A Compound Real Option Approach for Determining the Optimal Investment Path for RPV-Storage Systems

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Several countries are promoting renewable energy sources and discouraging fossil-fuel-based energy generation. On the one hand, these initiatives have resulted in a large integration of non-dispatchable energy sources, such as solar power, which, in turn, is demanding more flexibility in order to balance power supply and demand. On the other hand, the adoption of energy storage systems has expanded rapidly in recent years, mainly due to the observed decrease in the cost of batteries. In this context, the implementation of systems combining solar photovoltaic (PV) modules and batteries has significantly increased at the residential level.

The use of residential PV-Storage systems (RPV-Storage systems) may produce large economic and operational benefits to the owner. In addition, an increase in the RPV-Storage systems' penetration rate should translate into social and environmental benefits for the entire society. Unfortunately, the current methodologies to determine the optimal investment path for RPV-Storage systems do not consider some important real-world flexibilities that these projects offer.

This paper proposes a new method, called Compound Least Squares Monte Carlo (CLSM), to valuate both the flexibility of delaying the investments and the option of expanding the capacity of both PV modules and batteries during the evaluation horizon of a RPV-Storage system in a compounded way, considering the household can invest in different PV modules and battery capacities over a period of time and then add more PV modules and/or batteries.

To show the applicability of the methodology, we implemented the model to analyze the economic viability and the optimal investment path of a RPV-Storage system in Chile. The household has the option to invest directly in multiple RPV-Storage combinations and remain in that state for the rest of the evaluation horizon, or she/he can make multiple investments, upscaling to states with higher solar power production or larger battery capacity.

The results show that the household should invest in a RPV-Storage system in 60% of possible future scenarios. Additionally, our results suggest that, on average, in 36% of future scenarios it is optimal to invest in two steps or more, taking advantage of the option to postpone part of the investment until more favorable future scenarios occur. And even more importantly, the analysis of the value of the compound flexibility shown in this work suggests that investors should use the proposed CLSM method in the economic valuation of multi-stage projects, otherwise they could make sub-optimal decisions.

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