Lessons Learned Report 4

PROJECT SHIELD

Project SHIELD

Synchronising Heterogenous Information to Evaluate Limits for DNSPs

DECEMBER 2022

Contents

Acknowledgements..3

Disclaimer..3

Executive Summary..4

Context and Background..5

Lesson #1 - Age and differences in transformer design impact the viability of retrofitting monitoring..7

Lesson #2 - Engagements with multiple retailers and/or meter providers and/or metering data providers are required to access off-market smart meter data of sufficient density or at targeted network locations..9

Lesson #3 - Standing Data (Network design data) of sufficient detail and quality for state estimation was not always readily available for direct use without some data cleansing...11

Lesson #4 - Significant market movement and technology advancements have decreased the cost to deploy and procure data compared to what was originally provisioned..........13

Lesson #5 - Uneven distribution of monitoring devices limits complete network visibility .14

Lesson #6 - It is essential to keep redundant device measurements due to missing data points and measurement timestamps not always being aligned, which leads to the exclusion of some devices when creating scenarios..16

Acknowledgements

The project 'Synchronising Heterogenous Information to Evaluate Limitations of DNSPs' (Project SHIELD) is a collaboration led by Luceo Energy (Redback Operations trading as Luceo Energy) and Energex, Ergon Energy, GridQube, The University of Queensland and Essential Energy.

The Australian Government supports Project SHIELD, through the Australian Renewable Energy Agency (ARENA) with $2.6 million in funding over the 2-year project period.

The total project value of Project SHIELD is $5.7 million, consisting of cash and in-kind contributions from ARENA and the consortium partners.

Disclaimer

This project received funding from ARENA as part of ARENA's Advancing Renewables Program.

Executive Summary

The Lessons Learned Report No 4 is part of Milestone 4 and begins Stage 2 of Project SHIELD (Milestones 4-6). The Lessons Learned that are presented in this report summarise at a high level the key learnings made by the project team during Milestone 4.

In summary,

- Age and difference in transformer design affects the viability of monitoring
- Engagement with multiple retailers and meter providers/metering data providers is imperative for access to sufficient smart meter data
- Standing Data (design data) of sufficient detail and quality for state estimation was not always readily available
- Costs to deploy and procure data have dropped significantly compared to what was budgeted at the beginning of the project
- Uneven distribution of existing monitoring devices limits visibility accuracy
- Where a location has multiple data measurement devices, redundant device measurements should be kept

Context and Background

By the end of 2021 more than 3 million Australian households had installed a small-scale, behind-the- meter PV system at their properties. The cumulative capacity of these systems worth around 16GW, now represent the largest generator in the Australian energy system. Australia is the world leader in rooftop solar capacity per person.

Industry analysts forecast that between 2022 and 2030 an additional 2.5GW per annum will be added in this sector.

While the rooftop PV boom is positive for Australia's carbon emission reduction targets, employment in the sector and consumers, the fast and continued growth of rooftop solar PV generation creates a number of challenges for Australia's distribution network operators.

Project SHIELD has picked one of these challenges, rooftop PV hosting capacity on LV network feeders, and looks at how a data-driven, analytical approach can unlock additional PV hosting capacity on LV network feeders without investment by networks in augmentation. True to this investment conscious philosophy, Project SHIELD, in the first stage of the project, that concludes with Milestone 3, is looking to use existing data sources on LV network feeders to run the respective analytics.

The anticipated outcome for Project SHIELD is to develop a robust and reliable model that will allow Distributed Network Service Providers like Energex, Ergon and Essential Energy, to assess the cost- benefit of various data acquisition strategies to support a transition from general, static PV hosting capacity limits to a unique, feeder-individual PV hosting capacity limit. Project SHIELD will aim to reasonably quantify the benefits to network operators and consumers that result from a data-driven approach. The resulting documentation should allow Australia's distribution network service providers to argue their proposed investment in digital assets towards the Australian Energy Regulator as part of their regulatory investment submissions.

Opening up additional PV hosting capacity on network feeders without significant investment for network augmentation will yield tangible benefits to consumers, communities and support Australia's minimum required feeder instrumentation to make such a robust and reliable determination in order to minimise cost to consumers and allowing for the safe maximum penetration of consumer owned rooftop PV with export capabilities.

Since the data collected in Stage 1 of Project SHIELD was insufficient to determine a definitive outcome, the project team, in Stage 2, will move to source and install additional network devices that collect data in real-time at the node level in these feeders. Following installation, the project will test at what degree of data density and fidelity a robust and reliable result can be derived through the analytics process.

Lesson #1

Age and differences in transformer design impact the viability of retrofitting monitoring

Expectation

It was expected that across the distribution transformer fleet that is deployed in field, there would be capability to deploy monitoring using a consistent approach via either temporarily installing standard power quality loggers to supplement data collection or by installing a comms enabled permanent monitoring solution.

Experience

- Age and accessibility of the infrastructure provided hurdles in the following ways:
- The transformer cables on existing pad-mounted transformers were not always accessible to field crews. The lack of access prevented the installation of temporary power quality loggers at such locations limiting data collection to suitable pad-mounted sites only.
- Across the Port Macquarie feeder, which has 20 distribution substations active, the range of age, type, and design, has led to challenges or non-viability to install of monitors as a retro fit service
- Most of the modern transformer fleet in Port Macquarie comes prebuilt with either the provision to connect-in or an already connected meter that can have data read remotely. However, a significant portion, in particular aged ground mounted transformers, have challenges around space to undertake work safely, or at all, and challenges in providing communications to and from the device.
- Pole mounted transformers are the simplest in consideration for safety standards due to being able to facilitate a broader range of external solutions safely.

Lesson Learned

Existing distribution transformers are not always compatible with the installation of temporary or permanent logging solutions due to physical design, layout and access limitations.

What We Would Do Differently

Assess the suitability of sites for temporary or permanent monitoring solutions early in the project to identify potential risks to additional data capture.

Lesson #2

Engagements with multiple retailers and/or meter providers and/or metering data providers are required to access off-market smart meter data of sufficient density or at targeted network locations

Expectation

It was expected that the network would be able to acquire off-market data, sometimes referred to as engineering data or power quality data, from smart meters in the trial locations to provide a high density of monitoring to inform the grid visibility analyses undertaken.

Experience

Although smart meters have progressively been installed in Queensland for several years, the density of smart meter penetrations in the trial networks was not comprehensive. Moreover, the Power of Choice reforms created to stimulate competition in metering have also created a situation where any number of accredited and registered Metering Providers and Metering Data Providers may manage the smart meters in any given area.

A network would thus be required to engage with multiple parties, to gather data from all available smart meters in a specific network area. This is a time-consuming process involving individual negotiations with varying degrees of success.

The lack of requirements for the collection of off-market data from smart meters also means that further negotiations may be needed to align data collection from meters managed by different parties to ensure the data is valuable for the network.

Lesson Learned

Distribution Network Service Provider access to smart meter data is made challenging by the multiple parties that must be engaged and commercial arrangements established in order to acquire dense data coverage on individual low voltage networks.

What We Would Do Differently

There is nothing that the project could have done differently in this instance.

It is hoped that the current AEMC review of the regulatory framework for metering services reduces the cost and complexity for networks wishing to access off-market datasets from smart meters where the data to improve their service for customers.

Lesson #3

Standing Data (Network design data) of sufficient detail and quality for state estimation was not always readily available for direct use without some data cleansing

Expectation

It was expected that networks possess detailed and accurate datasets pertaining to the connectivity and assets on the network, including at low voltage. It was expected that this data could be readily extracted for use with the distribution system state estimation engine.

Experience

Although networks do possess extensive geospatial network and asset records the project encountered some limitations:

- Connectivity design and specification (in detail) within low voltage networks has not always been recorded, meaning there are areas where the specific connection point of a customer to the network is not known.
- Records of the types of conductors comprising low voltage networks were not consistently available or considered accurate.
- Customer supply phase/phases records are not comprehensively recorded or maintained.
- We do not have the data to algorithmically infer connection point location or phase.
- Relevant network datasets were held within multiple systems making extraction and cross-matching of records complex at times.
- Different distribution networks capture and maintain different records and use different systems meaning a tailored approach is required for each.

Lesson Learned

Distribution networks largely possess the network information required to establish some level of state estimation; however, data cleansing and consolidation must form part of this process. The process of collating and refining the data is challenging.

What We Would Do Differently

There is nothing that the project could have done differently in this instance.

Networks recognise that improvements in data quality are required, particularly at low voltage, and this is an area targeted for future investment. Unfortunately, due to the timeline of this project it was unable to benefit from the work being undertaken in this space.

Prioritising quality data capture and maintenance will make it easier for networks to benefit from the adoption of intelligent and automated data-intensive technologies.

Lesson #4

Significant market movement and technology advancements have decreased the cost to deploy and procure data compared to what was originally provisioned

Expectation

As reflected within the SHIELD budget, there was some expectation during the planning phase of the project that the costs to procure market data were going to be much higher than has been proven by today's rates.

Experience

- The markets around procuring customer level data have matured rapidly over the 3 years, with per customer costs being <$10 for a years' worth of 5 minute off-market data being capable of being delivered.
- When looking at feeders like Port Macquarie, the cost across a month for all available smart meter data comes <$1000, greatly reduced from the expected spend which looked for $40k+.
- Likewise for transformer and network monitoring advancements, bringing metering to a fraction of the cost originally thought at project initiation – even with covering all transformers that can be safely monitored.

Lesson #5

Uneven distribution of monitoring devices limits complete network visibility

Expectation

At the beginning of the project, the focus was to obtain measurement data from pre-existing monitoring devices as part of increased network visibility. The aim was to increase the number of monitoring devices for the purpose of the project. Then, it was expected to investigate how network estimated visibility change from actual device measurements for different measurement scenarios across the network feeder. This led to the outcome of minimum percentages of devices measurements required per network feeder visibility. Afterward, the findings were planned to include in the project' Simulator Tool. We therefore expected to investigate the quality of estimated network visibility across one network feeder and then repeat the process for other feeders.

Experience

- Network visibility estimated from a set of device measurements is required to investigate from actual device measurements, allowing us to study how maximum visibility can be achieved from a limited set of device measurements.
- Estimation quality is investigated from estimation error by subtracting nodal estimation results from the actual measurements obtained from monitoring devices across a network feeder. Given a set of measurements input, the estimator provides the most approximated estimation of entire network states.
- Most monitoring devices are accumulated in certain areas of a network and therefore many parts of the network remain undiscoverable due to the lack of actual device measurements.
- A comparison is only possible if the estimation and actual measurements exist.
- This limits the calculation of the estimation errors as part of computing estimation quality. No comparison can be concluded due to this limitation, resulting in limited scope of obtaining Simulator data. To sum up, DNSPs are advised to consider device locations with priority for network visibility through state estimation.

Lessons Learned

- Uneven distribution of monitoring devices limits complete network visibility. In practice, monitoring devices are generally installed without considering even distribution across network feeders.
- As a first consideration when installing monitoring devices, increasing the number usually comes first.

What We Would Do Differently

1. Collect more device measurements at other undiscovered areas.
2. Choose devices evenly distributed across a network feeder for a fixed number of devices.
3. Prioritize measurement devices' locations ensuring all areas of a feeder have least measurements.

Lesson #6

It is essential to keep redundant device measurements due to missing data points and measurement timestamps not always being aligned, which leads to the exclusion of some devices when creating scenarios

Expectation

It was expected the measurement data received from the available devices would have no data issues for the selected time durations. The detailed analyses include scenario creations which are obtained by increasing/decreasing the number of devices gradually considered in the investigation. As part of the process, obtaining a reference case is key to the planned strategies so that investigation can easily be conducted by comparing against a reference case.

Experience

- Despite having these data, roadblocks exist with creating the reference case for detailed analyses and obtaining data for the Simulator. One of the identified reasons is the missing datapoints from some devices which makes them unsuitable for the reference case.
- In addition, aligning measurement data for different devices by their timestamps is difficult, hindering the analysis process significantly as it takes considerable extra time. Moreover, despite having data from most of the devices, the data can't be used due to different timestamps.
- Consequently, some devices are not considered as part of the reference case and therefore needed to be excluded in the analyses. If a device has data missing for some duration or at different timestamps than other data, inclusion of the device in the analysis changes the measurement scenario resulting in unfair investigation.
- To avoid such a situation, devices with inconsistencies are excluded from the list.

Lessons Learned

- Due to missing data points, redundant device measurements for the same locations are essential for scenario analysis. The installation of redundant monitoring devices is not usually done for the same location with regard to missing data points.
- The alignment of measurement timestamps of different monitoring devices is not usually considered most often when collecting measurement data.

What We Would Do Differently

1. Keep the same location measurements from redundant devices since data issues can be resolved from additional devices.
2. Ensure device measurements data available for selected timestamps.