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ANALYSIS OF HYDROPOWER POTENTIAL UTILIZATION OF WATERCOURSES IN SLOVAKIA

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Abstract

This article analyzes the hydropower potential of watercourses in Slovakia, defining water as the most promising and most used renewable energy source. The hydro-energetic potential as a source of energy is determined by the calculation of the technically feasible potential of the watercourses, which is divided into exploited and unused. It also identifies the potential of utilizing the unused technical hydro-energetic potential.

Key words

hydropower potential, watercourses in Slovakia, database of sites, energy policy

Renewable energy sources (RES) are usually presented as key energy sources in the future, but their usage is becoming more and more important even today. The key element of the energy policy in various countries is the increase of the RES share on energy production and production of heating and transport fuels in order to create the appropriate additional resources needed to meet domestic demand together with the efforts to ensure sustainable development. "It is a development that preserves the present and future generations of the opportunity to satisfy their basic living needs while not diminishing the diversity of nature and preserving the natural functions of ecosystems" (1).

The basic indicator of the potential for water energy utilization is the calculation of the so called hydro-energetic potential (HEP). According to the updated Conception of the using the hydro-energetic potential of the Slovak waters, we can define the hydro-energetic potential, on theoretical basis, as the sum of the hydro-energetic potentials of all water flows in Slovakia calculated from the long-term average flows in the monitored flow profiles and from the total difference in the levels and the full efficiency of the conversion energy" (2).

According to the updated concept, the total theoretical hydropower potential of water flows in Slovakia is 13 682 GWh/year (2). This overall theoretical potential represents the statistical volume whose value provides an image of the characteristics of the individual flows. Actually, it is the potential of surface water and groundwater that flows into the river as flow. Since the amount of water flowing into the troughs of all surface water depends on the configuration and geology of the terrain, it

is necessary to adjust this potential in the first instance to the so called drain coefficient, that is calculated in order to identify the loss of surface potential mainly due to erosion, surface scrubbing and water absorption and evaporation. As a result of these variables, the water drainage coefficient changes from 0.28 to 0.38 and taking it as a correction factor when calculating the hydro-energetic potential, we get a gross hydro-energetic potential (3).
From the point of view of usability of water courses, we recognize two types of hydro-energetic potential, namely the power potential and the production potential. The hydro-energetic power potential represents the ability of the watercourse to provide some performance that is achievable at full flow utilization.

Table 1: Hydroenergetic potential of Slovak watercourses by river basin

Hydrological basin	**Total theoretical HEP** (GWh/year)	**Technical HEP** (GWh/year)
Morava	113	29
Dunaj	3394	2511
Váh a Malý Dunaj	5953	2985
Nitra	320	72
Hron	1406	427
Ipeľ	157	34
Slaná	314	96
Bodva	65	3
Hornád	807	262
Bodrog	692	138
Poprad a Dunajec	461	143
Slovak Republic	**13682**	**6700**

Ref.: HEP – hydro-energetic potential

Source: Concept of hydro-energetic potential of watercourses utilization in the Slovak Republic by 2030

The hydro-energetic production potential represents the theoretically usable hydro-energetic potential, taking into account losses and economic factors (3). If we subsequently take into account the technically unusable streams and energy loss values when converting energy, we receive the value of the technical hydro-energetic potential, which is 6,700 GWh/year and 625 profiles in the SR. As stated in the Concept of hydro-energetic potential of watercourses utilization in the Slovak Republic by 2030, "these profiles were selected and evaluated using a three-dimensional mathematical model of the flows so that they would not be hydraulically affected in case of their hydro-energetic use" (4). The technical hydro-energetic potential can be used to produce energy from large hydropower plants with installed capacity over 10 MW (VVE) and small hydropower plants with an installed capacity of up to 10 MW (MVE).

At present, the technical hydro-energetic potential of watercourses is utilized at 70%. Additional VVE will increase the utilized hydropower potential by 17.3%, which means that it is possible to meet the technical potential only by building MVEs. This is due to the fact that the water courses, which allow further construction of VVE, have filled up their hydro-energetic capacity (2).

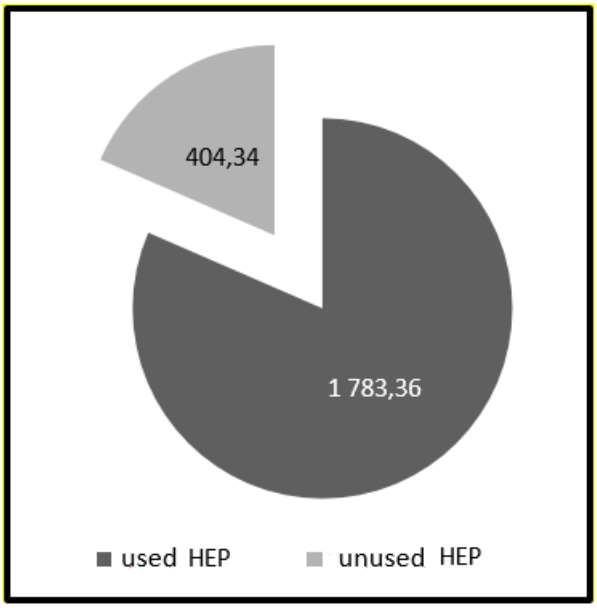

Fig. 1 *Usage of technical HEP - installed capacity [MW] (own processing based on VÚVH data)*

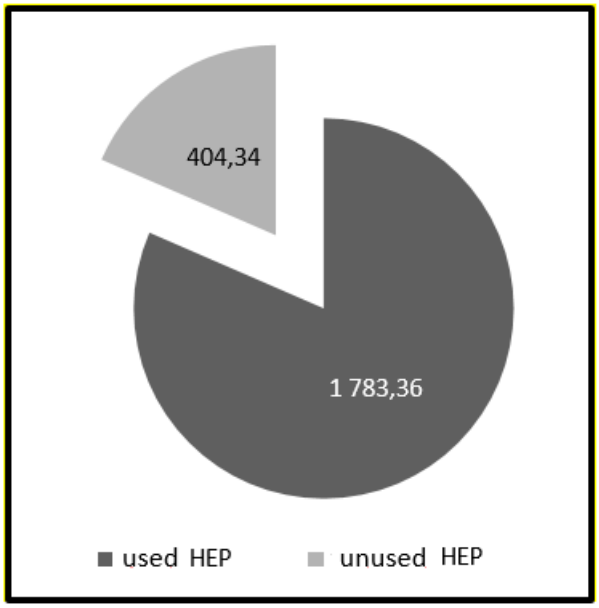

Fig. 2 *Usage of technical HEP - production [GWh / year] (own processing based on VÚVH data)*

The untapped technical hydro-energetic potential consists of a 60% potential of watercourses for the planned construction of large hydropower plants with a cumulative installed capacity of 241 MW and the annual production of 1159 GWh/year. The remaining 40% of the potential can be used to produce energy from the MVE. The unused hydro-energetic potential for energy production from the MVE can be used to build a total of 368 MWU in a structure that also takes environmental aspects into account. Above all, it is necessary to take into account the requirements of the Water Framework Directive which laid down criteria for the assessment of profiles of the technical hydro-energetic potential of watercourses for surface water bodies in order to avoid deterioration of surface water status.

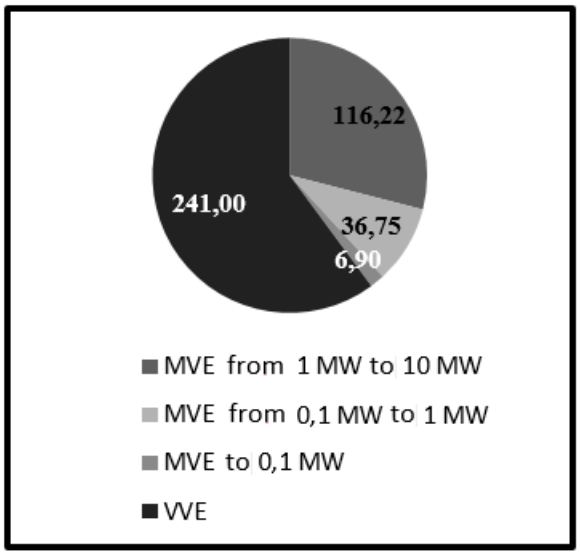

Fig. 3 *Usable technical HEP - Installed power [MW] (own processing based on VUVH data)*

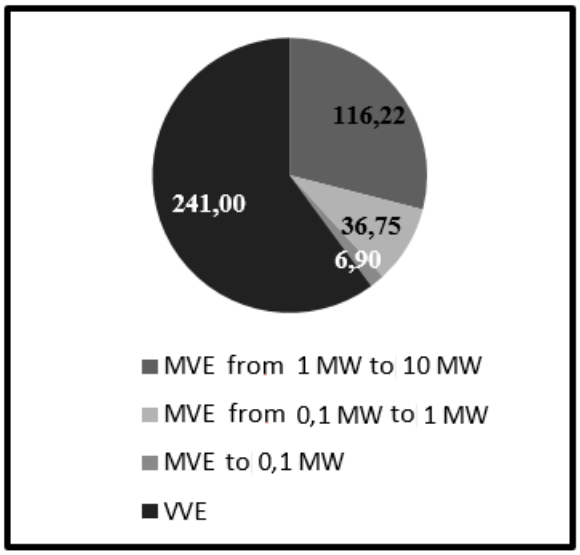

Fig. 4 *Usable technical HEP - production [GWh/year] (own processing based on VUVH data)*

Within the framework of the environmental assessment, the cumulative impacts on the water body were included in the assessment, which significantly extended the environmental aspect of the hydro-energetic potential assessment for the purposes of the River Basin Management Plans and Sub-basin Management Plans.

Table 2: Structure of unused HEP watercourses in the SR

	quantity (number)	installed power (MW)	production (GWh/year)
Built-in and not working VE	**26**	**3,47**	**11,88**
Upcomming VVE	**4**	**241,00**	**1 159,20**
VD Wolfsthal	1	146,00	901,00
VD Čunovo II	1	13,50	45,00
VD Nezbudská Lúčka	1	18,60	54,80
VD Sereď	1	62,90	158,40
MVE	**368**	**159,87**	**797,25**
MVE od 1 MW do 10 MW	69	116,22	587,45
MVE od 0,1 MW do 1 MW	125	36,75	179,00
MVE do 0,1 MW	174	6,90	30,80
IN SUM	**398**	**404,34**	**1 968,33**

Source: Own processing on the basis of data from Conception of hydro-energetic potential of watercourses utilization in the Slovak Republic by 2030

Regarding VVE, the planned water works are listed as a database of sites reserved for the construction of VVE, and the construction of VD Wolfsthal is subject to the consent of the Republic of Austria (2).

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