Energex

DMIA Report 2021-22

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energex
Part of Energy Queensland

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1. Introduction

1.1 Purpose and Compliance

Energex is pleased to present the Demand Management Innovation Allowance (DMIA) Report for the 2021-22 regulatory year. The purpose of this report is to allow the Australian Energy Regulator (AER) to:

- assess Ergon Energy's 2021-22 DMIA initiatives and Energex's entitlement to recover the expenditure under the AER's Demand Management Incentive Allowance Mechanism; 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 (refer Figure 1), 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.

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

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

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

a) Explain how it complies with project criteria detailed at section 2.2.1 of the demand management innovation allowance mechanism

b) submit a compliance report in accordance with section 2.3 of the demand management innovation allowance mechanism

2.2.1 Project Criteria:

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

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

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

i) is based on new or original concepts; or

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

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

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

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

i) recoverable under any other jurisdictional incentive scheme;

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

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

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

2.3 Compliance Reporting

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

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

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

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

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

i) The nature and scope of the eligible project;

ii) The aims and expectations of the eligible project;

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

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

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

vi) The costs of the eligible project:

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

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

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

vii) For ongoing eligible projects:

1. a summary of project activity to date;

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

3. reporting of collected results (where available).

viii) for eligible projects completed in that regulatory year:

1. reporting of the quantitative results of the project;

2. an analysis of the results; and

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

1.2 DMIA projects summary

In its Distribution Determination for the 2020-2025, the AER decided to apply the Demand Management Innovation Allowance Mechanism to Energex, approving an innovation allowance amount of $5,582,165 over the 2020-25 regulatory control period.

The DMIA 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 2021-22 DMIA program comprised five projects active during the year. The total cost incurred for the DMIA initiatives during 2021-22 was $248,440.28. 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 2021-22 regulatory year.

Figure 1: 2021-22 Expenditure ($)

	2021-22 expenditure ($) direct cost only				
Project	**Budget**	**Capital**	**Operating**	**Total**	**Status (as at 30 June 2021)**
Carseldine HEMS	42,907		9,090.91	9,090.91	Continuing
Electric Vehicle Research	745,942		146,746.19	146,746.19	Continuing
DOE Phase 1 Commercial	241,854		65,643.63	65,643.63	Continuing
Evolve	252,000		26,194.85	26,194.85	Closed
DLC Network Monitoring Device (Redback)	100,808		764.70	764.70	Closed
Totals			**248,440.28**	**248,440.28**	

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.

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 2021-22 DMIA program, all nominated DMIA projects are subject to a screening and feasibility processes, consistent with the AER's DMIS. The standard 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 expression of interest (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 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 Energex should, where possible, ensure their project aligns with these existing Energex 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.

The pipeline of DMIA projects has slowed somewhat this year. To help identify further potential projects, we engaged with external partners to who may wish to collaborate on DMIA projects. This included direct engagement to all Queensland based universities through our Energex university liaison officers. We have also improved the web presence on our website to include more case studies on previous DMIA projects, outlining the key DMIA criteria and inviting any interested parties to make contact.

A key highlight for this year was that the Dynamic Operating Envelopes (DOE) Phase 1 Commercial project, funded through DMIA, was awarded Energy Networks Australia (ENA) Industry Innovation Award.

3. DMIA Project updates

This section of the report details the status of the Energex DMIA projects in 2021-22 by describing each project, its objectives, progress and findings to date.

3.1 Carseldine HEMS

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

3.1.1 Compliance with DMIA Criteria

Through successful establishment of market-delivered demand response, Energex will be able to acquire access to cheaper and greater range of demand management. Market-delivered demand response via third-party suppliers (responsible for procuring load and generation control from customers) will significantly reduce the network’s cost of acquisition of demand management from today’s high audio frequency load control (AFLC) capital and operational costs. In addition, Energex has historically controlled loads like hot water and pool pumps. Third-party suppliers should routinely be able to add new electrical products for sophisticated management (air conditioning, solar PV, batteries, and electric vehicles). Further, this project allows for assessing data for opportunities to alter the network connections process and policies with regard to greenfield sites with high DER saturation. It differs from other similar programs by pursuing a greenfield site with developer-led customer acquisition, and is also targeting a group, being affordable housing, not engaged directly to date by Energex in similar technology-based programs.

3.1.4 Nature and Scope

The project will involve partnering with Economic Development Queensland (EDQ) as the developer, who will, with assistance from Energex secure suitable supplier(s) of HEMS, that will be included in the new build premises at the time of build.

Energex funding support is be proportional to the load/generation under management. It is anticipated that in every home the solar PV, battery, hot water and living space air conditioning is under HEMS management. Prior to an EOI response from potential HEMS providers, a funding agreement between Energex and EDQ would see each contributing a 50/50 share of total HEMS install costs.

3.1.4 Aims and expected outcomes

This project will enable Energex to find and trial solutions for mitigating these constraints and network challenges from distributed energy resources (DER), leading to their better integration in the future for new infill and greenfield property developments.

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 DMIA project Market Delivered Demand Response Pilot (MDDR) as a means of networks accessing third-party management of DER, the opportunity was to establish the cheapest and simplest pathway to customer participation. Greenfield residential development was seen as one pathway to achieve this opportunity.

Carseldine Village, a mixed-use 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. The project aims to develop a model for best practice integration of DER in new infill and 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 DER in a very localised area on the distribution network within the context of a broader energy system. Twenty-five (25) homes withing the 56 home Stage 1 build will have access to a HEMS optimising the solar, battery, air-conditioning and hot water use.

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

Due to COVID complications, the occupancy of the Stage 1 homes is at least 12 months behind schedule. However, we have our first occupant in a home and have extended the end date of the program by 12 months to acquire the data being sought.

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

Until data is obtained across the 25 participant cohort, it will be very difficult to derive any concrete learning or observations. Our next report will have some leading observations to report.

3.2 Electric Vehicle (EV) Research

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

3.2.1 Compliance with DMIA Criteria

Through understanding of residential EV charging profiles and willingness to accept charging 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 Energex, will further inform:

- how EVs can be managed effectively for network reliability and stability whilst also fulfilling a customer need for assurance of their charging 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.

3.2.2 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 EVs present. The project involved recruiting customers with home garaged and charged EVs across Queensland to participate through agreeing to have a device installed in their vehicle that provided data to Energex, and the customer, on the use and charging habits. This data formed that basis of various analysis to be undertaken.

3.2.3 Aims and expected outcomes

The specific objectives of this research program are to understand the charging behaviour of EV 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 low voltage (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 Energex new market segmentation;
- better educate and communicate optimal options for best charging practices for customers and the network;
- inform Energex on how EVs will influence future tariff requirements, and
- maximise the value of EVs to the Energex networks (maximum revenue for minimum cost).

3.2.4 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 Energex 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; alternative considerations were identified, including attitudinal research on how EV owners expect to charge their EV's as well as modelling of internal combustion engine 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. Internal combustion engine and EV usage patterns are assumed to be different, and this project will allow confirmation of same.

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

The program was provisionally planned to extend for a period of three years but will discontinue at the end of August 2022. Geotab, our program partner is refocussing their efforts on fleet programs and as such will not be supporting any residential focussed programs. Whilst this is unfortunate, the 19 months of trip and charging data captured has provided significant knowledge and insights of early EV adoption.

Stage 1/Year 1 (Recruitment & Data Baseline): The program launched at the end of May 2020. After the recruitment phase, as at 30 June 2021, 197 participants commenced in the program. As at the end of July 2022 there were 167 participants. A close out report with a range of insights and findings in currently being prepared with a view to publishing before end of October 2022. Small financial incentives of $100 for sign-on were provided to entice participant involvement in addition to access to individual portal dashboards for participants. All channels to market embraced the program well particularly during the participant recruitment phase and have been proactive in 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, registration, purchase date
- Vehicle size and categorisation- Battery EV small/large or plug in hybrid electric vehicle (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 were included within the participant base to supplement residential findings of EV driving and charging behaviour. Participants needed to have EVs registered in Queensland and be connected to the Ergon Energy or Energex distribution network. Energex purchased 'plug and play' C2 devices in bulk upfront from Geotab and facilitated the participant pre-registration process. Each participant received a C2, 3G connected car device from Energex that monitored their driving and charging data. Some initial teething issues had been experienced and data cleansing continued 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 original planned program timing but program end August 2022 as indicated.

A behavioural study was also completed in March/April 2022 to understand the opportunity to incentivise participants to change their charging behaviour around peak times (4-9pm) and during the day to assist with solar soak. A total of 14 events were conducted in total consisting of either 'charge your EV' or 'do not charge your EV'.

Sixty participants were involved in the study and received event notifications via SMS. Events were called at different times of the week and weekend with different durations and incentive amounts. A capped threshold of $150 in total per participant was introduced with greater than 90% of participants reaching the maximum amount. Participants were overwhelmingly positive about their involvement and the ease with which to participate and it did not interrupt their day-to-day lifestyle. Being early adopters highlighted the potential for managed charging going forward. The key determination is the extent to which managed charging can extend to the mass market.

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

Benefits from this program include identification and understanding measurable uncontrolled and controlled charging behaviour of private EV (car) owners. This will assist Energex and Ergon Energy networks for planning, forecasting, demand management and other EV-related purposes. In addition, to help support and determine any policy issues regarding connection of private EV chargers. It is also critical 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, including:

- Energy use whilst charging:
  - Level of charge – home vs public (impact of housing type e.g. apartment dwellers)
  - Energy and Diversified Demand profiles (impact of charger type/connection for network diversity)
  - Type of EV – residential BEV focus
  - Renewable impact – solar vs solar/BESS vs non solar
  - Energy losses (at time of charge and battery deterioration over time)
- When does charging occur:
  - Time of day: solar soak option, peak demand management, weekday vs weekend
- Influence on charging behaviours
  - Battery state of charge (minimum and maximum) and state of health analysis
  - Seasonal impacts and peak day analysis
  - Tariffs
  - Length of ownership (more trips, longer trips, eased range anxiety etc.)

Some findings include:

- 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);
- Charging losses are just 10% but when State of Charge reaches 90% losses jump to almost 20%;
- Higher middle of the day home charging profiles highlighted a desire to self-consume solar rather than exporting to the network;

- Conveniently timed charging for PHEV and smaller EVs is common during the evening period;
- Weekday and weekend charging is generally consistent although we found a higher daily average charge on weekends during the middle of the day;
- Early adopters demonstrate the influence tariffs can have with some charging peaks around 1am associated with some retail tariffs;
- Time of use tariffs, particularly for Level 2 charging and timers heavily influence charging behaviour; and
- EV's battery 'whole of life' is best extended by avoiding charging it to 100% regularly.

3.3 Dynamic Operating Envelopes 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) DER. A DOE defines a range of values for DER 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 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 trials the concept at five Energex owned and operated depots.

3.3.1 Compliance with DMIA Criteria

Having a mechanism to allow a greater penetration of DER 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 EV or 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 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 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 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 DMIA criteria by both the Demand and Energy Management and Regulation business units in Energex. The project was 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.

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

The project is nearing completion. PV systems are commissioned and operating at all five trial sites. Network monitors on the trial networks were reconfigured to enable near real-time voltage, active and reactive power data as these parameters have been identified as the most valuable in generating a clear picture of the operational state of the local network via distribution system state estimation (DSSE). The DSSE process generates synthetic data which can be used as an input to calculate DOE without installing a physical monitor. Capacity Constrained Optimisation (CCO) can then be applied. The CCO process calculates the maximum export permitted from a site without breaching network capacity or voltage limits. The application of DSSE will allow DOE to be offered more rapidly and economically to customers in areas of network which may not have physical monitoring available. The demonstration of this technology was awarded ENA's Industry Innovation Award in 2021.

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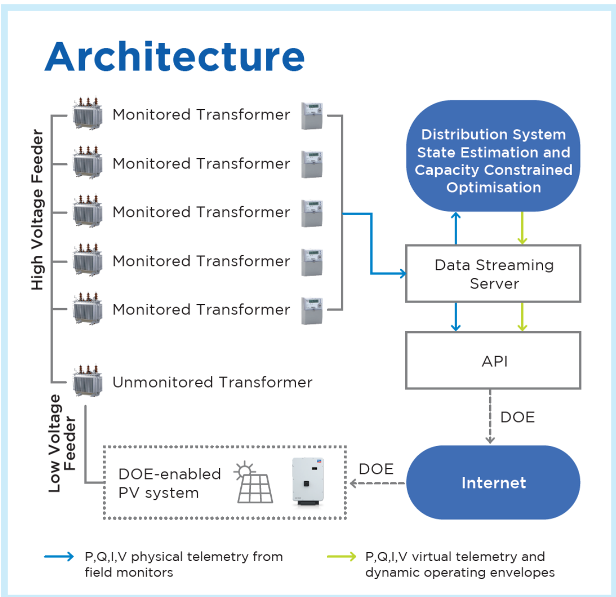

server has been established to test IEEE 2030.5 as an interoperability standard to support two-way communication with DOE-enabled PV systems. This project supported the development of a 2030.5 client to test the trial sites receiving DOE in this manner. This step is an advance on the previous

Application Programming Interface (API) approach which was good for a rapid deployment but not suitable to support large numbers of connected customers. The IEEE 2030.5 standard is generally favoured to be adopted more broadly across the industry. A two-way approach helps networks to verify that customer systems are operating within the published envelope as well as providing the network with operational data to help optimise the calculation of DOE in future time intervals.

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 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, due to the risk of problems on the network at critical times that aligned with minimum network load and 100% export from connected systems. Preliminary results indicate that there are times when those two sites could safely export to the network but there are times when export would have to be reduced. A more detailed report is currently being developed as part of project close-out.

3.4 Evolve

The Evolve project researched, developed and demonstrated a system for coordinating DER in the distribution network to underpin increased network hosting capacity of 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 distribution networks are not breached.

In simple terms, this involves calculating real and reactive power limits that controllable DER assets must remain within, at different times, to avoid creating voltage breaches or thermal overload issues, and sending these limits to the DER asset controllers. These limits have become widely known in Australia as DOEs.

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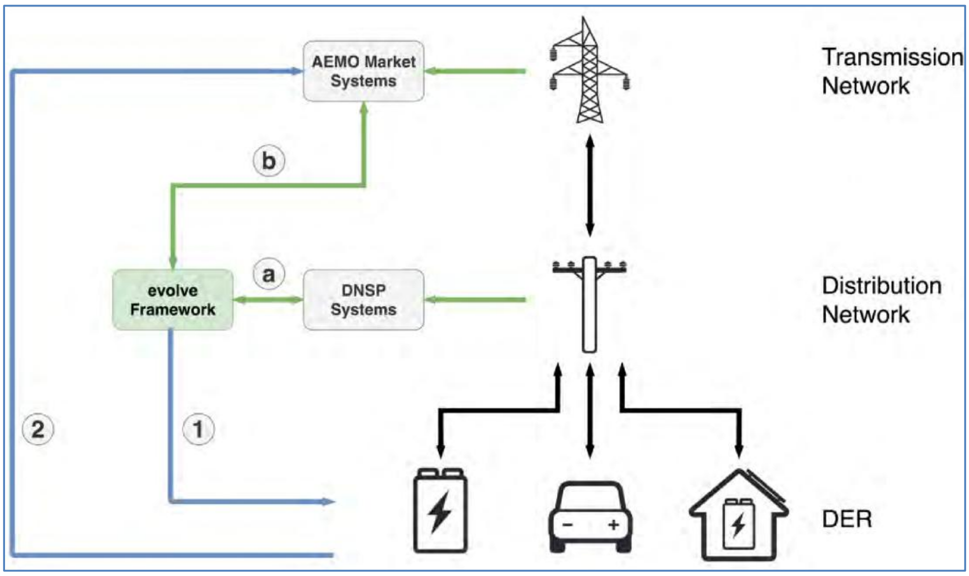

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The use of dynamic operating envelopes allows DER to bid into markets for energy and ancillary services without breaching physical or operational limits of electricity distribution networks. In this diagram, green lines correspond to operational monitoring data and network visibility, whilst blue lines correspond to the sequence of actions being demonstrated through the evolve project. DOEs could be used to manage system security constraints but this would require an additional integration with AEMO systems. If operating envelopes were also used to address system security concerns then the operating envelope algorithm would be updated to jointly solve for network voltage and thermal constraints and system security constraints. DER will be sent operating envelopes (Step 1) before separately bidding into AEMO markets (Step 2).

3.4.1 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 DOEs (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.

3.4.2 Nature and Scope

The scope was to calculate the DOEs for DER assets using a variety of LV and MV network data sources and to include the as-switched network model, as well as the current and forecast operating state. The DOEs will be published to DER aggregators and other interested parties.

3.4.3 Aims and expected outcomes

The Evolve project included development of software systems and installation of additional sensors targeting specific locations to calculate and publish normal-state and emergency operating envelopes and constraints that applied to individual or aggregated DER operating within the selected trial DNSP sites. The project developed capability with calculating and projecting localised envelopes, optimising deployment costs as well as network hosting capacity of DER, while ensuring the secure technical limits of the electricity distribution network are not breached.

3.4.4 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. 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 (i.e. general project update)

Initially, working closely with Zepben and the Australian National University (ANU) Battery Storage and Grid Integration Program, Energy Queensland via its DNSPs Energex and Ergon Energy and also its Digital Division, along with other evolve project partners Redback Technologies, Reposit Power and SwitchDIn was mostly involved during the establishment and initial implementation phase, or first half of the evolve project, providing technical expertise, support and network model data for initial trial areas. For the second half, the evolve project progressed to further develop and refine its solution alternatively with its other New South Wales (NSW) DNSP partners, Essential Energy, Endeavour Energy and Ausgrid, and also partners the NSW Government, SwitchDIn, Reposit Power and Evergen.

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

The Evolve project delivered results in the following areas (these were provided by Zepben and ANU, relating to the project findings and learnings for Queensland and NSW DNSPs):

- Research and development into methods of calculating operating envelopes for DER assets using electrical network models and forecasts for load and generation,
- Exploration of techniques to deal with missing and anomalous electrical network model and sensor data,
- A comprehensive report into the benefits that could accrue from the use of DOEs,
- Practical DER hosting capacity calculations; an essential outcome for longer range forecasting and asset investment decisions,
- Knowledge outcomes about data remediation activities to be undertaken to support high penetration DER, accompanying cyber security issues and general challenges with the integration of new technologies needed for the management of DER within the broader Operational Technology landscape,
- Development and promotion of standards in relation to the modelling of electricity network asset and measurement data, the exchange of these data models, and communications between DERs and DNSPs,
- Co-development and promotion of the Australian Common Smart Inverter Profile (CSIP) standard for DER,
- The publication of a considerable body of open-source software to support ongoing research and development outcomes.

The significant learnings and conclusions from the Evolve project were:

- The use of DOEs could potentially:
  - Increase the hosting capacity of electricity distribution networks by managing solar generation (export) and EV charging, and Vehicle to Grid (both import and export),
  - Help enable DER market participation (both import and export), and
  - Assist with the maintenance of system security.

- For DOE benefits to be realised, the DOEs must be sent to DER assets, and the DER assets must respond. Questions remain as to how to accomplish this. To do this, the roles and responsibilities of DNSP, aggregators and customer (DER owner) need to be clearly defined.
- DNSP owns and has access to network asset data, and the availability of sensor data for DER connected to the LV network needs to be improved for DOEs to be used effectively. Currently, networks do not have access to interval engineering/power quality data from smart meters. Availability of this data will improve the calculation of DOE for LV networks.

A case study for Evolve Project is available on the Energex website.

3.5 Direct Load Control (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 AFLC system not be available.

3.5.1 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.

3.5.2 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.

3.5.3 Aims and expected outcomes

The objective of this trial was 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 provide 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 System.

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

Energex 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 the 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.

3.5.5 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 final phase of the project involved application of three different schedules and analysis of the benefits.

Three different schedule scenarios were applied using the Redback platform to 50 electric storage hot water systems with varying kW elements and tank size, as follows:

- Scenario 1 – Solar soak schedule (13 December 2021 to 24 January 2022)
- Scenario 2- Peak demand schedule (25 January 2022 to 6 February 2022)
- Scenario 3 - No schedule (7 February 2022 to 6 March 2022)

Analysis of data was undertaken to determine the average daily load profile of the different schedules. This was achieved by graphing the one-minute data from the load control circuit, available via the Redback portal.

Analysis of the impact of the solar soak schedule was achieved by comparing the average daily load profile of the solar soak schedule and peak demand schedule.

During the trial only one hot water complaint was received and upon investigation this was found to be unrelated to the project and was a customer related matter which was resolved promptly.

The findings of the trial have:

- Proven the capability of the Redback device as load control device, with the additional benefits of monitoring and national metering identifier level control; and
- Informed the design of load control configurations to maximise solar soak and minimise impact on customer amenity, while also ensuring capability is still available to manage peak loads.

The final steps of the project will involve reinstating the existing 50 sites with network controlled AFLC Devices, and utilising the findings to implement a solar soak schedule, using the standard network AFLC systems to help to address minimum demand driven by excess solar generation.

3.5.6 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 DLC solution in comparison to the existing AFLC System.

- Understanding an alternative DLC 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 hot water 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.

A case study for the Redback DLC Project is available on the Energex website.

Load control relay and comms device in-situ