THE COST AND VALUE OF ENERGY STORAGE SYSTEMS

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Overview

The concept of *Levelized Cost of Energy* (LCOE) has achieved great popularity to express the competitiveness of renewable energy systems, especially when compared to conventional energy regimes, despite the fact that LCOE does not reflect the value of on-demand versus intermittent energy generation. The concept has also been carried over to energy storage systems. This appears reasonable in this context as storage systems should be able to deliver energy on demand just like conventional, dispatchable energy generation can. However, other flaws typically observed in the LCOE concept as well as the principally questionable method to compare technologies solely on a cost basis may render the concept of LCOE misleading for energy storage systems as well.

Methods

Recent journal entries, conference proceedings and summary reports have been reviewed to investigate the current cost of various energy storage systems. This was initially motivated by a study that explored how much photovoltaic capacity can be introduced before the grid code would be violated within a given network infrastructure with demand profiles based on actual smart meter data (Micallef, Weissenbacher, 2016). Several options of infrastructure upgrades to facilitate higher renewable energy penetration were considered, including on-load tap changers (OLTCs), reactive power controlled inverters and, indeed, energy storage units. It was thus necessary to assess the cost of storage options as well as their actual benefit provided for the grid integration of intermittent renewable energy systems.

Results

The cost of energy storage varies widely between available technologies. Notably, well over 90 percent of globally installed storage capacity is pumped hydro storage (PHS). Recently installed PHS plants had capital costs below 20 €/kWh, some as low as 4 €/kWh, while Li-ion battery packs are projected to see their cost decrease to 150 US$/kWh by 2030. To be sure, various authors appreciate the differentiated benefits associated with energy storage regimes, stretching from bulk energy to ancillary, transmission/distribution infrastructure, and customer energy management services (IRENA, 2015).

Conclusions

The value that energy storage systems provide is not always easy to quantify, and the usual cost metrics might be misleading. Electrochemical storage options may be a lot more expensive compared to large-scale mechanical storage regimes, but their location flexibility and scalability often provide unique benefits. A Swiss PHS plant, Engeweiher Schaffhausen, has been operational since 1909, attesting to the maturity of this technology. However, the low price tag associated with PHS may ignore the value of the land flooded for the purpose. (Take the construction of Austria's largest PHS by volume, the Malta plant, as one example: it involved sacrificing a protected natural area.) Notably, large storage plants depending on particular geological or environmental settings (waterheads, caverns, etc.) require a strong and vast grid environment to be of value, which in itself facilitates the integration of intermittent renewable systems but comes at a substantial cost. However, the cost of creating or upgrading transmission and distribution networks is not included in the LCOEs given for energy storage systems. And for those storage options that can indeed be flexibly placed, their benefit of avoiding grid upgrade expenses is likewise not reflected in their LCOEs. It was previously pointed out that any cost-of-energy metric needs to include the decommissioning costs (and to take into account any residual value) occurring at the end of the energy installations' useful lifetime (Weissenbacher, 2013). But the energy storage LCOEs usually don't. All in all, it can be concluded that a good and general metric to compare the costs and benefits of various energy storage options does not yet exist. Such metric would have to take into account the properties of the respective technology (response time, capacity, power, location flexibility, etc.) and the value provided and additional costs generated or avoided through its employment, which would be related to "system LCOEs" as suggested for intermittent renewable energy sources to reflect variability and integration costs to provide a market value perspective (Ueckerdt, 2013). Appropriate tools to assess energy storage options would in turn allow for an adequate assessment and planning of integrated renewable energy and storage regimes providing for an environmentally friendly and reliable energy system that enhances the local, regional and national energy security.

References

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