national electrical and communications association

A word from the CEO

By the time you read this issue of *Electrical Connection,* our industry conference in South Africa will have taken place. We had an excellent response to this event and we will tell you more about the themes that came out of the conference in our next supplement. At the same time I will give you an idea of what we will be doing in 2017 – which is also the year of our centenary. So watch this space.

Infinity Cables Campaign

The Infinity challenge continues and we endorse the Australian Competition and Consumer Commission's (ACCC) campaign to alert home owners to the dangers of having Infinity cable in their homes. As you know these cables (branded Infinity and Olsen) were officially recalled by the ACCC in 2014. After four to five years the cable can become more brittle than the standard, compliant cable. This deterioration – particularly near a heat source, could spark a fire or shock. As a large quantity of this cable was used in 2010/2011 this is now a real threat. Our message to homeowners is: if in doubt have it checked by a licensed electrician as soon as possible.

Greater VET scrutiny

Following media reports around the management practices of an Australia-wide provider of training. NECA is calling on the Government for greater scrutiny to the Vocational Education and Training sector. We believe that the Australian Skills Quality Authority (ASQA) should provide strict oversight and monitoring of poorly performing training organisations to maintain best practice in this area.

Advocacy update

As you can imagine much of the talk and debate in Canberra at the moment is around the prospect of an early double-dissolution Federal election in July and the use of legislation to reinstate the Australian Building and Construction Commission (ABCC). We have long been an advocate for the reintroduction of the ABCC and have been calling on the Senate to support this legislative change. The *Building and Construction Industry (Improving Productivity) Bill* was passed in the House of Representatives in early February. But it has been delayed in the Senate for an Inquiry. NECA has made a submission to this inquiry – which can be found on our website. We believe the passage of this legislation is in the national interest and one that would lead to greater transparency in the building and construction sector. Unfortunately, it may take an election and a new Senate to secure the passage of this legislation.

Best regards,
Suresh Manickam

Closing the books on the MAPS project

Since November 2014, NECA has undertaken extensive consultations with employers and other stakeholders to examine the strengths of the current apprenticeship system and identify areas where the system could be improved for employers and apprentices in training for the Certificate III in Electrotechnology.

These consultations were held across metro and regional Australia, by phone or face to face interviews, with the major purpose of determining employer and industry views on future training arrangements, including a review of the E-Oz EIAPMS Pilot Project.

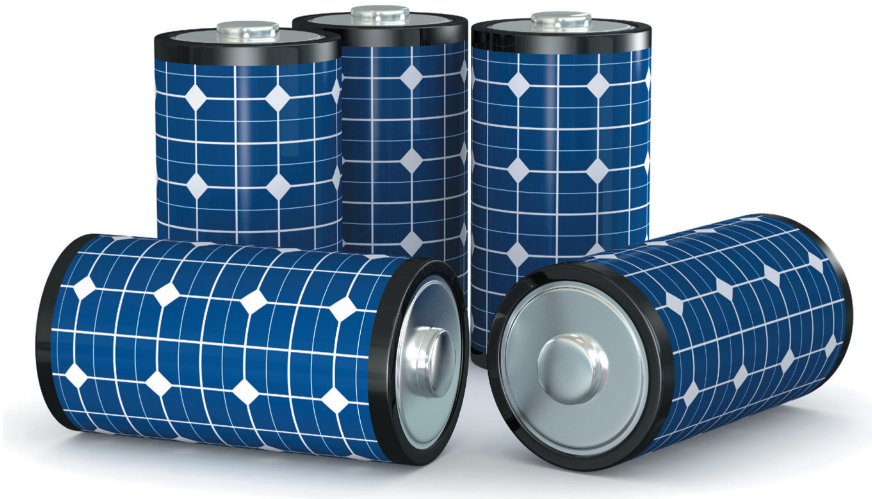
This review included an employer engagement exercise to test employers' views on the EIAPMS; a review of its features to examine what should be taken forward and the development of information kits on competency-based progression and support arrangements following industry endorsement.

The key issues and themes to emerge from these consultations were:

- A focus on 'good recruitment' was needed to increase apprenticeship completion rates;
- The need for a tailored 'recruitment tool' to meet the needs of the industry, and improve the matching of apprentices with employers;
- Support for a national benchmark industry entry test and the introduction of aptitude based testing;
- Agreement that a National Apprenticeship Register provided a focus on ensuring a good fit between the potential apprentice their employer and industry;
- NECA support for a compulsory national profiling system that tracks and measures the workplace activities of an apprentice;
- The need for RTOs to undertake training of apprentices in profiling to ensure apprentices conform to work related competencies;
- Competency based training and the validation of skills and competencies was supported, however there was no support for competency based wage progression;
- Pre-Apprenticeship programs were widely viewed by employers as an important preparation for an apprenticeship and NECA recommends that a national funding approach be adopted by Federal, State and Territory Governments; and,
- Employers were generally not familiar with the details surrounding training packages or pathways but remained strongly committed to training.

LEADING THE CHARGE

Rapid advances in technology mean that battery storage is becoming an integral part of solar PV systems. Glenn Platt of CSIRO reviews the sector.



Until recently, one of the well-known 'facts' regarding the electricity industry was the impossibility of large-scale energy storage.

At the very least, it wasn't economically viable. Without storage, at any instant in time, complex systems would be needed to ensure electricity supply was very carefully matched to demand, or the lights would literally go out.

However, things are changing dramatically, and large-scale electricity storage will soon be commonplace. A household battery system made by Tesla has been installed in a suburban house in western Sydney.

Tesla is one of the world's largest manufacturers of electric cars – in 2015 it sold about 50,000 cars, which are now able to drive autonomously.

The head of Tesla established PayPal and also runs a company that supplies rockets to the International Space Station, so he is well known for his success.

Half a dozen other large companies produce batteries designed for Australian houses and other buildings, and utilities are rolling out larger-scale battery storage systems to support their networks.

What we once considered a 'fact' is now a myth, and large-scale electricity storage is possible and economical.

What's changed?

Using large-scale batteries to store electricity isn't particularly new.

However, such systems – usually based on lead-acid batteries – were bulky, required careful safety procedures and regular maintenance, and were very expensive.

They were limited to quite niche applications: for example, providing back-up power in telephone exchanges, or supporting off-grid power systems in very remote areas.

As far as residential battery systems go, these were limited to crazy enthusiasts – typically old men with beards driving beaten-up old Land Rovers and living in mud-brick houses.

For batteries to be at the point of becoming commonplace in our houses and buildings, some significant changes have occurred:

- The price of battery systems has fallen about 70% in the past five years, and continues to fall.
- Australian electricity prices have risen more than 70% between 2007 and 2013.
- The price of solar generation systems has dropped dramatically, to the point where the price of electricity from rooftop solar is competitive with the retail price of electricity from the grid. Batteries can now be charged by cheap, self-supplied electricity.

Although these changes have occurred worldwide, some additional matters are unique to Australia.

This country will probably be the first in the world to experience the mass uptake of distributed battery systems, because:

- The incentives or feed-in tariffs for solar systems have changed dramatically in the past five years. For example, houses in NSW that installed solar in 2009 were paid 66 cents for every unit of electricity their solar system generated. Today, houses that install solar are paid only eight cents.
- Electricity tariffs are becoming much more complicated.

Households and small businesses used to pay the same amount for electricity no matter when they used it. Today, 'time of use' electricity tariffs are commonplace, varying from six cents in the middle of the night, to 50 cents at peak time, usually about 6pm.

Some utilities are even introducing residential 'demand' tariffs. Customers pay a rate based not only on the energy (kWh) they use, but also on their maximum power demand (kW) during the billing period.

What will drive the mass uptake of battery systems is simple economics.

Yet no one really expects the mass uptake of batteries to mean that customers will become truly independent of the grid. The electricity grid is a really useful way of distributing energy to where it is needed.

Being completely independent of the grid would mean many more batteries and solar panels than is economic. Only old guys in Land Rovers are likely to become entirely self-sufficient.

Batteries will be installed in houses and businesses that remain grid-connected. The battery is simply a way of reducing a customer's electricity costs.

Having considered these changes in the industry, investment bank Morgan Stanley predicts that about 2.4 million Australian households will install solar and battery systems over the next decade or so, with a payback time of less than 10 years.

CSIRO, and even the Australian Energy Market Operator, have released forecasts that about 30% of households or businesses will have their own battery systems in the not too distant future.

The opportunity

Broadly, there are two ways that a grid-connected house or business can use batteries to reduce electricity costs: energy arbitrage and solar storing.

Arbitrage means buying something when it is cheap, and selling it when it becomes more expensive. Batteries allow a customer to arbitrage energy by charging from the grid when electricity is cheap, then discharging to run the loads when electricity is more expensive.

For example, the battery system could be charged at midnight, taking advantage of six-cent grid power. Then, later in the day when electricity is at 50-cent peak rates, the household wouldn't need to buy expensive electricity from the grid.

Solar storing solves one of the conundrums with solar generating systems. They produce their maximum output in the middle of the day, when in many houses nobody is home and the electricity load is relatively low.

Batteries can save the solar energy generated in the middle of the day and make it available later when the household load is high.

An example of this is shown in Figure 1. Such a scenario is also described as using the battery to maximise 'self-consumption' – making sure all the energy from a customer's solar PV system is used to benefit that customer, rather than supplying the grid (and earning very little for it).

But battery systems don't just benefit the local household or business. They can offer widespread benefits to the broader electricity grid as well, improving power quality and reliability and even reducing electricity costs for those without a battery system.

This helps to avoid the installation of the expensive new poles and wires required to meet peak demand.

Benefits could come from the aggregate

"What we once considered a 'fact' is now a myth, and large-scale electricity storage is possible and economical," says Glenn Platt of CSIRO.

response of a large number of small battery systems (a utility might control the batteries in people's houses in exchange for a lower power bill), or by installing a few very large battery systems at key points in the network.

Both approaches are being trialled by electricity utilities in Australia.

The technology

The battery systems now being deployed are a far cry from the large bank of 12V lead-acid wet cells that made up stationary battery systems just a few years ago.

Today's systems are self-contained and maintenance free. The main components are:

- The inverter/charger. Previously based on large, expensive low-voltage (24-48V was common) transformer-based inverters. Today's transformerless inverters operate at much higher voltages.
- The battery cells. Today's cells are maintenance free. They are designed to operate across a wide range of states of charge and many thousands of charge cycles (often 5000 cycles or more). the most common cells are lithium based (a variety of lithium-type batteries exist), or advanced lead-acid (using new cell technology to match the performance of lithium). Other up-and-coming cell technologies include zinc bromine, vanadium redox and sodium-ion technologies.
- Battery management system. This is usually split into two components – a battery management system on the cells that ensures they are not excessively charged or discharged, and intelligence in the inverter/charger that communicates with the cell-level management to ensure optimal battery performance.
- A two-way electricity meter (usually an extra meter operating in addition to the tariff meter for the site). In operating modes such as solar storage, the battery system needs to 'know' whether the local site is importing or exporting energy from the grid. It determines this through a two-way meter that communicates with the battery.

The most common combined battery and solar systems are DC coupled. The batteries and solar panel are connected on a DC bus, and the inverter/charger interfaces this to the electricity grid.

Another approach starting to appear involves AC coupled battery and solar systems. The batteries and solar have individual inverters and are linked at the AC bus of the property.

AC coupled battery systems are particularly well suited for retrofitting a battery to an existing solar PV system, as the battery can be added independently of the existing installation.

Adding a DC coupled battery to an existing installation often requires the inverter to be changed.

The available battery cell technologies (from lithium to lead-acid and even sodium-ion) have various advantages and disadvantages. We'll provide a detailed study of each technology in a future article, but for now it's sufficient to say that there's no single 'winner'.

When considering cost, operating temperature range, power rating, depth of discharge, safety and even recyclability, the technologies have different attributes. They are suited to different applications, and careful consideration is essential to get beyond the marketing hype of some manufacturers.

One important consideration regarding battery system technologies is how well integrated the components are. In some systems the battery module is a separate box from the inverter/charger and other components. This can allow flexibility in installation and component selection, but it requires greater installation space and effort.

The Tesla system is one example of such a system. What's interesting is that most Tesla marketing material doesn't show the critical inverter/charger and other components needed to make the battery work.

Other offerings involve a completely integrated 'energy storage system', in which the batteries, inverter charger and other components are in one box. Such systems have a simpler appearance and easier installation, but they can limit flexibility.

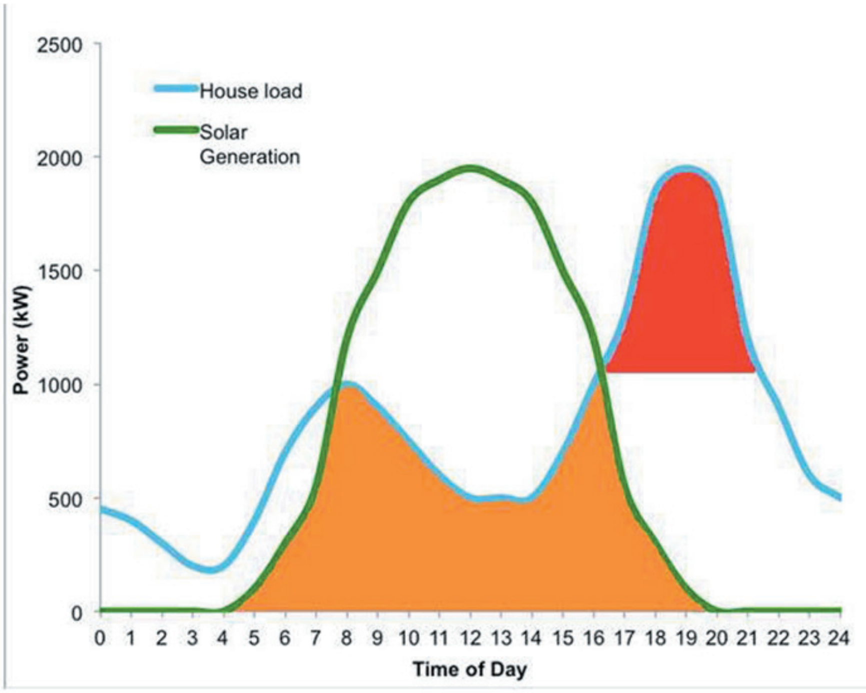


Figure 1. Power flows in a solar storing scenario. The blue line shows a typical residential household load profile, with the power generated by the solar system (green line) far exceeding the load in the middle of the day. Without a battery, this energy is essentially wasted for the householder. A battery changes this situation. With a battery, the excess energy (the area above the orange shading) is charged into the battery during the middle of the day. This stored energy (the red shaded area) is then used to run house loads during peak electricity prices, later in the day when household demand is greatest.

Challenges

There are still some important issues that need to be tackled.

Prices have come down, yet the systems remain expensive. Today, a typical battery and solar PV system costs about $17,000 installed.

Such systems are economic in certain deployments, but the number of households with the necessary electricity load and consumption patterns are relatively limited. Careful analysis and modelling should be carried out to decide whether a battery is economic for a given installation.

Experience with laptop fires, or even the lithium battery issues that caused Boeing's 787 aircraft to be grounded for long periods, suggests that great care must be taken to design safe and reliable battery systems.

Fire risk is actually relatively low if the system is designed and installed correctly – perhaps even less risky than storing a gas bottle or petrol tank in the house.

However, installation and operation Standards for battery systems, particularly technologies other than lead-acid, have not kept up with the pace of technological change.

We rely on the knowledge and experience of the installer to underpin the safety of many modern battery systems. Poorly implemented battery systems will represent a significant safety issue until the Standards catch up.

Considering the two most common uses for batteries – energy arbitrage and solar storage – the economic benefits depend heavily on the intelligence of the controller that manages battery charge and discharge.

For example, if a controller cycles a battery excessively, or operates it at too high a temperature, this will dramatically reduce battery life. An intelligent battery management system would adapt to the ambient temperature and aim to reduce battery cycling.

Even more advanced systems would adapt to local weather forecasts, ensuring the battery can reduce a property's dependence on expensive grid electricity (by charging late the night before) even if clouds reduce the availability of solar on a particular day.

Battery cells must be operated within tight temperature constraints if they are to realise their full life.

For example, most lithium batteries can be operated only up to 40°. Such temperature constraints pose a substantial limit on where a battery system can be installed and operated.

One key question as large battery systems become commonplace is what to do when the battery reaches the end of its life – typically after 10 years of operation.

Lead-acid batteries are relatively easy to recycle (the technology has been in car batteries for almost a century), but lithium-based batteries are much harder, with no large-scale recycling facilities in Australia.

However, for electrical and communications professionals the installation and maintenance of grid-connected battery systems in homes and businesses will become regular practice.

A future article will review the key technologies and some of the installation issues to be wary of.