

Investigation on Development of Pv and Wind Power with Hydro Pumped Storage to Increase Renewable Energy Penetration: A Parallel Analysis of Taiwan and Greece

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Abstract : Globally, wind energy and photovoltaics (PV) solar energy are among the leading renewable energy sources (RES) in terms of installed capacity. In order to increase the contribution of RES to the power supply system, large scale energy integration is required, mainly due to wind energy and PV. In this paper, an investigation has been made on the electrical power supply systems of Taiwan and Greece in order to integrate high level of wind and photovoltaic (PV) to increase the penetration of renewable energy resources. Currently, both countries heavily depend on fossil fuels to meet the demand and to generate adequate electricity. Therefore, this study is carried out to look into the two cases power supply system by developing a methodology that includes major power units. To address the analysis, an approach for simulation of power systems is formulated and applied. The simulation is based on the non-dynamic analysis of the electrical system. This simulation results in calculating the energy contribution of different types of power units; namely the wind, PV, non-flexible and flexible power units. The calculation is done for three different scenarios (2020, 2030, & 2050), where the first two scenarios are based on national targets and scenario 2050 is a reflection of ambitious global targets. By 2030 in Taiwan, the input of the power units is evaluated as 4.3% (wind), 3.7% (PV), 65.2 (non-flexible), 25.3% (flexible), and 1.5% belongs to hydropower plants. In Greece, much higher renewable energy contribution is observed for the same scenario with 21.7% (wind), 14.3% (PV), 38.7% (non-flexible), 14.9% (flexible), and 10.3% (hydro). Moreover, it examines the ability of the power systems to deal with the variable nature of the wind and PV generation. For this reason, an investigation has also been done on the use of the combined wind power with pumped storage systems (WPS) to enable the system to exploit the curtailed wind energy & surplus PV and thus increase the wind and PV installed capacity and replace the peak supply by conventional power units. Results show that the feasibility of pumped storage can be justified in the high scenario (that is the scenario of 2050) of RES integration especially in the case of Greece.

Keywords : large scale energy integration, photovoltaics solar energy, pumped storage systems, renewable energy sources

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