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410 kWh lithium-ion battery

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Tesla Corporation launched its latest product at the end of April in Los Angeles with much fanfare and a promise to change the future. Powerwall is a home battery that charges using electricity generated from solar panels and stores that power for use in the evening. The battery also is meant to insure against power outages by providing a backup electricity supply, and, Tesla says, it offers independence from the utility grid and the security of an emergency backup. But is this new battery really all that revolutionary?

In one sense, Tesla''s Powerwall transforms the battery from a storage device historically concealed as much as possible to a device proudly displayed on the wall of one''s home. It is this transformation that has captured consumer interest, or at least the attention of early adopters - Powerwall batteries are now sold out through mid 2016.

While design, ease of use, and marketing clearly are critical drivers for technology adoption, the cost to the consumer, as well as manufacturing costs, are key to further wide-scale adoption. So, let''s really examine how the Powerwall compares with other Li-ion battery pack designs, in particular with regard to manufacturing cost.

The power-to-energy (P/E) ratio is a critical aspect of the design with a direct impact on the specific manufacturing cost ($ per kWh). This dependence is shown in Figure 1, an adapted version of Sakti et al.''s techno-economic model, which plots the specific manufacturing cost of Li-ion batteries as a function of their P/E ratio for different electric vehicle (EV) applications.

By comparison, battery electric vehicles (BEVs) such as a BEV200 (BEV with a 200-mile all-electric range) have a larger battery pack over which to distribute power requirements, and hence need a lower P/E ratio.

Thinner electrode cells, while enabling higher power outputs, are more expensive on a per kWh basis due to higher costs associated with the inactive materials, such as separators and current collectors. This results in higher specific manufacturing costs for PHEV batteries, as illustrated in the accompanying figure.

Tesla"s 7 kWh Powerwall battery pack model has a maximum P/E ratio of ~0.5 (W/Wh), with a peak power of 3.3 kW. So, mapping this P/E ratio onto Sakti et al."s model projects that Tesla"s battery pack manufacturing costs are about $200 per kWh. By comparison, in 2014, industry-wide cost estimates of Li-ion batteries at the pack-level were about $410 per kWh.

For market-leading BEV manufacturers, such as Tesla, which uses Panasonic-made cells, these pack-level costs were estimated at about $300 per kWh. Given that the estimated manufacturing cost of $200 per kWh does not account for profit margin, or other cost components, such as a warranty that Tesla may be paying Panasonic, the $300 per kWh value seems fairly consistent with the established market.