Geophysical Research Abstracts
Vol. 19, EGU2017-6567, 2017
EGU General Assembly 2017

Gravity Storage – A new concept for large scale energy storage

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ABSTRACT

Renewable energy from wind and solar sources is now making a rapidly increasing contribution to global power supplies, with a growth rate of approximately 20 % per year. In order to ensure a continuous power supply based on such renewable energy sources, an efficient energy storage system is required to store the excess energy generated until it is required when the energy source is not available. There is currently no large-scale storage solution beyond Pump Hydro Techniques to store renewable energy at an affordable cost.

A completely new concept for storing energy on a multi-GWh scale is the Gravity Storage (GS), also known as Hydraulic Rock Storage. Besides of storing energy it can be also used for increasing and ensuring the resilience and reliability of the power grids.

For the construction of a GS a piston of rock of a large diameter of 100 m and more is separated from the natural surrounding rock. In times of excess power generation, water is pumped under the piston, raising it and thereby storing potential energy. When the stored power is needed, the pressurized water is released from beneath the piston to drive turbines, allowing the piston to lower. Generators are then used to produce electricity, which is fed into the power grid.

The GS system has a round-trip efficiency of over 80 %, similar to pumped hydro. Unlike pumped hydro storage, GS does not require any elevation difference. Suitable geological conditions are required, but these can be found in many regions around the world. Gravity Storage plants can be build using proven technologies from mining and tunnel construction, and can be expected to have a service life of 60 years or more.

In this paper, we present the basic concepts behind the Gravity Storage. We will discuss the physical principal and the challenges which we assume facing during construction of such a system. First numerical simulations are carried out to investigate the general design using different rock conditions. Also, the economic and technical feasibility of this concept are presented. The paper ends with an outlook of the “Proof of Concept” to verify the construction process and system-critical components with the aid of a full-scale test system and laboratory and model testing.

KEYWORDS

Gravity Storage, Large scale energy storage, pumped hydro energy storage, renewable energy