ENVIRONMENTAL RISK ANALYSIS AND ASSESSMENTS OF ELECTRICITY PRODUCTION OF RA

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1. Introduction

Growing importance of environmental issues at global and regional levels including pollution of water, air etc., and as a result the global warming and climate change are considered as effective factor for power generation. Power generation is among the most important factors causing risks in increasing the volumes of emissions.

Usually, decisions on environmental issues are complex and includes multidisciplinary knowledge concerning to the natural, physical social sciences, politics and ethics. It is crucial for the environmental decision makers to rely on different experimental tests, computational models, and tools to assess ecological risks associated with environmental stressors and abatement strategies on risk reduction. Nowadays, applying these tools is also becoming increasingly difficult, as there are many emerging risks (e.g., climate change, nanotechnology, etc.) for which information is not available and decisions should be made under significant uncertainty.

Republic of Armenia is almost entirely dependent on importing energy. The only domestic energy resource in use is hydropower, providing about 30% of energy demands, and the single nuclear power plant. The Environmental and Social Risks cover the power generation industry and includes power stations and the use of fossil fuels, nuclear power and renewable energy sources: such as hydroelectric power, wind farms, geothermal energy, photovoltaic and energy generation from biomass and waste. Feasibility assessments should also focus on interface issues, such as connection to the existing electric power system, evaluation the compliance of resource and technology (particularly, that is core aspect for investigation of biomass options), and identifying environmental concerns and regional constraints.

Armenia’s energy strategy (Poverty Reduction Strategy Paper (PRSP)) prepared in 2003 clearly emphasizes (among others): “Maintaining and strengthening energy independence by developing indigenous and alternative energy sources and promoting energy efficiency. Regarding the development of indigenous resources, priority should be given to developing renewable energy production.”

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

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

Over the past few years, energy sector of Armenia describes with considerable progress, mainly after the 1990s energy crisis, however there are several factors that are basic for future expectation of the sector development.

- 2/3 part of energy resources are imported
- Expected gap to meet energy demand. The existing production capacities are not enough to cover it.
- Expected demand will require 2-3 times more primary energy sources with outdated stations
- Over the last decade, the rise in energy prices leads to problems with accessibility and competitiveness.
- Electricity price increased by 94-112%
- Natural gas prices have increased by 200-250%
- GDP growth rate Decreased from 7.2% to 3.4% in 2012-2014

The use of renewable energy has played a crucial role in stabilizing the energy sector, and it is reaming dominant in the coming years, taking into account the energy demand, energy security, and the anticipated conservation of existing old generators.

One of the main goals of the national energy policy in the Republic of Armenia is to improve energy efficiency and further development of renewable energy sources, which requires assessment of the environmental risk.

The construction and operation of SHPPs in the Republic of Armenia is often carried out without the conservation of environmental norms, and as a result, natural, especially water ecosystems are suffered/ are affected. Small HPPs are often built in areas of vulnerable ecosystems (forests etc.) that can lead to degradation of forests after years, thus reducing biodiversity, reducing the living conditions of local residents and causing natural disasters (landslides, violation of water regime). There are not provides environmental flows and permitted water use requirements. All this creates serious ecological problems and can lead to social and economic tensions. On the other hand, the use of renewable energy sources can visibly reduce carbon emissions and atmospheric air pollution both indoors and open areas, and at the same time stimulate economic growth.

During the analysis of ecology system we face three types of uncertainty:

- Uncertainty of data,
- Uncertainty connected with the correctness (representativeness) of the applied model,
- Uncertainty caused by incompleteness of the model (Goedkoop et al. 2000).

Here, uncertainty is regarded as a parameter which is associated with the quantitative results of the evaluation and characterize systematic as well as random effects of the factors.

There are a lot of problems that rise in electricity production and supply system, which are mainly related to the energy system management. They are:

Public attitudes toward nuclear energy use - radioactive pollution and explosion

- Nuclear waste protection - is a hazard for health and object security
- Climate change - long-term impact and greenhouse gas emissions, pollution
- Non-compliance with environmental permits and regulations;
- health problems caused by pollution resulting from ecosystem activities;
- The development of electromagnetic fields - the impact on health.

2. Data

For the research, we applied to the main sources of statistical information on retrospective data for energy sector of Armenia, which is obtained from the online National Statistical Service of the Republic of Armenia and Public services regulatory commission of the Republic of Armenia.

The reduction of emissions from energy facilities will result to the increase of the energy efficiency. The historical experience in Armenia is that the poorer, rural households have switched—at least temporarily—to traditional fuels (mostly firewood, collected illegally) when electricity and gas tariffs were increased. Armenia’s forests shrunk by roughly half during the years of energy crisis, and now the forests cover only roughly 10 percent of total area of the country. Therefore, it was very important to reduce tariffs of energy production and construct new TPP.

The new power plants operating in Armenia, in comparison with Thermal Power Plants has higher environmental factors. In the equal capacity operation the new power plant produce less emissions to the atmosphere, particularly it produce 9 times less nitrogen dioxide (NO_2), 2 times less carbon dioxide (CO_2) and 3,8 times less carbon oxide (CO). The usage of water is reduced 3,6 times too.

The implementation of new power unit in the Thermal Power Plant of Yerevan that works with steam-gas combined cycle may allow reducing of emissions by over 20%. As per the projection, the urban water supply system will be rehabilitated and upgraded, which means that energy efficiency of the system will increase significantly. The heat annual demand will be 4732 thousand Gcal, fuel (natural gas) - 685 mln m3, the emissions from the heat sources – 3229 ton. Taking into account that in real practice the heating system do not operate fully, though the air pollution resulted from the these sources will be increased in perspective, but generally, the normative of urban pollution will not exceed threshold criteria.

Despite this, there are some barriers for environmental risks reduction in the country, especially, it worth to mention, that the Environmental Regulation and Enforcement is not uniform for all RE technologies and responsibilities for enforcing regulations is not clearly defined within the Government.

3. The objectives

There is significant number of environmental issues in energy sector of RA, since nearly all types of electric power plants have an impact on the environment and ecology. Some power plants have a bigger impact than others, thus the objectives of the research are the following:

- the assessment of expansion of renewable energy production with aim to increase the energy security of RA,
- the impact on volume of CO_2 emissions deriving from the replacement of old electrical equipment by new ones,
- Environmental risks management by scenario analysis.

4. Methods

Econometric models are among the most complex forms of energy forecasting. We applied to econometric methods to estimate electricity production, generators cost functions and supplier cost function. Those are applicable for all sectors of service: residential, industrial and commercial.

The data of the energy sector of Armenia are described with the trend and seasonality. Working with the time-series the researchers are able to consider the trend, the periodic and the random components of the certain set of data varying over the time. The data analysis of household's electric power consumption has been performed with the ARIMA models. The most suitable forecast period has been chosen considering the smallest value of the AIC and RMSE respectively.

Regression analysis gave us an opportunity to forecast the expected value of the future demand with the corresponding standard errors. In order to get a range of values for future demand based on a range of values for the input variables, we used Monte Carlo Simulation method. It shows the distribution of the future demand, and provides a framework for decision making process. The results of the regression analysis' forecast and confidence limits about the forecast values can gave an indication of the risks. Whatever, the Monte Carlo simulation used a probabilistic range of

The optimization method is suggested to get the equilibrium input values to get rid of future uncertainties. conditions for electricity supply chain of RA and the variation inequity formula is applied to provide qualitative properties of the equilibrium electric power flow. For final comparative results we used scenario analysis tools to manage environmental risks which had been discussed in this topic.

5. Dynamic analysis of Electricity production of RA

Armenia's power market is not yet competitive and has a long list of market challenges. Although some unbundling has occurred, the power market remains a monopoly under a single-buyer market structure. There is only one power distribution company (DISCO), and customers do not have a choice of a power supply company. Distribution was not unbundled into a Distribution System Operator (DSO) and suppliers and there are no clear rules guaranteeing third party access to transmission and distribution networks. There are no Market Rules for settling deviations between contracted and delivered amounts of power. Balancing is accomplished by an Independent System Operator (ISO) in cooperation with the DSO on an annual basis. There are no strict regulatory mechanisms to protect vulnerable customers; however, the Government of Armenia (GoA) uses different mechanisms to protect such customers through targeted and "means tested" social support schemes. Moreover, the GoA, Ministry of Energy and Natural Resources of Armenia (MoENR), and Regulator authorize new generating capacities that may include concessions. There is no Market Operator (MO) because the existing regulations are not systemized into the Market Rules and the Network Rules (Grid Code) are not yet developed.

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Current regulations for the internal market as well as tariff rules for export/import transactions have unnecessary restrictions on sector development, which makes the market less attractive for private investments. Import/export transactions are licensed, and the Regulator sets tariffs for imported electricity, but not for exported electricity.

Tariffs are regulated using rate of return methodology, which does not provide sufficient incentives for optimizing costs of regulated monopolies. Distribution tariffs are not yet determined. The absence of a proper legal framework artificially restricts consumers' rights to import electricity from neighboring countries. End-user tariffs are differentiated by voltage levels for day and nighttime tariffs, and there are no capacity charges, peak tariffs, or service fees. As a result, customers have no responsibility for defined capacity charges for large generation. The average difference between day and night tariffs isinsignificant: for high voltage customers (i.e., 35 to 110 kilovolts (kV)), it is only 12 percent and, for middle (6 to 10 kV) and low voltage (0.22 to 0.4 kV) customers, it is only 26 percent. These differences do not support load management efforts.

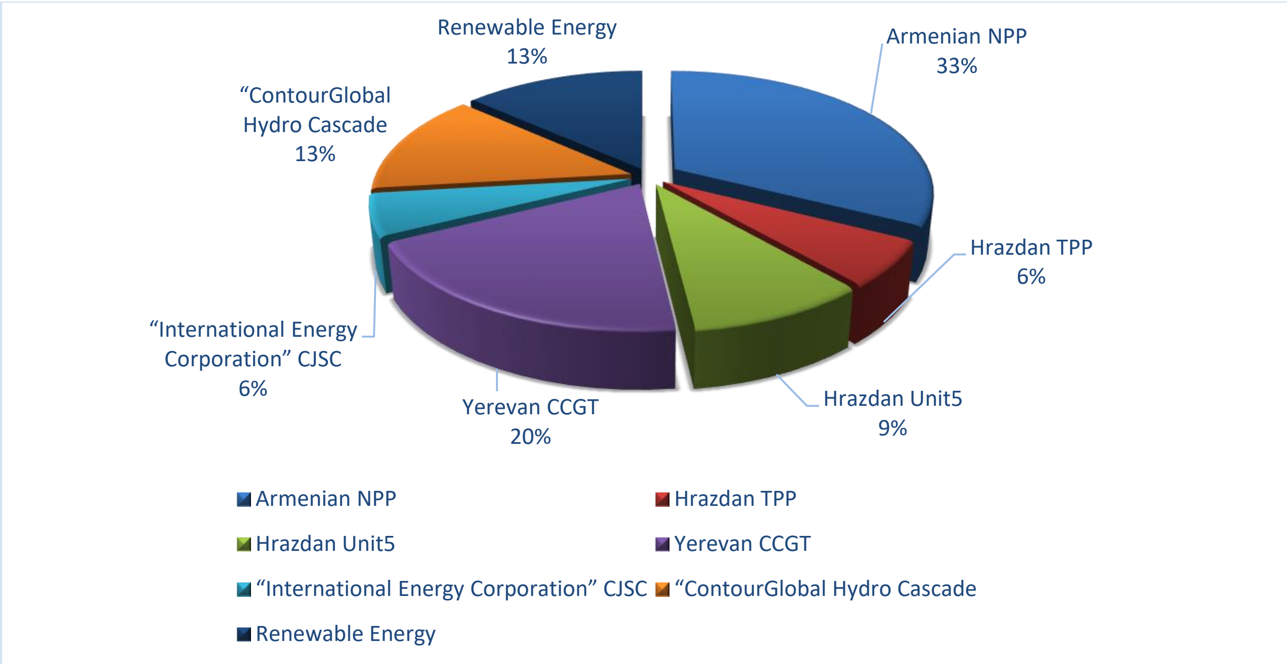
5.1 Power System of Armenia

Generation produces enough electricity to meet domestic demand, which is about 6,500[1] gigawatt hours (GWh) annually with an average growth of 2 percent. The total operating capacity of all generation units is about 2,400 MW and, after the decommissioning of the Hrazdan TPP in 2019, it will be 2,000 MW.

The main capacities of power generation in Armenia are nuclear, thermal and large hydro power plants, as well as small power plants . The share of each power plant production of total electricity generation in 2016 is shown in Figure 1.

Figure 1

The share of each power plant production of total electricity generation in 2016



Domestic demand is covered by 33-percent nuclear, 35-percent thermal, and 32-percent hydro generation. Peak electricity demand is about 1,300 MW and is observed during November through February. Summer peak demand is around 900 MW. There are no seasonal deficits. Generation surplus consists of TPPs; the possible exporting capacity is Hrazdan Unit5.

The power system of Armenia includes the following power plants:

Nuclear Power Plants

– **Armenian NPP:** Government owned ("HAEK" Closed Joint Stock Company (CJSC)); operating capacity is 385 megawatts (MW) (installed capacity is 440 MW and the year of commissioning was 1980); annual generation is approximately 2,400 GWh, covering about 37 percent of domestic supply. The Armenian NPP is scheduled to be rehabilitated sometime during 2017 and 2018 for a service lifetime extension up to 10 years. The rehabilitation is expected to cost about a $300 million.

Thermal Power Plants

– **Hrazdan TPP:** Private (“RazTES” CJSC); operating capacity is 400 MW (installed capacity is 1,110 MW and the year of commissioning was 1966 to 1974); the annual generation for the internal market is approximately 500 GWh, covering about 8 percent of domestic supply. Planning for decommission is expected in 2019 due to its low efficiency.

– **Hrazdan Unit5:** Private (“Gazprom Armenia” CJSC); operating capacity is 440 MW (installed capacity is 467 MW and the year of commissioning was 2011); and annual generation for the internal market is approximately 500 GWh, covering about 8 percent of domestic supply. Projected annual generation of the unit is about 3,000 GWh; therefore, the internal market takes only 17 percent of it. Currently, Hrazdan Unit5 is more oriented toward exporting capacity.

– **Yerevan CCGT:** Government owned (“Yerevan TPC” CJSC); operating capacity is 220 MW (installed capacity is 238 MW and the year of commissioning was 2010); and annual generation for the internal market is approximately 950 GWh, covering about 15 percent of domestic supply. The Yerevan CCGT is working under a “gas-electricity” exchange contract, exporting about 500 GWh annually.

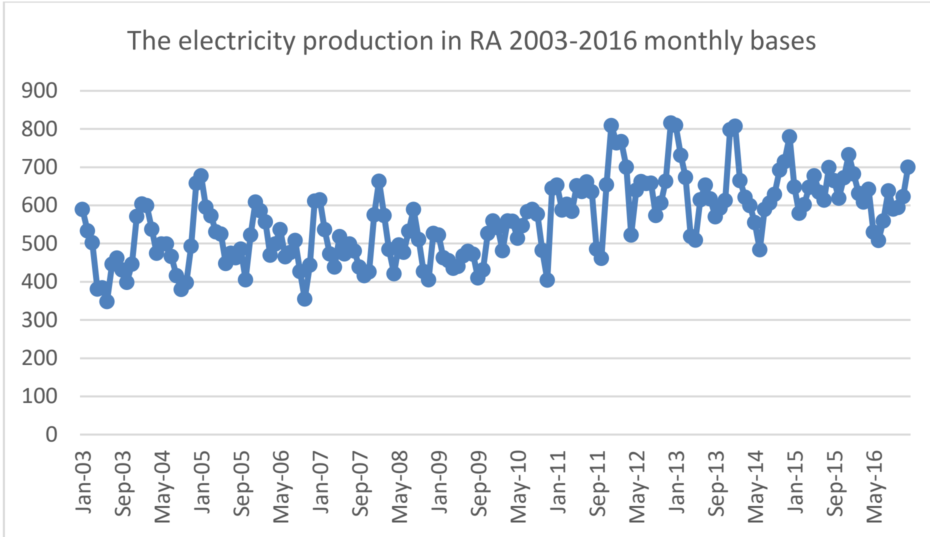
Large Hydropower Plants

– **Vorotan Cascade:** Private (“ContourGlobal Hydro Cascade” CJSC); operating capacity is 404 MW (installed capacity is 404 MW and the year of commissioning was 1970 to 1989); and annual generation is approximately 1,000 GWh, covering about 15 percent of domestic supply. Vorotan Cascade’s assets are old and require extensive upgrading. The short-term rehabilitation plan with an investment cost of 51 million euros (€) is now under development.

– **Sevan-Hrazdan Cascade:** Private (“International Energy Corporation” CJSC); operating capacity is 552 MW (installed capacity is 561 MW and the year of commissioning was 1940 to 1962); and annual generation is approximately 450 GWh, covering about 6 percent of domestic supply. Different upgrades were done on the Cascade’s power plants during the last 15 years. At present, the Yerevan HPP is under reconstruction with investment costs of $40 million.

Renewable Energy

– About 170 private, small HPPs (under 30 MW) are operating in the system and were generally constructed during the last 10 years. Installed capacity is about 300 MW, and annual generation is approximately 700 GWh, covering about 11 percent of domestic supply. There are several small-size wind, bio, and solar plants that have limited impact on system supply. The share of total electricity production was 13,11% in 2016.

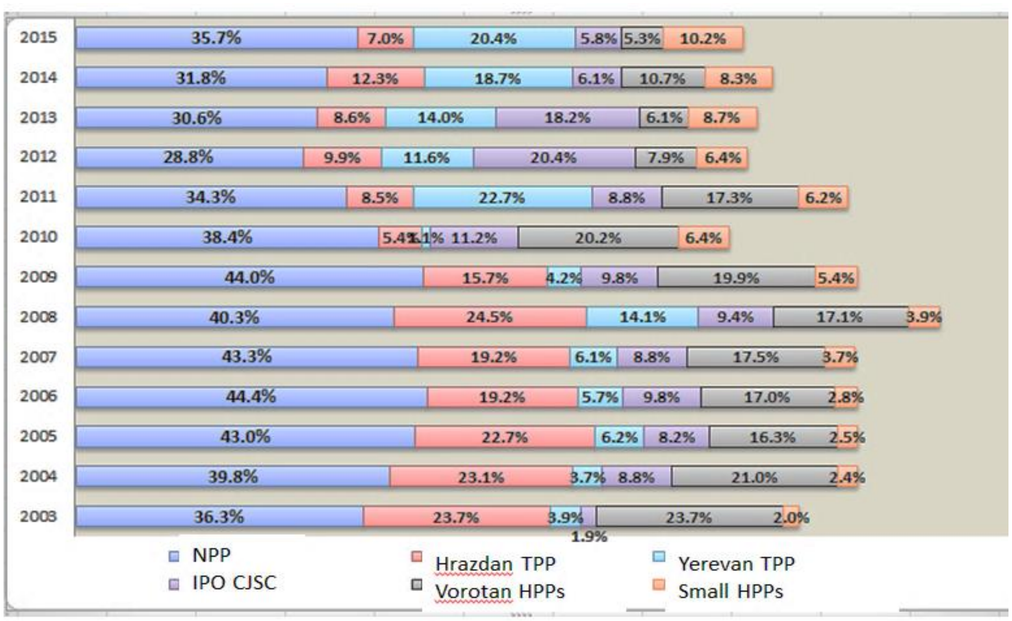


Armenia's energy strategy (Poverty Reduction Strategy Paper (PRSP)) prepared in 2003 clearly emphasizes (among others): "Maintaining and strengthening energy independence by developing indigenous and alternative energy sources and promoting energy efficiency. Regarding the development of indigenous resources, priority should be given to developing renewable energy production. Armenia's commitment to promote renewable resources relates to its need to diversify its energy resource base and reduce energy imports. The country has taken concrete steps to make renewable energy development part of its energy law and energy strategy.

The dynamic of electricity production according to generating stations from 2003-2015 is presented in Figure 2. It is shown that the share of small HPPs increased from 2 percentage to 10,2% in 2015 and 13,11% in 2016.

Figure 2.

The electricity production according to generating stations



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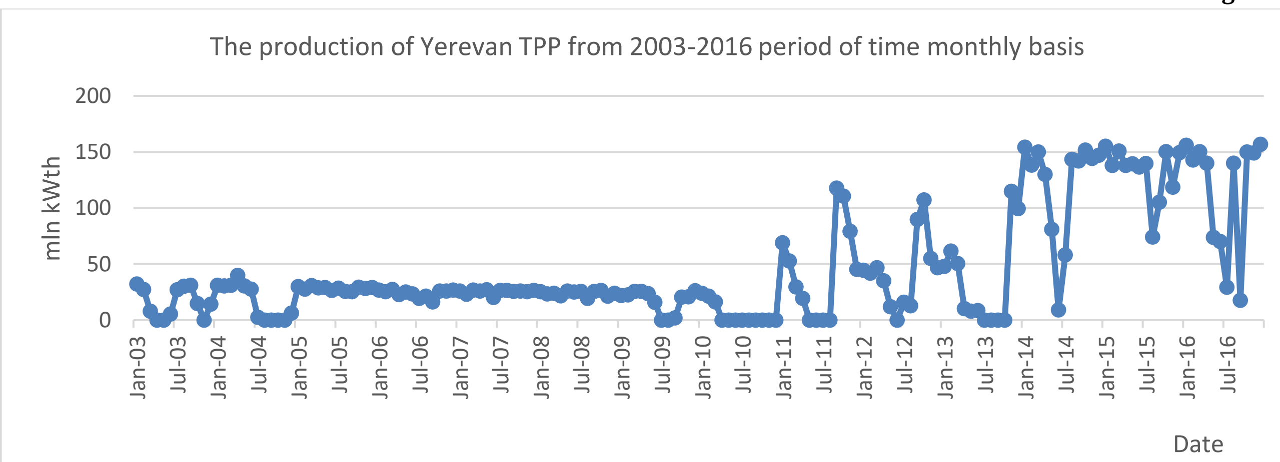
Increased share of SHPP's production means that renewable energy production is developing but at the same time it causes a lot of serious environmental problems and ecological risks. From the graph 2 we can see that the share of Thermal power plants also increased, particularly the share of Yerevan TPP. It is explained by the reconstruction of the power plant to the Combined Cycle Co-generation Power Plant from April 2010. The new power unit shall ensure higher reliability for the Armenian Power System, better covering of the load curves at maximal operational modes and cutting down the losses in the electrical networks due to optimization of the power interchange. The production dynamic of Yerevan TPP is shown in Figure 3, from 2010 the production increased essentially . The efficiency of the power plant was increased to almost 70%, the specific fuel consumption was reduced about two times, consumption quantities of sulfuric acid and caustic soda were reduced tens of times. Levels of emissions were reduced significantly. For instance, Nitric Oxides (NOx) by 9 times, Carbon Dioxide (CO_2) by more than twice, Carbon Oxide (CO) by about 38 times, as well as consumption quantity of drinking quality water by more than 3 times.

The Ecological Risk assessment

Figure 3



Risk management embodies measuring and managing the various risks within a company's portfolio of financial, commodity and other assets. Ecological risk assessments evaluate ecological effects caused by human activities such as electric power production.

The first task is to select the most appropriate market risk measure. Value-at- Risk has become an essential and The most popular risk measure is, which is essentially just a quintile on a loss distribution. VaR is a standard risk management tool that provides a quantification of the primary risk exposures that a firm faces. It also offers crucial information on the overall risk profile of the firm to senior management, traders, shareholders, auditors, rating agencies, and regulators.

Once the exposures to several risk factors have been identified and quantified, it is possible to analyze how those risk exposures interact with each other and to determine which ones are acting as natural hedges to the portfolio and which ones represent the largest sources of risk for the firm. VaR measures can be also used to assist a firm to minimize the variability of the firm's earnings, decide which risks are worth taking, and hedge those that may cause "too much" earnings variability

Within environmental risk assessment, value-at risk (VaR) can be used to quantify the maximum emission changes associated with a likelihood level. This quantification constitutes a fundamental point when designing risk management strategies. Analysis of expected emission based on ‘‘Value at-Risk’’ measures allows the firm to optimize the production process of energy power by the view of environmental management.

We used VaR methodology to describes the loss that can occur over a given period at a given confidence level, due to exposure to ecological risk. VaR is an easily interpretable summary measure of risk and also has an appealing rationale as it allows its users to focus attention on ‘‘normal market conditions’’ in their routine operations (Basek and Shapiro, 2001).

There are several methods for estimating risk measure and calculating VaR.

✓ *Non-parametric methods*. These methods estimate risks using a historical simulation data set, making minimal assumptions about the loss distribution. These approaches do not require strong assumptions about underlying distributions, the distribution of profits and losses or returns. The most popular non-parametric approach is historical simulation, in which a number of hypothetical portfolio profit and loss (or return) observations are simulated based on historical risk factor returns. The portfolio profit and loss observations are then ordered from lowest to highest, and the VaR is obtained as the relevant order statistic (i.e. *k* th largest observation) from the historical distribution.

✓ *Parametric methods*. These methods are based on assumptions about the particular form of the loss distribution (e.g. we might assume that losses are normal, lognormal, etc.). We then "fit" the relevant curve and use a formula to obtain the VaR. Parametric approaches specify that the loss distribution takes someparticular form (which might be Gaussian, *t*, Lévy, etc.). We then estimate the parameters of the underlying distribution using observed data and an estimation method suitable for the distribution we are dealing with. The VaR can then be obtained using the quantile equation appropriate for the distribution we have chosen, using the parameter estimates we have just obtained.

✓ *Monte Carlo simulation methods*. We specify the stochastic process or processes, calibrate the parameters, and then run a sufficiently large number of simulation trials. Each of these trials gives us a simulated loss value, and we obtain our risk estimates from the distribution of simulated losses. These require that we identify the underlying risk factors in our portfolio, make assumptions about their distributions, and then specify how the market values of the instruments in our portfolio depend on those risk factor changes. We then construct hypothetical paths for the value of our portfolio by drawing a set of random values of the stochastic variables that will determine the price of the instruments within the portfolio. Monte Carlo simulation enables the calculation of risk measures for quite complex portfolios, including those with non linear risk factors or path-dependent instruments.

Each of these methods has advantages and disadvantages. Nonparametric methods have the advantage of being robust, but their main disadvantage is that estimated risk measures are dependent on the implicit assumption that the future will be similar to the recent past. Parametric methods are more powerful but are dependent on the parametric assumptions and are limited to fairly simple problems. However, Monte Carlo methods can be applied to a wide range of problems and are very good at dealing with complicating factors.

As we have already shown in Figure 2, the share of Yerevan TPP production in total electricity production have increased, by contrast the share of Hrazdan TPP production decreased significantly in recent years. That is the main reason that we focused on assessment of Emissions of Yerevan TPP. We used above mentioned methods to estimate ecological risks of Yerevan TPP. At first we used historical simulation approach of VAR . Data covers GHG Emissions (CO2, SO2 and NOx) of Yerevan Thermal power plant in 2015 year daily bases. The main part of total emissions is emission of Carbon Dioxide (CO_2) is about 95 percentage.

The results of historical simulation is presented in Table 1. The mean of growth rate of total emissions is 0.0064, variance is 0.017 and the standard deviation is 0.13. Daily emissions of thermal power plan production will growth no more than 31% with probability of 99%. The 10-day 99% Value at Risk is thus estimated as: 28%, which mean that with 99% confidence we expect that during 10 days the emissions of production will not exceed 28%.

Table 1

GHG Emission		
Mean	**Variance**	**Standard Deviation**
0,00639855	0,01780627	0,13324
Daily SMA volatility	0,133239626	
Daily VaR (99%)	0,31	
Confidence Level	99%	
Holding period	10	
10-day holding VaR (99%)	0,28	

Historical simulation ARMA forecasting (HSAF) approach

In the first stage we test the stationary of emission series by applying ADF tests. Table 2 shows the test results. As can be seen in this table, the first difference of the series is stationary at 99% level of confidence.

Table 2

Null Hypothesis: EMISSION has a unit root
Exogenous: Constant
Lag Length: 1 (Automatic - based on SIC, maxlag=16)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-17.36820	0.0000
Test critical values:	1% level	-3.448211	
	5% level	-2.869307	
	10% level	-2.570975	

*MacKinnon (1996) one-sided p-values.

In the second stage we analyzed the autocorrelatıon functions of price returns by applying the Ljung–Box test. As can be seen in Table 3, the series show a statistically significant autocorrelation.

Table 3

Included observations: 365

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
		1	0.895	0.895	295.06	0.000
		2	0.830	0.144	549.49	0.000
		3	0.792	0.137	781.57	0.000
		4	0.750	0.018	990.17	0.000
		5	0.709	0.010	1177.2	0.000
		6	0.669	-0.006	1344.3	0.000
		7	0.632	-0.003	1493.6	0.000
		8	0.590	-0.035	1624.3	0.000
		9	0.548	-0.032	1737.3	0.000
		10	0.504	-0.041	1833.2	0.000
		11	0.463	-0.021	1914.4	0.000
		12	0.419	-0.044	1981.1	0.000
		13	0.376	-0.033	2034.7	0.000
		14	0.331	-0.042	2076.5	0.000
		15	0.284	-0.047	2107.5	0.000
		16	0.242	-0.024	2129.9	0.000
		17	0.199	-0.033	2145.2	0.000
		18	0.163	0.006	2155.5	0.000
		19	0.123	-0.042	2161.3	0.000
		20	0.070	-0.093	2163.2	0.000
		21	0.028	-0.021	2163.5	0.000
		22	0.001	0.040	2163.5	0.000
		23	-0.008	0.103	2163.5	0.000
		24	-0.016	0.061	2163.6	0.000
		25	-0.023	0.041	2163.8	0.000
		26	-0.032	0.007	2164.3	0.000
		27	-0.041	0.001	2164.9	0.000
		28	-0.051	-0.008	2166.0	0.000
		29	-0.059	-0.007	2167.3	0.000
		30	-0.062	0.007	2168.8	0.000
		31	-0.061	0.011	2170.4	0.000
		32	-0.047	0.075	2171.3	0.000
		33	-0.059	-0.101	2172.6	0.000
		34	-0.059	0.007	2174.1	0.000
		35	-0.060	-0.036	2175.5	0.000
		36	-0.062	-0.023	2177.1	0.000

Stage 3 is devoted to the ARMA Model estimation. This estimation is according to the results obtained from analyzing Autocorrelation and Partial Autocorrelation functions. The estimation results are summarized in Output 1.

Automatic ARIMA Forecasting
Selected dependent variable: EMISSION
Date: 06/18/17 Time: 15:37
Sample: 1/1/2015 12/30/2015
Included observations: 365
Forecast length: 0

Number of estimated ARMA models: 25
Number of non-converged estimations: 0
Selected ARMA model: (4,2)(0,0)
AIC value: 15.3967858598

Equation Output

Dependent Variable: EMISSION
Method: ARMA Maximum Likelihood (BFGS)
Date: 06/18/17 Time: 15:37
Sample: 1/1/2015 12/30/2015
Included observations: 365
Convergence achieved after 44 iterations
Coefficient covariance computed using outer product of gradients

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	4623.327	777.5453	5.946055	0.0000
AR(1)	2.600011	0.044290	58.70466	0.0000
AR(2)	-2.225860	0.065842	-33.80608	0.0000
AR(3)	0.550250	0.059947	9.178908	0.0000
AR(4)	0.068563	0.040278	1.702236	0.0896
MA(1)	-1.880823	0.038922	-48.32272	0.0000
MA(2)	0.958535	0.030872	31.04842	0.0000
SIGMASQ	270558.8	10101.58	26.78381	0.0000

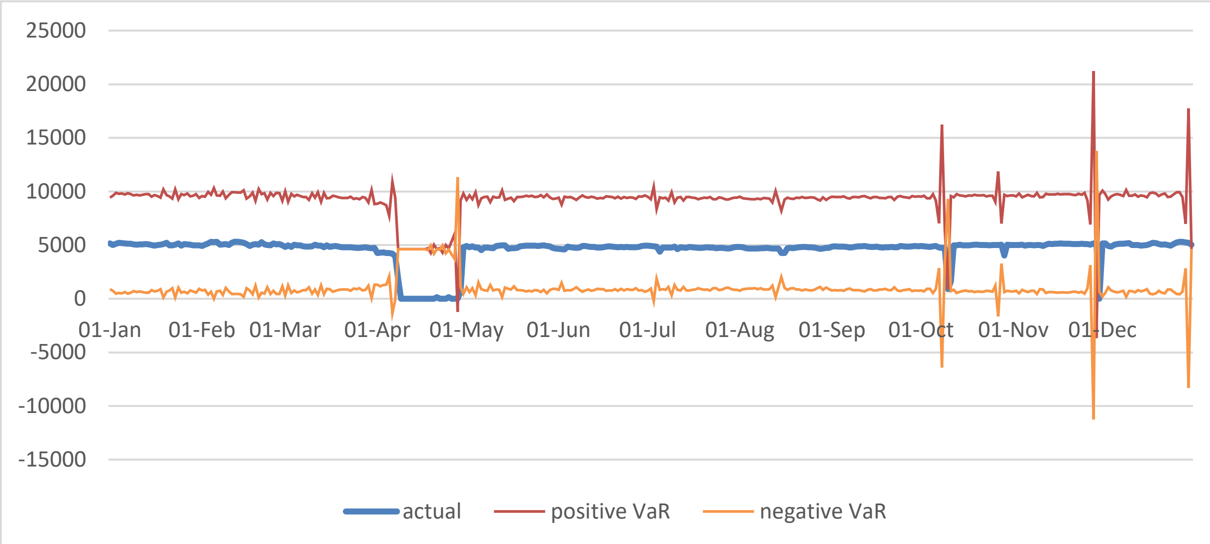
R-squared	0.814284	Mean dependent var	4580.425
Adjusted R-squared	0.810643	S.D. dependent var	1208.654
S.E. of regression	525.9484	Akaike info criterion	15.39679
Sum squared resid	98753946	Schwarz criterion	15.48226
Log likelihood	-2801.913	Hannan-Quinn criter.	15.43076
F-statistic	223.6129	Durbin-Watson stat	2.007872
Prob(F-statistic)	0.000000		

Inverted AR Roots	.90	.89+.23i	.89-.23i	-.09
Inverted MA Roots	.94-.27i	.94+.27i		

In stage 4, forecasts are made using the coefficients estimated in the third stage. We made these forecasts using the data provided by the ‘‘in the sample period’’ (1/1/2015 12/20/2015). Using these forecasts, we estimated the forecasting errors without any assumption about the skewness of the statistical distribution of the forecasting errors. We analyzed positive and negative forecasting errors separately and obtained the 99th percentile from their cumulative density function.

In the final stage, we used the model coefficients obtained in the third stage to forecast the future value of emission changes. Actually this is an ex ante forecast. Using the 99th percentile obtained in the previous stage, we corrected the future emission in tones. These corrected forecasts are the VaR estimations. The result of this VaR quantification together with actual emission changes is shown in Fig. 4.

Figure 4



Monte Carlo simulation

At the next step we used *Monte Carlo simulation method. The standard deviation we took as a random variable, we did 100 iteration and the results are shown in Table 2.* Simulation analysis involves working with continuous probability distributions, and the output of a simulation analysis is a distribution of Daily SMA volatility. Simulation analysis is a type of scenario analysis that uses randomly generated inputs rather than specific values. Here the uncertain is *standard deviation of total emission* variable are entered as continuous probability distribution parameters rather than as point values. Then, the computer uses a random number generator to select values for the uncertain variables on the basis of their designated distributions. Once all of the variable values have been selected, they are combined and Daily VaR is calculated. The process is repeated many times, say 100 times, with new values selected from the distributions for each run. The end result is a probability distribution of Daily VaR based on a sample of 100 values. Simulation can provide the distribution as well as summary statistics such as expected Daily VaR and 10-day holding VaR.

Table 2

Monte Carlo Simulation Input Data		
Mean	**Variance**	**Std. Deviation**
0,006412		0,133383
		Random
Daily SMA volatility	**0,2319**	**variable**
Daily VaR (99%)	0,54	
Confidence Level	99%	
Holding period	10	
10-day holding VaR (99%)	0,49	

Random variable is calculated as follows. = Mean+ Std. Dev.* NORMSINV(Rand())
Summary of Simulation Results are shown in Table 3. The mean of Daily SMA volatility and 10 day VaR is negative, which means that amount of emissions are decline to decrease, it is explained by the new technologies

of the plant. Value of Standard Deviation is higher than the value in previews one method. A higher standard deviation indicates higher volatility.

Table 3

Summary of Simulation Results (Thousands of Dollars)

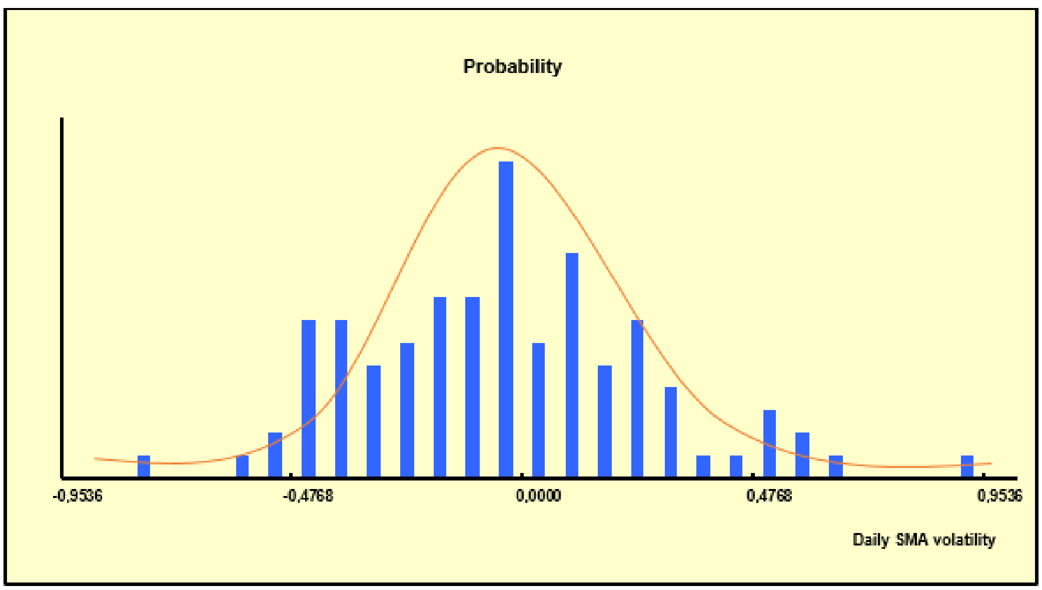
Number of Trials = 100

Simulated Input Variables and Key Results

	Daily SMA volatility	Daily VaR (99%)	Key Results: 10-day holding VaR (99%)
Mean	-0,01717	-0,03994	-0,03662
Standard deviation	0,14083	0,32761	0,30037
Maximum	0,44708	1,04007	0,95359
Minimum	-0,37240	-0,86634	-0,79431
Median			-0,05
Coefficient of variation			-8,20

Probability distributions are a much more realistic way of describing uncertainty in variables of a risk analysis. The distribution function of estimated Daily SMA volatility has the standard normal probability density function. it is shown in Figure 4.

Figure 4



Risk throughout energy production relates to uncertainty about future events, and in environmental changes this means the future changes and effects. For certain types of productions, it is possible to look back at historical data and to statistically analyze the riskiness of the production of electricity. We are constantly faced with uncertainty, ambiguity, and variability. And even though we have unprecedented access to information, we can't accurately predict the future. Monte Carlo simulation lets us see all the possible outcomes of decisions and assess the impact of risk, allowing for better decision making under uncertainty.

Monte Carlo simulation provides a number of advantages over deterministic, or "single-point estimate" analysis:

- ✓ Probabilistic Results. Results show not only what could happen, but how likely each outcome is.
- ✓ Graphical Results. Because of the data a Monte Carlo simulation generates, it's easy to create graphs of different outcomes and their chances of occurrence.

As a conclusion is that Value-at-Risk, calculated by any method, is a reliable measure of ecological risk.

Renewable energy potential estimation in Armenia

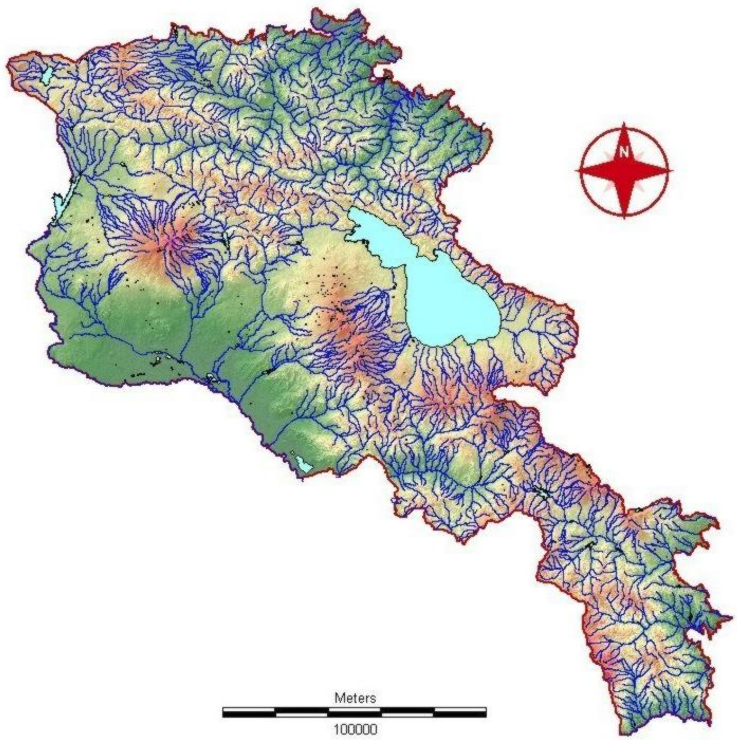
Renewable Energy generation would have mainly positive, long-term environmental effects as it reduces the need for power generation based on fossil fuels, thereby reducing Greenhouse Gas (GHG) emissions. Renewable technologies can also reduce water consumption, thermal pollution, waste, noise, and adverse land-use impacts. Of course, RE also has environmental impacts during construction and operations. Construction impacts are normally temporary and similar to other industrial projects.

Hydro Power

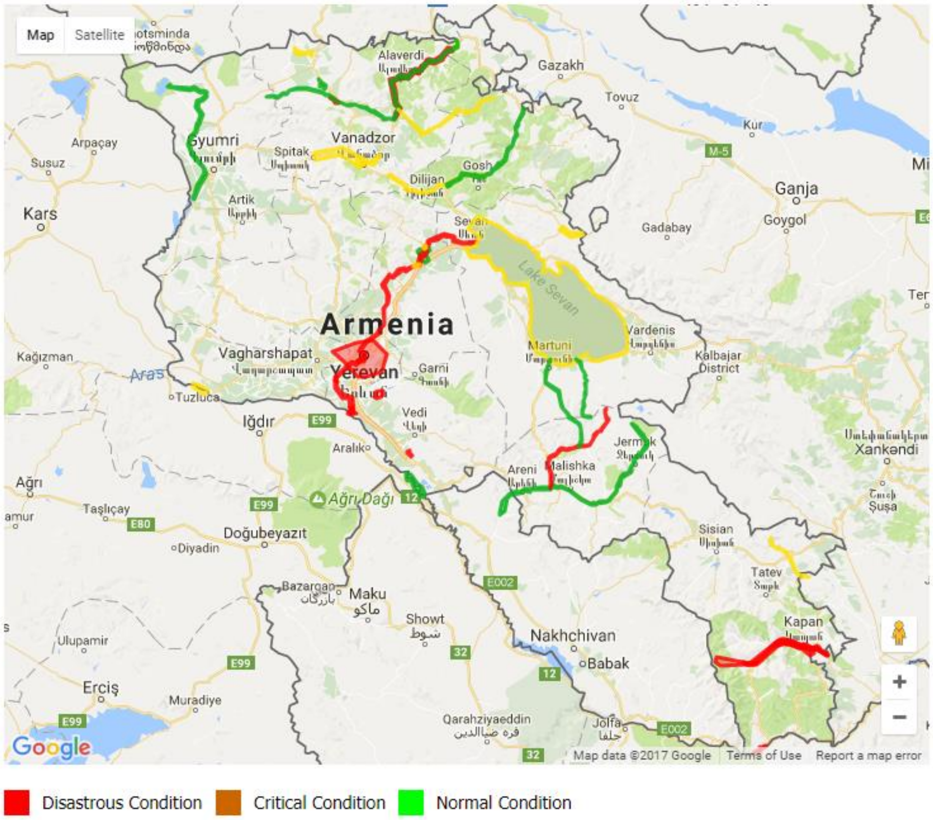
The main potential impacts of Small Hydro Power Plant (SHPP) projects could be impacts to migrating fish stock if proper fish bypasses are not installed or proper precautionary measures are not implemented to avoid fish being sucked into the turbines. There is also the possibility of an adverse impact to wildlife if the required minimum water flow is not maintained in the river downstream of the plant.

Armenia depends on its rivers to provide power generation to its hydro-electric plants and cooling water to its nuclear and thermal generation plants. If the country's current economic growth continues in the decades to come, demand for electricity will increase, as will the demand for 12 competing uses of water for agriculture and industry. As rates of river flow decline with climate change, the country's ability to meet its full domestic electricity demand will be at greater risk. If water reserves and releases are well managed, small changes in precipitation and evaporation need have little impact on hydro-electric generation. Regrettably, the projected changes to Armenia's river flows are neither small in scale nor temporary. Reduced river flow coupled with an increased demand for irrigation water is very likely to reduce electricity generation from these plants.

Map of Surface Hydrology (rivers, lakes, reservoirs)



Socio-economic impacts will depend on the season in which production is reduced, and the reaction of prices to electricity and energy shortages at home and abroad. A shortage of electricity could impede both industrial production and Armenia’s energy-intensive irrigation delivery systems.

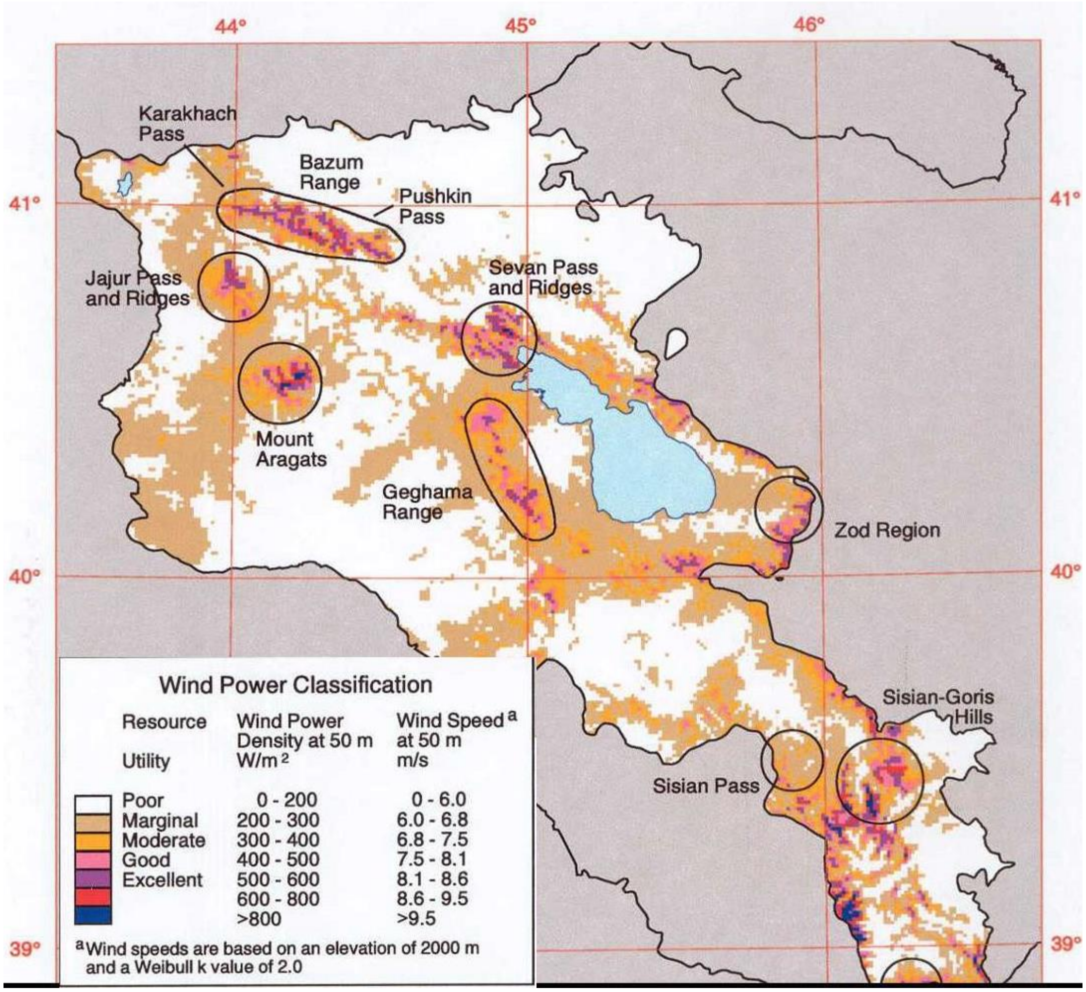


At present, there is no surplus electricity generated in Armenia, however, planned additions to thermal and nuclear generation capacity are substantial and competition for domestic use of electricity is only likely under three circumstances: 1) if summer demand increases significantly due to greater air conditioning use with higher temperatures and higher incomes; 2) if economic development causes significant increases to industrial production and household electricity demand; or 3) if the new thermal plants are not built on schedule or a new nuclear plant is not built to replace Medzamor by 2016. If electricity production falls below demand, some category of use will be curtailed or increased imports of electricity will become necessary and the allocation of this scarce resource would be a political choice. While it is impossible to predict market conditions for the next 30 years (much less 90 years), the current generation costs for hydro-electricity are lower than those for existing nuclear generation, which are far lower than those for thermal generation, again suggesting that a change in electricity tariffs is likely if hydro-power is a declining share of total power. Thus, energy efficiency measures to reduce electricity demand can actually be seen as both a mitigation measure and an adaptation measure.

Wind Energy

In Amenia wind energy production potentials are very little and limited. They are mostly located in remote mountain, which is specific to be higher than the sea level ÍáíÇ Ù³Ï»ñ»ëÇó ½·³ÉÇáñ»Ý µ³ñÓñ ÉÇÝ»ÉÁ (more than 2000m), where access is limited or very difficult.

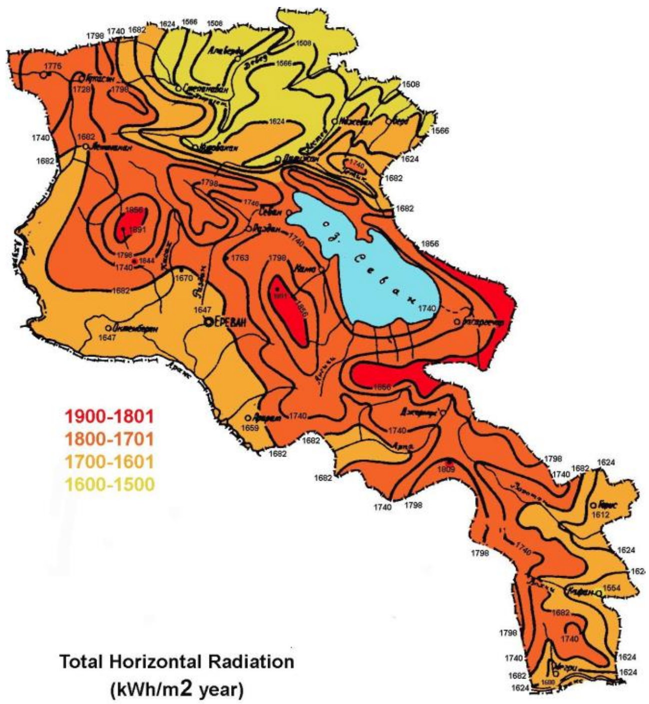
:It will increase production costs and consequently price of the wind electricity fo consumer. So to improve the wind energy production we need government support through loans, subsides and also rates for taxes, it will provide suitable condition to develop reneable energy production.



The main impacts resulting from the operation of wind farms are low frequency noise and visual disturbance of the landscape. There is a possibility of birds colliding with turbine blades; therefore, avoiding bird migration paths for wind turbine farms would minimize this impact.

Solar energy

Armenia has a significant solar energy potential. The average annual amount of solar energy flow per square meter of horizontal surface is about 1720 kWh (the average European is 1000 kWh). One fourth of the country's territory is endowed with solar energy resources of 1850 kWh/m2/year



Main findings of this study are the following: a) Armenia possesses a significant solar energy potential. There are 2500 sunny hours per year and the average annual insolation on horizontal surface is about 1720 kWh/m2 . b) Solar energy development at present is in Armenia is in its infancy. c) During the past ten years, the economic development of Armenia has been significant due to state policies economic reforms, substantial financial , capital growth, the development of various industry sector, and liberalization processes. e) The government of Armenia emphasizes the priority of renewable energy development in the country at both regulative and legislative levels. However, there are no real promotional mechanisms that can stimulate the new sector development. At the same time, foreign investors are encouraged to enter the local market and are treated as equals with local companies.

6. Results

Future oppotunites are follows: clean power provides the biggest opportunities to reduce emissions beyond the reference case, Reducing power demand which could be realized in buildings, industy and agicultue through energy efficiency initiatives, Changing techonologies in powe generation, making them "cleaner" and it will bring to better matched to demand. Generally about 60 percentage of total capacity is required to reconstruction.

The perspective of RE (wind, solar, small hydro, and biomass) in the future energy strategy of Armenia involves three major technological changes: energy savings on the demand side, efficiency improvements in the energy production, and replacement of fossil fuels. Therefore, the activities must include strategies for integrating renewable sources in coherent energy systems influenced by energy savings and efficiency measures. The necessary RE sources are present in Armenia, and if further technological improvements of the energy system are achieved, an increased role for RE in Armenia can be created.

Many serious ecological and environmental impacts are by-products of electrical power generation and delivery systems . The most important risks in electricity production were determined as follows according to the different assessments:

- From technological view point the most power plants used 38% of the capacity being under the operation for more than 30 years. The primary equipment at the thermal power plants (TPPs) has reached 200 thousand hours of use, and does not conform to internationally recognized technical and ecological standards. 70% of the equipment at the hydro-power plants (HPPs) has been in operation for more than 30 years (50% for more than 40 years).
- Climate changes increase the risk to cover energy demand over the years. Electricity consumption has seasonal feature: it is decreasing in spring or summer times, and increasing in winter and autumn
- Health risks: to develop the police of energy production and establish energy generation by using sustainable and renewable energy sources by lowering the capacity of energy generation through nuclear power station.

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