


Chapter 2

Optimized Hybrid Power System Using Superconducting Magnetic Energy Storage System: Hybrid Power System Using SMES

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ABSTRACT

Renewable energy sources always drag the attention of researchers as alternate sources of power generation. These sources are inexhaustible and free of cost, which makes them very important for fulfilling electrical load demand. Due to stochastic nature of these sources as these are nature dependent, power generation from these sources varies. In order to mitigate this issue, these sources are integrated with distributed generation along with energy storage system so as to maintain the system stability. This chapter focuses on diminishing the frequency variation of microgrid incorporated hybrid power system. A hybrid system consisting of solar, wind, diesel along with a controller and superconducting magnetic energy storage unit is simulated. Whenever load demand of the system increases, frequency falls as a result deviation occurred in the system. This is overcome by the automatic generation control mechanism. Superconducting magnetic energy storage unit absorbs the excessive power available during offload condition and injects the same during peak load condition.

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GENERAL

In a power system, whenever load disturbance takes place response of synchronous generators is not quick enough to maintain the stable system. In order to maintain system stability, FACTS devices are used for high-speed reactive power control. FACTS devices sometimes also control real power with the circulation of power in the converter. In order to achieve a reliable system and good power quality, energy storage systems are used. Due to advancements in power electronics technologies, the energy storage system plays a vital role in the field of power applications. These technologies have various advantages such as leveling of load at large scale, maintaining system stability, power quality, power transfer, etc.

According to a principle “energy can neither be created nor it can be destroyed but can transform from one form to another” i.e.

Total electrical energy input = mechanical energy output + energy stored in total + total energy dissipation

In an AC system, electricity is converted and can be stored in the form of potential as well as kinetic energy, electromagnetically as well as electrochemically. The amount and the rate of energy at which electrical energy is stored and transferred into the system or out of the system depend on the factors characterizing their suitability and these factors are peak power rating and response rate of the device as discussed by Singh et al (2014). These devices inject and absorb active and reactive power into or out of the system to solve power system failures like voltage dip, load leveling, quality of power, etc.

ENERGY STORAGE SYSTEMS

Energy storage systems classified into three main categories on the basis of a specific principle are:

1. Physical Energy Storage Systems
2. Electrochemical ESS
3. Electromagnetic ESS

This ESS possesses several advantages and disadvantages with its applications in the field of the power system. These technologies have a strength of maintaining system stability, large storage capacity, improved dynamic response, etc. A brief explanation of the above ESS are showed in Xun et al (2012)

Physical ESS

At present these energy storage systems are quite practical and mature storage systems. Due to the limitation of geographical conditions, these technologies do not possess large scale promotion. These technologies include pumped hydroelectric storage, compressed air energy storage and flywheel storage. CAES is mainly used in load-leveling with energy conversion efficiency less than 70%. On the other hand, the pumped storage system has a large unit volume and various environmental issues. Flywheel coupled with electrical machines stores energy in the power system. All these physical ESS have lower energy conversion efficiency and various limitations limit their use in the system.

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