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Increasing System Adequacy Using Integration of Pumped Storage: Renewable Energy to Reduce Thermal Power Generations Towards RE100 Target, Thailand

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Abstract : The Electricity Generating Authority of Thailand (EGAT) is focusing on expanding its pumped storage hydropower (PSH) capacity to increase the reliability of the system during peak demand and allow for greater integration of renewables. To achieve this requirement, Thailand will have to double its current renewable electricity production. To address the challenges of balancing supply and demand in the grid with increasing levels of RE penetration, as well as rising peak demand, EGAT has already been studying the potential for additional PSH capacity for several years to enable an increased share of RE and replace existing fossil fuel-fired generation. In addition, the role that pumped-storage hydropower would play in fulfilling multiple grid functions and renewable integration. The proposed sites for new PSH would help increase the reliability of power generation in Thailand. However, most of the electricity generation will come from RE, chiefly wind and photovoltaic, and significant additional Energy Storage capacity will be needed. In this paper, the impact of integrating the PSH system on the adequacy of renewable rich power generating systems to reduce the thermal power generating units is investigated. The variations of system adequacy indices are analyzed for different PSH-renewables capacities and storage levels. Power Development Plan 2018 rev.1 (PDP2018 rev.1), which is modified by integrating a six-new PSH system and RE planning and development aftermath in 2030, is the very challenge. The system adequacy indices through power generation are obtained using Multi-Objective Genetic Algorithm (MOGA) Optimization. MOGA is a probabilistic heuristic and stochastic algorithm that is able to find the global minima, which have the advantage that the fitness function does not necessarily require the gradient. In this sense, the method is more flexible in solving reliability optimization problems for a composite power system. The optimization with hourly time step takes years of planning horizon much larger than the weekly horizon that usually sets the scheduling studies. The objective function is to be optimized to maximize RE energy generation, minimize energy imbalances, and minimize thermal power generation using MATLAB. The PDP2018 rev.1 was set to be simulated based on its planned capacity stepping into 2030 and 2050. Therefore, the four main scenario analyses are conducted as the target of renewables share: 1) Business-As-Usual (BAU), 2) National Targets (30% RE in 2030), 3) Carbon Neutrality Targets (50% RE in 2050), and 5) 100% RE or full-decarbonization. According to the results, the generating system adequacy is significantly affected by both PSH-RE and Thermal units. When a PSH is integrated, it can provide hourly capacity to the power system as well as better allocate renewable energy generation to reduce thermal generations and improve system reliability. These results show that a significant level of reliability improvement can be obtained by PSH, especially in renewable-rich power systems.

Keywords : pumped storage hydropower, renewable energy integration, system adequacy, power development planning, RE100, multi-objective genetic algorithm
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