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NUCLEAR POWER AS AN OPTION IN MACEDONIAN ENERGY STRATEGY

Abstract: The possibilities for meeting the Macedonian electricity needs in the period until 2030 are analyzed in the paper. In order to secure the necessary electricity in the analyzed period, two possible options for construction of new production plants are considered in the Macedonian energy strategy. The first option foresees new lignite thermal power plants, while the second option foresees construction of nuclear power plant.

Taking into account that after 2025 the existing surface coal mines will be in the final exploitation phase, and that the existing lignite-fired thermal power plants are about to enter their final period of their life cycle of around 40 years, three new lignite thermal power plants with new pit exploitation mines are proposed in the Strategy as the first option. The nuclear option will have advantage in relation to the coal-fired thermal power plants option, if the price of lignite from the mines with pit exploitation and the carbon prices reached high values.

The expected electricity generation costs as well as the other comparative values of the two options are compared in the paper, but the main decision factor will depend on the public acceptance of the nuclear option in view of the new safety requirements and enhancements of modern reactor designs.

INTRODUCTION

The Government of the Republic of Macedonia in the beginning of the year 2010, adopted Strategy for energy development in the Republic of Macedonia until 2030, prepared by the Macedonian Academy of Sciences and Arts [1]. The Strategy addresses the energy, economic, organizational, institutional, legislative and educational dimensions of the energy sector development in the areas of energy production, transmission and utilization with a view of providing a reliable and good quality energy supply to the consumers.

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Macedonia with the import of more than 40% of the primary energy consumption belongs to the group of countries which are strongly dependent on energy imports. Macedonia imports its total demand for oil and petroleum products, natural gas, high-quality coals and about 15% of its electricity consumption. The only existing energy resources in Macedonia are lignite, hydropower, and biomass, as well as, to a smaller extent, geothermal, solar and wind energy.

The final energy consumption per capita in Macedonia is three times lower than the average consumption in the European countries members of the OECD and 35% less than the average of the European countries that are not members of the OECD.

As a result of the exceptionally low gross domestic product (GDP) per capita, Macedonia belongs to the group of countries with high primary and final energy consumption per unit of GDP, in spite of the low energy consumption per capita. The primary energy consumption per unit of GDP is about 3.7 times greater than the average in the developed European countries. When calculating GDP using purchasing power parity the situation is more favorable, but still not good enough. Macedonia has about 40% higher primary energy consumption per unit of GDP, according to purchasing power party than the average in the developed European countries.

The general characteristics of the energy infrastructure in Macedonia are: obsolete technologies and lack of investments for maintenance, modernization and expansion of the existing capacities, as well as construction of new capacities; high electricity losses (both technical and commercial); low energy efficiency; unfavorable structure of the energy types (production, import and consumption) from an environmental and economic aspect and from the security of supply aspect, and significant lack of engineering resources to carry out major energy projects.

Regarding renewable energy sources Macedonia uses primarily hydro power (for production of electricity), bio-mass (mostly wood mass for production of heat in the residential sector), geothermal energy (mostly for heating greenhouses) and some solar energy (for hot water in the residential sector).

In consequence of the above mentioned situations of the Macedonian energy sector, the following priorities have been taken into account for the realization of the three core sustainability objectives (accessibility to modern, affordable energy for all; availability in terms of continuity of supply and quality and reliability of service; and acceptability in terms of social and environmental goals):

– Maintenance, revitalization and modernization of the existing and construction of new, modern infrastructures for the purposes of energy production and utilization,

– Improvement of the energy efficiency in the production, transmission, and utilization of energy,

– Utilization of domestic resources (reserves of lignite, hydropower potential, wind and solar energy) for electricity production,

– Increase of natural gas utilization,

– Increase of the utilization of renewable energy sources,

– Establishment of market energy prices and adopt a program for supporting of the social category of consumers,

– Integrating the energy sector of the Republic of Macedonia in the regional and European market of electricity and natural gas by constructing new connections (transmission lines) and by harmonizing the legislation with the existing *acquis communitaire* for energy, environment, competition and renewable energy sources.

EXISTING ENERGY INFRASTRUCTURE

Organizational chart of the energy system

Within the framework of the Government of the Republic of Macedonia, the ministry responsible for the energy sector is *the Ministry of Economy*. One of the sectors in the ministry is the *Energy Sector*. Part of the responsibilities related to energy belongs to the Ministry of Environment and Physical Planning as well as to the Ministry of Transport and Communications.

For the purposes of providing support to the Government in the implementation of the energy policy, and *Energy Agency* has been formed.

The activities related to regulating specific issues related to the performance of energy activities specified in the Law on Energy are performed by the *Energy Regulatory Commission (ERC)* of the Republic of Macedonia. The Macedonian Radiation Safety Directorate acts as safety regulatory authority in the field of nuclear and radiation safety.

The council of the *municipality,* i. e. the Council of the *city of Skopje,* upon a proposal from the mayor, and after acquiring an opinion from the Ministry of Economy, enacts an energy development program for the municipality or the city of Skopje. They are responsible for the energy activities of public interest and of local significance.

In Macedonia there are a number of professional associations and nongovernmental organizations that are active in the energy area.

The electricity system

The Electric Power System of Macedonia is operated by four entities, namely: AD ELEM – Skopje (Electric Power Plants of Macedonia), state owned, shareholding company for production and supply of electricity, includes 800 MW lignite thermal power plants and 530 MW hydro power plants, AD MEPSO – Skopje, (Macedonian Electricity Transmission System Operator), state owned, operator of the electricity transmission system of Macedonia – shareholding company for transmission of electricity and management with the electric and power system of Macedonia, the distribution company EVN Macedonia AD (EVN Macedonia AD also owns 11 small hydropower plants with 25 production units with a total power of 45 MW) and AD "TPP Negotino", 210 MW heavy fuel oil power plant, state owned shareholding company for production of electricity.

In the recent period, at average hydrology, 80% of the electricity was produced in the lignite thermal power plants and 20% from the hydro power plants. The fuel oil power plant serves as a cold reserve.

The structure of the electric power system (EPS) of Macedonia comprises:

Hydro power plants, with total installed power of 580 MW;

Thermal power plants fueled by lignite with total installed power of 800 MW and fueled by heavy fuel oil fired with installed power of 210 MW;

Electricity *transmission system*, power lines with voltage level of 400 kV (594 km), 220 kV (103 km) and 110 kV (1480 km). Macedonia is connected to the transmission lines of Greece, Bulgaria and Kosovo through 400 kV power lines; and

Electricity *distribution system*. The distribution network of the Republic of Macedonia comprises 150 km of distribution network at a voltage level of 110 kV, 1000 km at 35 kV, 720 km at 20 kV, 8900 km at 10 kV and 11600 km at 0.4 kV.

POSSIBILITIES FOR MEETING THE MACEDONIAN ELECTRICITY NEEDS IN THE PERIOD UNTIL 2030

In order to secure the necessary electricity in the analyzed period, two possible options for construction of new production plants are considered in the Macedonian energy strategy. The first option foresees three new lignite thermal power plants with power of 300 MW each, while the second option foresees construction of nuclear power plant with power of 1000 MW. In both scenarios it is planned to build large hydro power plants (960 MW), natural gas combined heat and power facilities (564 MW), small hydro power plants (160 MW), wind power plants (180 MW), photovoltaics (20 MW), waste biomass combined heat and power plants (10 MW) and biogas plants (10 MW).

Taking into account that after 2025 the existing surface coal mines will be in the final exploitation phase, and that the existing lignite-fired thermal power plants are about to enter their final period of their life cycle of around 40 years, three new lignite thermal power plants with new pit exploitation mines are proposed in the Strategy as the first option. The nuclear option will have advantage in relation to the lignite-fired thermal power plants option if the carbon prices reached 20 €/ton CO_2 or higher values (Fig. 1).

The nuclear option will provide greater diversity as well as reliability in the supply of electricity. Around 40% of the electricity could be produced from a nuclear power plant, 23% from the renewable energy sources, 22% from the combined power plants running on natural gas and 15% from the lignite thermal power plants.

The expected electricity generation costs as well as the other comparative values of the two options are very important, but the main decision factor will depend on the public opinion, especially after the Fukushima power station case.

Our newest analysis conducted in accordance with the IAEA recommendations for entering into nuclear program, applied to the Macedonian conditions and in view of the expected new safety requirements after the Fukushima case, shows that Macedonia can not commissioned a nuclear power plant before the 2030.

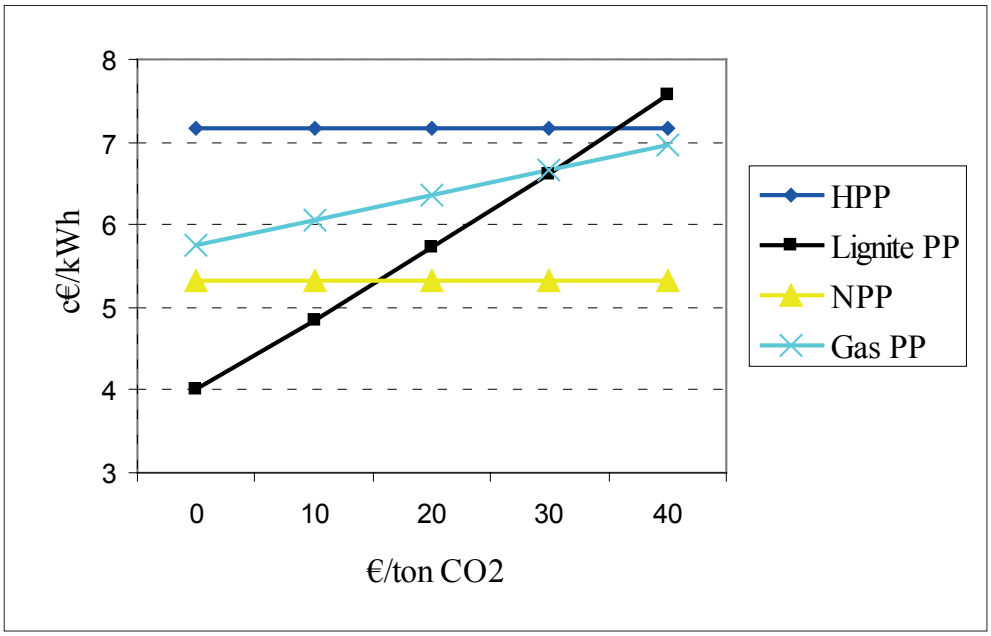

Fig. 1. Estimated Costs of Electricity Generation with Carbon Cost (at 7% Discount Rate)

CONCLUSIONS

In order to secure the necessary electricity in the period until 2030, two possible options for construction of new production plants are considered in the Macedonian energy strategy. The first option foresees new lignite thermal power plants, while the second option foresees construction of nuclear power plant. Most recent analysis shows that Macedonia cannot build a nuclear power plant before the 2030. Having this in mind Macedonia needs to consider other options to cover the energy demand in the period 2025 to 2030, as discussed in this paper.

REFERENCES

[1] Strategy for Energy Development in the Republic of Macedonia until 2030, Macedonian Academy of Sciences and Arts, Skopje, 2010