats and concerns that have been mentioned above, natural disasters, like earthquakes or hurricanes, can also become a major source of a threat. For example, the hurricanes in the Gulf of Mexico (Rita and Katrina in 2005, Ike in 2008) meant that consumers in the United States would see the new risks in terms of higher and more volatile prices both at the gasoline pump and in their home heating bills.[122] These events, damaging significant oil and gas facilities, created major fuel supply challenges.

Based on the above mentioned material it can be concluded that while ensuring energy security continues to be the primary obligation of any state, the complexity and universal character of the above mentioned risks and threats, as well as the scope of concerns about the challenges of global energy security determine the incapability of a single state for finding an adequte response. Thus, global nature of energy security issues has a direct effect on the energy security of individual states. Therefore, it is no coincidence that energy policies of numerous developed and developing countries, particularly of energy-importing countries, including Armenia, stress upon the high need for the development of renewable energy, which is considered as a mean of decreasing the country's dependence on possible future energy crisis at a global level.

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[121] Peter Johnstone, Energy Security Threats (June, 2011). The Technical Cooperation Program, pp. 35-37. (Webpage: http://drdc-rddc-gc.academia.edu/PeterJohnston/Papers/840169/Energy_Security_Threats).

[122] The New Energy Security Paradigm (Spring, 2006). World Economic Forum in partnership with Cambridge Energy Research Associates, pp. 4-5. (Webpage: https://members.weforum.org/pdf/Energy.pdf).

Part 1.3 The Problems of Energy Security of the South Caucasus

Based on the geographical location and presence or absence of energy reserves each of the three South Caucasian republics solves the problem of energy security in their own way.

Azerbaijan ensures its energy security through the development of its oil and gas industry and international cooperation in the field of mining and energy exports. In the National Security Concept of the Republic of Azerbaijan among the key activities aimed at ensuring the national security the following ones are mentioned: development and exploitation of the existing and prospective oil and gas reserves in the Azerbaijani sector of the Caspian Sea; construction and installation of modern oil and gas platforms; identification and assessment of the threats to the main oil and gas pipelines and terminals and taking appropriate countermeasures.[123] As the President of SOCAR (State Oil Company of Azerbaijan Republic), Rovnag Abdullayev mentioned the oil reserves of Azerbaijan totaled about four billion tones and the gas reserves about six trillion cubic meters. According to Abdullayev, the companies' oil production, increasing each year, passed the 50-million-ton milestone, while gas production almost reached 30 billion cubic meters.[124] Based on these indicators, Baku declares that the energy security of the country is completly ensured and the Republic has turned from an importer into a major exporter of gas both in the region and in the world. The National Security Concept of the Republic of Azerbaijan also emphasizes that "among the key tasks of the national security of the Republic of Azerbaijan are ensuring the security of energy transportation between the Caspian Sea, the Black Sea and the Mediterranean Sea via the Baku-Tbilisi-Ceyhan main export oil pipeline and the South Caucasus gas pipeline, as well as of the crucial facilities which ensure the geo-strategic and economic interests of the Caspian littoral States, and to this end managing and diminishing the growing risks.[125]

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[123] National Security Concept of the Republic of Azerbaijan (May, 2007), p. 20. (Webpage: http://www.un.int/azerbaijan/pdf/National_security.pdf).

[124] Energy Security of Azerbaijan is Completely Ensured (*in Russian* - Energeticheskaya Bezopasnost Azerbaijana Polnostyu Obespechena) (10 May, 2012). (Webpage: http://www.trend.az/capital/energy/2024252.html#popupInfo).

[125] National Security Concept of the Republic of Azerbaijan (May, 2007), p. 20. (Webpage: http://www.un.int/azerbaijan/pdf/National_security.pdf).

One of the key challenges facing Azerbaijan is the creation of alternative routes for energy supplies to the world markets, which would ensure the national security of the country and would allow to run a more independent foreign policy.

On the 14th of September in 2010 during the meeting between the Presidents of Azerbaijan, Georgia and Romania and in the Hungarian Prime Minister presence a memorandum with the purpose of creating a joint company to determine the feasibility of natural gas exports from Azerbaijan and Georgia to the Romanian port of Constanta was signed in Baku. According to the project, known as "Azerbaijan, Georgia, Romania Interconnection" (AGRI), the natural gas will be transported by pipeline from Azerbaijan to the Georgian port Kulevi (the latter is rented by Azerbaijan), then, being processed into compressed or liquefied state, will be transported to the Romanian port of Constanta by sea using tankers.[126] In the case the project is implemented, Azerbaijan will be able to diversify not only the transport routes, but the exported resources as well (partialy to shift to the supply of compressed or liquefied gas).

Apart from the Shah Deniz gas field, new deposits of natural gas were found in Azerbaijan. In December 2010 the SOCAR announced the opening of a new gas field, Umid, at a depth of 6500 meters. The fact is that all investigations of the field were undertaken by Azerbaijani oil and gas company itself. According to the preliminary estimates, the gas reserves in the deposit account for about 200-300 billion cubic meters. It is noteworthy that another field of natural gas, Babak, may be even more promising, as the reserves may turn to be twice as much as those of Umid.[127]

The increase in natural gas production in Azerbaijan is conditioned by the growing demand for this type of energy carrier and by the existing infrastructure in the Republic. The resolution of this task presupposes the existence of diversified transportation corridors, through which Azerbaijani gas could be

[126] Georgia Pumped Up About LNG Project With Azerbaijan, Romania (4 May, 2010). (Webpage: http://www.eurasianet.org/node/60980).

[127] SOCAR Prepares For Drilling New Exploration Well at Umid Offshore Field (14 January, 2011). (Webpage: http://www.news.az/articles/economy/29763).

easily exported to the European markets. However, the search for alternative routes is connected not only with political, but primarily with commercial and economic interests of the country.

Azerbaijan seeks to derive maximum benefit from gas exports, which should be supported by additional capabilities of Kazakhstan and Turkmenistan. At the same time the Nabucco project, supported by the European Union and the United States, is being discussed.

A bilateral agreement on the transportation of 16 billion cubic meters of gas form the "Shah Deniz" was signed between Baku and Ankara. From the volume mentioned, about 6 billion cubic meters of gas would be consumed in Turkey, while the remaining 10 billion cubic meters would be exported to the European countries. For bringing the project to life, the parties agreed on the construction of a new gas pipeline, the Trans-Anatolian gas pipeline, on the territory of Turkey towards the end of 2017. It is not hard to guess that after the construction of the latter the second part of the Nabucco project could be easily annexed. That is, the insufficient volume of the Azerbaijani gas, necessary to satisfy the need of the European countries, would be supplemented by the Kazakh and Turkmen fuel.[128]

Regarding the issue of oil export to the world markets, Baku with the assistance of the United States and the European Union is trying to persuade Astana to use the power of the Baku-Tbilisi-Ceyhan oil pipeline for the transportation of Kazakh oil in the Western direction.

With regard to the potential challenges of energy security of Azerbaijan, according to Baku, the most pressing of them are the attempts to undermine this sector of industry through political means or by inflicting physical damage to the related infrastructure.[129] As mentioned by A. Marjanyan not less important is the dependence of the energy sector of the country on one energy carrier, the sharp change of the price of which could have a negative impact on the energy and, consequently, economy of Azerbaijan overall.[130] Therefore, it is no surprise that even despite the complete ensuarance of the enegry security

[128] Silviya Khachatryan, Undestandable Choice (Ponyatniy Vibor) (May, 2012). (Webpage: http://etpress.ru/?content=article&id=4066).

[129] National Security Concept of the Republic of Azerbaijan (May, 2007), p. 6. (Webpage: http://www.un.int/azerbaijan/pdf/National_security.pdf).

[130] Interview with Ara Marjanyan (Coordinator of WB/GEF Renewable Energy Project in Armenia; "Noravank" Foundation), Yerevan, 6 June, 2012.

declared by Baku, the National Security Concept stresses the need for the development of alternative energy sources in the Republic of Azerbaijan. Given that Azerbaijan has a favourable number of sunny and windy days annually, energy needs of the country can be partially met by making use of power stations generating energy from wind, sun, biomass, lower mountain waters and by hydroelectric power stations.[131]

Thus, it is no coincidence that during the international conference titled "Azerbaijan-2020: Renewable Energy and Sustainable Development" that was held in Baku in April this year, the Minister of Industry and Energy of Azerbaijan, Natiq Aliyev stated that despite the fact that the oil and gas reserves would meet the need of several generations, the Azerbaijani authorities had made a decision to develop renewable energy.[132] The Minister also added that they "planned to increase the share of renewable energy in the energy mix of Azerbaijan up to 10% until 2020, but the President took the initiative to achieve the level of 20%....Azerbaijan possesses all the necessary capabilities to achieve this goal".[133] It is noteworthy that the Baku has not postponed putting the words unto action; by a decree from 1 June the President of Azerbaijan, Ilham Aliyev, State Company on Alternative and Renewable Energy Sources was formed. The main objective of the agency is to identify the sources of renewable energy in the Republic and contribute to the development of the sector overall.[134]

The next country of the South Caucasian region to be discussed in the study is Georgia. In the National Security Concept of Georgia is stated that the Republic is a part of important energy corridors, and is aware of its role in supplying the rest of the world with energy resources from the Caspian Sea and Central Asian regions via alternative routes.[135] Among the latter the Baku-Supsa, Baku-Tbilisi-Ceyhan oil pipelines and the Baku-Tbilisi-Erzurum gas pipeline can be mentioned. Thus, Georgia ensures its energy

[131] Interview with Ara Marjanyan (Coordinator of WB/GEF Renewable Energy Project in Armenia;"Noravank" Foundation), Yerevan, 6 June, 2012.

[132] Azerbaijan to Increase the Share of Renewable Energy Up to 20% Until 2020 (April, 2012). (Webpage: http://abc.az/rus/news/64296.html).

[133] Ibid.

[134] The President Ilham Aliyev Signed a Decree on the Establishment of STARES (President Ilkham Aliyev Podpisal Ukaz o Sozdanii GKAVIE) (June, 2012). (Webpage: http://az.salamnews.org/ru/news/read/140286/prezident-ilxam-aliev-podpisal-ukaz-o-sozdanii-gkavie/).

[135] National Security Concept of the Republic of Georgia (2005), p. 24. (Webpage: http://www.nsc.gov.ge/files/files/National%20Security%20Concept.pdf).

security not only through the transit of Azerbaijani energy resources in the western direction, but through the import of these fuels as well. Thus, the President of Georgia Mikheil Saakashvili during his visit to Baku (March 6, 2012) stated that with the help of Azerbaijan, Georgia has managed to strengthen its energy security. M. Saakashvili emphasized that "the steps towards the energy security of Georgia, made on the assumption of friendly relations, contributed both to the development and formation of our country's independence, for which we would always be grateful".[136]

However, despite the fact that Azerbaijan plays an important role in ensuring the energy security of Georgia through the supply of energy resources (for example, 15-20% of electricity is produced by thermal power plants), Tbilisi realizes that the country could become a "hostage" of the political interests of its Eastern neighbor. Thus, as mentioned by H. Baghdasaryan Azerbaijan could use this energy dependence of Georgia for its own political interests, for example with the purpose of even greater isolation of Armenia.[137] It is no coincidence that in the first National Security Concept of Georgia the development of energy infrastructure, the more efficient use of hydropower, and research into other clean-energy resources are among the main priorities of Georgia's energy policy.[138] The fact is that hydropower resources play a significant role in ensuring the energy security of the Republic. The hydroelectric power plants produce about 80-85% of Georgia's electricity consumed within the country. The power capacity of the largest hydroelectric power station "Inguri" is 1300 MW, but the difficulty lies in the fact that it is located in Abkhazia, and this raises concerns in terms of energy security. Moreover, according to the authorities, Georgia has exploited only 18% of its hydropower resource potential so far.[139]

Apart from the hydropower, the utilization of renewable energy sources contributes to the enhancement of energy self-sufficiency of the Republic. Thus, "Georgia actively cooperates with foreign

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[136] Georgia Has Managed to Strengthen Its Energy Security With the Help of Azerbaijan (March, 2012). (Webpage: http://www.1news.az/politics/20120306085352574.html).

[137] Interview with Hrant Baghdasaryan (Deputy Chief Engineer at "Yerevan Telecommunication Research Institute" CJSC), Yerevan, 5 June, 2012.

[138] National Security Concept of the Republic of Georgia (2005), p. 24. (Webpage: http://www.nsc.gov.ge/files/files/National%20Security%20Concept.pdf).

[139] Georgia Intends to Attract $3,5 billion of Investments Into the Hydropower Sector (*in Russian* - Gruziya Raschitivayet Privlech $3.5 invetitsiy v Gidroenergetiku) (February, 2011). (Webpage: http://energo-news.ru/archives/50280).

investors on developing renewable energy resources".[140] As Marjanyan emphasized Georgia to a large extent relies on foreign investments for increasing the role of renewable energy in the energy sector of the Republic overall.[141]

Moreover, for the purpose of increasing the energy independence of the Republic, the Georgian authorities have developed a governmental program aimed at expanding the usage of renewable energy sources. This program includes: the provision of government subsidies (10-12%) to the producers of "clean" energy; provision of government guarantees to producers in respect of the energy purchases at preferential prices; the establishment of tax cuts policy for the producers of "clean" energy.[142]

The most significant source of renewable energy in Georgia is hydropower. There are 26,000 rivers in the Republic, out of which only 12% is being exploited. The fact is that actual usage of hydropower resources falls behind the plans posed by the Government of Georgia.[143] About 85% of the hydroelectric power is concentrated in Western Georgia. As mentioned by Minister of Energy of Georgia, Alexander Khetaguri, Tbilisi intends to attract $3,5 billion for the construction of 15 hydropower plants with the purpose of becoming the main exporter of electricity in the region. The projects should be implemented within 2-3 years.[144]

The estimated potential of another source of renewable energy, wind energy, is 2300 MW. Currently, there are only a couple of small wind plants installed with a capacity of 6 kW. However, the existence of wind energy resource atlas will contribute to exploitation of this resource in the future. In fact, four main regions with the highest potential of wind energy were determined: the alpine zone of the Caucasus, the valley of the Mtkvari River, South Georgian plateau and the Southern highlands of the Black Sea region.

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[140] National Security Concept of the Republic of Georgia (2005), p. 24. (Webpage: http://www.nsc.gov.ge/files/files/National%20Security%20Concept.pdf).

[141] Interview with Ara Marjanyan (Coordinator of WB/GEF Renewable Energy Project in Armenia; "Noravank" Foundation), Yerevan, 6 June, 2012.

[142] In-depth Review of Policies and Programmes in the Sphere of Energy Efficiency in Georgia (2006). Energy Charter Secretariat, pp. 37-38. (Webpage: http://www.allbeton.ru/bibliotek/).

[143] Interview with Ruben Abrahamyan (independent expert), Yerevan, 4 June, 2012.

[144] Georgia Intends to Attract $3,5 billion of Investments Into the Hydropower Sector (*in Russian* - Gruziya Raschitivayet Privlech $3.5 invetitsiy v Gidroenergetiku) (February, 2011). (Webpage: http://energo-news.ru/archives/50280).

In these four regions the average annual wind speed is more than 6 meters per second at a height of 30 meters.[145]

Armenia is the last country to be discussed in this part of the essay. Emphasizing the importance of institutional and sectoral reforms' complex, the Republic of Armenia directs the latter at enhancement of its energy security, which presupposes the diversification of energy supplies and production, the creation of new sources of energy, including nuclear energy, and the development of a stable and reliable export-oriented energy system.[146]

Currently, energy industry is in the process of modernization and implementation of ways that will ensure energy security of the Republic in the long run. In November of 2007 the Government approved the program of the Energy Ministry's (now Ministry of Energy and Natural Resources), which is aimed at the long-term development of the sector. The program is compatible with the provisions of the National Security Strategy and defines the following main activities of the Ministry:

- provision of reliable electricity at low costs to meet the needs of all consumers, while simultaneously promoting energy conservation;
- prevention of those resource import mechanisms, as a result of realization of which the security and economy of Armenia could fall into dependence on external events and political factors, while simultaneously increasing the share of domestic renewable energy sources;
- ensuring the safe operation of Metsamor nuclear power plant up until 2016, that is, up to the point when it will be possible to replace the obsolete power plant with the new one, as well as the elimination of nuclear power plant without unacceptable economic, social, environmental or energy consequences;
- provision of a viable power system, which is based on the principles of sustainable development and is within the framework of international obligations of environmental protection of Armenia;
- construction of a viable financial system with the efficiency of all structures and with the participation of a private capital;

[145] Shalva Pichkhadze, Georgia After November 2003: Achievements and Trends (Yerevan, 2005), p. 95.

[146] National Security Strategy of the Republic of Armenia, Official Bulletin of Republic of Armenia, 2007.02.15/11 (535).

- Construction of an export-oriented energy system with the added value of production.[147] (According to some experts in case of electricity surplus in Armenia, it could be export not only to Iran and Georgia, but to Turkey and Eastern European countries as well).[148]

It is no coincidence all the experts and the country's leadership are primarily interested in the nuclear energy. The fact is that, firstly, the Metsamor NPP generates about 40% of electricity used in the country annually, and, secondly, nuclear power is preferable to the thermal energy because of the low cost of electricity generated. The nuclear power plant in Metsamor is equipped with two power units, the expected lifetime of which is about 30 years. Armenian Nuclear Power Plant was commissioned in 1976.[149]

With the decommissioning if the nuclear power plant the level of Armenia's energy security will reduce significantly. By 2016 without nuclear power plant and two obsolete thermal power plants our country will need additional power capacity in the amount of 2000 MW. Even with the modernization of the thermal power plants, Armenia will not be able to provide itself with electricity without nuclear power plant. This is recognized by international experts as well. The latter provides the Government with the confidence to prepare for the construction of a new unit.

It is noteworthy that the Presidential Council on Nuclear Energy Safety was established in 1996. It was created by the agreement with the EBRD (European Bank for Reconstruction and Development). The Board consists of respected international experts, well known in the world of nuclear energy. The Council's main responsibility is the hearing of the annual reports on the actual state of nuclear safety at

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[147] The Program of the Ministry of Energy and Natural Resources of the Republic of Armenia (Novermber, 2007).

[148] Interview with Ruben Abrahamyan (Independent expert), Yerevan, 4 June, 2012.
Interview with Hrant Baghdasaryan (Deputy Chief Engineer at "Yerevan Telecommunication Research Institute" CJSC), Yerevan, 5 June, 2012.
Interview with Ara Marjanyan (Coordinator of WB/GEF Renewable Energy Project in Armenia; "Noravank" Foundation), Yerevan, 6 June, 2012.
Interview with Artak Hambarian (Associate Director of the Engineering Research Center at American University of Armenia), Yerevan, 8 June, 2012.

[149] Armenia: Follow-up Review of the Investment Climate and Market Structure in the Energy Sector. Energy Charter Secretariat (2008), pp. 90-92. (Webpage: http://www.encharter.org/fileadmin/user_upload/Publications/Armenia_ICMS_2008_ENG.pdf).

the Armenian NPP. The members of the Council consider the documents related to the security of Armenian NPP and give appropriate advice to the President of the Republic.[150]

The President of Armenia signed the Law on the use of nuclear energy for peaceful purposes in 1999. The Law stipulates the procedure for export, import and storage of nuclear and radioactive materials and radioactive waste. The provisions of the Law presuppose the licensing of organizations working in nuclear power sector, prohibit the import of radioactive waste and the export of nuclear and radioactive materials, radioactive waste, nuclear devices, and nuclear technology to countries that are not signatory to the relevant international agreements. The law provides for radioactive waste disposal at special facilities. The current Law may become the basis for the development of the future nuclear code.[151]

The main power generating facilities in the hydropower sector are the Sevan-Hrazdan cascade of hydro power plants (556 MW) (follow-up review) and Vorotan hydro power plant (400 MW) (total capacity about 1000MW), as well as a number of medium and small stations. According to the plans of the Ministry of Energy and Natural Resources, the Loriberd HPP, with the capacity of 60MW and 200 million kWh generated electricity per year, will become operational in 2015. The estimated cost of the project will total about 80 million Euros and will be implemented at the expense of "soft" government loans. It is also planned to finish the construction of another HPP, Shnokh, by the same time. The latter will have the capacity from 70 to 100 MW and electricity generated will amount 300-440 million kWh. The cost of the construction is total from $100 million to $140 million. And, the last project aimed at the construction of the largest HPP in Armenia, Meghri HPP with the capacity of 140MW, should be noted. On October 15th, 2010 the energy ministers of Armenia and Iran, Armen Movsisyan,

[150] National Report of the Republic of Armenia. Convention on Nuclear Safety (September, 2010), p. 8. (Webpage: http://www.anra.am/upload/5th%20National%20Report%20of%20Armenia_2010.pdf).

[151] The Ministry of Energy and Natural Resources of the Republic of Armenia. Law of the Republic of Armenia on Safe Use of Nuclear Energy for Peaceful Purposes (February, 1999). (Webpage: http://www.minenergy.am/hy/en/laws).

and Majid Namjou, signed a number of bilateral agreements and memorandums in Yerevan, including an agreement on the construction of HPP on the border river Araks.[152]

The "Program of Strategic Development of the hydropower sector" was approved by the Government of Armenia on September 8th, 2011. The document emphasizes the goals, objectives and priorities for the development of this segment of the national energy sector. The implementation of the plans presented in the program will make the creation of additional capacity of 450 MW in the country possible (for comparison, the Armenian NPP generates the same amount of energy) through the utilization of renewable energy sources. A number of small hydroelectric power stations will become operational, the installed capacity of each of which shall be not less than 30 MW.[153]

There are three thermal power plants in Armenia - Yerevan, Hrazdan, and Vanadzor. The latter, with a capacity of 96 MW, mainly met the needs of the Vanadzor chemical industry and did not play a significant role in the structure of electricity generation of our Republic. In contrast, the other two power plants, Hrazdan, with a capacity of 1100 MW, and Yerevan, with a capacity of 550 MW, occupy an important niche in the energy system of Armenia. The fact is that both stations have reached the end of their service life, and in the condition of increased gas prices have become rather unprofitable for operation. Meanwhile, along with nuclear power station, these plants provide the system with electricity in the base mode. For example, in winter period or when fuelling the nuclear power plant the energy system cannot manage without them.[154]

The unfinished 5th unit of Hrazdan thermal power plant after long trials was handed over to the Russian side in exchange for writting off the Armenian Government debt. The Russian company "Gazprom" invested about $180 million to modernize the unit. It was planned that the capacity of the unit

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[152] Government of Armenia. Energy Sector Development Strategies in the Context of Economic Development in Armenia. N1 resolution of N 24 protocol (Yerevan, 2005). (Webpage: http://unpan1.un.org/intradoc/groups/public/documents/apcity/unpan042544.pdf) (Accessed January 20, 2012).
For more information see Part 2.2, p. 61.

[153] Armenia Tries to Increase the Level of Its Energy Independence (September, 2011). (Webpage: http://www.regnum.su/news/1444070.html).

[154] Government of Armenia. Energy Sector Development Strategies in the Context of Economic Development in Armenia. N1 resolution of N 24 protocol (Yerevan, 2005). (Webpage: http://unpan1.un.org/intradoc/groups/public/documents/apcity/unpan042544.pdf) (Accessed January 20, 2012).

would be increased up to 440 MW.[155] Up until recently the electricity produced at the Hrazdan TPP was exported to Georgia, but because of the high costs the Northern neighbor refused to purchase it.

Half less powerful than Hrazdan TPP, Yerevan thermal power plant was constructed in 1960s. Of the installed capacity (550 MW) only 50 MW has been used recently. The new unit with the combined-cycle gas turbines will increase the efficiency of electricity generation from gas 2-2.5 times. The construction was made possible thanks to the loan provided by the Japan Bank for International Development in 2005, which allocated approximately $150 million. However, over the past five years the prices for equipment and construction have increased significantly.[156] In May 2011 Japan agreed to increase the amount of financial support up to $100 million. Apart from the increase of the cost of construction works and equipment, it was decided to build a more powerful unit, about 240 MW instead of originally agreed 205 MW. Already in 2011 this capacity allowed to produce 1,5 billion kWh electricity annually. Within two years the TPPs will be able to produce up to 4,3 billion kWh of electricity totally.[157]

With regard to the renewable energy, a the Part 2.3[158] discusses the sources, such as wind, solar, hydro, biomass, and geothermal, which are utilized and have the potential to be utilized in Armenia.

To summarize, Armenia's energy system consists of the following components: the Metsamor nuclear power plant produces about 40% of the country's electricity; hydropower plants account for about 40% of the overall electricity; thermal power plants generate about 20% of the Republic's electricity; the wind-generated electricity in Armenia accounts for 0.1% of the country's electricity.[159]

The energy sector of each of the three South Caucasian republics has its own peculiarities, which are conditioned not only by the reserves of energy resources, but also by the challenges posed to the industry and opportunities for enhancing the energy security of the states. However, the development of

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[155] For more information see Part 2.2, p. 60.

[156] Yerevan Combined-Cycle Thermal Power Plant, Armenia (Webpage: http://www.power-technology.com/projects/yerevancombinedcylce/).

[157] Ibid.

[158] For more information see Part 2.3, pp. 65-88.

[159] National Statistical Service of the Republic of Armenia: Yearbook 2011, p. 8. (Webpage: http://armstat.am/file/doc/99466673.pdf).

renewable energy has become one of the main common components constituting the energy policies of the republics, while even in this case the level of integration of the sector into the energy-mix varies across the states. Thus, the need for the development of renewable energy is emphasized in the National Security Concepts of both Azerbaijan and Georgia. Moreover, Azerbaijan has made a decision to increase the share of renewable energy in the energy mix of Azerbaijan up to 20% until 2020, while the Georgian authorities have developed a governmental program aimed at expanding the usage of renewable energy sources. With regard to Armenia, the important role of renewable energy sector in enhancing the energy security of the Republic, although still accounting for only 0.1% of the country's electricity and not being highlighted in the National Security Strategy, is stressed upon in various national documents.

In other words, all three countries have decided to increase the role of renewable energy in enhancing the energy self-sifficiency of the state, and the republic that will be the fastest in this "race" will be granted with opportunity to become less dependent on future challanges for energy and, consequently, national security.

Part 2 - Challenges and Opportunities of Energy Security of Armenia

Part 2.1 The Problems of Armenia's Energy Security Dependence on Russia

Russia plays a significant role in ensuring the energy security of the Republic of Armenia. The "North-South" pipeline, which passes through the territory of Georgia, supplies 1.9 billion cubic meters of Russian gas to Armenia annually. The Armenian and Russian sides are negotiating about increasing the volume up to 2.5 billion cubic meters.[160] Today one thousand cubic meters of Russian gas costs Armenia $180.[161] In 1997 Armenian-Russian CJSC "ArmRosgasprom" was established. The share of "Gazprom" in the authorized capital of "ArmRosgasprom" has risen from 45% to 80%.[162] The remaining 20% are owned by the Government of Armenia. Thus, despite the relatively law prices[163], today the major gain from the sale of the Russian gas to the population and economic entities of Armenia goes to the Russian, not to the Armenian side. Such an imbalance in the distribution of profits by no means can be regarded as just between the countries that are considered strategic allies.

An important role in ensuring the energy security of the Republic has the Abovyan gas storage facility, by means of which a strategic reserve of natural gas is created. For the purpose of increasing the holding capacity of the reservoir "ArmRosgasprom" invested 678 million AMD. As a result, the underground storage can reserve at least 150 million cubic meters of gas, which will allow to supply the Republic with gas within 1,5 month in case of a force majeure.[164]

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[160] Vahe Davtyan, Energy Security of Armenia and Russia's Geopolitical Interests in the South Caucasus (*in Russian* - Energeticheskaya Bezopasnost Armenii i Geopoliticheskie Interesi Rossii na Yujnom Kavkaze) (Yerevan: Antares, 2012), p. 79.

[161] The Prices of the Russian Gas Will Not Increase in Armenia in 2011 (*in Russian* - Tseni Na Rossiyski Gas Dlya Armenii v 2011 Godu Povishatsya Ne Budut) (25 February, 2011). (Webpage: http://www.gazeta.ru/news/lenta/2011/02/25/n_1721141.shtml).

[162] Sevak Sarukhanyan, Energy Security of RA: Main Achievements and Challenges, N2 (Yerevan, 2011), "21-st CENTURY", #2, p. 30.

[163] In January 2012 1000 m³ of Russian natural gas cost $440 in Germany, $416 in Ukrain, $387,96 in Moldova and $460-$480 in Romania (Website: http://economics.lb.ua/world/2012/03/12/140586_rossiya_prodaet_moldove_gaz_deshevle.html)

[164] Environment, Climate Change, Energy Security" of the Eastern Partnership Civil Society Forum (Kiev, 2010), Centre For Global Studies "Strategy XXI, p. 2. (Webpage: http://ua-energy.org/upload/files/Docs/wg3_csf_eap_infostream_feb_2010engl.pdf).

The Russian side managed not only to privatize the Armenian section of Iran-Armenia gas pipeline, but also not to allow the construction of a pipeline with a diameter exceeding 34 inches, which would allow Armenia to become a transit country for the transfer of Iranian gas to the North. With regard to the 5th unit of Hrazdan Thermal Power Palnt, Yerevan yield to the pressure of the Russian side in this issue as well; the latter became the owner of the unit.[165]

Russian company RAO UES managed to acquire the Electricity Distribution Networks of Armenia. Since the Russian company did not pass the international audit, it had no right to purchase the Armenian power grids. Therefore, it began to implement the plan via a little-known upstart Midland Resources, a British offshore-registered firm, which according to analysts and experts had close connections with Russian. In 2002 the British company succeeded in the acquisition of 80 percent stake of the Armenian Electricity Network (AEN).[166] Afterwards, Midland Resources trasfered the right for control over the Armenian Electricity Network for 99 years to the Russian company RAO UES. And already in 2005 the Armenian government gave its consent for the sale of Armenia's national power grid by British Midland Resources Holding to Interenergo, a subsidiary of UES.[167]

On the 4th December 2002, the Armenian Parliament ratified the Assets-For Debt Deal that was signed on 17 July 2002. According to the agreement, nearly $100 million of the Armenian debt to Russia would be eliminated by relinquishing control of five state-run Armenian enterprises. Since Armenia owed a debt for the deliveries of nuclear fuel for the Armenian Nuclear Power Station, in August 2003 Yerevan signed another agreement with RAO UES, according to which the latter became the owner of the Sevan-Razdan Hydropower Plant.[168] The same year in return for writing off the Armenian Government debt Russia also acquired the four units of the Hrazdan Thermal Power plant, the most productive power

[165] For more detailed information see Part 2.2, pp. 59-61.

[166] Vladimir Socor, Armenia's Energy Sector, Other Industrial Assets Passing Under Russia's Control (2002), p. 2. (Webpage: http://www.iasps.org/strategic/socor12.htm).

[167] Fatma Ash Kelkitli, Russian Foreign Policy in South Caucasus Under Putin (Istanbul, 2008), p. 88.

[168] Ibid.

station, generating around 20% of the country's electricity.[169] As for the "Assets-For Debt" program, most of political and public organizations of Armenia not without reason emphasized that if Russia wrote off debts of billions of dollars to the countries of far abroad, the $100 million debt of its strategic partner it could if not write off, then at least restructure.[170] Indeed, it seems very strange that while the U.S. provide financial assistance to Armenia, Russia proposes to its ally an unprecedented Assets-For Debt program (according to the Extraordinary Plenipotentiary Ambassador to Armenia John Heffern "throughout these 20 years the amount of our aid has exceeded 2 billion dollars".* At the same time, the U.S. signed an agreement with Armenia to implement the "Millennium Challenge" five-year program (2006-2011), according to which 235.6 million dollars were allocated to Armenia)[171] If the actions of Moscow are dictated by the desire to avoid accusations from the West in the usage of economic and, particularly the energy lever for political purposes, with respect to Armenia such a "pragmatic" approach is not justified; in this case Russia could claim that, given the factor of two-way blockade of Armenia, she can make concessions to her not only in the issues of debts, but gas tariffs as well. However, the "Assets-For Debt" program became possible to a large extent "thanks" to the insufficient firmness of the Armenian authorities as well, who ought to persuade Russia to at least restructure the Armenian debt.

In 2008 a memorandum between "Rosatom" and the Ministry of Nature Protection of Armenia was signed, which aimed at the development of co-operation in the field of exploration of uranium deposits and mining of uranium in Armenia. According to the document the parties intend to establish a joint venture, which will become the property of the two countries. The joint enterprise will operate on an equal footing, that is a 50-50 split of profits. Russia plans to invest $3 million in the exploration of

[169] Rita Karapetian, Armenia: Alarm at Russian Gas Deal (UK: Institute for War and Peace Reporting, 2006).

[170] Eduard Kazaryan, About Some Problems of Armenian-Russian relations (*in Russian* - O Nekotorikh Problemakh Armyano-Rossiyskikh Otnosheniy) (11 August, 2007). (Webpage: http://www.etpress.ru/?content=article&id=1748).

[171] Ambassador's Remarks on the U.S.-Armenian Relationship: The Next Twenty Years (April, 2012). (Webpage: http://armenia.usembassy.gov/news040212.html).

uranium deposits in our Republic (Syunik region). "Armenian-Russian Mining Company" will be in charge of the geological investigation of uranium deposits. According to the Russian experts the predicted reserves of uranium in Armenia may total about 60 thousand tons. Taking into consideration the high world prices for uranium, it can be firmly stated that the implementation of the "uranium project" can significantly boost the state treasury. Moreover, the Russian side mentioned that after the successful start of the work the amount of Russian investments could increase tenfold.[172] However, as mentioned by some experts the project would hardly have a success, as the assessements showed that Armenia is not rich in the reserves of uranium. Moreover, the specialists emphasized economic inexpediency of the project due to the costliness of the transportation of uranium to Russia for enrichment.[173]

With regard to the program of uranium mining in Armenia, two main questions arise. First, weather the radioactive contamination of the environment during the extraction of uranium was studied? Second, won't there arise any problems with the country, via the territory of which the Armenian uranium will be transported to Russia?

Armenian Nuclear Power Plant is an important factor in ensuring the energy security of the Republic; it produces about 40% of the state's electricity. It should be noted that until recently the financial management of the plant was implemented by the Russian side, which supplies the station with its nuclear fuel. From January 1st, 2012 the Russian energy holding "Inter RAO UES" suspended the management of financial flows of the Armenian NPP,[174] which undoubtedly will increase to some extent the independence of the Armenian side in the management of the station.

As the Metsamor's service life span ends in 2016, the European Union proposed to allocate 100 million euros for its closure to Yerevan. However, this option of the station's closure was not favorable

[172] For the Exploration of Uranium Deposits an Armenian-Russian Company was Established in Yerevan (*in Russian* - V Yerevane Sozadana Armyano-Rossiyskaya Kompaniya po Razrabotke Zalejey Urana) (22 April, 2008). (Webpage: http://www.regnum.ru/news/990428.html/).

[173] Interview with Ruben Abrahamyan (Independent expert), Yerevan, 4 June, 2012.
Interview with Hrant Baghdasaryan (Deputy Chief Engineer at "Yerevan Telecommunication Research Institute" CJSC), Yerevan, 5 June, 2012.

[174] The Head of "Rosatom" Does Not Consider the Participation of Russia in the Management of Armenian NPP a Necessity (*in Russian* - Glava "Rosatoma" Ne Schitaet neobkhodimim Uchastiye Rossii v Upravlenii Armyankoy AES) (8 February, 2012). (Webpage: http://www.atomic-energy.ru/news/2012/02/08/30679)

for the Republic and the Armenian authorities, in response to the EU's proposal, offered the latter to take part in the construction of the new NPP. Nevertheless, the offer did not find any response in Europe, and that is why Armenia had to turn to Russia on the matter.

During the visit of the Russian Prime Minister Viktor Zubkov to Armenia in 2008 a joint declaration was signed, referring to the cooperation between the governments of Armenia and Russia in the sphere of improving the reliability of operation and safety of the Armenian nuclear power plant, as well as the development of nuclear energy in Armenia.[175] The Director General of "Rosatom" Sergey Kiriyenko stated that, because the Armenian nuclear power plant would operate until 2016, there was a necessity to start building a new nuclear power stations already in 2010 – 2011.[176] The estimated cost of the Project will be around $5-7 billion, and the capacity of the new nuclear power plant will be around one thousand megawatt. As it was mentioned by S. Kiriyenko, the major investments would be provided by the Armenian Government, "but we are, of course, considering the participation of the Russian side as well. I have already mentioned that the Russian side is ready to make 20-25% investments, but we can also discuss a greater figure. In any case, the Government of Armenia should be the owner of 50 plus one percent share. But all this is a subject to negotiations", added Kiriyenko.[177] Taking into account the unfavorable financial situation of the Republic, one can hope that during the negotiations the Armenian side will be able to convince Russia to increase the volume of investments in the construction of a new NPP. With regard to the construction of the new unit of nuclear power plant some of the experts stressed the point that this might result in the increase of the electricity prices.[178]

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[175] Russia and Armenia Plan Atomic Projects *in Russian* - (Rossiya i Armenia Planiruyut Atomnie Proyekti), N4 (Saint Petersburg: Energy and Industrial Sector of Russia, February 2008). (Webpage: http://www.eprussia.ru/epr/96/7019.htm)

[176] Russia Will Take Part in Tender For Construction of the New NPP in Armenia (*in Russian* - Rossiya Primet Uchastie v Tendere na Stroitelstvo Novoy AES v Armenii) (6 February, 2008). (Website: http://arka.am/ru/news/economy/7957/)

[177] The Head of "Rosatom" Does Not Consider the Participation of Russia in theManagement of Armenian NPP a Necessity (*in Russian* - Glava "Rosatoma" Ne Schitaet neobkhodimim Uchastiye Rossii v Upravlenii Armyankoy AES) (8 February, 2012). (Webpage: http://www.atomic-energy.ru/news/2012/02/08/30679)

[178] Interview with Ruben Abrahamyan (Independent expert), Yerevan, 4 June, 2012.
Interview with Hrant Baghdasaryan (Deputy Chief Engineer at "Yerevan Telecommunication Research Institute" CJSC), Yerevan, 5 June, 2012.

Moreover, as mentioned by A. Marjanyan,[179] A. Hambarian,[180] and R. Baghdasaryan[181] the probability of the nuclear power plant's closure in 2016 is rather low and, according to the latest decision made by the Government the exploitation term of the plant would be prolonged through the modernization of the facilities. In this context, equally important is the fact highlighted by A. Marjanyan on the compliance of the Armenian NPP to the international standards, revealed during the inspection made by the specialists of IAEA this year.[182]

The recent earthquake in Van led to the declaration of the necessity to close the NPP in Armenia by the Turkish authorities. The Minister of Energy and Natural Resources of Turkey Taner Yildiz stated that "the station is located 16 kilometers from Turkey's border, uses old technology and can become the epicentrum of a disaster. Therefore, Turkey will continue campaigning for the closure of this plant".[183] Moreover, he stated that Turkey would make a speech at the IAEA for "the closure of all stations with the expired operation life".[184] Ankara's position on this issue was supported by Baku. Speaking at the Nuclear Security Summit in Seoul (March, 2012), the President of Azerbaijan Ilham Aliyev expressed his concern about the functioning of the outdated Metsamor nuclear power plant in Armenia and stated that this "station is a potential source of disaster for the region and close neighbors", because "it is located in a highly seismic zone".[185] In response, the President of Armenia Serzh Sargsyan qualified the statement made by the Azerbaijani President as

[179] Interview with Ara Marjanyan (Coordinator of WB/GEF Renewable Energy Project in Armenia; "Noravank" Foundation), Yerevan, 6 June, 2012.

[180] Interview with Artak Hambarian (Associate Director of the Engineering Research Center at American University of Armenia), Yerevan, 8 June, 2012.

[181] Interview with Hrant Baghdasaryan (Deputy Chief Engineer at "Yerevan Telecommunication Research Institute" CJSC), Yerevan, 5 June, 2012.

[182] Interview with Ara Marjanyan (Coordinator of WB/GEF Renewable Energy Project in Armenia; "Noravank" Foundation), Yerevan, 6 June, 2012.

[183] "Atomic" Armenia Threatens the region (*in Russian* - "Atomnaya" Armeniya Ugrojaet Regionu) (23 March, 2011). (Webpage: http://1news.az/analytics/20110323064633914.html)

[184] Energy Minister of Turkey: "Armenian NPP Should Be Closed" (*in Russian* - Minister Energetiki Turtsii: Armyanskaya Atomnaya Stantsiya Doljna bit' Zakrita) (4 November, 2011). (Webpage: http://deyerler.org/ru/85774).

[185] President of Azerbaijan: "Metsamor NPP is a Potential Source of a Disaster for The Whole Region" (*in Russian* - President Azerbaijana: "Metsamorskaya AES – Potentsialni Istochnik Katastrpfi Dlya Vsego Regiona") (27 March, 2012). (Webpage: http://news.day.az/politics/322897.html).

a "blatant misinformation"[186] At the same time, the head of the state noted that Turkey and Azerbaijan "breaking the rules of international law, continue to keep our country in blockade throughout the past two decades, and among a number of other problems leave no alternative in choosing the ways of energy independence".[187] In other words, the President of Armenia connected the issue of the functioning of the obsolete NPP with the blockade of the Republic by Turkey and Azerbaijan.

Commenting upon the situation, the following can be mentioned. The motivation of Ankara's and Baku's negative attitude towards the operation of the NPP was their concern about the expired life span of the station, which is located in seismoactive region. However, firstly, the operation life of the NPP ends in 2016. Secondly, as it was already highlighted, Armenia and Russia signed an intergovernmental agreement on the construction of new power-generating unit. Thirdly, as international experience shows, the cause of the most severe in their consequences accidents at modern nuclear power plants in Ukraine and Japan was not the expiration of their operation life. Baku and Ankara should be aware of all these facts. Moreover, the latter is planning to build three nuclear power stations in the seismically active Turkish territory. Thereat, a rational question arises: why Turkey, which intends to build nuclear power plants on its territory, together with his strategic ally, raised a clamor about the Armenian nuclear power plant? The fact is that the countries that have nuclear power plants on their territories are more protected by the international community, for the simple reason that, in case of military actions on the territories of theses states, the threat of destruction of the station will sharply increase, with further radioactive contamination of not only the country, on the territory of which nuclear plant is situated, but of all neighboring countries as well, particularly Turkey and Azerbaijan. Thus, the Armenian NPP is a certain restrictive factor for Baku and Ankara on the issue of military aggression against Armenia. On the other hand, depriving our Republic of NPP, the Azerbaijani and Turkish authorities will succeed in depriving Armenia of 40% of its electricity.

[186] Serj Sargsyan Condemned the "Blatant Misinformation" About Armenian NPP by Azerbaijan in Seoul (*in Russian* - Serj Sargsyan v Seoule Osoudil "Otkrovennuyun Dezinformatsiyu" Azerbaijana ob Armyanskoy Atomnoy Stantsii) (27 March, 2012). (Webpage: http://tert.am/ru/news/2012/03/27/serge-sargsyan/).

[187] Ibid.

It is noteworthy that in matters of ensuring the supply of the Russian gas to Armenia a series of threats to the energy security of our Republic exists. Firstly, Russia, on the basis of its economic or political interests, may raise the prices for the gas, transported to Armenia, at any time. Secondly, in case of a possible aggravation of the internal political situation in Georgia a threat of "North-South" pipeline operation suspension will emerge, as it has already happened in the past. Thirdly, Georgia may increase the transportation tariffs for the transit of Russian gas to Armenia via its territory. Fourthly, the sharpening of the situation on the Karabakh fronts can lead to diversions on that part of the Georgian section of the pipeline, which passes through the territory densely populated by Azerbaijani Turks, as it was the case throughout the Karabakh war. And finally, in 2010 the Georgian parliament passed a bill, according to which the Georgian section of the "North-South" pipeline was removed from the list of strategic facilities. This means that the pipeline can be privatized. Immediately after the decision made by the Georgian authorities the State Oil Company of Azerbaijan Republic (SOCAR) expressed its willingness to purchase the pipeline, which naturally raised concern in Armenia.[188] On this occasion, the Minister of Energy and Natural Resources of Armenia A. Movsisyan stated that the Georgian side had assured the Government of Armenia of the possible sale of only 25% stake of the Georgian portion of the "North-South" gas pipeline to the Azerbaijani company.[189] However, as the saying goes, "the appetite comes with eating", and it should not be excluded that becoming the owner of a 25% stake, SOCAR, having huge financial resources, could purchase the rest of the shares, with all ensuing negative consequences for the energy sector of Armenia.

Abstracting from the political component of the issue, it is worth mentioning that along with the development of conventional energy, other environmentally friendly renewable energy sources should be developed as well. The energy generated by these new sources should gradually replace the energy supplies from the external markets, which will enable our country to gain energy self-

[188] Baku Wants to Take Control of Georgian Gas Pipeline (16 November, 2010). (Webpage: http://www.easternpartnership.org/daily-news/2010-11-16/baku-wants-take-control-georgian-gas-pipeline).

[189] Georgia Not Selling Gas Pipeline (16 February, 2011). (Webpage: http://asbarez.com/93476/georgia-not-selling-armenia-gas-pipeline/

sufficiency. Becoming energy independent, Armenia will not only reduce the level of its political dependence, but will also become independent of any force majeure situations, as well as will avoid the threat of potential environmental disaster.

Part 2.2 The Problems of Armenia's Energy Security Dependence on Iran

After the collapse of the Soviet Union, not only due to its geographic position, but, primarily, due to its energy value, Iran became one of the key states actively influencing the geopolitical and geo-economic situation in the South Caucasus. With the formation of new geopolitical realities in the post-Soviet South Caucasus, Armenia on the basis of its own interests started the process of establishment and development of relations with its southern neighbor in the economic and, particularly, energy spheres. It is no coincidence that in the National Security Strategy of the Republic of Armenia is stated: "The development of traditional neighborly relations between Armenia and Iran is based on a number of shared realities: shared borders, historic and cultural ties, and mutual economic interests".[190]

In the first years of independence the Republic faced above all the problem of overcoming the acute fuel and energy crisis. The pipeline, through which the Russian gas via the Georgian and Azerbaijani territories was supplied to Armenia, was closed due to the Karabakh conflict. In these hard for Armenia times, when the Republic was blocked by Turkey and Azerbaijan, and the transport routes leading to the CIS countries (particularly to Russia) and Europe via Georgia were closed due to the Georgian-Abkhazian and Georgian-Ossetian conflicts, energy supplies from Iran became one of the priorities of the Republic's energy policy.

Although the supplies of the Iranian energy resources (particularly liquefied gas) contributed to the overcoming of the energy crisis to some extent, nevertheless, the issue of Iran-Armenia gas pipeline construction was placed on the agenda to ensure a higher level of energy security of the Republic.

[190] National Security Strategy of the Republic of Armenia, Official Bulletin of Republic of Armenia, 2007.02.15/11 (535).

On the 25th of December 1993 a meeting between the Vice President of the Republic of Armenia Gagik Harutyunyan and the Director of the International Affairs department of the National Iranian Gas Company Reza Sani Rostam took place, during which an agreement on the preparation of the joint project on the natural gas pipeline construction was signed.[191]

In December 2001 during the official visit of Armenian President Robert Kocharian to Tehran an agreement on the construction of Iran-Armenia pipeline (Tabriz-Meghri) was signed. According to this contract, at the first stage the pipeline will deliver 1,1 billion cubic meters of natural gas to Armenia and 2,3 billion cubic meters after 2019. The agreement was signed for 20 years.[192] In Iran the construction works started in spring 2005 and already in March 2007 the gas pipeline was inaugurated by President Ahmadinejad and his Armenian counterpart, Robert Kocharyan.[193] With regard to the tender for the construction of the main 197-km section of gas pipeline, Kajaran-Sisian-Jermuk-Ararat, a competition between the Russian "Gazprom" and the Iranian company "Sanir" unfolded, which ended up with the victory of the former.[194] Becoming the owner of the Armenian portion of Iran-Armenia pipeline, Moscow assured to reduce the diameter of the pipeline up to 34 inches instead of 48 inches that was formerly agreed upon.[195]

Deprivation of Armenia to become a transit country can be explained by the following circumstances. Firstly, a large diameter of the pipeline would allow Iran to supply gas to Georgia, which in its turn would gain an energy independence from Russia. Secondly, the Iranian gas could be delivered to the Black Sea ports of Georgia, and then in its liquefied form reach the

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[191] Aleksandr Kourtov, Armenian-Iranian Relations (*in Russian* - Armyano-Iranskie Otnosheniya). Armenia: The Problems of Independent Development (Moscow, 1998), pp. 428-429.

[192] Julien Zarifian, Christian Armenia, Islamic Iran: Two (Not So) Strange Companions. Geopolitical Stakes and Significance of a Special Relationship. Iran and the Caucasus (2008), vol.12, p. 134.

[193] Elabeb Koolaee and Mohammad Hossein Hafezian, The Islamic Republic of Iran and the South Caucasus Republics. Iranian Studies. vol. 43, Issue 3, (June, 2010), p. 7
(Webpage:http://aphrodite.aua.am:2061/ehost/pdfviewer/pdfviewer?sid=6a4f87f5-8377-47b3-8d76-a1404403e3ea%40sessionmgr15&vid=2&hid=19).

[194] Armen Vardanyan, Energy Diplomacy of Tehran in the Transcaucasian Region (*in Russian* - Energeticheskaya Diplomatiya Tegerana v Zakavkazskom Regione) (2005).
(Webpage http://www.centrasia.ru/newsA.php?st=1129770960).

[195] Gaidz Minassian, Armenia, a Russian Outpost in the Caucasus? vol. 27, (Russie: NIS Center, February, 2008), p. 10.

countries of Eastern Europe through the Black Sea, and thus, become a rival for the Russian gas in the European market. Unfortunately, in this matter the Armenian authorities submitted to the pressure of Moscow and agreed to the option presented by it.

A competition between the Iranian and Russian sides unfolded also on the issue of the fifth unit of Armenian Hrazdan thermoelectric plant. The fact is that in accordance with the agreement, Armenia should pay for Iranian gas in electricity, which is to be transmitted via the power lines to Iran (for each cubic meter of the Iranian gas, Armenia is supposed to return 3 kwh of electric energy to Iran).[196] This electricity must be produced on the fifth power unit. Apparently, originally the Armenian authorities tilted the balance in favor of Iranian companies, however, under pressure of Moscow they were forced to alter the decision. The two contradictory statements made by the Minister of energy of Armenia are indicative of that. So, on 23[d] of September 2005 it was stated that the transfer of the 5th unit of Hrazdan TPP to Iranian company has already been carried out, while in March next year the same Minister presented the "Gazprom" company as a candidate, which won the tender for the completion of the unit.[197]

Privatization of Armenian part of Iran-Armenia gas pipeline and 5th unit of Hrazdan TPP allowed Russia, firstly, preventing Iran from acquring a niche in the Armenia's energy market, to maintain its energy influence on the latter. Secondly, in case of force majeure situations, to ensure not only Armenian, but also joint Armenian-Russian companies, as well as the Russian military base with the alternative Iranian gas. Thirdly, to ensure the impossibility of the transfer of Iranian gas to Georgia and Eastern European countries.

Still and all, it is noteworthy that due to the unpredictability of the development of the situation in the South Caucasus, the presence of the second pipeline became one of the guarantors of Armenia's

[196] Vahe Davtyan, Energy Security of Armenia and Russia's Geopolitical Interests in the South Caucasus (*in Russian* - Energeticheskaya Bezopasnost Armenii i Geopoliticheskie Interesi Rossii na Yujnom Kavkaze) (Yerevan: Antares, 2012), p. 60.

[197] Eduard Kazaryan, South Caucasian Policy of Iran in the Energy and Transport Spheres (*in Russian* - Yujnokavkazskaya Politika Irana v Energeticheskoy i Transportnoy Spherakh), vol. 1 (Yerevan: Herald of Russian-Armenian University, 2007), p. 23.

energy security. Thus, the Armenian Energy Minister Armen Movsisyan stated: "We hope that in situation of force majeure by means of the Iranian gas we shall be able to supply the domestic demand fully and avoid blackouts".[198] He also mentioned that the transmission capacity of the pipeline was from 2.3 to 2.5 billion cubic meters of gas per year.[199]

Armenia and Iran also agreed to build a hydropower station on the Araks River. Back in May 1995 an agreement on the realization of the project was achieved.[200] And only on the 15th of October in 2010 the energy ministers of Armenia and Iran, Armen Movsisyan, and Majid Namjou, signed a number of bilateral agreements and memorandums in Yerevan, including an agreement on the construction of HPP on the border river Araks. According to the contract the construction will be financed by Iranin side; the Farab Sepasad Company was presented as an investment company to resolve all the financial and organization problems. The project includes construction of a cascade of two hydroelectric power stations, each with capacity of 130 MW, one of which - HPP "Meghri" - will be located in the Armenian territory. while the other - HPP "Karachilar" in Iran. The HPP is to be completed within five years, with the energy to be transmitted to Iran for the following 15 years by means of a 230kw power line to be constructed by the investor. RA Minister of Energy and Natural Resources A. Movsisyan reported that the estimated cost of electric energy is U.S. $0.05-0.06 per kw for return on investment to be ensured. After the 15-year-period expires, the Meghri HPP is to be transferred to Armenia.[201] In February 2012 the Energy Minister Armen Movsisyan stated that construction will begin this year.[202]

For the purpose of integration of Armenian and Iranian power networks, an agreement on the construction of the third power transmission line was signed by the parties. This agreement was

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[198] Gas Consumption in Armenia Could Reach 2.7 Billion Cubic Meters Per Year (*in Russian* - Potreblenie Gaza v Armenii mojet Sostavit do 2.7 Milliardov Kubometrov v God) (16 March, 2006). (Webpage: http://pda.regnum.ru/news/607558.html)

[199] Armenia Can Become a Transit Country For Iranian Gas (*in Russian* - Armeniya Mojet Stat Tranzitnoy Stranoy Dlya Iranskogo Gaza) (2 December, 2008). (Webpage: http://prim.regnum.ru/news/1092040.html).

[200] Kaweh Sadegh-Zadeh, Iran's Strategy in the South Caucasus, vol. 2 (1) (Frankfurt am Main: Caucasian Review of International Affairs, 2008), p. 3.

[201] Armenian-Iranian HPPs to Be Constructed on Araks River (16 September, 2010). (Webpage: http://news.am/eng/news/31125.html)

[202] Cooperating with Iran, Armenia solves energy security problem (16 February,2012). (Webpage: http://news.am/eng/news/93583.html).

signed during the visit of the President Kocharian to Iran in June 2006. 312-kilometer long line will provide a significant increase in the supplies of Armenian electricity to Iran. Under the agreement, Yerevan has to repay the construction loan through the delivery of electricity to Iran.[203] In May 2011 Iranian Foreign Minister Ali Akbar Salehi stated that this project will strengthen the energy ties between Iran and Armenia. The project will cost $110 million and it will increase the transmission capacity of the network between Iran and Armenia from 300 MW (currently) up to 500-800 MW.[204]

It should be also noted that through the support of the Iranian government Armenia has initiated the process of a more intensive utilization of alternative energy sources. For the purpose of the wind power plant construction at the Pushkin Pass Iran has appropriated $3.5 million. The capacity of the plant is 2.6 megawatts. The station is capable to generate electricity at a wind speed from 3 to 25 meters per second. In addition, it is planned to increase the number of windmills for the power plant to generate up to 90 megawatts.[205]

After the negotiations held in Sochi in early 2007 between the Presidents of Armenia and Russia, Russia's "Kommersant" published an article, which stated that the Armenian and Russian sides had agreed on the issue of oil refinery construction in Meghri that would be the largest oil-processing factory in the region. Under this project, the Iranian oil was supposed to be supplied to the plant, while the profit from the sale of petroleum products should have been distributed among the three countries. The total cost of the proposed project exceeded $ 1 billion.[206] However, two years later the Russian Transport Minister Igor Levitin declared that the project was economically inexpedient. In particular, he mentioned that "according to the experts the construction of a plant with a production capacity exceeding 5 million tons is so far unprofitable; the proposal to build a plant with a capacity of about 2 million tons is inefficient either.... The question is not removed from the agenda, but it should be understood where all these

[203] $90m Loan for Armenian Project (11 June, 2006). (Webapge: http://www.iran.ru/eng/iran_news.php?act=news_by_id&news_id=27808).

[204] Iran to Build 3rd Electricity Transmission Line to Armenia (29 May, 2011). (Webpage: http://www.mehrnews.com/en/newsdetail.aspx?NewsID=1323883).

[205] Ruben Grdzelyan, Energy Security of Armenia: Current Situations and Perspectives (June, 2008). (Webpage: http://journal.nationalidea.am/articles.php?id=44&l=R).

[206] Naira Mamikonyan, Project with a Vague Perspective (Yerevan: Aravot Newspaper, 30 January, 2007).

products will be exported".[207] Apparently, Russia's such position can be explained not only by the financial crisis, but by the tense situation around the Iranian nuclear dossier as well.

According to the Iranian information agency "Pars", an agreement on the supply of 1.5 million liter of gasoline and diesel fuel to Armenia per day was reached between Iran and Armenia. On this occasion, Alireza Zeighami, the Deputy Minister of Petroleum and the Managing Director of the National Iranian Refining and Oil-products-distribution Company (NIORDC), stated that "in accordance with the agreement, Iran will supply Armenia with 750,000 liters of gasoline and 750,000 liters of diesel per day".[208] The agency recalls that in late January of this year the Iranian Oil Minister Masoud Mirkazemi stated that Iran and Armenia are planning to build an oil pipeline, which will increase the supply of Iranian energy resources to Armenia. The Minister also mentioned that the pipeline will start in Tabriz and continue up until the border with Armenia. The "Pars" information agency also reports that the pipeline, with a diameter of 8 inches and a length of 365 km, will be commissioned in 2014.[209] As was mentioned by the Minister of Energy and Natural Resources of the RA A. Movsisyan, the construction of the Armenian section of the pipeline will cost $100 million. He also noted that the project financing will be carried out by Iranian side, which will reimburse the funds from the revenues derived from the further operation of Tabriz-Yeraskh oil-products pipeline.[210]

The Armenian side is confident that the oil embargo on the supply of gas from Iran and the political situation in the region will not impede economic cooperation between the two countries.[211] However, the complexity of the situation should not be underestimated. It should be noted that one should agree with the Armenian authorities on the issue of "oil embargo". Thus, despite the fact that today the United States and its allies have sharply tightened their position in relation to those countries that

[207] There will be No Oil Refinery in Meghri: Iran Will Build an Oil Pipeline Connecting Tebriz with Armenia (7 March, 2009). (Webpage: http://news.mail.ru/politics/2417130/).

[208] The Iran-Armenia Oil Pipeline Will Be Commissioned in 2014 (*in Russian* - Nefteprovod Iran-Armenia Budet Sdan v Ekspluatatsiu v 2014) (14 February, 2011). (Webpage: http://www.iran.ru/rus/news_iran.php?act=news_by_id&news_id=71996).

[209] Ibid.

[210] Karine Ter-Sahakyan, Winged Comments: Armenia and Iran Construct an Oil Pipeline (*in Russian* - Operativniy Kommentariy: Armenia I Iran Sroyat Nefteprovod). (12 April, 2012). (Webpage: http://www.iran.ru/rus/news_iran.php?act=news_by_id&news_id=79748).

[211] Ibid.

continue to cooperate with Iran in the energy sphere, apparently, the Americans realize that, being blockaded both from the West and the East, Armenia cannot blockade itself from the South as well, leaving the only way out to the outside world through the territory of Georgia. Such a position of Washington was announced in June 2007 by the U.S. Charge d'Affaires in Armenia Anthony Godfrey, who expressed concern about the expansion of the Armenian-Iranian relations, at the same time mentioning: "We welcome the fact that Armenia builds its relations on the principle of transparency and we are pleased that the authorities are open about the further development of relations with Iran".[212] In this regard, the statement made by the NATO Secretary General's Special Representative for the South Caucasus Robert Simmons is also remarkable. During his visit to Yerevan in June 2007 R. Simmons stated that the desire of Yerevan to diversify its energy sources and the ways of their delivery were regarded with favor by the alliance, and from this perspective neither the U.S., nor their allies saw any problems in the cooperation between Armenia and Iran.[213] As for the confidence of the Armenian authorities in that the political situation in the region will not become an obstacle to the energy cooperation between the two countries, the statement seems to be very controversial. If the functioning of the gas pipeline is safe for today, with the beginning of possible military actions against Iran there is no guarantee that based on the hint from Baku the Azerbaijanis, living in northern Iran, will not organize explosions of the pipeline. Armenia has already faced this type of situations. Thus, during the Karabakh war the Azerbaijanis, living in Southern Georgia, permanently exploded the gas pipeline "North-South". That is why, if Washington and its allies are not so concerned about the Armenian-Iranian cooperation so far, Yerevan is rather concerned about the situation that has evolved around the Iranian nuclear issue. Although today the U.S. President urges Tehran to resolve the problem through co-operation, provided that the latter will cease its uranium enrichment activities, the military actions against Iran should not be ruled out by Armenia. These possible "actions" raise concern within Armenian side, as

[212] US Concerned By Armenia's Energy Ties with Iran (20 June, 2007). (Webpage: http://www.eurasianet.org/departments/insight/articles/eav062107a.shtml).

[213] Gayane Movsesyan, Robert Simmons: Good Relations with Armenia are Very Important for NATO (June, 2007). (Webpage: http://www.ra.am/?num=2007062209).

in that case the emergence of new threats to the national security of the country is not excluded. It is no coincidence that when the Prime Minister of the RA Tigran Sargsyan was asked whether Yerevan was preparing for that in case of the bombardment of Iran, the latter would close the border, he responded that Armenia had a clear national doctrine, which outlined all the risks and challenges. T. Sargsyan also added that "from the standpoint of ensuring the national security we should be ready for different scenarios".[214] Thus, the Prime Minister does not rule out that in case of a military strike on Iran the closure of the Southern border of Armenia is possible, which would put an end to the Armenian-Iranian cooperation not only in trade, but, as was already mentioned, in the energy sphere as well.

Part 2.3 Ensuring energy security of Armenia

Today, energy policies of many states, recognizing the significance of environmental issues and the finite quantities of world energy resources, emphasize the need for ensuring the sustainable development of the country. As a result, the reveal of renewable energy potential and its efficient application in the economy has become an issue of high priority, aimed at enhancing energy security of both developed and developing countries.

According to the International Energy Agency (IEA), renewable energy is defined as the one "derived from natural processes (e.g. sunlight and wind) that are replenished at a faster rate than they are consumed. Solar, wind, geothermal, hydro, and some forms of biomass are common sources of renewable energy".[215] The acknowledged benefits of the utilization of non-conventional energy sources are environmental protection, decentralization of energy production and security of supply based on indigenous resources, reduced exposure to fuel price volatility, technological innovation, and economic growth. Moreover, renewable energy sources can play an important role in the elimination of energy poverty and creation of many new employment opportunities (28, p7). The level of utilization of

[214] Prime Minister of Armenia About Relations with Russian Federation and the Situation Aroud Iran (*in Russian* - Premiyer Armenii o Vzaimootnosheniyakh s Rossiyskoy Federatsiey i o Situatsii Vokrug Irana) (4 April, 2012). (Webpage: http://www.iran.ru/rus/news_iran.php?act=news_by_id&news_id=79520).

[215] Renewable Energy. International Energy Agency. (Webpage: http://www.iea.org/aboutus/faqs/renewableenergy/)

renewable energy in the world (18% of the total energy production[216]) differs among countries due to various geographic and natural conditions. For example, the U.S., India, and China are the leading countries for using solar energy, while the leaders in the utilization of wind power are China, Germany, and the U.S.[217]

Today Armenia faces the need for reorganizing its energy policy to ensure a higher level of energy security. The fact is that the Republic is highly dependent on the imported energy resources, necessary for transportation, electricity generation and heat production. As it is mentioned in the "National Program on Energy Saving and Renewable Energy of the Republic of Armenia", the country can meet only 35% of the total demand for energy with its domestic resources.[218] Moreover, taking into consideration the fact that Armenia is situated in the heart of an unstable and unpredictable region, the stability of fuel supply much depends on the political life of the region. Therefore, in order to secure the sustainable development of Armenia, priority must be given to the development of domestic energy resources and widespread implementation of energy efficiency throughout the economy. If Armenia is to achieve sustained economic growth, besides increasing efficiency in all energy consuming sectors, it must develop renewable energy as well.[219] Thus, the Republic's energy policy could be considered effective only in case a comprehensive approach towards the development of energy sector is applied.

Among the environmental conventions ratified by the Republic of Armenia, which had and will continue to have a huge impact on the development of renewable energy in the country, the following ones can be mentioned:

- The Rio Declaration on Environment and Development (1993) and most of its addenda, the Johannesburg Summit resolutions (2002). The main idea reflected in the documents is that the

[216] Renewable Energy, Energy For Mankind. (Webpage: http://www.energyformankind.org/renewable-energies/)

[217] All Renewables Index (February, 2012). (Webpage: http://www.ey.com/GL/en/Industries/Power---Utilities/RECAI-Feb-2012---All-renewable-indices).

[218] USAID. National Program on Energy Saving and Renewable Energy of Republic of Armenia (2007), pp.2-4. (Webpage:http://www.renewableenergyarmenia.am/download/National_Program_English_Draft_Part_1.pdf).

[219] Ibid.

development today must not threaten the needs of present and future generations and that the long-term economic growth is possible only in case the environment is protected.[220]

- United Nations Framework Convention on Climate Change (UNFCCC, 1993) and the Kyoto Protocol (2003). The main objective of the Convention is the achievement of "greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system"[221], while the protocol contained the specific provisions and regulations.

Equally important for the enhancement of the role of renewable energy in the overall energy sector of the Republic is the establishment of the legal framework, which was particularly strengthened in 2000s:

- Energy Law of the Republic of Armenia (2001). The law highlighted the main principles of the government policy in the Energy sector. In particular, Article 59 contributed to the development of the hydropower energy of the Republic.[222]
- Law of the Republic of Armenia on Energy Saving and Renewable Energy (2004). The purpose of the law is to define the principles of the state policy on development of the energy saving and renewable energy and the mechanisms of the enforcement of those.[223]

The crucial role of the development of the renewable energy sector as a tool for enhancing the energy independence of Armenia was highlighted in various documents, the most important of which are presented below:

- Energy Sector Development Strategies in the Context of Economic Development in Armenia, adopted by the Government of Armenia on the 23 July in 2005. The strategy stresses upon the interdependence between the development of renewable energy and energy security of the country

[220] The Johannesburg Summit: An Overview. World Summit on Sustainable Development (2002). (Webpage: http://www.johannesburgsummit.org/html/media_info/press_kit/fact1_overview.pdf)

[221] United Nations Framework Convention on Climate Change. (Webpage: http://unfccc.int/essential_background/convention/background/items/1353.php)

[222] Ministry of Energy and Natural Resources of Armenia. (Webpage: http://www.minenergy.am/hy/en/laws)

[223] National Assembly of the Republic of Armenia. The Law of the Republic of Armenia on Energy Saving and Renewable Energy (2004). (Webpage: http://www.parliament.am/legislation.php?sel=show&ID=2119&lang=eng).

and discusses the potential of renewable energy resources development in Armenia. It also mentioned that the promotion of a substantial quantity of renewable energy projects will contribute to the country's energy independence.[224]

- National Program of the Republic of Armenia for Energy Saving and Alternative Energy adopted by the Government of Armenia on 18 January 2007. The main purpose of the Program was to set targets for the energy saving and renewable energy development in Armenia and to determine the means for their realization. According to the document the "inclusion of energy efficient technologies and renewable energy in the fuel-energy mix will play a key role in the increase of energy supply level of economy through the use of domestic fuel-energy resources and will ensure an increased level of energy independence".[225]

The initiative, demonstrated by the Government of Armenia in the promotion of the use of renewable energy resources proves the measure of significance that is attached to this sector. As it is stated in most of the official documents of the Republic the development of renewable energy sources is of primary importance for Armenia. The fact is that using renewable energy sources, 310 GWt/h energy power was generated in Armenia in 2010, however this potential may be increased 5 times. Particularly, in 2015, this indicator may be raised to 740 GWt/h, whereas by 2020 the index will reach 1500 GWt/h.[226] The energy policy of the country particularly emphasizes the possible development of wind, solar, hydropower, biomass, and geothermal energy. The most significant of implemented, ongoing, and potential projects, of each of renewable energy resources are discussed below.

Armenia's energy strategy documents consider the development of wind power as an issue of high priority for the development of energy sector. Wind energy is in its initial development stage in the

[224] Government of Armenia. Energy Sector Development Strategies in the Context of Economic Development in Armenia. N1 resolution of N 24 protocol (Yerevan, 2005). (Webpage: http://unpan1.un.org/intradoc/groups/public/documents/apcity/unpan042544.pdf) (Accessed January 20, 2012)

[225] USAID. National Program on Energy Saving and Renewable Energy of Republic ofArmenia (2007). (Webpage:http://www.renewableenergyarmenia.am/download/National_Program_English_Draft_Part_1.pdf).

[226] Renewable Energy Sources to Raise Armenia's Energy Independence (June, 2011). (Webpage: http://www.panarmenian.net/eng/news/73241/Renewable_energy_sources_to_raise_Armenias_energy_independence).

Republic. The monitoring and resource assessment programs, which have been implemented since 1999 by the Ministry of Energy of Armenia, revealed 10 billion kWh of annual wind energy theoretical potential, 1.6 billion kWh of which is regarded as technically available one. According to expert's estimations, economically feasible wind energy potential totals 500-600 million kWh, and the rated power totals 500-600 MW.[227]

For the purpose of determining the wind energy potential in some regions of Armenia, in 1999 the Government of the Netherlands extended a grant to Armenia for monitoring wind energy ("ArmNedWind" program). As a result of this project, implemented from 1999 to 2002, five wind monitoring stations were launched at Pushkin, Selim and Karakhach passes, in the village of Ardanish (Lake Sevan), and at Lake Arpi.[228] The most significant outcome of this resource assessment project was the construction of the first 2.6 MW wind farm at the Pushkin pass in 2006, which was built in the framework of an Armenian-Iranian inter-state program.[229] Equally important is the development of the "Wind Energy Resource Atlas of Armenia" by the U.S. National Renewable Energy Laboratory (NREL) 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.[230] According to the Atlas there are about 1000 km^2 (4% of the total land area of Armenia) of land areas with good-to-excellent wind resource potential in Armenia (see Table 1). These windy territories could support almost 5,000 MW of potential installed capacity. While, if the areas with moderate wind resource potential are considered as well, the

[227] Use of Renewable Energy Sources in the World and Armenia: Through Innovations to Clear Technologies (2010), pp. 48-50. (Webpage: http://www.nature-ic.am/res/publications/brochures/Final_RE_Eng_Dec16.pdf) (Accessed January 12, 2012).

[228] Armenia: Follow-up Review of the Investment Climate and Market Structure in the Energy Sector. Energy Charter Secretariat (2008), pp. 90-92. (Webpage: http://www.encharter.org/fileadmin/user_upload/Publications/Armenia_ICMS_2008_ENG.pdf)

[229] Vahe Odabashian and Susanna Khachatryan, Renewable Energy in the Republic of Armenia (2008). "21-st CENTURY", № 1 (3), pp. 115-116.

[230] Dave Elliott, Marc Schwartz, G Scott, Steve Haymes, Donna Heimiller, R George, Wind Energy Resource Atlas of Armenia (2003). National Renewable Energy Laboratory (NREL), pp. 1-2. (Webpage: http://www.nrel.gov/docs/fy03osti/33544.pdf).

estimated total windy land area increases to more than 2,200 km^2 (almost 8% of the total land area of Armenia) and could support more than 11,000 MW of installed capacity (see Table 2).[231]

As the investigation of wind recourse potential in Armenia shows, the best wind resource areas are generally located on top of the higher ridges or mountains or in wind corridors such as mountain passes. On the basis of the wind measurement program nine prospective areas for the use of wind energy technologies, mainly in the Northern, Eastern, and Southern parts of Armenia were identified (see Table 3). Currently, there are two active wind power projects in Armenia. The one in Zod region (50 MW) is being developed by SolarEn and the estimated output would be about 120 million kWh/year. The license for constructing of the other one at the Karakhach Pass was recievied by Italian private investors. The wind power station will have a capacity up to 90 MW.[232]

Another major source of clean and inexhaustible energy is the Sun. Over the past years a competition between the companies that base energy production on conventional and non-conventional energy sources has emerged. The latter proved to be quite profitable from the perspective of economic returns and safety.[233] It is no concidence that this source of renewable energy has attracted much attention both from the developed and developing world.

The use of this renewable source of energy depends on the geographic location and on natural climatic conditions of a country. Armenia has a significant advantage in terms of solar energy due to its proximity to the subtropical zone. According to the assessments carried out in the framework of EU program in 2000, about 10 km² is available in the Republic for solar energy exploration, including the possible usage of uncultivated land and the exploitation of buildings.[234] The two most important indices that describe the country's potential to utilize the solar energy are the annual average hours of sunshine

[231] Dave Elliott, Marc Schwartz, G Scott, Steve Haymes, Donna Heimiller, R George, Wind Energy Resource Atlas of Armenia (2003). National Renewable Energy Laboratory (NREL), pp. 1-2. (Webpage: http://www.nrel.gov/docs/fy03osti/33544.pdf).

[232] Ara Marjanyan, Independence, Invulnerability, and Ecological Compatibility of Energy System (June, 2011). "21-st CENTURY", № 2 (3).

[233] Vahe Odabashian and Susanna Khachatryan, Renewable Energy in the Republic of Armenia (2008). "21-st CENTURY", № 1 (3), pp. 110-119.

[234] Karen Hovhannisyan, Sustainable Development and Energy Security in Armenia: a Step Towards Dilemma (2003). Lund University, p. 33. (Webpage: http://www.lumes.lu.se/database/alumni/01.02/theses/hovhannisyan_karen.pdf)

and annual solar radiation. With regard to the first indicator, it varies from 2000 to 2800hours/year in Armenia. This value constitutes more than 50% of possible sunshine hours. Actual sunshine hours for Yerevan are 2700, for Martuni - 2750, for Ashtarak - 2837, for Vanadzor - 2019, for Idjevan - 1827 hours. Thus, for the territory of Armenia as a whole, actual annual average hours of sunshine are equal to 2500 hours.[235] As for the average annual flow of solar radiation on horizontal surface in the Republic, it totals 1720 kWh/m^2 (see Table 4). The case of Germany, leader in the usage of solar energy in Europe, can serve as a base for the objective assessment of Armenia's potential in the utilization of solar energy objectively. The annual solar radiation value for Germany is 950 kWh/m^2 and the number of sunny hours a year amounts to 1000. The country produces 9,676,800 kW of solar energy, which constituted 10.9% of the energy consumed in the country.[236]

Except for significant solar potential, there are some other positive factors contributing to the development of solar energy in Armenia. In particular, the presence of developed machine-building industry and qualified technical personnel to insure the implementation of the energy technologies, favorable public opinion and established reasonable and affordable tariffs create favourable conditions for the long-term evolution of the sector.[237]

The importance of the projects, which have been implemented in Armenia over the last two decades, should not be underestimated. Below are presented the most significant initiatives undertaken in the solar energy industry. Throughout the 1990s the installation of solar photovoltaic stations was the primary aim of the projects. Thus, in 1992 BP company (UK) installed solar photovoltaic station with installed capacity of 7.5 kW in the school after Byron in Gyumri. Similar power plants (108 solar modules each with capacity of 30W) were constructed in 1994-1996 by "Contact-A" LLC on 35 seismic

[235] Use of Renewable Energy Sources in the World and Armenia: Through Innovations to Clear Technologies (2010), p. 30. (Webpage: http://www.nature-ic.am/res/publications/brochures/Final_RE_Eng_Dec16.pdf) (Accessed January 12, 2012).

[236] Armen Gharibyan, Towards Eastern Partnership Civil Society Forum. The Need for Developing Alternative Energy Resources in the Context of Armenia-EU Relations Based on the Example of Introducing Solar Water heaters. (Yerevan, 2011) Eurasia Partnership Foundation. Europe Program, pp.2-4.

[237] Government of Armenia. Energy Sector Development Strategies in the Context of Economic Development in Armenia. N1 resolution of N 24 protocol (Yerevan, 2005), pp. 11. (Webpage: http://unpan1.un.org/intradoc/groups/public/documents/apcity/unpan042544.pdf) (Accessed January 20, 2012)

observation stations throughout Armenia, around Metsamor Nuclear Power Plant and Spitak Earthquake zone. Heliotekhnika Laboratory of the State Engineering University of Armenia has been working on the development and installation of photovoltaic modules each with total capacity of 2.4 kW on the roofs of St. Sargis Church and of Musical recording center of Armen-Hakob Culture Center in Yerevan in 1995.[238]

According to various investigations that have been implemented in the solar energy industry in Armenia and from the point of view of diversification of energy systems, finding solutions to environmental issues, as well as to the issues of socio-economic development and regional energy security, solar energy for water heating is considered as the most viable option for the Republic.[239] As mentioned by Ara Marjanyan the usage of solar energy for this purpose can turn into a rather competitive industry and is worth to be utilized more intensively in the Republic.[240] In 2000-2001, 15 pilot solar water heaters were installed for free on the territory of Armenia during the implementation of two-year program ARMNEDSUN sponsored by the Government of the Netherlands. Joint British-Armenian company SunEnergy LLC started to manufacture solar water heaters in Armenia. At present, less than 2000 m^2 of solar water heaters were installed by SunEnergy JV and Technokom LLC on the territory of Armenia, particularly on the roofs of seven homes in "Vahagni" residential community, in Terdjyan Hotel (22m2), in v. Tsapatagh near Lake Sevan, on the roof of building at Northern avenue (400 m2).[241]

In 2002 with the funding from European Commission a solar driven desiccant cooling demonstration system was installed and put into operation in American University of Armenia (AUA).

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[238] Use of Renewable Energy Sources in the World and Armenia: Through Innovations to Clear Technologies (2010), pp. 30-32. (Webpage: http://www.nature-ic.am/res/publications/brochures/Final_RE_Eng_Dec16.pdf) (Accessed January 12, 2012).

[239] Armen Gharibyan, Towards Eastern Partnership Civil Society Forum. The Need for Developing Alternative Energy Resources in the Context of Armenia-EU Relations Based on the Example of Introducing Solar Water heaters. (Yerevan, 2011) Eurasia Partnership Foundation. Europe Program, pp. 2-4.

[240] Interview with Ara Marjanyan (Coordinator of WB/GEF Renewable Energy Project in Armenia; "Noravank" Foundation), Yerevan, 6 June, 2012

[241] Vahe Odabashian and Susanna Khachatryan, Renewable Energy in the Republic of Armenia (2008). "21-st CENTURY", № 1 (3), pp. 110-119.

The system of solar water heaters with capacity of 40kW and total surface of 64m2 was installed on the roof of AUA.[242]

It is also worth mentioning that the assessment of the solar photovoltaic energy sector's whole potential (from raw material up to the production of the final product) revealed that Armenia is rich in raw material resources necessary for the production of the solar panels – quartzit. Thus, the experts concluded that the creation of a new branch of industry, from mining to marketing and sales of solar modules, is possible and economically feasible. The DEM consortium (Denmark) and Solaren LLC (Armenia) in 2008 proposed to organize production of solar photovoltaic panels.[243]

Among the project implemented by Solaren LLC, which is specialized in manufacturing solar water heaters, the following ones can be mentioned: installation of solar water heating system with total surface of solar collectors of 150m^2 for space heating and hot water supply at Red Cross Rehabilitation Center in Yerevan; installation of solar water heating system with total surface of solar collectors of 140m^2 at Addiction (Narcological) Clinic in Yerevan; installation of 5kw solar water heating system at Vasgenian theological seminary (Sevan) in 2009; installation of 10kW solar photovoltaic station at Armenian-American Health Center in 2007.[244]

Another basic source of energy that traditionally has been utilized in the Republic of Armenia is hydro power. Various projects, which were aimed at the assessment of the potential of the rivers, determined the existence of favourable natural conditions and revealed the high possibility of hydro power, in particular the small hydro power generation system, to become a component part of the renewable energy sector. The adoption of the "Energy Law of the Republic of Armenia" by the Armenian Parliament in April 2001 contributed to the development of small hydropower system. According to the

[242] Use of Renewable Energy Sources in the World and Armenia: Through Innovations to Clear Technologies (2010), pp. 31-32. (Webpage: http://www.nature-ic.am/res/publications/brochures/Final_RE_Eng_Dec16.pdf) (Accessed January 12, 2012).

[243] Ara Marjanyan, Independence, Invulnerability, and Ecological Compatibility of Energy System (June, 2011). "21-st CENTURY", № 2 (3).

[244] Use of Renewable Energy Sources in the World and Armenia: Through Innovations to Clear Technologies (2010), pp. 31-32. (Webpage: http://www.nature-ic.am/res/publications/brochures/Final_RE_Eng_Dec16.pdf) (Accessed January 12, 2012).

Article 59 of the Law "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".[245] Further, for the purpose of enhancing the development of small hydropower energy several amendments were made to the Law. The above mentioned Article was reformulated, so that the purchase of electricity produced by small hydropower plants (SHPP) was to be guaranteed not during the fixed period of "15 years", that is up to April 2016, but during 15 years starting from the moment the license for electricity production for a given SHPP was received.[246] Equally important for the attraction of local and international investments to this field was the establishment of tariffs higher than average electricity tariffs by special independent body, Public Services Regulating Committee of the Republic of Armenia (PSRC RA). The latter develops and implements the market rules of purchasing produced electricity by SHPPs. Current tariffs for electricity without Value Added Tax (VAT) delivered from all types of SHPPs were established by PSRS in May 2007 (see Table 5).[247]

The theoretical potential for hydropower resources of Armenia has been estimated as 21.8 billion kWh/year. It includes 18.6 billion kWh/year for large and medium rivers, and 3.2 billion kWh/year for small rivers. Technically available potential is estimated around 7-8 billion kWh/year, and economically feasible potential – 3.2-3.5 billion kWh/year (1.5 of which has already been developed and the remaining hydro potential is to be developed during the next 15 years),[248] out of which the potential annual power output of SHPPs will total 737.38 million kWh.[249] As it is mentioned in the National Program on Energy Saving and Renewable Energy of Republic of Armenia developed with USAID assistance, the available water resources in the RA (the rivers Debed, Aghstev, Akhurian, Hrazdan, the Lake Sevan, etc.) and their potential are sufficient for the construction of 313 small hydropower plants (see Table 6).

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[245] Ministry of Energy and Natural Resources of Armenia. (Webpage: http://www.minenergy.am/hy/en/laws)

[246] Ibid.

[247] Public Services Regulatory Commission of the Republic of Armenia. (Website: http://resolutions.psrc.am/view.php?rid=1501)

[248] Use of Renewable Energy Sources in the World and Armenia: Through Innovations to Clear Technologies (2010), pp. 55-56. (Webpage: http://www.nature-ic.am/res/publications/brochures/Final_RE_Eng_Dec16.pdf) (Accessed January 12, 2012).

[249] Vahe Odabashian and Susanna Khachatryan, Renewable Energy in the Republic of Armenia (2008). "21-st CENTURY", № 1 (3), pp. 110-112.

Back in 1991 Armhydroenergyproject Institute developed "The Scheme of Development of Small Hydropower Engineering", according to which construction of 371 SHPPs with total capacity of 392MW and annual power production of 1178 million kWh was possible. Six years later due to the reassessment, made by the Institute 325 small HPPs instead of 371 was considered feasible. The total capacity of the new group of SHPPs was estimates as 274 MW and average annual electricity generation as 833 million kWh. From 1997 to 2002 11 new HPPs have been constructed and 11 HPPs were under construction (total capacity 25.5MW) Thus, in 2002 only 29 small hydropower plants were in operation with total capacity of 42.8 MW and average annual electricity generation of 107 million kWh.[250]

According to data from Armhydroenergydesign Institute as of 2008, the used hydro potential of Armenia was 1060 MW with annual average power generation of around 1.8 billion kWh, including small HPPs with capacity of 75MW and power generation of 244 million kWh. While already in 2009 the electricity generated by the SHPPs totaled 297.63 kWh, accounting for 5.65% (see Table 7) of total power production of the Republic.[251] For comparing purposes, this indicator is less than 0.5% in such countries like Georgia, Iran, Azerbaijan and Russia. It is no coincidence that both the World Bank and Armenian Government regard the development of small hydro power system in Armenia as exemplary for the whole region.[252] What is even more important is that in case the full potential of both large (including the underutilized potential of Araks and Debed rivers) and small scale HPP becomes operational, the common capacity will amount to 500MW, which is almost 100MW more than it is produces by the Armenian Nuclear Power Plant.[253]

In the list of sources of renewable energy that have just started paving their path towards occupying a niche in the energy sector of the Republic the geothermal and biomass energy should be mentioned.

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[250] Use of Renewable Energy Sources in the World and Armenia: Through Innovations to Clear Technologies (2010), pp. 55-56. (Webpage: http://www.nature-ic.am/res/publications/brochures/Final_RE_Eng_Dec16.pdf) (Accessed January 12, 2012).

[251] Ibid.

[252] Ara Marjanyan, The Future We Must Not Miss (June, 2011). "21-st CENTURY", № 2 (3).

[253] Ibid.

Biomass is non-processed (raw) or processed organic material that possesses chemical energy. This can be any material of biological origin, products of biological activities, and organic wastes generated during their processing. Biomass can be used for the production of thermal or electrical energy and for production of different types of fuel, in particular solid fuel (fuel wood, wood chips, and pellets), liquid fuel (bio-ethanol, biodiesel fuel, bio-oil), and gaseous fuel (biogas, hydrogen, and other gases).[254]

Although Armenia is a newcomer in this particular sector of renewable energy, it has a potential to utilize biomass as a source of energy production. From the wide variety of biomass types the production of bio-ethanol, biogas and hydrogen are considered as the most viable options for the Republic.

"A Preliminary Feasibility Assessment of the Preferred Alternative For Implementing Commercial Scale Bio-Ethanol Fuels Program For Armenia in the Near to Mid Term" report, implemented in frames "Assistance to the Bio-Ethanol Production Development in Armenia" in 2008, highlighted the main possibilities of the RA to produce bio-ethanol. As a result, lands that were not allocated for agricultural utilization and plants, such as Jerusalem Artichoke, Feed Corn for livestock and poultry, Sweet Sorghum, and Chicory were determined to form the base for bio-ethanol production. The document envisaged the construction of two plants. The first one required investments in the amount of $17 mln. and had to be located in Syunik Marz; the production of bio-ethanol was to be based on Jerusalem Artichoke. As for the second project, which was to be constructed in Tavush Marz and use Feed Corn for the production, the necessary financial resources totaled $19mln.[255]

The efficient production of bio-ethanol much depends on the technology used. In case the production is based on the first generation technology, 30 thousand tons of bio-ethanol annually could be produced, which could substitute 10% of the imported gasoline. While if second generation technology is set in motion the indicators can improve greatly: the production of bio-ethanol could reach 100 thousand

[254] Renewable Energy in Europe. Building Capacity and Markets (2004).European Renewable Energy Council, p. 3.

[255] A Preliminary Feasibility Assessment of the Preferred Alternative For Implementing a Commercial Scale Bio-Ethanol Fuels Program For Armenia in the Near to Mid Term: Assistance to the Bio-Ethanol Production Development In Armenia (2003), Renewable Resources and Energy Efficiency Fund of Armenia, pp. 23-34.

ton per year, out of which 50% could be used within the country, while the other half be exported. The fact is that at least two of the RA neighbors, i.e. Gerogia and Iran, face shortage of gasoline. Thus, the profitability of the bio-ethanol prodcution could even reach that of gasoline.[256]

While organizing and developing the production of bio-ethanol in Armenia, particular characteristics of the sector should be taken into consideration. The issue of primary importance is that, given the fact that the plants to be used as a source for this sector of renewable energy can grow in mountainous non irrigated lands, the fertile land of the Ararat valley should not be utilized. Another aspect worth mentioning is that the balance of flora in a particular region should not be distorted because of "bio-ethanol" crops agressive growth nature.[257]

Thus, the development of the sector will guarantee not only the energy security of particular regions within Armenia, but will also contribute greatly to the enhancement of energy security of electricity generation and transport sector and will decrease to some extent the dependence of the country on the fluctuating prices of the imported gasoline.

The next type of biomass that has been actively developing in recent years throughout the world is the hydrogen economy, which is a newly emerging renewable energy technology. The concept of hydrogen is not new, but its practical implementation has gained momentum only recently. Among the countries, which included hydrogen energy as diversification strategy of their power sector the members of the European Union, the U.S., China, India and many others can be mentioned.[258] Such interest in hydrogen energy can be explained by the following characteristic features:

• Used in fuel cells, hydrogen appears to be the only renewable fuel that can potentially displace the conventional engines in the vehicles (Fuel cell is a generator of electricity based on electrochemical reaction between hydrogen and oxygen. Fuel cells can be considered a renewable energy source only if

[256] Ara Marjanyan, Independence, Invulnerability, and Ecological Compatibility of Energy System (June, 2011). "21-st CENTURY", № 2 (3).

[257] Ibid.

[258] Other Renewables in Armenia: Hydrogen Economy in Armenia. (Webpage: http://www.renewableenergyarmenia.am/index.php?option=com_content&task=view&id=28&Itemid=120).

the hydrogen used by them is obtained from renewable sources (for example, wind and solar energy). The only waste produces is water.) [259]

• Hydrogen can be an efficient storage medium for the excess energy generated from renewable and traditional sources; later this energy can be used when needed;

• Fuel cells offer an extremely broad scope of applications; they can replace or supplement batteries, engines, and small power plants, serve a source of electric power for portable devices (e.g., cell phones, videocameras) as well as, residential houses, industrial buildings, satellites, and many more;

• Hydrogen fuel cell based uninterruptible power supply system can compete with the conventional batteries both in terms of cost and size when the need for backup power exceeds 2-4 hours.[260]

The Republic of Armenia is the only country in the South Caucasian region that undertakes various research projects aimed at the assessment of the potential of the country to develop hydrogen economy. Moreover, the sole enterprise, H_2ECOnomy CJSC, within the entire region that specializes in the production of fuel cells was incorporated in 2002 in our Republic. The research, manufacturing and commercialization of the hydrogen fuel cells by the company is funded by the Cafesjian Family Foundation. The long-term goal of the company is to reach the global markets with these high-tech products.[261] The research in the filed is also undertaken by Solaren LLC and by several research groups, like State Engineering University of Armenia, State University of Armenia, Institute of Microbiology, and American University of Armenia.[262]

The list of completed and potential projects implemented in this sector of economy is quite modest. The "H2 ECOnomy" created and operated a new model of a solar hydrogen system in 2007 thanks to the support ($500 thousand) by the US Department of Energy and the US National Renewable

[259] Fuel Cell Technology Program. Energy Efficiency and Renewable Energy. U.S. Department of State. (Webpage: http://www1.eere.energy.gov/hydrogenandfuelcells/pdfs/fct_h2_fuelcell_factsheet.pdf).

[260] Vahe Odabashian and Susanna Khachatryan, Renewable Energy in the Republic of Armenia (2008). "21-st CENTURY", № 1 (3), pp. 118.

[261] Emil Danielyan, U.S. To Fund Hydrogen Energy Research In Armenia (August, 2004). (Webpage: http://hyeforum.com/index.php?showtopic=9739)

[262] Other Renewables in Armenia: Hydrogen Economy in Armenia. (Webpage: http://www.renewableenergyarmenia.am/index.php?option=com_content&task=view&id=28&Itemid=120)

Energy Laboratory (NREL) (22). The same company has successfully developed and tested 0.5 kW and 1 kW net output fuel cell based uninterruptible power supply (UPS) extender systems. As for the future projects, the "H2 ECOnomy" develops a 5 kW fuel cell backup power system that will enable to significantly extend the operating time of the conventional battery based UPS systems.[263]

Thus, currently being in the stage of research of hydrogen energy development potential, Armenia, through continuous commitment and actions of the government, could establish hydrogen economy as an integral part of the overall economy of the Republic, which will at the same time correspond to the main principles of sustainable development of the country.

The last component of biomas energy system to be discussed in this paper is biogas energy. Biogas is a mixture of methane and carbon dioxide, produced by the breakdown of organic waste by bacteria without oxygen (anaerobic digestion). The main sources of biogas are urban solid wastes (to produce landfill gas), municipal sewage waters, manure of agriculture animals and poultry, remnants of flora and forestry entities.[264] In Armenia power genereration from biogas is in its initial stage. The evaluation of the biogas potential of the Republic was organized by USAID in 2007, according to which investment of $34.17 million would provide for generation of 38.34 million m^3 of biogas annually, which will reduce greenhouse gas emissions by 544.6 thousand tons per annum in CO_2 equivalent during the period from 2006 to 2020. According to estimates, it is possible to construct biogas production plants with total capacity 100 000 m^3/day in the coming 15 years in case of involvement and availability of foreign investments. (7, p2). The data recieved as a reslut of this program is presented in Table 8.

Biogas plant construction at the Nubarashen city landfill can be considered as one of the most successful initiatives in the sector. The average annual generation of municipal solid waste in Armenia today is estimated to be 340 tons/day. The traditional disposal of municipal waste is in landfills or in mass burn incineration both of which generate serious environmental problems. Land for disposal is becoming

[263] Vahe Odabashian and Susanna Khachatryan, Renewable Energy in the Republic of Armenia (2008). "21-st CENTURY", № 1 (3), p. 118.

[264] Use of Renewable Energy Sources in the World and Armenia: Through Innovations to Clear Technologies (2010), pp. 39-40. (Webpage: http://www.nature-ic.am/res/publications/brochures/Final_RE_Eng_Dec16.pdf) (Accessed January 12, 2012).

increasingly scarce in urban areas and incineration emits toxic gases unless expensive sorting techniques are employed. From this perspectipe the joint Armenian-Japanese project ($4.5 USD) initiated in 2001 and (Municipality of Yerevan City, the local authority owning Nubarashen landfill site and three Japanese companies Shimizu, Hokkaido Electric Power and Mitsui) aimed at generating methane from the Nubarashen city landfill and utilizing it as fuel is of great importance. The main purpose is the aggregate reduction of greenhouse gas emissions during 16 years for estimated 2.16*106 ton-CO_2, as well as to contribute to the improvement of environment, reduce fire risks, etc.[265] At present, various investigations are undertaken to evaluate the potential of other landfill (there are 58 landfill in RA) for methane generation throughout Armenia.

Apart from landfills, resources for power genereration from biogas can be also provided by pig, cattle and poultry farms. Thus, Lusakert Biogas Plant (LBP) was successfully implemented with financing through Clean Development Mechanism (CDM) in Armenia in 2008. The methane generation is based on the combustion of poultry manure. As a result a reduction of 62832 ton of CO_2 is reached. Installed capacity and annual average electricity production of power plant are 0.85 MW and 7 million kWh correspondingly.[266] Table 9 shows technical and economic data on the other biogas plants in Armenia and their current status.

The utilization of biogas for production of gas and electricity proposes numerous advatages. Firstly, compared to the other sources of renewable energy, due to the short payback period of 7-8 years investment in methane production technology is economicaly justified.[267] Secondly, the installation of the methane producing technology is chracterized by simplicity and does not require huge capital; greater

[265] Tamara Babayan, Areg Gharabegian, Artak Hambarian, Morten Søndergaard, and Kenell Touryan, Renewable Energy in Armenia (December, 2011).

[266] Use of Renewable Energy Sources in the World and Armenia: Through Innovations to Clear Technologies (2010), pp. 40-43. (Webpage: http://www.nature-ic.am/res/publications/brochures/Final_RE_Eng_Dec16.pdf) (Accessed January 12, 2012).

[267] Tamara Babayan, Areg Gharabegian, Artak Hambarian, Morten Søndergaard, and Kenell Touryan, Renewable Energy in Armenia (December, 2011).

portion of investments are done in the initial stage of the project.[268] Thirdly, the environmental analysis of biogas system indicates of its significant contribution to the fight against global warming and to the struggle for the mitigation of deforestation and soil erosion through the substitution of firewood as an energy source.[269] Fourthly, from the perspective of biogas users the system processes agricultural waste and saves expenditures via the substitution of mineral fertilizers with bio-fertilizer at the same time.[270] Filthy, epidemiologic situation and sanitary conditions improve due to elimination of adverse pathogenic bacteria and microorganisms in the wastes.[271]

The above stated material proves the possibility of biomass to become a valuable source of energy in Armenia. However, this sector of economy still requires significant analysis and financial support. Thus, the effective and successful utilization of biomass as a part of energy sector of the Republic much depends on the commitment and strategy of the government.

The final source of renewable energy to be presented in the paper is the geothermal energy. It has been produced commercially for nearly a century both for electricity generation and direct use. The fact is that, geothermal energy, with its proven technology and abundant resources can make a very significant contribution towards reducing the emission of greenhouse gases worldwide. The North and Latin American have about 50% share of the world total electricity generation with geothermal, while Europe and Asia have 10% and 30% shares respectively.[272]

The Republic of Armenia is located in a zone with high tectonic activity and recent volcanic activity, however, as various investigations show the country's geothermal resources can be characterized both by low-to-medium and high temperature thermal waters (*Geothermal resources are classified as

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[268] Priscilla E. Hampton, Methane and Cogeneration Technology: Renewable Energy Opportunities for Erie County Wastewater Treatment Plants (November, 2007). (Webpage: http://green-cities.wikispaces.com/file/view/methane+cogeneration.pdf)

[269] Biogas Digest: Costs and Benefits, Program Implementation (2012). Information and Advisory Service on Appropriate Technology, pp. 5-7. (Webpage: http://www.gtz.de/de/dokumente/en-biogas-volume3.pdf).

[270] Ibid.

[271] Use of Renewable Energy Sources in the World and Armenia: Through Innovations to Clear Technologies (2010), p. 41. (Webpage: http://www.nature-ic.am/res/publications/brochures/Final_RE_Eng_Dec16.pdf) (Accessed January 12, 2012).

[272] Ingvar B. Fridleifsson, Direct Use of Geothermal Energy Around the World (Reykjavik, 1998). (Webpage: http://geoheat.oit.edu/bulletin/bull19-4/art2.pdf).

low temperature (less than 90°C), moderate temperature (90°C - 150°C), and high temperature (greater than 150°C) – 25, p1). The studies of geothermal potential in the Republic started back in 1984 in Sisian region. As the results showed, the temperature of surface water could reach 32°C, while at the depth of 920m geothermal sources were as hot as 99°C. The geothermal studies revealed both fissure-vein (Jermuk: 64°C, Hankavan: 42°C, Arzakan: 54°C, Sisian: 45°C, Martuni: 52°C) and bedded (Azatavan: 42°C, 2600 m, Sevaberd: 83°C, 3100 m) deposits of thermal waters.[273] The investigation of the geothermal potential of the region continued form 1987 to 1990 and resulted in a report entitled "Exploration Aiming at the Identification of Geothermal Sources in the Northwest Part of the Sisian Region". The report provided evidence of a geothermal anomaly, which could make the construction of a geothermal power station a commercially feasible project. The next stage of investigation of the Sisian region, initiated by the Ministry of Energy, the Institute of Geophysics and Engineering Seismology of the National Academy of Sciences of the Republic of Armenia started in 2004. The main aim of the project was to prove the presence of geothermal anomy identified in late 1980s and determine all the characteristics necessary for the efficient construction of the geothermal plant.[274]

In 1998 GeotherEx company in the frames of the program "Assistance to Armenia" presented a report on the geothermal potential of Armenia, according to which 18 potential zones were identified. Only five zones from the list were considered feasible from the economic perspective: Martuni (Tmax= 400 °C)1, Jermuk (Tmax= 630 °C), valley of r. Vorotan (Tmax= 430 °C), Hankavan (Tmax= 420 °C), Arzakan (Tmax= 450 °C).[275] Another project initiated in that same year, which was funded by the World Bank and was aimed at geological and geophysical studies of Garni area (Azat-1 borehole), discovered bedded deposit at the depth of 2280-2285 m. Later, in 2000-2001 thanks to the Russian LUKOIL oil

[273] Vahe Odabashian and Susanna Khachatryan, Renewable Energy in the Republic of Armenia (2008). "21-st CENTURY", № 1 (3), p. 117.

[274] Armenia: Follow-up Review of the Investment Climate and Market Structure in the Energy Sector. Energy Charter Secretariat (2008), p. 93. (Webpage: http://www.encharter.org/fileadmin/user_upload/Publications/Armenia_ICMS_2008_ENG.pdf).

[275] Use of Renewable Energy Sources in the World and Armenia: Through Innovations to Clear Technologies (2010), p. 53. (Webpage: http://www.nature-ic.am/res/publications/brochures/Final_RE_Eng_Dec16.pdf) (Accessed January 12, 2012).

company the parameters of Azat-1 deposit (temperature, pressure, mineralization, etc.) were determined. However, for technical reasons the works were suspended. Later, the research was resumed by the Geoenergetica enterprise of the RA Ministry of Energy and as a result, the geothermal distribution in the area and its orientation towards Yerevan were revealed.[276]

With regard to the areas with high petro thermal regimes (more than 1000 °C), the North-Eastern part of Syunik, particularly Jermaghbyur and Angeghakot sites, should be mentioned. According to the "Jermaghbyur geothermal power plant feasibility study" program, initiated in 2006, the installation of geothermal power plant with installed capacity of 25 MW required investments in the amount of 17.6 billion AMD. Annual average electricity production was estimated as 199.4 million kWh. Minimum temperature of geothermal resources at the depth of 2500-3000m is estimated as 2500 °C. Nowadays, the right to implement this project belongs to private investor. Another report, "Identification of perspective high-potential geothermal zones" 2007, discussed some other perspective zones with high-potential of geothermal resources: the North-Eastern part of Geghama volcano mountain plateau in the Central part of territory of Armenia.[277]

As stated by the head of Renewable Resources and Energy Efficiency Fund, Tamara Babayan Armenia's geothermal potential is currently estimated at about 30 megawatts, mentioning three main areas, Dzhermakhpyur (Syunik region), Qaraqar (Syunik region), and Gridzor (Gegharkunik region), which are prospective for the construction of geothermal power plants. She also emphasized that the exploration works are carried out within World Bank's GeoFund program, which provided $ 1.5 million, while the construction of the plants should be made at the expense of private investments.[278]

As all types of renewable energy sources, geothermal energy has both positive and negative aspects. The most important advantage of this non-conventional source of energy compared to the others,

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[276] Vahe Odabashian and Susanna Khachatryan, Renewable Energy in the Republic of Armenia (2008). "21-st CENTURY", № 1 (3), p. 117.

[277] Use of Renewable Energy Sources in the World and Armenia: Through Innovations to Clear Technologies (2010), p. 53. (Webpage: http://www.nature-ic.am/res/publications/brochures/Final_RE_Eng_Dec16.pdf) (Accessed January 12, 2012).

[278] Armenia to construct geothermal power plants (July, 2011). (Webpage: http://news.am/eng/news/68035.html)

like solar and wind, is its constant nature and independence from the environment.[279] The other factor of great significance is the large scope of geothermal energy application: it can be used directly in temperatures ranging from about 35°C to 150°C to heat buildings, greenhouses, aquaculture facilities and to provide industrial process heat. Indirectly, high temperature geothermal steam can be used to drive a turbine and create electricity or in heat pumps.[280] As for the negative traits of geothermal energy utilization, the one of high importance is that the extraction can have adverse environmental impacts. The thermal waters usually contain a large amount of toxic metals (e.g. boron, lead, zinc, cadmium, arsenic) and chemicals (ammonia, phenols), which excludes the discharge of water into natural water systems on the surface. Nevertheless, most of these impacts can be controlled via the application of up-to-date technologies that make the operation of the plant less harmful for the environment.[281] The other form of pollution that is typical to geothermal energy is the noise pollution, the highest level of which during the well drilling, stimulation, and testing phases (80-155 decibel), while the normal operation of the power plant the level of the noise dercreeases (70-83 decibel).[282] However, it is obvious that the negative aspects of utilization of renewable energy are miniscule compared to the advantages it proposes.

Most of the projects undertaken in the field of renewable energy aimed at assessing the potential of the country to increase the weight of the sector in the Armenian economy and tried to develop a classification of the most feasible resources available in the Republic. In this context, the hierarchical framework presented by a group of experts is of great interest. According to the specialists, the first in the list are the hydro power and solar plants (particularly, solar hot water heaters), the projects of which seem to be the most feasible ones. The next in the classification system comes the generation of energy from

[279] Gerry White, Geothermal Energy: A constant Source of Renewable Power (May, 2011). (Webpage: http://energyinnovation.ie/2011/05/geothermal-energy-a-constant-source-of-renewable-power/).

[280] Renewable Energy Technology Fact Sheet. UNEP, Division of Technology. (Webpage: http://www.unep.fr/energy/information/publications/factsheets/pdf/geothermal.PDF)

[281] Use of Renewable Energy Sources in the World and Armenia: Through Innovations to Clear Technologies (2010), pp. 52-56. (Webpage: http://www.nature-ic.am/res/publications/brochures/Final_RE_Eng_Dec16.pdf) (Accessed January 12, 2012).

[282] The Future of Geothermal Energy: Impact of Enhanced Geothermal Systems (EGS) on the United States in the 21st Century (2006). Massachusetts Institute of Technology, p. 275. (Webpage: http://www1.eere.energy.gov/geothermal/pdfs/future_geo_energy.pdf).

wind power. This group is followed by the geothermal and biomass energy (in particular, bio-ethanol), the high costs of which decrease the commercial viability of the sectors.[283]

In fact, the cost associated not only with the geothermal and biomass energy, but with the renewable energy overall is frequently emphasized as one of the main obstacles to the development of the sector. The application of these sources of energy in the economy requires considerable amount of investments, lack of which impedes the fulfillment of the potential of the industry. For example, if in order to have 100 MW wind power capacity installed before 2020, it is necessary to invest $100-130 million USD,[284] the investment cost for a solar photovoltaic power plant in Armenia is around $250 million USD for 100MW.[285] Moreover, the electricity purchasing tariff structure established by the government of Armenia does not favour the development of some of renewable energy sources, particularly the wind energy. Thus, as one of the experts in this sector of economy, A. Marjanyan mentions the tariffs for wind energy should be at least 25-30% more (about 37-40 AMD/KWh) than the present 31.343 AMD/KWh.[286] Another expert in the field of renewable energy, the National Renewable Energy Laboratory's (NREL) top scientist, John Turner, considers the problem of the low profitability of renewable energy, particularly hydrogen economy enquiry of time. According to the specialist the search for a more cost-effective technology will intensify in the next few decades as the world gradually runs out of its oil and natural gas deposits. "The transition to a hydrogen-based energy system can occur in the 20 to 40-year time frame if governments will make a strong focused effort to bring it about".[287] The absence of the necessary legislative and regulatory framework in the energy sector "contributes" to the impossibility of the Republic to attract the investments as well. Moreover, as mentioned by A. Marjanyan

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[283] Tamara Babayan, Areg Gharabegian, Artak Hambarian, Morten Søndergaard, and Kenell Touryan, Renewable Energy in Armenia (December, 2011).

Interview with Ara Marjanyan (Coordinator of WB/GEF Renewable Energy Project in Armenia; "Noravank" Foundation), Yerevan, 6 June, 2012.

[284] USAID. National Program on Energy Saving and Renewable Energy of Republic ofArmenia (2007), p. 56. (Webpage:http://www.renewableenergyarmenia.am/download/National_Program_English_Draft_Part_1.pdf).

[285] Vahe Odabashian and Susanna Khachatryan, Renewable Energy in the Republic of Armenia (2008). "21-st CENTURY", № 1 (3), p. 113.

[286] Interview with Ara Marjanyan (Coordinator of WB/GEF Renewable Energy Project in Armenia; "Noravank" Foundation), Yerevan, 6 June, 2012.

[287] Emil Danielyan, U.S. To Fund Hydrogen Energy Research In Armenia (August, 2004). (Webpage: http://hyeforum.com/index.php?showtopic=9739)

one of the main obstacles to the development of renewable energy sector is the fact that all the approved documents have just a declarative nature and there is a lack of governmet decisions that would call for action in the field.[288] It is also worth mentioned that the technical issues faced by the sector also hinder the development of non-conventional energy in the Republic. For instance, most of the areas with high wind indicators are not easily accessible for heavy machinery that is needed for the installation of the wind turbines.[289] With regard to the construction of small hydropower plants, the main technical difficulty is the availability of promising sites within reasonable proximity to good roads and transmission line.[290] However, as for the small hydropower plants most of the experts emphasize the inefficient usage as the main hindrance to the development of the sector. That is, the ownership of these plants mostly by the state officials results in the low quality of the technology used, which in its turn has a huge negative environmental impact. The situation is aggravated by the fact that the profit gained from the selling of the electricity produced at the SHPP is not reinvested back into the industry.[291] What is even more disappointing there is even a sector of renewable energy, geothermal energy, where no specific projects are currently implemented despite the revealed potential.

The fact is that the evaluation of the renewable energy projects should not be done from one perspective only, i.e. from finantial point of view. In case all advantages of utilization of non-conventional energy sources, which were listed in the beginning of the current part, are taken into account, the long-term benefits could not only defray the expenses, but also ensure the energy self-sufficiency of the country, which determines the level of political independence of the latter. Thus, for the

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[288] Interview with Ara Marjanyan (Coordinator of WB/GEF Renewable Energy Project in Armenia; "Noravank" Foundation), Yerevan, 6 June, 2012.

[289] Tamara Babayan, Areg Gharabegian, Artak Hambarian, Morten Søndergaard, and Kenell Touryan, Renewable Energy in Armenia (December, 2011).

[290] Ibid.

[291] Interview with Hrant Baghdasaryan (Deputy Chief Engineer at "Yerevan Telecommunication Research Institute" CJSC), Yerevan, 5 June, 2012.

Interview with Ara Marjanyan (Coordinator of WB/GEF Renewable Energy Project in Armenia; "Noravank" Foundation), Yerevan, 6 June, 2012.

Interview with Artak Hambarian (Associate Director of the Engineering Research Center at American University of Armenia), Yerevan, 8 June, 2012.

purpose of overcoming the dependence of energy security of Armenia from global energy crisis, energy-exporting countries, various force-majeure situations that can emerge in our unstable region, as well as for solving the environmental issues the Government of the Republic should pay serious attention to the development of renewable energy. Hence, the level of contribution to be made by the renewable energy sector of economy much depends on the policy and the will of the government, which should ensure the necessary legal, policy and regulatory framework to attract both foreign and local investors.

Conclusion

Based on the analysis of the current state of Armenia's energy security, as well as the challenges and opportunities for the energy security of the Republic, the following conclusions can be made.

Numerous definitions of “energy security” are based on the fact, whether a country is an exporter or an importer of energy resources. Given that Armenia basically ensures its energy security through the import of energy carriers, when defining the essence of the energy security of our Republic one should proceed from the fact that the country is an importer of energy resources. Therefore, energy security of Armenia comprises the following crucial elements: ensurance of a reliable supply, diversification of supply sources, ensurance of security of the energy infrastructure, utilization of new technologies to reduce dependence of energy imports. Apart from these elements, all countries importing energy resources, including Armenia, prioritize the development of domestic conventional and alternative sources to decrease the dependence on imported resources and the development of clean energy technologies. Consequently, when defining the term “energy security” in respect to Armenia, the level of development of renewable energy should be taken into consideration.

Global and national energy securities are highly interconnected and interdependent. If global energy crisis can pose a threat to energy security of a country, particularly to the energy-importing country, the energy crisis on the national level, especially in the countries exporting energy carriers, could serve as a cause for the eruption of energy crisis at a higher level with more serious consequences. Thus, it can be assumed that global energy crisis will least of all affect those countries, where the level of the development of renewable energy is high enough. It is no coincidence that energy policies of both developed and developing countries, particularly of energy-importing countries, stress upon the high need for the development of renewable energy, which is considered as a mean of decreasing the level country's vulnerability to possible future energy crisis at a global level. Therefore, in case of a global energy crisis the development of renewable energy in Armenia can become a long-term guarantor of energy security.

It is noteworthy that some of our neighboring countries, in particular Azerbaijan and Georgia, despite great differences of the energy systems, have already started to give special consideration to the development of renewable energy.

Thus, Azerbaijan ensures its energy security through the development of oil and gas industry and international cooperation in the field of mining and export of energy resources. But even being an energy-exporting country, Azerbaijan draws particular attention to the possible threats to its energy security. According to the authorities of the Republic these threats are mainly associated with the possible usage of either political or physical methods to undermine the main sector of economy of the country. For the purpose of overcoming these threats and ensuring energy security of the Republic, Balu proposes to pay serious attention to the increased utilization of renewable energy sources, in particular, solar, wind, hydropower, and biomass energy.

With regard to Georgia, the Republic ensures its its energy security not only through the extensive utilization of abundant hydropower resources and the transit of Azebaijani energy resources in the Western direction, but thanks to the import of the latter as well. However, Tbilisi cannot but be aware that such energy dependence on Azerbaijan is fraught with political dependence. Thus, in order to ensure energy self-sufficiency of the Republic, the Georgian authorities have developed a government program aimed at expanding the utilization of renewable energy sources.

As was already mentioned throughout the whole study Armenia is highly dependent on external energy supplies. And, although the ensurance of energy security can be considred as one of the main achievments of the Republic, this does not exclude the propability of undergoing many severe trials by Armenia, leaving the country's energy system highly vulnerable to new external challenges.

Thus, the dependence of Armenia on the supply of Russian energy resources contains a number of potential threats. Fristly, Russia may raise the prices for the gas transported to Armenia at any time. Secodnly, Armenia can be deprived form the Russian gas in case of an internal political destabilization in Georgia or in case of sharpening of the situation on the Karabakh fronts, which can lead to diversions on the Georgian section of the “North-South” gas pipeline (as already happened during the Nagorno-

Karabakh conflict) that passes through the territory densely populated by Azerbaijani Turks. Thirdly, Georgia may increase the transportation tariffs for the transit of Russian gas to Armenia via its territory. Forthly, the possible privatization of the Georgian section of the "North-South" pipeline by the State Oil Company of Azerbaijan Republic (SOCAR), could make the supply of the Russian gas to Armenia to become dependent not only on Russia and Georgia, but on Azerbaijan as well.

As for the Iranian gas that is supplied to Armenia, the following can be noted. Prior to the opening of the Turkish-Armenian border, the tightening of the West's position in relation to countries that continue to cooperate with Iran in the energy sector is unlikely to impact Armenia. However, in spite of this, with the start of possible military action against Iran the gas supplies to Armenia will be brought into question.

In conclusion, taking into consideration the analysis carried out in the essay and the answers given to the research question, the hypothesis put forward in the following study can be assumed to be supported. That is, Armenia's energy security is vulnerable because of disproportional development and import-based nature of energy system. So, for the purpose of overcoming the dependence of energy security of Armenia from global energy crisis, energy-exporting countries, various force-majeure situations that can emerge in our unstable region, as well as for solving the environmental issues the government of the Republic should pay serious attention to the development of renewable energy.

In other words, to ensure energy self-sufficiency of the country the Armenian authorities should extensively develop renewable energy simultaneously with the development of available components of energy system. That is, in order to enhance energy security of Armenia a more extensive development of renewable energy becomes highly relevant and can be considered as the only feasible way to achieve energy self-sufficiency as of today, which in turn will reduce the current energy, economic, and, consequently, the political dependence of our Republic.

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TABLES

Table 1. Wind Electric Potential of Armenia. Good-to-Excellent Wind Resource at 50 m**						
Wind Resource Utility Scale	Wind Class	Wind power at 50 m W/m^2	Wind Speed at 50 m m/s*	Total Area Km^2	Percent Windy Land	Total Capacity Installed MW
Good	4	400-500	7.5-8.1	503	1.8	2,500
Excellent	5	500-600	8.1-8.6	208	0.7	1,050
Excellent	6	600-800	8.6-9.5	165	0.6	850
Excellent	7	>800	>9.5	103	0.4	500
Total				979	3.5	4,900

*Wind speeds are based on an elevation of 2000 m and a Weibull k value of 2.0

Assumptions
Installed capacity per km^2 = 5 MW
Total land area of Armenia = 28,400 km^2

** Dave Elliott, Marc Schwartz, G Scott, Steve Haymes, Donna Heimiller, R George, Wind Energy Resource Atlas of Armenia (2003). National Renewable Energy Laboratory (NREL). (Webpage: http://www.nrel.gov/docs/fy03osti/33544.pdf).

Table 2. Wind Electric Potential of Armenia. Moderate-to-Excellent Wind Resource at 50 m (Utility Scale)**						
Wind resource Utility Scale	Wind Class	Wind power at 50 m W/m^2	Wind Speed at 50 m m/s*	Total Area Km^2	Percent Windy Land	Total Capacity Installed MW
Moderate	3	300-400	6.8-7.5	1,226	4.3	6,150
Good	4	400-500	7.5-8.1	503	1.8	2,500
Excellent	5	500-600	8.1-8.6	208	0.7	1,050
Excellent	6	600-800	8.6-9.5	165	0.6	850
Excellent	7	>800	>9.5	103	0.4	500
Total				2,205	7.8	11,050

*Wind speeds are based on an elevation of 2000 m and a Weibull k value of 2.0

Assumptions
Installed capacity per km^2 = 5 MW
Total land area of Armenia = 28,400 km^2

** Dave Elliott, Marc Schwartz, G Scott, Steve Haymes, Donna Heimiller, R George, Wind Energy Resource Atlas of Armenia (2003). National Renewable Energy Laboratory (NREL). (Webpage: http://www.nrel.gov/docs/fy03osti/33544.pdf).

Table 3. Distribution of wind power potential in Armenia***					
	Area	Design Capacity, W/m^2	Strength of the Wind,* m/s	Area of the zone **, km^2	Collective capacity of wind power generators, MW
1	Qarakhach mountain pass	300-400	6.5-7.0	-	
2	Pushkin mountain pass	500-600	7-8.0	-	2.5
3	Jajur mountain pass	200-300	5.0-5.6	-	
4	Sevan western mountain range	300-450	5.8-6.0	-	
5	Aragats	400-450	7.0-7.5	-	
6	Geghama mountain range	200-300	5.8-6.8	-	
7	Zod area	500-600	7.5-8.0	-	20
8	Sisian-Goris	300-400	6.8-7.0	-	
9	Sisisan mountain range	200-300	5.6-6.5	-	
10	Meghri area	400-450	7.5-7.8	-	

*Wind speed is presented 50 m height
** N/A

*** USAID. National Program on Energy Saving and Renewable Energy of Republic ofArmenia (2007).
(Webpage:http://www.renewableenergyarmenia.am/download/National_Program_English_Draft_Part_1.pdf).

Table 4. Annual solar radiation indices in Armenia, kWh/m^2*	
Area	**Radiation index**
Yerevan	1,647.2
Kalinino	1,404
Gyumri	1,624
Sevan	1,670
Martuni	1,740
Jermuk	1,682
Kochbek	1,786.4
Kapan	1,647.2
Total	13,200.8

* USAID. National Program on Energy Saving and Renewable Energy of Republic ofArmenia (2007).
(Webpage:http://www.renewableenergyarmenia.am/download/National_Program_English_Draft_Part_1.pdf).

Table 5. Current tariffs for electricity delivered from all types of SHPPs in Armenia (Without VAT)*	
Type of SHPP	**Tariff Armenian dram/kWh (without VAT)**
SHPP on natural water flow	18.274
SHPP on drinking water systems	8.122
SHPP on irrigation systems	12.182

* Public Services Regulatory Commission of the Republic of Armenia. (Website: http://resolutions.psrc.am/view.php?rid=1501*)*

Table 6. Main energy and technical characteristics of small HPP's by the water sources in Armenia (potential calculated from 1997)*									
N	Name of water reservoir	Number HPP-s units	Total installed capacity, kW	Average yearly production *min. kWh*	Level, m		Static pressure m	Designed expenses M^3/s	Total water flow through HPPs, min. m^3
					max	min			
1	2	3	4	5	6	7	8	9	10
1	r. Debet	79	35,501	123,47	2,075	635	1,440	0,12-2,8	682,09
2	r. Aghstev	67	58,270	159,27	1,725	610	1,115	0,3-4,5	958,5
3	r.Akhurya n	14	24,985	79,75	2,500	1,109	1,381	0,5-29	653,1
4	r. Qasakh	14	7,905	19,16	2,805	2,055	750	0,6-1,8	117
5	r. Hrazdan	13	9,070	27,37	2,225	1,490	735	0,5-4,0	188,1
6	Lake Sevan	20	22,965	66,03	2,760	1,960	800	0,6-4,0	262
7	Azat and Vedi rivers	20	18,215	56,15	2,455	1,310	1,145	0,7-2,6	394,5
8	r. Arpa	26	35,410	88,58	2,523	1,165	1,358	0,26-4,8	593,7
9	Meghri and Vokhchi rivers	52	21,245	72,63	2,960	690	2,270	0,3-6,0	803,5
10	r. Vorotan	8	9,800	44,97	2,208	1,440	768	0,5-11,6	263,4
11	Total	313	243,366	737,38					

Before 2020, it is expected that the Meghri HPP with 140 MW capacity and the Loriberd HPP with 60 MW capacity will be built with cumulative generation of 1,012 million kWh/year.

* USAID. National Program on Energy Saving and Renewable Energy of Republic ofArmenia (2007).
(Webpage:http://www.renewableenergyarmenia.am/download/National_Program_English_Draft_Part_1.pdf).

Table 7. Power production in RA in 2009 (based on data received from PSRC of RA)*		
Name of the power plant	**Power production**	
	mln kWn	%
Thermal power plants (TPP)	1053.07	19.7
Metsamor Nuclear power plant (MNPP)	2290.44	42.9
Large and medium hydropower plants (HPPs)	1693.51	31.7
Small hydropower plants (small HPPs)	297.63	5.6
"Lori 1" Wind Energy Plant	3.91	0.1
"Lusakert Biogas Plant"	2.69	
Total power production	5341.3	100

* Use of Renewable Energy Sources in the World and Armenia: Through Innovations to Clear Technologies (2010).
(Webpage: http://www.nature-ic.am/res/publications/brochures/Final_RE_Eng_Dec16.pdf)

Table 8. Production of biogas in Armenia for the period 2006-2020*						
Source of biogas	Volume of investments million USD	Yearly volume of biogas, mln. m^3/year	Yearly saving of organic fuel thousand tcf	Payback period, year	Decrease in greenhouse gas emissions, Thousand ton CO_2/year	The ratio of yearly fuel savings and investments, thousand tcf/mln. USD
Cattle manure from farms	0.73	1.06	0.83	8	15.57	1.15
Pig manure from farms	0.21	0.3	0.24	8	4.41	1.15
Excrement from poultry farms	16.55	9.79	7.69	8	206.84	0.46
Nubarashen city land fill	6.83	9.72	7.62	8	135.0	1.12
Lands fills of other Armenian cities	3.85	5.47	4.29	8	76.08	1.12
Clean-up of sewage	6.01	12.3	9.43	8	106.7	1.57
Total	34.17	38.34	30.10		544.6	

* USAID. National Program on Energy Saving and Renewable Energy of Republic ofArmenia (2007). (Webpage:http://www.renewableenergyarmenia.am/download/National_Program_English_Draft_Part_1.pdf).

Table 9. Technical and economic data on biogas plants in Armenia and their current status*						
No	Name of station	The volume of methane tank, m^3	Biogas output, m^3/day	Capital investments, USD	Start of operation	Current status
1.	Small biogas station (manure from cattle) combined with solar collections	6	8-10	3000	1988	In operation (under question)
2.	Experimental small biogas station at Lusakert poultry factory	50	90-135	30000	2002	Not in operation
3.	Biogas production station at "Agroservice" Ltd (manure from cattle) v.Shahunyan	25	50	12500	2003	Not in operation
4.	Small biogas plant in v.Slovak, Gegharkunik marz	25	15	15000	2005	Not in operation
5.	Small biogas stations in Gegharkunik and Tavush marzes (manure from cattle) (WB program)	3-4,5	6-9	1250	2005	A few are in operation (under question)
6	Biogas plant in v.Arzni combined with solar collectors	25	14-15	n/a	2006	Not in operation
7	Lusakert biogas plant at Lusakert poultry factory	4400	9600	3.4 mln.Euros	2008	In operation

* Use of Renewable Energy Sources in the World and Armenia: Through Innovations to Clear Technologies (2010).
(Webpage: http://www.nature-ic.am/res/publications/brochures/Final_RE_Eng_Dec16.pdf)

Appendix A: List of Interviewees

- Ruben Abrahamyan (Independent expert), Yerevan, 4 June, 2012.
- Hrant Baghdasaryan (Deputy Chief Engineer at "Yerevan Telecommunication Research Institute" CJSC), Yerevan, 5 June, 2012
- Ara Marjanyan (Coordinator of WB/GEF Renewable Energy Project in Armenia; "Noravank" Foundation), Yerevan, 6 June, 2012
- Artak Hambarian (Associate Director of the Engineering Research Center at American University of Armenia), Yerevan, 8 June, 2012

Appendix B: Questionnaire

1. Would you, please, describe energy security system of Azerbaijan? What components does it consist of? What are the main threats to the energy security of Azerbaijan?
2. Would you, please, describe energy security system of Georgia? What components does it consist of? What are the main threats to the energy security of Georgia?
3. If no investors are found for the construction of new nuclear power plant in Armenia and the Metsamor nuclear power station is closed in 2016, how will Armenia solve the problems of its energy security?
4. In 2008 a memorandum between "Rosatom" and the Ministry of Nature Protection of Armenia was signed, which aimed at the development of co-operation in the field of exploration of uranium deposits and mining of uranium in Armenia. What steps have been undertaken in this field during the last 4 years? Has Russia made any investments in this field?
5. What potential challenges for energy security of Armenia can you mention?
6. Could you, please, mention the ways for overcoming the threats to energy security in Armenia?
7. What are the main obstacles for the development of the renewable energy in Armenia?
8. What types of renewable energy will have a primary role in energy system of Armenia?
9. What are the potential markets, where Armenia, in case of a possibility, could export electricity to?