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ENERGY INVESTMENT

The many lives of energy storage

Energy storage offers potential to support a changing electricity sector, but investors remain uncertain about its attractiveness. Analysis now shows that this can be overcome for battery technology by providing more than one storage service in a single facility.

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Energy storage is considered a highly valuable resource in power systems today due to the wide range of services it can provide across the electricity sector. Its flexibility is also particularly valuable, given the current process of decarbonization of electrical systems and the need to integrate an increasingly larger share of intermittent renewable generation. Yet, energy storage (excluding pumped hydroelectric storage) is still considered unattractive by investors on mainly two grounds: cost-competitiveness with other technologies and the absence of a commonly shared classification of electrical storage as a competitive or regulated activity — that is, as an electricity generation asset or as a network component.

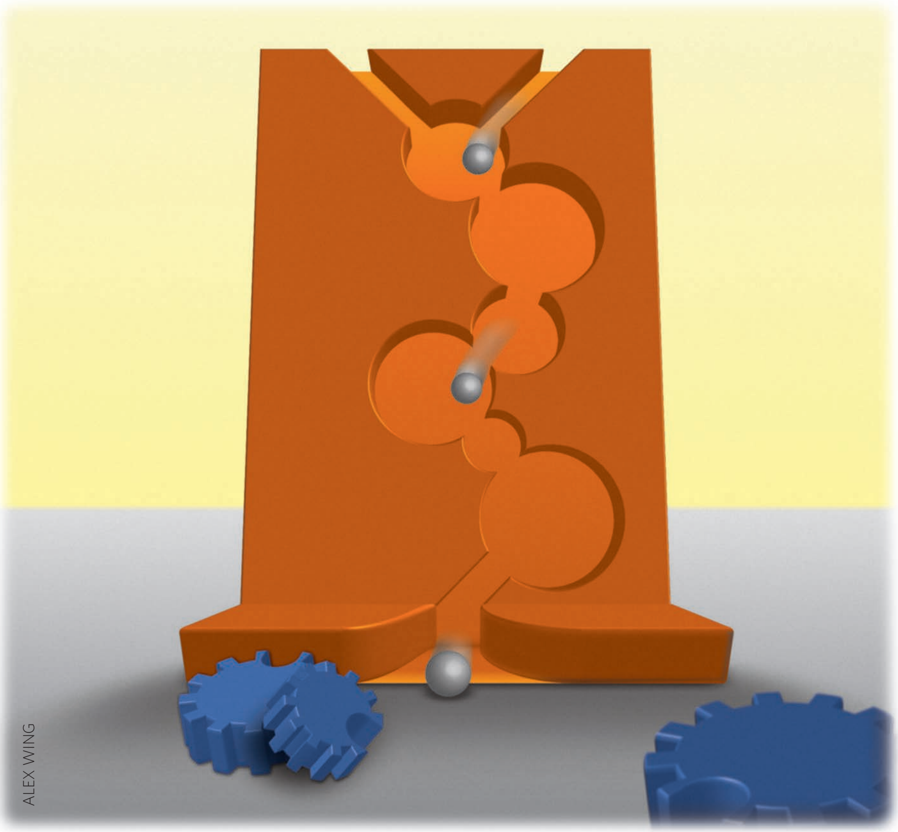
Writing in *Nature Energy*, Tobias Schmidt and colleagues[1] at the Swiss Federal Institute of Technology (ETH Zurich), add to our understanding of these issues by showing that the attractiveness of an investment in electrical energy storage can be substantially increased by combining applications; that is, by providing more than one product or service with the same storage facility. Their resulting policy indication is clear: if allowing storage facilities to provide a wide array of services could make them attractive for investors even today, the current debate should focus more on removing non-market barriers hindering diversification and less on technology diffusion policies.

Applications where energy storage has the potential to bring substantial benefits include higher self-consumption from on-site photovoltaic generation, provision of balancing reserve, and deferral of investments in existing network assets. Schmidt and colleagues consider a number of such applications and classify them as primary (those directly beneficial to the owner — either a final consumer or a network operator) or secondary (those beneficial to the electrical system as a whole — for example, reserve generation capacity, acquired by the system operator to provide additional energy when needed to keep supply and demand in balance).

Focusing first on each individual application, they identify the desirable technical characteristics of the battery (such as power and energy ratings) via an optimization process that maximizes the technology's economic value. For instance, value is created when the costs of energy produced by an on-site photovoltaic system is lower than the price of energy purchased from the grid. The profitability index of the application over the lifetime of the battery is then computed as the present value of annual cash flows divided by the initial investment.

While none of the applications is individually attractive for an investor today, when the researchers combine a primary application with a secondary one, the results change significantly. In the case of lithium-ion batteries in the German market, the addition of a second value stream (typically, revenues from the reserve market) often yields a positive net present value per euro invested. Notably, the underlying assumption is that only idle capacities of the same storage facility can be devoted to provide the secondary service, such that additional investments are not necessary.

One of the interesting aspects of the study is that each application is given not only a different revenue stream, but also a different level of risk. In general, expected cash inflows are higher for secondary applications, but are also more volatile. This is captured via the opportunity cost of capital, which is used to discount future cash flows (riskier applications involve higher expected returns on investments). This also



ALEX WING

means that when the second application is added, the cost of capital is adjusted as well, to account for the overall risk of providing more than one service with the same storage facility. This aspect has been neglected in other studies (which only consider different revenue streams[2–4]) but is shown to be relevant in the calculation of the combined profitability index.

A second insight of the study regards the role of financial and technical compatibility between applications. A different level of risk correlation between the two services has, of course, a non-negligible effect on the investment's profitability — with perfect risk correlation translating into more conservative estimations. Notably, a similar effect is observed when more or less of the idle capacity from the primary service can be channelled into the secondary one.

As for the policy discussion, the recommendation by Schmidt and colleagues to focus on removing non-market barriers highlights that the institutional and regulatory frameworks are key elements in the determination of the economic value of storage. After all, they define the ownership and the services that a storage facility is allowed to provide[5,6].

Considering this from a broader perspective, energy regulators and policy makers have been working for quite some time now towards a modification of the rules and market design, which were originally developed for conventional generators. Such changes are motivated by the willingness to integrate a number of new technologies, including distributed generators, demand resources (consumers managing their energy use in response to prices or network conditions), and storage[7–9]. In this regard, economic principles require new, enabling rules to be technology neutral, that is, not directed at the diffusion of storage or any other technology in particular. In turn, larger participation in the provision of a certain product or service is expected to decrease the costs of procurement.

Given this premise, the necessary regulatory changes are clearly substantial and, understandably, will still require some time to be completed. Nonetheless, examples of market design modifications can already be found, for instance, in the UK where, under the common classification of 'non-balancing units', small generators, demand resources and energy storage providers have recently been allowed to take part in both the capacity and the ancillary service markets[10–12].

Finally, we should consider that providing additional services requires not only an appropriate regulatory framework, but also time, effort and expertise. This is why the presence of an aggregator (a third party enlisting a number of service providers and selling their combined capabilities on the market) is typically part of the discussion over the preferable business model for storage. Schmidt and colleagues leave the determination of the value of storage as part of a portfolio to further work. Such future work offers a promising research direction that might provide clearer answers also regarding whether competition or integration into network operations is the most suitable institutional model for storage diffusion. ❐

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