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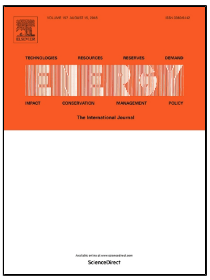

Dynamic Energy Management for Photovoltaic Power System Including Hybrid Energy Storage in Smart Grid Applications

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Abstract — Energy storage technologies will become an important grid integration part of the renewable energy systems (RES) in near future. Using energy storage with RES is the best way of utilizing renewable power and reducing the conventional fossil fuel consumption. Sudden variation of load demand requires energy storage with high power density ability. This paper includes a hybrid energy storage system (HESS) that contains both high energy and power density storage battery bank and ultra-capacitor unit respectively to respond the above-mentioned necessities. The proposed power system arrangement and the dynamic energy management algorithm can vigorously supply the dynamic load demand supported by the components of the hybrid energy storage system, photovoltaic power and grid connection. Control of the unit by an energy management algorithm, depending on the dynamic changes in the system is provided. Experimental test results are presented in this paper to demonstrate the feasibility of the proposed energy management structure. The validity of the proposed dynamic energy management algorithm with efficient converter is experimentally tested in laboratory based prototype HESS in smart grid.

***Index Terms* — Battery, Energy Management, Hybrid Energy Storage System, Ultracapacitor, Photovoltaic, Smart Grid**

I. INTRODUCTION

The main challenge of using HESS's is the capability of sharing active power between different types of energy production and storage systems. Energy storage technologies are remarking in the today's power systems due to the fast development of renewable power generation system. Any type of energy storage system cannot accomplish all functions efficiently required with RES powered by smart grid. The discontinuous environment of RES like photovoltaic (PV) power demands usage of the energy storage with high energy density capability. Energy storage provides many services such as energy time shifting, ancillary services, capacity backup, intermittency management, transmission congestion relief, and power quality improvements by supporting the renewable energy producers and also system operators [1].