Delivering a grid that's **ready for net zero**

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As we transition to net zero, data—particularly around the low-voltage network—will become increasingly important. New demands on the network from the cars we drive, to the way we heat/cool or repower our homes will change the traditional power flows and role of the electricity network. In many countries, decarbonisation ambitions are now enshrined in law, and enabling a 'Green Recovery' is a feature in many governments' policies to 'build back better' in a post COVID-19 world.

In the 2022 ISP (draft) issued by Australian Energy Market Operator (AEMO), Step Change scenario (consumer led transformation) has been proposed as the central scenario leaving behind the slow/steady change scenarios. Australia is rapidly advancing towards the Progressive Change scenario (also known as Net Zero 2050) pursuing an economy-wide net zero emissions 2050 target progressively. Decentralisation and decarbonisation are progressing hand in hand in Australia, as evident from coal retiring two to three times faster than anticipated and extra-ordinary growth in the distributed PV capacity.

As a result, minimum operational demands forecast is rapidly declining to a critical point posing many challenges to the low-voltage networks. Peak demand in the national electricity market (NEM) is driven by the air-conditioning load in the summer, except for Tasmania. This will be exacerbated as EV uptake increases, and we reach a tipping point for domestic vehicle charging.

We know that to deliver decarbonisation, there will be a fundamental shift in the way the power flows through, in particular, the low voltage electricity networks.

Society can move faster than power networks

We are expecting, and indeed already seeing, big changes in the 2020s as citizens and businesses move towards alternative sources to fuel our cars and heat/cool our homes. A typical EV or reverse cycle air-conditioner draws the same amount of power as an electric kettle or a hair drier, but these are on for several hours, rather than a few minutes. Experiential data also shows that one EV takes about the same amount of power as one house in a year. That means to replace all cars with EVs (ignoring electrified heat), it's pretty much equivalent to having to have enough capacity for a doubling of the housing stock!

The low-voltage (LV) electricity network delivers power to every home, and many businesses, and is fast becoming one of the most important parts of the power grid.

It is huge. With more than 11 million electricity customer connections across Australia , the total stock of distribution transformers is assumed to be around 574,000 units, with a capacity of approximately 92,700MVA . Asset life of a typical power network is 45 years, with the design principles more like 60-plus years. This part of the network was traditionally installed on a 'fit-and-forget' basis, with the assumption that a customer of the future, looks similar to a customer at the time the network was installed... Possibly reasonable, and provided a nice efficient network, but when we realise that many of the cables powering our homes and business were installed in the middle of the 20th century (and a very different time), we can see the problem! LV network was efficiently designed at that point in time without any considerations of reverse power flows and without any monitoring, control and communication for the last mile transformer.

FIGURE 1: Autodesign—a connections software tool developed by EA Technology for Northern Powergrid (northernpowergrid.com/auto-design)

The LV network has finite capacity, and when this capacity is exceeded, the life expectancy falls off a cliff, increasing the chance of sustained long-term damage. Without intervention, we risk building a much bigger network, which may require extensive disruption and investment of a significant per cent of streets being dug up in the next 20 years!
In order to get the most out of the LV network two things are becoming more of a necessity:

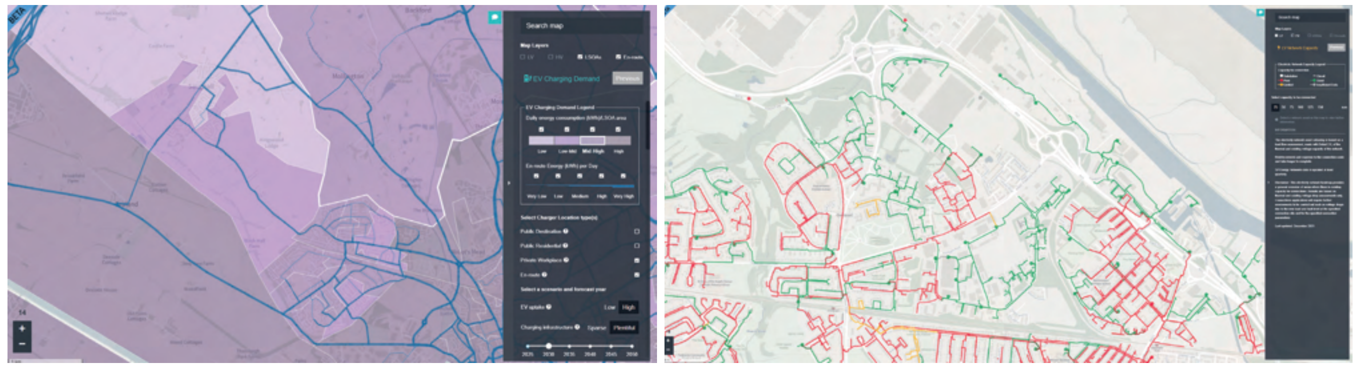
- Modelling to show where the capacity exists, and with increasing sharing of this data to the public, and
- Monitoring to look in detail at how the demand moves on a daily/weekly/monthly basis in order to allow the network to operate up to (but not beyond) its limit.

More on modelling

The importance of having modelling of the network right down to the LV level where individual customers are connected has never been greater. Starting from a low base, where many low-voltage networks are either not modelled, or modelled on a specific piecemeal basis, it is now becoming essential that this model cover the entire network to make it valuable for decision making.

Data quality can be a problem in some areas, but the key is to work with what is available and seek to improve it, rather than wait for data perfection some years down the line. There are various techniques that can be applied to interpolate and make engineering judgements where there are data gaps; which can then be checked and confirmed as data improves.

FIGURE 2: ConnectMore–a transport and network planning software tool developed by EA Technology for SP Energy Networks (spenergynetworks.co.uk/pages/connectmore_interactive_map.aspx)



Once the model is established, it can not only be used to ascertain where there might be network constraints today, but is a powerful tool in analysing scenarios based on changing customer profiles and new connections of customer-side technology (such as electric vehicles) into the future, providing an indication of future investment needs and where hotspots are likely to form.

Beyond these internal uses though, many network companies are beginning to share a version of this model with their customers via web portals. This allows customers to understand available capacity and to self-serve their connection requests for building a new property, or connecting a new chargepoint to the network, receiving a quote for this connection in a matter of minutes rather than by submitting an application to the network operator and waiting several weeks for the response. This not only improves customer satisfaction but also reduces the burden on the connections department within the utility.

Key to making this a success is presenting the complex engineering that lies in the background in a simple and intuitive format for users to understand and use. EA Technology has worked with several companies to realise this and examples can be found in the AutoDesign and ConnectMore applications, which are live on Northern Powergrid and SP Energy Networks' websites respectively.

More on monitoring

Monitoring solutions are becoming more widespread. By way of example, in Britain, there are approximately 560,000 medium voltage and low voltage substations. Ten years ago only a fraction of 1 per cent were monitored. We are expecting this to rise to approximately 4 per cent by the end 2022, and around 20 per cent by 2028 (the end of the next regulatory price control period). Most of the 100,0000 monitoring deployments planned are expected to be prioritised for substations feeding multiple customers in denser urban areas, (e.g. ground-mounted transformers), but all in support of the transition to net zero.

One such monitoring technology, now deployed at scale, is the VisNet Hub developed by EA Technology. With over 4,500 installed in British substations (from first installation in summer 2019), the solution measures voltage and current on every LV circuit giving insight about load, faults, and circuit heath information across the network. It measures three phases, plus neutral for up to six Low Voltage circuits, busbar voltage and equipment temperature, providing rich information on the performance of the LV feeders and the distribution transformer. The VisNet Hub utilises EA Technology's Low Voltage Common Application Platform (LV-CAP) operating system. This allows a network operator to deploy a single hardware unit per substation, incorporating a tailored suite of Apps, analogous to a smartphone, rather than having to deploy multiple devices in each substation with varying functionality and data protocols. The LV-CAP Platform:

- Allows insights to be mined from data locally and consolidated centrally
- Can be combined with a tailored suite of relevant software Apps, allowing operators to distribute intelligence across the network and optimise the data transfer volumes in this data rich environment
- Provides local intelligence to allow credible decisions to be made

This rounded solution gives network operators the opportunity to have full visibility and control of their LV network, at the most economic price point.

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FIGURE 3: Typical VisNet Hub installation in distribution substation to monitor transformer and feeder demand