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Case Study: Development of an enclosure for an EV charger buffer battery energy storage system (BESS)

Although only a comparatively small volume of electric vehicles (EVs) have been purchased in Australia the market is growing. According to the electric vehicle council "Sales of plug-in electric vehicles tripled in the past year from 6,900 in 2020 to 20,665 in 2021. EVs now account for 2% market share of new cars, up from 0.78% in 2020". With this fast-emerging market the demand for EV charging infrastructure is also on the rise. In line with general industry trends Australia has the potential to generate much of the power required for EV charging via sustainable methods.

What is an EV Charger Buffer BESS?

Innovation in the EV charger space requires companies that can develop scalable solutions and be able to navigate the complicated regulatory framework for the Australian network and energy markets. PowerTec Engineered Solutions is one such company.

In managing director Michael Jansen's words "we basically work with utilities, industry and communities to power their sites or their network more sustainably, more reliably and more independently."

PowerTec has developed the PowerCache® EV charging buffer battery system which can support ultra-fast chargers, where the network is too weak. This system is a "Micro-grid in a box" that can be implemented as a turnkey solution for many applications.

> PowerTec provides solutions to power commercial, industrial or community sites more resiliently, sustainably, and autonomously. PowerTec combines its PowerCache® "Grid-in-Box" battery energy storage system with distributed controls to augment, stabilise or mirror the electricity network for a site and access wholesale energy markets.
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> PowerTec designs and produces the technology for distribution networks, industrial and commercial sites, electric vehicle charging stations, and renewable generators (30kVA – 5MVA).

Microgrids are playing an increasingly significant role in transitioning power infrastructure from the traditional centralised network of power station to the consumer into distributed bi-directional networks where smaller solar, wind and renewable generation can be accommodated.

Again, in Michaels words "Microgrid technology delivers what I call autonomous cells. In a future network a commercial or industrial operation or a community can not only power itself more sustainably with their own renewables but also more independently. That means they can access the energy wholesale markets which reduces their energy bill. At the same time, the network can be more resilient to avoid overload and congestion. So, the end result is a network that is more democratic and that allows for more exchange."

So, from an EV charging perspective Microgrid technology can assist in managing sustainable generation and importantly oversee the peak load and generation spikes from and into the Network. For example, more solar generation and more EVs mean more power spikes for the network. These spikes need to be managed by fast and precise control of charging/discharging and other technical network parameters

PowerTec have provided the first of a fleet of EV-charging station batteries for Australia's largest public EV-charging network, Chargefox. The 250kVA / 270kWh version of PowerCache® delivers benefits for the owner, the energy company, the network, and the site operator (for example the Goulburn Budget Petrol Station) – all at once! It primarily serves as fast EV-charging buffer, energy markets service provider , and site back-up power.

PowerCache® in testing

PowerCache® in the field

Design of the PowerCache® Enclosures

PowerTec's approach to innovation has been to work and grow together with customers and partners. Understanding the application and the various issues in implementation is usually the best way to draw any innovation.

Implementation of the PowerCache® can be a turn-key system customised towards a particular requirement the enclosure system had to be modular and flexible enough to allow for changes between systems.

PowerTec combined with the Erntec to find solutions to house versions of the PowerCache®.

Erntec specialise in the design of enclosure systems with the aim to provide flexible and solution orientated collaboration.

For the Chargefox EV system two enclosures were required, the inverter/transformer enclosure and the battery enclosure.

From a mechanical design and assembly point of view each enclosure presented its own unique challenges. Multiple consultation sessions between PowerTec and Erntec took place where the build configurations and scope of works was defined and documented. During this process emphasis on value add in both the design and assembly was discussed and elements of the design agreed on. The working process required flexibility from both parties as we worked through a range of issues as they came up.

After the builds were completed, a review occurred where improvements for construction, assembly, and fitout time were discussed and implemented. This remains an ongoing process with each version of the PowerCache®. A more detailed outline of the considerations for each enclosure is in sections below.

Inverter Enclosure Implementation

With a footprint of 1100 mm x 1880 mm the initial challenge for the inverter enclosure was how to accommodate large components without having to go larger. The solution was innovative but intuitive and technically a little challenging. The enclosure was designed to be assembled around the components (In two halves of 1880 mm depth).

The large and heavy inverter and LCL filters were installed in the front shell then the internal walls were added to create various compartments for isolation switching and Dc control.

The inverter/filter area has a lowered roof with a distinctive design vent/return air flow system. A portion of the vented air re-circulates back into the compartment via an adjustable vent.

Insulated busbar systems between compartments were constructed along with sound deadening and vented isolation covers and baffles.

Special attention was given to earth grounding points between mating surfaces to reduce harmonic feedback from the inverter and LCL filter throughout this half of the enclosure.

Likewise, the large transformer was lifted into the rear shell before the switch and control compartments were assembled over the transformer in such a way that a heat chimney behind these new compartments allowed for the transformer to vent. Fans in the inner roof draw the heated air into the outer roof cavity which is also sound deadened before venting out of the sides.

Cable routing was considered, and cable management arrangements were put in place to facilitate quicker installation. Cable gland plates were pre-machined to further save time during fit out.

All of this, when assembled was mounted on a heavy-duty C-channel welded, galvanised plinth with lifting pipes and support rails aligned with the heaviest components, especially the transformer.

Battery enclosure

Battery Enclosure Implementation

The battery enclosure presented its own set of challenges.

With the same footprint as the inverter kiosk, it needed to house three full sized 19-inch battery racks and a control cabinet. Also, hot/cold air flow for the racks was an important design consideration in their placement.

DC power feed into the battery racks through bus bars and cable management were integral to the overall design and function of the system.

Provision for a fire suppression bottle and system was accommodated for and a ventilation system for the control cabinet independent of the rest of the kiosk interior was designed.

Being outdoor, the kiosk required an outer skin to help keep the enclosure interior cooler. As such, all weld seams for the inner skin could be external and hidden by the outer skin. This made for easier construction and limited weld clean-up.

For ease of assembly the door openings had removable mullions to get the battery racks in and secured first. All interior assembly was completed before the mullions were fitted followed by the doors. Each door in front of a battery rack had provision to mount an air conditioner and the interior of the doors had air flow re-direction baffles fitted to keep hot and cold from mixing and direct the cool air to the rack inlets. Door switches on brackets allowed feedback to the HMI for air conditioning control.

Again, when assembled all this was mounting on a C channel welded, galvanised plinth with lifting pipes and support rails aligned to support the battery racks.

Summary

Distributed power management and EV charging are clearly emerging markets where Australia has an opportunity to lead. We think the experience outlined in this article demonstrates how small companies can successfully work together to achieve excellent end-to-end solutions.

By taking an innovative approach to the market and to design implementation.

- The design of the enclosures was not an open and shut scope and build various criteria needed to be addressed in collaboration along the way (air flow management and cooling, power distribution in and between the enclosures etc.)
- PowerTec were looking to their partners to bring as much value add to the design, construction, and assembly of the enclosures as they could.
- Throughout all phases of the project the enclosure outcome became offering a semi complete solution which allowed smoother transition into electrical fit out.

Inverter enclosure

Erntec Pty Ltd design and manufacture enclosures and turnkey solutions for small- and large-scale infrastructure and electronic solutions.

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We think outside the box.

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