Utilization of hydropower in Slovakia

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Abstract: Electricity from water is one of the cleanest and friendly ones. Technology use of hydropower is the most renewable developed. Exploiting the potential of water flows in the form of water energy through hydropower is currently very relevant. Renewable energy sources (RES) in the form of small water systems (small hydropower) is potential for further development of the Slovak Republic. Question of RES and their utilization is becoming a topic of political and social issues. The article describes situation of the using of hydropower in Slovakia.

Keywords: Hydropower, hydropower potential, SHP, LHP

Introduction

Hydropower, as well as most other renewable energy arises due to solar activity, which promotes evaporation of seas, oceans and bodies of water, followed by formation of water vapor, clouds, and finally re-return to the surface in the form of precipitation, thus creating a closed water cycle. Energy, which the water offers , can be used to electricity generation in hydroelectric power plants. A clear advantage of these resources is their flexibility and also the fact that the production of electricity not produces harmful emissions (including greenhouse gasses). For large hydropower and water works, however, have shown their negative impacts on the environment and local ecosystems.

Energy of water flow and reservoirs

Energy of water can be obtained by converting the flow (i.e. physical or kinetic energy), pressure (or pressure potential energy) or both energies simultaneously in an appropriate field of water flow into mechanical work first and then into electricity. This transformation provides hydroelectric power plant (assembly building and machinery).

Hydroelectric power plants are classified according to how the flow of water uses:

1. Storage - are accompanied by a large water storage tank
2. Diversion channel - are built on the diversion canal
3. Flow - create a dam to original or new bed of the watercourse
4. Pumping - at the time of low load is transferred to the higher located water tanks and during higher load that drives the water pump to generate electricity
5. combined [Boleman, 2009]

According to the utilization of hydropower distinguish different types of hydropower plants.

- The kinetic energy is given by the flow velocity of water flow; the water velocity depends on the gradient flow. Kinetic energy in the past converted water wheels into mechanical work, today the turbines Banki and Pelton and converted into electricity.
- Potential energy arises due to gravity and depends on the difference in elevation levels. It is used by different types of turbines - Kaplan, Francis, Reiffenstein and various types of propeller turbines and turbine pumps in operation. [Dusicka, 2003]

Following the power generation, hydroelectric plants are divided into large (over 10 MW) and small (up to 10 MW). In terms of government has the meaning given to small hydro power (SHP), because the construction of large dams is extremely capital-intensive According to the position of the watercourse SHP can be placed directly on the flow inside or outside (diversion).

For environmentally acceptable sources deemed hydropower installed capacity of the smaller, so-called small hydropower (SHP). Their classification is currently fragmented and for SHP in India and China treated plants up to 25 MW in Latin America with the performance even up to 30 MW, while the European Union has set a limit of 10 MW, but the Member States have put this figure even below 5 MW Germany and Italy even only 3 MW. At the same time these sources

should meet certain criteria in terms of location should to some extent be decentralized sources, often abandoned or placed into. remote areas, their advantage should be an easy adjustability, in most cases should be locally owned and satisfying especially local energy demand, priority should be the individual technical solution and the least impact on the environment. [MESR]

Hydropower potential

The theoretical hydropower potential is a key indicator of the possibility of using the energy of water flow in rivers. Is the theoretical value of electricity generated flow of water in this river section for a period of one year. The total theoretical hydropower potential of water flows is the sum of the theoretical hydropower potential of all segments.

For each section Is quantified by the following formula:

$$HEP = \rho . g . \eta . Q . H . t \quad [Wh/y]$$

Where ρ = 1000 kg/m3 (Densities of water),

g = 9,81 m/s2 (acceleration due to gravity)

η - efficiency of energy conversion,

Q – flow rate in m3/s,

H – level difference in m

t = 8760 hours (hours per year)

Given the different levels of recovery and quantification method hydropower potential can be divided into:

- Theoretically exploitable hydropower potential is only part of the total theoretical hydropower potential of reducing the potential flow segments, the use of which can not be foreseen or for technical or other reasons.
- Environmentally exploitable hydropower potential is reduced technically exploitable hydro potential by reducing the number of available profiles or sections of streams of interest, which cannot be used for environmental reasons. It also reduces the usable flow of bio-transferred fish passes or the natural flow of river bed in the derivative scheme for the maintenance of patency and flow habitat for migratory animals, reduces possible backwater flow and gradient field of environmental constraints to maintain a water level of river and groundwater.
- Technical hydropower potential is less than the total notional value of hydro energetic potential technically unusable sections flows and values energy loss in the conversion of energy. The average value of the coefficient of energy conversion efficiency is about 0.85. Height technical hydropower potential of rivers in Slovakia is 6700 GWh / year and presents it 625 profiles. These were collected and evaluated using three-dimensional mathematical model of the surface flows, so that in case of hydropower utilization hydraulically do not affect each other. Table 1 provides summary hydropower potential of rivers in the Slovak Republic.

Tab. 1 Inventory of hydropower potential of rivers in Slovakia by river basin

Hydrologic basin	Total theoretical hydroenergetic potential (GWh/year)	Technical hydroenergetic potential (GWh/year)
Morava	113	29
Danube	3394	2511
Váh and Little Danube	5953	2985
Nitra	320	72
Hron	1406	427
Ipeľ	157	34
Slana	314	96
Bodva	65	3
Hornád	807	262
Bodrog	692	138
Poprad and Dunajec	461	143
Total	13682	6700

Source: [MESR2]

Amount of the total hydropower potential of rivers in Slovakia is 13682 GWh/year. The total amount of technical HEP is 6700 GWh / year, while the sharing of HEP is 4732 GWh / year (70.6%), unusable 1,968 GWh / year (29.4%).

Table 2 shows summary of built LHP and SHP - also used and unused.

Tab. 1 Built LHP and SHP to watercourses of Slovakia

	Developed LHP and SHP	Number (pcs)	Installed capacity (MW)	Production (GWh / year)
1	LHP (above 10 MW) total	24	1713.2	4447.6
2	LHP (up to 10 MW) total	203	70.16	284.31
2a	LHP from 1 MW to 10 MW	19	40.09	149.28
2b	LHP from 0.1 MW to 64 MW	64	25.64	116.48
2c	LHP to 0.1 MW	120	4.43	18.55
	Unused			
	Unused or inoperative HPP	26	3.47	11.88

Source: [MESR2]

The benefits and drawbacks water energy

The production of electricity using hydroelectric power plants hydropower potential of our courses, which is persistently renewing and inexhaustible primary energy source - unlike fossil fuels of all kinds. Hydroelectric power plants - their operational flexibility with rapid changes in power - are able to cover the rapidly changing performance requirements in top of the daily load and thus

are suitable to cover emergencies in the power system. Hydropower plants with large water reservoirs (eg Orava, Liptovská Mara, Nosice, Kráľová) and pumped storage power plants (eg Čierny Váh, Liptovská Mara, Ružín, Dobšiná) create water supply to tackle inequalities in consumption of electricity in the day and thus help strict compliance with the business plan for electricity supply. [SE]

Water plants are suitable as regulatory or backup power in the power system and are also suitable in terms of the use of primary energy sources, which are located in our area. Hydroelectric power is usually set as hydro work that fulfills multiple purposes, the importance of energy or may not be a priority.

The purpose of these dams is:

- protection against floods;
- industrial water supply;
- agricultural water supply;
- leveling uneven flow in the river during year;
- Environmental Protection;
- shipping;
- Recreational and sports use.

The main negative effects:

- Hydro power plants alters the flow of river water, changes in water quality in the river, changes in the living conditions of aquatic organisms, especially fish.
- Can cause changes in local climate and groundwater levels.
- The transverse structure separates populations of fish found in the lower and upper flow and blocking their migration routes.
- Changes in flow may result in changes in sediment transfer.
- Sedimentation in the tank, may lead to erosion of the bottom stream.
- Construction of the dam causing an accelerated transfer of mud and sediment, thus reducing water quality in the lower reaches of the river.
- Can cause disruption in the affected waterway flows.
- Implementation of hydropower will require land occupation.
- Can be negative urban intervention in the surrounding nature.
- It can have a negative impact on flora, fauna, and ecosystems.
- It can affect the system of protected areas (SPAs, Special Areas of Conservation or the European network of protected areas Natura 2000).

Conclusion

Electricity from water is one of the cleanest and friendly ones. Technology use water energy is the most developed renewable. If mankind wishes to continue to exist, must observe around for renewable sources of energy. In recent decades, rediscovered energy rivers, seas and oceans is a possible way out of this really a difficult situation. Hydropower and electricity produced from it is quite clear, when it does not manufacture any hazardous waste, or meets another important condition for the world, and it's environmentally friendly energy. Countless benefits of electricity from power plants should be a reason for the development of hydroelectric power network in the Slovakia. Certainly, the construction of hydroelectric power many times reward at a higher cost.

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