Ergon Energy Demand Management Innovation Allowance Mechanism Report 2023-24

September 2024

Part of Energy Queensland

Contents

1. Introduction

1.2 Purpose and compliance

Ergon Energy Network (Ergon Energy) is pleased to present the Demand Management Innovation Allowance Mechanism (DMIAM) Report for the 2023-24 regulatory year. The purpose of this report is to allow the Australian Energy Regulator (AER) to:

- assess Ergon Energy's 2023-24 DMIAM initiatives and Ergon Energy's entitlement to recover the expenditure under the AER's DMIAM; and
- confirm Ergon Energy's compliance with the annual reporting requirements of the AER's Regulatory Information Notice (RIN).

This report has been completed in accordance with Schedule 1, item 7 of the AER's RIN, which requires a distribution network service provider (DNSP) to which the DMIAM applies, to submit an annual report to the AER on its expenditure. This report, and the information contained in the report, is suitable for publication by the AER.

DMIAM reporting requirements Schedule 1: Item 7 – Demand Management Incentive Allowance Mechanism

7.1 Identify each demand management project or program for which Ergon Energy seeks approval.

7.2 For each demand management project or program identified in the response to paragraph 7.1:

a) Explain how it complies with project criteria detailed at section 2.2.1 of the Demand Management Innovation Allowance Mechanism

b) Submit a compliance report in accordance with section 2.3 of the Demand Management Innovation Allowance Mechanism

2.2.1 Project Criteria:

(1) An **eligible project** must:

(a) be a project or program for researching, developing or implementing **demand management** capability or capacity; and

(b) be innovative, in that the project or program:

i) is based on new or original concepts; or

ii) involves technology or techniques that differ from those previously implemented or used in the **relevant market**; or

iii) is focused on customers in a market segment that significantly differs from those previously targeted by implementations of the relevant technology, in relevant geographic or demographic characteristics that are likely to affect demand; and

(c) have the potential, if proved viable, to reduce long term network costs.

(2) A **distributor's** costs of a project or program are not eligible for recovery under the **mechanism** if those costs are:

i) recoverable under any other jurisdictional incentive scheme;

ii) recoverable under any state or Australian Government scheme; or

iii) otherwise included in forecast capital expenditure or operating expenditure approved in the **distributor's** distribution determination.

(3) For avoidance of doubt, the **mechanism** does not require a **distributor's eligible project** to be geographically constrained to its **distribution network**.

2.3 Compliance Reporting

(3) Each compliance report must include, for the regulatory year to which the compliance report relates:

(a) the amount of the allowance spent by the distributor;

(b) a list and description of each eligible project on which the allowance was spent;

(c) a summary of how and why each eligible project complies with the project criteria;

(d) For each eligible project on which the allowance was spent, and in a form that is capable of being published separately for each individual eligible project, a project specific report that identifies and describes:

i) The nature and scope of the eligible project;

ii) The aims and expectations of the eligible project;

iii) How and why the eligible project complies with the project criteria;

iv) The distributor's implementation approach for the eligible project;

v) The distributor's outcome measurement and evaluation approach for the eligible project;

vi) The costs of the eligible project:

1. incurred by the distributor to date as at the end of that regulatory year;

2. incurred by the distributor in that regulatory year; and

3. expected to be incurred by the distributor in total over the duration of the eligible project.

vii) For ongoing eligible projects:

1. a summary of project activity to date;

2. an update of any material changes to the project in that regulatory year; and

3. reporting of collected results (where available).

viii) for eligible projects completed in that regulatory year:

1. reporting of the quantitative results of the project;

2. an analysis of the results; and

3. a description of how the results of the eligible project will inform future demand management projects, including any lessons learnt about what demand management projects or techniques (either generally or in specific circumstances) are unlikely to form technically or economically viable non-network options.

1.3 Demand Management Innovation Allowance Mechanism projects summary

In its Distribution Determination for the 2020-2025 period, the AER decided to apply the DMIAM to Ergon Energy, approving an innovation allowance amount of $5,669,345 over the 2020-25 regulatory control period.

The DMIAM is provided to investigate opportunities that are not yet commercial, in addition to any business-as-usual capital and operating expenditure allowances for demand management and embedded generation projects approved in Ergon Energy's Distribution Determination. This provides a direct incentive for DNSPs to assess emerging opportunities for potentially efficient non-network alternatives, to manage the expected demand for standard control services in some other way or to enable more efficient connection of embedded generation other than through network augmentation.

Ergon Energy's 2023-24 DMIAM program comprised six active projects during the year. The total cost incurred for the DMIAM initiatives during 2023-24 was $801,220. This total amount is exclusive of indirect costs (financial overhead and fleet on-cost). Table 1 below summarises the costs of eligible Ergon Energy DMIAM projects.

Table 1 - DMIAM Eligible Project Costs ($)

DMIAM Project	The costs ($) of the eligible projects[1]:			
	expected to be incurred in total over the duration of the eligible project	incurred in 2023-24 regulatory year	incurred to date[2] as at the end of the 2023-24 regulatory year	Status (as at 30 June 2024)
Alternate Supply Bustard Head	1,118,588	87,417	522,271	Closed
Clairview Stanage Project	688,844	315,794	442,803	Closed
West Leichhardt Single Wire Energy Return (SWER)	3,716,371	101,534	1,083,985	Closed
Allawah Fringe of Grid Field Trial	458,698	128,758	292,629	Continuing
Fringe of Grid Phase 2 Development	291,500	112,463	159,193	Continuing
Model Free Dynamic Operating Envelopes	141,849	55,255	103,222	Continuing
Total	**6,415,850**	**801,220**	**2,604,103**	

Ergon Energy confirms that the costs of the projects specified in this report are:

- not recoverable under any jurisdictional incentive scheme;
- not recoverable under any other Commonwealth or State Government scheme;
- not included as part of:
  - the forecast Capital Expenditure or the forecast Operating Expenditure; or
  - any other incentive scheme applied by the 2020-25 Distribution Determination.

[1] As per DMIAM reporting requirements Schedule 1: Item 7 –DMIAM section 2.3 (3) (vi) 1,2,3

[2] For the current 2020-25 regulatory period

2. DMIAM Project development and selection process

Ergon Energy considers DMIAM investments an important component of its commitment to delivering customer value over the longer term. The DMIAM program complements our demand management program, which is geared toward providing a more efficient solution to network augmentation. The DMIAM initiatives have enabled Ergon Energy to investigate and test innovative approaches to a range of network issues, customer behaviours, renewable integration and cost-reflective tariffs which have the potential to reduce long term network expenditure.

For the 2023-24 DMIAM program, all nominated DMIAM projects are subject to a screening and feasibility process, consistent with the AER's DMIAM criteria. The standard DMIAM project development and assessment process applied in Ergon Energy involves:

- Promotion of DMIAM funding and criteria:
  - To internal stakeholders to encourage project ideas to be submitted, as an expression of interest (EOI) or more formal DMIAM Project Scope;
  - To external stakeholders through improved web presence to invite any interested parties to make contact
- Review of EOI or DMIAM Project Scope against DMIAM criteria as a minimum, and against relevant internal strategy documents, including the Energy Queensland Future Grid Roadmap[3] and the Demand Management Plan;
- Project proponents are encouraged to discuss project ideas with other Ergon Energy subject matter experts, which helps guide and refine the idea;
- Projects that are deemed to meet the DMIAM criteria are then formally submitted to the DMIAM Program Manager for approval, or endorsement to the appropriate financial delegate.

Budgets are prepared in accordance with Ergon Energy standard project methodology, detailing information including project goals, deliverables, milestones and resources required. Cost estimations were developed for the requirements identified, for each phase of the project. These cost estimations drew upon various sources including the cost of similar projects undertaken by Ergon Energy, current preferred contractor panel contracts and market research.

[3] The Future Grid Roadmap is a document that outlines a range of themes and supporting activities and no-regret investments necessary for Ergon Energy to achieve a transition to the intelligent grid of the future over the next 10-20 years. It is not essential to meet criteria other than the stated DMIAM criteria, however project proponents should, where possible, ensure their project aligns with these existing strategic network directions and priorities.

3. DMIAM Project updates

This section of the report details the status of Ergon Energy's DMIAM projects in 2023-24 by describing each project, its objectives, progress and findings to date.

3.1 Alternative Supply Bustard Heads

This project is to trial a stand-alone power system (SAPS) as a network support device, with the long-term aim to reduce network costs.

3.1.1 Compliance with DMIAM Criteria

The Bustard Head SAPS project complies with the DMIAM criteria as the project will enable the substitution of costly network components with alternative supply arrangements that provide improved power quality and reliability whilst enabling improved value to all customers.

3.1.2 Nature and Scope

Trial a stand-alone power supply system as a network support, with the long-term aim of using SAPS as a lower cost solution to network maintenance/replacement.

3.1.3 Aims and expected outcomes

The direct outcomes and benefits include:

- Customers will have a more reliable power supply.
- The network will have reduced operating costs and reduced network losses on the distribution system.

The indirect outcomes and benefits include:

- Ergon Energy has developed new approaches to working with customers towards more cost-effective supply solutions through the development of a SAPS Customer Engagement Strategy;
- Ergon Energy will develop new equivalent electricity supply standards for solar/battery hybrid systems including working with Energy Networks Australia (ENA) to develop new business standards and guidelines for utility grade SAPS;
- Ergon Energy is using the knowledge and experience gained from the SAPS trials in working with the ENA and other DNSPs to develop national guidelines for DNSP-led SAPS.

3.1.4 The process by which it was selected, including its business case and consideration of any alternatives

All Ergon Energy DMIAM projects are selected and scoped to respond to current and emerging network limitation drivers and adhere to the standard governance framework. The eligibility screening process is performed on nominated projects as a high-level assessment, to determine whether the projects meet the DMIAM criteria. Other internal criteria are then assessed – including how the findings of the project, should it be successful, could be applied within the business. Provided all the specified conditions are met, then the project proceeds to the feasibility assessment and approval stages, as per the gated governance framework and with internal subject matter expert review and feedback. Information from the development activities undertaken enables implementation scheduling, milestone planning and confirmation of resources.

3.1.5 How it was/is to be implemented (i.e. general project update)

The Bustard Head SAPS was installed and commissioned in December 2020 (see Figure 1 below). It has been in operation since this time supplying the full energy needs of the two customers it supplies. The SAPS is being monitored and its performance measured, and a customer survey has been undertaken to gather customer insights through the whole project process. Following on from the project completion of the project, the SAPS will continue to be monitored and lessons learnt captured for the development of future standardised DNSP-led SAPS. Trial outcomes will be fed into new work to enable appropriate life-time management of alternative supply dependent on the criteria set under the new regulatory framework that will enable DNSP's in Queensland to supply customers by SAPS.

3.1.6 Any identifiable benefits that have arisen from it, including any off peak or peak demand reductions

During the project, criteria was developed through assessment of the customers energy usage profile for ensuring that the design was equivalent to the customers energy and demand needs, which will be tested through business-as-usual processes. Customer engagement was positive throughout the project and included discussions around the topic of appliance use and load management to optimise the systems. As a result of this project, a SAPS Customer and Community Engagement Strategy was developed which can be used for any future similar engagement.

Figure 1 - Bustard Head SAPS

3.2 West Leichhardt Single Wire Earth Return (SWER)

This project involved installing two larger scale SAPS as network support devices as a trial of an alternative to grid supply.

3.2.1 Compliance with DMIAM Criteria

The West Leichhardt SAPS project complies with the DMIAM criteria as the project will enable the substitution of costly network components with alternative supply arrangements that provide improved power quality and reliability whilst enabling improved value to all customers.

3.2.2 Nature and Scope

Trial SAPS as network support and develop supporting policies, processes and systems that can more broadly enable DNSP-led SAPS across Ergon Energy's network.

3.2.3 Aims and expected outcomes

- Improved reliability and power quality for the two customers involved in the trial
- Informing design rules and scenarios for SAPS
- Developing customer engagement strategies and plans to transition customers from grid to SAPS supply
- Identifying changes to Ergon Energy's Connection Policy and connection agreements to ensure a consistent approach for SWER customers and encouraging alternate solutions where appropriate rather than extending the SWER network
- Acquiring the knowledge and experience to inform:
  - future business requirements for SAPS supply; and
  - future product solutions to enable a more flexible approach to connections in the future by the planning teams.

3.2.4 The process by which it was selected, including its business case and consideration of any alternatives

All Ergon Energy DMIAM projects are selected and scoped to respond to current and emerging network limitation drivers and adhere to the standard governance framework. The eligibility-screening process is performed on nominated projects as a high-level assessment to determine whether the projects meet the DMIAM criteria. Other internal criteria are then assessed – including how the findings of the project, should it be successful, could be applied with the business. Provided all the specified conditions are met, then the project proceeds to the feasibility assessment and approval stages, as per the gated governance framework and with internal subject matter expert review and feedback. Information from the development activities undertaken enables implementation scheduling, milestone planning and confirmation of resources.

3.2.5 How it was/is to be implemented (i.e. general project update)

Two SAPS to supply the two customers involved in this trial were commissioned in February and March 2021 and have been operational since this time supplying the operational needs of the two customers (installation photo's below).

During the project the SAPS were monitored, their performance measured, and customer surveys were undertaken to gather customer insights through the whole project process. The SAPS will continue to be monitored and lessons learnt captured for the development of future standardised DNSP-led SAPS.

The trial results will continue to support decisions for new work to enable appropriate life-time management of alternative supply dependent on the criteria set under the new Australian Energy Market Commission rules for SAPS.

3.2.6 Any identifiable benefits that have arisen from it, including any off peak or peak demand reductions

During the project, criteria for equivalency in design was developed that will be tested outside of the project. Customer engagement has been positive for the project and included discussion around the topic of appliance use and load management to optimise the system – for example, scheduling use of appliances during the daytime to maximise solar energy use.

Figure 2 - SAPS Trial Site 1

Figure 3 - SAPS Trial Site 2

3.3 Model Free Dynamic Operating Envelopes

This project is part of a broader dynamic operating envelopes (DOE) program. It is focused on exploring alternative methods for determining DOEs without any network model data, leveraging available low voltage (LV) visibility from Network Service Monitors and procured smart meter data. A DOE specifies a varying operating range at the connection point for exports and/or imports within the operational limits of the network. DOEs will play an important role in supporting ongoing uptake of consumer energy resources (CER) by enabling dynamic CER connections at scale to provide benefits to customers and the wider market while mitigating risks to the operation of the network.

3.3.1 Compliance with DMIAM Criteria

The project was viewed as meeting the DMIAM criteria by developing a method for determining more optimal DOE in parts of the network, particularly the LV, where network model data is poor which can reduce the degree of curtailment in comparison to more conservative alternatives – zero, fixed (FOE) or scheduled (SOE) operating envelopes for example. DOEs can also be applied to flexible loads such as electric vehicle chargers reducing the need to restrict charging to times when the network is truly approaching constraints rather than on a more frequent (eg. SOE) or constant (eg. FOE) basis. Improving DOE performance enables demand and generation management with the lowest impact possible without further network augmentation.

DOEs maximise utilisation within existing network capacity only driving augmentation when excessive/unacceptable curtailment or load reduction is caused. A model free DOE can generate a more optimised DOE on networks with poor model quality (such as LV). It leverages available network visibility and machine learning based methodology via Software as a Service, to determine DOE in a new innovative way, potentially reducing DOE implementation costs.

3.3.2 Nature and Scope

This Project has two stages, the first focuses on three LV networks with high solar photovoltaic (PV) penetrations (60% - 120% of transformer rating) that also have moderate coverage of Network Service Monitors or procured smart meter data to provide LV visibility. The second extends the focus to the rest of the medium voltage (MV) network. The stage one LV networks are supplied from and all other LV networks with some monitoring. In the second stage near real time closed loop performance of DOEs will also be tested from different LV visibility sources and the performance will be compared with other methods for generating DOE such as a basic calculated methodology and a capacity constrained optimisation.

3.3.3 Aims and expected outcomes

The purpose of this project is to develop and demonstrate a new DOE generation engine that determines DOEs based on customer and network monitoring but independent of network model or topology. The project has the following objectives:

- Demonstrate generation of DOE based on machine learning using LV and MV telemetry
- Compare model free DOE with other DOE determination approaches in terms of curtailment and computational requirements, and
- Identify minimum data requirements to generate a model free DOE that reliably outperforms basic DOE

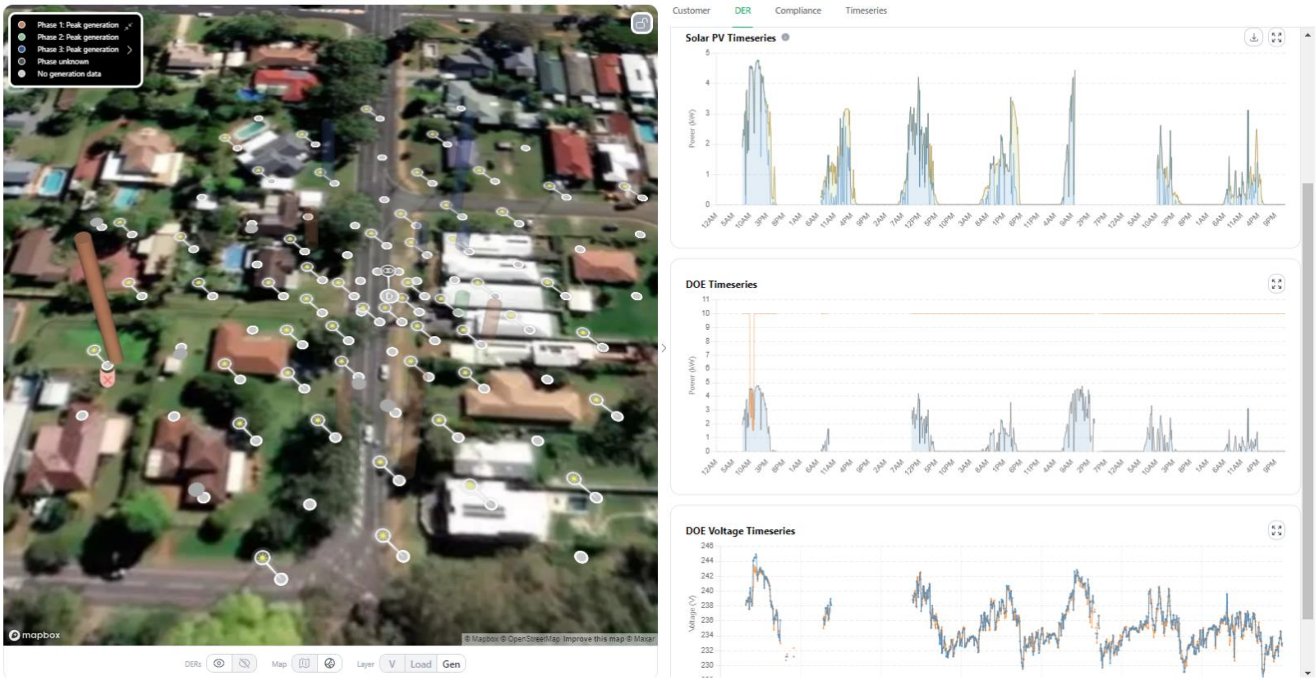

Figure 4 - Model Free DOE platform (source Gridsight, 2023)

3.3.4 The process by which it was selected, including its business case and consideration of any alternatives

The DMIAM project approval process was followed for selecting this project. Potential DMIAM projects are selected and scoped to respond to current and emerging network limitation drivers and adhere to the standard governance framework. Accordingly, once projects are identified and nominated, the eligibility screening process is performed on nominated projects as a high-level assessment, to determine whether the projects meet the DMIAM criteria. Other internal criteria are then assessed – including how the findings of the project, should it be successful, could be applied within the business. Provided all the specified conditions are met, then the project proceeds to the feasibility assessment and approval stages, as per a gated governance framework and with internal subject matter expert review and feedback. Information from the development activities undertaken enables implementation scheduling, milestone planning and confirmation of resources.

3.3.5 How it was/is to be implemented (i.e. general project update)

This project analysed the performance of a model-free DOE solution developed by Gridsight. The design aimed to generate DOEs using historical customer data and network monitoring to train a machine learning algorithm. Gridsight's model-free DOE aims to set accurate and dynamic export limits with limited availability to network models across Energex and Ergon Energy Network's LV networks.

Gridsight performed a variety of tests and comparisons to measure model-free DOE performance under an array of conditions. This compared existing static and dynamic solar PV connections and a scenario of 100% PV uptake with all non-PV sites modelled with a new 10kVA dynamic PV connection. Additionally, equal and optimal allocation methods were simulated both with and without DOE voltage constraints.

Figure 5 demonstrates accurate transformer load estimations by Gridsight's machine learning model, providing highly comparable results to the measured transformer data. This demonstrates that the load is calculated relatively precisely, proving that appropriate model-free DOE limits can be generated. Energex and Ergon Energy Network apply a SOE where grid visibility data is not available assuming maximum import and export 'worst case' conditions.

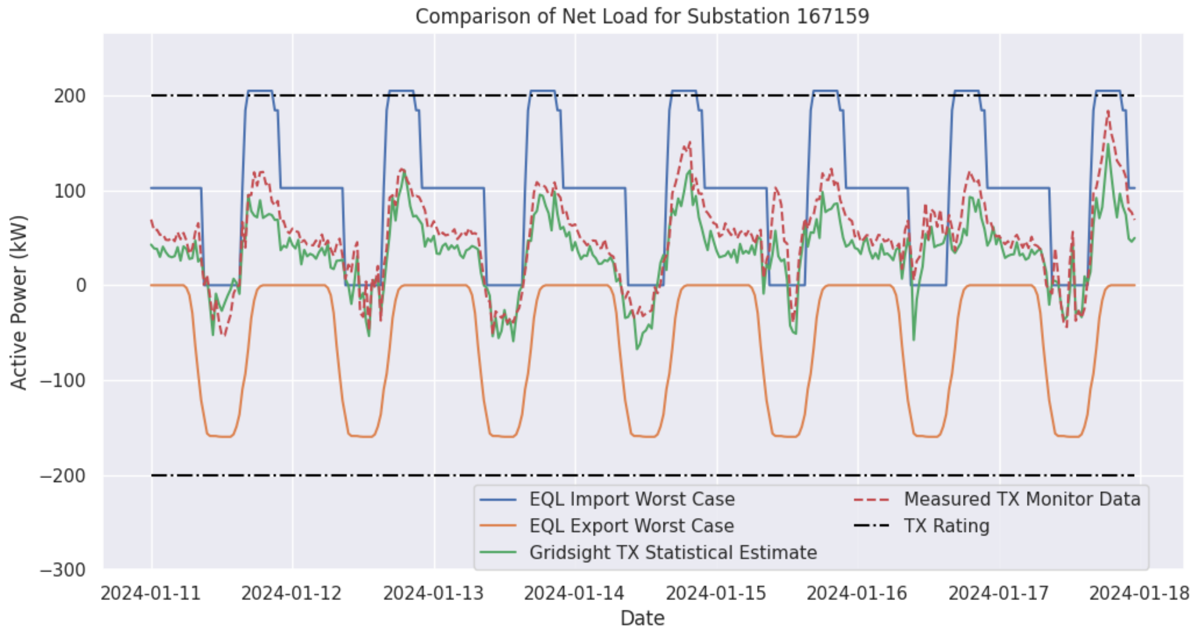

Figure 5 - Comparing measured transformer monitor load with Gridsight and network estimates

Comparative analysis between SOEs and model-free DOEs with existing static and dynamic connections demonstrated reduced curtailment for customers with model-free DOEs. Table 2 highlights the most insightful findings of the study, showing calculations across the total of all 52 LV sites from 3 MV networks. Another notable finding was the reduced total curtailment that resulted when using optimal allocation of curtailment as opposed to equal allocation, and approximately half as many connections required curtailment.

Table 2 - Existing static and dynamic connections scenario simulation curtailment comparisons

DOE allocation	Voltage Constraints	SOE Average Daily Curtailment per Customer (kWh)	DOE Average Daily Curtailment per Customer (kWh)	SOE Curtailed kWh (%)	DOE Curtailed kWh (%)
Optimal	Managed	0.29	0.02	3.90	0.19
Optimal	Unmanaged	0.28	0.00	3.80	0.00
Equal	Managed	0.29	0.13	3.90	1.13
Equal	Unmanaged	0.28	0.00	3.80	0.00

Figure 6 demonstrates SOE and DOE curtailment over one day for a specific substation. This example is under simulated conditions with optimal allocation, voltage constraints and a scenario with 100% solar uptake, with all new solar customers being put on a dynamic connection. The results display less curtailment with the model-free DOE compared to the SOE. Curtailment is evident when the power flow after DOE (brown) or SOE (green) implementation is less than the net transformer power flow (light blue). All 3 of these lines converge before 8am and after 5pm, indicating no SOE or DOE curtailment outside of peak export times. The blue dashed line displays the transformer voltage after DOE implementation with voltage constraints. The DOE evidently constrains the voltage to remain below its 253V limit. The voltage predicted by the red dotted line does not account for autonomous volt-var and volt-watt response which would likely minimise over voltages but at the expense of additional curtailment during peak generation.

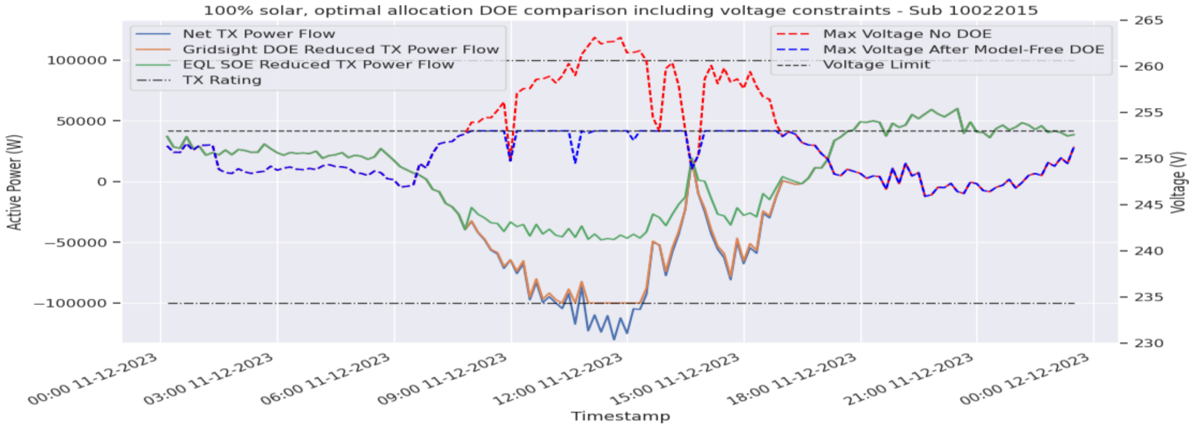

Figure 6 - 100% solar uptake load comparisons with optimal allocation and without voltage constraints

Model-free power flow relies on the ability to calculate customer voltages based on active and reactive power injections measured from customer points of connection. Typically, the accuracy of model-free transformer voltage estimates increases as a function of smart meter penetration. Figure 7 demonstrates that as smart meter penetration increases, the root mean squared error of transformer voltage predictions reduces. The plot suggests that smart meter penetrations over 20% result in relatively accurate transformer voltage predictions.

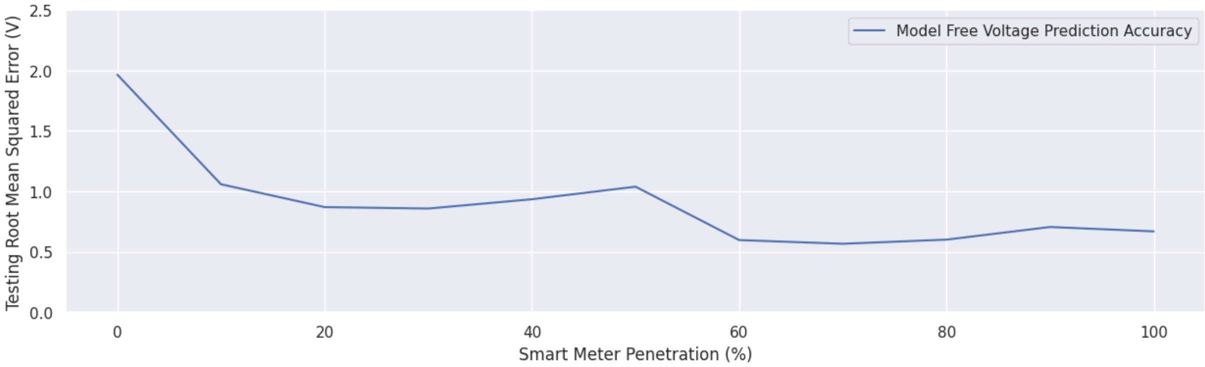

Figure 7 - Model-free DOE voltage prediction accuracy with variable GV

3.3.6 Any identifiable benefits that have arisen from it, including any off peak or peak demand reductions

Gridsight's proposed model-free DOE effectively generates import and export power limits whilst minimising the required curtailment for customers. Comparison of model-free DOE and SOE performance across 52 LV sites indicated an overall reduction in PV curtailment with Gridsight's model-free DOE in 8 different simulation scenarios.

This model benefits customers on LV networks with very high PV penetrations compared to SOEs by increasing their export capacity and will also provide wider system benefits by increasing sustainable energy generation.

A limitation of the model-free DOE is the requirement of grid visibility to train the machine learning model and produce accurate results. In the event of a change in network state, the model-free DOE requires updated data and retraining of the machine learning model to ensure accurate power estimations.

Due to the challenges of providing near real time smart meter data, historical data was used for both model-free DOE training and testing. Future studies should investigate the performance of model-free DOEs when fed near real time smart meter data.

While model-free DOEs would benefit from further work, Gridsight's DOE offers beneficial outcomes for customers with dynamic connections and the network and support ongoing efforts to enable increasing CER penetration with dynamic connections.

3.4 Fringe of Grid Phase 2 Development

The purpose of this project is to develop the next evolution of Fringe of Grid (FOG) technologies in several areas; more reliable and lower cost communications for monitoring systems, improvement in battery technology and improvement of fault response in SAPS.

3.4.1 Compliance with DMIAM Criteria

The project was viewed as meeting DMIAM criteria because SAPS and FOG improvements increase the possibility to provide standard and more cost-effective battery/inverter/solar options, and advance standardisation which will result in economies of scale which will further enable cost reductions for the supply and management of SAPS.

SAPS cost is a key consideration in their use and effectiveness as a lower cost alternative to network augmentation.

3.4.2 Nature and Scope

The purpose of this project is to address three key areas that still need development to enable new technologies and test safety aspects of SAPS and FOG technologies:

1. Develop reliable and lower cost communications to remote systems using Long-Term Evolution for Machines (LTE-M) Low-Power, Wide-Area Network (LPWAN) Internet Of Things communications.
2. Ensure safe fault operation of SAPS and microgrids through testing of customer fault current responses.
3. Assess new energy storage technologies which are fit for purpose, in float and deep cycle and provide adequate fault current.

3.4.3 Aims and expected outcomes

1. Achieve LTE-M communications between the Selectronic SP Pro Inverter and Battery Management System and the Category M1 (Cat-M1) modem back to a non-Operational Technology Environment (OTE) service that can be implemented for the SAPS Pilot. LTE Cat-M1 is a LP-WAN designed specifically for devices that transmit small to medium amounts of data over wide ranges.

2. Identify any changes to current communication asset process and procedures for LTE-M LPWAN infrastructure to be utilised for SAPS and FOG applications

3. Achieve comms back to an OTE Ergon service for the next round of SAPS Pilot.

4. Determine capability of managing fault currents for SAPS and provide standard protection paper for ongoing management as part of the Safe by Design process for SAPS and microgrids.

5. Have a viable and safe standardised battery and inverter solution for long term SAPS and FOG operations.

3.4.4 The process by which it was selected, including its business case and consideration of any alternatives

Market scans, and discussions with industry partners, regarding alternatives for the most appropriate next steps in both reliable communications and battery technology were carried out.

A DMIAM business case to fund testing of the selected alternatives was submitted and approved.

3.4.5 How it was/is to be implemented (i.e. general project update)

LTE-M Communications:

- A Teltonika TRB 255 modem was identified as a suitable representative modem for LTE-M communications. The CAT M1 network has been tested in the Innovation Lab with a suitable SAPS style inverter, and field testing of its signal strength in remote areas.

New Energy Storage technology:

- Polarium was identified as a robust battery technology. Nine batteries with a suitable testing rack have been procured and general load/recharge testing has commenced. Learnings are being shared with the internal business unit who are overseeing the next SAPS installations.

Fault Operation testing:

- This testing will commence at the completion of the general testing.

3.4.6 Any identifiable benefits that have arisen from it, including any off peak or peak demand reductions

The project is in its early stages and concrete benefits are yet to be realised at this stage.

Figure 8 – SAPS and Polarium Battery Testing

3.5 Clairview and Stanage Bay Microgrid Feasibility Project

Ergon Energy has recently completed its feasibility study investigating the implementation of microgrids at the communities of Clairview and Stanage Bay to improve customer reliability. This project was funded in part by the Australian Governments Regional and Remote Communities Reliability Fund (RRCRF) grant scheme. As part of the funding agreement, Ergon Energy was required to fund a portion of the project, which was done through DMIAM.

3.5.1 Compliance with DMIAM Criteria

This project meets DMIAM criteria as it was evaluating an innovative approach to reduce network costs through managing network demand. It identified customer energy usage trends through customer metering and energy audits, which was used to inform community energy literacy education activities.

A key consideration in the development of a microgrid is to understand the customers' load and where there are opportunities for demand management to optimise the design and cost of the microgrid. Microgrids will be a future demand management tool as they will allow load to be moved off the network as a financially viable alternative to investing in traditional network upgrades.

The feasibility of DNSP-led microgrids for grid connected communities has not yet been explored in detail by the business and therefore this project is the first of its kind. The concept of a microgrid is an innovative solution that would potentially utilise controlled renewable generation and energy storage to increase customer reliability and the network's resilience to disturbances, while reducing the need to upgrade existing infrastructure. The aim of the microgrid is to automate seamless switching between the grid and island mode, using smart grid controls to ensure a continuous reliable energy supply, while additionally offering grid support services while in grid connected mode.

3.5.2 Nature and Scope

Establishing microgrids in FOG communities, particularly in remote and challenging environments, will enable Ergon Energy to cost effectively improve or maintain the reliability of supply to customers in these areas and increase community resilience to extreme weather events such as cyclones, flooding and bush fires, that impact the upstream network. Advances in intelligent control systems and reductions in the cost of renewable energy and storage technologies will further enable microgrids to become economically viable compared to traditional network supply from poles and wires. The feasibility study focused on the townships of Clairview and Stanage Bay, with community and stakeholder engagement, data acquisition and analysis, microgrid network and economic modelling and simulation of viable and sustainable solutions.

3.5.3 Aims and expected outcomes

The project objectives are to:

- determine the technical and financial feasibility of installing microgrids at the communities of Clairview and Stanage Bay and use the lessons learnt from the feasibility study for other FOG locations;
- understand customers' energy needs and their interest and willingness to be involved in a future microgrid solution; and
- develop business intelligence to include deployment of microgrids by Ergon Energy as an option for addressing network constraints such as reliability, power quality or capacity, where viable as an alternative to augmenting the network.

3.5.4 The process by which it was selected, including its business case and consideration of any alternatives

Ergon Energy selected the townships of Clairview and Stanage Bay as the locations for the microgrid feasibility study. Both communities are supplied by the PD-203 'Northern' 22kV feeder. This feeder is over 1,000 km in length and has been consistently identified as one of the "worst performing feeders" in Queensland in terms of the Minimum Service Standards requirements. Clairview is located at the northern-most extremity of this feeder and is supplied from the three-phase network, while Stanage Bay is located at the extremity of a 100km SWER network.

After being awarded funding (approximately 60% of the total project cost) from the RRCRF, Ergon Energy has created a project which has the balance of required funding sourced from DMIAM.

3.5.5 How it was/is to be implemented (i.e. general project update)

The project was delivered through six stages. Each of these stages was completed with the assistance of the relevant teams and subject matter experts, with reporting, coordination and management of the project conducted by the Project Manager. Project timings were tied to RRCRF funding requirements for feasibility delivery.

Most of this project utilised internal skillsets. External work has been required for energy auditing. When procuring plant and equipment or arranging external work, the relevant network business processes and procedures were followed.

We have taken a no-assumptions approach to our community engagement and invited customers to participate in a quick energy survey which provided us with key insights into what customers care most about when it comes to their supply of electricity. In addition, the project team has visited each of the two communities and talked to residents and business owners about their experience with the power supply and our project. A project webpage was launched which acts as a landing page for all information regarding the project. A flyer was sent out to each of the customers in the two communities, which detailed the project and included a QR code that links back to the webpage.

Project activities included working with an Australian inverter manufacturer to design and develop a single-phase grid forming inverter for use on SWER networks. Currently there is no market segment for utility scale grid forming inverters in a single or split phase configuration, due to the limited application globally. Due to Ergon Energy's extensive use of SWER networks, this inverter will have applications beyond microgrids, including Grid Utility Support Systems (GUSS).

Figure 9 - Single Phase Grid forming Inverter

In addition, the project team have connected a containerised energy storage system that was previously not being used, to our innovation lab. These systems were used to design and test microgrid control schemes and better understand the challenges of islanding (disconnecting) and resynchronising (reconnecting) a load from the grid.

Figure 10 - Centralised Energy Storage System

In summarising the outcomes of the project, the study worked through the technical, operational, community/customer and business change management considerations, setting the foundation and preparation to pilot microgrid projects.

The key learnings and outcomes from this study are:

- Key stakeholders in each community are supportive of microgrid technologies and network connected batteries being installed in their communities to improve reliability and resilience of their electricity supply.
- A microgrid technical proposal has been developed and includes details of the required components and operational philosophy for a future microgrid.
- There are market limitations in microgrid solutions for single phase networks, however several options have been explored as part of this study and some have proven viable.
- At the time of writing this report, the estimated cost to build a microgrid at each of the communities is between $4-5M and will take approximately 18-24 months to complete.

The feasibility of network connected microgrids in the Ergon Energy network depends on the amount of value that can be leveraged from the battery, both when grid connected and islanded, versus the total lifecycle cost of the system. Value of Customer Reliability (VCR) is an economic value applied to customers' unserved energy for any particular year and is intended to represent customers' willingness to pay for their reliability of electricity supply. It is unlikely, based on the current estimated cost to develop Ergon Energy's first microgrids, that VCR alone will justify the cost of microgrid projects.

However, increasing the value stack of the microgrids through other network support services, which can defer network augmentation, combined with the falling cost of battery systems, means that network owned and operated microgrids can potentially be financially feasible. The appropriate application of microgrids depends on a number of factors including community load, location, network reliability and other network constraints.

This study has set the foundation for Ergon Energy's microgrid strategy. Learnings from this study will influence Ergon Energy's broader energy storage strategy and rollout, with the potential for future battery projects to have microgrid capability, improving reliability, resiliency, and readiness for future demand through utility grid modernisation techniques.

The next stage in Ergon Energy's implementation of microgrids is piloting two community microgrids which have been funded in part by the Queensland Government's, Queensland Microgrid Pilot Fund (QMPF). Unfortunately for the communities of Clairview and Stanage Bay, they did not fit the selection criteria for the QMPF grant scheme.

Building on the work done during this study, Ergon Energy will continue to engage with the communities of Clairview and Stanage Bay as well as others, as we explore additional funding opportunities to trial microgrid technologies, allowing us to build the business knowledge and expertise required to improve the reliability and resilience of power supply to regional and remote communities.

3.5.6 Any identifiable benefits that have arisen from it, including any off peak or peak demand reductions

A customer study which included detailed energy audits of major customers in the community was completed. This audit not only provided information to the project team regarding the community's energy usage and requirements but was also used to provide energy efficiency tips back to the customers, ultimately helping them to make informed decisions around reducing consumption and saving money on energy bills. To maximise the utilisation of any microgrid technology, such as battery energy storage, network support functionality can be incorporated to potentially address capacity constraints by reducing maximum demand. The customer and community energy study has helped inform the potential for this functionality.

Lessons learnt in this project were used to successfully apply for funding in the QMPF in March 2023, to pilot two microgrid projects. These two projects will be Ergon Energy's first owned and operated microgrids and will further increase business knowledge and skills regarding the use of microgrids to increase customer reliability and optimise network performance.

3.6 Allawah Fringe of Grid Field Trial

The purpose of this project is to field trial battery energy storage system (BESS) technologies that can reduce the overall demand on the Western fringe of Grid (FOG) and SWER by supplementing customer loads and enabling increased value from customer solar PV systems.

3.6.1 Compliance with DMIAM Criteria

The storage of customer's renewable energy in batteries with a hybrid inverter can be used on problematic FOG locations to reduce the demand and improve power quality on the grid overall and at the customer connection to an acceptable level, to avoid network capital works.

The project is innovative using commercially available BESS technology programmed in a way to support both the customer and the grid.

Traditionally an overload of a FOG location can lead to major works, including:

- upgrading of conductor size
- upgrade of major plant such as SWER isolators
- installation of additional major plant such as Medium voltage regulators

If the trial is successful, a deployment of the trialled system in targeted locations could be used to defer or eliminate the need for these works. This project is different from the previous DMIAM funded project, GUSS, as that project relied on purpose designed and built inverter technology that was connected on the network side of the meter, with limited ability to harness the value of customer owned renewable energy. This concept differs from the other SAPS systems already being trialled, because the SAPS are designed to immediately allow complete disconnection from the grid, and in a different customer segment. This concept instead augments the grid connection in the short term, allowing increased maximum demand to be served whilst reducing the maximum load on the grid. This is achieved with lower upfront capital cost than immediate complete disconnection via a SAPS.

It should be noted that the project is also complementary to the SAPS project and the GUSS project, with its view to integrate system elements that can be used on all three applications into the future – thus providing a more sustainable way of working through consistency in standards, the ability to reduce overall costs by having greater volume in products, reducing the variety of spares to be managed and through consistency in products and form factor, also ensuring a targeted upskilling for the operation, management and maintenance of these systems.

Along with this trial providing an alternative for specific network upgrades noted above, the trial working to align standardised building blocks across the SAPS, FOG and GUSS technologies will enable reduced costs for products due to quantity of scale and through consistency of products to be carried as spares, for integration into the Telemetry Hub and in relation to service and maintenance skills.

As part of the project learnings, an estimate to install standardised systems of this type on a more widespread basis will be provided to Network Planning to use as an option to consider when network augmentation is being evaluated.

3.6.2 Nature and Scope

The Western FOG refers to extensive SWER and remote powerline networks which are managed by Ergon Energy, mainly constructed in the 1970s and 1980s.

These networks are characterised by long lengths, with some 65,000 km (or 40%) of the Qld network comprised of SWER where customer connections are often sparse, and with around 26,000 customers (or 3.5% of the Ergon Energy customer base).

These networks are being challenged by a number of issues.

Those most relevant to this project are:

- increasing expectation of customers to add renewable energy;
- increasing expectation of customers for increased reliability and power quality;
- increasing load growth beyond original design capacity; and
- proliferation of loads including more sensitive electronic loads and heavy loads such as air-conditioning.

In some specific cases these SWER powerline networks may be removed and replaced by SAPS to meet overall customer needs. More commonly the most economical solution will be to repair and augment the existing grid to cater for increased demand for power, or to correct network deficiencies causing power quality issues. The reconductoring of powerlines, upgrade of major plant such as SWER isolators, or installation of additional major plant such as MV regulators can resolve these issues but can attract high capital outlay. This project is trialling customer level grid battery storage systems as an alternative method to address grid quality of supply and peak demand issues.

3.6.3 Aims and expected outcomes

This project seeks to demonstrate that a targeted installation of local storage of energy in a battery to reduce maximum demand on the grid can provide a reliable and economical methodology to:

- Increase the maximum demand (kW) available to a customer without causing peak demand or power quality issues;
- Provide a demand reduction alternative in grid augmentation scenarios;
- Improve power quality by limiting the export of generated solar PV by storing and using the energy onsite; and
- Reduce system losses.

A customer hosting these local energy storage systems can also receive the following side benefits:

- Provide some level of redundancy during grid outage; and
- A power bill reduction where excess PV reduces the bill instead of being exported at a lower tariff.

3.6.4 The process by which it was selected, including its business case and consideration of any alternatives

Under the previous Western FOG project, testing in the lab was done to prove the consistency, reliability and functionality of several devices including battery inverters, home energy management systems and LV regulators.

From this testing two devices were recommended to be used in field trials as the next step to confirm their suitability for wider application in the network, the SP PRO and the LVR-30.

The SP PRO is a BESS inverter with advanced functionality and reliability, which is what will be trialled in the Allawah project. (The LVR-30 is a voltage regulator which will not be required for this site.)

During lab testing the SP PRO inverter demonstrated its ability to provide:

- Reliable maximum demand limitation;
- Off grid backup power; and
- Consistent performance with a supplier that provides excellent support.

Maximum demand limitation is a key objective of the field trial project. The BESS inverter can be set up to provide power from the battery when the customer’s load exceeds a certain threshold. The main source of power for the battery is PV. In the event of reduced PV generation, the battery is topped up at low load times at night if needed. A DMIAM business case was submitted with a 2-year timeframe to install, monitor and learn from the system in the field.

3.6.5 How it was/is to be implemented (i.e. general project update)

The 20kWh battery bank and inverters system was installed in a cubicle at the Allawah Retreat in Tolga, North Queensland. This site has been chosen as a friendly site with people with good understanding of the technology (and its challenges). The location is ideal as it has good mobile coverage, extreme summer temperatures, is on a spur line and is still relatively close to Cairns, where Ergon Energy staff are located. We have had monitoring installed at this site for more than a year, so we also understand the energy usage variability on site.

The system, network and customer will be monitored for 18 to 24 months and the effectiveness of the system throughout various seasons and weather patterns will be evaluated. Learnings along the way are being used to improve the system parameters including export thresholds, battery state of charge targets, grid battery top-up schedules, and other parameters. The project will also provide learnings for development of standardised battery and inverter products.

Whilst the BESS will be physically installed on the customer side of the meter, the trial will explore the pros and cons of both customer side and network side connection.

Whilst examining the customer side connection scenario, direct control of the customers solar PV and possibly some loads by the system will be enabled via communication link.

The BESS was commissioned onsite in January 2024 and is being monitored and improvement to parameters implemented.

Figure 11 - The Project Cubicle, Inverters and Batteries during factory testing

Figure 12 - The BESS cubicle onsite at the Allawah retreat

3.6.6 Any identifiable benefits that have arisen from it, including any off peak or peak demand reductions

Learnings about the layout for a BESS system which is suitable for outdoor deployment including:

- Cubicle design withstanding heat and passively dissipating heat as much as possible;
- Keeping the cubicle layout as compact as possible;
- Beginning the journey of standardisation of such cubicles for widespread replication; and
- Developing the import, export and load support system settings to maximise use of renewables minimise grid load.
- Demonstration of the potential that the site load, which fluctuates greatly (up to 7kW - 10kW per phase) can be capped to a maximum demand of 2kW per phase at almost all times. This will be improved further throughout the project.