

# **Investment in electric energy storage under uncertainty: a real options approach**

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**Abstract—** In this paper we develop a real options approach to evaluate the profitability of investing in a battery bank. The approach determines the optimal investment timing under conditions of uncertain future revenues and investment cost. It includes time arbitrage of the spot price and profits by providing ancillary services. Current studies of battery banks are limited, because they do not consider the uncertainty and the possibility of operating in both markets at the same time. We confirm previous research in the sense that when a battery bank participates in the spot market alone, the revenues are not sufficient to cover the initial investment cost. However, under the condition that the battery bank also can receive revenues from the balancing market, both the net present value (NPV) and the real options value are positive. The real options value is higher than the NPV, confirming the value of flexible investment timing when both revenues and investment cost are uncertain.

**Index Terms—** Real options ; Electric energy storage; Markov regime switching; Economic dispatch; Least squares Monte Carlo

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