Multi-scale Operational Planning of Energy System Containing Wind Farm and Battery Device

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In this research, operational planning of small and isolated energy system having large wind farm and battery device is studied, whose decisions are made in two time-scales: daily unit commitment and hourly dispatch. For this problem, Markov decision process (MDP) and stochastic programming (SP) is combined to capture both daily and hourly changes of wind uncertainty. Two stage SP is formulated for one-day unit commitment (first stage) and dispatch (second stage) decision with a number of scenarios of wind uncertainty capturing hourly ramping. Here, the value of being in a state of current commitment and battery beyond a day (called value function) is included in the objective function to ensure longer term implications of the decisions. Meanwhile, in the MDP formulation, daily evolving exogenous information on wind is captured, and the value function is approximated with a linear model. The coefficient vector of the linear model is recursively updated with a sampled observation estimated from the daily SP model. An estimation of the wind model for timescales from seasonal to hourly is developed to enable seamless connection of the decision making across the scales. The results of the proposed method are compared to those of the original SP model through a case study and real wind data.