

Thematic Investment Opportunity – Lithium Battery Technology

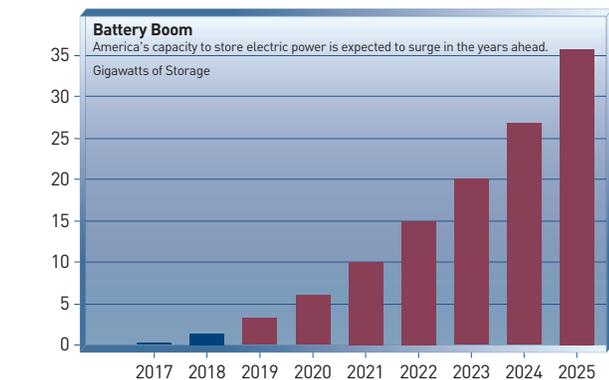
Lithium batteries are already the choice energy source for many products, such as smartphones and laptops. The global market for lithium consumption is expected to grow considerably over the coming decade (Chart 1). Lithium’s light weight, high energy density, and rechargeable properties make it an attractive energy source. But until recently high production costs have limited its applications. Over the last decade, however, research and development dollars have made their way into the lithium battery value chain, driving down production costs and improving battery efficiency. According to Bloomberg, lithium-ion battery costs fell nearly 50% from 2014 to 2016¹ (Chart 2).

Future growth drivers include the increase in electric vehicle (EV) usage, a supportive regulatory

environment, and advancements in alternative/renewable energy sources (for example, solar and wind energy). These applications require more powerful batteries than traditional consumer electronic devices, helping to increase the demand for lithium. While we do not anticipate a maturing consumer electronics market to be the primary driver of lithium battery growth, with most people already owning a smartphone or laptop, we believe this market should serve as a stable floor for lithium battery demand.

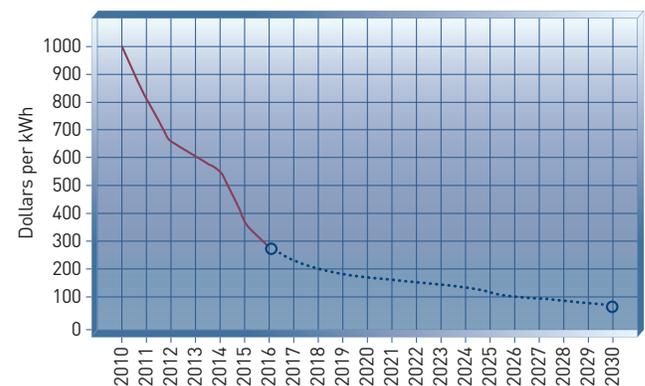
Ultimately, we believe both the economic and regulatory environments influencing lithium batteries and other associated technologies are becoming more favorable.

Chart 1
Advances in Lithium-Ion Batteries Driving Electric Power Storage



Source: Navigant Research

Chart 2
Falling Cost of Lithium-Ion Batteries



Source: Bloomberg New Energy Finance (November 2017)

¹ P. Tullis, “The Great Nevada Lithium Rush to Fuel the New Economy,” Bloomberg (March 29, 2017), <https://www.bloomberg.com/news/features/2017-03-29/the-great-nevada-lithium-rush-to-fuel-the-new-economy>.

Navigating the Adoption Curve: Sources of Future Lithium-Ion Battery Demand

Electric Vehicles

Advancements in EV technology and infrastructure coupled with tailwinds from supportive government policies are forecasted to drastically expand EV adoption over the coming decades (Chart 3). Declining costs of lithium-ion batteries are helping to make EVs more cost-competitive with traditional vehicles. The efficiency of some EVs has tripled since 2014, rising from an estimated 84 miles to about 240 miles.

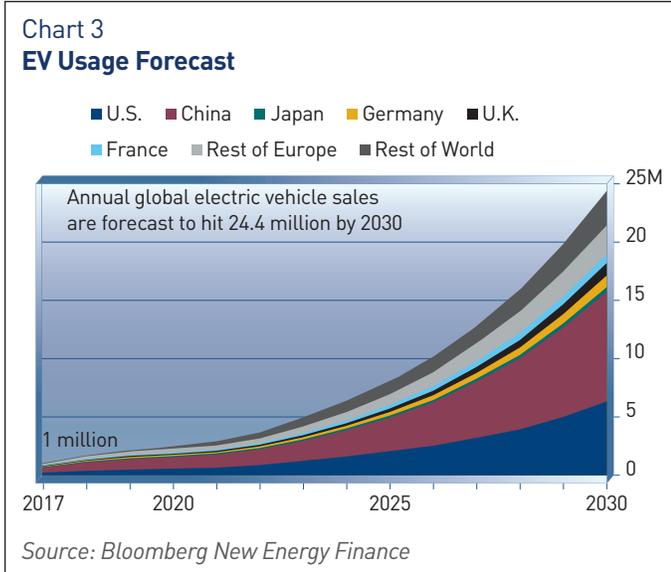
Additionally, larger and more efficient batteries are permitting lithium-ion battery usage beyond traditional consumer electric cars. Commercial vehicle manufacturers are beginning to develop “eTrucks,” foreshadowing a boom in EV adoption in the commercial trucking industry. According to McKinsey & Company, commercial bus and truck producers are ready to convert to electric commercial

vehicles, or eTrucks.² We believe the conversion of commercial vehicles to EVs will be more rapid than consumer decisions, which are often blurred by individual preferences. A company’s decision framework is more rigid and solely focused on economic and regulatory factors, both of which are favorable today. While there are technical and operational efficiencies still to be ironed out, the potential eTruck impact on lithium-ion battery demand could be robust. According to Bloomberg, “buses are lithium-intensive; each uses about 8 times as much as an average electric vehicle, which in turn uses about 10,000 times as much as an iPhone.”³

Government Policy and Regulatory Intervention

Several governments have instituted policies that are favorable to the EV industry. Countries such as Norway, France, Germany, and the United Kingdom have introduced policies setting end dates on the future sales of internal combustion engine vehicles, some as soon as 2040. This transformation is already beginning to take place on a municipal scale. In the United Kingdom, an Ultra-Low Emission Zone will be instituted in London starting this year. Under this regulation, vehicles will need to meet new, more restrictive exhaust emission standards or pay a daily charge to travel within the designated area. Other European cities, including Rome, Paris, Madrid, and Athens, are following London’s lead and drafting policies to be in place by 2024–25.⁴ The European Union promised €800 million in EV charging infrastructure and another €200 million in battery production.⁵ The EU also has partnered with several private companies to build “MEGA-E” charging hubs in metropolitan areas and along highways throughout 20 countries on a pan-European scale.⁶

This shift in zero emission/EV transportation guidance is also taking hold in the United States. Nine states



² Excerpted from “What’s Sparking Electric-Vehicle Adoption in the Truck Industry?”, September 2017, McKinsey & Company, www.mckinsey.com. ©2018 McKinsey & Company. All rights reserved. Reprinted by permission.

³ P. Tullis, “The Great Nevada Lithium Rush to Fuel the New Economy.”

⁴ P. Hockenos, “End of the Road: Are Diesel Cars on the Way Out in Europe?,” *Yale Environment 360* (April 12, 2018), <https://e360.yale.edu/features/end-of-the-road-are-diesel-cars-on-the-way-out-in-europe>.

⁵ R. Toplensky, “New EU Vehicle Emission Rules Disappoint Climate Activists,” *Financial Times* (November 8, 2017), <https://www.ft.com/content/e075af19-e7b0-3da3-ac84-94bc916a5130>.

⁶ “Allego Project Mega-E Secures €29M in EU Funding,” <https://www.electrive.com/2018/04/25/allego-project-mega-e-secures-e29m-in-eu-funding/>.

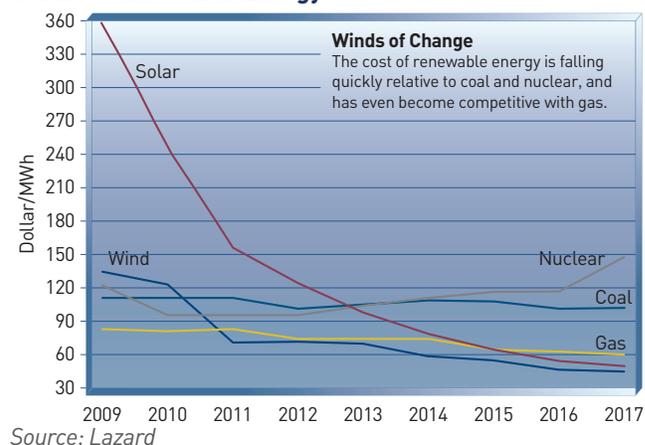
have signed onto the U.S. Multi State Zero Emission Vehicle (ZEV) Plan, building on early success in some states and identifying clear objectives for reducing emissions through 2021 and beyond. This action plan recommends “high priority” actions for states, automakers, charging and fueling infrastructure companies, utilities, dealers, and other partners to guide coordination among stakeholders and encourage rapid adoption of EVs. These actions include consumer education and outreach, offering consumer purchase incentives and building EV charging infrastructure.

Renewable Energy

Historically, high costs and inefficiencies in power storage of renewable energy sources (for example, solar and wind power) have acted as barriers to entry except for the most earth-conscious. The sun is most intense, generating the most solar energy in the middle of the day. Wind blows the hardest at night, that is, creates the most wind energy, so is most efficient as an energy source at that time. However, consumer electric demand is highest in the early evening. This mismatch often forces renewable energy users to pay peak energy prices to fill the gap. Lithium-ion batteries may offer a solution to this issue.

According to Lazard, 2017 was the first time in history it became profitable for the owner of an average coal plant to replace it with a wind farm.⁷ Two variables have led to this eye-opening dynamic. First, the cost of wind (and solar) energy production has fallen to less than nuclear, coal, and gas (Chart 4). Second, lithium-ion battery storage costs of surplus electricity production have fallen to levels where they are included in renewable power projects.

Chart 4
Costs of Renewable Energy



Conclusion

Tailwinds from economic and regulatory factors position lithium-ion batteries as an attractive alternative energy source. Given its potential cost-effectiveness and availability, it is clear to us that lithium-ion batteries could play a significant role in both future household consumption and commercial industries.

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⁷ J. Hough, “How Batteries Will Change the Power Business” (June 9, 2018), <https://www.barrons.com/articles/how-batteries-will-change-the-power-business-1528509035>.

For definitions of indexes used in this publication, please refer to pnc.com/indexdefinitions.

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