Common Storage Misperceptions

Costs, Competitveness, Technology

BY KERINIA CUSICK

Grid-connected battery storage is both a relatively new industry and a complex product. Its versatility naturally leads to confusion when trying to understand its applicability. Additionally, the rapid pace of change within the industry leads to misinformation and misperceptions.

The cost competitiveness of energy storage cannot be distilled to a single metric, such as dollars per kilowatt-hour.

Misperception #1: Battery Storage Costs Will Decline at Same Rate as Solar or Wind

Much has been written about the rapid decline of solar and wind costs, particularly in the last decade as costs have fallen dramatically. As the volume of installed solar costs doubles, costs decline by twenty to twenty-five percent.

This "learning rate" trend has been documented in many industries from aviation to electronics. As the volume of units produced increases, improvements in manufacturing processes, standardization, product redesigns, and automation all lead to cost declines.

Both wind and solar spent decades in slow growth mode, remaining a niche product used in very limited applications, struggling to build scale. But grid-connected battery storage is benefiting from manufacturing scale that has already been achieved in different industries, electric cars and consumer electronics.

The electricity generation and distribution industry should anticipate that cost of stationary grid-connected battery storage will drop even faster than solar or wind. Grid-connected storage is benefiting from the manufacturing advances being made for other sectors.

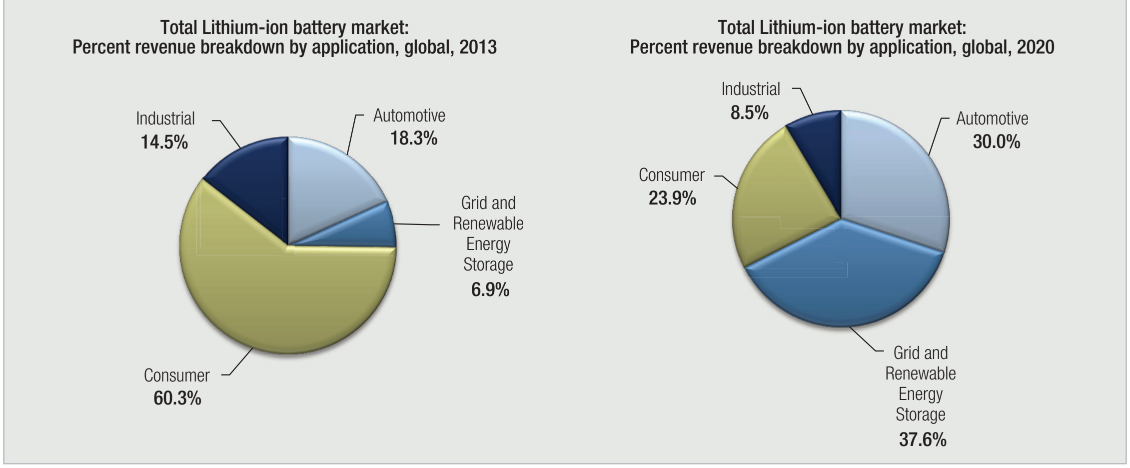
Almost ninety-seven percent of grid connected storage in 2016 was Lithium Ion. Figure 1 shows projected use of Lithium Ion battery storage in 2013 and 2020. One can see that grid-connected storage is a small percentage of the total Lithium Ion sales in 2013. Consumer electronics (such as laptops) and electric vehicles are the majority.

Most analysts project this will change in the next few years. Some project grid-connected storage driving the market by 2020.

Based on data published by the International Energy Agency, the number of electric cars on the road is beginning to achieve rapid growth. In 2015, there were one and a quarter million electric vehicles on the road, driven in part by a sudden spike of these vehicles in China, which is quickly matching the U.S. in market size.

Kerinia Cusick has worked in renewable energy and energy storage since 2008. During that time, she developed renewable energy projects, lobbied on renewable energy legislation, participated in electricity regulation cases, developed strategies for state government procurements of renewable energy, and advised private clients on solar procurement (as well as go-to-market strategies). Kerinia also co-led a team responsible for developing and executing a two-year strategy to launch a world-wide solar company into energy storage. In that role, Kerinia led greenfield development of solar and storage projects in California, participated in M&A to procure operational assets, led storage financeability, and supported joint development of storage-only projects. Most recently, she co-founded Center for Renewable Integration, developing policy solutions to integrate renewables onto the grid without impacting reliability.

FIG. 1 **HISTORICAL AND PROJECTED WORLD-WIDE USE OF LITHIUM ION ENERGY STORAGE**



Tesla has been focusing on building high end electric cars in the U.S. BYD Auto in China is concentrating on lower-cost models.

It can be difficult to calculate the size of the automotive battery storage market currently deployed worldwide. The size of batteries installed in cars ranges significantly. The total range is estimated between ten and twenty gigawatt-hour.

In contrast, the total installed capacity of grid-connected energy storage in the U.S. is three hundred thirty-six megawatt-hour. It is a small fraction of world-wide automotive capacity.

This is also particularly relevant due to the potential application for using a secondary market electric vehicle battery in grid storage applications. Most of these manufacturers have established secondary market sales channels for their batteries. Generally, the batteries are available for a fraction of their original cost.

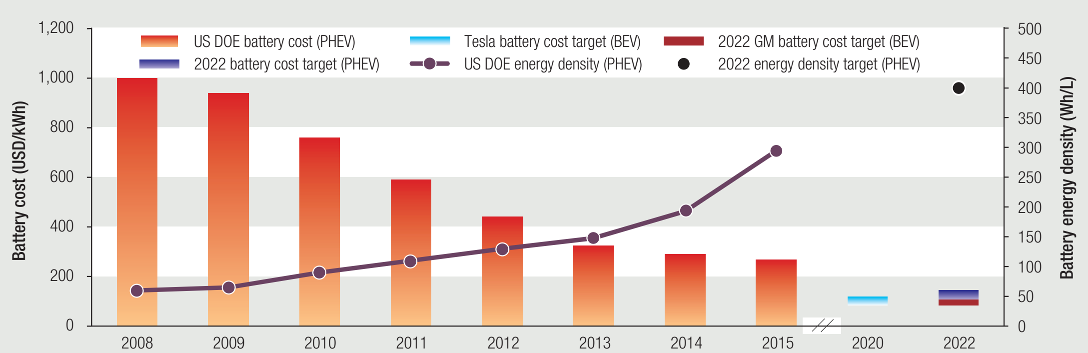
Some electric vehicle companies, such as Mercedes Benz, have decided to directly enter the grid connected energy storage market. These companies are not just limiting themselves to participating via a secondary market channel.

IEA projects electric vehicle Lithium Ion battery costs of a hundred dollars per kilowatt hour by 2020. But with the growth of consumer electronics and grid-connected battery storage, cost declines might be even faster, far outstripping the declines of solar and wind. See Figure 2: Current and Projected Battery Cost.

Misperception #2: Battery Storage Won't Be Cost Competitive in Foreseeable Future

Battery storage is a flexible asset that can provide capacity, ancillary services, and energy, or be used as a transmission and distribution asset. It can be installed on the customer's side of the meter to provide load shifting, reduce peak demand,

FIG. 2 **CURRENT AND PROJECTED BATTERY COSTS**



Notes: USD/kWh = United States dollars per kilowatt-hour; Wh/L = watt-hours per litre. PHEV battery cost and energy density data shown here are based on an observed industry-wide trend, include useful energy only, refer to battery packs and suppose an annual battery production of 100,000 units for each manufacturer.

Sources: US DOE (2015 and 2016) for PHEV battery cost and energy density estimates; EV Obsession (2015); and HybridCARS (2015) participate in wholesale markets where allowed, and provide backup power in the case of an outage; particularly if combined with a local generation asset such as solar.

On the utility's side of the meter, it can be used to provide voltage control, peak capacity, energy, ancillary services, and defer transmission and distribution upgrades. There are a number of additional ways that energy storage could be used, beyond the ones listed, some of which are either not currently allowed by regulations, or are simply not practical given current technology.

Figure 2 shows that Lithium Ion battery costs in 2015 hovered around two hundred fifty dollars per kilowatt-hour, and are projected to drop to a hundred dollars per kilowatt-hour in 2020. At those price points it can be tempting to come to the conclusion that battery storage will never be cost competitive.

That analysis assumes battery storage is only being used as an energy product. Energy is measured in dollars per kilowatt-hour. In day-ahead or hourly markets, energy costs will typically drop in off-peak hours, and increase during peak hours such as early evening in the summer.

With zero fuel costs, wind and solar are most competitive when purchased under long-term contracts, which amortize the capital costs. Due to variable fuel costs, energy from natural gas is cheapest when purchased under short-term contracts.

Competitive energy contracts for wind, solar and natural gas can range from thirty to seventy dollars per megawatt-hour, depending upon location and contract terms. Clearly, at one hundred dollars per kilowatt-hour, battery storage isn't cost effective as an energy product.

Capacity is measured in dollars per kilowatt per month (or the equivalent, such as dollars per megawatt per year, or dollars per kilowatt per day). It ranges from a low of approximately one cent per kilowatt per month in some MISO zones to fifteen dollars per kilowatt per month in NYISO congested areas.

In high density areas, the cost to deliver electricity can spike even higher. For example, California requires its utilities to meet a local capacity requirement and procure capacity for specific zones, often through confidential bilateral contracts.

> **A lot of research is being done to develop new chemistries better suited for energy applications, where a low cost per kilowatt-hour is critical.**

In California, these have led utilities to exceed their commission-required targets for energy storage, contracting with storage assets simply based on cost-competitiveness. California does have a state-wide incentive for energy storage, which boosts the competitiveness of energy storage, but it can only be applied to a fraction of total project costs.

Ancillary services markets include several products, one of which is frequency regulation. Typically grid operators procure between half of one percent to one percent of their peak load to provide minute to minute load balancing and maintain the U.S. grid at sixty hertz. More recently, FERC required independent system operators to create a market for fast frequency regulation, and compensate those resources at a higher price point, given that they deliver a higher value service.

A significant percentage of installed U.S. battery storage is located in PJM, strictly to provide frequency regulation. Very few of these projects benefitted from any incentives, and were built simply based on the economics and cost competitiveness of energy storage.

Figuring out the cost-competitiveness of battery storage and the price points at which it is cheaper than other resources can be complicated. Batteries can be automatically controlled to provide multiple services.

For example, a commercial behind-the-meter battery in PJM could be used daily to shift load from high time-of-use rates to low time-of-use. On anticipated peak days, it could be used to reduce peak load, thereby reducing demand charges.

And, during off-peak hours, the battery could participate in the PJM frequency regulation market. All of these value streams stack one on top of the other, and can make energy storage cost competitive.

In short, the cost competitiveness of energy storage cannot be distilled to a single metric, such as dollars per kilowatt-hour.

Misperception #3: Battery Storage Technology Still in Testing Phase

While Lithium Ion batteries comprise the vast majority of grid-connected storage projects to date, that doesn't mean research isn't underway to develop new technologies. Because of its use in the consumer product and automotive sectors, Lithium Ion is simply the one technology that has progressed out of the lab and into full commercialization, and major companies such as Panasonic, Samsung, and Tesla are backing their products with warranties that can be used for financing purposes.

Designed primarily to meet the requirements of the automotive or consumer electronics industries such as laptops, Lithium Ion batteries are designed to charge quickly, provide thousands of charge-discharge cycles, and provide high energy density in order to fit into a laptop or a car.

Lithium Ion works well in some grid-connected storage use cases, specifically ones that require thousands of charge-discharge cycles like frequency regulation (an ancillary services application), and demand charge management (a capacity application). A lot of research is being done to develop new chemistries better suited for energy applications, where a low cost per kilowatt-hour is critical, from advanced alkaline to flow batteries and others.

However, at this point, most of these chemistries remain in the lab, with limited deployments in geographically remote applications such as powering cell phone towers or train track signals. Third-world micro grids, which only require a slow trickle charge during the day, typically from solar, and a slow discharge at night, are well suited for lead-acid batteries.

Lithium Ion cost declines will continue in the automotive sector, and spill over into grid-connected storage.

As of the first quarter of 2017, lead-acid and Lithium Ion are the two chemistries in the U.S. that are considered “shovel ready.” And able to meet the requirements imposed by most lenders providing project financing, such as a product warranty backed major firm.

While it is too soon to tell if a new chemistry will emerge from a lab to become a leading technology for energy applications, it is clear that Lithium Ion cost declines will continue in the automotive sector. This will spill over into grid-connected storage. ❖