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# Hydro projects delivering regulating power: Technical challenges and cost of operation

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## **Abstract**

The value of hydro power stations is shifting from merely delivering power to delivering regulating power and ancillary services to the electrical grid. In Europe, the continuous drastic increase of non-dispatchable renewable energy sources contributing to the electricity production is clearly the main driver for increased need for balancing power. In other regions of the world other drivers may be prevalent, such as the need to balance electricity production and consumption in an electrical grid which is dominated by coal fire base load power stations. Therefore, in many regions of the world grid operators are increasingly faced with the technological challenges of ensuring grid stability, balancing frequency and voltage.

Hydro power stations are extremely well suited to contribute to grid stability because they deliver considerable output and, at the same time, can be regulated within very short time from part load to full load in order to deliver primary control, or, in case of pump turbines, from pump mode to turbine mode. However, changing the main purpose of an existing hydro power station from delivering base load to delivering balancing power means additional dynamic stress, wear and maybe hydraulic stability issues which need to be checked beforehand. Furthermore, the turbine controller might need adjustments, and various manoeuvres have to be checked in order to ensure system stability. This paper gives an overview of technical issues, checks to be carried out and may be used as a draft of a White Paper on HPP delivering regulating power. Its purpose is to support utilities intending to switch from base load to frequency control.

It is shown that major technological issues arise from the increase of dynamic load at low load and speed no load as well as starts and stops. A considerable challenge is to reliably predict life time of the main turbine components for such operating conditions and new analysis and simulation methods are required. New findings are presented and discussed in this paper.

As a result of the life time prediction of turbine components the impact of various modes of operation on the lifetime of the turbine are discussed leading to considerations on the cost of operating a machine in frequency control. A concept and first draft of "cost operation" is presented and discussed in this paper.