Market Insight Report Reprint

Innovation and investment are just beginning for batteries

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The history of batteries begins with the Leyden Jar in 1746, but after 275 years, electrification and decarbonization are fueling a new wave of innovation. The greentech investment spree continued this summer as investors splashed billions on new battery technologies.

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Introduction

As we bid fossil fuels farewell and turn to renewable energy resources, batteries are set to become a key ingredient of the all-electric society. In a recent spotlight series, we looked at how electrification is changing the automotive market and how the charging demands of battery electric vehicles (BEVs) impact the electric grid. We believe batteries will play a broader role en route to the all-electric society. As the energy transformation comes to full steam, the battery market saw record investments in 2020, and the cash continues to flow, with billions spent during the summer. Redwood Materials, Northvolt and SolidPower were among those that landed the biggest deals in the sector.

THE 451 TAKE

Across the industry, vendors are looking to increase power density and capacity. At the same time, the automotive industry is trying to bring down the weight of batteries, which is a large barrier for adoption in commercial transportation. Sustainability challenges and limited availability of some components are also driving innovation in the sector, and some technologies are more promising than others. The automotive industry primarily eyes solid-state technology as the next evolution, but the use case eventually determines the best suitable technology. For BEVs, a long discharge cycle is required to drive hundreds of miles, but for datacenter power-backup purposes, batteries are required to instantly kick in megawatts of power when the grid fails.

Climate change and transitioning to renewable energy resources are the primary drivers for growth of the energy storage market, often supported by legislation and policies such as a new bipartisan infrastructure bill, which the US Senate passed in August. The bill specifically allocates $73bn in renewable infrastructure investment and is likely to spur further growth of the US battery industry.

Context

In this report, we will try to provide a general overview of the battery market and then look at some of the largest deals of the summer, followed by an overview of vendors participating in the competitive landscape for batteries in the BEV, enterprise energy storage system (ESS) and home energy storage segments. We will conclude by looking at some of the innovation in the market and increased recycling efforts. The report will focus on pure-play battery vendors and leave out the adjacent fuel cell market. The main difference being that a battery stores energy in a charge and discharge cycle, while a fuel cell generates energy by converting available fuel. Fuel cells can have a battery component to store the generated electricity for later release.

The first battery, the Leyden Jar, was invented 275 years ago. The glass bottle had the capacity to store electric charges between electrical conductors. Multiple jars in a row were called a battery, to reflect their connectedness like a battery of guns working in unison. The first rechargeable lead-acid battery was invented in 1859. Since the 1970s these have been known as valve-regulated lead-acid batteries (VRLA). Compared with newer technology, lead-acid batteries have the lowest energy density, but are cheap compared with other types of batteries, and traditionally find their way into fossil-fuel-based vehicles needing to ignite a spark to start the combustion process. About 60% of VRLA batteries globally are used in the automotive market. Two other main applications for VRLA are UPS systems and telecommunications. The two main components of these batteries are sulfuric acid and lead. Both lead and sulfuric acid can contaminate solid and ground water, and can pose a threat to the environment, as well as human health, if improperly disposed of. Currently the most widely used types of batteries are lithium-ion (Li-ion or Li-on), nickel manganese cobalt oxide (NMC) or lithium iron phosphate (LFP).

In addition to private equity, a considerate amount of money is flowing into the battery market through government funding. Aside from the $73bn in the US Infrastructure Bill for Renewable Energy, the European Battery Innovation project was approved by Brussels in January, in which 12 EU countries will jointly invest almost €3bn into innovation in battery cell technology for electric vehicles and energy storage. South Korea is ready to charge its battery industry: It plans to invest 40.6 trillion won ($35bn) in its EV industry before 2030.

Summer of storage

In June US-based Solid Power announced intentions to go public via a SPAC merger deal valued at $1.2bn. Solid Power develops solid-state batteries, and the announcement followed just one month after the company received an investment of $130m from BMW and Ford, whereas General Motors placed its bet on lithium-metal battery developer SES in April in a $139m investment round. In the same month, Swedish lithium-ion battery maker Northvolt raised a staggering $2.2bn in venture funding after it had already raised $600m in private placement in October 2020, to invest in capacity expansion, research and development, and large-scale recycling. In 2019 the company also secured $1bn in equity capital, with BMW and Volkswagen participating in the funding. Its Li-ion based Voltpacks provide high-density battery modules for demanding industrial applications, such as datacenter backup. A third summer signature deal was the $700m in series C funding for Redwood Materials in July. The company was founded by former Tesla battery designer JB Straubel and recycles scrap from battery cell production and consumer electronics, and extracts materials like cobalt, nickel and lithium.

With major investments holding strong, the battery industry seems a secure spot to store money. However, in July Clarios International cancelled its IPO at the last minute, citing volatile market conditions. The IPO was expected to raise $1.7bn. The world's largest manufacturer of automotive batteries – and the owner of the Varta and Heliar brands – provides both VRLA and lithium-ion battery technologies.

Competitive landscape

Some of the largest vendors in the battery industry are located in Asia, including Contemporary Amperex Technology and BYD in China; Panasonic in Japan; and LG Chem/LG Energy, Samsung SDI and SK Innovations in South Korea. SK Innovations, a subsidiary of the SK Group, manufactures high-nickel-content NMC batteries for electric vehicles. It reported revenue of 34.2 trillion won ($31.4bn) over 2020 and an operating loss of 2.6 trillion won. Battery sales were 1.6 trillion won.

Battery electric vehicles

The BEV market is currently dominated by liquid-state Li-ion batteries based on ion conductivity, where ions move from one electrode to another across a liquid electrolyte. The larger automotive manufacturers primarily eye solid-state technology as the next evolution of EV batteries. In these all-solid-state batteries, the liquid electrolyte is replaced by a solid compound that allows lithium ions to migrate within it. A Harvard team of researchers recently designed a stable, lithium-metal solid-state battery that could increase the lifetime of BEVs to 10-15 years.

As EV sales are increasing, many battery manufacturers have seen an uptick in investments. Some of the largest recent deals include a $1.4bn SPAC merger in February as Norway-based FREYR went public. FREYR is a manufacturer of semi-solid-state lithium-ion batteries and was founded in 2018. It aims to provide high-energy density and cost-competitive clean batteries for a growing international market for EV, marine and stationary storage solutions.

QuantumScape went public in late 2020 through a SPAC merger. The company manufactures solid-state lithium-metal batteries, and raised $200m in 2020 prior to its IPO and close to $1bn in post-IPO equity. UK-based Zenobi Energy raised $150m in November 2020, while Taiwanese ProLogium Technology, a manufacturer of solid-state lithium ceramic batteries, raised $100m in April 2020.

Tel-Aviv-based StoreDot makes fast-charging lithium-ion batteries for mobile phones, commercial drones and electric vehicles. The company has raised $130m over eight rounds, and raised an undisclosed amount in a secondary market round in 2020.

Grid-scale and enterprise ESS

With the increased share of renewable, yet intermittent, energy sources like wind and solar, utilities will need gigawatts of storage capacity to maintain a balance of demand and supply on the grid. Key players in grid-scale ESS include large industrial players such as ABB, General Electric, Honeywell, Johnson Controls, LG Chem, Mitsubishi, Toshiba, Samsung SDI, Schneider Electric, Siemens and SK Innovation.

Energy-storage specialist Fluence received $125m in private placement funding from the Qatar Investment Authority in the closing hours of 2020. With the $125m investment, the Qatar Investment Authority acquired a 12% stake in Fluence, while founders Siemens and AES each retain 44%. The latest investment puts the overall market value at slightly over $1bn. Fluence offers modular and grid-scale storage solutions with different chemistries, including NMC or LFP, depending on customer requirements.

With the increased challenges of balancing grid stability and extreme weather events, power outages are beginning to appear more frequently. To ensure business continuity, large enterprises are starting to look toward energy autonomy with smart-microgrid deployments, in which they install generation and storage capacity to operate independently from the grid. Most of the grid-scale storage providers are beginning to offer modular storage to tailor capacity to the smart-space energy needs, such as Finnish Wärtsilä, which recently released its modular GridSolv Quantum ESS. Its batteries are Li-Ion-based, and Wärtsilä is moving from NMC to LFP composition because LFP has a higher throughput capacity.

Further growth of the enterprise ESS segment can be found in the datacenter industry, where diesel generators and VRLA battery-based UPS systems are being replaced with Li-ion batteries. Schneider Electric, a leading provider of datacenter facility products, has been testing new UPS systems based on supercapacitors and Li-ion batteries, while Vertiv recently integrated grid management capabilities into its power storage units. Chicago-based Methode Electronics launched a lithium-ion battery UPS as early as spring 2014.

Home energy storage

Another market set for growth is home energy storage, as consumers increasingly generate their own power with solar photovoltaics and store their energy in batteries to consume later in the day or to charge BEVs. Providers of home energy storage solutions include Enphase; Generac; LG Chem; Panasonic; Pika Energy (acquired by Generac in 2019); sonnen, a subsidiary of Royal Dutch Shell; and the Tesla Powerwall and Nissan XStorage batteries.

Next-generation storage

After 275 years, the innovation in battery technology is just beginning. The industry is looking to increase efficiency and decrease weight. At the same time, sustainability concerns, rare-earth mineral dependencies and geopolitical forces drive the search for alternative chemistry.

For instance, Natron Energy seeks eco-friendly battery power with its Prussian blue sodium ion-based batteries. The components of the batteries are readily available on each continent and provide a high power density, a high number of charge and discharge cycles, and fast discharge capabilities, making them suitable for use cases like datacenter backup. The company has raised roughly $135m across several funding rounds. The latest, a series D investment round, raised $35m in July 2020 and included investments from ABB Technology Ventures, NanoDimension and Volta Energy Technologies.

Similarly, ZincFive pursues nickel zinc (NiZN) technology and has raised a total of $67.4m in funding over seven rounds. Its latest funding raised $33m in April. According to French R&D contractor SunEnergy, zinc-based batteries are made with commonly available materials and are 100% recyclable.

Other emerging technologies include iron flow batteries (ESS), compressed air technology (Hydrostor, Lightsail Energy), metal-hydrogen (EnerVenue), thermal energy storage system (1414 Degrees) and porous silicon (Cross Border Power). Small Dutch startup Dr Ten is looking for funding to bring its patented batteries based on saltwater energy storage to production. Austrian BlueSky Energy already has a natrium-ion-saltwater battery on the market – the Aqueous Ion Exchange Battery – while Australian HydraCell provides its saltwater-based Power Cube.

Named after the original mother of all batteries, Dutch startup Leyden Jar Technologies puts its focus on reinventing the graphite anode in Li-ion batteries, which it thinks is the bottleneck to solving the energy density problem. Its silicon anode holds the promise of a tenfold capacity, but silicon swells during lithiation, and the company is tackling the challenge of keeping the silicon in a mechanically stable manner. Leyden Jar Technologies has raised a total of €6.2m in funding over four rounds.

Israeli startup Addionics is reinventing the physics of battery technology. Traditionally, the battery either has a thin electrode offering high power and low energy, which is expensive and long-lasting, or thick electrodes offering high energy and low power, which are cheap but have a shorter lifespan than thin electrodes. Addionics offers a 3-D electrode that is both high-power and high-energy. The company has received a total of $8.5m in funding and announced a partnership with French conglomerate Saint-Gobain in 2020; it says it has four other proofs of concept running, including with a few automotive companies.

Finally, a team of researchers from MIT and the Technical University of Eindhoven (the Netherlands) are working on improving the electrode for redox-flow batteries. The flow battery is a 50-year-old NASA technology that could potentially be used for extremely large-scale storage. Canadian Vanadium is working on a Vanadium-based redox-flow battery.

Battery recycling

According to S&P Global Ratings, mining is hazardous to the environment by nature. Thus, from a sustainable production and consumption perspective, the mining industry should prioritize the reasonable and economical acquisition and use of mineral resources. When it comes to lithium mining, the major miners look toward increasing sustainability by extending the lifespan of the minerals by adding recycling capacity.

Limited reserves and rising prices are also likely to drive further investments into recycling efforts, such as the Redwood Materials investment this summer. The biggest lithium miner, Albemarle, which annually produces more than 65,000 tonnes of lithium, is making investments and partnering with automotive OEMs on recycling minerals from used batteries. Similarly, Chinese lithium miner Ganfeng has recycling facilities in China capable of recycling about 65,000 tons of old batteries a year, and expects to add new recycling facilities in other locations. In May, Canadian battery-recycling startup Li-Cycle was awarded a multiyear contract with Ultium Cells to recycle critical materials from scrap and manufacturing excess.

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