From Source to Socket – Rapid Change Has Commenced

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Robert Whiteley, Business Solutions Manager, Brennan IT and AIB MBA Alumni.

Electrical utilities, in the form of generation, transmission or distribution have been largely unchanged in more than a hundred years. The type of fuel creating steam to turn a power generation turbine may have altered. However, the process of providing an operational outlet for consumers has been relatively constant. Until now.

Generation is changing, consumers' demands are becoming radically different and the interconnection from source to socket now has seen significantly shifting demands. This article touches on history and looks forward, investigating current challenges and taking a glimpse at the future.

One thing will remain unchanged: an expectation that whenever the switch is flicked on, power will be available.

Looking Back

Historically, power stations were located close to consumers. In Sydney for example there were power stations across the city, with Australia's first large scale facility in the central suburb of Ultimo.

Mid last century there was a realisation that significant industrial facilities in cities and suburbs were less than ideal. There was also the not-insignificant cost of moving fuel from the source to the power stations. The majority of power stations are now located adjacent to the fuel source. Coal-fired plants have the fuel transferred from the mine via a conveyor, directly to the power station. Electricity is then provided via high voltage transmission lines to the now remote consumers.

More recently there has been a demand for change. From consumers in the form of their consumption requirements to the highly reported social focus calling for a move away from fossil fuels. These elements, combined with a rapid decrease in the cost of photovoltaic, more commonly termed solar, has seen a rapid increase in rooftop systems especially in sunny countries such as Australia.

The evolution in consumers is also coming in the form of electric vehicles. Countries such as Norway, have provided incentives to adopt electric cars. Such policies have seen market share from electric vehicles exceed 50%, with Norway now on track to reach 100% of new car sales to be electric in less than five years.

While the push to electrify everything is potentially the perfect plan to eliminate fossil fuels and rein in climate change, it may not be the best for the power grid. The addition of renewables with inconsistent generation has the potential to cause grid instability.

As indicated earlier, generation traditionally has been achieved with steam spinning a turbine to drive a generator. Generators are huge machines which provide a stable, predictable output and have a fundamental response to load.

Power grids operate with small tolerances in frequency to remain in balance. The amount of electricity from generators must equal that demanded from consumers, otherwise, the grid has the potential to collapse, causing a blackout. When there is additional demand from consumers, additional supply is required to maintain frequency or conversely a reduction in demand requires a reduction in supply for the same reason.

The addition of large-scale renewable generation to the mix in Australia's National Energy Market is creating challenges for grid stability, especially with the rapid decline of fossil fuel generation.

Future Vision

There is an energy transition underway. Electrical utilities are under pressure to move away from fossil fuels both from economic and environmental demands, and at the same time accommodate the challenges of renewable generation.

Fortunately, operators are taking this opportunity for a holistic review of the grid. Operators are looking at both the grid design, and the components that are required for future reliability with a view to the smart grid. These smart girds bring bi-directional flow of electricity and communications between utilities and consumers to detect faults and proactively optimise resources.

Residential rooftop solar is a prime example where smart controls are required with consumers also acting as small-scale generators. Innovative initiatives such as virtual power plants will assist. VPP configurations are networks of decentralised, power generating units such as wind and solar farms, and combined-heat-and-power units, as well as flexible power consumers and storage systems. Benefits include the ability to deliver peak load electricity or load-following generation on short notice.

There will be an increasing requirement to educate consumers on their use of energy. With electric vehicles potentially adding up to a third to a household power bill, albeit with likely a greater reduction in other vehicle expenses, consumers will need to consider when and how charging is provided.

Operators and energy device manufacturers are proactively building resilient solutions. A beneficial example being air-conditioning systems that can be de-rated by grid operators during times of peak demand.

The grid itself is also under scrutiny. Some remote communities are connected by extremely long cable runs and there may be better solutions. Microgrids powered by solar allow grid operators to decommission the long cable runs and likely provide a less expensive, more reliable solution.

With an inevitable move toward renewable generation, there is a requirement for flexible, on-demand generation from dispatchable power sources such as gas, batteries or hydro.

Thankfully electrical utilities are adapting to the changes. They are working to ensure that whenever we flick the switch, power is available, even if the systems required are undergoing the greatest revolution in nearly 200 years.

Robert Whiteley

Brennan IT, Queensland Business Solutions Lead

Robert career has focused on customers achieving maximum business value from their technology investments. Many years' experience delivering technology services to electric utilities has provided insight into the industries evolving challenges, especially as the world moves toward renewable generation.