Hybrid Electric Energy Storage and Its Dynamic Performance

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EXECUTIVE SUMMARY

This chapter concerns energy storage technologies. It firstly outlines two popular storage technologies, batteries and supercapacitors, while their working principles are revealed. The key issues of these two technologies, such as costs, key types, capacities, etc., are also discussed. Afterwards, a hybrid electrical energy storage (HEES) system consisting of both technologies are demonstrated where the electrical circuit is illustrated. The design of the system aims to demonstrate different characteristics of these two technologies via their charging and discharging process. A test rig is explained in detail while other components, including a load bank, an inverter, a data acquisition subsystem (both the hardware and the software) are also clarified. The experimental results are illustrated and analyzed thereafter. Also, this chapter presents several other promising technologies where their key features, pros and cons, and core applications are pointedly reviewed. The concerned storage technologies include photovoltaic (PV) systems, pumped hydro-energy storage (PHES), superconducting *magnetic energy storage (SMES), gas, and other alternatives sources. The authors provide the readers with a brief insight of various energy storage technologies and the inspiration of developing a low-cost, accessible energy storage system for the reader's own purposes.*

INTRODUCTION

Electrical energy is an incredible type of energy that can be efficiently changed into different types of energy with high effectiveness and, much more essentially, it is able to regulate lower class of energy easily. Currently, energy storage devices are playing very pivotal role and have a huge impact on harvesting technologies especially on the electrical grid. Storage of energy during off peak times and without the need of additional generation and then reuse the same energy whenever it is required is the biggest ability of the energy storage devices and it is called electrical supply matching with respect to the load. Though, it is a challenging job to build an economically cost effective electrical energy storage (EES) framework regardless of consistent advances in the plan and assembling of EES components including advances in different technologies in battery and supercapacitor. This actually assistances the generation of power and with the help of this the cost of distribution of electrical energy to the consumer is efficiently reduced. Starting today, no single sort of EES component satisfies high power conveyance limit, high energy density, minimal effort per unit of capacity, minimum leakage and long cycle life (Pedram, Chang, Kim, & Wang, 2010). The hybrid electrical energy storage(HEES) administration issues can be broken into charge portion into various banks of EES components, charge substitution (i.e., discharge) from various banks of EES components, and charge movement starting with one bank then onto the next bank of EES components. Regardless of the ideal charge portion and substitution, charge movement is required to use the EES framework productivity (Wang et al., 2011). Generally, there are two basic classes of energy storage devices e.g. batteries and supercapacitors which are considered as electrical energy storage devices. The other types of storage devices are non-electrical storage devices in which kinetic and thermal energy is exchanged into electrical energy e.g. hydro storage system, pumped hydro and pumped air and flywheels (Olabi, 2017). The actual attention of this book chapter is to classify battery and supercapacitor with their applications of energy storage systems and their advantages and disadvantages are presented with respect to electrical vehicle and electric grid applications. We propose a HEES framework that comprises of at least two heterogeneous EES components, along these lines understanding the upsides of each EES component while concealing their shortcomings. Further a potential available on the photovoltaic, pumped hydro and other alternative sources in the context of power system applications have been described in the book chapter.

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