

# **Pumped Storage Power Plants with Special Consideration on Variable Speed Units for the Integration of Fluctuating Renewable Energy Sources**

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The integration of large renewable energy systems into a common national grid leads everywhere on the world to several challenges in the energy market. The energy storage for a stable grid operation has become in Europe a necessity. Pumped storage is the only technology available today to be able to store large amounts of energy efficiently and with low specific storage costs. After a standstill period, the number of newly installed or planned pumped storage power plants (PSP) is rising again.

In Europe the problem with conventional PSP is their large area requirements regarding the storage reservoir, which most of the involved parties hardly accept at all. Therefore the time for the licensing procedure can reach several years with a big number of included parties. Also the costs for this procedure are not neglectable and cause for new solutions. In case of large pumped storage power plants variable speed units have found the way into operation to give the operators better performance and grid stabilizing possibilities. Nevertheless new solutions in the small pumped storage range have to be investigated beside the developments at large pumped storage power plants.

The Vienna University of Technology (VUT) is currently investigating how existing artificial lakes for snow production could be integrated in pumped storage production systems. Depending on the storage volume this results in plant layout with a capacity of 15MW or lower. In conventional construction methods such small PSP are hardly competitive in terms of specific storage costs.

This paper will give an overview about the historic development of pump-turbines. Further on the needs of PSP for the development of Renewable Energy Sources are discussed. As a result of this needed combination the developments in the field of pump-turbines for large and small hydro are shown.