Operation of Battery Energy Storage System in Power System Scheduling With High PV Penetration

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Abstract

Scheduling of thermal generator and BESS charge/discharge are one of the problems in the operation of power generation systems with the integration of PV and BESS. This paper presents genetic algorithm method for solving the BESS charge/discharge operation problem and the Mix Integer Quadratic Programming Method for solving the unit commitment thermal generator problem. The amount of PV penetration will affect the BESS charge/discharge operation and also affect the energy capacity used. Moreover, it shows that with BESS on electric power systems, the higher the penetration of PV, the more significant the decrease in operating costs of thermal generators.

Introduction

Rapid growth of PV penetration and Battery Energy Storage System (BESS)

→ Power generated from PV depend on the natural state of the sun. Provide power only during the day

→ Battery Energy Storage System as load shifting in electrical power system

→ The operation power generation system with the integration of thermal generator, PV and BESS

Proposed Method

Start

→ Solve Battery Energy Storage System Charge/Discharge by Genetic Algorithm

Objective Function of GA

$$\min \sum_{t=1}^{T} (Pd_t + Pbd_t - Ps_t - Pbc_t)^2$$

→ Set Net Load and Unit Commitment Parameter

→ Solve Unit Commitment Problem by MIQP considering BESS

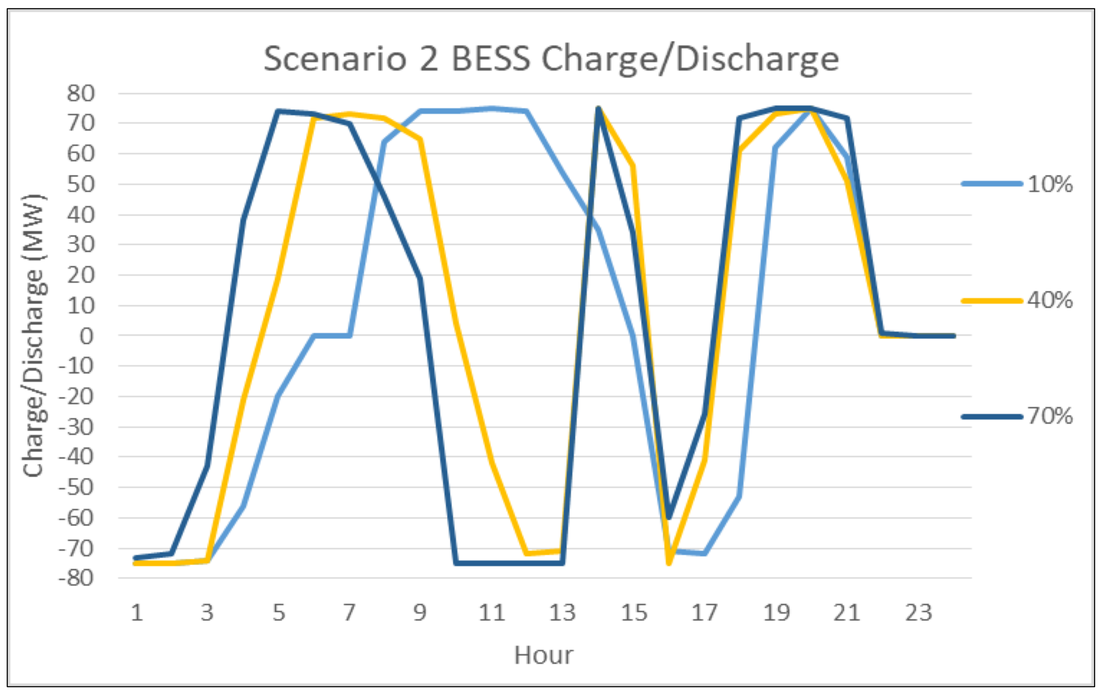
Objective Function of UC

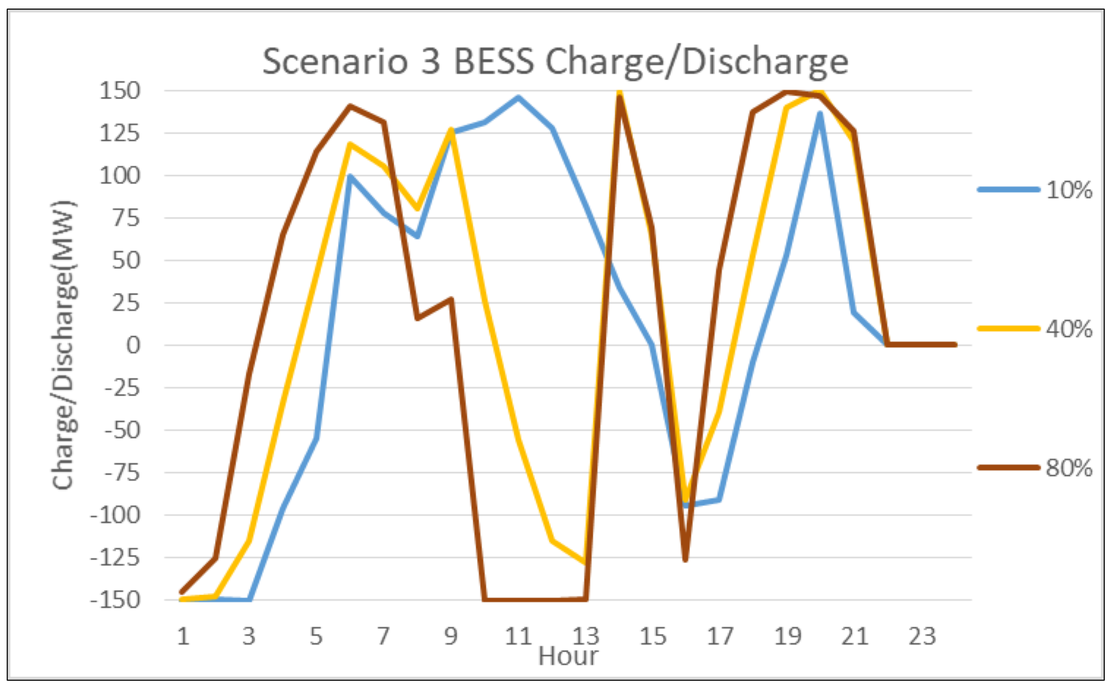
$$\min \sum_{t=1}^{T} \sum_{g=1}^{G} ((f_i(Pg_{g,t})U_{g,t}) + SU_{g,t} + SD_{g,t})$$

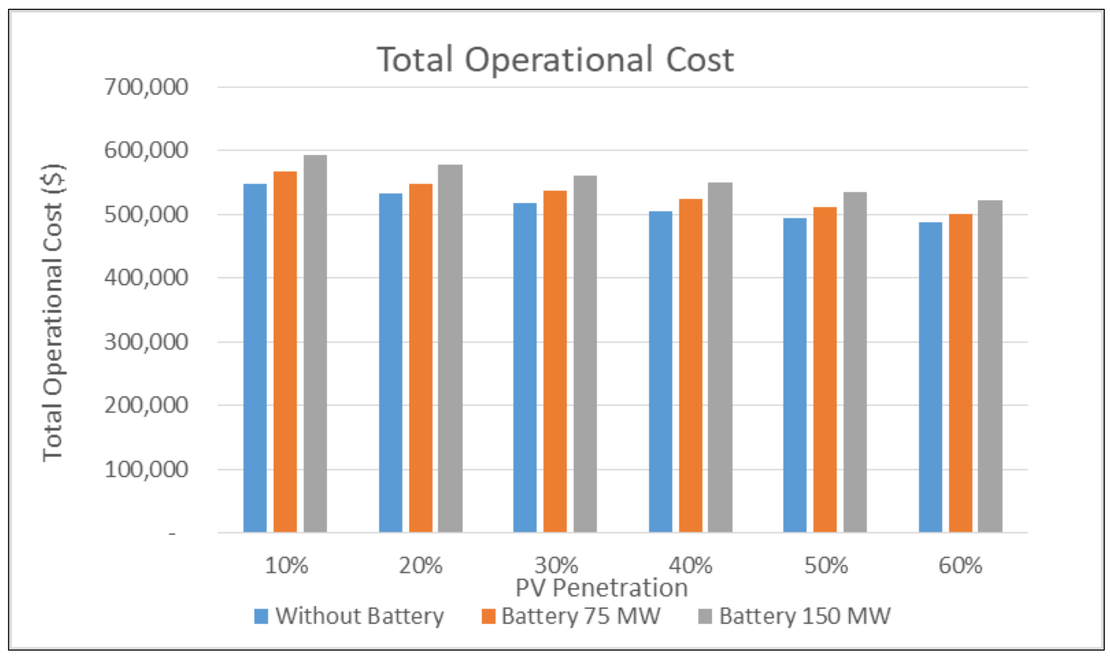
→ End

In step I, the BESS charge and discharge operation is solved by Genetic Algorithm (GA) method.
Step II, thermal generator scheduling and dispatch is solved by Mixed Integer Quadratic Programing.
Simulation is done in 3 scenarios. In each scenario, BESS operations and generator scheduling are carried out at an increasing PV penetration rate. Scenario 1 is without BESS, and the other two scenarios are PV and BESS penetration with BESS capacity of 75 MW and 150 MW.

Result







Conclusion

BESS in scenario 2 and 3 have a role as load shifting. The load profile and PV profile on the tested system have peak loads and peak PV output at the same time. Changes in battery charge and discharge time at different PV penetration level, especially at 10-14 when PV penetration is 10% to 30 %, BESS is discharging. However, when PV penetration is above 40 %, BESS is charging. This change was caused by a change in peak load to a low load at that time with increasing PV capacity. It can be concluded that the amount of PV penetration will affect the BESS charge/discharge operation and also affect the energy capacity used.
Thermal generator unit commitment and dispatch with different BESS capacities show that with higher capacity of BESS, the generator with characteristics of a lower price, higher capacity but longer minimum uptime and minimum downtime, are more widely used. As a result, there is a decrease in the operating costs of thermal plants but higher BESS cost.