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Small Scale Solutions for Energy Transfer using Pumps and Turbines

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Potential Clients

Potential Clients from various Balance Group Managers (BGM) and Distribution System Operators (DSO) have been interviewed allowing to identify this main specification for small hydro storage :

A storage capacity of half a day for a cycle duration from 1 to 6 hours and an installed power between 1 and 10 MW.

In order to develop the use of flexible hydro storage capacity allowing a better management of the energy distribution network, some remuneration tracks have been discussed: secondary reserve (ancillary services) or reduction of the cost due to balance energy.

Hydraulic potential study in Wallis and Vaud

Provided that one or ideally two reservoirs already exist, small scale pumped storage power plant (SSPSP) is a competitive option compared to other storage systems. The main idea is to promote the multi-usage of such reservoirs currently use for drinking water, irrigation, artificial snow cover, leisure or energy production (turbines).

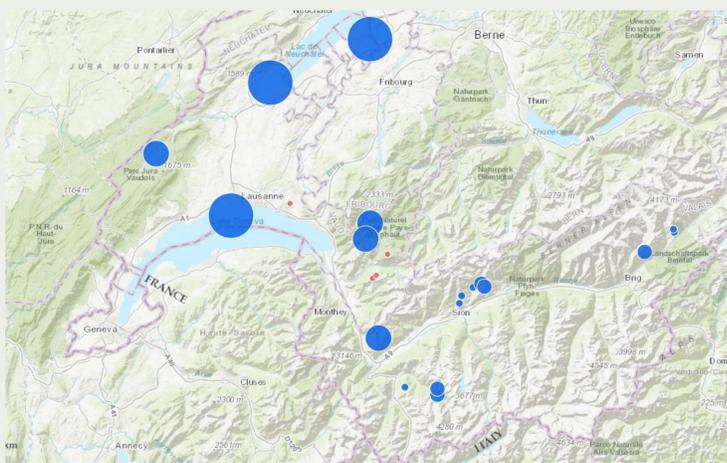


Fig. 1 – Potential sites (> 1MW) in the Wallis and Vaud cantons.

A detailed study for the installation of a SSPS over 10 various sites in Wallis and Vaud has been carried out:

- 2 sites with two existing reservoirs, a turbine and a penstock that can be reused (case 1 and 4)
- 1 site with two existing reservoirs and a turbine that can be reused (case 3)
- 1 site with two existing reservoirs in Wallis (case 2)
- 1 site with a existing reservoir and a pump that can be reused (case 5)
- 5 sites with an existing reservoir in Vaud(case 6 to 10)

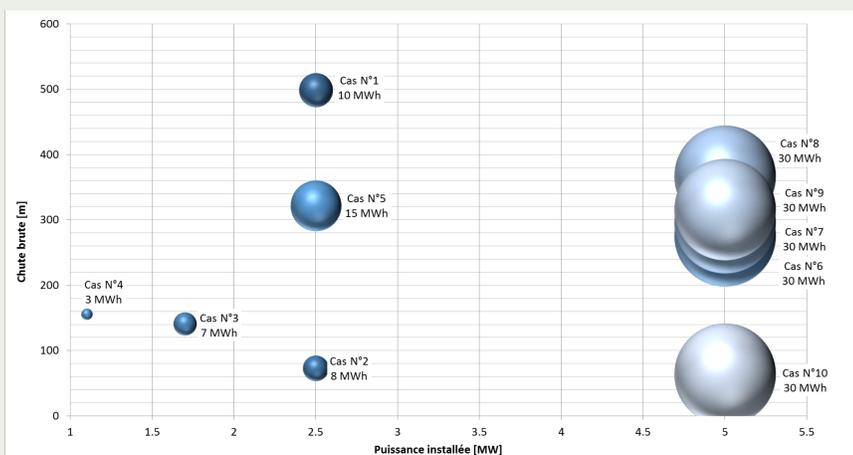


Fig. 2 – Gross head, installed power and available energy storage capacity for ten sites.

Comparison

Regarding the power and the capacity, a SSPSP is located between the largest energy storage system such as the large scale pumped storage power plants or the CAES and the smallest energy storage system such as the batteries with a cycle efficiency (load and unload) close to these latter.

Moreover the integration of a SSPSP is made easier by using existing infrastructures and low environmental impact.

For the time being, the SSPSP solution is still at a “demonstrator” step since some technologies are already available, with a life time higher than the batteries and an investment cost between 1’500 and 4’000 CHF/kW. Nevertheless, the business plan has still to be stated and the electric market will probably better pay ancillary services in the future.

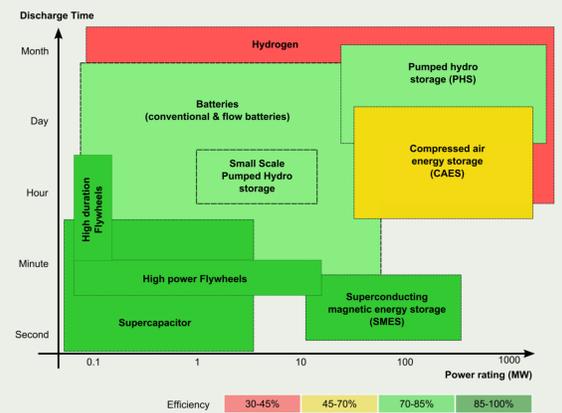


Fig. 3 – Discharge time versus Power rating and efficiency. Comparison between the various technologies

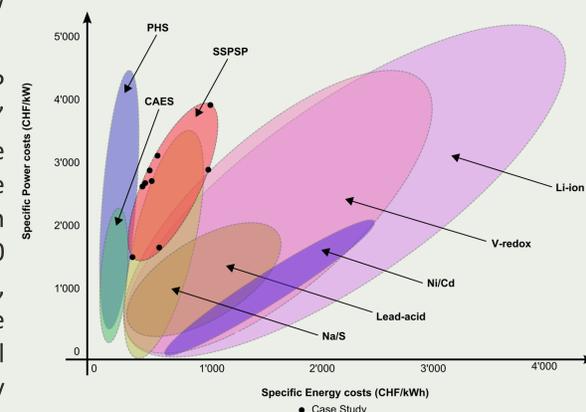


Fig. 4 – Specific power costs versus specific energy costs for the various technologies

Technology

In order to improve the profitability of the low head sites, the preliminary development of a low to medium head pump-turbine has been done starting based on the blade design of an existing pump. Then the scaling and the integration of the blades in an existing machine have been performed. Several numerical simulations based on a perfect fluid approach have been carried out in order to investigate the operating range of the pump-turbine both in pump and turbine modes. An efficiency of almost 90% in both modes has been observed.

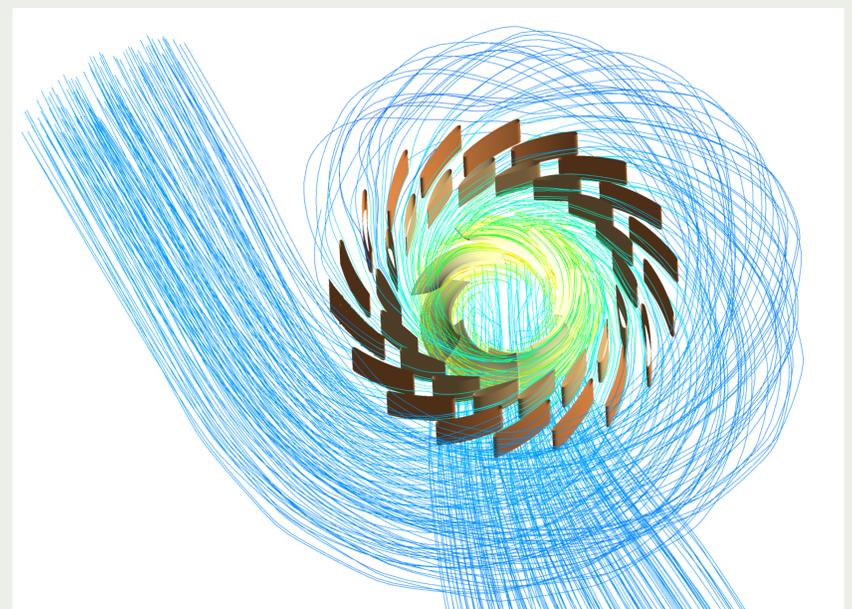


Fig. 5 – Streamlines in a low-head pump-turbine. Pump mode.

References:

Shadya Gabathuler, Davide Pavanello, Cécile Münch-Alligné, 2015, «**Le pompage-turbinage à petite échelle pour le stockage local d’énergie**», Bulletin Electro-Suisse, 2/2015, pp. 49-54.

Partners:



Acknowledgements:

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