Small scale demonstrator of PSPs services to the grid
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GRIDLAB
Gridlab is a platform of the HES-SO Valais/Wallis which is used to study storage systems and the integration of renewable energies in a smart grid. A reduced scale infrastructure allows to reproduce the injection of different renewable energies in the high voltage electricity network.

MODEL OF THE VARIABLE SPEED UNIT
The objective is to implement a variable speed pumped storage power plant in the Gridlab to study its behaviour and its time constants. This power plan is based on a double-fed induction generator (DFIG). This machine is regulated by a back to back voltage source inverter (VSI) connected to the rotor side and the stator is connected to the grid. In this configuration, the machine can work as a motor or as a generator.

- The power absorbed in pumping mode can be varied.
- The losses in the electronic are smaller than for a synchronous machine.
- The start-up in pump mode is supplied by the rotor cascade while the stator is short-circuited with KM2.
- The slip range is within ±10%.

DOUBLE-FED INDUCTION GENERATOR
Depending on the operating mode (motor/generator) and on the rotating speed (hyper/subsynchronous), 4 cases are considered. The operating modes are determined by the rotor frequency and the slip range (which can be negative). The 4 cases can be described by the following equations:

\[ P_s - P_r = P_{mech} \]
\[ f_r = f_s \cdot s \]
\[ P_r = P_s \cdot s \]

HYDRAULICS
Pumped storage power plants (PSPs) are one of the only available solution for large scale energy storage. In variable speed group, the pump-turbine is reversible. Two large projects with DFIG are currently under construction in Switzerland: Nant de Drance & Linthal.