The importance of time resolution, operational flexibility and risk aversion in quantifying the value of energy storage in long-term energy planning studies

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This paper analyzes the impact of modeling detail in long-term energy planning models when assessing the value of energy storage in electricity markets. By running six optimization models for the long-term planning of combined generation and storage installed capacities in the Chilean electricity system (each with different levels of detail/complexity in terms of time resolution, recognition of operational inflexibility ?i.e. technical constraints of power plants? and recognition of uncertainty in fossil fuel prices), we determine six portfolio solutions with significantly different levels of energy storage installed capacity. Furthermore, we found that the total installed capacity of storage plants escalates when increasing the level of modeling complexity, which can be achieved by augmenting the time resolution and the number of constraints that better recognize the inflexibility of generation plants and by acknowledging the presence of long-term uncertainties associated with fossil fuel prices fluctuations. In our particular study, we found a difference of more than an order of magnitude between the amount of installed capacity of storage plants determined by the detailed model (that with hourly resolution and full consideration of technical constraints of power plants) and that obtained by the planning model that adopts the traditional assumptions commonly utilized in regulatory offices around the word (i.e. low time resolution and no recognition of technical/unit commitment constraints and uncertainty). Particularly, we found that the traditional, simplified solution can deliver an installed capacity of storage plants as low as 240 MW (?1.3% of estimated peak demand), while one of the most sophisticated solutions (which recognizes technical constraints of generating units, but ignores risks) delivers 7.8 GW (?41.7% of estimated peak demand). Moreover, by running a risk-constrained stochastic planning model, we also determine a risk-averse portfolio solution, which demonstrated the increased value of energy storage capacity in

reducing electricity cost risk.