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THE EMERGENCE OF COST EFFECTIVE BATTERY STORAGE

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Abstract

The article deals with the prospects of storage for overcoming the intermittency and variability of renewable energy sources. The article suggests the metrics that are used to save energy and provides the best storage system. The levelized cost of energy storage is the minimum price per kWh that a potential investor requires in order to break even over the entire lifetime of the storage facility.

Keywords: battery storage, power, industry, electric power system, efficiency, accumulation.

Introduction

As the share of renewable energy in the overall energy mix increases, issues of intermittency and dispatchability of the electricity supply are emerging as central in the quest for a grid that is both stable and decarbonized[1,2]. Cost effective energy storage is arguably the main hurdle to overcoming the generation variability of renewables. Though energy storage can be achieved in a variety of ways, battery storage has the advantage that it can be deployed in a modular and distributed fashion. This feature partly explains the recent growth in behind-the-meter storage applications, for instance, when rooftop solar is combined with battery storage. Analysis builds on recent studies that have sought to assess the economic viability of battery storage systems in conjunction with renewable power generation.

Research results

The Levelized Cost of Energy Storage (LCOES) metric exam-ined in this paper captures the unit cost of storing energy, subject to the system not charging, or discharging, power beyond its rated capacity at any point in time. This power constraint effectively determines the average duration of the storage system, that is, the average amount of energy that can be stored per kilowatt of power capacity.

The cost of energy storage. The primary economic motive for electricity storage is that power is more valuable at times when it is dispatched compared to the hours when the storage device is charged[3]. These benefits will accrue over the entire lifetime of the storage system and must be weighed against the cost of acquiring a system capable of performing the storage service for a given number of charging/discharging events per year over the useful life of the system. A battery will be sized in the two dimensions of power and energy capacity. The size of the power component, measured in kW, governs the maximum rated electricity charge/discharge rate. The energy component determines the total capacity of electricity that can be stored. It is measured in kWh. Moreover, the ratio of energy capacity to rated power determines the duration for which the storage facility can provide the rated power. This is also the length of time needed to charge the battery given its power rating. To capture the unit cost associated with energy storage, we introduce the Levelized Cost of Energy Storage (LCOES) which, like the commonly known Levelized Cost of Energy, is measured in monetary units (say U.S. $) per kWh. Similar to the LCOE that indicates the average revenue an investor would need in order to break-even over the life cycle of a power generating facility[4], the LCOES measure captures the break-even value for charging and discharging electricity on a per kWh basis.

Absent any battery storage, the household will self-consume the energy represented by the area marked I in Fig. 1, and buy the energy outside the time interval [t−, t+] at the going retail rate, denoted by p. The surplus energy from the solar system, i.e., the regions marked II and III, can possibly be sold back to the energy service provider at some overage tariff, OT which, in Germany, is given by the prevailing feed-in tariff. If a battery system is added, the energy corresponding to the region marked as II in Fig. 1 would be discharged during times when household demand exceeds generation by the rooftop solar facility. Accordingly, region IV in Fig. 1 is equal to region II minus the round-trip efficiency losses. The following derivation also maintains the implicit assumption that the demand represented by combined areas represented IV and V is sufficiently large to absorb the stored energy corresponding to II. Region V is residual demand that would not be met by the battery and must be met through purchases from the grid at the going retail rate p.

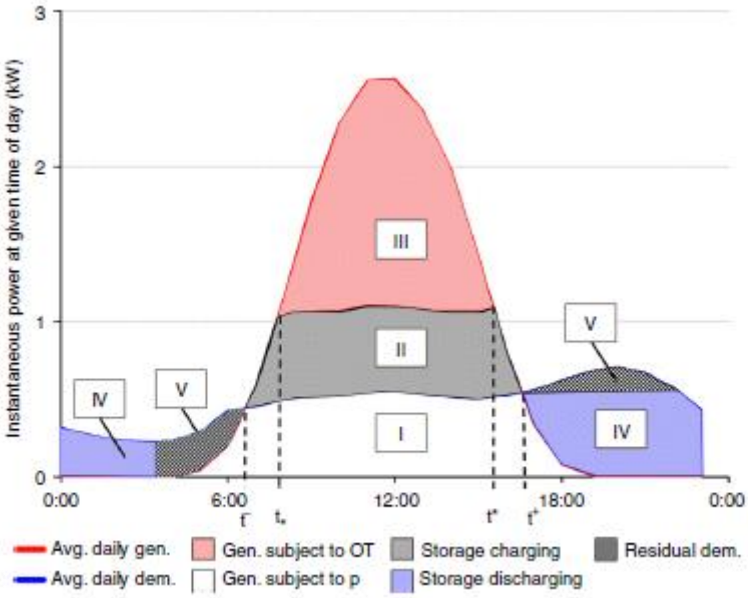

Fig. 1 Pattern of daily charging and discharging of a battery supplementing a PV system.

Conclusion

Energy storage will be key to overcoming the intermittency and variability of renewable energy sources. forecast the dynamics of this cost metric in the context of lithium-ion batteries and demonstrate its usefulness in identifying an optimally sized battery charged by an incumbent solar PV system. While LCOES measure is also calibrated as a break-even measure, our metric departs from two individual levelized cost measure (power and energy) and then aggregates these two measures depending on the average duration of the system. This disaggregation will prove useful in characterizing optimally sized storage systems.

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