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Assessment of Pumped Storage Plants in Romania

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Abstract

European statistics (EUROSTAT) showed that, until some years ago, Romania has been considered a country without pumped storage plants (PSPs). Currently, Romania appears to have a total capacity of 91.5 MW, installed in five pumped storage plants operated by Hidroelectrica within their hydropower developments portfolio. The paper presents the hydropower developments of PSPs type in Romania; and an evaluation of their electricity production with emphasis on the renewable component, as well.

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Keywords: pumped storage, PSP, renewable energy, hydropower in Romania.

1. Introduction

The basic purpose of pumped storage plants (PSPs) is to store the electrical energy surplus generated by a power plant or available within the power system, in periods of reduced demand of energy, as potential hydraulic energy. This energy is reclaimed in periods when the amount demanded by the system exceeds the total generating capacity of the electrical energy production plants [1]. In this regard, a PSP utilizes the surplus of electrical energy available in the network, during the low demand (off peak) periods, to pump the water from a lower reservoir (tail pond) to an upper one (head pond). In periods of peak load when there is a higher request for energy in the system, the stored volume of water is released through turbines into the lower reservoir in order to produce additional electrical energy.

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The author classifies PSPs depending on their regulation type: daily-weekly and seasonal-annual. According to the development type, he considers that PSPs can be classified as pure PSPs and mixed PSPs. The additional amount of power produced by a mixed PSP, compared to the one that can be generated from the previously pumped water, may be due to a surplus of inflow in natural regime in the upper reservoir, or due to the production of electricity at a head greater than the pumping height. The problem arising is the delimitation of PSPs that can be considered of mixed character, since in several mixed developments the storage part can be the prevailing feature, while in other developments it can have a secondary role in relation to the total power output.

For closed circuit PSPs, where pumping and release through turbines are done between the same two reservoirs, delimitation between a pure PSP and a mixed PSP is the ratio between the inflow of water in natural regime (V_n) in the upper reservoir and the volume of water released to the lower reservoir, in one year (V_t). Thus:

$$for\ \frac{V_n}{V_t} < 5\% \rightarrow \text{ the development is considered a pure PSP; otherwise it is a mixed PSP.} \quad (1)$$

In both cases, the PSPs that use the water between the same two reservoirs, a lower one and an upper one are defined as being with *obligatory pumping or close circuit.* If the pumps are connected to a lower reservoir and the water from the upper reservoir is conveyed through turbines to another reservoir, the only purpose of the pumping being to lift the water collected by the reservoir feeding the pumps, then the development will be defined as being with *contributive pumping or open circuit*.

It is easy to be noticed that, when defining the role of a PSP, every author references mainly one advantage of this type of hydropower developments (HPDs) for the electric power system in which it functions, and that they use the same classification criteria.

PSPs can be classified in several ways:

- according to the type of the hydraulic circuit (fig. 1):
  - PSP with obligatory pumping (close circuit), which can be pure or mixed;
  - PSP with contributive pumping (open circuit), which can be pure or mixed;
- according to the pump-turbine cycle:
  - daily cycle;
  - weekly cycle: during non-working days the extra volume is pumped into the upper reservoir, while in the working days this volume will be released through turbines;
  - annual/seasonal cycle: pumping during summer and production of electricity in turbines during winter;
- according to the number of power machines:
  - with four power machines - turbine, pump, electrical motor, electrical generator;
  - with three power machines - pump, turbine, reversible electrical machine;
  - with two power machines - reversible electrical machine and reversible hydraulic machine.

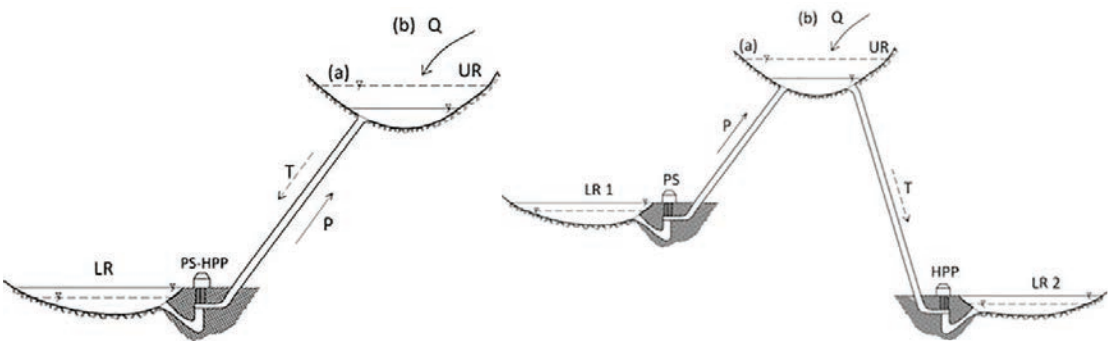

Fig. 1. PSP in close circuit (left) and in open circuit (right), (a) pure, (b) mixed.