

Environmental risk analysis and assessments of electricity production of RA

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”.

Data

For the research we applied to the main sources of statistical information on retrospective data for energy sector of Armenia, which were 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. And 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 (NO₂), 2 times less carbon dioxide (CO₂) 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.

The objective

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 CO₂ emissions deriving from the replacement of old electrical equipment by new ones,
- Environmental risks management by scenario analysis.

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 input values to get rid of future uncertainties.

The optimization method is suggested to get the equilibrium 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.

Results

The most important risks in electricity production were determined as follows according to the different assessments:

- From technological viewpoint 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.