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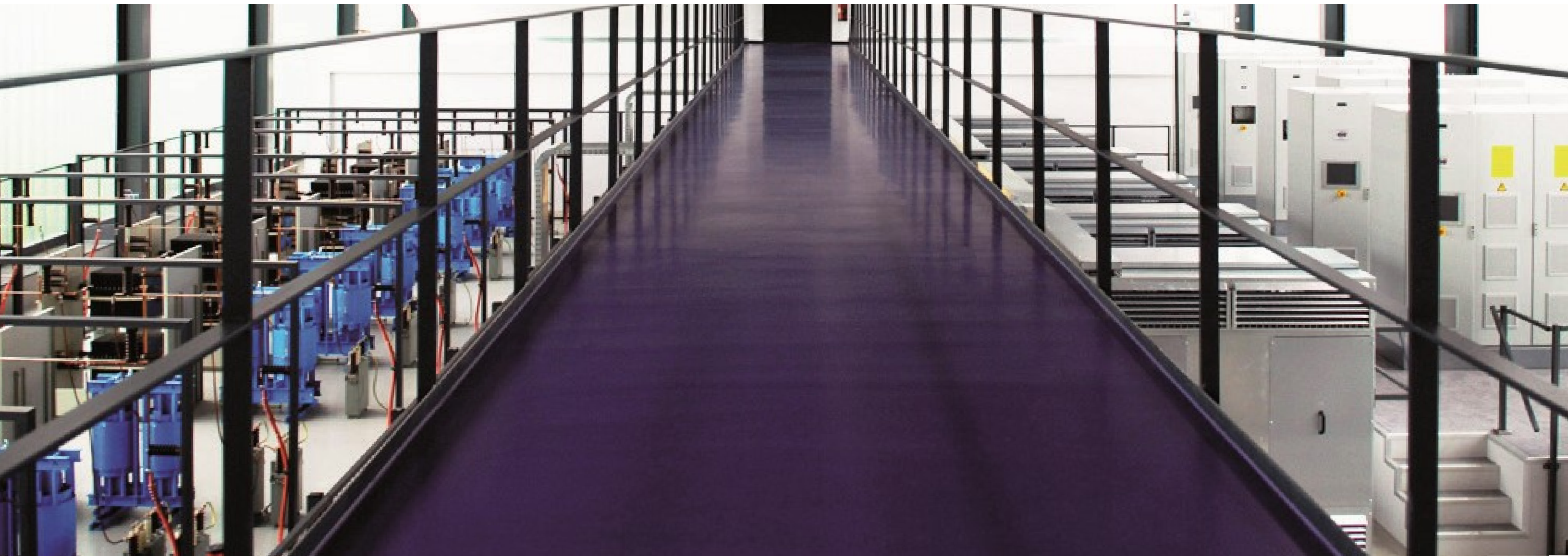

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Sustainability & Resource Productivity

Battery storage: The next disruptive technology in the power sector

Low-cost storage could transform the power landscape. The implications are profound.

David Frankel and Amy Wagner

Storage prices are dropping much faster than anyone expected, due to the growing market for consumer electronics and demand for electric vehicles (EVs). Major players in Asia, Europe, and the United States are all scaling up lithium-ion manufacturing to serve EV and other power applications. No surprise, then, that battery-pack costs are down to less than $230 per kilowatt-hour in 2016, compared with almost $1,000 per kilowatt-hour in 2010.

McKinsey research has found that storage is already economical for many commercial customers to reduce their peak consumption levels. At today's lower prices, storage is starting to play a broader role in energy markets, moving from niche uses such as grid balancing to broader ones such as replacing conventional power generators for reliability,[1] providing power-quality services, and supporting renewables integration.

Further, given regulatory changes to pare back incentives for solar in many markets, the idea of combining solar with storage to enable households to make and consume their own power on demand, instead of exporting power to the grid, is beginning to be an attractive opportunity for customers (sometimes referred to as partial grid defection). We believe these markets will continue to expand, creating a significant challenge for utilities faced with flat or declining customer demand. Eventually, combining solar with storage and a small electrical generator (known as full grid defection) will make economic sense—in a matter of years, not decades, for some customers in high-cost markets.

In this article we consider, as these trends play out, how storage could transform the operations of grids and power markets, the ways that customers consume and produce power, and the roles of utilities and third parties. Our analysis is directed mostly at developments in Europe and the United States; the evolution of storage could and probably will take a different course in other markets.

Implications for the utility industry

Storage can be deployed both on the grid and at an individual consumer's home or business. A complex technology, its economics are shaped by customer type, location, grid needs, regulations, customer load shape, rate structure, and nature of the application. It is also uniquely flexible in its ability to stack value streams and change its dispatch to serve different needs over the course of a year or even an hour. These value streams are growing both in value and in market scale (Exhibit 1).

Cheap battery storage will pose a challenge for utilities behind the meter (that is, small-scale installations located on-site, such as in a home or business). But it will also present an opportunity for those in front of the meter (large-scale installations used by utilities for a variety of on-grid applications).

Behind the meter

Cheap solar is already proving a challenge to business as usual for utilities in some markets. But cheap storage will be even more disruptive because different combinations of storage and solar will likely be able to arbitrage any variable rate design that utilities create.

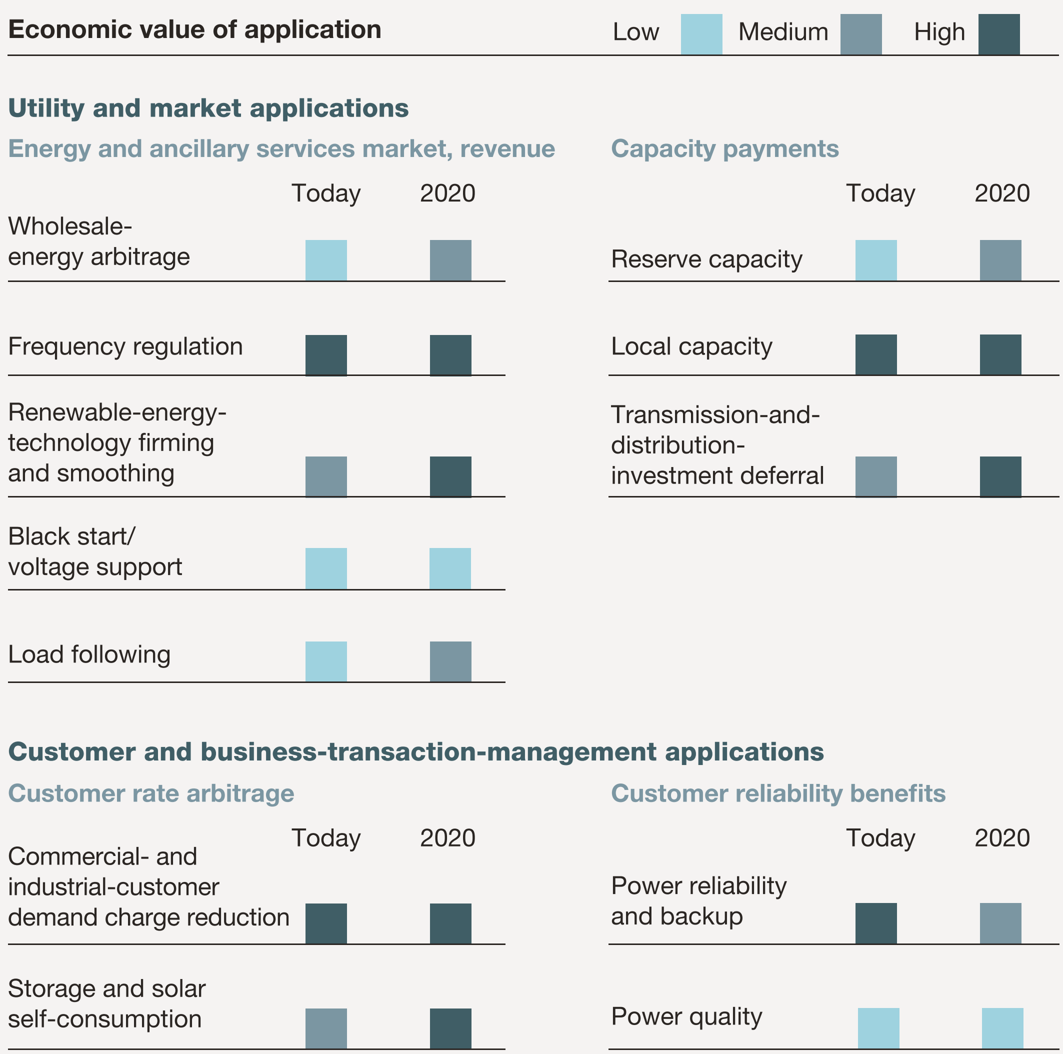
Specifically, net energy metering (NEM) refers to rules that allow excess power to be sold back to the grid at retail rates; and feed-in tariffs, which are guaranteed price adders for renewable power, have played an important role in expanding the global market for renewables. In the US states that have implemented such rules, NEM has proved to be a powerful incentive for consumers to install solar panels.

Although it has been helpful for solar, NEM also has put utilities under pressure. It reduces demand because consumers make their own energy; that increases rates for the rest, as there are fewer bill payors to cover the fixed investment in the grid, which still provides backup reliability for the solar customers. The solar customers are paying for their own energy but not paying for the full reliability of being connected to the grid. The utilities' response has been to design rates that reduce the incentive to install solar by moving to time-of-use pricing structures, implementing demand charges, or trying to reduce how much they pay customers for the electricity they produce that is exported to the grid.

However, in a low-cost storage environment, these rate structures are unlikely to be effective at mitigating load losses. This is because adding storage allows customers to shift solar generation away from exports to cover more of their own electricity needs; as a result, they continue to receive close to the full retail value of their solar generation. This presents a risk for widespread partial grid defection, in which customers choose to stay connected to the grid in order to have access to 24/7 reliability, but generate 80 to 90 percent of their own energy and use storage to optimize their solar for their own consumption.

We are already seeing this begin to play out in places where electricity costs are high and solar is widely available, such as Australia and Hawaii.

Exhibit 1 Battery storage economic value varies by application and is expected to evolve and grow.



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On the horizon, it could occur in other solar-friendly markets, such as Arizona, California, Nevada, and New York (Exhibit 2). Many utility executives and industry experts thought the risk of load loss was overblown in the context of solar; the combination of solar plus storage, however, makes it much more difficult to defend against.

Full grid defection—that is, completely disconnecting from the centralized electric-power system—is not economical today. At current rates of cost declines, however, it may make sense in some markets earlier than anyone now expects. Of course, economics alone will not dictate how much and when customers choose to disconnect from their utilities. For example, another important factor is confidence in the reliability of their on-site power. But this dynamic will affect business-model and regulatory decisions sooner.

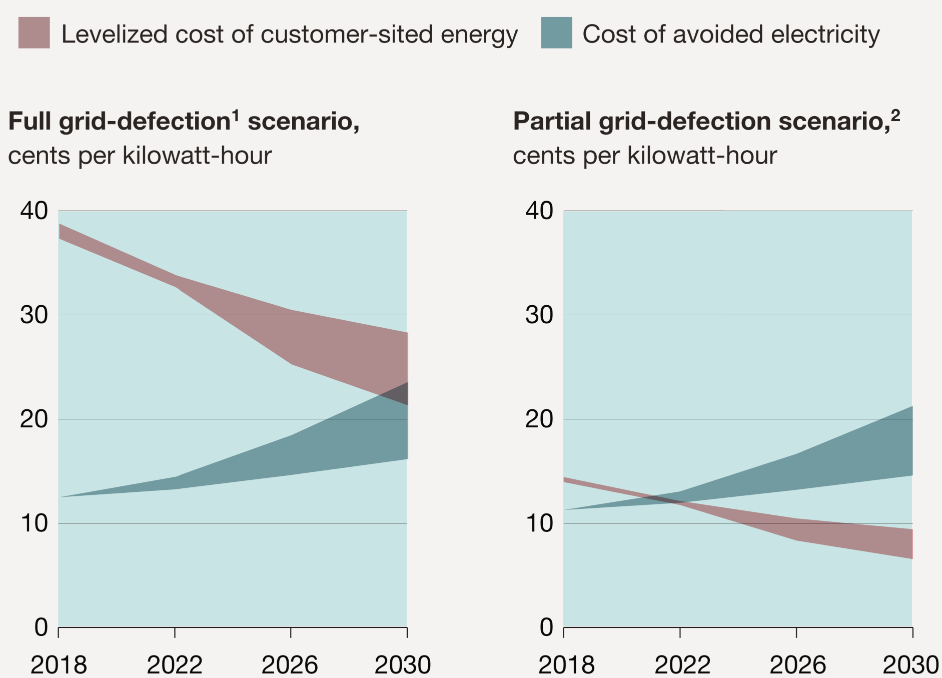
In front of the meter

Storage can also benefit utilities by helping them to address the challenges of planning and operating the grid in markets where loads are expected to be flat or falling. Regulators in some US states, for example, are testing new models of compensation by offering utilities incentives to earn returns by providing contracts for distributed generation. This would, among other things, allow utilities to defer expensive new investments and reduce the risk of long-lived capital projects not being used.

Utilities are also acting to procure storage assets to address both long-term regulatory requirements and short-term needs, such as reliability and deferring the construction of a new substation. As storage costs drop, such projects could lower generating costs—and, thus, consumer electricity rates—by putting further pressure on existing conventional gas and coal-generation fleets, depressing prices in capacity markets and providing load-following services.

Exhibit 2

In some cases, grid defection is beginning to make economic sense.



[1] Grid-defection-economics estimates are based on Arizona residential customer. Partial defection assumes 90% load departure with solar and storage only. Full defection includes a small generator set for backup power. Solar and storage costs are from McKinsey's cost-curve forecast.
[2] 90%.

What utilities can do

Utilities must start now to understand how low-cost storage is changing the future. In effect, utilities need to disrupt themselves—or others will do it for them. There are two broad categories of action to consider.

Redesign compensation structures and explore new opportunities

Sooner or later—sooner is better—regulators and utilities will need to find new ways to recover their investment in the grid.

The grid is a long-lived asset that is expensive to build and maintain. Fixed fees for grid access are unpopular with consumers, and regulators are therefore not particularly keen on them, either. However, imposing fixed fees could ensure that everyone who uses the grid pays for it. The volumetric or variable rate structure in general use today is a historical construct. People are used to paying for the energy they use. But as more and more customers generate their own energy, the access to the grid for reliability and market access becomes more valuable than the electrons themselves.

Because any rate-design changes will likely be slow and incremental (particularly those transitioning to fixed charges), utilities need to respond to these new market realities by capturing new earnings opportunities from expanded services and new transaction fees. There are already some interesting initiatives along these lines. In Australia, utilities are becoming solar-and-storage installers and providing advisory services [2]; while in the United States, one pilot program is selling advanced analytics and data-management services to consumers to help them manage their energy use.[3] Utilities in several states are also exploring new services and investing in grid modernization and electrification.

Rethinking grid-system planning

Utilities must radically change their grid-system planning approaches. This means investing in software and advanced analytics to modernize the grid. It also means changing how traditional system planning is done, by reconsidering codes and standards (some of which have been in place for decades), moving to circuit-by-circuit nodal planning, and employing asset health assessments to ensure the highest priority needs on the system are addressed.

Storage can be a unique tool in support of this. The straight economics of changing grid planning, with respect to return on capital, may not look different at first glance. But, because storage is more modular and can be moved more easily, the risk-adjusted value is likely to be much higher. That will enable utilities to adapt to uncertain needs at the circuit level and also to reduce the risk of overbuilding and stranded investments.

The role of third parties

As for third parties—meaning distributed-energy-resource (DER) companies, technology manufacturers, and finance players—there is tremendous potential for growth. But they must be nimble to take advantage of these opportunities.

Distributed-energy-resource companies can devise new combinations of solar and storage, tailored to specific uses. While storage could eventually provide more customer value and lower bills, new rate structures will be more complex and policy is unlikely to lock in rates for long periods. But shorter periods of defined rates and more complex rate schedules will make it more difficult for DER providers to add new customers, who don't like complexity and want to be sure their investment will pay off. New product offerings and financing creativity could solve these challenges and tempt customers currently sitting on the fence.

Technology players will need to understand how and where to play along the storage value chain, and adapt their offerings to meet customer needs as the technology and use cases quickly evolve.

Financing players, such as banks and institutional investors, will need to create options that adapt and match the investment horizon of the customer. As the market grows more confident of the underlying economics and performance of storage, they will develop financial products adapted to the technology's specific needs. When that happens, financing costs will fall, further expanding the market's potential, creating a virtuous cycle akin to what has happened to solar this past decade.

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Battery storage is entering a dynamic and uncertain period. There will be big winners and losers, and the sources of value will constantly evolve depending on four factors: how quickly storage costs fall; how utilities adapt by improving services, incorporating new distributed energy alternatives, and reducing grid-system cost; how nimble third parties are; and whether regulators can strike the right balance between encouraging a healthy market for storage (and solar) and ensuring sustainable economics for the utilities. All this will be treacherous territory to navigate, and there will no doubt be missteps along the way. But there is also no doubt that storage's time is coming. ■

[1] Examples include using storage as replacement capacity after the Aliso Canyon shutdown in Southern California, as well as storage participating in a tender for capacity in Australia and in capacity-market auctions in the United States.
[2] Amy Gahran, "Can battery storage recharge Australian utilities?" *Greentech Media*, July 18, 2016, greentechmedia.com; James Paton, "AGL eyes power storage in 1,000 homes to tap solar surge," Bloomberg, May 26, 2016, bloomberg.com.
[3] Shay Bahramirad, Patrick Graves, and Joseph Svachula, "Evolution of ComEd asset management," *T&D World*, April 21, 2016, tdworld.com.

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