

Energex Demand Management Innovation Allowance Mechanism Report 2023-24

September 2024



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1. Introduction

1.1 Purpose and Compliance

Energex 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 Energex's 2023-24 DMIAM initiatives and entitlement to recover the expenditure under the AER's DMIAM; and
- confirm Energex'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 Energex 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.

1.2 Demand Management Innovation Allowance Mechanism projects summary

In its Distribution Determination for 2020-2025, the AER decided to apply the DMIAM to Energex, approving an innovation allowance amount of \$5,740,322 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 Energex'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.

Energex's 2023-24 DMIAM program comprised five active projects during the year. The total cost incurred for the DMIAM initiatives during 2023-24 was \$196,323. This total amount is exclusive of indirect costs (financial overhead and fleet on-cost). Table 1 below summarises the costs of eligible Energex DMIAM projects.

Table 1 - DMIAM Eligible Project Costs (\$)

DMIAM Project	The costs (\$) of the eligible project ¹ :			Status (as of 30 June 2024)
	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	
Carseldine Home Energy Management System (HEMS)	59,584	0	37,091	Continuing
Valuing Dynamic Connections	90,540	79,140	79,140	Closed
Dynamic Operating Envelope (DOE) Phase 1 Commercial	241,854	28,905	177,910	Continuing
Model Free Dynamic Operating Envelopes	141,849	33,745	82,495	Continuing
Development of an Aggregated Dynamic Model of Consumer Energy Resources Master	145,565	13,497	17,511	Continuing
Autumn Demand Response Trial	68,944	41,037	41,037	Continuing
Totals (\$)	748,336	196,323	435,184	

Energex 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

Energex 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 Energex 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 criteria. The standard DMIAM project development and assessment process applied in Energex 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 Future Grid Roadmap³ and the Demand Management Plan
- Project proponents are encouraged to discuss project ideas with other Energex 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 Energex 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 Energex, 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 Energex 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 within Energex should, where possible, ensure their project aligns with these existing Energex strategic network direction and priorities.

3. DMIAM Project updates

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

3.1 Carseldine Home Energy Management System

A program to rollout out Home Energy Management Systems (HEMS) within a new building housing development. The project aims to develop a model for best practice integration of energy efficiency and consumer energy resources (CER) in master planned communities with learnings to be shared with the property sector.

3.1.1 Compliance with DMIAM Criteria

The Carseldine HEMS project was viewed as meeting the DMIAM criteria. The project pilots using developer-led, customer acquired, market-delivered demand response at a Queensland affordable housing greenfield site. Market-delivered demand response via a third-party supplier (i.e. where network procures, from a 3rd party, customers' load and generation control) has the potential to significantly reduce the network's cost of acquisition of demand management.

3.1.2 Nature and Scope

The project involved partnering with Economic Development Queensland (EDQ) as the developer who, with assistance from Energex, secured a suitable HEMS supplier, which were included in half of the new build premises at their time of build.

Energex funding support is proportional to the load/generation under management. For every home in the development, the solar photovoltaic (PV), battery, and living space air conditioning were to be under HEMS management. A funding agreement between Energex and EDQ allocated a 50/50 share between the two parties as a contribution to the HEMS install costs.

3.1.3 Aims and expected outcomes

This project seeks to establish the value of orchestrated CER solutions for mitigating constraints and network challenges. Findings will inform better integration of CER in the future for new greenfield property developments. It will also enable measurement and verification of demand response from greenfield residential developments with high saturation of CER.

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

Following the technical success of the previous DMIAM project Market Delivered Demand Response Pilot as a means of networks accessing third-party management of CER, the opportunity was to establish the cheapest and simplest pathway to customer participation. Greenfield residential developments were seen as one pathway to achieve this opportunity.

Carseldine Village, a residential project being developed by EDQ, part of the Queensland Government, is pushing traditional electrical subdivision boundaries. By delivering 196 terrace homes with 100% solar PV and battery within the Brisbane region to create low energy, low emission, comfortable homes over four stages commencing in 2020, EDQ's goal is to deliver net zero emission sub-divisions. From a network perspective, the project aims to develop a model for best practice integration of CER in new master planned communities with learnings to be shared with the property sector. The Carseldine Village project provides a perfect opportunity for Energex to have a clear view on the behaviour created from a high

uptake of CER in a very localised area on the distribution network within the context of a broader energy system. Twenty-three (23) homes within the 56 home Stage 1 build have access to a HEMS optimising their solar, battery and air-conditioning use.

3.1.5 How it was/is to be implemented

Due to COVID complications, the occupancy of the Stage 1 homes was delayed by 18 months. However, at end of calendar year 2024 all homes are occupied, and requisite HEMS installed. The finish date of the trial has been extended to end of June 2025 to enable collection of sufficient data on seasonal household energy consumption, demand and response to requested events called by Energex network.

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

Data collection across the 25-participant cohort has commenced, but it is too early to derive any concrete learning or observations on baseline data until October 2024. Our next report will have some leading observations to report.

3.2 Valuing Dynamic Connections

Dynamic Operating Envelopes (DOE) implemented through dynamic connections, have become an integral component of the connection arrangements for CER Customers. While networks derive benefits by managing peak and minimum demand and voltage management, the customer value proposition is not well understood, particularly in relation to managing minimum demand.

DOEs have often been referred to in terms of limiting customer export, however they also promote additional network capacity when it can be supported, for example, in periods of minimum demand. This project seeks to identify the value of minimum demand to incentivise for new or existing load shifting.

3.2.1 Compliance with DMIAM Criteria

This project was assessed as meeting the DMIAM criteria. The ability to effectively value minimum demand supports greater social licence to implement demand management capability through dynamic connections, and to effectively assess alternatives to augmentation to support export services.

3.2.2 Nature and Scope

This project involved partnering with specialist economic consulting services to review existing approaches to valuing dynamic connections across the NEM as well as Rule requirements to ensure any minimum demand support program developed is compliant. The consultant was also required to provide a modelling tool to estimate the value of static and dynamic connections for different customers, connection types and different parts of the distribution network.

3.2.3 Aims and expected outcomes

The project sought to calculate the value of minimum demand both in terms of provision of export services and potential minimum system load requirements to demonstrate the viability of non-network demand management options to reduce or remove the need for network augmentation.

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

The range of both contributing and avoiding minimum demand technologies available to customers is rapidly expanding and challenges the traditional economic assessment of demand management solutions. This project was selected to effectively contribute to assessment of non-network alternatives and support future customer engagement towards the benefits of demand management, particularly in respect of addressing minimum demand constraints.

3.2.5 How it was/is to be implemented

This project partnered with a specialist economic consulting firm to undertake key research and modelling activities to develop an approach to valuing minimum demand and dynamic connections. Reports on both valuing dynamic connections and valuing minimum demand were received which summarised other national and international trials and studies and the outputs of the calculators produced. The calculator for valuing dynamic connections considered customers with PV, electric vehicles (EV) and residential batteries. The calculator can also consider varying inputs to model different scenarios and the value to customers and to the network. The minimum demand calculator provides the value stack of broad-based minimum demand management from the perspective of different participants.

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

Key benefits for this project include to the ability to appropriately include a value of minimum demand programs and dynamic connections when assessing non-network alternatives and prompted greater insights into the benefits of non-network alternatives against traditional network augmentation over a time horizon.

3.3 Dynamic Operating Envelopes Phase 1 Commercial

This project is part of a broader DOE Program designed to explore the merits, challenges and viability of the DOEs as applied to small to mid-sized (10kVA - 1500kVA) CER. A DOE defines a range of values for CER export/import to/from the grid such that the network's technical and operational limits are not breached. DOEs will play an important role in supporting dynamic customer connections to manage CER at scale such that the CER is able to provide benefits to customers, the network and the wider market without posing a risk to the operation of the network.

Phase 1 of the program trials the concept at five Energex owned and operated depots.

3.3.1 Compliance with DMIAM Criteria

Having a mechanism to allow a greater penetration of CER into the network through the implementation of DOEs will assist in alleviating demand. The typical PV connection process assesses a new application based on a worst-case scenario assuming full export from all existing systems at a time of minimum load. A system assessed as "Nil" export cannot export at any time, even under times of high network load. The DOE concept also applies to managing electric vehicle or battery energy storage system (BESS) charging to reduce demand when the network is constrained.

3.3.2 Nature and Scope

DOE Phase 1 is focussed on trialling the concept at a commercial level targeting three phase 30kVA-100kVA low voltage (LV) connected systems typical of small-medium commercial or industrial establishments. This work extends the initial implementation at Energex's Cleveland Depot by transitioning beyond the one-way broadcast concept to a two-way communications approach. DOE-enabled PV systems have been installed at five sites with a DOE management platform, a robust and secure operational platform developed to support the necessary data capture, processing and publishing of operating envelopes, implemented in the network businesses' operational technology environment.

3.3.3 Aims and expected outcomes

The DOE Program has the following key objectives:

- Demonstrate as a proof of concept the data, communication and controls required for DOEs to be implemented in near real-time at commercial sites as applied to PV and any available BESS or EVs.
- Evaluate the effectiveness of DOEs as applied to sources of generation and chargeable loads.
- Evaluate the impacts of variations in the DOE on other customers connected to the same LV and medium voltage (MV) feeder on which the DOE is being trialled. Ensure DOE management does not negatively impact other customers as a result of the dynamic nature of the control.
- Evaluate the effectiveness of Institute of Electrical and Electronics Engineers (IEEE) 2030.5 in implementing DOEs.
- Initiate amendments to standards and connection contracts to facilitate the offering of DOE for embedded generation ($\leq 1500\text{kVA}$) at a broader scale in the Energex and Ergon Energy Networks.

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

The business case for the project was reviewed against the DMIAM criteria and was deemed to meet the DMIAM criteria and costs confirmed to be not in any way recoverable from another source. The business cases were presented to the Energex Investment Review Committee which endorsed the projects for DMIAM funding. The project was evaluated against the business' Opportunity Matrix and identified as being an innovative venture with high opportunity potential.

3.3.5 How it was/is to be implemented

During the past year the trial sites have been converted to align with the now standard dynamic connection on offer in Queensland. The first gateway device approved for use on 3-phase dynamic connections was installed. The Common Smart Inverter Profile (CSIP-AUS) compliant device allows standardised communication between the site and the network's Smart Energy Profile (SEP2) utility server which has been stood up to manage dynamic connections across Queensland. The depots are now being transferred to dynamic connection agreements to be managed in the same way as other dynamic connections in Queensland.



Figure 1 - Cleveland Depot Dynamic Solar PV Installation

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

The solar generation available at each site is offsetting most of the typical energy requirements throughout the day with four of the five DOE-enabled sites exporting surplus generation to the grid. The dynamic connection enables the site to export surplus renewable generation while responding at times of excess generation due to other unmanaged PV connections to ensure the local network is not stressed. The project also supported testing of the first gateway device approved for use in single phase applications which was undertaken to ensure dynamic signals did not interfere with the expected volt-var/volt-watt inverter response mechanisms. The testing led to refinements to the Energy SEP2 handbook and installer and customer messaging to ensure robust, secure dynamic connection adoption in the residential space as well. The process of upgrading the Energex depots to align with STNW3511 Dynamic Standard for Low Voltage Embedded Generation Connections has also revealed gaps to be addressed to remove barriers which may hinder customers with existing installations converting to dynamic connections.

3.4 Model Free Dynamic Operating Envelopes

This project is part of a broader DOE program. It is focused on exploring alternative methods for determining DOE without any network model data, leveraging available 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 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.

3.4.1 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 EV 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.

3.4.2 Nature and Scope

This Project has two stages, the first focuses on three LV networks with high 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 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.

3.4.3 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
- Identify minimum data requirements to generate a model free DOE that reliably outperforms basic DOE

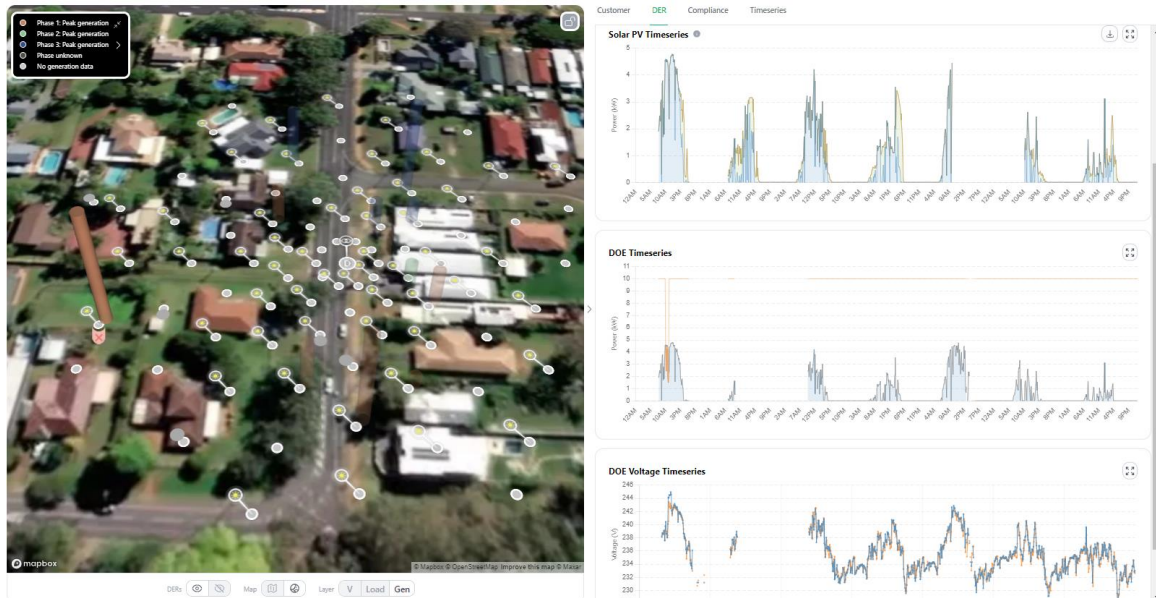


Figure 2 - Model Free DOE platform (source Gridsight, 2023)

3.4.4 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 (Model Free DOE). 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.

3.4.5 How it was/is to be implemented

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 3 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, and so 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.

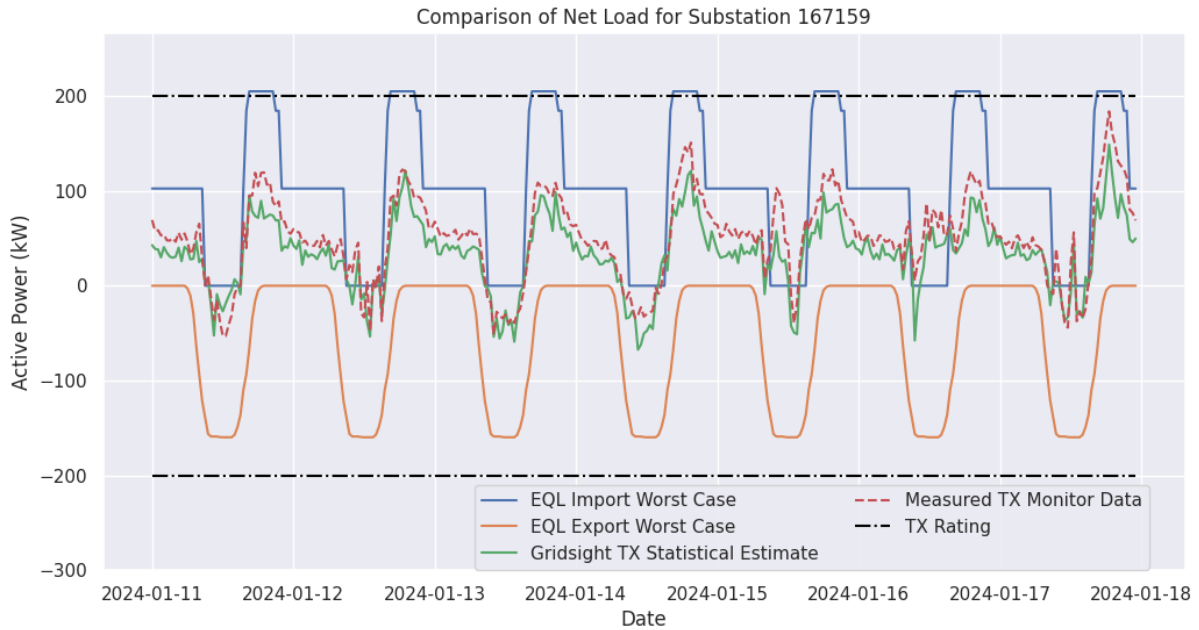


Figure 3 - Comparing measured transformer monitoring load with Gridsight and network estimates

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 4 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.

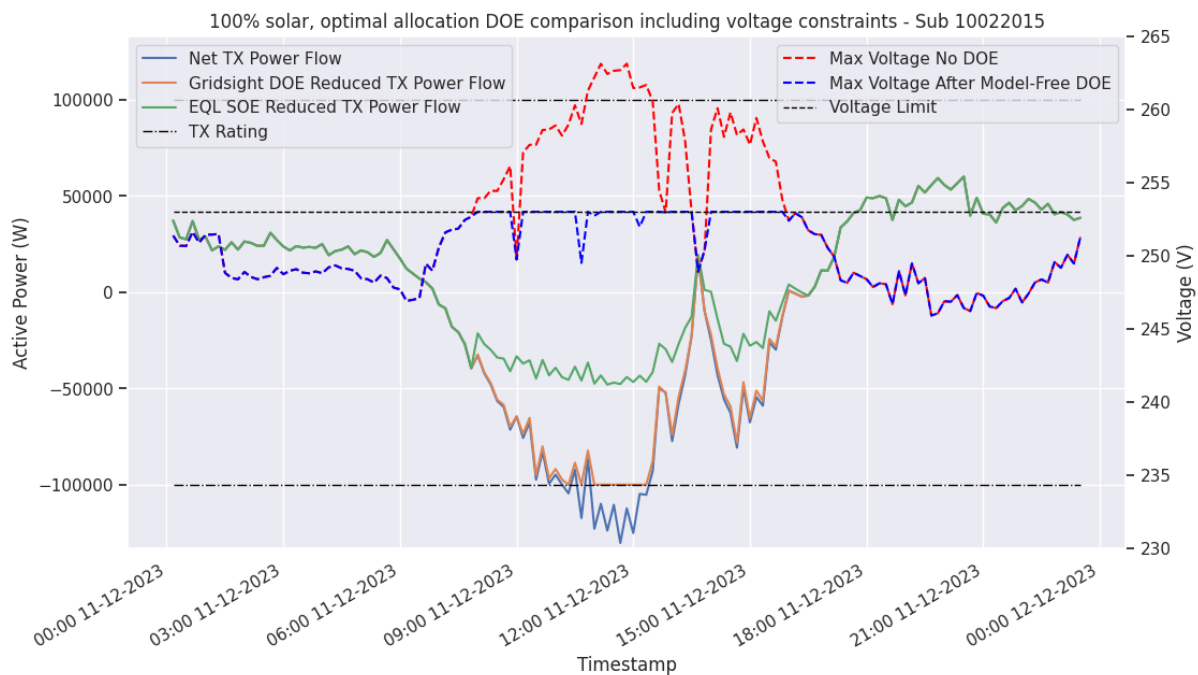


Figure 4 - 100% solar uptake load comparisons with optimal allocation and without voltage constraints

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 5 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.

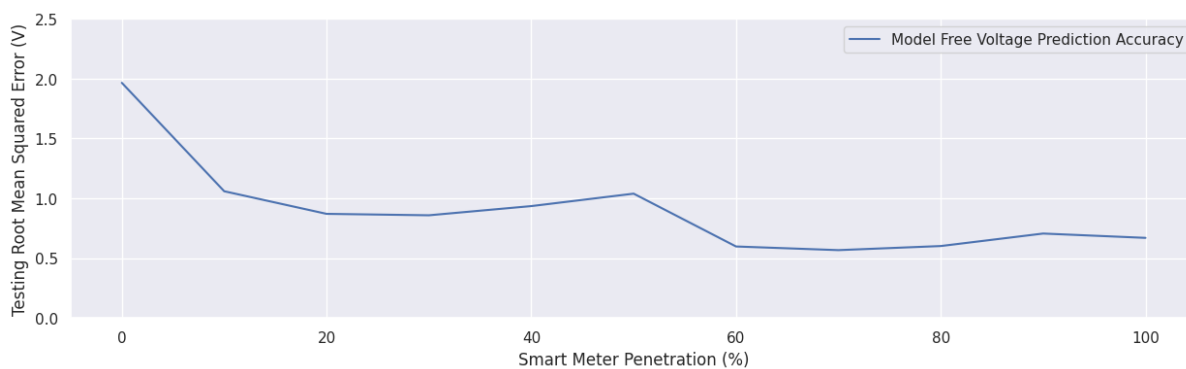


Figure 5 - Model-free DOE voltage prediction accuracy with variable GV

3.4.6 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 and with dynamic connections.

3.5 Development of Aggregated Dynamic Model Consumer Energy Resources Master

The purpose of this project is to develop an aggregated dynamic model of distribution networks with CER such as solar PVs, batteries, and electric vehicles, to be used in enhanced modelling of the whole electrical grid for the future stability studies and network capacity assessment to host all combination of renewable energy resources.

3.5.1 Compliance with DMIAM Criteria

The project meets the DMIAM criteria in terms of providing the initial research and development of demand management capabilities, is innovative and has the potential to reduce long term costs.

This project will develop individual / aggregate models & planning techniques required to identify stability constraints and develop processes for evaluating solutions to understand the effectiveness of various network & non-network solutions.

Electromagnetic transient models for LV connected Inverter Based Renewables (IBR) and verified aggregation techniques, for the purposes of assessing system strength impact, do not exist today. Therefore, the proposed project is both new and innovative.

The outcomes of this research project would lead to a reduction in effort and costs that would otherwise be borne by both networks and others. The developed aggregation techniques will be simpler and less costly than modelling individual IBR models and the complex and high volume of LV networks they are connected to.

3.5.2 Nature and Scope

This preliminary research study will develop an aggregated dynamic model of distribution networks with consumer energy resources connected at LV. Once these models are developed, the focus will then be on identifying processes to integrate LV CER models into existing Energex and Ergon Energy Network models and forecasts so that these systems can be considered in the overall Demand Management, CER Management & Network Connections Processes.

3.5.3 Aims and expected outcomes

- Literature review report
- A power systems computer aided design (PSCAD) model of single-phase CER
- Final PSCAD model of single-phase CER
- Report on dynamic behaviour of two CERs with mathematical analysis
- Report on dynamic behaviour of CERs collectively
- Aggregated model of CERs on a feeder case study in PSCAD
- Final report with developed models
- Processes & tools developed for integrating PSCAD CER models into existing Demand and Energy Management, CER Management & Network Connection processes

3.5.4 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.

3.5.5 How it was/is to be implemented

This project will be delivered by a joint research team across Deakin and Monash University. The universities will provide in-kind support via Senior Professors to supervise, guide and project manage the project delivery by dedicated researchers. The industry partners across Energex and Ergon Energy Network, Powerlink Queensland and the Australian Energy Market Operator will provide cash contributions to support the acquisition of the two dedicated research fellows. The project will also be supported by C4NET who will provide additional cash contributions and in-kind contributions for project management and administration.

The project has completed the following outcomes:

- Literature review report
- A PSCAD model of single-phase CER

The project is well advanced on developing the aggregation methodology.

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

The project has just commenced with all parties recently agreeing on the scope of work and support. The key benefit of the scoping process to date has been to clearly identify the common priorities and benefits for the distribution network service provider, the transmission network service provider and the system operator.

3.6 Autumn Demand Response Trial

The purpose of this project is to develop a fit for purpose Network Support Agreement (NSA) and execute an agreement with a market participant to explore the potential for a flexible demand response to address forecast negative peak demand that is expected through Easter 2024 and to assess the availability and cost of flexible load and generation, and other non-network solutions, that can be called on to mitigate forecast network minimum demand constraints.

3.6.1 Compliance with DMIAM Criteria

This project was assessed as meeting the DMIAM criteria. The project seeks to explore flexible demand response during a forecast period of significant minimum demand. Through an EOI, large customers and market participants will test contractual processes, communication protocols for generation reduction and potential demand/cost reduction evaluation.

3.6.2 Nature and Scope

The project sought to explore the potential for a flexible demand response to address a forecast minimum demand event. This forecast event included a period where solar irradiation was high but corresponded with lower ambient temperatures that supported high solar PV generation without heating/cooling load. This forecast period was expected 29 April 2024 to 01 May 2024 inclusive (Easter period).

Through an EOI, large customers/retailers were enlisted to participate in an NSA that would require their solar PV exports to be disabled during an established demand response event period. Additionally, customers were also sought that may increase load, such as storage customers, to ultimately reduce the impacts of minimum demand.

Analysis of premise data against a baseline was undertaken to validate demand flexibility potential and the level of network support (including benefits derived), including from national metering identifier to transformer, feeder and system level. Commencement of an event was undertaken through the retail partner linking to communications protocols.

3.6.3 Aims and expected outcomes

The aims of this project were two-fold: testing the ability to provide market signals to participating customers to reduce exports; and market testing for customers willing to do so through an NSA.

These aims enabled the realisation of the expected outcome of a reduction in minimum demand impacts, along with key insights to scale up such an approach in future years to reduce network augmentation.

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

A market based EOI was a foundational aspect of this project to gain external inputs and contribute to the final business case. Alternatives to this project included traditional approaches to network management of excessive levels of minimum demand.

3.6.5 How it was/is to be implemented

Engagement with CS Energy occurred through their response to the EOI. The project involved collaboration with CS Energy to manually isolate the Solar PV Inverter at each of the selected sites during the project period of Easter 2024. The EOI resulted in a retail partner that was successful in providing large customer sites possessing large scale solar PV but without corresponding load throughout the forecast event dates (schools).

Following the test processes, demand response events were enacted in the minimum demand period.

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

Four school sites in Springfield participated in the project, orchestrated via CS Energy. These customers were considered to have large solar PV export during the trial period.

The trial identified that through network support agreements customers could be influenced to participate in curtailing solar PV generation export during periods of low network demand. The network benefit is realised when excess solar generation is curtailed during low demand periods, which can assist to reduce thermal constraints caused by reverse flow energy.

Taking one customer site with 132kW of Solar PV as an example, transformer monitoring found that when the customer elected to cease exporting energy, the reverse energy flow from that location during the minimum demand period was negated. Similar comparative weekends where the customer did not curtail solar PV generation, showed reverse energy flow from transformer monitoring.

The project is currently exploring opportunities to replicate peak demand events using a similar approach, for example on a larger scale and/or using synchronised integration systems to prevent manual switching and improve demand response times.