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Challenges for Hydro Generators Caused by Frequent Start-Stop Operation

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Introduction

Rapidly increasing production of renewable energies of wind and photovoltaic power plants leads to continuously increasing share in the energy portfolio mix all over the world, especially in middle Europe. This process however is in line with the European Union target 20-20-20, where in 2020, amongst others, 20% of the entire energy production shall be from renewable energy.

At the same time these two renewable energy categories are highly volatile and to certain extend unpredictable. These facts require more and more significant grid stabilisation measures with conventional power from hydro and gas power plants. Such new grid stabilisation measures involve frequent load changes and start-stop operations.

So far large hydro generators have been designed for about 3 start-stops per day in (pump) storage power plants; however 10 – 15 start-stops per day are requested at present and in the future and are needed for dynamic and effective stabilisation even of today's strong power grids.

Each start-stop cycle induces mechanical stresses in various parts of the generator. Mainly two components are concerned: the rotor with its highly loaded mechanical parts and the high voltage stator winding. The rotor and the rotor pole components are statically stressed by centripetal forces during operation but the increased number of start-stops may cause fatigue and therefore limit the service life of critical parts.

For the electrically and thermally stressed high voltage insulation systems in the stator frequent start-stop cycles cause additional thermo-mechanical stresses due to different thermal expansion coefficients of copper, mica-glass insulation composite and iron in the stator core and their different temperature levels.

This paper gives an overview of the impact of frequent start-stop operation on large hydro generators as well as an assessment and solutions to overcome such challenges for a save and green energy production by hydro power plants today and in the future.