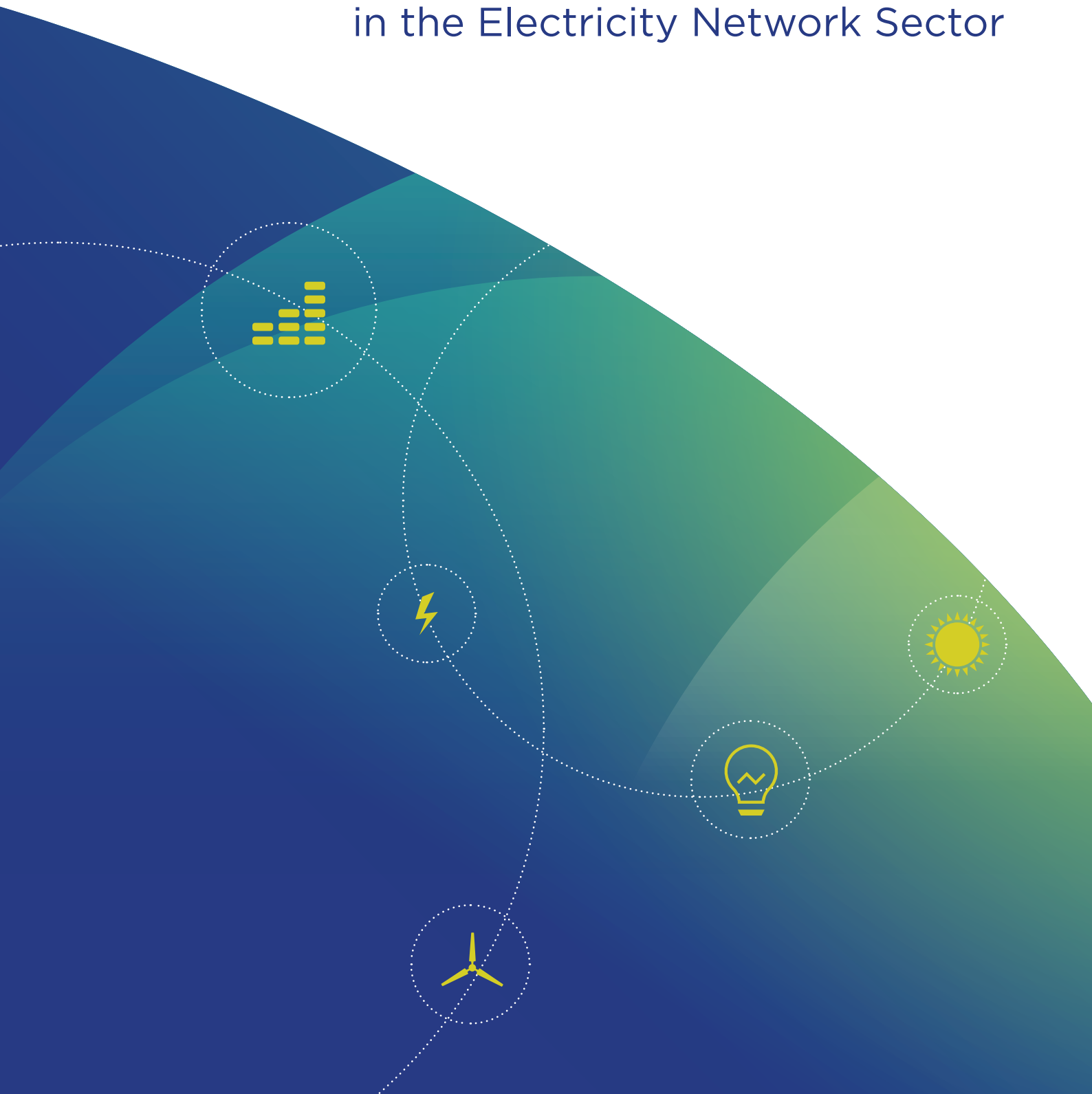
Energy Networks Australia

Innovation

in the Electricity Network Sector



INTRODUCTION

Innovation within energy networks has become essential in Australia to ensure our 20th century grid is able to deliver energy the way consumers of the 21st demand.

The generation, distribution and consumption of energy is undergoing extensive change. Developments in new types of generation, the emergence of the 'internet of things', consumer preferences, electrical storage and other drivers are encouraging innovation and adaptation of existing infrastructure to support new demands and directions in network transformation.

In the **Electricity Network Transformation Roadmap** (ENTR), key technical challenges and/or gaps in innovation were identified which need to be addressed if grid transformation and optimisation is to be achieved. Key areas where gaps were identified include:

- voltage management
- frequency control
- decentralised control techniques
- management of local constraints optimising demand side services.

The benefits associated with the transformation of Australia's power system include:

- direct participation by customers
- accommodating all generation and storage options
- enabling new products, services, and markets
- providing power quality and reliability
- optimising asset utilisation and providing operational efficiency
- anticipating and responding to system disturbances
- operating resiliently and managing environmental impacts.

Significant research, development and deployment is occurring in power networks as new techniques and technologies are being investigated to help manage changes in demand and generation in the most cost-effective manner.

Across Energy Networks Australia member organisations, numerous innovation projects are being undertaken to address network challenges. Business investment in research and development is being integrated into the system while improving grid resilience at a local and system-wide scale. This report is a product of the ENTR which highlights a number of case studies detailing innovative work being undertaken by networks.

Andrew Dillon
CEO, Energy Neworks Australia

Contents

CONSORT BRUNY ISLAND BATTERY TRIAL

ENTR Themes

- Customer-oriented electricity
- Intelligent Networks and Markets
- Power System Security

Rationale

Bruny Island is connected to Tasmanian distribution network via an undersea cable. This cable can be overloaded during holidays when people visit the island. Traditionally, TasNetworks has used a diesel generator to manage this peak load constraint. Orchestration of residential battery storage offered an innovative alternative to operating the diesel generator. The CONSORT Bruny Island Battery Trial helped 34 customers install solar generation and a battery on their homes to test the coordination of distributed generation as an alternative to operating the diesel generator.

Principal Company

Australian National University

Project Timeline

April 2016 – April 2019

Location

Bruny Island, Tasmania

Funding

ARENA funded (partially)

Stakeholders

TasNetworks
Reposit Power
University of Tasmania
University of Sydney

Objective

This project aims at testing a future where customers have invested in storage that can be accessed to support the network at peak times.

Approach

The project is founded on customer behaviour, which is central to the project's design and implementation. Customers had choices, and were involved at every step of the process. In particular, the concept of customer choice, overlaid with the technical requirements to manage a network problem, are embodied in the Network Aware Coordination (NAC) algorithm. This algorithm allows networks to simultaneously and automatically manage multiple network issues while preserving customer privacy and choice.

The NAC algorithm is based on the concepts of state estimation, optimisation and negotiation. In this algorithm the network negotiates with customers, through their Reposit Power battery controllers, to resolve network limitations with the lowest possible cost. The customers are free to optimise their own consumption and ensure that participation is in their best financial interests.

The NAC algorithm, while developed before the Open Energy Networks consultation, has foreseen many of the issues. In this way, the CONSORT Bruny Island Battery Trial is a 'living laboratory' to test these concepts.

Results

The coordinated use of the battery energy has reduced diesel use by 30 per cent and prevented at least one generator start, while allowing customers to maximise their battery use for storing solar energy and managing a time-of-use tariff.

CAPTION:
A project participant's home with solar

CUSTOMER ENGAGEMENT

ENTR Themes

» Customer Oriented Networks

Rationale

Essential Energy's customer engagement approach was to ensure the views and expectations of their regionally, culturally, demographically and economically diverse customer base were accurately and meaningfully reflected in the business's 2019-24 regulatory proposal.

Principal Company

Essential Energy

Project Timeline

June 2016 - Ongoing

Location

New South Wales

Description

Essential Energy's stakeholder groups have varying levels of interest in and knowledge of Essential Energy and were approached accordingly. Genuine intent, visibility and support from the most senior levels of the organisation were critical, along with a willingness to facilitate robust discussion and ongoing dialogue.

Milestones Addressed

Essential Energy consulted with more than 3,000 customers in three phases:

» 'understanding our customers'

» 'deep dive engagement'

» 'testing and submission'.

Approach

Essential Energy's engagement strategy was built on and consistent with its Stakeholder Engagement Framework, which sets out a clear methodology for customer and stakeholder research and analysis and is informed by:

» International Association of Public Participation

» AER Stakeholder Engagement Framework (2017)

» CSIRO and Energy Networks Association's 2016 ENTR: Customer Engagement Handbook.

With the CEO at the front of the room on many occasions, teams from across Essential Energy worked closely to ensure genuine executive support for the program. This continues to be a focus at a senior executive level.

Results

When surveyed, more than 80 per cent of residential and business customers were satisfied with the engagement activities. The benefits of the program went far beyond the regulatory proposal itself with cultural, process, marketing and service feedback helping tailor broader business activities. Customers prioritised themes were safety, affordability, reliability, good customer service, transparency/bill itemisation, environmental friendliness and innovative technologies.

CAPTION:
Customer feedback at Tamworth Customer Forum

MOOROOLBARK MINI GRID

ENTR Themes

- Intelligent networks and markets
- Customer oriented electricity
- Power system security
- Carbon abatement

Rationale

The project envisages a future where Distributed Energy Resources (DER) play a major role in the electricity supply system and the distribution network becomes a dynamic platform that facilitates trade of energy and energy services. Additional network controls are required to facilitate these new markets, manage the technical impacts of large volumes of DER and extract and optimise value from the diversity of connected devices for the benefit of all stakeholders.

Principal Company

AusNet Services

Project Timeline

January 2016 – January 2019

Location

Mooroolbark, Victoria

Funding

Regulated funding, under Demand Management Innovation Allowance

Stakeholders

PowerTec Engineered Solutions

Description

The project encompassed the design, build and operation of an 18 household mini grid within a single street in Mooroolbark, a typical suburban community in Melbourne's east. All customers are connected to a common distribution transformer via typical 3-phase overhead low voltage reticulation.

Milestones Addressed

- Achieving end-to-end control integration of DER devices into the network
- Demonstrating DER orchestration functions that integrate network supervisory control and data acquisition (SCADA) information with customer DER data
- Limiting peak demand on the high voltage network through utilisation of behind-the-meter DER
- Operating the mini grid in island mode with 100 per cent inverter-based supplies for an extended period (22 hours)
- Effectively managing DER devices to reduce negative impacts on the network, especially power quality

Approach

- Cloud-based control optimisation platform that can flexibly integrate with multiple third-party DER platforms
- Distributed architecture for the mini grid, with 90 per cent of DER capacity distributed and only 10 per cent centralised
- Use of 100 per cent inverter based supply sources
- Design of protection scheme to operate on the legacy network under a low fault-current environment
- Islanded operation with active management ability, rather than typical droop settings

Results

Customers: Customers increased their support for DER from 14 per cent to 87 per cent across the course of the project. Energy cost reduction is the primary customer motivator, with solar delivering about 80 per cent of benefit and batteries 20 per cent. Increased awareness of benefits of DER devices such as back-up power functionality during grid outage with some interest from customers to purchase their own battery systems.

Technical: Demand on the upstream automatic circuit recloser was able to be limited, with a 65 kVA reduction. Stable and secure mini grid islanded supply achieved for 22 hours. Network limits can be easily exceeded by new business models such as Virtual Power Plants (VPPs) that respond to the wholesale market. The concept of DER orchestration combining 3G communications and cloud-based data platforms was proven.

CAPTION:
Mooroolbark site

GRID BATTERY ENERGY STORAGE SYSTEM

ENTR Themes

- Power System Security
- Intelligent Networks and Markets

Principal Company

Endeavour Energy

Rationale

Deferral of upgrade of an 11 kV feeder through peak shaving

Project Timeline

January 2018 – January 2020

Location

West Dapto, NSW

Funding

Self-funded, network capital

Stakeholders

Mpower, Ingeteam, LG

Description

The Battery Energy Storage System (BESS) trial is an 11 kV grid support storage system of 1.5 MWh capacity to be deployed at West Dapto, NSW, which will help defer the West Dapto zone substation construction. Targeted learnings include:

- Suitability for peak shaving, and other network support applications such as voltage, power quality and power factor management
- Innovating the use of battery storage as grid backup supply in for reliability support
- An understanding of design considerations such as capacity, charge/discharge rates, system lifecycle, safety, control and monitoring requirements, and any limitations of the equipment
- Practicalities of installation, relocation, testing and commissioning
- Maturity of the technology and suppliers in the Australian market

Milestones Addressed

Battery built and in-testing underway.

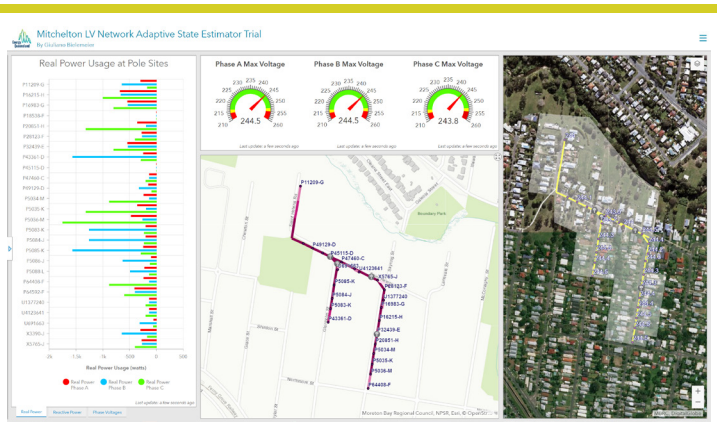
Approach

The supplier Mpower has designed the BESS based on Endeavour Energy's functional specification. Notable design criteria include:

- Modular and transportable with design to minimise onsite profile
- Inverter with four quadrant power supply capable of peak lopping, power factor correction, voltage/PQ support
- Capable of supplying a section of network in island during planned outages or faults
- End of life storage capacity of 1 MWh
- Round trip charge/discharge efficiency at the 11 kV grid connection point above 80 per cent
- SCADA connected and fully protected at 11 kV
- Must comply with safety requirements of all relevant company, industry and Australian standards as per requirements of AS5577.

CAPTION:
Battery container and cooling system

LOW VOLTAGE STATE ESTIMATION



ENTR Themes

» Intelligent Networks and Markets

Principal Company

Energy Queensland

Rationale

Development, implementation and testing an innovative state estimation algorithm for monitoring low voltage electricity distribution networks.

Project Timeline

2016 - 2019

Location

Brisbane, Queensland

Funding

ARC Linkage

Stakeholders

University Queensland

Description

This project demonstrates the technical viability of distribution network state estimation to complement incomplete measurement data and produce a best estimate of all operational aspects of the monitored network.

Available information such as measurement data architecture and components of the network and statistical data about the loads and generators will be used by the to produce a complete, consistent and coherent estimate of the operational state of the entire monitored network, including all voltages, currents, losses and power flows. The aim of this project is to test this capability to improve the understanding of the operational conditions in the network not seen before.

Approach

State Estimation has great similarity with simulation-based power flow analysis in modelling of the electrical characteristics of the analysed power network and producing an estimation of the network's complex-valued voltage profile. Together, the network model and the voltage profile allow for every current, power flow, electrical power loss and other operational values to be calculated.

The operational conditions throughout the entire analysed network are known once estimation of power flow analysis has been performed. The difference lies in how many and what type of input data these two analysis techniques can process to calculate the voltage profile. While power flow analysis is intended for simulation purpose only, it assumes its input data to be perfectly accurate and requires the user to provide specific types of information. State Estimation abstracts from this by allowing a wider range as well as lesser quality of data. In considering the quality of all data, it then calculates the most probable voltage profile.

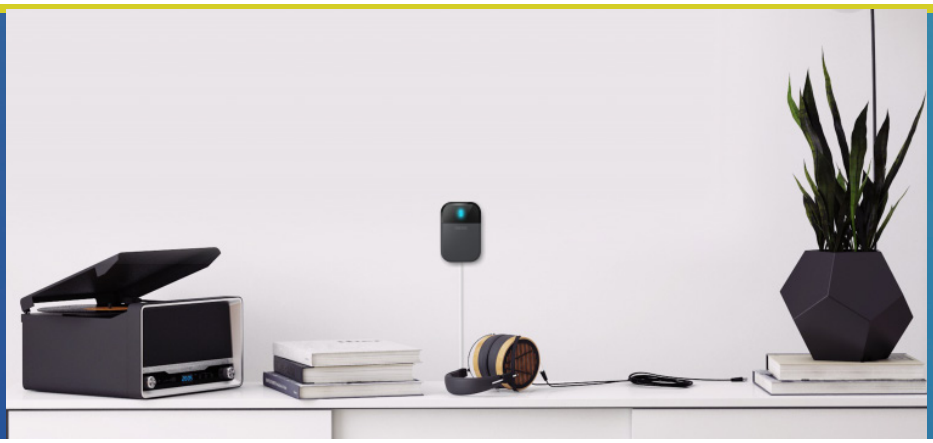
Results

The project has successfully demonstrated that low voltage state estimation, and state estimation on any other voltage level within the distribution network, is not only technically feasible, but can be done at a relatively low level of measurement penetration, given that the estimator can access and interpret already available statistical data about the supplied customers.

The results generated by the estimation system operated in this project, estimate the system state of a low voltage network every five seconds based on data acquired from four network mounted.

CAPTION:
Operations dashboard
– overview of the estimator

ENERGY PARTNER



ENTR Themes

- Customer-oriented electricity
- Network Optimisation and Platforms
- Grid Transformation
- Pricing and Incentives
- Power system security

Principal Company

CitiPower Powercor

Rationale

Reduce Energy at Risk

Project Timeline

May 2018 – April 2019

Location

Bellarine Peninsula and Surf Coast (Victoria)

Funding

Self-funded

Stakeholders

RACV, ITConnexion, Sensibo and AppliancePro

Description

Energy Partner is a demand response program targeted at incentivising customers for control of their air conditioners (AC's) via an Infrared (IR) control device called Sensibo Sky. Sensibo Sky replicates a user's remote control for split system AC's and is controlled via a smartphone app. Customers can use this app for everyday control of their AC, which provides a unique value proposition to the customer.

Milestones Addressed

- Enhanced the customer meter data portal to support demand response registrations (one portal for all functions)
- Unique, scalable demand response control solution developed for autonomous demand response event communications and deployment
- Established a successful installation program for installation/setup of each Sensibo device and provide a positive customer experience
- Established a customer support model with RACV, ITConnexion and AppliancePro

Approach

- Establish channel partnership with RACV
- Determine suitable product solution (Sensibo) and proof of concept fleet control solution
- Develop Energy Partner registration functionality within myEnergy portal

Market product to residential customers living in the target area (direct mail, email, SMS, Sustainable House Day, media release, social media, websites)

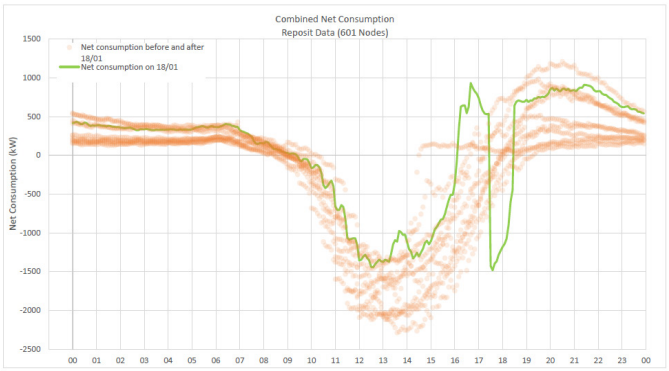
- Develop demand response event control and communications solution
- Reconcile customers' event participation and deliver incentive payments

Results

- 93 per cent participation rate
- Reduction in 'energy at risk' on zone substations in the target area (largest reduction was 473.6kW)
- Highest average demand reduction per customer was 0.66kW

CAPTION:
Operations dashboard
– overview of the estimator

ACTIVATING DISTRIBUTED BATTERIES FOR NETWORK SUPPORT



ENTR Themes

- Power system security
- Intelligent Networks & Markets

Principal Company

Evoenergy

Rationale

A more effective tool has been identified in the form of reactive power, or Volt Amps Reactive (VAR) control. This solutions helps stabilise fluctuations in the network by discharging residential batteries at varying power factors, creating either an inductive or a capacitive generation source. This would also be a big step towards developing a smart grid for the ACT.

Project Timeline

December 2017 – January 2019

Location

ACT

Funding

DMIA, Opex

Stakeholders

Evoenergy, Reposit Power

Description

Evoenergy selected systems under the Reposit fleet to be integrated with the Advanced Distribution Management System (ADMS) portal to provide a real time representation of solar generation, current battery storage levels, and node level low voltage (LV) network data.

Milestones Addressed

Evoenergy has developed the Internet of Things (IoT) Hub in June 2018 to integrate two key tools for network control: the virtual power plant (VPP) fleet and Evoenergy's ADMS. This integration is the first of its kind in Australia and delivers real-time information directly into the ADMS. This direct interface with the VPP platform unlocks a level of visibility and control of the LV network that has never before been possible, giving network controllers the ability to assess available supply, via battery levels within the network, and utilise the stored energy to help protect the grid.

Approach

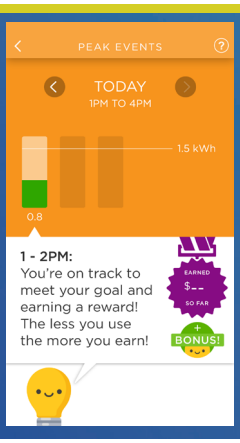
To maintain a safe and reliable network, Evoenergy investigated voltage control using network and non-network solutions. Using the VPP fleet as a digital solution, Evoenergy is conducting VAR trials to investigate the voltage control capability. Three trials have produced encouraging results showing the LV network can be manipulated through intelligent, automated export of power at different power factors. Further trials are underway harnessing this capability to understand the level of voltage reduction possible with the current and future VPP, and the associated cost-saving for the customer.

Results

- Proof that a VPP can be used to help reduce peak demand
- Confirmation that the Reposit Power's VPP Fleet system is capable of coordinating residential batteries to provide grid support
- Demonstration that a third-party service engagement is a practical and effective means of supporting Evoenergy's distribution network
- Identification of the need to continue the integration of similar dynamic data services, for solar modelling and IoT devices for network state estimation.

CAPTION:
Sensibo Sky

SUMMER SAVER PROGRAM



ENTR Themes

- Incentives and network regulation
- customer focused electricity

Principal Company

United Energy

Rationale

Performed a Summer Saver trial study and as result of this successful trial continued to recruit customers to participate in reducing their energy usage during each summer as per Program requirements.

Project Timeline

December – March

Ongoing (annually)

Location

43-45 Centreway Place, Mount Waverley, Victoria

Funding

AER and Capex-Opex substitutions

CAPTION:
Net consumption from the grid for the 601 nodes for days before and on the day of ACT wide dispatch (18 Jan 2019)

Description

United Energy (UE) introduced Summer Saver Program to provide a non-network demand response solution as an alternative to building network capacity to address the short-duration maximum demand. The program incentivises UE customers to voluntarily reduce their electricity usage for a three-hour period for up to four days each summer (Summer Saver Event Days). The incentives are designed to encourage maximum demand reduction during the event periods. This defers the need for costly network augmentation preventing asset failure and customer outages. The program primarily targets residential customers as the network peak demand typically coincides with residential load profile. However, some commercial customers are also invited to participate.

Milestones Addressed

- Develop marketing and council engagement plan for Summer Saver Program 2018/19 in September 2018
- Implement the registration platform and update production website for Summer Saver Program 2018/19 by October 2018
- Develop a customer interface portal to visualise performance during the Summer Saver Event by November 2018
- Recruit customers for Summer Saver Program 2018/19 in November 2018
- Process the customer rewards and deposit incentive payments in April 2019

Approach

Utilise voluntary customer reduction of their load during for a three-hour period for up to four peak-demand days each summer. This is a non-network demand response solution alternative to building network capacity to address the short-duration maximum demand.

Results

Summer Saver Program has positively influenced customer behaviour towards electricity utilisation during maximum demand conditions on the network. The customers participating in the program have reported greater awareness of their electricity usage and assisted in addressing network constraints during hot days. In a post implementation survey, 43 per cent of participants reported making permanent changes to their electricity use as a result of the program. Behavioural changes were largely around increasing temperature set-points for air-conditioners and turning off appliances at the power source. 30 per cent of respondents reported their primary motivation in participating in the program was to do the right thing for the community/environment followed by financial incentives at 26 per cent. This demonstrates how the Summer Saver Program was successful in articulating its benefits and its impact on the environment. The principal benefit of the program to the customer was the financial incentive. On average, each household was rewarded $50 in reward payments.

GRID TRANSFORMATION ENGINE

ENTR Themes

» Customer Oriented Electricity

Principal Company

Western Power

Rationale

With billions of dollars of network investment occurring in Australia each year, the potential benefits from even minor improvements in investment efficiency will be significant.

Project Timeline

1 July 2017 – 1 July 2019

Funding

Self-funded

Stakeholders

CSIRO

UWA

Description

The Grid Transformation Engine (GTEng) is a software modelling system that tackles the challenge from a number of directions starting with a customer demand driven, scenario based energy forecast that looks at potential economic, demographic and technology changes that will occur over 30 years. A future grid solution is developed to best meet customer demands at the 30-year mark looking at stand-alone power system and microgrid solutions, where energy consumption density is low and high capacity network solutions where it is high.

A near term objective is to include intelligent network capabilities in the solutions considered. For each future grid solution defined, a transition pathway is developed that identifies the optimal network maintenance and construction activities required to transition to the future grid. This is presented as a grid transformation plan that is evaluation for financial, reliability and safety risk performance.

Milestones Addressed

The following GTEng capabilities have been developed:

» Customer profile

» Customer energy forecast

» Future grid - solution option selection

» Future grid - network augmentation

» Transition pathway

» Scenario dashboard

The following GTEng capabilities are in progress / planned:

» Underground solution option

» Opex model

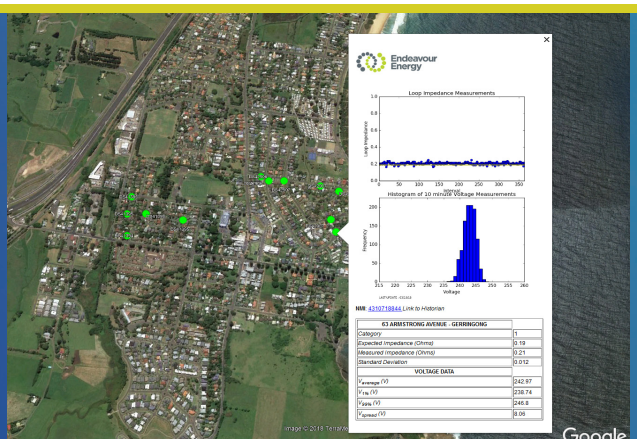
Approach

The GTEng has been developed as a series of discrete modules working within an overall grid transformation methodology. Each module operates from a set of data inputs and produces data outputs for consumption by the downstream modules. The GTEng is a proof of concept that will be replaced by an enterprise grade solution in the near term.

Results

Initial grid transformation scenario outputs are being produced - these are presented in a dashboard view with geospatial visualisations produced separately. As more scenarios are produced, a cross-scenario analysis will enable insights to be drawn about future directions for the network.

NEUTRAL INTEGRITY METERING TRIAL



ENTR Themes

- Customer Orientated Networks
- Intelligent Networks and Markets

Principal Company

Endeavour Energy

Rationale

Use of in-meter analytics to determine the quality of the network connection and to proactively respond to network faults. The original implementation was targeted to the LV CONSAC network which has a high failure rate.

Project Timeline

January 2016 – January 2019

Funding

Self-Funded, Network Capital

Stakeholders

EDMI Meters Pty Ltd

Location

Western Sydney, NSW

Description

There has been analysis done to quantify the related shocks and faults between the Consentric Neural Solid Aluminium Conductor (CONSAC) and non-CONSAC underground network. Analysis shows that the introduction of condition monitoring on high risk cables is justified on high risk CONSAC feeders. The introduction of Neutral Integrity (NI) meters provides condition data of the mains which assists in the following:

- Determine risk of failure for each CONSAC feeder based on cable loop impedance
- Identify existing/evolving issues
- Rectify identified issues on CONSAC network
- Monitor the integrity of the CONSAC post fault rectification
- Replace sections of CONSAC that are subject to failure
- Safely defer replacement of healthy mains

Milestones Addressed

- Monitoring implemented on all CONSAC feeders with spans greater than 65m
- Develop reporting mechanism for representing NI meter data to all stakeholders
- Investigate and rectify any potential failures
- Upon completion of Meter rollout, quantitatively assess high risk safety and OPEX burden geographical locations to prioritise for proactive renewal

Approach

Supply tender and work with supplier and platform to refine analytics

Results

During the rollout period, potential issues were investigated using the NI meter data. A significant finding was that the majority of issues identified by NI monitors were related to the transition joints within columns/pillars rather than the cable itself. Since the deployment of the monitoring, three genuine CONSAC related issues have been identified and brought forward in the replacement program. Significant areas of the CONSAC network is in good condition, with pockets of geographical areas with localised issues including elevated safety and potential OPEX burden risks which have been prioritised for renewal.

CAPTION:
Neutral Integrity monitor data on the GE KML layer

SOLAR ANALYTICS CUSTOMER DEVICES ENABLING RENEWABLES

ENTR Themes

» Customer Oriented Networks

Principal Company

Energy Queensland

Rationale

This cooperative industry project will develop prototype devices with added control and visibility functionalities providing customers and networks with useful information related to the operation of PV and battery systems.

Project Timeline

2018 – 2020

Funding

Cooperative Research Centre

Stakeholders

Solar Analytics (Lead Participant), WattWatchers, SwitchDin, SAPN, UNSW

Description

With an increasing number of customers installing renewable energy systems and smarter load devices, the diversity on our network grows and the need for better understanding of what is happening at the low voltage (LV)level escalates.

Solar Analytics have developed an in-meterbox/switchboard device that monitors energy flows in the customer's premises. Their value-add propositions include monitoring energy flows, including net energy at the point of connection, as well as solar and other sources. The project aims to bring together these established industry participants to broaden the scope of opportunity of the Solar Analytics hardware product and customer value-add functionalities.

Milestones Addressed

By 2027, network information and digital services provide a platform for stimulating customised energy options in dynamic markets.

Approach

Provide information and feedback to the lead participant, Solar Analytics, to facilitate the development of prototype devices capable of improving control and LV visibility.

Deploy prototype devices to suitable trial locations including isolated networks experiencing emerging constraints with distributed energy resources hosting capacity.

Assess the outcome of the project against the following measures of success:

» Increase the hosting capacity of renewables within an isolated network

» Positive feedback from trial participant customers – quantified by improved survey results between pre and post installation

» An improved customer outcome for trial participants

» Multiple indications of where the prototype devices have successfully mitigated a network constraint that would have otherwise resulted in an unfavourable customer or network outcomes.

Results

Initial trial customer engagement and interest has been high. Technical results of first trial deployment expected early 2019.

CAPTION:
Solar Analytics Energy Monitoring Device

STANDALONE POWER SYSTEMS TRIAL

ENTR Themes

» Incentives and network regulation

Principal Company

Western Power

Rationale

Local generation supply options such as Stand-alone Power Systems (SAPS) have seen considerable cost reductions in recent years and, in some circumstances may present a safer, more reliable and more economical alternative to network rebuild. Thus, in addition to the financial benefits, Western Power believes that in some situations SAPS will provide improved reliability and reduced bushfire risk when compared to a network solution.

Project Timeline

June 2016 - June 2019

Funding

Self-funded

Description

Western Power undertook a pilot project to determine whether SAPSs achieved better outcomes for electricity consumers at a lower cost than the replacement of end of life electricity network infrastructure and to inform the regulatory and statutory changes required to enable their deployment. The project business case recommended the design and installation of six hybrid diesel/ photovoltaic-battery SAPS along with meeting minimum maintenance and emergency response requirements in operating and maintaining the SPS for a 12 month period from the date of installation of the last SPS unit. The delivery of quarterly SAPS system performance and customer experience survey data is also included as part of this project in order to inform regulatory and statutory reform and the most effective business models for business as usual deployment of SAPS.

Approach

Started by identification modelling of suitable SAPS candidates where:

» sites had to be more than 50 per cent cheaper to install and operate a SAPS when compared with traditional building and replacement methods

» customers had to be within medium to high bushfire risk areas where a safety benefit could be realised

» they had to be on short spurs on the same feeder to make the pilot meaningful, and consume less than 40kWh/day

» heightened reliability issues.

After stakeholder engagement, confirmation with load logging, system specification and market tender to procure SAPS units, trial was initiated. Sites were continuously monitored and report was prepared after first year of trial.

Results

Systems were remotely monitored. A range of activities were undertaken to ensure that system performance met both customer expectations and the intention of the Technical Rules, regulated by the Economic Regulation Authority, including:

» customer surveys to gauge customer satisfaction with our service and provide a comparison with grid supply

» ongoing monitoring of the systems' performance and detailed analysis of defects and outages to avoid reoccurrence

» comparison of the reliability of supply (minutes of each outage) of SAPS versus the known network outages affecting customers in the area

» analysis of voltage and frequency levels to confirm that SAPS meet the requirements within the Technical Rules.

SOLAR STORAGE PROGRAM

ENTR Themes

- Incentives and network regulation
- Customer focused electricity

Principal Company

United Energy

Rationale

United Energy has undertaken a targeted consumer engagement initiative for deployment of solar photovoltaic (PV) and battery energy storage systems at customers' premises that are connected to constrained (or overloaded) distribution substations on the distribution network.

Project Timeline

July 2017 – June 2019

Location

43-45 Centreway Place, Mount Waverley, Victoria

Funding

ARENA, United Energy

Description

Comprehensive investigation into system specifications resulted in the selection of solar PV system with optimisers (15 solar PV panels Ð 270W = 4 kW, 9.8 KWh battery, a 5 kW inverter) as the least-cost lifecycle option for the program.

United Energy has installed solar PV and storage at customer locations providing the least cost lifecycle solution. In order to identify and target 'high value' customers along an overloaded substation, United Energy used a combination of smart meter data, demographic profiling and market research, to assist in analysis and selection of suitable customers on each substation, subsequent to customers registering. United Energy strategically targeted customers providing the best network benefits for installation of solar and storage systems.

Milestones Addressed

- Customer Engagement Strategy – May 2017
- Customer Marketing – June 2017, October 2017 and February 2018
- Customer Registration – June 2017 to March 2018
- Site Assessment and Customer Engagement (Q & A) – July 2017 to March 2018
- Customer Contract Execution – July 2017 to March 2018
- Installation – July 2017 to March 2018
- Development of Operational Protocols – December 2017 to March 2018, December 2018 to March 2019
- Final Report – 30 June 2019

Approach

Undertake a targeted consumer engagement initiative for deployment of solar PV and storage at customers' premises that are owned by United Energy as per contract term and are connected to constrained (or overloaded) distribution substations on the United Energy distribution network, resulting the deferral of traditional network augmentation.

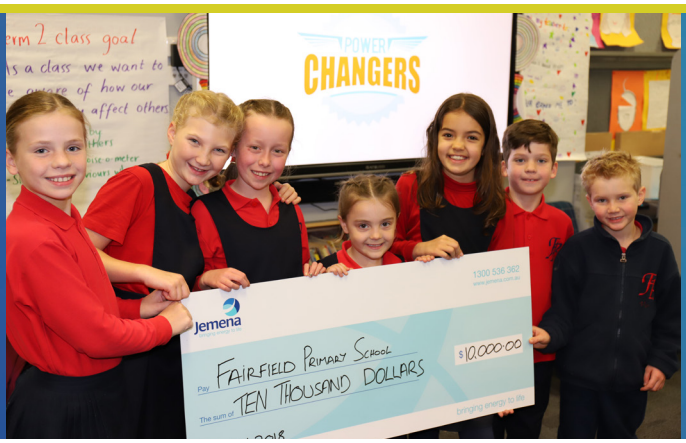
Results

Of the 1,500 targeted customers, 42 took up the contract.

The main benefit arising from this program is confirmation that residential solar and storage systems can be an economic network augmentation alternative, in certain instances. Distribution networks can potentially procure such a solution to achieve prudency of investment by deferring larger network augmentation projects and reduce network costs for customers.

CAPTION:
Inverter and battery at the same premises

POWER CHANGERS



ENTR Themes

» Customer-oriented electricity

Principal Company

Jemena

Rationale

On hot days, households can use three times more electricity than usual. This can place the electricity grid under pressure. Jemena is looking for cost-effective ways to reduce this peak demand pressure. Power Changers was aimed at empowering residential customers in six selected Victorian suburbs in the Jemena Electricity Network.

Project Timeline

August 2017 – May 2018

Funding

Jemena & co-funded by Victorian Government

Stakeholders

Victoria Government Department of Environment, Land, Water and Planning (DELWP) Energy Affordability Team in the Energy Sector Reform Division, BehaviourWorks Australia, Billcap, GreenBe, Positive Charge and the Centre for Market Design, Melbourne University

CAPTION:
Community Rewards

Description

The Power Changers trial utilised the capabilities of Advanced Metering Infrastructure (AMI) to set individual household targets, deliver electricity consumption data to participants and determine how much electricity was saved. 613 households signed up to participate in the trial. Depending on their suburb, they were assigned to one of two treatment groups:

» Personal rewards: where the points they earned from participation could be converted into gift cards, or

» Community rewards: where the points they earned could be donated to local schools and community organisations.

Milestones Addressed

» Recruitment-applied various channels including social media and lottery-achieved 613 registrations

» Processes-developed and implemented processes for customer validation, customer surveys, Demand Response (DR) event management and measurement & verification of demand response

» Analysis-set of customer engagement matrix and data analytics developed

» DR challenges - Six DR Challenges were called across summer.

Approach

Engagement with participants was facilitated by a new smart phone app and web portal through which participants were able to participate in challenges. Participants could choose to sign up to each DR challenge, when they would be allocated a target for their energy consumption for a three-hour period, with the objective of reducing their expected consumption. If they met their target, they earned points. In addition, they could participate in multiple "learn and earn" challenges designed to encourage participants to learn more about the electricity market and how to manage their electricity usage and bill; and obtain vital feedback on their engagement with the trial. As part of the recruitment process all customers went through a strict validation process which included screening for life support customers as they were not allowed to take part in the trial and not calling an event when the predicted temperature is greater than 40°C.

Results

Households were able to reduce their peak electricity consumption by between 23 per cent and 35 per cent during the DR challenges that took place on hot days. Participation in each DR challenge ranged between 43 per cent and 53 per cent, with higher participation by the personal rewards group. Participants expressed a high level of satisfaction with the trial (85 per cent) and reported that the trial:

» motivated them to reduce their electricity usage

» helped them to save money on their electricity bill

» motivated them to be more conscious about conserving electricity.

BREMER BAY AUTOMATION

ENTR Themes

» Incentives and network regulation

Principal Company

Western Power

Rationale

Bremer Bay is supplied from Albany substation via a 180km distribution feeder, which experiences poor reliability. There is a local power station (owned by Synergy) which is only utilised when supply from the network is lost. This requires phone calls between Western Power network operators and power station controllers to initiate supply restoration via the power station. Due to the length of the network supplying the area, 45 outages have been experienced by Bremer Bay customers over the past 5 years, with an average duration of just under 2 hours.

Project Timeline

2017-2018

Funding

Internal

Stakeholders

Synergy

Description

To reduce customer outage durations to under one minute, Western Power has worked in collaboration with Synergy to provide an automated scheme that determines the location of fault and starts the power station automatically when supply from the network is lost (if logic determines safe to do so), and stops the power station automatically when supply from the network is restored.

Milestones Addressed

» Late 2016: Synergy initiated the control system replacement project

» Early 2017: Western Power were informed that the control system replacement project was going ahead. Western Power expressed the desire to automate the local network with power station inorder to improve reliability

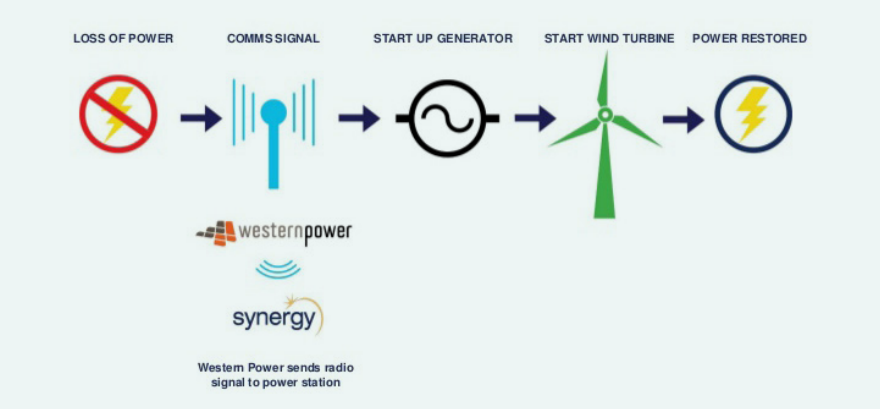
» April/May 2017: Scope of work was completed and RFQ was issued to the market

» Aug 2017: Syenergy award contract to Contract Power to supply, install and commission the comap control system

» Sep/Oct 2017: Engineering and procurement activities

» Nov/Dec 2017: Construction and commissioning.

Approach



Results

The Bremer Bay microgrid project supplements the existing network by improving power reliability and security throughout the year. This energy innovation also better equips the town to cope with exceptional holiday maker power demands, as well during storm and bushfire seasons. Also reducing System Average Interruption Duration Index and System Average Interruption Frequency Index for Western Power.

ON-LOAD TAP CHANGE DISTRIBUTION TRANSFORMERS TRIAL

ENTR Themes

- Incentives and network regulation
- Customer focused electricity

Principal Company

United Energy Distribution Pty Ltd

Rationale

Trial two different distribution transformers with on-load tap changing (OLTC) functionality to be installed on the low-voltage distribution network to compliantly regulate voltages where customers are exposed to both steady-state over-voltages and under-voltages at certain times during the year.

Project Timeline

July 2017 – March 2019

Funding

United Energy Capex Budget

Description

Power quality data populated from Advanced Metering Infrastructure (AMI) devices was utilised to determine the worst performing steady-state voltage distribution substations. From this list, two distribution substations were strategically selected for trial installations in 2017 of the on-load tap changing (OLTC) distribution transformers.

The objective of the trial is to:

- evaluate the performance of OLTC distribution transformers at regulating the voltage within the stipulated regulatory limits
- evaluate the total cost to supply and install OLTC distribution transformers (for use in future installation analysis)
- evaluate the available products (build quality, reliability, standard adherence, etc.)
- determine the benefits of using OLTC distribution transformers on the United Energy network

On completion of the trial, it is expected the OLTC distribution transformers will be added to the standard materials list for use by electricity networks in solving voltage issues, where it is identified, that customers are exposed to both steady-state over-voltages and under-voltages at certain times during the year. These devices will be utilised when its solution is the least lifecycle cost technically appropriate, when compared to other options.

If the trial is successful, it is intended to leave the OLTC distribution transformers in-service, otherwise they will be decommissioned at the end of the trial.

Milestones Addressed

- Stage 1 of trial was completed in November 2018 showing good regulation of over-voltage
- Stage 2 and final stage of the trial is to be completed by the end of March 2019 and will deal with load balancing and under-voltage issues.

Approach

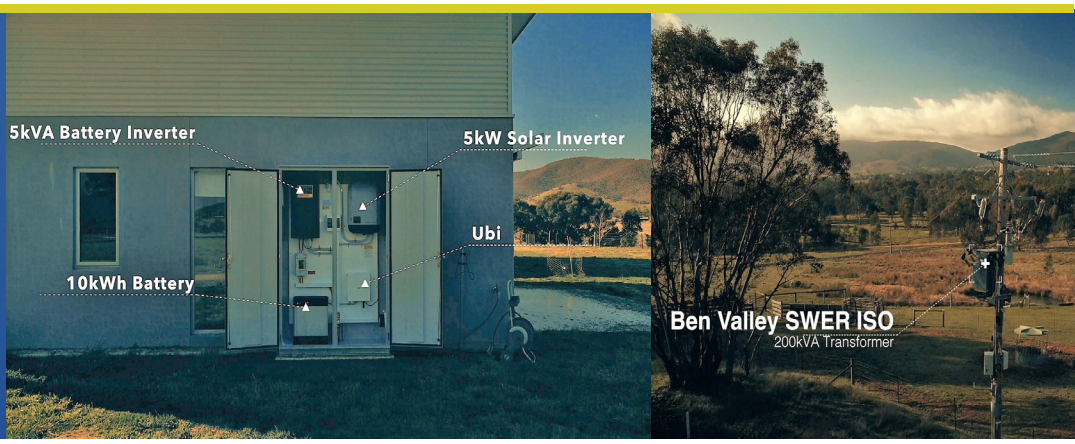
Perform a trial to determine if a selected distribution transformer with OLTC is able to manage the customer voltages within compliance levels for the various times and conditions of the network.

Results

Results to date from the related AMI meter voltages show that the distribution transformer with OLTC is controlling the over-voltage conditions within compliance levels, however some fine tuning work needs to be done to further improve the performance of this new asset.

CAPTION:
Minera SGrid LV Distribution Transformer with OLTC

NETWORKS RENEWED



ENTR Themes

- Customer-oriented electricity
- Intelligent networks and markets

Principal Company

AusNet Services and Essential Energy

Rationale

Networks Renewed aims to prove that the reactive power capabilities of modern smart solar and battery inverters combined with dynamic control platforms can be used to help improve network voltage levels. Consequently, this concept may allow greater solar power penetration to be hosted by the distribution network.

Project Timeline

December 2017 – June 2019

Funding

ARENA

Stakeholders

University of Technology Sydney's Institute of Sustainable Futures, Mondo Power, Totally Renewable Yackandandah, Solar Integrity

Location

Yackandandah, VIC

Collombatti, NSW

ian.askell@essentialenergy.com.au

CAPTION:
Single-wire earth return Iso Transformer and Solar and Battery Installation

Description

Due to the strong growth of behind the meter, solar photovoltaic (PV) and battery storage technology, challenges are starting to emerge connecting additional systems to the network, particularly in managing voltage levels in rural networks, resulting in connections rejected or limited or investment required in the network. Noting the growing challenges of integrating solar PV, two key objectives include to:

- Develop a set of guidelines for future uptake to ensure such technology is optimally integrated to the network and does not result in costly network expenditure
- Explore the possible value such technology can provide on a least cost basis to address network constraints.

Milestones Addressed

- Customer engagement and recruitment campaign
- Successful control platform integration from DENOP-Mondo
- Installation & commissioning of solar & battery systems
- Business case for voltage support services developed by UTS with input from AusNet Services.
- Initial testing and preliminary results achieved
- Public industry forum to present preliminary results

Approach

- Identifying a site with existing voltage issues and a very pro-solar community
- Developing a customer offer that involved solar at market rates, batteries at discounted rates and an incentive to allow control of their systems
- Detailed low voltage load flow modelling of the SWER network to assist in designing the hardware and control solution
- Preliminary testing of the voltage response to reactive power support from the solar, from the battery, and from both systems combined by performing 'notch tests'.
- Development of more advanced dynamic and autonomous control algorithms for both reactive and active power to allow testing of an orchestrated solution across summer 2018/19.

Results

Initial testing showed a very promising level of voltage response given the generally resistive nature of Single-wire earth return (SWER) network construction. Utilising the 3 kVAr available from the 5 kVA solar inverters reduced supply voltages by 3-5 V. Including reactive support from the battery inverter (of up to 4 kVAr), a reduction of over 6V was achieved. Overnight voltages during hot water peak demand times were able to be supported by around 5 V through use of the battery inverter reactive power.

PERENJORI BATTERY ENERGY STORAGE SYSTEM

ENTR Themes

» Incentives & network regulation

Principal Company

Western Power

Rationale

Perenjori is supplied from the Three Springs substation via a 75 km 33 kV distribution feeder, which experiences poor reliability. Given the small population of the town and distance from the substation for any material traditional reliability reinforcement option, it was decided to explore energy storage and microgrid functionality.

Project Timeline

2015 - 2018

Funding

Self-funded

Stakeholders

EPC contractor - Balance Utility Services / Decmil
O&M - Balance Utility Services

Location

Perenjori

Description

Western Power recently installed a 1MW/1MWh battery storage system at Perenjori, with the main objective being to improve the reliability of supply to the town. The system has been designed so when the 33 kV feeder supplying the town is faulted, the battery back-up system will form an intentional island to maintain supply to Perenjori town. In this project, Western Power pioneered a unique fault detection and islanding capability of 150 ms - so fast that most equipment in the town won't even see a black out or brown out voltage dip. It is the first microgrid that can address momentary outages (Momentary Average Interruption Frequency Index), as well as improving System Average Interruption Duration Index (SAIDI) and System Average Interruption Frequency Index (SAIFI) for an entire rural town.

Milestones Addressed

» Functional specification development and market tender in 2016
» Execution through 2017
» Commissioned mid 2018
» Ongoing trial testing and information collection

Approach

» Initial need to address top reliability hotspots
» From hotspot list, a weighted matrix was used to choose town which was small enough to trial battery energy storage at cost effective value
» Specification was developed and Western Power partnered with market to source and deliver project

Results

The system has operated to successfully protect the town for upstream feeder disturbances 18 times in the three months since commissioning. There were issues with inverter failure requiring replacement and ongoing problems with the battery management system requiring resolution by the supplier. Learnings have been applied to next microgrid project.

DYNAMIC VOLTAGE MANAGEMENT DEMAND RESPONSE

ENTR Themes

» Incentives and network regulation

Principal Company

United Energy Distribution

Rationale

The project objectives include to:

Deliver quality of supply voltage compliance by dynamically adjusting voltages at zone substations using customer voltage feedback from advanced metering infrastructure meters.

Deliver demand response services to the NEM using voltage reduction when called by AEMO.

Allow higher solar photovoltaic (PV) systems to be connected without adverse impacts to the network. Demonstrate United Energy's capability in supporting the NEM.

Deliver customer outcomes of fewer supply/demand outages and extended appliance lives.

Project Timeline

November 2017 – October 2020

Funding

Partial funding by ARENA

Stakeholders

ARENA, AEMO, Customers

Location

Mount Waverley, Victoria

Description

The distribution of voltages supplied to United Energy customers uses actual time-lagged voltage information (by 25-60 minutes) from United Energy's entire fleet of smart meters advanced metering infrastructure (AMI). This is compared with the regulatory voltage limits through a data-analytics engine and the magnitude of the voltage reduction applied to maintain voltage compliance. To implement this scheme on the entire network, United Energy needs to replace the bulk of its voltage regulation relays (VRRs) at zone substations to cater for multiple float voltage settings. Field rectification works to distribution transformer tap changes are required to maximise the demand response capability. ARENA funding was used to justify replacements of all of these relays.

Milestones Addressed

» Completion of trial at Clarinda zone substation – March 2017

» Develop the operational procedure for NCC staff – November 2017

» Perform risk assessment and implement risk mitigation controls – December 2017

» Prioritise the zone substations according to their demand and voltage reduction level for relay replacement sequence – February 2018.

» Develop the performance report (PIR) for the DVMS CDA trial with recommendations for rollout – March 2018

» Perform the system tests for AEMO via emergency voltage set-points – May 2018

» Replace the relays at the prioritised zone substations in the field – November 2018

» Perform the system tests for AEMO via dynamic voltage set-points – November 2018

» Deliver demand response services to the NEM using voltage reduction when called by AEMO – beyond November 2018

Approach

Undertake a trial to prove the concept, determine issues and refine the solution prior to full deployment across 47 zone substations in 2018.

Results

United Energy has successfully passed AEMO testing to deliver at least 12 MW for the NEM. 19 MW delivered on the relatively low 900 MW demand test day. Complete rollout will ultimately achieve a minimum 30MW in summer 2018/19. The following customer outcomes have and will continue to be delivered: enable higher penetrations of customer solar PV systems to be connected without adverse impacts while reducing customer complaints; fewer supply/demand outages, extended appliance lives and enable PV connections; and step change improvements in quality of supply compliance.

FUSESAVER

ENTR Themes

» Customer oriented electricity

Principal Company

Western Power

Rationale

Many utilities worldwide have chosen to remove fuses from their overhead network entirely to address reliability, operator safety and fire prevention concerns. In order to meet this requirement, Siemens has released a new range of Fusesaver models that provide an additional open operation in case the Fusesaver recloses onto a fault. The O-CO Fusesaver provides a new solution to improve rural networks' reliability.

Project Timeline

2015 - 2017

Funding

Internal

Stakeholders

Siemens

Location

Various remote rural WA

Description

Western Power started trialling this technology, installing a number of Fusesavers in strategic locations. Fusesavers have the potential to reduce operating expenditure associated with supply restoration during a temporary fault event, as well as improving network safety (particularly in bushfire prone areas). The Fusesaver's ability to reclose after a short open period, typically 10 seconds, is expected to significantly reduce outage durations for customers located at the periphery of rural distribution networks.

Milestones Addressed

Trial completion in late 2018.

Approach

» Technology investigation started in 2015
» Strategy for trial approved and items ordered in 2016
Installed in 2017
» Firmware upgrade in 2017
» End of 2017 data extraction
» Integrate and analysis of data in 2018

Results

During the 12-month trial, there were 90 temporary faults that were cleared by the Fusesaver and zero permanent faults with one site showing 16 temporary faults. On average when correct sites are chosen a Fusesaver will pay for itself in one year given rural Western Australia's long distances to cover.

PEAK PARTNERS

ENTR Themes

» Customer oriented electricity

Principal Company

AusNet Services

Rationale

The objective of the project was to prove the concept of incentive-based behavioural demand response at a small scale and measure performance, with a view to scaling up if successful. The project also sought to test the benefit of customers having real-time energy monitoring and alternative control-based demand management methods such as air conditioning load control as per AS/NZS 4755, and the supply capacity control function of smart meters.

Project Timeline

July 2017 – July 2018

Funding

AusNet Services: Demand Management Innovation Allowance

Stakeholders

EnergyOS

Location

Clyde North, Victoria

Description

A 22 kV distribution feeder in the fast growing Victorian suburb of Clyde North had forecast energy at risk and was chosen as the pilot site for Peak Partners. The project involved offering a $5/kWh incentive (critical peak rebate) to customers on this feeder to reduce their consumption of electricity at peak times across summer, with communication via SMS. Smart meter data was used by AusNet to evaluate customer performance and rewards, using an in-house analytics tool. Customers were offered a data portal from EnergyOS to view their energy consumption data.

Milestones Addressed

» Go-live for the online material and registration page
» Media launch event at the Berwick Chase Primary School
» Enrolment of 82 customers and installation of equipment
» Declaration of nine peak demand events (across different customer cohorts)
» Customer survey conducted during and post-program

Approach

Given that residential demand response is still a new and evolving concept in the energy industry, the project sought to test multiple product offerings:

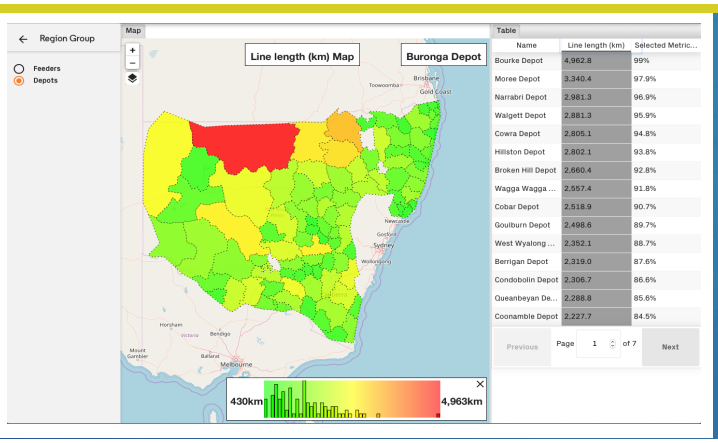
» Behavioural response with advanced metering infrastructure (AMI) data portal (delayed data)
» Behavioural response with real-time data portal
» Air conditioning load control
» Supply Capacity Control via the AMI smart meter

Marketing and customer engagement material was developed in-house and an approach to the community was made via a local Primary School, including rewards to the school for the number of families that signed up. Other marketing avenues included a letter-drop and emails to myHomeEnergy customers. Customer response was slower than expected, but ultimately sufficient to undertake the pilot.

Results

Peak Partners was successful in proving both a strong level of customer demand response during events (40 per cent reduction against comparable days) and an overall positive customer experience (96 per cent willing or very willing to recommend to friends and neighbours). Rebate payments to customers varied widely from around $5 to $30 an event. No significant difference in response was noted between customers with real-time data monitoring and those with delayed AMI data monitoring. Air conditioning load control was found to be effective but costly to implement due to an early stage supply market for control solutions. The results fed into the design of 'GoodGrid', AusNet's subsequent residential demand management project for 2018-19.

NETWORK ECONOMICS



ENTR Themes

» Intelligent Networks and Markets

Principal Company

Essential Energy

Rationale

Network Economics provides Essential Energy with data-driven modelling that reconciles business economics with customer expectations and engineering insight to integrate alternative energy solutions and deliver progressive energy distribution outcomes for the benefit of everyone.

Project Timeline

January 2018 – June 2019

Location

NSW

Description

The provision of a Proof of Concept (PoC) geospatial and graphical decision support tool that identifies areas of the network that have potential for economic improvement at a level that can facilitate real network decisions (Stage 1). How does Essential Energy better identify economic opportunities to integrate new approaches to serving customers, in a way that benefits all customers?

Milestones Addressed

The project's objective was to deliver a new capability to the business and undertake broad and open engagement with a wide range of internal potential users of the project output. Rather than coming to the business with a project plan for delivery, approaching the business with a 'blue sky' consultative approach to project development was used. This was designed to identify the broader yet to be identified use cases for the project output and informed the project team about what should be within scope.

Approach

A proof of concept decision support tool that brings together previously disparate and isolated data into a single geospatial representation. This has taken the form of a web-based general user interface that enables a user to drill down to the balance sheet and financial performance of each of Essential Energy's 25,000+ network segments. This level of detail provides insights into changes that although notable at the network wide level, provided little insight into how our strategies flowed through our day to day decisions to affect the bottom line and more importantly customers' bills.

Results

The project was a first of its kind in what it set out to achieve. It has changed the way Essential Energy looks to build, deploy and utilise decision support tools. Showing that integrated decision making is critical to enable holistic efficient network business decisions that consider customers and their long-term interests. An example of how the project has contributed to innovation across the sector, is the insight the holistic network data was able to provide when Essential Energy assisted in informing the AEMC's work on stand alone power systems (SPAS) regulatory frameworks. Using the data provided by the Network Economics tool, at the most granular level with a median segment size of 1.8 km, with 61 kVA of capacity and three premises, we have been able to provide a reasonable estimate of the long-term opportunity SAPS present to our customer base in terms of avoided network investment and reduction in ongoing network risk.

CAPTION:
Network Economics Depot Line Length

LOAD ESTIMATION

ENTR Themes

» Intelligent Networks and Markets

Principal Company

Endeavour Energy

Rationale

Use of metering data and analytics to extrapolate likely customer behaviour and effect on the grid. Medium-long term goal to replace traditional manual Maximum Demand Indicator (MDI) reads with load estimation for asset management, planning and operational purposes.

Project Timeline

January 2016 – January 2019

Location

Western Sydney, NSW

Funding

Self-Funded, Network Capital

Description

The primary benefit in the load estimator over the traditional Maximum Demand Indicator (MDI) is the ability to estimate the load profile curves for each substation, which allows for estimating time of day loading, and duration of overloading. In 2016 the proof-of-concept (PoC) load estimator was developed. The PoC load estimator has a static data feed from the following sources to estimate a time series load profile of every distribution substation on the Endeavour Energy network:

» Geographic Information System (GIS) – Network model to identify which customers are supplied from which substation

» Historian – To retrieve interval kWh data from customers with interval metering

» BANNER – To retrieve accumulation kWh data for all customers

» Ellipse – To obtain specific information for each substation on the network

In 2018 the PoC load estimator was rebuilt into production, designed to be hosted and supported on the production Historian environment. The production load estimation has the following features:

» Dynamic network modelling

» Automated load estimation

» Quality indication for each estimate to provide confidence in the estimation for either planning or operational purposes

» Time of day estimates (weekday, weekend)

» Load duration curves

» Feed into Condition Monitoring table of Ellipse to update “Estimated” Maximum – medium term goal to replace MDI reads with estimated maximums.

Milestones Addressed

Load Estimator Production has gone live and is integrated to companies’ historian.

Approach

Internally developed proof of concept and use of consulting partner to develop production system.

Results

Estimation is as accurate as MDI measurements at 15 per cent interval meter penetration and can be used in lieu of direct measurement at 50 per cent penetration in residential areas. Future developments will include time of day loading for the type of day to be used by regional services for operational switching.

CAPTION:
Substation with > 50 per cent interval metering

DYNAMIC LINE RATINGS

ENTR Themes

» Power system security

Principal Company

Western Power

Project Timeline

December 2017 – In service

Location

Mandurah to Pinjarra 132 kV transmission line

Stakeholders

Lindsey TLM

Funding

Self-funded

Rationale

Static "summer" and "winter" transmission line ratings are utilised when planning and operating the transmission system. The ability to more closely monitor environmental and asset parameters (e.g. local ambient air temperatures, wind speed, conductor temperature) with new technology that can be mounted on transmission poles / towers enables the use of ratings that are more accurate. As a result, we are able to push these circuits "harder" (while not compromising safety), resulting in deferral of costly transmission network reinforcement. A trial is currently underway to one unit on the constrained Mandurah to Pinjarra (MH-PNJ) 132 kV transmission line.

Description

The Lindsey TLM system measures conductor ground clearance using an on-board laser measuring device. Measured data is transmitted to the EMC for real time conductor ground clearance and line rating. Together with special predictive software the system can forecast the lines expected capacity in the next half hour and a day ahead. The ability to definitively, and in real-time, confirm line capacity is extremely valuable in the management and ownership of transmission networks and particularly in the future constrained electricity market.

Milestones Addressed

The business case for the trial project was approved in March 2017.
The installation of three units on MH-PNJ line was completed in Dec 2017.

Approach

Information Pack for the Lindsey TLM Dynamic Line Rating Trial

Results

Trials still underway.

SMART METER VOLTAGE MANAGEMENT

ENTR Themes

- Power system security
- Customer-oriented electricity
- Grid Transformation

Principal Company

CitiPower Powercor

Rationale

In March 2017, the Hazelwood Power Station was closed which removed 1.6 GW of capacity from the national electricity market (NEM). During this time, AEMO forecast significant shortfalls in generation. To assist AEMO in meeting this shortfall, CitiPower Powercor proposed to decrease demand by optimising voltages across its network on a continual basis during the network peak period (~4 hrs).

Project Timeline

July 2017 – March 2018

Location

Melbourne

Funding

Self-funded

Description

Leveraging the advanced metering infrastructure (AMI) smart meters in Victoria, CitiPower Powercor was able to get near-real time information of the voltages of all the customers on its low voltage (LV) network. With this live data, we were able to monitor and optimise system voltages by lowering or raising voltages at the zone substation level with little to no effect to our customers while generating significant power reductions throughout the network.

Milestones Addressed

- Project Inception & Justification
- Project Scoping
- Network Analysis
- System Design
- Field Construction
- Application to the AEMO RERT Market
- System Testing
- System Activation
- Project In Review (PIR)

Approach

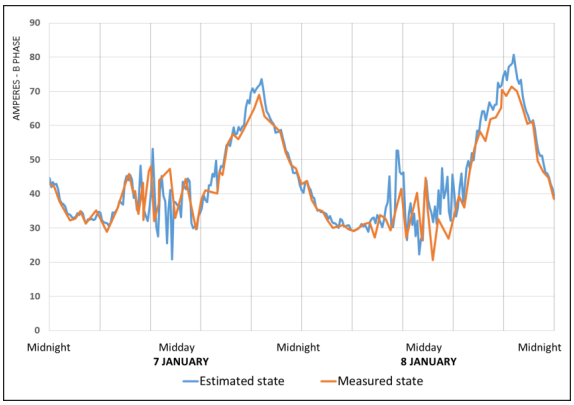
Utilising our expertise in network planning, field construction, AMI communications, network control and data analytics, we identified the core problem and iteratively conceived, tested and evaluated a range of possible solutions. After a single, viable solution was determined, all effort was focussed into physically implementing this solution in the field and socialising it within CitiPower Powercor.

Results

CitiPower Powercor successfully tested the system three times and officially participated twice in the AEMO RERT.

On each occasion CitiPower Powercor delivered between 48-100 MW of demand response.

SOLAR ENABLEMENT INITIATIVE



ENTR Themes

» Intelligent Networks & Markets

Principal Company

The University of Queensland

Rationale

Develop and trial a highly sophisticated distribution network analysis tool to lower the barriers to the connection of mid-sized (>30-1500 kW) solar PV systems to the network.

Project Timeline

2017 – 2019

Location

Queensland

Stakeholders

Energy Networks Australia, Australian Power Institute (API), Springfield City Group, Aurecon, The University of Queensland, Energex Limited, TasNetworks, United Energy, Queensland Institute of Technology

Funding

ARENA, Energy Networks Australia, API, Springfield City Group, Aurecon

Description

The project's key objective is to demonstrate that the semi-automated network analysis tool and the State Estimation Algorithm (SEA) provide a reliable mechanism to allow more flexibility in a PV system's operation and thereby reduce the protective measures that currently need to be adopted and funded by the customer.

In the simplest terms, the SEA combines and uses data on known parameters of the network, transformer set-points and outputs of voltage power flow meters in conjunction with statistical data about the typical network utilisation. From these thousands of pieces of data, the SEA creates a more complete understanding of load flows and other aspects of the network's operational state than has ever been possible. State Estimation is used extensively at the transmission network level, but hasn't, until now, been adapted for use at the distribution level.

In addition, the project will trial the ability of a distributor to use the SEA, among other tools, to dynamically reassess, and possibly raise, current limits imposed on the export of a PV system at times, thereby allowing it to export as needed most of the time. This outcome would create financial and other benefits for the customer, reduce network risks, enhance network benefits, and facilitate more renewable energy export than otherwise might be possible.

Milestones Addressed

By 2027, network information and digital services provide a platform for stimulating customised energy options in dynamic markets.

Approach

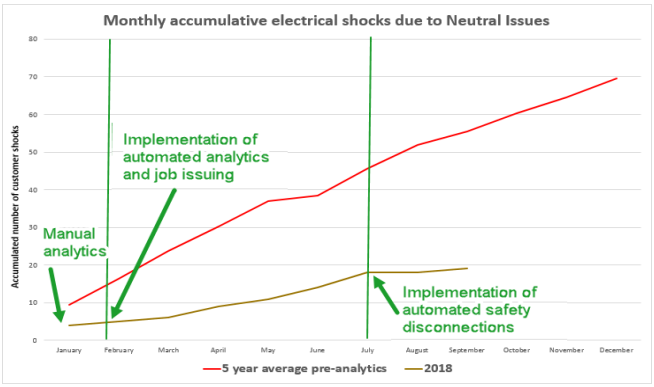
Demonstrate the viability of the SEA and the semi-automated analysis tool on seven feeders across three networks that have different measurement devices and topologies. Once proven, their use can be expanded to progressively more network feeders.

Results

Approaching the half way point of the two-year project, the preliminary results confirm the hypothesis and all milestones are being achieved.

CAPTION:
Comparisons of early applications of the State Estimation Algorithm (SEA) with measured states over this two-day period

NEAR REAL TIME LOW VOLTAGE NETWORK FAULT AUTOMATION



ENTR Themes

» Customer focused electricity

Principal Company

United Energy Distribution Pty Ltd

Rationale

United Energy's Network Analytics team saw huge potential in implementing a robust low voltage network fault detection solution and subsequently, to automate the manual, labour intensive job of checking, investigating and issuing low voltage network faults (non-supply fail related).

Project Timeline

February 2016 – September 2018

Location

Mount Waverley, Victoria

Funding

Self-funded

CAPTION:
Accumulated Number of Loss of Neutral Electrical Shocks Past and Present

Description

The project's key objectives included to:

» Reduce the risk and number of shock incidents to customers and public due to faults on the low voltage network

» Reduce the risk of potential fire starts due to faults on the low voltage network

» Improve productivity and response times by replacing the human investigations and job issuing with fully automated algorithms that interface with works management systems, running 24/7

» Save further OPEX by replacing the 10 yearly field inspection program with an hourly proactive automated integrity check

» Change from periodic age and type based service mains replacement to proactive, just-in-time, condition based replacement resulting in significant deferred CAPEX savings.

Milestones Addressed

Phase 1 – detect and investigate potential loss of neutral problems and repair – start: 1/2/2016; end: 30/04/2017.

Phase 2 – enhance neutral integrity issue detection algorithms, expand to a range of LV and HV fault detecting use cases and automate the jobs to DMS/OMS with no human intervention – start: 1/3/2017; end: 31/8/2018.

Phase 3 – further enhancements to algorithms and expand to automatically and remotely remove the safety hazard in as near real time as possible – start: 1/3/2018. end: 30/9/2018.

Phase 4 – ongoing enhancements and detection speed improvements.

Approach

The approach was to deliver the project in three phases as per milestones above with emphasis on ongoing analytics algorithm refinement once new facts came to light as the complexity of the algorithms to address all the characteristics of the save cases were impossible to foresee at the initial design stage.

Results

United Energy developed and deployed a highly successful near real time low voltage fault detection system that monitors conditions on the LV network 24/7. Various fault conditions are being detected, prioritised and electronically raised in DMS with no human intervention. It typically takes less than 15 minutes from when the meter has logged its last reading to when the data is retrieved, analysed, fault patterns and severity identified, safety disconnect performed where justified and the job raised in DMS. The accuracy of faults raised is now better than 99 per cent.

RESIDENTIAL ENERGY STORAGE SYSTEM

ENTR Themes

- Customer focused electricity
- Intelligent Networks and Markets

Principal Company

Endeavour Energy

Rationale

Understanding of customer behaviour and battery performance in a virtual power plant setting installed in an urban residential network

Project Timeline

January 2017 – January 2020

Location

Parklea, NSW

Stakeholders

IT Power, Reposit, LG Chem and SMA

Funding

DMIA

Description

The growth in residential developments, particularly in Western Sydney, has created the need to upgrade network assets to accommodate the additional demand from new connections. Parklea zone station is one of several zone substations supplying this area and is forecast to exceed its firm capacity due to the additional load from new developments in the supply area. The focus of the trial is to investigate how Endeavour Energy could use the battery technology to reduce peak demand, improve power quality and defer or avoid capital investment. The analysis of the results will pay particular attention on the technical viability and financial attractiveness to both the customer and the network business.

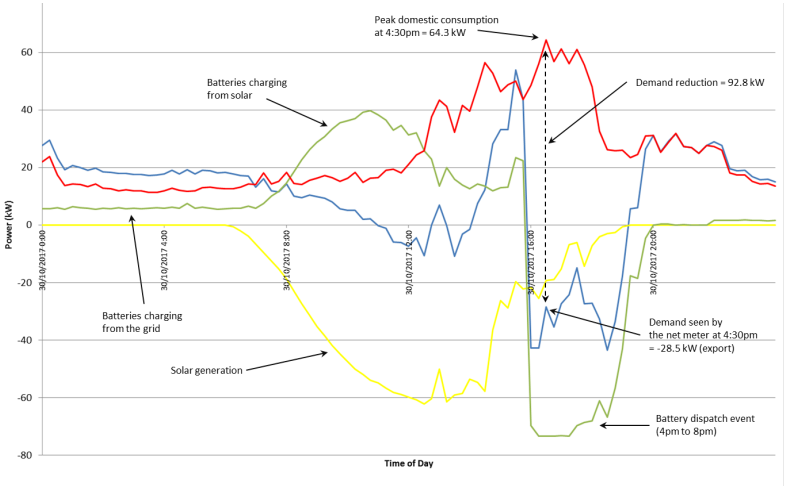
Milestones Addressed

40 battery systems installed and commissioned. Nine peak demand events during summer 2017/18 were conducted and 10 events during the winter 2018.

Approach

Supply tender and work with supplier and platform to refine behaviour

Results



Net meter power, solar power, battery power and domestic power for one of the battery dispatch events during summer 2017/18 period

CAPTION:
Battery and inverter installed on site

GRID ADVOCACY PROJECT

ENTR Themes

» Customer Oriented Networks

Principal Company

Energy Queensland

Rationale

The Grid Advocacy Project aims to enable learnings from the integration of solar photovoltaic (PV), battery, home energy management systems (HEMS) and a summer timeof-use demand tariff with respect to potential demand management opportunities, customer cost impacts and level of customer engagement and support required for such devices.

Project Timeline

2016-2018

Location

Townsville, Queensland

Stakeholders

Ergon Energy & SwitchDin

Funding

DMIA

Description

Installed solar PV, battery and home energy management systems at nine residential households. Network monitoring was also installed at the distribution transformer and end of line.

SwitchDin were engaged to supply the HEMS solution and develop control to manage the customers energy usage around demand Tariff structure and to develop distribution management control concepts. The distribution management concepts trialled included PV curtailment and peak demand support at the distribution transformer level via control of the solar PV and battery inverters.

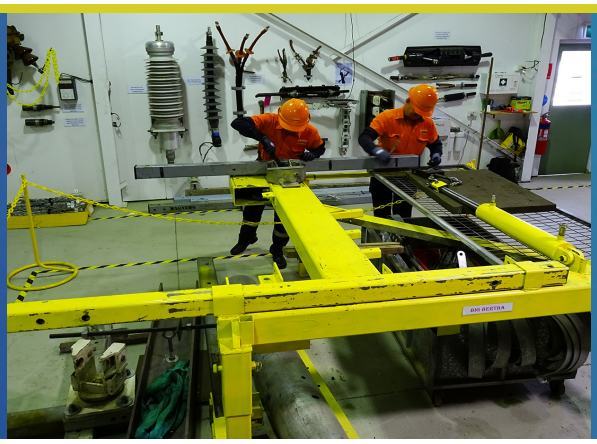
Approach

Field trial to gain knowledge of the technology and customer engagement and support required.

Results

Learnings and proof of concepts obtained.

QUALITY ASSURANCE ENVIRONMENTAL TEST LAB



ENTR Themes

» Intelligent Networks & Markets

Principal Company

Essential Energy

Rationale

The Quality Assurance (QA) Lab was conceived from necessity as a place where asset performance intelligence, coupled with research and development, could be achieved with the goal of minimising life-cycle costs, promoting innovation, improving safety and optimising investments.

Project Timeline

2016 - present

Location

Port Macquarie

Description

Responding to a need for better testing of electricity network equipment, Essential Energy created a trailblazing materials testing laboratory to a high standard on a shoe-string budget. The goals in doing so were pragmatic, with practical application in mind:

» ensure that the materials Essential Energy acquires meet or exceed manufacturers' specifications and Australian industry standards

» better understand long-term asset performance in the variety of climates in which Essential Energy operates

» minimise life-cycle costs by developing asset models and selecting suitable materials

» undertake research and development for future asset management

» manage safety and optimise investments.

Milestones Addressed

The Mains Standards and Specifications team noticed an increasing trend in issues with the quality of products that met manufacturing compliance standards but did not stand up to environmental conditions, posing risks to employees and the community. Resourcing was managed via careful team business planning and dedicated staff who donated their own time to build capability. Within three years the value proposition had become highly favourable and the Lab was established as a permanent business operation. In February 2016, the Lab was moved to a new, permanent location that enabled significantly expanded testing capability and equipment innovation. During 2017/18, using information from testing at the Lab, Essential Energy built asset degradation models that remain relevant in informing and directing investment decisions today.

Approach

With a focus on lowest whole of life asset costs and safety, the Lab has directly and indirectly contributed to in excess of $95 million of value over the past five years, inclusive of operating costs. The Lab has directly contributed to improved safety outcomes by identifying and removing defective or unsuitable materials that would otherwise have entered the supply chain.

Results

QA Lab is the only known facility of its type within Australia. The QA Lab is recognised within Essential Energy, peer organisations and suppliers for its innovative approach to eliminating a common problem: inferior or specification non-compliant materials entering the network. For customers the work done by the QA Lab directly influences the company's 40 per cent reduction in network costs in the current regulatory period.

CAPTION:
Big Bertha – Crossarm Strength

DYNAMIC SERIES REACTOR

ENTR Themes

» Power system security

Principal Company

Western Power

Rationale

Developments in technology have resulted in the availability of a product that can be mounted on transmission lines to dynamically re-direct power flow from an over-utilised transmission line to adjacent underutilised transmission lines. In doing so, costly transmission network reinforcement can be deferred. A trial was undertaken using three units on the constrained Mandurah to Pinjarra (MH-PNJ)132 kV line.

Project Timeline

Dec 2017 – In service

Location

Mandurah to Pinjarra 132 kV transmission

Funding

Internal

Stakeholders

Powerline Guardian
Smart Wires Technology

Description

PowerLine Guardian devices are designed to restrict the current transfer capacity of transmission lines by increasing line reactance when the line current reaches a critical point, typically the transfer limit. The rise in line reactance, when the Guardian devices are switched on, effectively chokes the current transfer in the circuit and by so doing the required current to the load is forced to find an alternate parallel path via another path which is potentially a lighter loaded circuit. This ability to restrict the current flow enables lines to be run optimally without risking transfer capacity limit exceedance.

By avoiding overloading of lines, the PowerLine Guardian potentially defers or eliminates the need for expensive line uprating, re-conductoring or rebuilding of the transmission line.

Milestones Addressed

The business case for the trial project was approved on Mar 2017.
The installation of three units on MH-PNJ line was completed in Dec 2017.
After a six-month trial, the devices were shipped back in Jun 2018.

Approach

Information Pack for the Smart Wires PowerLine Guardian Trial

Results

Technology has been verified with good results on the following aspects:

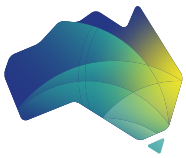
» Communication system (reliability & availability)
» Settings (manual or automatic switching ON/OFF of device)
» Associated software (control, monitoring)
» Responsive time of device

However, the disadvantages are:

» Weight of device (needs line reinforcement)
» Limited amount of current can be changed by a single unit

Hence another ground-mounted device (Power Guardian) could be more beneficial.

CAPTION:
A project participant's home with solar



Energy Networks Australia

Energy Networks Australia
P +61 3 9103 0400 **E** info@energynetworks.com.au
Unit 5, Level 12, 385 Bourke Street Melbourne VIC 3000

www.energynetworks.com.au