

COMPARISON OF EXISTING AND PLANNED HYDROPOTENTIAL AND ADDITIONAL ACTIVITIES TO ENCOURAGE THE USE OF HYDROPOWER PLANTS IN THE REPUBLIC OF NORTH MACEDONIA

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Abstract

Hydropower plants as the most ecologically acceptable sources of electricity are expensive investment projects which in a longer time interval are economically sustainable due to low operating costs.

In the Republic of North Macedonia there is a considerable unused hydro potential for the construction of large and small hydropower plants (HPPs). Recently, an increase in interest in small HPPs has been noted. In the Development Program of the Republic of North Macedonia, the government's investment in large and small HPPs is one of the priority parts in the development of the energy sector. In our country, the concession for the construction of small HPPs has started with the Ministry of Economy announcing four calls for applications for concession over 140 locations for small HPPs with installed capacity from 35 kW to 2500 kW.

The aim of this paper is to provide an overview of hydropower plants as a facility for generating electricity from renewable energy sources. The current situation in the Republic of North Macedonia is discussed. The paper highlights the needs and opportunities for the construction of HPPs in the Republic of North Macedonia. Hydropower potential: technically available hydropower potential and also the hydropower potential used with small and large HPPs are given through concrete data. The thesis discusses future plans and scenarios for the use of hydropower potential in the Republic of North Macedonia.

In the Republic of North Macedonia, the use of hydropower potential for energy needs is below 50%. Although the largest hydropower plants were built 60 years ago, they still remain certain locations and opportunities for the construction of hydropower facilities. The installed capacity is around 1500 MW, with an average annual production of 1200 GWh, although due to the growing electricity needs in the Republic of Macedonia, the participation of hydropower in total consumption is below 15%.

Keywords: Hydropower plant; Electric power system; Hydroelectric power plant; Capacity; Potential; Annual production; Hydropower; hydropotential.

Introduction

Water is a natural resource of every country that is not only used for drinking, irrigation or other purposes, but is also used to produce electricity.

In 1882, the first hydroelectric power plant was built on the Fox River in Wisconsin, United States of America. After this event, the first hydroelectric power plant was built at Niagara Falls, marking the beginning of the era of hydropower.

Hydropower plants use water as energy, which is the main source of energy, but in general, hydroelectric power plants also use the sun as energy, because the hydrological process by which the earth is supplied with water is initiated by the sun. A small part of the precipitation, in fact atmospheric water as well as that of snow when it melts, evaporates, while the greater part sinks into the ground and flows to the surface of the earth to then flow into lakes, seas, artificial reservoirs/accumulations and oceans.

Part of the water that flows to the surface of the earth through underground streams or springs, goes to the water masses, while part has the possibility of remaining as stored water, which in periods of drought can return to the atmosphere through evaporation, which condenses into fog and returns to the surface of the earth in the form of precipitation, with which the hydrological process is complete.

The economic and agricultural benefits of hydroelectric power plants would be greatest if, in addition to the energy effect, hydro facilities would also have multiple purposes (for irrigation, water supply, for tourist sites, etc.). With the largest deficit compared to the large needs of electricity in the region and beyond, the opportunity for investment also opens up in this part of the energy sector.

The use of the hydropower potential of each country depends on the level of economic, technical and social development of the country itself. In developed European countries, the rate of utilization of hydropower potential ranges from 65 to 95%. This rate in the Republic of North Macedonia is below 50%. Compared to developed European countries, we see that our country is not at the right level in terms of maximum utilization of hydropower potential for electricity production.

The Macedonian energy policy was built within the framework of the collective Yugoslav policy until the country's independence in 1991. At that time, almost 50% of the electricity needs in the Republic of North Macedonia were provided by domestic production, while the remaining 50% were provided by the common Yugoslav electricity network. Immediately after independence, the overall electricity needs in the Republic of North Macedonia were provided by domestic production, which came as a result of the transition process, the degradation of industrial production, the closure of many factories, the deterioration of living standards, etc. In recent years, the restart of some larger industrial facilities as well as the start of some new facilities resulted in an increase in electricity consumption. Nowadays, electricity imports are important and it is expected that this trend will continue. Hydropower plants are currently the second largest electricity production capacity, after thermal power plants. The Ministry of Environment of the Republic of North Macedonia has conducted feasibility studies for the exploitation of hydropower potential through more than 400 small hydroelectric power plants, where they state that these hydroelectric power plants do not destroy the habitats of animals and plants, do not pollute the environment, do not require the construction of large dams and lakes, which means that they protect the environment.

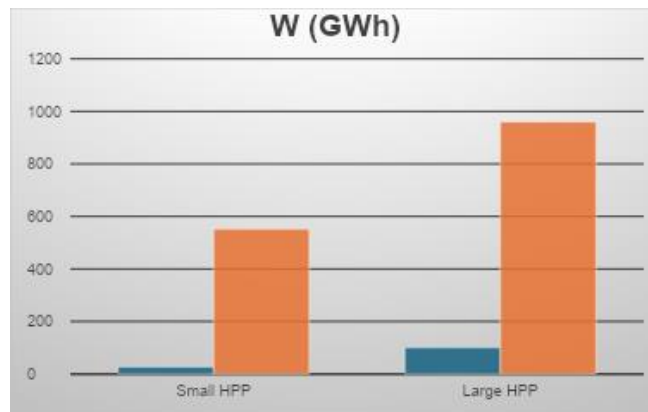
Comparison of existing and planned hydropotentials

Regarding the hydro potential, an overview of the existing built hydropower potential in the R.M.V, as well as planned hydropower facilities is provided. Table no. 1 provides an overview of the existing and planned hydropower potential in the R.M.V. A graphical overview of the installed capacity and the corresponding production, for permanent, planned and total hydropower plants in the country, is also provided.

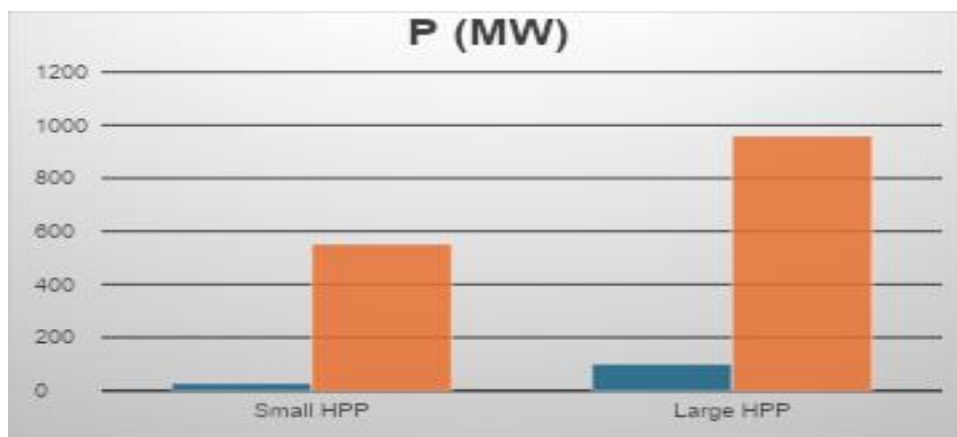
Table 1. Overview of existing and planned hydro potential.

Hydropower plants	Existing		Planned		TOTAL	
	P inst. (MW)	W year. (GWh)	P inst. (MW)	W year. (GWh)	P inst. (MW)	W year. (GWh)
Large HPP	552	1392	960	2280	1512	3672
Small HPP	27	76	100	267	127	343
TOTAL	579	1468	1060	2547	1639	4015

(Energy Agency in the Republic of North Macedonia, n.d.)



Graph 1. Average annual production of existing and planned HPPs.



Graph 2. Installation of existing and planned HPPs.

The planned hydropower plants to be built in the coming period in the Republic of North Macedonia have a total installed capacity of about 1060 MW, of which 960 MW are larger hydropower capacities, and about 100 MW are in small hydropower plants. The corresponding total average annual production amounts to about 2550 GWh, of which about 2280 GWh are from larger hydropower plants and about 270 GWh are from small hydropower plants. With the announcements for the concession of additional locations for the construction of small hydropower plants, it is expected that in the coming period the contribution of new small hydropower plants will reach an installed capacity in the range of 80 to 120 MW with an annual production of 210 to 310 GWh. In the period (2025-2035) the construction of the remaining small hydropower plants is expected. By revitalizing existing hydropower plants, additional electricity production can be achieved. (Panovski & Janevska, Hydroenergy in Macedonia, 2010)

With the hydropower plants planned in this way, North Macedonia should increase its hydro potential to a total installed capacity of around 1,700 MW and an average annual production of around 4,400 MWh in the coming period until 2035. (Panovski & Janevska, Hydroenergy in Macedonia, 2010)

Incentive and the future of hydro power plants

According to the Law on Energy of the Republic, the incentive fees and the installed capacity of hydropower plants for obtaining the right to use incentive fees are determined by the Regulatory Commission of the Republic. Regarding the incentive fees for HPPs, the Regulatory Commission has adopted the Regulation on the manner and procedure for

determining and approving the use of incentive fees for the sale of electricity produced in small hydropower plants. (Panovski & Janevska, Hydroenergy in Macedonia, 2010)

According to the rules, incentive fees apply to the quantities of electricity supplied by newly constructed run-of-river HPPs with an installed capacity of up to 10,000 kW, which have acquired the status of a preferential producer. The preferential producer is obliged to use the incentive fees, for the use of which it has made a Decision for approval, for a period of 20 years. (Causevski, A.; Nikolova, S., 2011)

The electricity market operator is obliged to purchase the entire amount of electricity supplied by the preferential producer at the incentive fees for which the Energy Regulatory Commission adopted a Decision on the approval of the use by this preferential producer. (Panovski & Janevska, Hydroenergy in Macedonia, 2010)

Also, the Energy Regulatory Commission has adopted a Decision on the determination of fees for the sale of electricity produced and supplied by small hydropower plants that have acquired the status of preferential producers. These fees are given in Table No. 2.

Table 2. Incentive fees for electricity produced and furnished by HPPs.

Unit	Monthly electricity supplied (kWh)	Annual power supplied (kWh)	Incentive fees (€ cent/kWh)
I	1 – 85000	1 - 1020000	12,00
II	85001 – 170000	1020000 - 2040000	8,00
III	1700001 - 350000	2040001 - 4200000	6,00
IV	350001 – 700000	4200001 – 8400000	5,00
V	Over 700001	Over 8400001	4,50

(Energy Agency in the Republic of North Macedonia, n.d.)

In the future, it is planned to increase the use of energy from renewable sources. According to the Strategy for the Development of Energy in North Macedonia until 2040, there is a technical potential of hydropower for annual electricity production of about 5500 GWh. So far, there are hydropower plants with a total installed capacity of 580 MW and an average production of about 150 GWh, which represents 27% of the available potential. According to the aforementioned study, it is planned to use additional hydropower plants with a production of about 2500 GWh, so that the total production increases to 4000 GWh or 73% of the available technical potential.

The base scenario of the aforementioned Strategy is the planning of the construction of 6 large hydropower plants in the period until 2035 with a total installed capacity of about 690 MW and an average annual production of about 1200 GWh. (Panovski & Janevska, Hydroenergy in Macedonia, 2010)

Considering that the concession tenders ended in failure in some cases, there is a possibility for a certain extension of the construction of these 152 hydropower plants. In this case, in 2040 the production from the new large hydropower plants would be around 600 GWh.

In the period until 2040, in addition to the above-mentioned ones, the construction of the Veles HPP and the remaining 10 smaller HPPs of the Vardar Valley is also foreseen. Thus, the total installed capacity of the newly built hydropower plants will be 960 MW with an average annual production of around 2280 GWh.

The available potential for the construction of small hydropower plants in 400 possible locations is estimated at 255 MW. According to the average production of small hydropower plants available, the annual production from these 255 MW would be 670 GWh. (Causevski, A.; Nikolova, S., 2011)

The locations for the construction of small hydropower plants have been granted by concession through tender by the Ministry of Economy. Small hydropower plants are also planned for the construction of water supply systems, as well as in irrigation systems. Despite some administrative problems and problems with the unclear hydrology of the locations, the realistic scenario foresees the construction of small hydropower plants with an installed capacity of 80 MW and an annual production of 210 GWh by 2035; and by 2040, 160 MW in small hydropower plants with an annual production of 420 GWh are expected. There is also an optimistic scenario which foresees the construction of small hydropower plants with an installed capacity of 120 MW and an annual production of 310 GWh by 2040; and by 2035, 240 MW is projected in small hydropower plants with an annual production of 620 GWh.

Additional activities to encourage the use of hydropower plants

The construction of the Galishte and Cebren HPPs should be carried out through a public-private partnership. As a first step, a program should be prepared to find at least one strategic partner interested in a Public Private Partnership with the inclusion of the Tikvesh HPP, and based on the Energy Strategy and mutually agreed terms, a tender should be signed. An investment consultant should be hired for the tender, who will prepare the tender documentation according to the conditions clearly defined by the state and will assist in the selection of strategic partners. An additional incentive for attracting strategic partners and at the same time a selection criterion would be the possibility of building a hydro-nuclear complex (if a positive decision is made at the state level for the construction of a nuclear power plant).

AD ELEM can build small hydropower facilities. Accordingly, it is recommended to prepare an action plan for the construction of the Lukova Plain association with the Guri i Zi HPP and the Ura e Boshkos HPP by AD ELEM, with state support within the Public Investment Program. (Panovski & Janevska, Hydroenergy in Macedonia, 2010)

Regarding the Vardar Valley project, as a first step it is necessary to announce a tender for the creation of an innovative study for the Vardar Valley that will provide accurate answers regarding the railway (time of relocation or relocation of a new route already determined or the first. construction of a new modern railway) and regarding transporters (the idea of Vardar navigability has been definitively abandoned, and consequently the transition to optimal energy use). As in the case of Çebren and Galishte, at least one interested investor must be found and the tender announced. An investment consultant should be hired for the tender, who will prepare the tender documentation according to the conditions clearly defined by the state and will assist in selecting the most favorable bidder.

Of primary importance for supporting small hydropower plants is the simplification of water concession procedures, which should also include a requirement for a previously defined land use. The procedure should ensure the right of priority for obtaining a concession for the construction of a small hydropower plant for private landowners. (Causevski & Bosevski : Model for Generation Planning in an Electric Power System, 2004)

The Energy Agency should be authorized to accurately monitor all stages of the preparation and construction of the first ten small hydropower plants and provide assistance in removing administrative and legal obstacles for their rapid implementation. Also, based on the experience gained, the Energy Agency should prepare a manual with a clearly defined procedure for the construction of small hydropower plants, which will be used by future investors.

Considering the unreliability and complexity of the available data on hydropower potential, before further tenders for small hydropower plants are announced, it is necessary to prepare and implement a project to update the data on hydropower potential and other relevant parameters (preferably in the level solution concept) for each of the identified locations. (Panovski & Janevska, Hydroenergy in Macedonia, 2010)

Conclusions and suggestions

Renewable energy sources, with the exception of large hydropower plants, are, as a rule, not concentrated and can be used to produce electricity in smaller production units distributed over a large area and much closer to consumers.

The distribution of production capacities and their connection to distribution networks and their proximity to consumers reduces electricity losses in the network and improves the reliability of electricity supply. But on the other hand, this concept creates additional problems in the management and management of systems from a technical and economic point of view.

The existing hydropower plants in the Republic of North Macedonia have a total installed capacity of about 579 MW, of which 552 MW are large hydropower plants, and 27 MW are small hydropower plants. The planned hydropower plants to be built in the coming period in the Republic of North Macedonia have a total installed capacity of about 1060 MW, of which 960 MW are large hydropower capacities (investments for all facilities are estimated at about 1.53 billion euros), and about 100 MW are small hydropower plants.

In the Republic of North Macedonia there is considerable hydropower potential, estimated to be about 5600 GWh of technically usable hydropotential. Today, about 1470 GWh is used, which is only about 26% of this potential.

The Strategy for the Use of Renewable Energy Sources in the Republic of North Macedonia provides four scenarios depending on the share of renewable energy in the total final energy consumption.

In all four scenarios, it can be expected that the Republic of North Macedonia can realistically achieve a 21% share of renewable sources by 2035. Scenarios C2 and C3 appear as the most likely.

Scenario C3 is based on the final energy consumption scenario with enhanced energy efficiency measures according to the Strategy for the Development of Energy in North Macedonia, in order to represent a targeted option.

Scenario C2 predicts the final energy consumption as in the baseline scenario of the Strategy. For the realization of scenarios C2 and C3 or any option between them, by 2035, the use of hydropower from large HPPs in the amount of 2000 - 2350 GWh is required, as well as hydropower from small HPPs in the amount of 350 - 360 GWh.

Furthermore, the percentage of participation of large and small HPPs in the total amount of renewable energy by 2035 is: according to the C2 scenario, large HPPs participate with 34.1% and small HPPs with 5.2%, and according to the C3 scenario, large HPPs participate with 30.9% and small HPPs with 5.4%.

The strategy foresees the participation of HPP production in final energy consumption in the range of 3430 - 4410 GWh from large HPPs and in the range of 510 - 710 GWh from small HPPs by 2035.

Construction of all planned HPPs (including large and small ones as well as HPPs from the Vardar Valley), the expectation for electricity production for 2040, could be from 2000 GWh for dry hydrology, about 4000 GWh for medium hydrology and over 6000 GWh for wet hydrology. This means that the share of hydro production in covering the electricity demand could be over 20% for medium and wet hydrology.

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