

Case study: Developing smart solutions to stabilise grid voltage

Clean Energy Knowledge Sharing Initiative



Summary

Rooftop solar systems in NSW are being installed in record breaking numbers, which is excellent news for the environment and our wallets. Careful planning on how to integrate rooftop solar systems into the grid can maximise the benefit they can provide. However, too many installations in one region can impact grid stability in areas where grid voltage is already high. A high grid voltage can also cause household solar systems to shut down. This results in additional energy costs for the customer and lost revenue from the solar that can't be exported.

Australian energy management company Reposit Power is developing a technology that can allow solar systems to play a crucial role in maintaining grid stability. With support from the NSW Government, Reposit teamed up with network service operator Endeavour Energy to trial the ability of the Reposit control boxes to improve voltage by adjusting the power output of the inverter.

The project confirmed that the technology can both moderate grid voltage and protect the customer's revenue through reducing the instances of solar systems switching off. Further testing is underway to quantify the benefit to the network and the customer accurately.

Fast facts



Demonstration project cost

\$200,000
(\$30,000 from NSW Government)



Number of solar installations in NSW houses or businesses

470,000
(1 in 5 houses)



Potential shutdowns during a voltage disturbance

40% of solar systems

Background

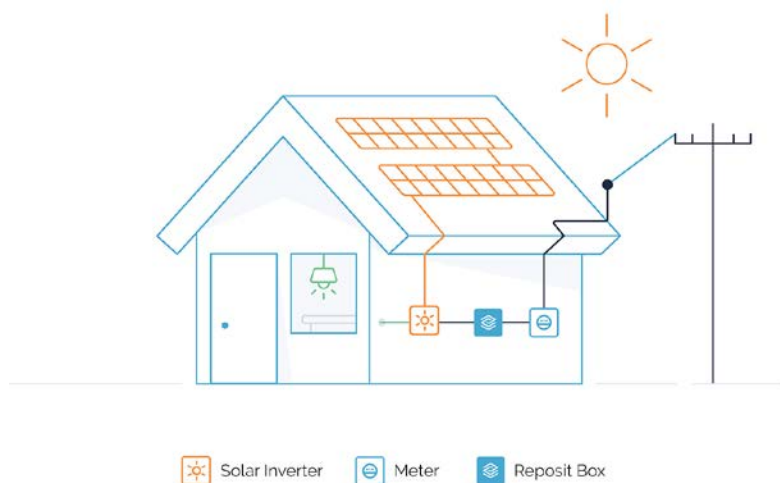
Reposit Power is an Australian company specialising in energy management for solar and battery systems. One of the new services Reposit is developing is voltage support from solar inverters to the grid. By optimising and controlling how energy is used, or when it is generated and exported, customers can get more out of their energy.

To be ready for changes in demand, networks sometimes set the grid voltage close to the upper limit. Every solar system that is exporting power to the grid will raise the voltage a bit. Many solar systems on a section of the grid can lead to voltage exceeding the allowed level. In such cases, solar inverters are forced to reduce output or shut down, which means that the house needs to import all its power from the grid, and they will lose the potential revenue from their exports.

The Reposit control box (Reposit box), together with an inverter, makes up a voltage management system that can directly control grid voltage. The Reposit box will receive signals from the grid operator to increase or decrease grid voltage, and in response, command the inverter to adjust its power output slightly - resulting in a rise or fall in grid voltage.

Grid operators usually require installers to set the inverter to meet specific voltage requirements. A Reposit box will replace the need for the reliance on the installer and make it easier for the grid operator to manage voltage.

This dynamic response to changes in grid voltage could reduce the number of times a solar system shuts down and improve the voltage stability in the local grid. If the grid operator can use this voltage management system instead of installing separate equipment, it would reduce energy costs for everyone, improve grid resilience and help more households access clean energy.



Journey

Assisted by the NSW Government's Clean Energy Knowledge Sharing Initiative, Reposit partnered with grid operator Endeavour Energy to test how grid voltage could be directly controlled by the operator with its Reposit box. The first step of the project involved integrating the Reposit box with two common solar inverters. This ensured that the inverters can change their power output in response to a signal from the grid operator.

An initial challenge for the project was finding customers on the Endeavour Energy grid to take part in the trial. As an incentive, Reposit offered a free Reposit box, inverter and installation, as well as a \$200 credit. Reposit

found that these strong incentives were needed because many customers were reluctant for a company to control their solar system and because many existing systems were not compatible. Soon they had found 25 households and set about installing the equipment.

Once the systems were installed, they were connected to an online platform. This online virtual network allowed Endeavour Energy to see the grid voltage at each site, see how much the solar systems were producing and to control the inverters' settings. When an overvoltage is detected in the grid, Endeavour

Energy can send signals to the Reposit boxes, requesting the inverters to lower voltage.

This process is designed to stabilise the overall grid voltage to safe levels, providing a useful tool for the grid operator to manage voltage issues.

Endeavour tested the voltage management system over four days to see how the inverters responded to control signals, and what the impact was on the grid. Some of the challenges experienced and the learnings are listed in the following table.

Challenges	Learnings
The trial was not large enough to provide detailed insight into the network's response	<ul style="list-style-type: none"> Consistency of results shows that the solution can be replicated on a larger scale Future trials to focus on increasing the density of Reposit boxes installations to produce more observable responses
Customers were reluctant to participate in the trial	<ul style="list-style-type: none"> Revised incentives structure to attract more participants – trials should test incentives early Going forward, emphasis needs to be placed on educating participants on the potential benefits of the trial, especially reducing instances of a solar system shutting down
Many potential participants had outdated inverters, incapable of responding to the voltage management unit	<ul style="list-style-type: none"> A compatible inverter was provided to the participants In the future, trial will focus on new solar installations where a compatible inverter can be used

“Getting solar inverters to respond to network voltage can help customers get more out of their solar system, and even get paid for supporting the grid.”

Saad Akbar, Project Manager, Reposit Power

Outcomes

The trial found that Reposit boxes can directly impact grid voltage by changing the power output of the inverter.

By changing the inverter settings through the Reposit box, it directly resulted in grid voltage changes of around 2 volts. This change is significant when viewed in the context of a recent AEMO study, which found that a voltage disturbance event of approximately 4 volts can cause 40% of rooftop solar systems to shut down¹.

While the trial only demonstrated voltage impacts at a small scale, the consistency of results indicated that this solution could become an important voltage management tool for networks. The technology could also reduce solar system shutdowns and help customers get more benefit from their solar systems.

An additional finding from this trial was that underground cable networks experienced less voltage change while controlled by Reposit boxes, compared to overhead cable networks.

¹ AEMO. Technical Integration of Distributed Energy Resources. April 2019
Available at www.aemo.com.au/-/media/Files/Electricity/NEM/DER/2019/Technical-Integration/Technical-Integration-of-DER-Report.pdf

This suggests that grid operators need to consider the local grid's design when responding to a voltage issue. Solutions will need to be tailored depending on the location of the boxes, the site of the control point, and whether the network contains underground or overhead cables.

“The Reposit system responded as we had hoped, demonstrating that voltage can be actively controlled to support the safe and reliable operation of the local grid.”

Endeavour Energy

Takeaway points

- Voltage management through dynamic control of inverters can help stabilise grid voltage and reduce solar system shutdowns.
- Each inverter can only contribute a small amount so to have a significant effect on local grid voltage, this technology would need to be adopted by most solar systems.
- For customers to adopt this technology, its value to customers and to the network needs to be better understood and clearly communicated.

Next steps

The initial results were encouraging and showed that the voltage management system can support grid stability. Endeavour will continue testing the voltage management into 2020, exploring the system's performance under different seasonal and energy demand conditions.

During this time, more customers may be recruited into the trial to increase the voltage impact on the local grid. This would allow Endeavour to estimate how many installations are needed across the network to deal with existing and potential future voltage issues.

The next stage of testing will also confirm the effectiveness of the 'set and forget' feature of the Reposit box. Once set, inverters could automatically respond to changing network voltage levels. These settings could be changed remotely, avoiding the need for additional visits from solar installers.

If voltage management systems are widely adopted, this could present an important tool for the grid operator to manage grid voltage fluctuations and allow more solar to be installed without the need for network upgrades.

About the Initiative

The NSW Clean Energy Knowledge Sharing Initiative supports the NSW Government's objective to achieve net zero emissions in the state by 2050. The Initiative gives innovators and early adopters an opportunity to test and trial new clean energy solutions. To find out more or learn about similar projects, visit energy.nsw.gov.au/clean-energy-initiative.

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Images courtesy of Reposit Power