

# Frequency regulation of thermal power plant pumped storage

Do thermal units contribute to secondary LFR in pumped-storage power plants?

In both cases, the pumped-storage power plant is initially operating in hydraulic short circuit mode and the change in wind power is compensated by the turbine. In neither of these papers, the AGC system and, therefore, the contribution of thermal units to the secondary LFR were considered.

Does peak and frequency regulation affect power systems with PSHP plants?

When the more number of units in the generation state, the more capability of frequency regulation can be provided by the PSHP. This paper proposes an optimal dispatch strategy for minimizing the operation cost for power systems with PSHP plants and battery storage considering peak and frequency regulation.

Can a PSHP plant participate in frequency regulation?

In addition, the capability of participating in frequency regulation for PSHP plants is strongly impacted by the operation state of units. When the fixed-speed unit is shutdown or in a pumping state, the unit cannot provide frequency regulation capability.

Can a fixed-speed unit provide frequency regulation capability?

When the fixed-speed unit is shutdown or in a pumping state, the unit cannot provide frequency regulation capability. When the more number of units in the generation state, the more capability of frequency regulation can be provided by the PSHP.

What is pumped storage hydropower power (PSHP)?

Pumped storage is one of the most mature energy storage technologies. It can generate/pump for long time and has large capacity. Pumped storage hydropower power (PSHP) plants have the functions of peak regulation, valley filling, frequency regulation, and accident backup.

How much power does a synchronized thermal unit supply?

A load demand of 390 MW has been assumed to be supplied by the synchronized thermal units in all simulations; this value is an average between typical peak (530 MW) and off-peak (250 MW) power demands. Maximum power of all synchronized thermal units has been assumed to be 500 MW.

Due to the lack of pumped storage development in Hunan Province before, the remaining pumped storage resources are relatively rich, and 18 reserve projects have been included in the "medium and long-term planning", with a total installed capacity of 24.6 gigawatts (including Pingjiang, Anhua and other pumped storage power stations that have ...

Thermal is widely recognized as the main flexible regulation power source to alleviate the fluctuation of RES [12]. However, relying solely on the regulation capacity of thermal power plants (TPP) will not only lead to frequent start-stop operations and over-limit climbing rates, but also affect the low-carbon economic operation

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[13].

Pumped storage hydropower power (PSHP) plants have the functions of peak regulation, valley filling, frequency regulation, and accident backup . On the one hand, it can ...

Abstract: The requirement for primary frequency regulation (PFR) capability of thermal power plants (TPPs) in power systems with larger penetration of renewable energy resources (RESs) ...

Small and medium-sized pumped storage power station is the collective name of medium and small pumped storage power station, which refers to the pumped storage power station with a total storage capacity of less than 100 million cubic meters in the reservoir area and an installed capacity of less than 300,000 kW, and the approval and construction time of such ...

To achieve more accurate frequency regulation for the grid, ternary pumped storage hydropower (T-PSH) technology has been proposed . This new technology is potentially cost-competitive with C-PSH if ancillary ...

The results show that when the thermal power unit is disturbed by external load, the frequency regulation of hybrid energy storage auxiliary thermal power unit effectively ...

Recently, the supercapacitor hybrid energy storage assisted thermal power unit AGC frequency regulation demonstration project of Fujian Luoyuan Power Plant undertaken by XJ Electric Co., Ltd has been successfully put into operation, marking the successful application of supercapacitor energy storage assisted frequency regulation technology.

Special interest is being gained by non-conventional PSPP such as those using variable speed technologies [3], [4] and hydraulic short-circuit pumped-storage power plants (HSCPSPP) (i.e. PSPP operating in hydraulic short-circuit mode), mainly due to their capability for providing LFR both in generating and pumping or consumption modes.

In an analysis of how the coordinated frequency regulation of BESS and pumped storage units works, simulations are carried out on MATLAB. The results demonstrate that the frequency ...

Energy storage can be an important element in the transformation of the energy systems towards climate neutrality, in conjunction with other flexibility enablers for the integration of large shares of variable renewable energy sources - such as grid expansion, demand response and energy efficiency. Pumped hydro storage systems and thermal storage

A hybrid energy storage system combined with thermal power plants applied in Shanxi province, China. Taking a thermal power plant as an example, a hybrid energy storage system is composed of 5 MW/5 MWh lithium battery and 2 MW/0.4 MWh flywheel energy storage based on two 350 MW circulating fluidized bed

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coal-fired units.

In this paper, the contribution of a hydraulic short-circuit pumped-storage power plant (HSCPSPP) to the load-frequency regulation (LFR) of an isolated power system has ...

As secondary frequency regulation (SFR) is related to the economic operation and the quality of auxiliary services provided by PSPs, it is critical to clarify its performance and compensation....

However, some studies have the following problems. Firstly, there are many articles that focus only on the optimization of the dispatch of "small power systems" such as wind-thermal, wind-hydro-thermal, wind-thermal-pumped storage, hydro-thermal-wind-photovoltaic, etc. [6, 7, 9, 11, 13, 14]. However, for an actual power system, its power source composition should include ...

With large-scale penetration of renewable energy sources (RES) into the power grid, maintaining its stability and security of it has become a formidable challenge while the conventional frequency regulation methods are inadequate to meet the power balance demand. Energy storage systems have emerged as an ideal solution to mitigate frequent frequency ...

This study aims to derive a frequency response mechanism model of the ASPSU and to quantitatively analyze its superiority in frequency regulation performances to those of the ...

The regulation rate of Beijing Shisanling Pumped Storage Power Plant with automatic generation control (AGC) is approximately 100 MW/min. ... 1-5 [2] Wen X, Zhan S, Deng T et al (2018) A summary of large capacity power energy storage peak regulation and frequency adjustment performance. Power Generation Technology, 39(6): 487-492 [3] Gao S (2015 ...

The paper [20] studied the competitive interaction between autonomous pumped storage hydropower plants and thermal power plants to optimize power generation and energy storage. ... A hierarchical optimal control strategy for continuous demand response of building HVAC systems to provide frequency regulation service to smart power grids.

In this paper, the primary task is to conduct a comprehensive assessment for PFR performance of VSPSPs in isolated power systems. Initially, the hydraulic-mechanical-electrical numerical models...

The pumped storage power station has the characteristics of frequency-phase modulation, energy saving, and economy, and has great development prospects and application value. In order to cope with the large ...

On May 14, 1968, the first PSPS in China was put into operation in Gangnan, Pingshan County, Hebei Province. It is a mixed PSPS. There is a pumped storage unit with the installed capacity of 11 MW. This PSPS uses Gangnan reservoir as the upper reservoir with the total storage capacity of 1.571×10<sup>9</sup> m<sup>3</sup>, and

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uses the daily regulation pond in eastern Gangnan as the lower ...

In recent years, increasing penetration of VRE in power systems has been a global tendency, and the utilization of VRE has become a major concern for governments, corporations and researchers [[1], [2], [3]] aling with the unpredictable and intermittent nature of VRE in an effective and efficient manner is a key research problem [[4], [5], [6]]. ...

Traditional thermal power-plant frequency regulation exhibits drawbacks such as slow responses and limited ramping capability; ... pumped-storage and thermal power-generating units and the DC line is included, and ...

Pumped storage hydropower power (PSHP) plants have the functions of peak regulation, valley filling, frequency regulation, and accident backup . On the one hand, it can provide fast power support after the failure of large-capacity transmission channels, and on the other hand, it can reduce the amount of abandoned wind and solar energy when the ...

Aiming at the "net-zero carbon" target, a higher proportion of variable renewable energies (VREs) has been integrated into power grids, and pumped storage plants (PSPs) are crucial for ...

In 2023, global renewable energy additions reached nearly 510 GW, an approximately 50% increase [1, 2].Pumped Storage Hydropower (PSH) is emerging as a key solution to address the challenges of volatility, intermittency, and randomness in large-scale variable renewable energy (VRE) like wind and solar power [3, 4], essential for grid stability ...

Pumped-storage can quickly and flexibly respond to adjust the grid fluctuation and keep the grid stability because of its various functions. Besides, it is an effective power storing tool and now ...

In Makinen et al., 13 a hydropower-battery integrated model in the simulation of grid frequency control was established. ... because the power system has higher requirements for the regulation capacity and operation ...

Pumped storage units have become the first choice of energy storage equipment for power systems because of their large capacity, low cost, and unlimited energy storage cycles [12 - 15].However, traditional pumped storage units need help with a small power adjustable range and slow response speed, which cannot meet the demands of new power systems.

Primary frequency regulation (PFR) is a crucial operating condition for PSPs to realise frequency modulation, and the effectiveness of PFR is significant to the stability of power system frequency. Several challenges and ...

scheme as a means to provide power regulation or load-frequency control [2]. HSC occurs when at least one unit operates in pumping mode and the others in generating mode, which often increase ...

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