ARENA Advancing Renewables Project

2020/ARP016

Synchronising Heterogenous Information to Evaluate Limits for DNSP's (Project SHIELD)

Lessons Learnt Report 2

July 2021

PROJECT SHIELD

Table of Contents

Acknowledgement

The “Synchronising Heterogenous Information to Evaluate Limitations of DNSP’s” (Project SHIELD) is a collaboration between Luceo Energy, Energex, Ergon Energy, GridQube, Essential Energy.

The Australian Government, through the Australian Renewable Energy Agency (ARENA), is providing $2.6 million in funding for the two-year project.

Disclaimer

This Project received funding from ARENA as part of ARENAs Advancing Renewables Program.

Executive Summary

This is the second Lessons Learnt Report for the ARENA funded Project SHIELD (Synchronising Heterogenous Information to Evaluate Limits for DNSP's) and is to be submitted under Milestone 2.

The report will cover activities and work taken place subsequent to Milestone 1, namely recruitment, knowledge sharing requirements, data sourcing and analysis, communication and transparency. Additional lessons learned through Project SHIELD will be captured throughout the life cycle of the project and are expected to cover a range of topics from commercial, technology, community engagement and policy learnings.

It is intended for those undertaking a similar project and audiences including industry and distribution network providers.

Project Overview

Project SHIELD (Synchronising Heterogeneous Information (to) Evaluate Limits (for) DNSP's) is an ARENA (Australian Renewable Energy Agency) funded project, attempting to tackle one of the biggest obstacles on the road towards more Distributed Energy Resources (DER), especially rooftop solar. Australia now has in excess of 2.5 million households with Solar PV (DER) installed and in a world shifting to renewable energy and alternative energy sources at a rapid pace, the expectation is that many more households with have solar in the coming years. The Project seeks to address a question which relates to a households ability to continue to export the energy generated by solar and the networks ability to continue to provide electricity to the grid - what level of measurement data is required to allow for an accurate assessment of how much DER can be connected safely without additional network investment?

Luceo Energy leads a consortium of five companies within the Project, including Ergon Energy, Energex, Essential Energy and GridQube. By utilising an array of current data sources, coupled with Luceo Energy's 'Luceo Platform' and GridQube's 'State Estimation Software System,' a safe and reliable determination of networks available hosting capacity can be made.

In this way, Distributed Network Providers (DNSPs) like consortium members Energex, Ergon Energy and Essential Energy, have the opportunity to move from static, conservative limitations to a more accurate determination of those limitations, based on data. This has the ability to allow network operators to not only better manage the flow of DER, but to also better plan or defer network investment or upgrades, to the benefit of customers.

Key Lessons

This is the second lessons learnt report for Project SHIELD. The learnings in this report covers the activities since Milestone 1 in April 2021 including, knowledge sharing requirements, data sourcing and analysis, communication and transparency.

The key lessons discussed are as follow:

- **Lesson #1: Establish a list of relevant data feeders/sources and companies to be contacted early in the project and invited to share data to the project and utilise present relationships between members of the Project Advisory Group and data sources.**

    - Establish three to five companies/feeders/sources which members of the project advisory are confident of having relevant and usable data to minimise unnecessary stakeholder engagement and wasted time.
    - With the combination of data privacy and cyber security being prevalent across society and industry, it was found to be best practice to utilise members of the Project Advisory Group with established relationships as first points of contact.
    - A number of sources will be unable to deliver the data relevant to the project.

- **Lesson #2: Remain flexible with budgets that have been written for aspects of the project prior to announcement and funding.**

    - The time between the approval of a project and the funding and announcement of Project SHIELD was a tumultuous period, with the global COVID-19 pandemic forcing hundreds of thousands to work from home and pushing businesses online.
    - As a result, the cost of things like website and logo creation increased.
    - Stay flexible, accept that budgets will change and stay in contact with ARENA on possible changes.

- **Lesson #3: Create industry presence and public knowledge of Project SHIELD through social media platforms and media distribution.**

    - Linkedin and Twitter are industry mainstays and responsible for the wide-scale distribution of information and news.

- Create social pages for Project SHIELD, follow industry bodies and stakeholders, share news relevant to the project and its findings.

- **Lesson #4: Maintain stakeholder engagement and buy-in for the project through consistent engagement and industry buy-in.**

  - Keep project parties engaged and invested in the project and its results through ongoing and consistent stakeholder engagement.
  - It's essential for the creation of content, website and logo development, consultation and decision making moving forward.

- **Lesson #5: Prepare for difficulties when attempting to access and gain measurable and statistical data for GridQube's State Estimation Tool**

  - Issues when accessing measurable and statistical data forced the project to adopt new methods.

- **Lesson #6: Be flexible in your approach to data, especially when relevant to network connectivity, as available data and its quality might not initially allow for the creation of a detailed model**

  - The more and better the statistical information, the higher the accuracy of the estimate of a networks operational state, while functionality can be achieved on relatively coarse data.

- **Lesson #7: Due to issues with the availability and accessibility of complete data sets for integration with the Luceo Platform, the Project is adapting in order to access data from alternate sources**

  - Consider the issues associated with data privacy, the legal implications in relation to the sharing of data and the implication that unavailable and incomplete data sets may have on the Project.

The following sections provide details surrounding each lesson.

Lesson #1: Establish a list of relevant data feeders/sources and companies to be contacted early in the project and invited to share data to the project and utilise present relationships between members of the Project Advisory Group and data sources.

Knowledge Category: Data and Privacy

Knowledge Type: Data Sourcing

Technology Type: Software/data

State/Territory: National

Key Learning

Data is the key component of Project SHIELD's success over the course of the two-year project – essential to answering the question posed for DNSP's. From the outset, more than a dozen companies, providers and data sources were listed to be contacted by Project SHIELD. It is an opportunity to reach out and secure new and relevant data sources but with the number of prospective data sharers, it was decided that it would take some time and ultimately would be less beneficial.

Further to this was the issue of data sharing, cyber security, and user/consumer privacy. Discussions held by the Project SHIELD Working Group identified potential problems when essentially cold-contacting data sharers and asking for their particicaption in the project and future ongoing co-operation.

Process Undertaken by Project SHIELD

A list which included several irrelevant data sharers and companies was heavily compressed after clear deliberation from the Project SHIELD Working Group. It was decided that as opposed to targeting numerous parties for data sharing was inefficient and problematic and as a result, a goal was set to contact three to five relevant parties.

This was based off timeliness and efficiency but also due to the fact that it would be more beneficial to contact parties that members of the Project SHIELD Working Group had prior relationships with. For a new project, headed by a number of companies (Luceo Energy, Ergon

Energy, Energex, GridQube and Essential Energy) it was deemed more appropriate to contact those most parties likely to participate in Project SHIELD and be prepared to share data.

Considerations for future projects

In this time of rapid change, industry movement and heightened security, it is important for projects of a similar nature to be aware of potential limitations associated with contacting third parties and the time required to do so. It is also important to note that utilising relationships when sourcing information and data for third parties is preferable to cold contacting individuals who may struggle to understand the project and what it's trying to achieve.

Key takeaways from this lesson, which may be applicable to future projects, are:

- Establish companies/third parties that the project will attempt to contact early in order to establish those that are irrelevant or potentially problematic.
- Utilise relationships and avoid cold contacting.
- Work collaboratively with members of the project and relevant stakeholders.

Lesson #2: Remain flexible when dealing with budgets that have been written for aspects of the project prior to announcement and funding.

Knowledge Category: Finance

Knowledge Type: Project Development

Technology Type: Not Applicable

State/Territory: Not Applicable

Key Learning

Budget preparation is an essential component in the process of successfully receiving funding from ARENA. As a result, budgets are often set several months prior to the announcement of the project. With a changing business and industry landscape following the events of the last two years and the impact of the global COVID-19 Pandemic, previously created budgets that may have been accurate now require revision and flexibility moving forward.

During the completion of Knowledge Sharing associated with Project SHIELD, including the creation of a dedicated website and new project logo, it was discovered that initial monetary amounts set out in the budget were insufficient and could potentially put further pressure on the budget moving through Project SHIELD.

Process Undertaken by Project SHIELD

It was clear that funds set aside originally within the Project SHIELD budget for the website and logo creation was substantially less than was required. After engaging creative agencies and receiving several quotes, the project came to the conclusion that due to the fact that the website and logo was an essential part of the Milestone process and knowledge sharing deliverables, that we pursue the creation of these deliverables (*Appendix 1).*

Having made this decision, the project has now begun preparing and planning for the next 18 months of Project SHIELD. Laying out potential costs and ensuring that funds will be adequate.

In the event that they are not, initial discussions with ARENA regarding possible alterations to the Project SHIELD budget have revealed that additional funds may be available at a later stage in the project if required.

Considerations for future projects

It is important for projects of a similar nature to be aware of the changing landscape of the renewable energy industry, businesses and the general community. It is clear that the global COVID-19 Pandemic has had a serious impact on business models and practices, forcing more and more companies online – this seems to have had an impact on digital website and logo creation. As everything has progressively moved online, forcing the cost of deliverables higher, earlier quotes that Project SHIELD based budgets on, became irrelevant.

It is important to remain flexible and accept that things will change not only prior to the project commencing and even throughout the life of the project.

Lesson #3: Create industry presence and public knowledge of Project SHIELD through social media platforms and media distribution.

Knowledge Category: Media/Social Media

Knowledge Type: Project Development

Technology Type: Not Applicable

State/Territory: National

Key Learning

Essential to Project SHIELD's success is visibility in the public space and some industry and public knowledge and understanding of what the project is investigating and trying to achieve.

It's also important to seize on any opportunity to create and disseminate content relating to Project SHIELD. Linkedin and Twitter are the two most prominent social media sites when referencing businesses and projects and the creation of dedicated accounts is easy and effective. The ability to share, communicate and create conversations with stakeholders, consumers and other industry bodies in real time and at a moments notice is essential to the projects success and reach.

Process Undertaken by Project SHIELD

As Project SHEILD emerges from its infancy, additional media coverage, news, milestones and achievements will be realised and made public on the Project SHIELD Linkedin and Twitter accounts (Linkedin, Twitter).

These accounts were created early in the projects lifespan and will act as destinations to share news and create conversations. Already, a written article, covering the launch of Project SHIELD, has emerged in industry media publications. This poses an opportunity to share and develop industry knowledge for Project SHIELD and the article was immediately shared to the project's social media accounts, garnering outside interest and driving people to learn more. As time goes on, more and more information will become available to share and it's important to continue to update these pages regularly.

It was also decided that instead of waiting for industry and stakeholders to find the project's social media pages, it would be more beneficial and faster to create a social community for Project SHIELD. This was done by actively following industry bodies and engaging in conversations centred around what the project is trying to address.

Considerations for future projects

It is important for projects of a similar nature to be aware of the positive impacts' social media accounts like Linkedin and Twitter can have on a project. Whether it be to share information at the click of a button or develop conversations with industry stakeholders, these are goldmines for engagement and feedback.

It's also important to note that complacency is this space is not beneficial. In the beginning, when content may be at a premium and the project is working up to speed, reach out to industry, join conversations and create a community for your project.

Lesson #4: Maintain stakeholder engagement and buy-in for the project through consistent engagement and industry buy-in.

Knowledge Category: Stakeholder Engagement

Knowledge Type: Project Development

Technology Type: Not Applicable

State/Territory: National

Key Learning

The question that Project SHIELD will attempt to answer impacts several very different stakeholders – the renewable energy industry, Distribution Network Service Providers (DNSP's) and consumers. Thus, the impact of extensive and informative stakeholder engagement and communications is key to a successful delivery of the projects results and key to creating buy-in from the various project partners.

Creation of specific and relevant working and reference groups (*Project SHIELD Steering Committee, Project SHIELD Working Group, Stakeholder Management Group*) provided an essential mechanism for consultation from the outset.

Process Undertaken by Project SHIELD

Project SHIELD has clear and defined stakeholders, a number of which are partners on the project, however, it was identified that there was a potential large-scale impact of the project for DNSP's and industry nationwide. As a result, three working groups were established to steer the project over the course of the next two years. Representatives from the Australian Energy Market Operator, United Energy and City Power were invited to participate as part of the Project SHIELD Steering Committee, which meets every quarter. Also, part of the working group are representatives from Luceo Energy, Ergon and Energex Australia, Essential Energy and GridQube – consortium members of Project SHIELD.

The Project SHIELD Working Group meets every fortnight via Microsoft Teams, discussing emerging issues, topics and developments from the project, consulting on next steps and

presenting deliverables as part of upcoming milestones for the project. Engagement and debate is at a high level throughout these meetings, which have guided the project on:

- Data sourcing
- Website and logo development
- Media and stakeholder engagement

The Stakeholder Engagement group meets immediately following the Steering Committee Meeting and will discuss actions and decisions to come from the SteerCo.

Through the dissemination of project documents and through the use of these working groups, Project SHIELD has established a strong framework for stakeholder engagement throughout the life of the project.

Considerations for future projects

It is important for projects of a similar nature to be aware that engagement with industry and ongoing conversations with project partners is critical to the success and of the project. This project engaged with key industry stakeholders and project partners to:

- Create project working groups with key stakeholders and project partners.
- Collaborate with wider industry bodies.
- Make key decisions pertinent to the project.

Given the current nature of business, in a world changed by the global COVID-19 Pandemic, it will be important for future projects to consider the importance of virtual knowledge sharing, meeting and presentations. At present, Microsoft Teams provides a platform that allows for documents to be shared in a central location, with the ability to meet, instant message and collaborate.

Lesson #5: Difficulties arose when attempting to access and gain measurable and statistical data for GridQube's State Estimation Tool

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Knowledge Category: Data and Software

Knowledge Type: Data Aggregation

Technology Type: State Estimation Tool

State/Territory: National

Key Learning

The network analysis system used in Project SHIELD is a model-based approach. It combines a mathematical representation of the electrical inter-dependencies of the analysed part of the network with available measurement data, measurement-complementing statistical information and measurement meta data to estimate the most likely operational state of the analysed part of the network. All higher-level analyses, including but not limited to capacity assessments, are based on this estimation functionality.

For most of the individual pieces of data that are required to generate there are alternative sources, and many can be substituted with reasonable assumptions. But in general terms, the more of these pieces of data are based on known specifics of the individual elements, and therefore don't have to be replaced by assumptions, the more precise the electrical inter-dependencies can be modelled and the lower the overall uncertainty in the results. Or said differently, functionality can be achieved on relatively sparse data, but more and better quality data improves accuracy and drives down uncertainty.

One of the most important pieces of data is network connectivity. Network connectivity includes the list of physical assets plus information in which way they are electrically connected at the time. Deficiencies in knowledge about network connectivity are hard to compensate for and can usually only be compensated for by grouping of network connection points (like customer connection points) and assumed connectivity and asset types based on planning guidelines.

To illustrate this: One specific example are models of Low-Voltage sections of the network, where available data and its quality might not allow creating a detailed model for these sections. An option is to group all customer connection points behind a virtual line, parameterised based on planning principles (e.g. maximum voltage drop at full load) and representing the entire LV network. In this way functionality to capture likely end-of-network voltages can be achieved, but at reduced accuracy and without detailed visibility of the internal operational state of the LV network.

Process Undertaken by Shield

During the early stage of Project SHIELD multiple different ways to establish information on Network Connectivity have been observed and implemented:

Network Connectivity	Advantage	Disadvantage
Fully formed network models in power flow analysis tools	Contains unambiguous data about assets, their electrical details and inter-connectivity	Complex to generate and maintain. Updates to reflect changes, like switching, require generation of new models.
GIS data with electrical connectivity.	Contains unambiguous data on asset inter-connectivity. Better inter-connectivity with other IT systems. Usually offers rapid tracing to carve out network sections.	Usually lacks electrical details of inter-connected assets.
GIS data without electrical connectivity		Usually lacks electrical details of inter-connected assets. Asset inter-connectivity must be inferred by proximity, leading to ambiguity in parallel paths. Oftentimes does not clearly identify assets and asset boundaries.

While fully formed network models have the advantage of being complete and unambiguous, their integration with other IT systems is rather poor. GIS data, on the other hand, integrates with other IT system much easier and allows for easier updates on the data. Since most GIS

systems are not designed to host details on specifics of particular asset types, but rather their high-level inter-connectivity and location, for network modelling purposes GIS-sourced data needs to be accompanied by systems offering the specific details of assets as an additional complementing service.

Considerations for future projects

The experience in Project SHIELD lead to a preference for GIS-sourced data. This includes information on electrical inter-connectivity. Best results were achieved when GIS data contained the following information:

- Unique identifiers for all assets and connectivity nodes that are in line with other data sources containing asset details.
- Clear information on the connectivity of conducting assets and connectivity nodes. Best practice would be the use of named terminals on conducting assets to reflect directionality (e.g. for transformers) and for conducting assets that connect to more than one connectivity node.
- Where certain types of conducting assets are modelled as nodes (in particular switching elements and transformers) these nodes have to be replaced by edges before being inserted into a network model. This involves associating edges that connect to the original node with one of the terminals of the new edge. To facilitate this and to avoid ambiguity in the process, the use of named terminals also on these nodes should be considered. This could be achieved e.g. by back-referencing the edges connected to these nodes. Generally, all conductive equipment, including switching elements and transformers, should be modelled as edges and edges should generally be directional, e.g. through the use of named terminals.
- For performance reasons in the retrieval of asset inter-connectivity, the states of switching elements should be recorded and updated regularly. Storing them in external systems is extremely detrimental to the performance of tracing out connected parts of the network for anlaysis.
- For performance reasons in the retrieval of asset attributes, as many static asset attributes as possible should be stored in the GIS to reduce the number of time-consuming additional queries into other asset databases. Examples of such information are line and cable lengths and their standard types.

- To support further analyses that involve possible topology changes, an export of a GIS network trace should also include switching assets that are located at the edge of the traced-out network and marked as open. This information greatly facilitates the re-combination with adjacent parts of the network, which is required when evaluating possible load transfers or verifying the validity of current switching information.
- To support analyses of past, future and hypothetical network connectivity, GIS should also support 'substation-to-substation' traces disregarding the recorded state of switching elements. This facilitates the analyses of past, future and hypothetical network connectivity as it allows the receiving process to complete the trace of individual sections based on alternative switching scenarios.
- To support analyses of past and future (planned) network states, GIS elements representing physical assets should be amended with their actual or planned installation and retirement date and, upon retirement, not be removed from the GIS but marked with their date of retirement.

Lesson #6: Be flexible in your approach to data, especially when relevant to network connectivity, as available data and its quality might not initially allow for the creation of a detailed model

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Knowledge Category: Data and Software

Knowledge Type: Network Connectivity

Technology Type: Measurement Data

State/Territory: National

Key Learning

The main challenge in distribution network monitoring is the scarcity of actual measurement data. This can largely be compensated by using available complementing statistical information on network utilisation, which can take different forms and different levels of details. Like with network models, the more and better the statistical information, the higher the accuracy of the estimate of a networks operational state, while functionality can be achieved on relatively coarse data.

The most common way to utilise available statistical data to complement incomplete measurement data is best described as aggregation-disaggregation approaches. There are different varieties of how this can be performed, but both directions, aggregation and dis-aggregation, require statistical information to operate to their best potential.

Process undertaken by SHIELD

To enable best use of available statistical information to complement available, yet incomplete, measurement data SHIELD established that the following statistical information should be kept for every customer connection point:

- Type of load and generation are connected (e.g. residential, C&I, solar, etc.)
- If available, for each of these types a metric that relates the likely extend of the network utilisation at this connection point to the same types at other connection points.

[Examples are customer count, annual energy consumption, or installed capacity.] This is relevant to the apportioning in any dis-aggregation process and to the correct weighing in any aggregation process.

For available measurement data that has been collected at the edge of the network, or even on customer premises measuring only a specific part of the customers equipment, to best support the aggregation-disaggregation, SHIELD established it should be accompanied by the following meta-data:

- Referring to the statistical information provided for customer connection points, what proportion of the different types of load and generation are being measured.
- If there are multiple measurement points within the customer's installation, does this specific measurement device have a 'parent' device? Meaning, is the measured power flow captured again as part of an upstream measurement? And if so, what is the next one?

To illustrate this, SHIELD assumed a customer with a Smart Meter and two solar inverters with one of the inverters being measured. Further assuming the customer had an average energy consumption of 10kWh/d and both inverters had 2.5kW capacity. The average energy consumption would need to be corrected for the likely amount of self-consumption to arrive at a statistical value for the native residential load. A plausible value might be 24kWh/d for the native consumption. Under this scenario:

- Statistical information for the connection point should be:
  - Residential load: 24kWh/d
  - Uncontrolled solar: 5kW
- For the Smart Meter XYZ the meta-data should be:
  - Parent meter: - none -
  - Measured types
    - Residential load: 24kWh/d
    - Uncontrolled solar: 5kW
- For the inverter measurement:
  - Parent meter: Smart Meter XYZ
  - Measured types:

- Uncontrolled solar: 2.5kW

Considerations for future projects

Future project should take into account that this approach would enable the better and easier ingestion of on-premise measurement data and support any aggregation-disaggregation technique. For measurements taken within the network, like at distribution transformers, re-closers and at sub-stations, these measurement 'parent' relationships can be established using the network model. For on-premise measurements they would have to be provided as meta-data to the measurement data separately.

The main observations that lead to these recommendations were:

- Most power flow measurements measure the aggregate of power flows to or from a number of loads and generation. These types can be categorised and often have very similar behaviour in regard to external influences like time of day, weather conditions, holidays, etc.

The power flows to and from individual loads and generation can be, and often are, measured multiple times. In most cases this is through the measurement of an aggregate power flow including the power flowing to or from the individual load or generation unit plus the power flowing to or from other measured or unmeasured loads and generation.

Lesson #7: **Due to issues with the availability and accessibility of complete data sets for integration with the Luceo Platform, the Project is adapting in order to access data from alternate sources**

Knowledge Category:	Data and Software
Knowledge Type:	Legal and Technical
Technology Type:	Luceo Platform
State/Territory:	National

Key Learning

Subsequent to the Project's first Milestone it became apparent that acquiring live data from external sources to feed into the Luceo Platform would prove difficult and time-consuming. The integration of live data as opposed to alternative data sets was preferred at the outset for more real time results. Essentially, this forced the Project SHIELD Working Group and Steering Committee to adapt to the issue and as a result, search for alternative data to integrate with the Luceo Platform.

Currently, the Project has access to fifty Luceo monitoring devices, feeding data back to the Luceo Platform, but very limited other forms of data.

Data privacy and the issue of a large number of disparate and incomplete data sets means it is extremely challenging to get access to additional data for the feeders that the Project is studying.

Process undertaken by SHIELD

At this point, data is flowing through the platform from 50 Luceo devices currently installed in Energy Queensland's territory. Prospective data sources on the Energy Queensland network include:

- NBN Nodes (Yet to make contact)
- Smart Meter Data (Acquiring Access)
- Inverter data (70 sites spread amongst 25 manufacturers)

The largest of the manufacturers holds eleven inexpensive systems, most without monitoring, leaving potentially five data points. A further challenge is that manufacturers are not under any obligation to share the required data.

Project SHIELD, following extensive consultation within the Project Working Group and Steering Committees, came to the conclusion that the best option for third party data is to start with Smart Meter Data and continue a concerted approach of approaching data sharing agents with the intention of acquiring a richer and broader data set, for example from inverter manufacturers. One key potential risk is that the Project data that is available may not be live data.

Considerations for future projects

Projects of a similar nature should consider the issues associated with data privacy, the legal implications in relation to the sharing of data and the implication that unavailable and incomplete data sets may have on the Project. As was Project SHIELD's case, the ability to adapt and identify other sources of information and data for integration is essential.

Appendices

Appendix 1: Current development and status of Project SHIELD logo and website.

PROJECT SHIELD