Energy Strategy of Armenia Accomplishments, Challenges, Next Steps

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Objective

- The objective is to present the Government of Armenia Energy Strategy to the international community.

- The presentation describes the current status of the energy sector, major accomplishments to date, planned activities and challenges.

Energy Strategy Pillars

- Development of Nuclear Energy
- Development of Renewable Energy, Energy Efficiency and Energy Saving Programs
- Diversification by Primary Energy Sources and Supply Routes
- Regional Integration

Overview of the energy strategy of Armenia

Diversification of energy supplies (fuels) and power generation

- To ensure the appropriate level of energy security a Concept of the Energy Security of the RoA has been developed in cooperation with the Armenian National Security Council. The Concept was approved by the RoA President's decree in October 2013. The GoA discusses the program of energy security concept events for 2014-2020 that include:
  - Electricity and gas consumption quotas in emergency and force majeure situations
  - Programs to neutralize internal and external threats
  - ANPP life-time extension
  - Construction of new generating facilities at least cost

Diversification of energy (geographic) sources and routes

Achievements

Construction of new generating capacities

- Yerevan Combined Cycle Gas Power Plant – project entirely completed in 2013. Iran-Armenia economic efficiency increased.
- 440 MW Hrazdan-5 Combined Cycle Gas Turbine – commissioned in December, 2013. Implemented within framework of agreement between GoA and RF “Gazprom” OJSC.

Regional integration

- Armenia and Georgia signed Parallel Operation Agreement, Agreement on Power Supplies during Emergency Situations and Dispatch Instructions, which lays the ground for trade between two states.
- Armenia and Georgia approved feasibility study of interconnection transmission line with installation of substation with B2B converter at total capacity of 1,050 MW and signed Amendment#2 to the New Transmission Line Construction Agreement on April 16, 2014.

Achievements (cont.)

- Under USAID umbrella developed and organized signing of MoU for Sub-Regional Transmission Planning and Integration between Armenia and Georgia energy companies to establish the foundation for joint planning and development of legal and regulatory framework for integration.
- Established Armenia-Georgia joint working group to conduct the economic analysis and dispatch based on GTMax, to implement information exchange and modeling of the Armenia and Georgia integrated power system.
- Established Armenia-Georgia Joint-Working Groups (JWGs) comprised of decision-makers and technical staff tasked with development of legal framework for power systems integration.
- Developed and organized signing of critical agreements governing parallel operation of Armenia and Georgia power systems which establish the framework for sustainable power trade increases operational security.

Planned activities

- Construct first 350 MW module of B2B substation and connect to 220 kV Alaverdi-Gardabani TL – 2015 – 2018. Cost - €105 million. Electricity exchange – 220-230 MW.
- Construct first circuit of 400 kV Hrazdan-Ayrum line and second 350 MW module – 2017-2021. Cost - €100 million. Electricity exchange – 700 MW.
- Install third 350 MW module, construct second circuit of 400 kV Hrazdan-Ayrum line. Cost - €100 million. Electricity exchange – 1,050 MW.
- Construction of Iran-Armenia transmission third line and construction of Meghri HPP with EDBI financing.

Planned activities (cont.)

- Implementation of loan programs on modernization and rehabilitation of 220 kV overhead lines (OHL) and substations (S/S)

World Bank

- $40 mln project:
  - Haghtanak, Charentsavan-3 and Vanadzor-1 S/S
- $50 mln project:
  - Ashnak and Yerevan TPP S/S, Lori and Tumanyan 1, 2 OHL,
  - Power Sector crisis dispatch management panel

ADB and EBRD – 80 mln – in two phases:

Phase 1

- Lot 1: S/S Agarak 2, S/S Shinuhayr, S/S Yeghegnadzor, S/S Ararat 2
- Lot 2: Expansion of SCADA System and EMS

Phase 2

- S/S Lichk, S/S Shahumyan, S/S Marash, S/S Zovuni

Development of competitive energy markets

- Regulation of access to energy networks and infrastructures
- Pricing policies
  - Fulfillment of EU obligations, compliance of RoA legal economic acts with EU directives aimed to revise power market internal rules.
  - Providing conditions for third parties access to power market that will also open the generation market.
  - Liberalization of generator's market to attract investments in existing and new generation capacities.
  - Enduring maximum use of existing installed capacities upon availability of trans-boundary trade.

Bottlenecks

- End-users electricity tariff growth rate
- Technical problems due to absence of sufficient capacities and existing limitations on trans-boundary power flows and trade
- Possibility of implementing partial of phase-by-phase power market liberalization
- Problems due to guaranteed purchase of electricity delivered by renewable energy sources effective for 15-year period

Customs Union Road-map

Armenia is planning to join the following agreements:

- Agreement on unified principles and rules of regulation of natural monopolies operations
- Agreement on ensuring access to the natural monopolies' services in the energy sector, including principles of price formation and tariff policy
- Agreement on ensuring access to the natural monopolies' services in the area of gas transportation via gas transporting systems, including principles of price formation and tariff policy
- Agreement on operation of Common Markets of oil products of the Custom Union member countries

Main purpose of agreements is to ensure access to the services provided by the natural monopolies involved in power transmission and gas transportation systems.

Amendments to the Energy Law

Amendments to the Energy Law required from the viewpoint of regional integration and increase of the level of reliable and efficient power supply and use.

Amendments resolve two strategic issues:

- Remove obstacles and create conditions for parallel operation of Armenia power system with neighboring systems, trade and allow for power supplies during emergency situations.
- Stipulate terms and conditions, under which the purchase of power, supplied by renewable energy resources is guaranteed.

Gas Market Structure

Operations of the RoA Gas Supply System is implemented by:

- “Gasprom Armenia” CJSC – import, distribution and supply of natural gas
- “Transgas” LLC – transportation of gas from Armenia border to Distribution Company and operation of underground storages.

On December 2, 2013 Armenia and Russia signed the following agreements:

- On the terms of the purchase and sale of ArmRusGasProm CJSC shares and further operation.
- On price formation order in case of natural gas delivery to Armenia.
- The gas price for the Republic of Armenia for the period of January 1, 2014-December 31, 2018 shall be defined by indexation of the gas price effective in Armenia during the previous period.

Development of Renewable Energy Sources in Armenia

- Hydroelectric power
- Wind power
- Solar power and biomass

Summary of RE Potential

Technology	Capacity (MW)	Generation (GWh/yr or GWh/yr)
Wind	795	1,640
Solar PV	835 – 1,169[a]	1,735 – 2,118[a]
Concentrating solar power	1,169	2,358
Distributed solar PV	93	128
Geothermal power	31 - 54	244 - 436
Landfill gas	2.5	19
Small hydropower	91	334
Pumped storage hydropower	150	1,161 – 1,362[b]
Biogas	3.3	26
Biomass	29	228
Total electricity [c]	1,876 – 2,208	4,358 – 4,921
Solar thermal hot water	n/a	254
Geothermal heat pumps	n/a	4,423
Total (heat)		4,677

a - depends on which solar PV technology is assumed to be deployed: fixed-tilt polycrystalline PV, single-axis tracking polycrystalline PV, dual-axis tracking mono-crystalline concentrating PV.

b – pumped storage projects do not “generate” new renewable energy, but store energy that has been generated elsewhere. So, the pumped storage number is extracted from the total.

c – the total includes only the generating potential for one of these technologies, so as not to double count.

Achievements in RE

- During 2005-2013 more than US $150 million was invested in SHPP, which has added around 210 MW of new SHPP capacity.
- All generation facilities are owned and operated by private companies.
- Renewable energy based annual electricity generation increased from 150 GWh in 2005 (2.5 percent of total generation) to 740 GWh in 2013 (around 10 percent of total generation).
- Donor community played important role in promoting development of RE in Armenia through investment and technical assistance to improve legal and regulatory framework, as well as through a number of projects including resource assessment and mapping.
- Observer status to the Energy Community is a way to get closer to EU legislation adaptation. Research and technical capacity, studies, policies and plans for renewable energy development already exist in Armenia.

RE projects

- Investment projects: WB&EBRD REP, GEF/WB REP, KfW REP, EBRD-ArmSEFF, IFC-SEF.
- TA projects financed by WB, USAID, ADB, etc.
- SREP – scaling-up RE in low income countries
- Armenia is involved in reserve countries list with initial $40 mln concessional financing and soft loan possibility in future from WB, ADB, EBRD.
- Technologies – utility scale solar PV, geothermal power, solar water heating and heat pumps.

RE projects (cont.)

- Armenia is in the list of the pilot countries eligible for funding for investments in RE area. To seek this funding the country should submit Investment Plan (IP) for development of RE resources.
- IP is the result of an extensive internal and public consultation process led by government to identify priorities in the development of renewable energy technologies for electricity and heating. The IP also serves as an update and further elaboration of the Renewable Energy Roadmap developed by Armenia in 2011.
- All technically feasible technologies were discussed and compared by cost of generation. As a result, two technologies were selected as priority: a) geothermal power; b) solar PV. Solar water heating and heat pump technologies are recognized as priority but not included for financing.
- The IP has been submitted to the CIFs Administrative Unit to the SREP Sub-Committee approval.

Promotion of energy efficiency in Armenia

Implementation of the Action Plan on Energy Saving and Roadmap on Energy Efficiency (EE).

- In 2012 the GoA approved EE project under the WB financing implemented by R2E2 fund. The project is targeted to implement energy saving activities in public facilities to reduce the level of energy consumption by social and other public facilities. The cost of the project estimated to be about 10.7 mln USD.
- Membership in the Eastern Europe EE and Environment Partnership (E5P) will enable implementing very important EE projects. The investment from Armenia will amount to about €1 million to be paid in portions and in addition to which Armenia will be granted nearly €20 million. Armenia did not yet pay the first portion of the membership fee to commence the projects.
- On 8 April 2014 the MoE has received a letter from EBRD informing that three countries (Czech Republic, Poland and Sweden) have already contributed to Armenian window in total €1.84 mln. The next step for Armenia will be signing the Contribution Agreement with EBRD, the Fund manager, and make its first installment in accordance with the timeline specified in the contribution agreement.

R2E2 Energy Efficiency Project

- Objective – Reduce energy consumption in public buildings
- Financing – Revolving Fund - $8 mln from GoA to R2E2 fund WB/GEF Grant - $1.8 mln
- Beneficiaries – public and municipal agencies
- Typical ESMs – Insulation of walls and roofs, replacement windows, replacement of street lighting system
- Repayment within 10 years with 2.5% interest
- Currently about 15 Energy Savings Agreements were signed with total $2.6 mln.

Nuclear issues

Nuclear safety and security issues in Armenia including steps to close ANPP Unit 2, stress tests of ANPP Unit 2, and plans for the construction of a new nuclear power unit

During the last two years, the following conventions have been ratified by the parliament of RA:

- **2005 Amendment to the Convention on the Physical Protection of Nuclear Material** was ratified on 18 March 2013.
- **Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management (Joint Convention)** was ratified on 21 March 2013 and entered into force on 20 August 2013. Currently we are in the process of preparing the National report. It will be provided to IAEA not later than the first week of October 2014.

Nuclear issues (cont.)

Projects implemented in ANPP:

- ANPP Unit 2 Safety Upgrade and Lifetime Extension. “Stress tests” implemented by Belgium “Tractebel” company is completed and report is submitted to the State Nuclear Safety Regulatory Committee and to a European “risk Audit” organization for expert opinion, which revealed necessity to implement 38 safety measures. The works will be implemented within the framework of ANPP Unit 2 lifetime extension program.
- OSART mission in 2013 recorded that 10 out of 14 recommendations given in 2011 have been completed and additional works are needed to complete the remaining 4 measures, particularly issue of middle and high level radioactive waste management.
- The activities implemented up to now for enhancement of the ANPP safety and equipment upgrades amounted to about $160 mln – 205 safety upgrading activities and 1,460 safety improvement measures.

Nuclear issues (cont.)

The 13th session of Presidential Nuclear Energy Safety Council (Chairman of the Council Mr. Birkhofer (Germany)) was held on November 6, 2013 in Yerevan. Council heard and discussed the following reports:

- "Report on the ANPP Activity for the Period from January 2012 to September 2013" presented by Mr. G. Markosyan, General Director of CJSC "ANPP".

- "Report of the State Nuclear Safety Regulatory Committee under the Government of the Republic of Armenia for the Period from September 2011 to September 2013" presented by Mr. A. Martirosyan, Chairman of the Committee.

The Council came to a general conclusion that since the previous session all activities of the State Nuclear Safety Regulatory Committee are carried out by performing their duties at the highest level.

Nuclear issues (cont.)

The Council developed the following recommendations:

1. To give high priority to the development of the national strategy for management of radioactive waste and spent fuel.
2. To give a high priority status to the project on further expansion of capabilities of the ANPP full-scale training simulator, which is very important from the safety viewpoint.
3. The Council considers an urgent issue completing the efforts on improvement of the ANPP containment integrity.
4. The Council considers an urgent issue completing all operational safety improvements recommended by OSART mission, and the most serious issue to focus on among the highly important needs of the plant related to the ongoing safety enhancement is the area of operational safety, against the enhancement of safety characteristics through “equipment” upgrade.

Radioactive waste and spent fuel management strategy

- Within the framework of ARM-EU cooperation, development of radioactive waste and spent fuel management strategy for Armenia is carried out. In November 2013, the ITER Consulting Consortium started the development of radioactive waste and spent fuel management strategy for Armenia. The first technical meeting was held on January 20-23, 2014 followed by the second one held on April 14 - 18, 2014. It is planned to complete the development of the strategy in 2016.
- Republic of Armenia invited an IAEA International Physical Protection Advisory Service (IPPAS) mission. IPPAS mission objective is to assess the system of physical protection, compare it with international best practices and make recommendations for improvements. The mission will pay a visit to Armenia tentatively in July 9 - 11, 2014. During this visit, a preparatory meeting will be held to discuss the scope and schedule of the mission, participating organizations, selection of experts for IPPAS team, advanced information package to be provided by Armenian authorities to the IAEA, support in logistic, preparation and confidentiality of the mission report, and other issues related to preparation and conduct of the mission.

ANPP lifetime extension

- New Nuclear Unit development activities started in 2008 aiming to commission it in 2017. However, due to the lack of investor's interest it is not feasible to complete the project on time. In 2013 it was decided to extend the lifetime of existing unit in order to meet internal demand.

- By adopting the resolution on the ANPP Unit 2 LTE the safety issues become especially important. The State Nuclear Safety Regulatory Committee under the RoA Government and IAEA established the minimum safety level, compliance with which is mandatory for the issuance of a license for design lifetime extension.

- The LTE program lists the actions necessary to bring the Unit's safety level in line with the licensing requirements, describes their sequence and deadlines (to be implemented in two phases).

- Negotiations of contract on full implementation of the LTE Program is at the final stage and will be signed shortly.

ANPP lifetime extension (cont.)

On 27 March 2014 the RoA Government during its Session has adopted a Protocol Decision No. 12 on Approval of the ANPP Unit 2 Design Lifetime Extension Program, which will be conducted in two phases. The list of works, their sequence and timing required for being in compliance with the licensing requirements are described in the program:

- First phase of the program – Assessment of Technical Feasibility of the Unit 2 LTE (including complex inspection and safety analysis of the unit) is designed to implement analysis of efficiency measures and programs aimed at increasing the safety level. At the end of the first phase it is planned to develop a Program for Preparation of the Unit for the Period of Extended Operation. The first phase is expected to be completed in December 2014.

- Second phase - Preparation of the Unit for the Period of Extended Operation includes:
  i. implementation of all the measures defined within the first phase for obtaining a license for the project when its design lifetime is expired - to be completed in November 2016.
  ii. upon receiving the license for operation of the plant when its design lifetime is expired should be implemented the rest of the measures defined within the first phase.

ANPP Safety Upgrade

- Continuous technical assistance is provided to the Armenian NPP on safety upgrade, ANPP Unit 2 lifetime extension, including implementation of procedures, personnel training and improving safety analysis capabilities.
- Since 1996, USA (through USAID & DOE), EU, RF, Czech Republic, Great Britain and Italy have been providing support to raise the safety level of Armenian NPP. During that period safety measures have been implemented in the framework of technical cooperation approximately with the value of $160 mln. Implementation of the safety measures was coordinated by IAEA.
- The 5th Donor's conference on ANPP safety upgrade assistance will take place in Yerevan on September 2-4, 2014.

Armenia New Nuclear Unit (ANNU) Project

- Taking into consideration the restrictions on providing the credits to the Republic of Armenia by sovereign guarantee, the implementation of the project on construction of a new nuclear unit(s) in Armenia was slowed down. By the commitment of GoA dated 27 March 2014 the MoENR had to activate the works towards the implementation of the mentioned project and it is included in the program of new Government.
- Since the development of Armenia New Nuclear Unit has been delayed, the GoA made the decision to extend the lifetime of the existing unit in order to assure sustainable and secure electricity supply to Armenia customers. However, this phenomenon requires reconsidering its energy strategy in order to address the short and medium term challenges.
- The Government of Armenia with USAID/LEDS project assistance is implementing the Least Cost Generation Plan, which will define the development strategy, which will meet criteria of energy security at the lowest cost.

GoA action plan for 2014 – 2020

- Decrease high level of wear and obsolescence of the power sector equipment and mechanisms
- ANPP Unit 2 Design Lifetime Extension for a period of 10 years
- Construction of Armenia New Nuclear Unit. Commissioning is planned for 2026.
  - — Develop a program to organize a process for construction of the new nuclear unit, due for 2015.

GoA action plan for 2014 – 2020 (cont.)

- Construction of Small HPPs with total of 260 MW capacity to produce additional 300 mln kWh of electricity.
- Construction of Lori-Berd HPP (60 MW capacity) with daily regulation reservoir to produce about 200 mln kWh of electricity. Commissioning is planned for 2023.
- Construction of Shnogh HPP (75-100 MW capacity) to produce about 300-400 mln kWh of electricity. Commissioning is planned for 2023.
- Construction of Meghri HPP (100-130 MW). Commissioning is planned for 2020.

GoA action plan for 2014 – 2020 (cont.)

- Construction of wind power plants (up to 200 MW total capacity) to produce about 400 mln kWh of electricity.
- Conduct study and construct geothermal power plant.
- Construction of PV station up to 30 MW (primary program). Competitive tariff setting.
- Construction of second combined cycle unit at the Yerevan TPP with 250-450 MW capacity. Commissioning is envisioned in 2018, to be confirmed by the Least Cost Generation Plan.
- Development of electrical transport to connect Yerevan with neighboring cities to decrease the emissions.
- Establish the minimum requirements for energy efficiency and energy saving for the public sector procurement.