ECONOMIC AND COST MODELING OF THE REPURPOSING OF ELECTRIC VEHICLE BATTERIES FOR STATIONARY STORAGE APPLICATIONS

Sam Jaffe

IDC Energy Insights, Boulder, CO, USA

ABSTRACT

Lithium (Li)-ion batteries represent a tremendous opportunity for vehicular and grid storage applications. When measured against other battery chemistries, Li-ion excels at high energy and power densities, while cycling at high efficiencies over long periods of time. Their primary weakness is the high manufacturing cost, which should come down over the next five years as manufacturing plants scale up. However, additional value and lower prices can be achieved if the Li-ion batteries are repurposed after their useful life in vehicles for other applications, primarily grid storage. This poster examines the chemistry and the economics behind repurposing vehicular battery packs for grid storage applications and includes a model for pricing the batteries and the impact of repurposing strategies on both the vehicular application and the grid storage application.

Keywords: battery management system, lithium-ion, EV batteries, grid storage

GENERAL

In the race to determine the next-generation battery that is optimal for use in electric vehicles (EVs) and in grid storage applications, it is now clear that Lithium (Li)-ion has won the first few laps. Due to the excellent efficiency profile, energy density, power density, cycle life, and calendar life, Li-ion is able to outperform most other chemistries. Its primary drawbacks are safety (due to the possibility of thermal runaway) and manufacturing cost. Due to next-generation formulations, Li-ion batteries have proven that they can solve the safety issues that have hampered previous iterations of the technology.

Additionally, the Li-ion manufacturers are making good progress at cutting manufacturing costs to the point where IDC Energy Insights predicts that cells will reach the $500 per kilowatt hour (kWh) threshold sometime in the next three years. However, advancements beyond that point will be hard to make. It is hard to determine a route that Li-ion manufacturing can take to get prices significantly below $400/kWh.

Repurposing Li-ion batteries in order to lengthen their useful lifetime and thereby reduce the overall cost of the cells (thanks to a resale value of the used batteries for the initial buyer and a deeply discounted value for the second buyer) allows for a further reduction in the cost of the batteries.

The concept of repurposing batteries introduces several potential problems, however, including:

- The initial buyer of the battery system (the automotive original equipment manufacturer) has to pay careful attention to the care and conditions of the battery during its lifetime in the vehicle than it would otherwise be required to if it assumed that the battery were to be disposed of after being taken out of the car.
- The secondary buyer (the electric utility) must change its cultural predisposition to purchasing used equipment, something which is very rarely done today.
- The battery pack for the vehicle must be designed for the easy refurbishment of cells upon repurposing, rather than being solely designed for the optimization of the driving experience.
- A method for replacing failed cells within a module or pack should be made possible, which is not the case today due to adhesives that hold the cells together.

- Thermal management systems, power electronics, and battery management systems for the repurposed modules must be designed for specific grid applications.

Assuming that sufficient solutions for each of the above problems can be achieved, then repurposing batteries can become an active part of both the EV ecosystem and of the grid storage ecosystem.

It's also important to determine how much such batteries could cost the secondary buyers. Assuming that a $400 per kWh price point is achieved by 2020 (when the first large volumes of batteries will start to come out of cars), the residual value of battery packs must be priced at a steep discount to the new packs that will be available at that time. According to modeling done by IDC Energy Insights, it is realistic to expect that the repurposed battery packs will have a residual value of at least $100 per usable kWh and as much as $150 per usable kWh.

The implications of that price range are significant for both the EV industry and the grid storage industry. The cost of a new battery pack for an EV will effectively be $250 to $300 per kWh at the cell level, which makes plug-in electric vehicles (PEVs) extremely price competitive with internal combustion vehicles. Likewise, a $100 to $150 per kWh price point for grid storage batteries enables them to be utilized for a wide range of applications, ranging from ancillary services to demand response to possibly even bulk load shifting.

While repurposing of grid storage batteries is still a decade away, it is important for both the PEV industry and the grid storage industry to begin the strategic planning process for utilizing this process to make Li-ion batteries usable for both industries.

BIOGRAPHICAL NOTE

Sam Jaffe is responsible for researching, writing, and editing qualitative and quantitative reports and presentations evaluating a range of distributed energy topics. His recent research includes reports on the utility industry’s response to the rollout of electric vehicles, an analysis of the concept of the virtual power plant, and an overview of the energy storage sector. In addition to primary research authorship, he provides custom consulting, advisory, and research services for clients, most of whom are executives in the utility industry and vendors that sell into that industry. He also gives public talks at industry events and is frequently quoted in the media.

Before joining IDC Energy Insights, Mr. Jaffe ran his own consulting company, Panea Energy, which specialized in providing business development advice and consultation in the energy storage and renewable energy fields. Before Panea Energy, Mr. Jaffe was a magazine journalist, writing for such publications as *Wired*, *Scientific American*, *The Scientist*, *Business Week*, and *The Wall Street Journal*. He is the author of two books, *Jewish Wisdom for Business Success* (2008) and *The New Korea* (2010), both published by Amacom, the publishing arm of the American Management Association. He received a B.A. degree from Wake Forest University and an M.A. degree from New York University.