Not all reductions in battery costs are found underneath the microscope

Perspective by The Townsend Company (www.thetownsendco.com)

The one topic that all people involved in the electric vehicle industry agree on is that batteries cost too much. This has led to a wave of investment in material science developments by both governments and private investors alike over the past few years. Yet, when a wider perspective is taken to this issue, the active material content (anode and cathode) in an electric vehicle battery only constitutes towards 20 percent of the price, falling to less than 10 percent in hybrid applications.

Therefore, if we are really going to focus on reducing the price of batteries, a total battery system and not just cell material perspective needs to be taken and costs addressed that are not found beneath a microscope alone.

If we first consider the cost of a cell, the anode and cathode costs contribute toward approximately one-third of the total cell cost. The rest of the cost is a mixture of electro chemical and electro mechanical packaging. Separators, electrolyte, coating foils and cell casing (pouch or can). In an EV application cells will constitute approximately 75 percent of the cost of a vehicles battery pack. Yet two thirds of this cost is inactive material or cell packaging, which equates to half of the total cost of the vehicles battery system.

If we pause on this issue for a moment and look at the activities that are ongoing to improve the active to inactive cell material ratio, most of them continue to be under the microscope at the material science level. Lower cost electrolytes, foils and separator material combinations continue to be sought. Larger format cells are also becoming more prevalent with the aim to reduce cell casing and labor cost elements, but these are hindered by power train voltage and vehicle packaging requirements. Yet although the inactive material in a cell represents the largest potential cost reduction opportunity, its biggest handicap is time. Once a breakthrough technology step has been found, it needs to be taken out of the lab and validated at a cell level, typically taking up to 18 months, assuming no set backs are found. Once validated at the cell level this then needs to be validated at a module and vehicle pack level, taking a further 18 to 36 months, meaning that a new development found today is four and a half years away from production. This is further complicated by the current market build out of billions of dollars in manufacturing equipment focused on high speed volume production of today's technology that needs to be utilized to give a return on investment and could act as a further constraint to new cell tech.

Looking beyond the microscope presents a significant and shorter term opportunity to reduce costs. Non-cell pack costs represent between 25 – 75 percent of the total battery system cost in EV and HEV battery packs, respectfully.

If we examine this, the two main cost drivers in the pack are the packs electronics and cells mechanical module costs at around 30 percent each of the total non-cell pack cost build up.

The electronics include the body control module, current sense module and module balancing electronics. Although fail safe and complex in design to a great extent these components are typically fabricated from the automotive commodity parts bins and represent a significant potential for cost reductions as volumes rise, designs mature and potential failure modes are eliminated. When combined with potentially less than a six month lead time for introduction a battery's electronic and electrical components represent a significant opportunity to impact cost reductions.

Mechanical module costs, although significant, do not represent the same short term opportunity for cost reduction that a pack's electronics represent. The module components provide the cell with its series and parallel configuration, thermal management and mechanical robustness. Modifications in this area typically tie back to the cell performance or packs durability resulting in extended, 18 month plus type, validation programs for new ideas. With the module representing a mechanical, power and energy extension of the cell configured to support a vehicles packaging and power train requirement.

The next significant elements of a battery pack's cost are represented by the wiring and enclosure.

The enclosure represents the more obvious of the two costs encasing all of the battery pack components, modules and cells and providing a mechanical structure to support them and retain them within a vehicle. A number of material options are in use from resin transfer molds, sheet steel, aluminum and reinforced plastic components that each offer their own unique combination of packaging flexibility, strength, thermal and electrical insulation properties with associated tooling investment to obtain targeted production volume quantities. Two factors will reduce costs in this area, production volume and mechanical engineering ingenuity. The later representing significant cost avoidance if a vehicle system approach is undertaken with the battery casing and the common scenario of a box in a box packaging avoided in favor of an optimized combined structural solution for the vehicle and battery pack.

Wiring represents 10 -15 percent of the cost of a pack's non-cell components, cost drivers include copper (material), pack layout and external connector positioning. Designs can be optimized to reduce wiring costs however they rarely are with vehicle packaging and systems architecture design and layouts taking precedence. The cost of the battery packs wire harness is often lost as it's considered a battery and not a vehicle harness cost in the eyes of a vehicle manufacturer. However, this hidden cost needs to be recognized and considered during a vehicle's electrical architecture design and requires advanced collaboration between the battery pack designer and the vehicles electrical system architect. The other factors in wire harness cost are labor and volume, a battery pack's wire harness cost is yet far removed from that of a typical vehicles harness cost as so far production volumes have typically been in hundreds and not tens of thousands of units. So as electric vehicle volumes rise, this cost should also reduce significantly.

The last two significant non-cell pack cost drivers are thermal management and connectors.

Thermal management, especially relevant in HEV packs can take a number of forms traditionally split by air or liquid and external or closed loop driven. An external air feed representing the least cost and a closed loop liquid system representing the most costly. The need for the type of thermal management system is entirely driven by the cell chemistry and user application. Certainly cells with low internal resistance and low self heating properties have a thermal system cost advantage over those that don't, likewise with cells that can still operate a low, sub -25C conditions, can possibly avoid the need for a heating element. Therefore the thermal management system cost can greatly vary but has a direct link to the core cell chemistry and although unique system solutions are being developed this cost will be driven in its majority by developments under the microscope. As a side note, the unique costs of a packs thermal management requirements are often lost in $/whr chemistry comparisons, as an over simplified 'one cost' for all is generally applied, which is simply not true and can often result in hundreds of dollars of cost add to system.

One of the most surprisingly problematic areas of supply and cost is the high voltage connector set. With prices anywhere from the tens to hundreds of dollars a pack offering a very disproportional cost to price ratio for what is basically copper flashed plate in a plastic or cast molding. These are not the connectors that the vehicle user plugs into, but the internal connections from the battery to a vehicle. Unfortunately the choice of high voltage connector options is currently limited in the market presenting both opportunities for new entrants and economies of scale for cost reductions as prices increase.

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In summary, material science developments still represent the largest potential cost reduction opportunity to increase the ratio of active to inactive cost within a cell and pack. Be it by increasing a materials power or energy densities, reducing a cells need for support components or improving its thermal and mechanical robustness. However, time and changes to manufacturing process costs remain limiting factors. Beyond these 'microscope' driven advancements, the majority of a packs non-cell components have yet to be cost optimized. With the pack's electrical and electronic controls representing a significant and possibly short term cost saving opportunity. As vehicles are designed from the ground up, rather than adopted for conversion, further strides can be made in optimizing mechanical pack and thermal management costs and lastly but by no means least, purchasing and commoditization pressure needs to come to bear on wiring and connector costs.

About The Townsend Company

The Townsend Company l.l.c. is a consultation and business development practice to help companies wanting to enter, grow or become more profitable in the alternative energy market. Prior to founding the company Glynne Townsend, President and CEO, led the revenue growth for A123 Systems in the automotive and grid markets and is one of the industry's leading commercial authorities.

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For media information please contact: **info@thetownsendco.com**