



## Prospects for Electric Energy Export: Promising Trap?

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### ***Armenian Power Engineering: Baby with Voracious Appetite***

Armenia ranks between 110 and 120 among 213 countries under Power Generation Performance Indicator. Presently, 100 Armenian power companies, including 95 hydroelectric, 3 thermal and a nuclear power plant, generate about 6.5 billion kWh of electricity per year. In 2010, electric energy worth over 48.4 billion AMD was generated in Armenia through efforts of over 4.5 thousand workers involved. Power generation capacity in Armenia totaling about 3,200 MW comes to be fairly impressive for our small economy. More than half of total generation capacity is provided by thermal power plants, 32 percent – by hydroelectric power plants and 13 percent – by the nuclear plant. Since 2005, a wind power plant with production capacity of 2.6 MW, the first of its kind in the Caucasus, has also been run in the north of the country. It is quite obvious that the economic efficiency of energy generation in Armenia is fairly low as energy consumption is too low compared to generation capacity; actually, only over 30% of total generation capacity is used. As a result, the average price per kWh of electricity produced in Armenia totals around 7.5 AMD (without transmission and distribution costs).

Armenian electricity transmission infrastructures are interconnected with those of all its neighboring countries; while electrical interconnections with Azerbaijan and Turkey (220 kV Gyumri-Kars overhead line of 300 MW capacity, about 80 km long) are not exploited nowadays, capacities of electric power transmission lines with Georgia and Iran have been increased steadily. It is quite noteworthy

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that the law allows Armenian producers to export only "expensive" energy generated by low efficiency thermal power plants with production prime cost actually exceeding 15 AMD. With transmission costs (1-2 AMD), export price of energy exceeds the prime cost of energy generated in neighboring countries; therefore, electricity is exported almost exclusively in seasonal exchange mode.

At the same time, Armenia continues to modernize and expand its power generation capacities. Thus, a nuclear power unit with capacity of almost 1,000 MW is planned to be launched. In 2010, construction of combined-cycle thermal power plant with capacity of about 250 MW was completed at Yerevan Thermal Power Plant, and 5th power unit of Hrazdan state regional power plant (SRPP) with capacity of about 500 MW will be operational in autumn, 2011. Such thermal energy capacities, efficient from economic perspective, are expected to double by 2016-2020. It is planned to expand the use of hydroelectric resources through constructing the following hydroelectric power plants: 140 MW capacity Meghri

hydroelectric power plant on Araks River to produce about 800 million kWh of electricity per year, 75 MW capacity Shnogh hydroelectric power plant on Debed River to produce over 300 million kWh of electricity per year, 66 MW capacity Loriberd hydroelectric power plant on Dzoraget River to produce over 200 million kWh of electricity per year. It is also planned to expand the overall capacity of small hydroelectric power plants to more than 250 MW by 2025, and water-power potential of Armenian small rivers and water pipes are estimated to make up to 600 MW (with energy resources of 21.8 billion kWh). Capacity of wind power plants is estimated to reach up to 200 MW, and the overall capacity potential of Armenian economically profitable wind power plants was estimated about 450 MW with 1,26 billion kWh annual energy output. A geothermal power plant with capacity of 25 MW, to be the first of its kind in Armenia, is planned to be constructed in Jermaghbyur. Besides, installation of solar power conversion photovoltaic modules and discussions on possible ways of using natural gas power resources are under way.

In case the mapped projects are completed, the total energy generation capacity in Armenia will have reached up to 5,500-6,000MW by 2020. However, despite plans for unprecedented expansion of generation capacities, no tendency for significant growth in energy consumption seems to be expected. Given the average annual GDP growth of 4-6 percent, energy consumption annual growth rate made only 3 percent. Such situation is apparently linked with two key factors: energy security challenges and electricity export opportunities.

### ***Energy Security Paradox: Dependence on Diversification***

Given our highly explosive region with its closed borders and many unresolved conflicts, energy

resource infrastructures are in constant danger. Following concerns over smooth supply of natural gas for thermal power plants, gradual reduction of hydrocarbon energy resources and substantial growth in their prices worldwide, management features of electricity production, transmission and distribution infrastructures in our country and their impact on our country's energy policy, as well as a number of other political and economic factors, Armenia has to develop alternative energy sources and relevant capacities. As a result, the need for energy security comes to win logic behind economic efficiency. Moreover, although short-term but substantial risks within energy security make everybody shut their eyes even to long-term interests and vital issues within environmental and ecological security. And it is well behind such logic that Armenia seems to be doomed to develop nuclear energy. While Armenia does have great energy capacities, the country also has equal political risks. Moreover, large energy capacities seem to result from such risks. And, at the same time, our country policy to reduce energy security risks was perhaps based and still continues to rely on energy generation capacities and possible diversification of energy sources in a number of respects: seasonal, technological, energy carriers, investments, etc.

However, in search of energy security Armenian consumers have to pay too high electricity bills.

In essence, the consumers pay for both energy generation and security. Therefore, it is quite natural that current and future investments into Armenian energy sector continue to be political in character to some extent.

However, various estimations suggest that our country's energy security policy surprisingly enough led to even greater energy dependence of Armenia and vulnerability of the system to rapid changes in particular political, economic and military issues.

Prospects for exporting electric energy to neighboring, regional and even farther countries serve as yet another factor for expanding energy generation capacities in Armenia. How realistic are such prospects, and what challenges and obstacles would they face?

### ***Georgia: Armenia's Electric Energy gateways***

Our country's principal partner in energy sector is our neighbor Georgia which till 2006 served as a consumption market for energy generated in Armenia. Nowadays, however, Georgia can successfully meet its own energy needs as it has developed its own adequate and dynamically increasing generation capacities to meet consumption and is likely to need no imported energy for next 20 or 30 years except for seasonal exchanges.

Hydro-power stations appear to be key energy generation capacities in Georgia: more than 80% of energy produced by six hydro and three thermal power plants is generated by the former. Currently, 40% of energy produced by 1300 MW capacity Inguri hydroelectric power plant, the largest hydroelectric power plant in Georgia and in the Caucasus, is consumed by Abkhazia and 60% - by Georgia. Nowadays, Georgia generated over 8.5 billion kWh of electricity per year.

Georgian energy system functions in parallel operation with those of almost all of its neighbors. Till 2009, Georgia exchanged, i.e. imported and exported some portion of energy from and to the following neighboring countries: Russia, Turkey, Armenia and Azerbaijan. Since 2009, energy exchange balance in the country has already been quite proper. While in 2009, Georgia exported about 580 million kWh of electricity, including 180 million kWh to Turkey, it imported only a total of 380 million kWh of electricity from Russia. In 2010, Georgia had

already exported around 1.3 billion kWh of electricity. Georgian and Armenian energy systems are interconnected through "Alaverdi" 220 kV, "Larvari" and "Javakhk" 110 kV overhead lines.

The neighboring country continues to increase electric power generation and transmission capacities and attempts to attract investments to this end. Estimations suggest that presently, Georgia uses only about 18 per cent of its water resources. In order to broaden the scope of exchange, Turkey and Georgia are planning to construct a powerful 500/400 kV energy transmission line, in order to increase electricity exchange rate.

It is also quite noteworthy that energy generation, including transmission and distribution facilities in our neighboring country that has rather complicated relationship with the region's energy heavyweight, Russia (4<sup>th</sup> energy producer in the world, after United States, China and European Union) are owned by Russian companies. Russian "Inter RAO UES" which is also the principal owner of Armenia's energy capacities, owns about 20 percent of Georgian energy generation capacity and, despite Russian-Georgian conflicts, aims to launch some new large-scale investment projects in the Georgian hydroelectric power market. The Russian company mentioned also owns 75 percent of the Georgian "Telasi" company controlling one of the largest electric power distribution networks in Georgia. Actually, the present-day Georgian energy system is no less "russified" than the Armenian one. Late March, 2011, Georgian and Russian energy companies once more committed themselves to working in parallel operation mode that was an unprecedented step even back in the Soviet period. On the threshold of 2014 Sochi Winter Olympic Games, such cooperation between the two countries can become even

more dynamic. It turns out to be quite true that energy- and petrodollars have no homeland, live their own lives and impose their own logic.

Enhancing cooperation between Armenia and Georgia in the field of energy generation and transmission is mutually beneficial. Cooperation issues and benefits are by no means limited to exporting or importing energy from Armenia to Georgia or seasonal exchange. Cooperation is first of all beneficial in respect of shaping and stabilizing systems in both countries in line with European standards, based on providing parallel operation of such systems. It is no secret either that the greater the energy system, the greater stability it has against change of local parameters so that it can meet relevant standards.

Cooperation between Armenia and Georgia will contribute towards diversification of energy generation sources in both countries through combining Georgian predominantly hydroelectric generation capacities with Armenian powerful thermal and nuclear generation capacities. The region will be able to address even more significant political and economic risks under local conflicts and economic transition. As a result, both countries will considerably benefit in terms of their energy independence and new opportunities to pursue their common interests.

Cooperation between Armenia and Georgia will create favorable conditions for enhanced economic efficiency of energy generation in both countries and the region in general; the general market and its expansion impose their own logic. After all, both Armenia and Georgia will enjoy considerably increased opportunities for energy export to third countries, including Iran and Turkey, Russia and Europe. Energy systems of both countries will gain the opportunity to work with different quality standard systems, if necessary, in greater and therefore more

sustainable and economically efficient remote "islands" mode.

Expansion of cooperation can be highly dependant on large common shareholders in the energy system whose economic interests are likely to become the key driving force in the medium-term sector.

### ***Iran: when Diamond Can Cut Only Glass***

Iran, our other neighbor, is energy generation and consumption world heavyweight as it ranks 19 in energy generation and 20 - in energy consumption. Iran generates almost 1/5 of energy in the Middle East and Africa regions totaling around 200 billion kWh per year. Given unprecedented scale of consumption per capita and huge electricity transmission losses (about 18% of generated energy is lost), Iran succeeded in meeting its own energy consumption needs. While this enables our neighbor to export electricity to other countries in the region (more than 1.3 percent of the output), Iran also imports energy (about 1.2 percent of consumption) to keep seasonal balance. In Iran, electric power generation capacities are mostly thermal based on hydrocarbon energy resources, i.e. gas (about 75%) and oil (about 18% ), while hydroelectric resources make only some 7%. The indiscriminate use of expensive natural gas in the global market can perhaps be accounted for by the fact that following international sanctions and fundamental contradictions with the West, Iran lacks the opportunity to map plans for gas pipelines connecting the country to the world market. It should be also noted that despite huge scope of energy generation, Iranian energy system fails to meet quality standards acceptable in European energy systems.

Electricity consumption rates in the country continue to increase by some 6% per year with 2% annual GDP growth; however, energy generation capacities increase quite

progressively; Iran plans to have expanded its generation capacities by some 15,000-20,000 MW by 2025. By the year mentioned, Iran also intends to have produced about 23,000 MW hours of electricity. Today, Iran manages not only to meet its energy consumption, but rather build power plants and satisfy its own technical needs. It appears to be quite true that Armenia is located between northern (Russia) and southern (Iran) regional and global energy giants. Besides, the North-South energy cooperation is likely to assume decisive role not only for our country but rather for global economy. What about current and potential cooperation in this field between Armenia and Iran?

Currently, Armenia cooperates with the southern giant in the scope of energy exchange. For instance, in 2011, Armenia will receive more than 800 million cubic meters of gas from Iran through pipeline with capacity up to 2.5 billion cubic meters. In its turn, Armenia will transmit to Iran 2.4 billion kW/h of electricity (Armenia committed to provide Iran with 3 kWh of electricity for a cubic meter of gas). The exchange process entails parallel operation of Hrazdan state regional power plant (SRPP) 5th unit and modernized Yerevan Thermal Power Plant (TPP) generation capacities. Along with the two operating energy transmission lines with capacity of 450 MW, a 400 kV energy transmission third line along with "Noravan" substation will be constructed in the near future, 275 km long in Armenia and 163 km long in Iran to increase general exchange capacity up to 1,000 MW. Projects to enhance cooperation between Armenia and Iran in this field of energy also imply construction of "Meghri Hydroelectric Power Plant (HPP)" on Araks River with Iranian funding and stage by stage exploitation as follows: construction-ownership-operation-delivery.

In case of implementing regional transit projects and lifting energy resources export sanctions Iran will probably feel the need for importing energy along with energy exchange or joint energy production. Such developments can give Armenia significantly increased chances to export energy to Iran.

In fact, the scope of energy exchange capacities and possibilities comes to extend. However, in case of parallel operation of capacities with the Iranian power system, the Armenian power system will have to face the great challenge of system quality. Considering possibilities for parallel operation with other regional systems requiring and imposing more advanced technical standards will pose even stiffer challenges. The problem in question surely has technical solutions, including through fragmentary "islands" of a separate facilities isolated from the Armenian power system.

### ***Turkey: Three Sons and the Broom***

High rates of population growth, industrialization and economic development in Turkey are accompanied by unprecedented increase in electric energy market to make about 2.5% of the country ranking 18 among global economic powers. Along with overcoming the economic crisis, Turkey has again increased energy production with the annual output totaling about 200 billion kWh. In 2011, energy generation capacities in the neighboring country exceeded 50,000 MW with more than 65% produced by thermal, about 32% - by hydro and about 3% (more than 1,300 MW) - by wind power plants. The country counts power generation geothermal facilities with a capacity over 100 MW. At the same time, over 28% of thermal power plants functioning in the neighboring country use coal, including imported coal. It is quite noteworthy that annual coal production in Turkey falls by over 7%.

Having launched key structural reforms in the energy sector a little bit later as compared to Armenia, Turkey has started the denationalization, liberalization and deregulation process of the energy market in recent years. In 1993, through separating energy generation and transmission (TEAS) and distribution functions (TEDAS) from Turkish Electricity Authority (TEK), state united agency, Turkey initiated approximation of its system to the EU standards in the market by means of continuing to separate functions among four public companies EUAS (generation), TEIAS (transmission), TETAS (wholesale realization) and TEDAS (distribution) throughout 2001-2003. EUAS controls 60% of energy production facilities, and EMRA, the regulatory agency, restricts generation capacities and growth of separate private and independent production companies. While TEIAS has a monopoly on electricity transmission, it is under obligation to purchase all production by EUAS. TETAS predominates in the wholesale market through controlling 90% of the market, export and import, while 25 private companies in the aggregate control about 10% of the wholesale market. And TEDAS coordinates energy distribution to over 30 million customers with the help of local companies and controls 75% of the retail market. In 2008, the real process of generation facilities privatization gained momentum. Thus, 52 hydroelectric power plants were privatized throughout 2009, and privatization of 45 others is underway.

Wholesale electricity prices in Turkey range among the highest in Europe making about 9 US cents per kWh. This seems to be basically accounted for by the fact that excessive energy supplies are mostly sold by thermal power plants using natural gas. It is quite obvious that with oil and gas price increase in the medium-term sector, wholesale prices will at best remain unchanged. At the same time, January 2009,

Turkey ratified the Kyoto Protocol, leading to increased prices for electricity generated from gas and coal and, therefore increased average wholesale prices.

In order to comply with EU Regulation No 714/2009 on Conditions for Access to the Network for Cross-Border Exchanges in Electricity, Turkey passed a new regulation on electricity export and import, June 1, 2011. Under the regulation, the export/import transactions within synchronous interconnection with European continental electric networks are exempted from the special permission that is still required for transactions with other countries and systems.

Technical, structural and legal reforms taking over ten years and costing the state over 1 billion US dollars, according to estimations, enabled Turkey firstly, to join the Continental Europe power system within parallel operation mode in 2010 and secondly, to provide for trade exchange with Bulgaria (65%) and Greece (35%) June 20, 2011.

Electricity trading capacities are distributed between Turkey and its European neighbors through transparent auctions declared and held by TEIAS that enjoys observer's status within the ENTSO-E. ENTSO-E is a European association for operators of 41 electricity transmission systems in 34 European countries with members who with their total capacity of 880,000 MW annually serve 532 million consumers of 3,200 billion kWh and thus provide about 380 billion kWh of annual electricity exchange among the members. Today, electrical power frequency variations between synchronously operating Turkish and European networks never exceed 0.15 hertz. While Turkey still has a long way to go before successful integration into the European energy market, joining Continental Europe Synchronous Area, in fact, opened up a new era for energy systems in

Turkey and its neighbor states. It is also noteworthy that Turkey starts joining European power systems from its "hostile friend" country with rather complicated military and political bilateral relations.

Present-day Turkey's power system is also connected to those of other neighboring states, namely Georgia, Azerbaijan (Nakhijevan), Iran, Iraq and Syria's. While Turkey imports energy from Georgia, Azerbaijan and Turkmenistan (twice more than from the former two countries), it also exports energy to Iraq and Syria. In frames of the Eight Country Interconnection Project (EIJLLPST), Turkey is expected to join electric networks of five more countries: Egypt, Jordan, Libya, Lebanon and Palestine.

Medium-term electricity demand is estimated to continue growing by 6 or 7.5 percent annually having reached 320-380 billion kilowatts hour by 2016. To meet such demands, Turkey intends to increase electricity production capacities and discuss a wide range of recommendations on hydroelectric, thermal and nuclear power plants using coal. It has been estimated that to generate energy, Turkey presently uses over only some 36% (13,000 MW) of its total water resources with capacity of 36,000 MW. In frames of 627 projects, construction of about 11,000 MW capacity hydroelectric plants is under way; as a result, the country will use about 2/3 of hydroelectric resources.

In order to diversify energy resources, Turkey is considering projects to raise nuclear resources up to 15,000 MW by 2012. In particular, Turkey has already taken actions in Akkuyu and Sinop to build nuclear power plants with capacity of 5,000 MW by 2012. To this end, Turkey expects funding from its neighbor Russia through offering a nuclear power building contract.

Turkey also has an overall potential for wind power generation with the capacity of about 48,000 MW through which it attempts to boost private sector investments, including provided realization of total energy produced by private wind plants for 5.5 euro-cent per kWh. Turkey expects wind power plants capacity increase by more 2,000-3,000 MW within the next 3 or 5 years as a result of such investments. However, wind power plants in the area can provide only 5-15% of energy to be consumed. At the same time, such plants provide some extra economic benefits in terms of meeting Kyoto agreement requirements and reducing carbon dioxide emissions. It is also noteworthy that Turkey ranking 1st in Europe and 7th in the world with its geothermal resources, almost fails to use its potential by implementing 1 or 2 projects only.

Generally, despite expensive projects on energy production capacities requiring huge financial investments, the Turkish economy is most likely to feel the need for energy import starting from 2014 or 2016. Therefore, Turkey should be interested in cooperation with its Caucasus neighbors in this field and parallel mode interconnection of power systems to enable use of more efficient and available economic means to ensure its energy security, cut costs, as well as promote diversity of its energy sources and interconnection among countries in the region and therefore regional stability. In this respect, Turkish policy seems to try pragmatic approach. Current process of forming interconnection with Georgia comes to support this assumption. It is quite noteworthy that the current capacity for electricity exchange with neighboring countries is quite limited. For instance, even in case of potential use of Akhalkskhe-Borchka sector 400 kV power line (about 100 km long) with its entire capacity, energy imported from Georgia in frames of asynchronous mode as a result of exchange can meet only 2-4% of Turkey's demand and therefore, can have no significant

impact on wholesale prices. At present, possible electricity exchange between Turkey and Armenia through whole capacity of Gyumri-Kars line by no means exceeds 0.5% of current demand. As for Azerbaijan and Iran, the current border import possibilities remain unchanged. Anyway, interconnection of the above countries into a united electric energy system, current developments within power capacities and investments projects in Armenia, Georgia and Iran will provide a strong base for Turkey's economic development in case of building new facilities with increased capacities and securing its smooth synchronic operation. Reputable Turkish private companies are sure to take interest in this issue.

Enhancing technical possibilities for electricity exports from Armenia to Turkey requires about 80-90 million US dollars. At the same time, to develop power generation facilities in line with increased capacity, Turkey will need tenfold investments. Such cooperation offers quite an obvious economic interest. Besides, potential stakeholders, i.e. private companies, can be clearly traced. Alas, the economic interest is in some cases hostage to political agenda. Thus, in September 2008, the Armenian "High-Voltage Electric Networks" and the Belgian "Unit International SA" companies signed a contract to supply power to Turkey: initially, Armenia is expected to export 1.5 billion kWh of electricity and then increase the export up to 3.5 billion kWh. The Armenian company started mapping out a modernization and recovery plan for Gyumry-2 substation built back in 1972. However, following the lack of any certain prospects for Armenian-Turkish Rapprochement in "post-reaction" period, this project came to a standstill.

Restoring of political relations between the two countries would certainly forge cooperation between infrastructures in both countries and first of all, in terms of electric power systems interconnection and cross-border trade. It also appears quite obvious that current capacities, economic interests and key stakeholders within the energy cooperation between Armenian and Turkey lack either sufficient power or urgency to remove the political barrier.

However, immediate need for first steps in this direction is quite evident. Along with actions necessary for parallel operation with the Georgian energy system, further needs and potential solutions to possible problems within energy cooperation among Armenia, Turkey and regional countries must be discussed. The same subsystem is obviously unable to operate with systems based on different standards and therefore, calls for enormous investments and efforts. Economic development and related needs of countries never wait for resolution of outstanding political issues. Today, such needs continue to wait and follow in silence current political developments, steps by state authorities and intermediaries' role. Tomorrow, liberalization of energy markets, their complete integration into European continental network, economic interests and economic development issues of third countries will inevitably impose their own logic. However, the longer countries seek solutions to short-term problems and postpone discussions of cooperation prospects, the bigger the danger that medium- and, particularly, long-term cooperation can mostly serve interests of third parties.