Energex
DMIA Report 2020-21

September 2021

energex

Part of Energy Queensland

Contents

1. Introduction

1.1 Purpose and Compliance

Energex is pleased to present the Demand Management Innovation Allowance (DMIA) Report for the 2020-21 regulatory year. The purpose of this report is to allow the Australian Energy Regulator (AER) to:

- assess Energex's 2020-21 DMIA initiatives and Energex's entitlement to recover the expenditure under the AER's Demand Management Incentive Scheme (DMIS)
- 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, paragraph 6 of the AER's RIN (refer Figure 1), which requires a DNSP to which the DMIS applies to submit an annual report to the AER on its expenditure under the DMIA. This report, and the information contained in the report, is suitable for publication by the AER.

Figure 1 DMIA reporting requirements Schedule 1: Item 6 – Demand Management Incentive Allowance

6.1 Identify each demand management project or program for which Energex seeks approval.

6.2 For each demand management project or program identified in the response to paragraph 6.1:

a) Explain:
   (i) how it complies with the Demand Management Innovation Allowance criteria detailed at section 3.1.3 of the demand management incentive scheme;
   (ii) its nature and scope;
   (iii) its aims and expected outcomes;
   (iv) the process by which it was selected, including its business case and consideration of any alternatives;
   (v) how it was/is to be implemented;
   (vi) its implementation costs; and
   (vii) any identifiable benefits that have arisen from it, including any off-peak demand reductions.

b) confirm that its associated costs are not;
   (i) recoverable under any other jurisdictional incentive scheme;
   (ii) recoverable under any other Commonwealth or State Government scheme; and
   (iii) included in the forecast capital or operating expenditure approved in the 2015-20 Distribution Determination or recoverable under any other incentive scheme in that determination; and:

c) state the total amount of the Demand Management Innovation Allowance spent in the relevant regulatory year and how this amount has been calculated.

6.3 Provide an overview of developments in relation to projects or programs completed in previous years of the regulatory control period, and any results to date.

1.2 DMIA projects summary

In its Distribution Determination the AER decided to apply Part A of the DMIS (i.e. the DMIA component) to Energex, approving an innovation allowance amount of $5,582,165 over the 2020-25 regulatory control period. Energex's 2020-21 DMIA program comprised nine projects active during the year. The total cost incurred for the DMIA initiatives during 2020-21 was $894,494.60. This total amount is exclusive of indirect costs (financial overhead and fleet on-cost). The table below summarises the Energex DMIA program expenditure recovery for the 2020-21 regulatory year

Figure 2: 2020-21 Expenditure ($)

Project	Budget	Capital	Operating	Total	Status (as at 30 June 2021)
Enabling Dynamic Export Limits	258,520		12,577.78	12,577.78	Continuing
IPDRS Pilot*	553,707		0	0	Continuing
Expanded Network Visibility Initiative	692,939		630,901.24	630,901.24	Closed
Market Driven Battery Storage Pilot	795,000		29,625.33	29,625.33	Continuing
DLC via Network Monitoring Device (Redback)	100,808		$28,490.25	$28,490.25	Continuing
Evolve	252,000		49,701.73	49,701.73	Continuing
WP4 Tesla Eagle Farm DC	178,206		7,922.31	7,922.31	Closed
Electric Vehicle Research	745,942		82,360.41	82,360.41	Continuing
DOE Phase 1 Commercial	241,854		52,915.55	52,915.55	Continuing
Totals	**3,818,976**		**894,494.60**	**89,4494.60**	

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 2015-20 Distribution Determination.

*Project continued during 2020/21, however no expenditure incurred.

2. DMIA Project development and selection process

Energex considers DMIA investments an important component of its commitment to delivering customer value over the longer term. The DMIA program complements our demand management program, which is geared toward providing a more efficient solution to network augmentation. The DMIA initiatives have enabled Energex to investigate and test innovative approaches to a range of network issues, customer behaviours, renewable integration and tariff enablement.

For the 2019-20 DMIA program, all nominated DMIA projects are subject to a screening and feasibility processes, consistent with the AER's DMIS. This governance process was reviewed and enhanced during the year, in-line with the merger of Energex and Ergon Energy and alignment of application of DMIA funding with the respective DNSP's. The general DMIA project development and assessment process applied in Energex involves:

- Promotion of DMIA funding and criteria to internal stakeholders to encourage project ideas to be submitted, as an EOI or more formal DMIA Project Scope;
- Review of EOI or DMIA Project Scope against DMIA criteria as a minimum, and against relevant internal strategy documents, including the Energy Queensland Future Grid Roadmap*, the Demand and Energy Management Strategy and Load Control Strategy;
- Project proponents are encouraged to discuss project ideas with other Energex or Ergon Energy subject matter experts, which helps guide and refine the idea;
- Projects that are deemed to meet the DMIA criteria are then formally submitted to the DMIA Program Manager for approval, or endorsement to the appropriate financial delegate.

*The Future Grid Roadmap is a document that outlines a range of themes and supporting activities and no-regret investments necessary for Energex and 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 DMIA criteria, however project proponents within EQL should, where possible, ensure their project aligns with these existing EQL strategic network direction and priorities.

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.

In November 2020, a workshop was held with key internal stakeholders at which a wide range of potential DMIA project ideas were brainstormed and assessed against DMIA criteria and other internal strategy documents. A list of projects was identified as possible or probable, which will be considered for further development into actual projects during the regulatory period. Looking forward to 2021/22, formal engagement with universities will be undertaken to explore potential project partnerships, potentially using DMIA funding where applicable.

3. DMIA Project updates

This section of the report details the status of the Energex DMIA projects in 2020-21 by describing each project, its objectives, progress and findings to date.

3.1 Enabling Dynamic Export Limits

This is a trial to demonstrate the benefits to customers and network of moving from static export limits to dynamic export limits.

3.1.1 Compliance with DMIA Criteria

The objective of this trial is to demonstrate the benefits to customers and our network of moving from static export limits to dynamic export limits. This proposal is aligned with Stream 1 of the Future Grid Roadmap - Managing two-way energy flows, specifically around Customer Distributed Energy Resources (DER) Active Management. A number of research collaborations including the Solar Enablement Initiative (SEI), Queensland Integrated Power Platform (QIPP), Advance Queensland Platform Technology Program and the Evolve DER Project are developing techniques for more active DER management.

3.1.2 Nature and Scope

The scope of the trial includes the installation of a commercially available 50 kW, 3 phase rooftop solar photovoltaic (PV) system complete with a Dynamic Export Limit Controller (DELC) which enables the solar inverter to respond to near real-time export limit signals. The DELC system responds to published limits calculated based upon reverse power flow through the local network LV transformer. The purpose of this trial is to investigate the viability of enabling energy flow from small to medium sized commercial solar PV customers otherwise subject to a zero export connection agreement which may be the case in areas with already high PV penetrations .

3.1.3 Aims and expected outcomes

The potential learning objectives will include the following:

Customers

- Understanding customer drivers and barriers to taking up solar PV with active DER control; and
- Understanding what level of control can be implemented which has minimal impact on customers' use of the Solar PV whilst providing maximum benefit to the network and the customer.

Technology

- Foster and drive the development of technologies and interface techniques required for active management of solar PV;
- Gain a better understanding of the technology impacts of potential increased levels of solar PV penetration with active management take up on the electricity network and how Energex/Ergon Energy might need to evolve the LV network design to accommodate

customer technology requirements (Solar PV, BESS, and Energy Management Systems); and

- Gain a better understanding of the inverter technology configurations, sizing and optimal control methodologies to enable active DER to support network real-time conditions and load requirements.

Energex/Ergon Energy

- Gain an understanding of what role Energex/Ergon Energy should play in the Solar PV enablement market incorporating active management of DER;
- To demonstrate operational real-time active DER response to network constraints as part of the Solar Enablement Initiative; and
- Test if the existing Energex/Ergon Energy connection requirements allow easy access to increased levels of Solar PV output with active management capability on the EQL distribution network.
- Determine how to minimise the technological changes required to enable active DER management.

3.1.4 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 DMIA criteria by both Demand Management and Regulatory Departments. The project was deemed to meet the DMIA criteria and costs confirmed to be not in any way recoverable from another source. The business case was presented to the Energex Investment Review Committee which endorsed the project for DMIA funding.

3.1.5 How it was/is to be implemented (ie general project update)

The Enabling Dynamic Export Limits for Commercial Solar PV trial has been constructed and commissioning was completed at Energex's Cleveland Depot (mid-August 2019). The trial and testing phase has been initiated.

The trial site was selected as it represents a site that a customer would be likely to install solar PV to reduce their annual energy consumption to below the maximum 100 MWh / year which is the threshold for a network demand-based tariff threshold. This sector of customers often applies for a zero-export solar PV connection application to mitigate additional engineering costs and assessment process delays. In this case there is no ability for the distribution network to benefit from any excess generated energy to be exported from these sites or the ability of the customer to receive a Feed-In-Tariff (FIT). The Dynamic Operating Envelope (DOE) enables both of these opportunities to be available with little to no impact on the customer's solar PV system operation and only a moderate investment in comparison to the financial earning capability of the FIT over the lifetime of the system.

All of the technology outcomes outlined above have been demonstrated and are now operational in the stage one trial site at Cleveland. The DOE and network control platform have been further developed and will align with other state and national energy trials to include compliance with existing and influence future Australian Standards for DER connection capabilities as more customer connections are sort. This will require the adoption of the DOE platform at the inverter manufacture stage to offer widespread deployment to realise the holistic distribution network support opportunities.

Energex is furthering this initiative as part of the Dynamic Operating Envelopes Phase 1 Commercial project (refer to 3.6 below) which will expand the trial to five sites based upon the initial success of

the prototype Cleveland site. The Cleveland trial, nominated as “Smart solar export in real-time via Dynamic Operating Envelopes“, was a finalist for the Energy Networks Australia Innovation Award 2020.

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

The site has the capability to export excess solar PV generation beyond the site demand to support the local LV and 11 kV feeder network, to date up to 32 kW of peak demand network export support has been measured at the NMI. This project has demonstrated near real-time dynamic export based upon the actual network conditions rather than a fixed export value determined based on worst case conditions.

3.2 IPDRS Pilot

The purpose of this project was to undertake market discovery to establish a complete end-to-end energy management system that enables the Internet Protocol Demand Response Device (IPDRED) functionality. Regulatory change regarding a DNSPs ability to own assets behind the customer meter has led to a Network strategic change as to the securing of demand management/response direct with customer. The movement away from direct firm load control has shifted to market procurement. This project is jointly funded under Energex and Ergon Energy DMIA allowances.

3.2.1 Compliance with DMIA Criteria

The project aims to orchestrate improved energy management (peak lopping, valley filling, neutralise otherwise disruptive loads) to reduce network augmentation requirements. The purpose of an IPDRED is to increase the amount of load under management (more appliances, improved geographic coverage), improved the ability have more granular / targeted load control; and to complement existing load control based around audio frequency-based load control. As the project was initiated in 2019-20 but expected to carry forwarded into the 2020-25 regulatory period, it was assessed against the DMIA criteria applicable in both Regulatory periods. The project was deemed to be in compliance as it was a program for researching, developing or implementing demand management capability or capacity, that could be in used broad based or specific network demand constraint areas.

3.2.2 Nature and Scope

Undertake market discovery to establish a complete end-to-end energy management system that enables the IPDRED functionality already identified. Market discovery will enable improved costings for a Gate 3 Business Case. The scope covers engagement of potential service providers of solutions being sought for platform and communication pathway solutions.

3.2.3 Aims and expected outcomes

The aim is to identify suitable service providers for a complete energy management platform (from platform serve to a demand response communications pathway). The outcome will be a detailed business case to move forward with market roll-out Internet Protocol Demand Response Enabling Device (IPDRED) requirements if the pilot is successful.

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

With regulatory requirements seeking DNSP movement away from any activity behind customer meters and encouraging a market that can release greater value to customers via other market players, this program seeks to meet this opportunity. Supporting a pathway to an enabled market-delivered demand response market will broaden the variety and number of loads and DER accessible for network support and augment the existing audio frequency load control / demand management platform.

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

The project was meant to operate through the engagement of service providers of technology solutions being sought for platform and communication pathways. Service providers were asked to secure new participants to their existing “home energy management systems” based on a set of DNSP requirements, including an incentive payment. Unfortunately, this customer acquisition model was not successful. Alternatives to boost customer participation to the pilot were under with an end result of 28 active participants.

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

Given the regulatory moves toward market procurement of load control, part of the original objective to have a better understanding of the cost to deliver an end to end control methodology has morphed to being that of formalising with the market, a DNSP's requirements of their vendor solutions to enact demand management/response on the DNSP's behalf.

18 events were called seeking a mixture of both peak and minimum demand between the 22 February and 6 June 2021. Very positive results identify that the IPDRS solution is technically successful in delivering significant network relief when required. Diversified demand reductions of over 2kW, and diversified minimum demand relief of at least 2kW per event participant were observed with relative ease. A full report on the pilot will be released providing full detail of the pilot and results.

As the project draws to a conclusion in Q1 of FY 2021/22, it has identified five outcomes;

(i) The existing embryonic market conditions make it exceedingly difficult for third-party providers to make meaningful inroads to customer acquisition. Solutions can be costly due to lack of economy of scale, and customers are not really aware of the home energy management market, meaning
(ii) significant financial assistance would be required to inject impetus to the market, whilst
(iii) finding other channels to market will assist in generating market uptake (e.g. greenfield sites),
(iv) that IPDRS orchestration of DER and loads within a home can present significant opportunities for network support as well as direct customer savings and other benefits, and
(v) the IPDRS program has helped EQL networks understand better how to request the specific network support from IPDRS suppliers.

3.3 Expanded Network Visibility Initiative

The purpose of the Expanded Network Visibility Initiative (ENVI) is to build on the work of the Solar Enablement Initiative and LV State Estimation project, former DMIA projects, which successfully demonstrated a novel state estimation in operation on Energex's network. ENVI will develop the tools and systems to enable the scale-up of Distribution System State Estimation (DSSE) across Energex and Ergon Energy medium and low voltage feeders. This project is joint funded with Ergon Energy DMIA funding.

3.3.1 Compliance with DMIA Criteria

The Expanded Network Visibility Initiative complies with the Demand Management Innovation Allowance criteria detailed at section 3.1.3 of the demand management incentive scheme. The visibility over historical and near real-time network performance that can be achieved by application of DSSE will improve the business' ability to identify areas of network which may benefit from additional demand management and facilitate better orchestration of distributed energy resources on the low voltage network.

3.3.2 Nature and Scope

Broadly, this project will focus on developing and deploying the capability to perform state estimation on medium and low voltage feeders in Energex and Ergon Energy. In addition, it will explore the application of state estimation to improve existing demand management approaches through improved network visibility and capacity constrained optimisation analysis.

3.3.3 Aims and expected outcomes

The purpose of the Expanded Network Visibility Initiative (ENVI) is to expand on the work of the Solar Enablement Initiative (SEI), a previous DMIA project, which successfully demonstrated a novel State Estimation Algorithm (SEA) in operation on Energex's network. ENVI has one primary objective and three secondary objectives:

1. Development of the tools and systems required for Ergon Energy and Energex to scale-up the SEA across their MV and LV networks to provide expanded network visibility as an intelligent foundation to enable distributed energy resources (DER) and facilitate demand management activities (Primary).
2. Refine the prototype semi-automated network analysis tool developed by the SEI to enable engineers to accurately predict the impacts of future Distribution Energy Resource connections – both generation and load (Secondary).
3. Further refine and maintain the SEA to facilitate Dynamic Operating Envelope trials which seek to dynamically signal customers or third parties, such as Virtual Power Plants (VPPs) or aggregators, to operate within an operating envelope based on near real time network operating conditions (Secondary).
4. Develop a tactical plan for the use of the SEA's companion Capacity Constraint Optimisation to inform and automate existing manual Load Control Schedules (LCS) (Secondary).

The work will be undertaken in a collaborative engagement with external company GridQube who has been granted the rights to commercialise the SEA from the University of Queensland.

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

This project was selected based on the multiple benefits it can provide to many areas of the business, demand management being one. DSSE is seen to be an efficient approach to gaining visibility over the network, without the need for extensive and costly network monitoring. It can achieve the same level of visibility using less data. Using the business' Opportunity Matrix it was identified as an innovative venture with high opportunity potential.

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

The project is progressing well with DSSE operational in EQL's Amazon Web Services tenancy. A data streaming platform has been established to push data from field devices in near real time with data available for DSSE every 5 minutes on select trial feeders. The transfer of time series data has also been established with an interface to the businesses' PI Historian databases. Basic network tracing scripts have been built to extract network feeder models from both Energex and Ergon systems enabling testing of various use cases.

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

The project was not targeting a specific quantity of peak or off-peak demand reduction but is targeted as establishing platforms and capability from which sound demand management decisions can be made based on the increased network visibility provided by DSSE.

This project is now in the close-out phase having delivered:

(i) A cloud-based technology platform on which DSSE can be run within EQL's operational environment.
(ii) A data streaming solution to deliver data from various sources and systems to the DSSE.
(iii) Access to network monitoring data to support both near real-time and historical DSSE.
(iv) A basic mechanism to extract and load network feeder models into the DSSE. A more advanced and automated solution is under development as EQL introduces new geospatial and asset record systems from which future network models must be extracted.
(v) An integration of DSSE, capacity constrained optimisation and dynamic operating envelope calculations as run in AWS with the operational technology platform from which DOE will be published externally. This work is directly related to the Dynamic Operating Envelopes Phase 1 Commercial project (refer to 3.6 below).
(vi) A demonstration of the use of DSSE to optimise demand management calls via peak smart. This demonstration is still being refined as part of the project close-out together with a demonstration related to optimising AFLC scheduling across a zone substation.
(vii) A demonstration of the use of DSSE to automate network connection assessments.

3.4 Market Driven Battery Storage Pilot

A battery trial for residential homes who already have solar to understand customer and grid impacts / benefits (15 residential sites in Brisbane).

3.4.1 Compliance with DMIA Criteria

The BESS Pilot complies with the Demand Management Innovation Allowance criteria detailed at section 3.1.3 of the demand management incentive scheme. The BESS project focuses on an emerging technology that is anticipated to be taken up by customers at an increasing rate over the coming years. It is imperative that Energex gain early insights into how customers will take up BESS, how Energex can provide a direct demand load control value proposition, how the systems will be integrated into the network and what changes need to be made to the network to accommodate the technology.

3.4.2 Nature and Scope

A targeted Market Based Battery Trial was undertaken in cooperation with BESS manufacturers who were selling BESS to customers in South East Queensland. The trial ran from September 2016 to June 2020 and included installation of batteries in 15 homes that already had solar systems. At the time of installation, the battery market was immature, installers had little experience and the Australian Standard for household battery installation (AS/NZS 5139:2019) had not been published.

The Market Based Battery Trial was planned to run in two stages: firstly, with 15 staff sites and secondly with customers in selected areas of the network. The trial is focussing on the coordination of demand response capable BESS that are compliant with AS/NZS 4755.3.5. The trial aimed to investigate the value to the network from coordinated and standardised BESS demand response, particularly during peak demand and peak export periods.

Since commencing the first stage of the trial, several larger scale BESS trials looking at coordinated demand response were run in Australia, Consequently, the second stage of the trial was not be undertaken.

The trial has now been completed and all batteries removed.

3.4.3 Aims and expected outcomes

The trial objectives were to:

- understand how customers use batteries and what the impact of these new customer load profiles will be on the network;
- investigate coordination of standardised demand response from batteries to enable more customers to connect solar PV and batteries to the network; and
- explore customer incentive options that provide new value to the industry and ultimately to our customers.

3.4.4 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 DMIA criteria by both Demand Management and Regulatory Departments. The projects were deemed to meet the DMIA 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 DMIA funding.

3.4.5 How it was/is to be implemented (ie general project update)

The Market Based Battery Trial concluded this year. The 3-year trial was due to end December 2019; however, the trial was extended to March 2020 to allow the capture of data over an additional summer period. The batteries were then removed between the period of March and August 2020.

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

The trial has produced several benefits including:

- Peak demand reduction: This project successfully demonstrated that batteries do provide peak demand reductions, and can be successfully called upon, using existing Load Control System (LCS) infrastructure, to reduce demand when required. Refer to preliminary finding report.
- Data for use by external parties: Data from the trial has been requested by University of New South Wales for analysis on effectiveness of battery energy systems to reduce peak demand, and by Powerlink for analysis as part of a chronological demand trace for different parts of Powerlink's network.
- Learnings and insights on battery installation: Learnings from the battery installation phase of the trial were published in May 2017, including an Energex report on practical learnings and tips for battery installers and a Clean Energy Council (CEC) Inspections Summary report.
- A final report and case study have been prepared that provide the key results provided by the trial (available on request).
- The trial also provided insights into the application of batteries for addressing minimum demand (refer to case study and final report).
- The trial has increased awareness of demand response standard AS/NZS 4755.3. Also working with different third-party battery applications has highlighted the need for standardised demand response communication protocols.

3.5 WP4 Tesla Eagle Farm DC

Following on from the installation and commissioning of the Eagle Farm 150kW PV system and 250kW BESS identifying opportunities for network support from large scale BESS and PV.

3.5.1 Compliance with DMIA Criteria

The Solar PV and BESS trial represents the first operational commercial scale system compliant to AS4755.3.5 with DRED functionality and Island operation. The system has the ability to disconnect completely from the distribution network and operate in island mode for short durations as well as the ability to inject or export energy for grid support if required.

3.5.2 Nature and Scope

Testing of the installed system post commissioning to ensure stable operation, ability for the system to manage peak demand on site and operate for short durations in an islanded mode.

3.5.3 Aims and expected outcomes

Benefits anticipated from this project include:

- Identifying opportunities for network support from large scale BESS and integrated PV, which may typically be installed at a commercial premises;
- Demonstrate load control of a large scale BESS and integrated PV via local control software and how networks can interact with the systems;
- Investigate options for control via Demand Response Enabled Devices (DRED);
- Inform the development of a customer BESS control strategy for large scale systems;
- Identify improvement opportunities for existing IES connection standards;
- What modes a customer may operate in and how this might affect their connection to the network (i.e. connection agreements, tariffs, ADMD's, etc.); and
- Identify knowledge and skills relation to:
  - Enabling effective integration
  - Understanding impacts on planning, forecasting, switching and fault finding.

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

This was a follow-on project from a previously funded DMIA project and was approved on the basis of compliance with DMIA criteria and the requirement to continue development of this project concept.

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

Operation of the system between July 2020 and April 2021 demonstrated relatively stable operation. There were some network events that tripped the system and we have learnings as a result. The system also was taken through a planned network outage to test its automated islanding capabilities which have been proven. In short, the system's day-to-day operation is demonstrating peak site demand limitation, utilising renewable energy as part of the solution. This program has been shut down prematurely (fail fast) due to challenges with variable operation of the BESS (including a considerable outage between April 21 and August 21) due to manufacturer changes in operating protocols and challenges (non-technical, more commercial) with how the device was able to operate on the local distribution network (the connection point is not to the Energex distribution network).

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

The combination of battery and solar has enabled overall management of the peak demand of the site. It has highlighted the importance of tight control integration between the BESS and PV to enable effective levels of demand management.

The system has transferred to island mode during grid outages. During these outages a tighter integration with the Building Management system was identified to maximise the available energy.

3.6 Electric Vehicle (EV) Research

A longitudinal program (provisionally 3 years) of monitoring EV charging primarily at customer residential properties.

3.6.1 Compliance with DMIA Criteria

Through understanding of residential EV charging profiles and acceptance to be managed, Energex will be able to assess the value of demand management within the EV market.

By understanding charging profiles and behaviours and testing the control available to EQL, will further inform:

- how EVs can be managed effectively for network reliability and stability whilst also fulfilling a customer need for assurance of charge for their requirements;
- The value of EV load management for the network and customers in both a broad-based and targeted sense; and
- how the introduction of vehicle-to-home/grid can be optimised to best effect for the customer and the network.

Once EV charging profiles of residential customers is better understood, and trialling of load control of said vehicles illustrates the flexibility available in managing these charging profiles, so value propositions can be established that encourage either:

- behavioural and attitudinal changes to charging profiles that suit the network (generic primary tariff solutions);
- opportunities for third-party (aggregator) influence in managing charging profiles, or
- direct control by the DNSP of charging profile through load control tariffs.

3.6.2 Nature and Scope

Energex and Ergon Energy need to better understand the charging patterns of residentially used EVs to mitigate potential risks and maximise opportunities that EV's present.

3.6.3 Aims and expected outcomes

The specific objectives of this research program are to understand the charging behaviour of electric vehicle (car) owners to:

- provide charging profile data for Scenario Planning and Forecasting to assess the impact on Queensland networks and other EV-related purposes;
- determine any policy issues and requirements regarding connection of private EV chargers and their ability to be managed;

- inform requirements for any future EV specific data capture systems
- assess the necessity for possible EV LV network monitoring;
- incorporate residential charging models to inform future planning of public charging station locations and network requirements for supply;
- prepare for vehicle to home/grid EVs;
- customer journey mapping to understand buying behaviour and likely spatial take-up using EQL's new market segmentation;
- better educate and communicate optimal options for best charging practices for customers and the network;
- inform EQL on how EVs will influence future tariff requirements, and
- maximise the value of EVs to the EQL networks (maximum revenue for minimum cost).

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

To date there has been no primary research undertaken in Australia to deliver actual charging profiles of residential EVs across a wide model range, their geographic location, potential charging capacity, and the availability of renewables at home.

Through DMIA funding this project will allow Energex networks to understand charging profiles and behaviours and through testing the control available to EQL will provide bench marking data, inform how existing connection processes may need to be modified to improve customer and network outcomes and provide evidence and direction on what energy management options are available to optimise these network and customer outcomes.

The standard DMIA process was adhered to in seeking funding to support this project. A formal business case was developed, and cross company approval sought. alternative considerations were identified. These included attitudinal research on how EV owners expect to charge their EV's as well as modelling of internal combustion engine (ICE) vehicles as a proxy for EV driving and charging data.

Both were eliminated given less reliable and less accurate data as well as only being informative at a static point in time. Additionally, these considerations were limited by lack of customer knowledge of their EV charging, and their intention not matching actual activity.

Real charging data also allows confirmation of assumptions around charging of an EV and importantly the peak demand generated and associated load profile analysis. ICE EV usage patterns are assumed very different and this project will allow confirmation of same.

3.6.5 How it was/is to be implemented (ie general project update)

The program will provisionally extend over 3 years.

Stage 1/Year 1 (Recruitment & Data Baseline): The program launched end of May 2020, and as at 30 June 2021, 197 participants had been recruited in the program. Small financial incentives of $100 for sign-on were provided to entice participant involvement in addition to access to individual poral dashboards for participants. All channels to market have embraced the program well and been proactive in on promotion to constituent or member bases.

Participant sub segment user groups were identified and targeted during recruitment phase considering:

- EV details – make/model, model year, max charge rate, rego, purchase date
- Vehicle size and categorisation- BEV small/large or PHEV
- Geography- urban, regional and rural
- Electrical connection type & tariff connected to, retailer association
- Charge method
- Dwelling type- detached house, apartment, townhouse
- Integration of solar and BESS

A small sample of fleet vehicles are included within the participant base to supplement residential findings of EV driving and charging behaviour. Participants must have EVs registered in Queensland and be connected to the Ergon or Energex network. Energex purchased the C2 devices in bulk upfront (from FleetCarma – hardware and licencing partner) and facilitated the participant pre-registration process. Each participant received a C2, 3G connected car device from Energex that will monitor their driving and charging data. Some initial teething issues have been experienced and ongoing data cleansing continues to ensure validity of what the data is demonstrating. Energex receives raw data files in addition to access to its own utility dashboard. Some definitions and modifications to data sets were made to ensure usefulness of data going forward for respective internal audiences and external stakeholders.

Stage 2/Years 2 & 3 (Baseline & Control): mid 2021 – mid 2022.

The first-year data analysis insights will assist in determining the opportunity to incentivise participants to change behaviour if normal charging is deemed not at appropriate times for the network i.e. 4-9pm peak periods. The original participants acquired in Year 1, will be introduced to incentive rewards for changing their charging behaviour to understand participant willingness to change charging behaviour and what are the variables to achieve that (e.g. tariffs, incentives, etc...). Structure and format of the charging incentives within the will be determined following data analysis of participant charging.

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

Benefits expected from this program include identification and understanding measurable uncontrolled and controlled charging behaviour of private electric vehicle (car) owners. This will assist Energy Queensland networks for planning, forecasting, demand management and other EV-related purposes. In addition, help support and determine any policy issues regarding connection of private EV chargers. It is also critically necessary to understand how EV usage and charging behaviour will alter over time as owners become more confident with their EV range, speed of charging and access to suitable public charging. Collated data will also be used to validate the potential for public destination (fast) and travel (ultra-fast) charging station installations for third-party, commercial charging operatives.

A number of use cases to satisfy have been developed:

- Energy use whilst charging:
  - Home Vs Public (impact of housing type e.g. apartment dwellers)
  - Demand profile (impact of charger type/connection for network diversity)
  - Type of EV
  - Energy Losses (at time of charge and battery deterioration over time)
- When does charging occur
  - Time of day: solar soak option, peak demand management
- Influence on charging behaviours
  - Battery state of charge (minimum and maximum)
  - Seasonal impacts
  - Tariffs
  - Length of ownership (more trips, longer trips, eased range anxiety, etc…)

Initial findings as at July 2021:

- Across all EV categories (BEV large/small and PHEV) approximately 8kWh per day plug in charging of average commute of 40km daily;
- 10.5% of EV participants let their battery discharge to 20% or below, before recharging
- 25% of charging occurs when the battery is at least 80% State of Charge (significant 'top-up" charging);
- 39% of BEV charging sessions end at 80% State of Charge, 21% to full (battery protection);
- Almost 39% of participants do not exercise any control when their EV charges (e.g. timers, tariffs, soft controls); and
- Charging losses are just 10% but when State of Charge reaches 90% and losses jump to almost 20%.

3.7 Dynamic Operating Environments Phase 1 Commercial

This project is part of a broader Dynamic Operating Envelope (DOE) Program designed to explore the merits, challenges and financial viability of the concept of DOEs as applied to small to mid-sized (10kVA - 1500kVA) Distributed Energy Resources (DER). It is postulated that DOEs will play an important role in managing DER at scale such that the DER 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 will focus on trialling the concept at a commercial level at five Energex (EGX) owned and operated depots.

3.7.1 Compliance with DMIA Criteria

The DOE Phase 1 – Commercial Project complies with the Demand Management Innovation Allowance criteria detailed at section 3.1.3 of the demand management incentive scheme. Having a mechanism to allow a greater penetration of DER into the network through the implementation of Dynamic Operating Envelopes will assist in alleviating demand. A PV connection may not be permitted to export into the network based on a worst-case assessment which considers full export of the system under minimum loading. A system assessed as "Nil" export cannot export at any time, even under times of high network load. The DOE platform also enables managed EV or battery

energy storage system charging to reduce demand when the network is constrained. A subsequent customer benefit of a dynamic approach helps customers to access the available capacity of the network at all times.

3.7.2 Nature and Scope

DOE Phase 1 is focussed on trialling the DOE concept at a commercial level targeting three phase 30kVA-100kVA LV connected systems typical of small-medium commercial/industrial establishments. This work will build on the prior project at Energex's Cleveland Depot by transitioning beyond the one-way broadcast concept to a two-way communications approach. DOE enabled PV systems will be installed at five sites with the companion 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 operational technology environment.

3.7.3 Aims and expected outcomes

The DOE Program has the following key objectives:

1. Demonstrate as a proof of concept the data, communication and controls required for Dynamic Operating Envelopes to be implemented in near real-time at commercial sites as applied to PV and any available BESS or EVs.
2. Evaluate the effectiveness of DOEs as applied to sources of generation and chargeable loads.
3. Evaluate the impacts of variations in the DOE on other customers connected to the same LV and 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.
4. Evaluate the effectiveness of IEEE 2030.5 in implementing Dynamic Operating Envelopes.

Initiate amendments to standards and connection contracts to facilitate the offering of DOE for embedded generation (≤1500kVA) at a broader scale in the EGX/EECL network.

3.7.4 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 DMIA criteria by both Demand Management and Regulatory Departments. The projects were deemed to meet the DMIA 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 DMIA funding. The project was evaluated against the business' Opportunity Matrix and identified as being an innovative venture with high opportunity potential.

3.7.5 How it was/is to be implemented (ie general project update)

The project is progressing well with PV systems commissioned and operating at all five identified sites. Network monitors on the trial networks have been reconfigured to enable near real-time reads of voltage, active and reactive power as these parameters have been identified as the most valuable to support DSSE. The application of DSSE will allow DOE to be offered more rapidly and economically to customers in areas of network which may not have local monitoring available.

The project has also demonstrated the generation of dynamic operating envelopes via the work of the Expanded Network Visibility Initiative which utilises DSSE to establish network visibility followed

by capacity constrained optimisation which calculates the maximum export permitted from site without breaching network capacity or voltage limits.

A trial server has been established to test IEEE 2030.5 as an interoperability standard to support two-way communication with DOE-enabled PV systems. A two-way system helps network to verify that systems are operating within the envelope as well as provide the network with operational data to help optimise the calculation of the DOE in future time intervals.

Internal and customer connection standards and processes are being reviewed to support the introduction of dynamic connections for DER and a public consultation was undertaken in December 2020. This work, particularly the integration with the DSSE as delivered through ENVI, was a finalist for the Clean Energy Council Innovation Award 2021.

3.7.6 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 business' standard PV connection assessment process was used to evaluate the connection of all five systems. Two systems were evaluated as requiring partial or Nil export, else they are predicted to cause problems for the network at critical times that align with the system having full export. A key outcome of this project will be evaluating if the application of DOE helps to overcome the Nil or Partial export limitation, allowing the systems to export safely during non-critical periods. An evaluation of the additional export which could be achieved from the previously export-limited sites is under way.

3.8 Evolve

The evolve project will implement systems and capabilities that calculate and publish, (via a software API), the operating envelopes for individual and aggregate DER (specifically rooftop PV and batteries) in the distribution network that underpin increased network hosting capacity of distributed energy resources (DER), by ensuring high penetration DER are able to maximise their connection, operation and participation in markets for energy, ancillary and network services, whilst ensuring the secure technical limits of the electricity networks are not breached.

3.8.7 Compliance with DMIA Criteria

The project was viewed as meeting DMIA Criteria by investigating ways to shift or reduce demand for standard control services through non-network alternatives. The evolve project includes active management of DER to enable visibility and control of targeted network areas with constraints. The operating envelopes (outcome of the project) will provide an upper and lower limit for safe operation of the network for both DER import and export that potentially can be used to implement more granular and effective demand management programs to respond to local network constraints.

3.8.8 Nature and Scope

The scope is to calculate the operating envelopes for DER assets using a variety of low voltage (LV) and medium voltage (MV) network data sources and will include the as-switched network model, as

well as the current and forecast operating state. The operating envelopes will be published to DER aggregators and other interested parties using a mutually agreed and developed API.

3.8.9 Aims and expected outcomes

The evolve project will include the augmentation and extension of software systems and installation of additional sensors targeting specific locations to calculate and publish normal-state and emergency operating envelopes and constraints that apply to individual or aggregated DER operating within the electrical network. Outcomes of the project are to develop capability with calculating and projecting localised envelopes, reduce the costs of deployment as well as optimal network hosting capacity of DER, while ensuring the secure technical limits of the electricity distribution network are not breached.

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

The DMIA project approval process was followed for selecting this project (evolve). Potential DMIA 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 objectives of DMIA. Specifically, it tests whether any potential project is in accordance with paragraph 3.1.3 of the DMIS. 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.

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

The evolve project is strengthened by the involvement of multiple distribution network partners by allowing it to understand and meet the needs of different types of electricity networks, with varying age, construction and population densities. It will also provide an opportunity to integrate with different operational technologies and explore the development of standards based approaches to obtaining the reference electricity network models needed for the envelope engine algorithms.

By involving a number of DER aggregators, it will be possible to better understand the coordination and orchestration requirements between different DER assets, DER aggregators and different software architectures and implementations used by each.

The evolve project is implementing operating envelopes within an evolve framework, an open-source technology framework which is deployed into cloud infrastructure and integrated with both DNSP and aggregator systems. The evolve framework ingests the relevant network and DER data and then makes this available for analysis in a standards-based form. The calculation and publication of operating envelopes are implemented as a series of software modules and algorithms within the evolve framework. Testing and validation of operating envelopes for Energex and Ergon Energy networks occurred in the first half of 2021 and preliminary results were presented to Energex and

Ergon Energy staff. More knowledge sharing session available to broader audience will be scheduled by the project team at ANU after results from NSW utilities are analysed.

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

The evolve project is still in the testing phase and has shown potential capability for DER management and consequently network demand management.

There are several projected benefits of operating envelopes at the current maturity levels of DER deployed within the electricity system:

1) Operating envelopes can address multiple use cases addressing network constraints and peak demand challenges currently being faced in both electricity distribution networks and at the whole of system level;

2) Operating envelopes promise to be simple to implement across a variety of different DER assets, and do not require the use of sophisticated local control and optimisation systems;

3) Enhanced DER Management abilities will allow the electricity system to make use of the capabilities provided as a result of the approval of a greater number of Customer DER connections;

4) Operating envelopes can be deployed progressively into different segments of a distribution network as they are needed;

5) Operating envelopes at this current version are focused on DER export limits, however same principal can be applied in future for managing load (Electric Vehicles)

3.9 DLC via Network Monitoring Device (Redback)

The purpose of this project is to investigate an alternative load control option for simple domestic appliances such as hot water load should this standard audio frequency load control (AFLC) system not be available.

3.9.1 Compliance with DMIA Criteria

Increased functionality of load control system to feeder and transformer level could assist in managing network load control in areas with high PV penetration to manage impacts of minimum demand and phase unbalance due to PV. Similarly, load control through the technologies being trialled in this project can be implemented in areas where there is limited or no AFLC infrastructure. The technology being trialled differs from current ripple control technology as it will utilise 4G communications and provide increased functionality for example individual addressability.

3.9.2 Nature and Scope

A selection of approximately 50 residential sites preferably in one geographic cluster on dedicated transformers and feeders with high PV penetration.

The load control will be via a 5-amp relay in Redback monitoring device to control the hot water system. This project will evaluate if this relay can successfully simulate a network AFLC relay at the premise. The Network AFLC relay would be disconnected for the length of the trial.

3.9.3 Aims and expected outcomes

The objective of this trial is to determine the subtility of a Direct Load Control (DLC) solution as an alternative option for hot water load under control should the Network AFLC not be viable or available using 4G communications medium. The outcome will insights into determining the increased functionality of controlling residential load at transformer and feeder level which can have benefits where areas with high penetration of PV including minimum demand and reverse energy flow.

This will also assist in determination of cost and associated benefits of such DLC solution compared to the existing AFLC Load Control System.

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

Energex Network has developed a *Future Grid Roadmap* that outlines the strategic priorities and tactics to enable Queensland DNSP's to transition to a grid of the future, taking into account the rapidly changing energy market and the way our customers use, and services they expect from, the electricity Network. This project is deemed to meet the DMIA criteria but also assisting in evaluating options for network load control, particularly in the context of a generally reliable yet aging AFLC system.

3.9.5 How it was/is to be implemented (ie general project update)

The project implementation was as follows:

- Bench testing of a prototype OL2 (4G comms) device;
- retrofit prototype OL2 (4G comms) devices to the 2 existing 'friendly' sites and test to verify the functionality; and
- install production version of Redback OL2 device at 50 sites.

Sites selection for the 50 trial sites will:

- Leverage existing relay end of life replacement program with Distribution Metering to create efficiencies; and
- Sites will be chosen in cluster of same transformer and feeder with High PV penetration.

Following installation, the project will then test the end-to-end DLC platform and node device capability.

Currently the 50 Sites are installed at Upper Coomera and scheduled to simulate existing customer tariff and schedule from local zone injection point (installation photo's below). Sites are operating correctly and minor scheduling adjustments for testing purposes. One site had intermittent communication failure over a one month period. The modem was installed adjacent and in close vicinity of the metal metering cabinet and the fault was rectified by moving the modem pack slightly away from the metal cabinet into a more open unobstructed area. The site has regained

communication and remains online. Regular collaborative meetings with vendor to feedback issues and improve and develop operating platform and scheduling tool.

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

Benefits of the project findings to date:

- Individual sites can be addressed individually and increased functionality of controlling residential load at transformer and feeder level which can have benefits where areas with high penetration of PV including minimum demand and reverse energy flow.
- Potential solution where AFLC Infrastructure is not available.
- Assist cost benefit analysis and associated benefits of such Direct Load Control solution in comparison to the existing AFLC Load Control System.
- Understanding an alternative Direct Load Control solution to transition from the ageing current AFLC infrastructure.
- Capability to control hot water load at Feeder/ Transformer level and its benefits to solve localised issues.
- Capturing hot water usage and data analysis to develop and optimise Hot Water solar soak and peak load switching schedules.
- Availability of real time and historical one-minute data for current, power voltage and KWH import and export of total site and HW circuit.
- Improved understanding of consumer behaviours and consumption of hot water usage
- Determining the reliability and security of alternative 4G communication network for signalling commands to device.

Image 1: Load control relay and comms device in-situ