The EaP CSF WG 3 Workshop/October 20, 2015

POLICY PAPER

ENERGY SECURITY AND ENERGY UNION PERSPECTIVES FOR ARMENIA

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There are several common energy security problems in Armenia and EU, particularly:

- dependence on imported fossil fuel;
- dependence on gas imports;
- secure operation of its nuclear power plants;
- insufficiency in electricity and gas network connections between countries, etc.

Today, the EU imports 53% of the energy it consumes at around EUR 400 billion a year. Adopted in 2015 by European Commission, Energy Union strategy sets the goal of Energy Union with an ambitious climate policy - to give EU consumers - households and businesses **- secure, sustainable, competitive and affordable energy.** Achieving this goal will require a fundamental transformation of Europe's energy system.

- In Armenia the share of electrical energy produced by hydropower plants (including small hydropower plants) was 31% in 2014.
- The share of Thermal Power Plants was 32.8% (operation on imported natural gas) and the share of Armenian Nuclear Power Plant was 36.2% (nuclear fuel is supplied from Russia).

Energy relations between Armenia and European Union

*Armenia's energy relations with the EU are in the first turn supported through t*he Eastern Partnership (EaP) framework - a joint initiative of the EU and its Eastern European partners: Armenia, Azerbaijan, Belarus, Georgia, Moldova and Ukraine (launched in 2009 at the EU Prague Summit).

EaP Riga summit (21-21/05/2015) confirmed that energy is an important issue in cooperation.

With that Armenia's accession treaty to The Eurasian Economic Union (EAEU or EEU, sometimes also Customs Union is used) came into force on 2 January 2015.

That may oblige Armenia to follow Energy Policy dominated in Customs Union and to some extent limits its opportunities to take advantages of European Union Energy Policy.

Balanced policy in Energy Sector should be developed to maintain cooperation with its main partners in Energy Sector taking into account Armenia’s geopolitical issues.

There are three key energy security issues in Armenia:

(1) Securing diversified energy sources and supply routes, including nuclear;

(2) Securing investment to ensure efficient, economically and environmentally sustainable renewable energy generation and usage and improve energy efficiency;

(3) Supporting country's energy systems regional integration.

Armenia imports most of its fossil fuel resources, in particular gas, from Russia and smaller part of gas from Iran.

In 2014, the Armenian Nuclear Power Plant (ANPP) in v. Metsamor met around 36.2% of Armenia's electricity demand while thermal power plants – around 32.8%.

Armenian government does not presently see any alternative to nuclear power. The National Energy Security Concept of RA was adopted by GoA in 2013.

Gas pipeline	**Daily maximum capacity, million m3**	**Annual maximum capacity, billion m3**
North-South pipeline	10	3.65
Iran-Armenia pipeline	8	2.30
Total	18	**5.95**

Energy security external threats/risks:

1. Disruptions in supply of fuel/energy/oil resources; long-term damage to North gas supply pipeline or damage to North and South gas supply pipeline at the same time.
2. Interceptions/failures in parallel operation of electric power systems of Armenia and Iran, and as result, appearance of Armenia power systems in isolated state.
3. The subversive and terrorist activity against subjects of fuel/energy system.

Energy security internal threats/risks:

1. High-level of physical and moral deterioration/obsolescence of equipment and machinery used in Energy Sector.
2. Failures in activities directed at construction of the new nuclear power unit instead of currently in operation nuclear power unit at Armenia Nuclear power plant (ANNP) (*Example: in September 2013, Armenia announced that the operation of the Armenian nuclear power plant would be extended until 2026).
3. The consequences of non-adequate tariff policy when tariffs don't cover the maintenance and operation expenses.
4. Failures in implementation of large-scale projects due to absence of routes to brought heavy and large dimension equipment (*Example: problems to bring heavy wind mill equipment).
5. Natural disasters, man-made accidents and so on (*Earthquakes like Spitak Earthquake in 1988*).

- *Examples are brought by author

Reviews of Armenia Energy Sector

Latest reviews of Armenia Energy Sector were done in

"Least-cost Generation Plan (LCGP) for Armenia" project that was made public in 2015 [1] and

"In-depth review of the investment climate and market structure in the energy sector of THE REPUBLIC OF ARMENIA". (ENERGY CHARTER SECRETATIAT, 22 January 2015)

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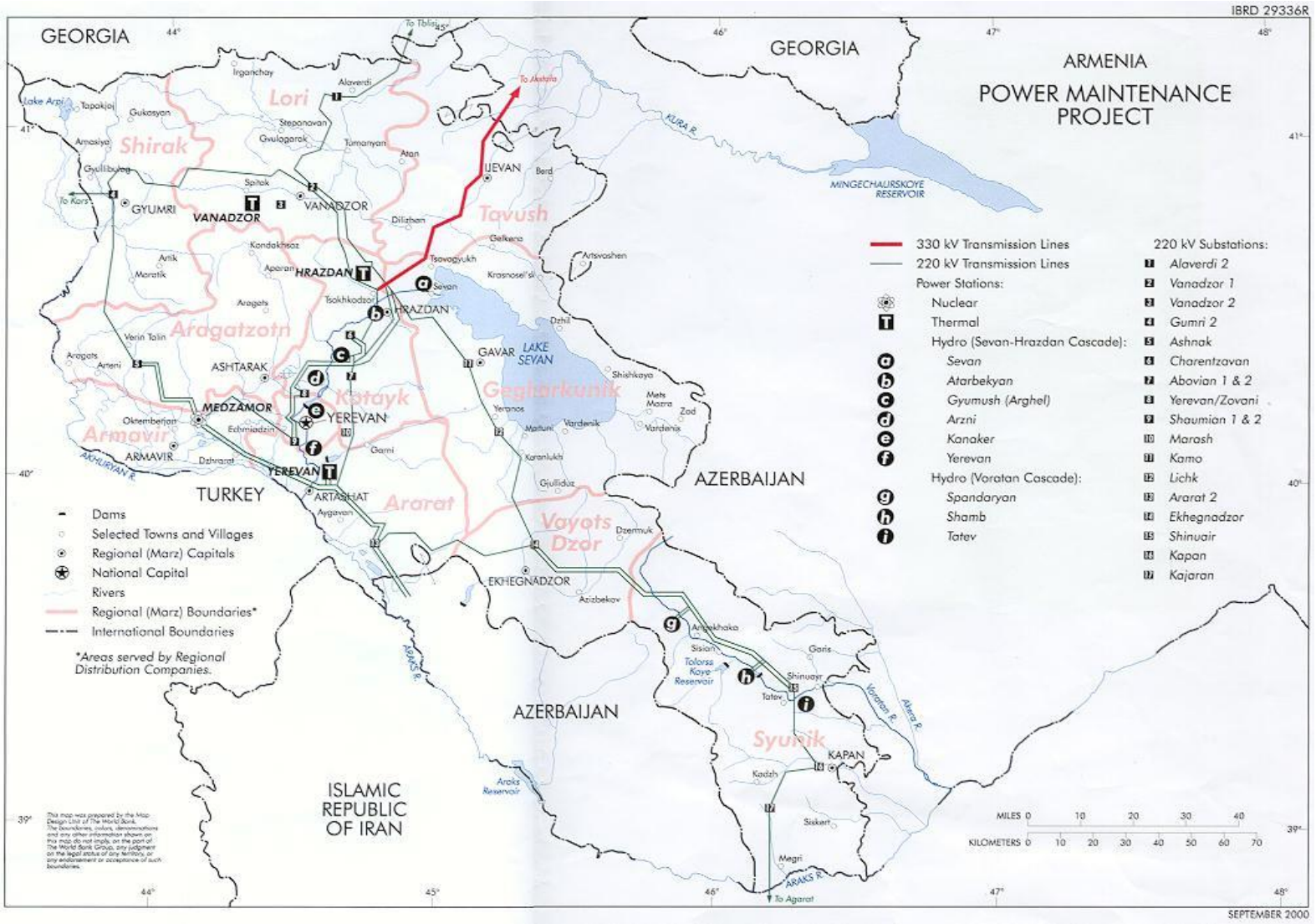
Power System of Armenia, Map Source: Global Energy Network Institute



ELECTRICITY GENERATION

- The total installed capacity of the power system of Armenia is around 4336.6 MW.
- Available capacity due to the condition of the aging equipment is 2589.6 MW.
- The installed capacity of thermal power plants (TPP) is 2347 MW. Currently the TPPs burn imported from Russia and Iran natural gas. The installed capacity of the Hrazdan TPP is 1110 MW (available -370), Yerevan TPP is 550 MW (is not operational now), Hrazdan 5 unit with 445 MW, and Yerevan CCGT 242 MW.
- Available capacity of all TPPs is 1380 MW.
- The maximum system load of 1520 MW was registered on December 31, 2012.

- The first unit (VVER-440/270 reactor) of The Armenian Nuclear Power Plant (ANPP) was put into operation in 1976, and the second unit (VVER-440/270 reactor) - in 1980. Total installed capacity of ANPP was 815 MW. In 1989, after the earthquake in Spitak on December 7, 1988, the ANPP was stopped for safety considerations.
- In 1995, Unit No. 2 with the installed capacity of 407.5 MW) was re-commissioned.
- Now available capacity of ANPP is 385 MW.

Power Plant	Available Capacity (MW)	Efficiency	Annual Max. Generation (GWh/yr)	VOM (€/MWh)	FOM (€/kW)	Last operation year
Armenian NPP	385	30.3	2124	0.44	84.09	2016
Yerevan CC	220 (200 in summer)	49	1888	-	42.41	2040
Hrazdan 5	440 (420 in summer)	45	3277	1.49	7.05	2040
Hrazdan TPP	370	34	2755	-	19.82	2019
Sevan-Hrazdan HPP cascade	550	0.88	472*	0.44	15.18	2040
Vorotan HPP cascade	400	0.88	1120	9.41	25.01	2040
Small HPPs	222	0.9	558	39.29	-	2040
Lori Wind Farm	2.6	-	3	67.7	-	2040

* Based on water release limits from Lake Sevan for irrigation purposes

Electricity delivered by energy companies of RA for internal consumption in RA in 2014. (Source: based on data from PSRC)

Name of the power plant	**Power production**	
	mln kWh	%
Thermal power plants (TPP)	2076.2	32.8
Nuclear power plant	2290.4	36.2
Large and medium hydropower plants (HPPs)	1309.6	20.7
Small hydropower plants (small HPPs)	669.8	10.6
“Lori 1” Wind Energy Plant	3.7	0.06
“Lusakert Biogas Plant”	0	
Total electricity production	**6324.9**	**100**

Renewable Energy in Armenia

HYDRO. Electricity is produced by 154 small hydropower plants, with an aggregate design capacity of around 260 megawatts and actual average annual energy supply of around 720 mln. KWh (as of January 01, 2014).

71 small hydropower plants are in construction phase with total design capacity of around 145 megawatts and expected annual average energy supply of around 515 mln. kWh (as of of January 01, 2014).

WIND ENERGY. The only operating in Armenia wind energy plant is Lori-1 plant with capacity of 2.64 MW. It was put in operation in December 2005 under a grant from Iran. Capacity factor of the plant is approximately 11 per cent. Annual electricity production of wind plant in 2014 was 3,7 GWh and its share in net production of electricity was around 0,06%. Wind plant is grid connected.

BIOGAS. The largest in the region Lusakert biogas plant was put into operation in 2008 (capacity - 0.85MW, annual electricity production – 7mln kWh) didn't produce electricity in 2014 due to low amounts of wastes as poultry plant operates at low capacity. The plant is also grid connected.

SOLAR PV. In spite of some good examples of PV station installation and operation in Armenia total capacity of all PV stations are less 100kW. There are no operational geothermal projects in Armenia. Development of PV stations is hindered by relative high prices on its component and not enough high feed-in tariffs.

SOLAR THERMAL. According to expert estimates it 2000-3000m^2 of solar water heaters are installed in Armenia. There exists local small scale production of solar water heaters. Many solar heaters are imported from China.

17 KW PV station installed at the roof of YMCA building in Spitak, October 06, 2015

Table 1.
Feed-in-Tariffs for Renewable Energy Systems, 2013 (excluding VAT)

RE Technology	Feed-in Tariff	
	AMD/kWh	US$/kWh
Wind	34.957	0.08
Biomass	38.856	0.09
Small hydro-power built on “natural water systems”	20.287	0.05
Small hydro-power built on irrigation systems	13.523	0.03
Small hydropower built on “drinking water supply systems”	9.017	0.02

Cooperation with EU

Armenia's energy cooperation with EU is being implemented or can be implemented through the following EU Initiatives/programs [22-23] :

- **The Energy Flagship Initiative,** launched in 2010, has three main goals: to facilitate the trade of gas and electricity between the EU and the six Eastern European partner countries (Armenia, Azerbaijan, Belarus, Georgia, Republic of Moldova and Ukraine), to improve energy efficiency and to expand the use of renewable energy sources. The INOGATE programme supports the economic convergence of energy markets and the enhancement of energy security within the EaP region.

At municipal level regional support is provided through the Covenant of Mayors and Sustainable Urban Demonstration Energy projects (SUDEP), as well as through the reinforcement of the Eastern Europe Energy Efficiency and Environmental Partnership (E5P).

Within Covenant of Mayors initiative, whereby cities are committing themselves to reduce CO2 emissions by 20% through the implementation of Sustainable Energy Action Plans, ten Armenian cities (Aparan, Artik, Ashtarak, Dilijan, Gyumri, Hrazdan, Spitak,Tsakhkadzor, Vayk and Yerevan) have already signed up to this ambitious initiative.

Multilateral and bilateral donors that are involved in investments and financing renewable energy projects in Armenia.

European Bank for Reconstruction and Development (EBRD)

•Rehabilitation of Sevan-Hrazdan HPP. EBRD is co-financing the rehabilitation of the Sevan-Hrazdan cascade with ADB's PSOD.

•Development of small HPPs. Under the Renewable Energy Project EBRD provided US$7 million to Cascade Bank (Ameria Bank) for on-lending to Armenian companies involved in developing SHPPs. These funds, combined with a World Bank loan of US$5 million, US$3 million equity investment from a private investor, and US$13 million co-financing from project developers, which enabled to develop 25 SHPPs with total installed capacity of 45 MW.33 The Renewable Energy Project included also US$3 million GEF grant to help create a better enabling environment for development of renewable energy

- **Caucasus Energy Efficiency Program (CEEP).** EBRD extends loans to local commercial banks for sub-lending to industrial companies for energy efficiency and rational energy utilization investments which include geothermal heat pumps and solar water heaters. Loans will be extended to residential customers on a demand-driven basis. The Project also includes grant funding to engage consultants in order to prepare energy audits, review investment proposals, support companies in securing funding from PBs and implementation support.

- **Eastern Europe Energy Efficiency and Environment Partnership (E5P).** Armenia recently joined E5P, a multi-donor fund managed by EBRD to improve energy efficiency and environmental protection in the Eastern Partnership region. Armenia plans to scale up ongoing energy efficiency program to invest additional $20 million (from E5P) in energy efficiency EBRD. The E5P funding is expected to become available to Armenia in 2016.

- **Regulatory support to promote renewable energy.** EBRD provided technical support to the PSRC on feed-in tariffs (FiT) and third party access (TPA) regulations.
- **KfW's** focuses on developing and maintaining renewable energy resources and financing transmission investments to support regional cooperation
- Construction and rehabilitation of SHPPs. KfW provides financing and advisory support for construction and rehabilitation of privately-owned SHPPs. Under Phase 1, KfW supported 14 SHPPs through several commercial banks. Under Phase 2, KfW supported 20 SHPPs with a total capacity of 45 MW. Phase 3, will include up to EUR 40 million in financing SHPPs.

- On 25 February 2015 the European Commission adopts Energy Union Strategy [22, 23]. The goal of Energy Union with an ambitious climate policy is to give EU consumers - households and businesses **- secure, sustainable, competitive and affordable energy.** Achieving this goal will require a fundamental transformation of Europe's energy system.

- The Energy Union strategy has five mutually-reinforcing and closely interrelated dimensions designed to bring greater energy security, sustainability and competitiveness:

- Energy security, solidarity and trust;
- A fully integrated European energy market;
- Energy efficiency contributing to moderation of demand;
- Decarbonizing the economy, and
- Research, Innovation and Competitiveness

- **Promotion of Energy Efficiency in Armenia (**Implementation of the Action Plan on Energy Saving Renewable Energy 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. Objective of R2E2 Energy Efficiency Project.– reduce energy consumption in public buildings. Financing – Revolving Fund - $8 mln from GoA to R2E2 fund WB/GEF Grant - $1.8 mln. Currently about 15 Energy Savings Agreements were signed with total $2.6 mln.

GoA action plan in energy sector for 2014 – 2020:

- extension of Unit 2 of ANPP Design Lifetime for a period of 10 years and construction of Armenia New Nuclear Unit (commissioning is planned for 2026),
- Construction of Small HPPs with total of 260 MW capacity to produce additional 300 mln kWh of electricity,
- Lori-Berd HPP with 60 MW capacity (2023),
- Shnogh HPP with 75-100 MW capacity (2023),
- Meghri HPP with capacity 100-130 MW (2020),
- Wind power plants (up to 200 MW total capacity,
- Geothermal power plant,
- PV station up to 30 MW.

GoA action plan in energy sector for 2014 – 2020:

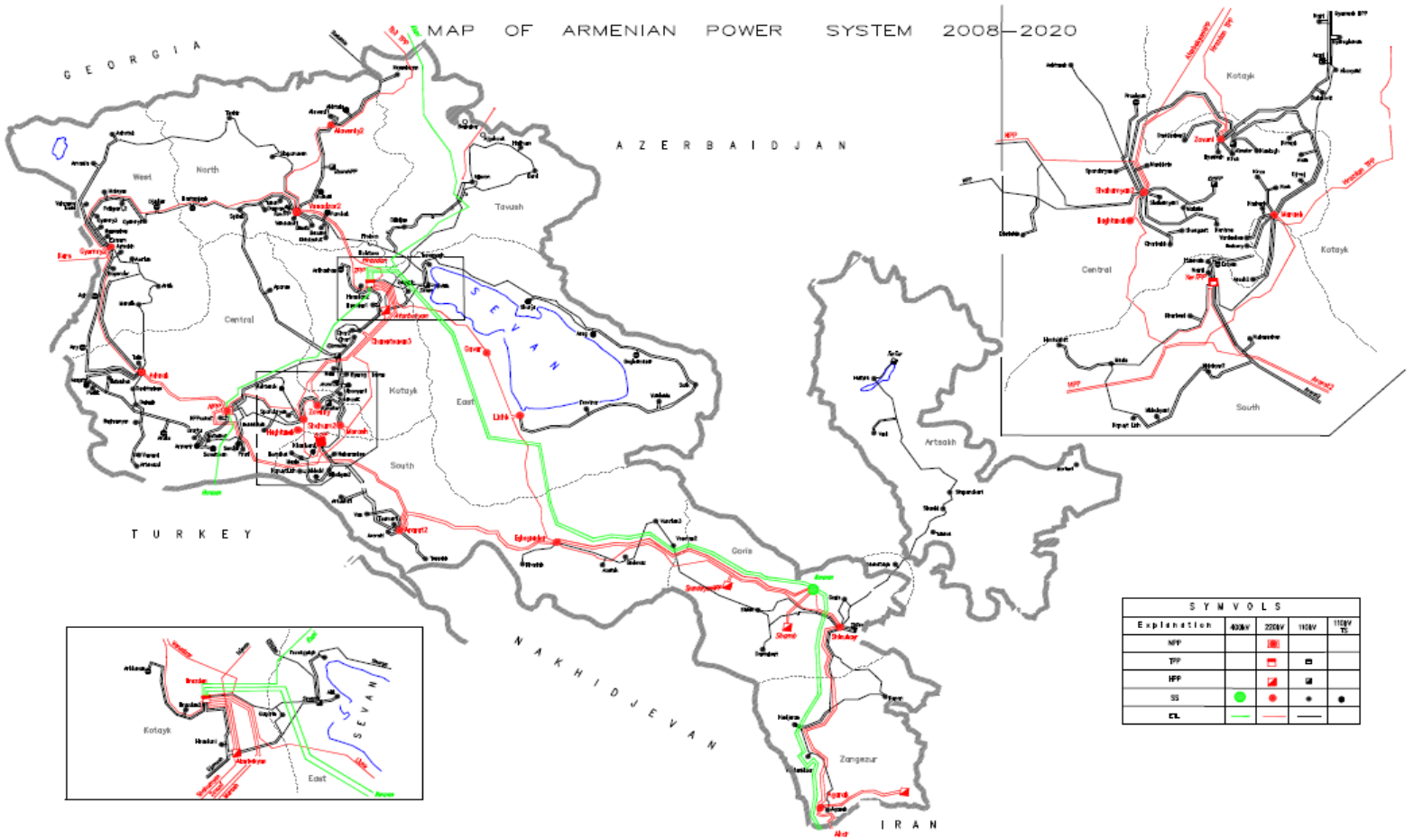
- Competitive tariff setting will be introduced. It is planning to construct second combined cycle unit at the Yerevan TPP with 250-450 MW capacity (2018).

- Among priorities are development of electrical transport to connect Yerevan with neighboring cities to decrease the emissions. Also the minimum requirements for energy efficiency and energy saving for the public sector procurement should be established.

GoA action plan in energy sector for 2014 – 2020:

- In the area of regional cooperation it is planning to construct first 350 MW module of B2B substation and connect to 220 kV Alaverdi-Gardabani TL (2015 – 2018), first circuit of 400 kV Hrazdan-Ayrum line and second 350 MW module (2017-2021). Also are scheduled to install third 350 MW module, to construct second circuit of 400 kV Hrazdan-Ayrum line, to construct Iran-Armenia transmission third line and to construct Meghri HPP with EDBI financing.
- The mechanisms to integrate Armenia into regional energy projects are Black Sea Economic Cooperation; European Energy Charter; Power Council of Commonwealth of Independent States (CIS); USAID, Interstate Oil and Gas Transportation to Europe (INOGATE), Organizations for the Promotion of Energy Technologies (OPET), and Development of economic relations on bi-lateral and multi-lateral basis.

Armenia - network map



OPTIONS AND SUGGESTIONS

1. It is planned to construct PV Station up to 30MW till 2020. Then to increase the capacity of PV stations up to 80MW. It can be considered an option to enlarge the capacity up to 120 MW and at the same time to reduce construction those remaining small HPPs that are economically non feasible without feed-in tariffs. Forecasts for PV long-term system prices are brought in Appendices 7.

OPTIONS AND SUGGESTIONS

2. There are many estimates of renewable energy potential in Armenia made in different reports and researches [2,13, 19, 20]. It seems reasonable to re-evaluate renewable energy potential in Armenia regarding biogas and biomass use.

- Data on biomass use are far from exact data since there was no systematic research on volumes of biomass use. There are large Illegal tree cuttings and data on volumes are artificially reduced. Several attempts were made at NGO level to evaluate biomass use and data should be reevaluated with modern techniques.
- Biogas production estimates and forecasts made in [21, 13] are significantly more than in Appendices 2.

OPTIONS AND SUGGESTIONS

3. More intensive cooperation with Energy Union's 5th direction: Research, Innovation and Competitiveness: Facilitating the participation of consumers in the energy transition through smart grids, smart home appliances, smart cities, and home automation systems to involve local population in similar programs.

4. It is reasonable to consider development of electrical transport for inter Yerevan communications to decrease the emissions in Yerevan. The best choices to develop subsequent metro stations including underground and above ground options, especially above ground versions as they are less expensive.

OPTIONS AND SUGGESTIONS

5. To promote improvement of energy efficiency and development of renewable energy sources it is reasonable to form and support Research Centers and Laboratories that will focus their activity at adopting world advanced technologies to Armenia and will be involved in development of innovative products or components in its true meaning i.e. ready to sell product in the area of renewable energy technologies. Of course, Armenia market is very small for products to be developed from the start to end and this is not the suggestions. International cooperation in these centers should be organized with government support and involvement of their resources. A good example can serve the Solar Center in Uzbekistan organized with support of ADB and other donors (to be refined). More international funding should be reallocated from Ministries to similar centers and laboratories at which scientific knowledge should be prevalent over managerial experience and «copy paste» activity.

OPTIONS AND SUGGESTIONS

6. Corruption in Energy Sector as well as in other areas of Armenia should be reduced as it hinders involvement of investors and country development. There are no official data on corruption but its existence in large volumes is admitted at governmental level and appropriate structure at governmental level was created to fight against corruption. No significant examples of fight with corruption were demonstrated up to now. Concerns with some of constructed SHPPs that raised significant environmental concerns in Armenia can be explained by not appropriate activities of officials from Ministry of Nature Protection of RA that provided approval for projects that don't comply with environmental rules to be implemented with. With that a lot of loans for Small HPPs constructions are provide from abroad.

OPTIONS AND SUGGESTIONS

7. Provisions of soft loans from EU to Armenia for development and improvement of Armenia's Energy sector, to improve its energy security and implement its plans on energy sector development (the plans that were developed to large extent within technical assistance from EU and USAID) and technical assistance to RA in the forms of programs development, training of specialists, providing modern equipment at affordable prices are the financial basis for further modernization of Energy Sector of RA and improvement of its Energy Security.

Trainings of local specialists by EU experts will also provide occupancy for foreign experts and through that synergy of cooperation will come into effect.

More intensive cooperation with Energy Union strategy's 5th direction: Research, Innovation and Competitiveness: Facilitating the participation of consumers in the energy transition through smart grids, smart home appliances, smart cities, and home automation systems should be promoted to involve local population in similar programs.

Conclusion and recommendations

- As can be seen from above mentioned, significant financial investments are required to implement plans that were developed in Armenia with technical assistance from EU and USAID to modernize Armenia's energy sector and improve its energy security. Armenia itself has no opportunities to get funding without external help. To avoid untargeted waste of funding that can be brought into Armenia it should adapt to its conditions the large experience of EU to solve security of energy supply problems since there are many common energy security problems in Armenia and EU as we have seen from key facts on Armenia and EU energy security, particularly, dependence on imported fossil fuel, dependence on the Russia in gas imports, secure operation of its nuclear power plants, insufficiency in electricity and gas network connections between countries, etc.

Conclusion and recommendations

1. There are no economically justified alternatives to life extension of the existing Armenia Nuclear Power Plant (ANPP) through 2026. Several options were considered to replace Armenian Nuclear Power Plant with the new one after 2026. Three NPP technologies were identified for replacement of the old 2nd Unit of ANNP: VVER-1000 design AES-92 (capacity 1028MW), the Enhanced CANDU 6 (EC 6) with capacity of 670 MW and the several Small Modular Reactor (SMR) designs with capacity of 385 MW, which offer the capability to add nuclear generation capacity in smaller increments although still unproven on a commercial scale.

Conclusion and recommendations

2. Currently Energy Sector of Armenia completely provides internal market of Armenia with electricity and even exports it to neighboring countries around 10-16 times more than imports. During 2012 Armenia imported 98 million kWh of power mainly from Georgia (67.9 million kWh), as well as from Iran and Artsakh and at the same time it exported totally 1696 million kWh to Iran (1578,1 million kWh) and Artsakh (118.1 million kWh). There is still a need for installation of 620 MW of additional thermal capacity starting 2018 as the several or all outdated units of TPPs (Hrazdan Thermal Power Plant) will be decommissioned by that time. To provide reliable power flows with Georgia the construction of a 400 kV line and a Back-to-back converter is required as it approved by GoA program.

Conclusion and recommendations

3. Commissioning in 2009 Armenia-Iran gas pipeline (South pipeline) has allowed significantly reduce possible negative consequences on Energy system of Armenia and risks in the event of gas supply interruptions from Russia through North pipeline. Taking into the account the positive evolution of relations between EU and Iran as well as US and Iran and upon appropriate agreement with Russia Armenia can develop and implement joint plans with EU and Russian of enlarging of capacities of Armenia and Iran gas pipeline and transit Iran gas to EU countries through Georgia gas pipelines.

Conclusion and recommendations

4. Latest intensive social tensions of Armenia population in summer 2015 were caused from another one raise of end-use daytime electricity tariffs for consumers (including population /residential sector/) feeding from 0,38kV voltage networks from 41,85AMD/kWh to 48,78AMD/kWh ((effective since August 01, 2015)) and nighttime residential electricity tariffs from 31,85 AMD/kWh to 38,78 AMD/kWh approved by PSRC and temporary stopped by GoA, reflects the fact that one component of security energy supply i.e. supply of electricity at formidable prices is underestimated in official approaches to energy security of Armenia. The tensions among population started still in 2014 but were neglected by PSRC. This time they brought about to large protests, closing of streets by protesters, collisions between police and protesters. The issue is still not resolved. Raise of tariffs was requested by Electric Network of Armenia as they accumulated large debts in last years (according to some estimates around 300mln USD). Under pressure of protesters in September 2015 the GoA decided to subsidize electricity prices for population for one year in the amount of around 7 drams and to use 41.85 AMD/kWh tariff.

Conclusion and recommendations

5. GoA outlined plans to develop alternative energy sources (we mean not only small HPPs). To reach successes in that direction amendments in «Energy saving and Renewable energy» law is required as its current version don't reflect the demand in alternative energy sources. Historically it was designed only as energy saving law and already during development Ministry of Finance rejected to provide financial support to that law. So the law has declarative nature in its essence. It is reasonable to have separate law on renewable energy, provide financial support through Ministry of Finance with involvement of bilateral donors and multilateral donors with purpose to develop in first turn solar, wind, biogas and geothermal energy sources. The appropriate financial foundations should be organized to promote renewable resources excluding small hydro at no more than 6-7% long-term (10-15 years) loans for development and installations of these sources. Foundations operation should be under umbrella of UNDP, GEF, UNIDO, USAID, Energy Union's appropriate Facility and should be additionally introduces to already existing R2E2 Foundation that can focuses further its activity on energy saving and small HPPs where it acquired enough experience.

Conclusion and recommendations

6. Formation of Research Centers and Laboratories that will focus their activity at adopting world advanced technologies to Armenia and will be involved in development of innovative products or components in its true meaning i.e. ready to sell product in the area of renewable energy technologies. Of course, Armenia market is very small for products to be developed from the start to end and it is not the suggestions. International cooperation in these centers should be organized with government support and involvement of their resources. A good example can serve the Solar Center in Uzbekistan organized with support of ADB and other donors (to be refined). More international funding should be reallocated from Ministries to similar centers and laboratories at which scientific knowledge should be prevalent over managerial experience.

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8. Provisions of soft loans from EU to Armenia for development and improvement of Armenia's Energy sector, to improve its energy security and implement its plans on energy sector development (the plans that were developed to large extent within technical assistance from EU and USAID) and technical assistance to RA in the forms of programs development, training of specialists, providing modern equipment at affordable prices are the financial basis for further modernization of Energy Sector of RA and improvement of its Energy Security. Trainings of local specialists by EU experts will also provide occupancy for foreign experts and through that synergy of cooperation will come into effect. More intensive cooperation with Energy Union strategy's 5th direction: Research, Innovation and Competitiveness: Facilitating the participation of consumers in the energy transition through smart grids, smart home appliances, smart cities, and home automation systems should be promoted to involve local population in similar programs.

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Brief and reduced description of 15 action points of the Energy Union strategy

The Energy Union strategy envisages implementation of fifteen action points [22], among them we want to draw attention to some points of them, which in its turn are given with reductions:

1. The EU needs to diversify its supply of gas and make it more resilient to supply disruptions.
2. The Commission will bring together information on EU-funded infrastructure projects and will create a dedicated Energy Infrastructure Forum to discuss progress on major infrastructure projects with Member States, regional cooperation groups and EU institutions.
3. Creating a seamless internal energy market that benefits citizens, ensuring security of supply, integrating renewables in the market.
4. Regional approaches to market integration.
5. Greater transparency on energy costs and prices
6. The EU target of reaching at least 27% energy savings by 2030.
7. Retrofitting existing buildings to make them energy efficient and making full use of sustainable space heating and cooling will reduce the EU's energy import bills, reinforce energy security and cut energy costs for households and businesses.
8. The EU needs to speed up energy efficiency and decarbonisation in the transport sector.
9. The EU has agreed the target of at least 27% at EU level for renewable energy by 2030. This will include a new policy for sustainable biomass and biofuels as well as legislation to ensure that the 2030 EU target is met cost-effectively.
10. The Commission will develop an active agenda to strengthen EU energy cooperation with third countries, including on renewable energy and energy efficiency

Thank you

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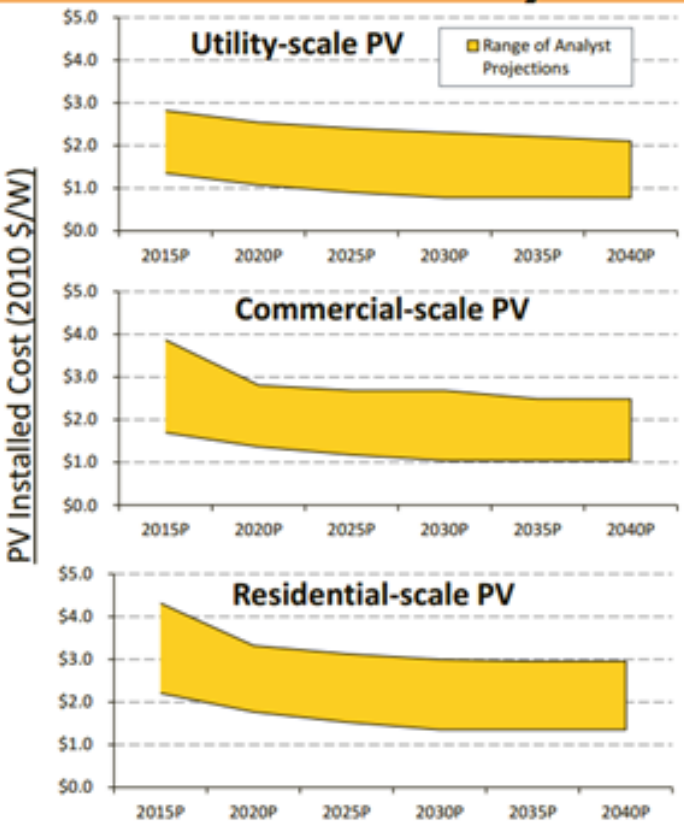
Range of Analyst Expectations of Long-term System Price



- Analysts expect pricing in all PV markets to continue to decrease in the long-term
- Low-end of analyst projections get very close to SunShot target by 2020-2030
  - High-end still approximately $1.00-$1.50/W above targets, though these estimates align with some of today's modeled prices
- Current analyst projections are far lower than projections made in recent past
  - 2020 price projections are approximately ½ of what same analysts projected 5-10 years ago.

Sources: Greenpeace/EREC, "Energy Revolution," May 2014 (utility-scale only); International Energy Agency, "World Energy Outlook 2013," November 2013 (New Policy & 450 Scenarios for utility-scale & commercial-scale); Bloomberg New Energy Finance, Q2 2014, "PV Market Outlook" (05/15/14); U.S. Energy Information Administration, Annual Energy Outlook 2014 ER (December 2013). In years where projection was not made, most recent projection used.

SunShot U.S. Department of Energy

energy.gov/sunshot

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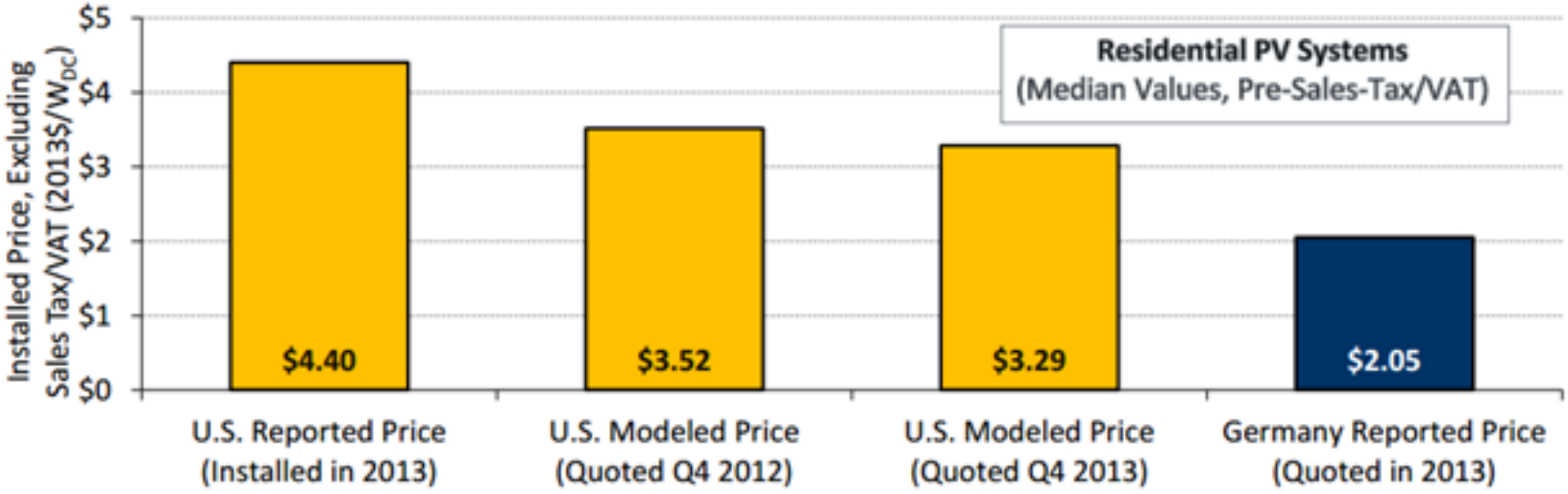
Installed Prices for Residential PV: United States vs. Germany



Note: The German data are based on price quotes for roughly 2,300 individual PV systems obtained by EuPD through its quarterly survey of German installers and provided to LBNL.