Commercial Models for Regulating Network Voltage with Customer Inverters

Dr Scott Dwyer, University of Technology Sydney

Australia's interconnected power system is geographically one of the largest in the world with over 735,000km of electricity T&D infrastructure.

With over 1.84 million PV installations in Australia (over 7.8 GW), power quality issues can occur in less densely populated areas.

Power network companies in Australia are reporting problems regulating voltage on residential feeders with large amounts of connected solar PV.

Solar PV inverter control offers a solution to network issues arising from a largely unmanaged generation resource.

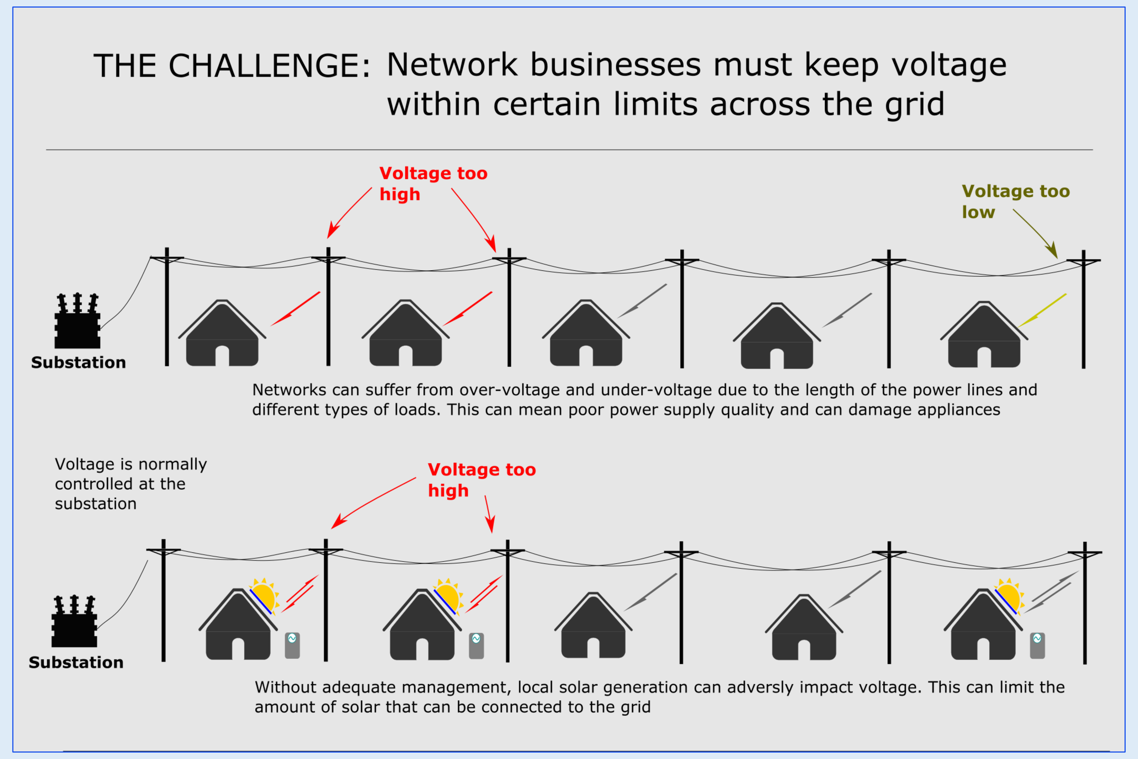
Two commercial-scale demonstrations are underway of controlled solar PV and energy storage in regional New South Wales and in North-East Victoria.

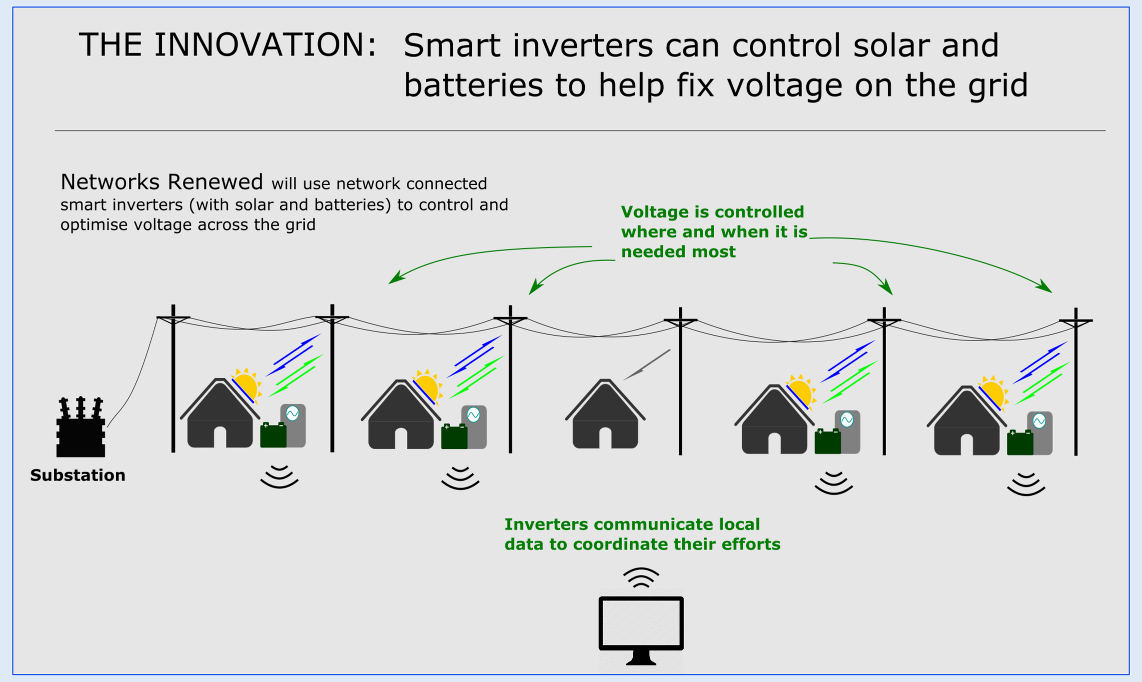
This paper describes the trial, the business model used, and the results to date.

The Challenge

The overall aim of the Networks Renewed project is to help increase the amount of renewable energy in Australia.

It will do this by paving the way for small-scale solar photovoltaic (PV) and battery storage installations to improve the quality and reliability of electricity on Australia's distribution networks – the poles and wires that are needed to deliver electricity to consumers.





NETWORKS RENEWED

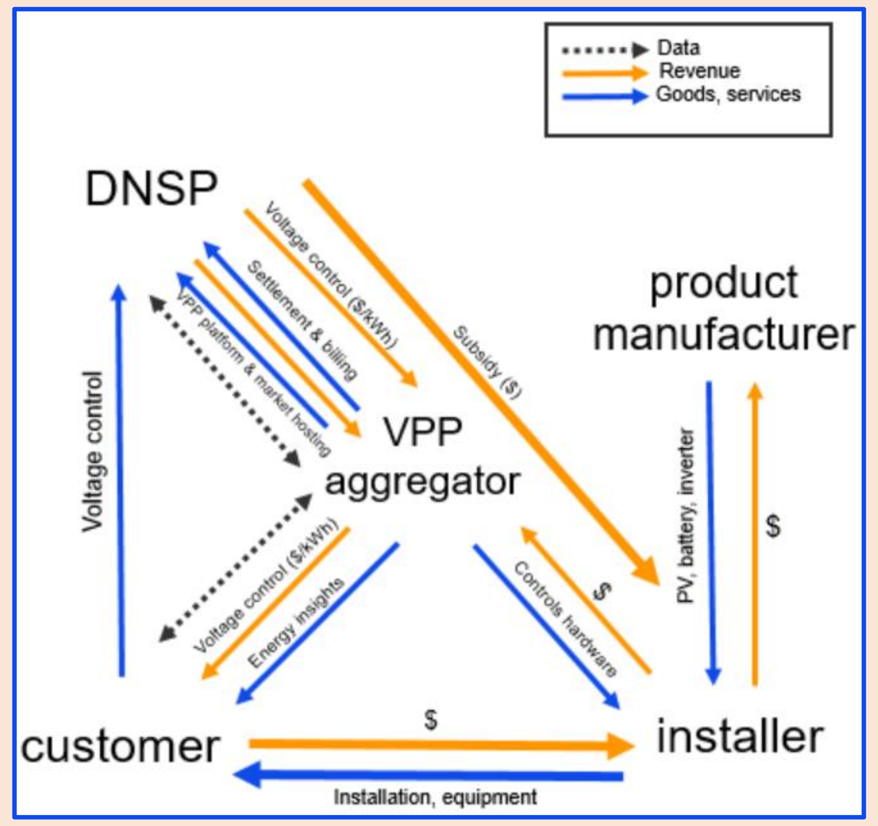
Networks Renewed is a 'smart' inverter demonstration project funded by the Australian Renewable Energy Agency (ARENA). Its aim is to understand the extent to which solar PV, battery storage and inverters can support distribution networks in managing power quality.

How it works

- Residential solar, batteries and other generators are connected to the grid through inverters that now have embedded IoT (Internet of things) communications technology.
- This two-way communication through the smart inverters allows the network to 'talk' to the local generator and request support services, through what's called reactive power, on top of regular active power.
- Reactive power can help raise and lower voltage on the network, improving the quality of our power including the voltage stability.

Function	Description
Connect/ disconnect	Physically connects or disconnects from the grid in an orderly way.
Adjust maximum generation level	Sets maximum generation which can be used to implement a curtailment order from the network or system operator.
Adjust power factor	Adjusts reactive power level to provide a given leading or lagging power factor.
Volt-VAR model	Adjusts reactive power level to an explicit level that may be a function of real power of voltage
Frequency ride-through	Sets frequency parameters governing the conditions under which connection should be maintained.
Voltage rid-through	Sets voltage parameters governing the conditions under which connection should be maintained.
Event/history logging	Provides logged data on request.
Status reporting	Provides status information on request.

Table 1: "Smart" inverter capabilities
Inverters required the following functions to participate in the trial.



The Commercial Model

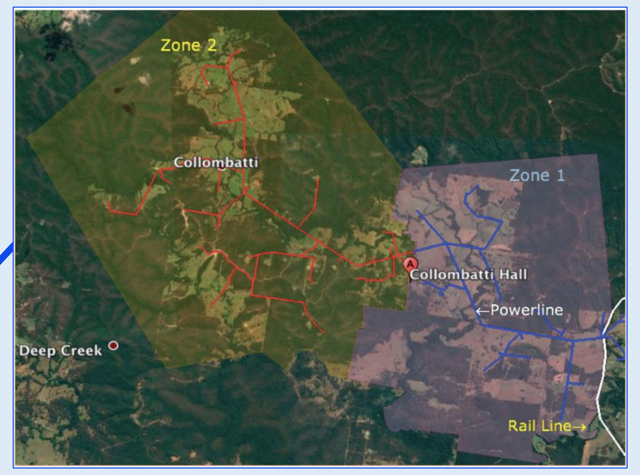
- Both the NSW and the Victoria projects deployed customer-owned commercial models, with financial incentives for customers to offer their systems for third-party control.
- Customers received payments for allowing their inverters to be controlled as part of a Virtual Power Plant (VPP). Remuneration was in the form of either a single annual payment, or as ongoing payments i.e. a payment per event.
- The VPP aggregators (Mondo Power or Reposit Power) worked closely with the local community and the local installers, as well as the DNSPs.

Figure 1: Customer-owned business model for behind-the-meter voltage control
Majority of excursions are over-voltages but under-voltages do occur.
DNSP = Distribution Network Service Provider, VPP = Virtual Power Plant, PV = Photovoltaic

The Pilots and Market-Scale Demonstration

The project partners have contributed to market-scale demonstrations in both New South Wales (NSW) and Victoria to investigate if smart inverter technologies are a viable commercial option for providing network support services.

The demonstrations has been designed to be large enough to achieve meaningful improvements to power quality and generate sufficient market revenues to develop a strong business case for future projects.



Map data © Essential Energy 2018.

Figure 3: Two commercial scale trials (shown is Collombatti, NSW)
Two commercial-scale demonstrations are underway of controlled PV and energy storage in regional NSW (Collombatti) and North-East Victoria (Yackandandah). The pilot-scale demonstration was completed in September 2017, and the market-scale demonstration runs to October 2018.

The Results

To date there is good preliminary evidence to indicate that controlling the inverters within the virtual power plant (VPP) leads to improved power quality.

- In the NSW trial, over 50kW of electricity was generated and local voltage was improved by 1.73%. The market-scale demonstration (currently underway) has a target of 5% improvement.
- A series of local voltage responses implemented in the pilot-scale Victoria demonstration showed an influence on network voltage compatible with the small number of inverters at each network location.

CONCLUSIONS SO FAR….

- The commercial model presented to customers proved popular, typically resulting in around 1-in-3 expression-of-interests (EOIs) leading to the joining of the VPP. Such high uptake is promising.
- The resultant voltage correction from the notch tests has also shown that behind-the-meter voltage control can be an effective tool for network service providers.
- However, before adopting this approach DNSPs need assurance that a sufficient number of customers can be enlisted to have a corrective influence on power quality. There are also challenges still with regards to the cost of residential batteries – future business models will need to address this.
- Work is continuing on the market scale demonstration and also on quantifying the cost differential between behind-the-meter voltage control and the more conventional network upgrade options.

Contact
scott.dwyer@uts.edu.au

Acknowledgements
Funding: ARENA
Project lead: UTS
Partners: Essential Energy, AusNet, Mondo Power, Reposit Power