Essential Energy
10.01.02 Demand Management Plan
January 2023

Our Vision, Purpose and Values

Our Vision

What we want to be

Empowering communities to share and use energy for a better tomorrow.

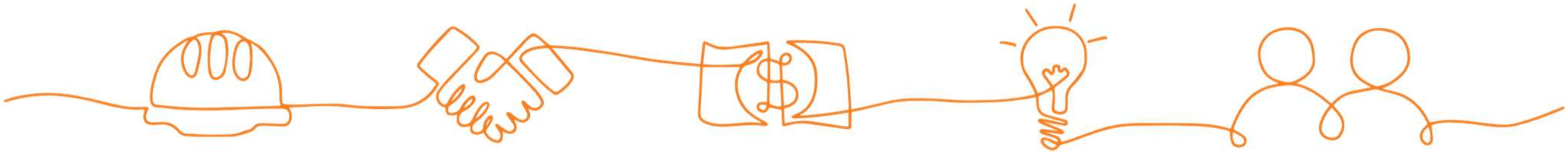
Our Purpose

What we stand for

To enable energy solutions that improve life.

Our Values

What we care about



Make safety your own

Be easy to do business with

Make every dollar count

Be courageous, Shape the future

Be inclusive, supportive and honest

Business Overview

Business Objectives:

- Continuous improvements in safety culture and performance
- Operate at industry best practice for efficiency, delivering best value for customers
- Deliver real reductions in customers' distribution network charges
- Deliver a satisfactory Return on Capital Employed
- Reduce the environmental impact of Essential Energy where it is efficient to do so

Fast Facts:

> 880,000 customers

1,404,814 power poles – which equates to 1.6 power poles for every customer

183,099 km overhead powerlines – equivalent to driving around Australia 13 times. 10 over 1,000km long.

More than 1 million spans in designated bushfire zones

95% of NSW and parts of Southern Queensland

737,000 kms² total network area

Essential Energy's fleet travel approximately 40 million kilometres annually

364 zone substations and 139,303 distribution substations

Increasing extreme weather conditions

Increasing renewable penetration

4.8 customers to fund every kilometre of powerline
Ausgrid 43.7
Endeavour 33.9

36.8 years average age of network assets

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Demand management (DM) strategies

- DM investment
  - Continued engagement with both customers and market to source and deliver DM solutions as cost-effective alternatives to network options
  - Investments in new supply chains to deliver optimised network expenditure reducing network prices in the long term
- Active customer response
  - Continue to maintain current load control methods of frequency injection (FI), while also investing in improving cost efficient demand response (DR)
  - Investments in smart network devices and platforms to dispatch DR, which will be done under future network investments
  - Improved DR will enhance capability of the network, lower augmentation costs and allow greater hosting capacity for two-way power flow
- Incentivise customer efficiency
  - Provide customers incentives via improved Time of Use (TOU) tariffs to encourage uptake of DM solutions
- Two-way energy flow
  - Plans include investment to increase Essential Energy's (EE’s) hosting capacity for consumer energy resources (CER) while ensuring reliability and power quality
- Transform remote supply
  - Solutions such as stand alone power systems (SAPS) being deployed in high cost to serve, and remote supply areas. DM will help optimise CER with the aid of SAPS providing a cost effective non-network alternative
- Invest in innovation – Continued investment in trials and projects to test DM solutions to provide non-network alternatives to be funded by Demand Management Innovation Allowance (DMIA)

DM projects in progress and/or under investigation

Project	Description	End state
1. Network battery storage trials	Develop capability to leverage storage technology to address network constraints whilst addressing network requirements	Utilise network batteries as loads and generators to dynamically manage network demand
2. Hydrogen SAPS	Higher energy density of hydrogen storage enables us to develop a SAPS solution with enough autonomy to remove the backup diesel generator	Essential Energy has developed a diesel free (100%renewable) SAPS solution which is cost competitive and value generating for stakeholders. Reduced variable and fixed opex costs against conventionally deployed SAPS of similar scale. Integrating the hydrogen SAPS with our current SAPS program as a BAU offering
3. Virtual power plant (VPP) trials (Collombatti and Bellingen)	To determine how best to implement solar and storage to address network constraints. In the Collombatti example, the timing mismatch between loads and generation will be removed or reduced by the assistance of energy storage, whilst in the Bellingen example the voltage will be supported using reactive power from the customer inverters	Combine the various forms of CER on the network into VPP will be used as dynamic loads and generators to reconfigure the network and manage demand and supply
4. Control Load 1 Solar Soak pilot	Turning ON of Controlled Load 1 during the period 10:30am to 3:00pm to soak up excess generation from small scale PV	Optimise 1GW of rooftop PV back feed from 24% of customers on network

DM projects in progress and/or under investigation, cont

Project	Description	End state
5. Low-voltage (LV) transformer monitoring	Trial alternative products for transformer load monitoring offering additional features and lower cost than devices currently in use	Increased LV network visibility allowing for better DM and operational decision making
6. Standalone Power Systems (SAPS)	To deliver the capability to deploy SAPS solutions according to a defined and agreed set of criteria in normal, degraded and emergency situations. The outcome is that we are confident we have identified all high ‘cost to serve’ customer sites and have a range of measures in place to deploy SAPS (or otherwise) at these locations	SAPS solution as standard non-network solution as an alternative to network augmentation and reduce overall asset portfolio
7. Electric vehicle (EV) charging on poles	Investigate viability of ready to deploy charging solutions on network poles, with load control and metering provisions	Provide necessary infrastructure to meet increasing uptake of EV in NSW and facilitate transition to net zero 2050. Furthermore provide a dynamic load that can be controlled and used for DM purposes to vary load based on demand
8. Bi-directional relay communication to retrofit existing load control infrastructure for more data acquisition of load profile	Improve data acquisition from existing load control network assets to create more dynamic load profiles or network elements	Use data out of new relays to inform DM and network investment decisions

DM projects in progress and/or under investigation, cont

Project	Description	End State
9. Advanced solar inverter	Test battery storage systems and advanced solar inverters with eligible customers within a virtual power plant arrangement to better manage the demand for network capacity and integration of renewables	Aggregate customer CER such as rooftop solar and home batteries storage to provide demand response service to the network and assist in managing demand
10. Switched reactors	Developed to reduce reactive power demands in single wire earth return (SWER) systems, thereby reducing network voltage swing, line losses and the need for larger isolation transformers, deferring or removing the need for augmentation and lowering the cost of supply to customers	Reactors are augmented with intelligent switches that disconnects them when network voltages drop below a certain level. Furthermore, switched reactors that also have the ability to log and transmit voltage (and optionally, current) measurements at points of installation. Deployed across the SWER network
11. Conservation voltage reduction (CVR)	CVR is the intentional operation of network at the lower end of the acceptable voltage range, with the goal of achieving energy and demand reductions. Trial conducted at zone substation level lowering nominal supply voltage from 240V to 230V as per AS60038	Success of implementation of 230V supply standard at Taree zone substation (Refer to case study) freed 327kW of capacity and reduced line losses of 171MWh/year. Standard to be rolled out gradually across the network

Overview of load control (LC)

474,000 premise relays
56% of our Residential customers have one/more CL services

70 frequency communication sites (zone-sub or HV sub) that signal over the electricity network

Load timing at our discretion provided total hours supplied

Current services offered:
CL1 5-9 hrs power (Mon-Fri extra w/e)
CL2 10-19 hrs power (Mon-Fri extra w/e)

Tariff revenue : $40m pa
Note CL is discounted compared to traditional load

~2GW of controllable load
950 GWh pa. ~ 21% of total residential network load (2020)

Direct management of CL through system control rooms (Port Macquarie & Queanbeyan)

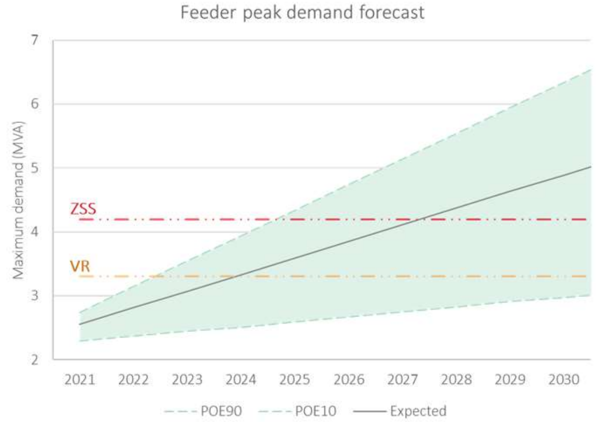
25-30 Year Life
Over 50% of load control assets are less than 15 Years old

Load control

- A large portion of our DM portfolio is provided by direct control of appliances such as hot water systems and pool pumps that are connected to load control tariffs using frequency injection (FI) technology
- Reducing peak demand
  - Avoid capex due to shifting demand out of peak periods, reducing the need for network augmentation
  - Possible due to the fact hot water can be stored for a period of time and not affect customers
  - Estimated net benefit $320M
- Demand response for wholesale and FCAS markets
  - Secondary benefit of delivering demand reduction at short notice when constraints in wholesale markets e.g. 2022 Market suspension EE had demand response of almost 2GW on standby for FCAS response
  - Varies with the time of day depending on the number of hot water systems under load
  - Service from EE is free to AEMO upon request
- Increased rooftop PV, we will be focusing on enabling more rooftop PV through ‘solar soaking’. Controlled load will support this transition but will no longer be the primary driver for deferring capital investment
- Increased rooftop PV, uptake of EV’s, EV charging, residential batteries and the emergence of VPP will require the development of more sophisticated load control platforms to enable the uptake and control of CER at scale
- Smart meter roll out will benefit DM and load control activities if data access is enabled
- Progressively moving to automate elements of our system to optimise load control

Case study - Sovereign Hills network battery

- Essential Energy's development of control and integration of storage to manage network constraints starts with the installation of a 1MW 2MWH battery in Sovereign Hills west of Port Macquarie
- The location was chosen due to forecast load growth and imminent network investments of a new voltage regulator, and a new 66/11kV zone substation
- The economics of batteries requires full value to be achieved across multiple value streams, as such approval from the AER has been received to operate the battery for network and market services



Network investments to manage peak demand

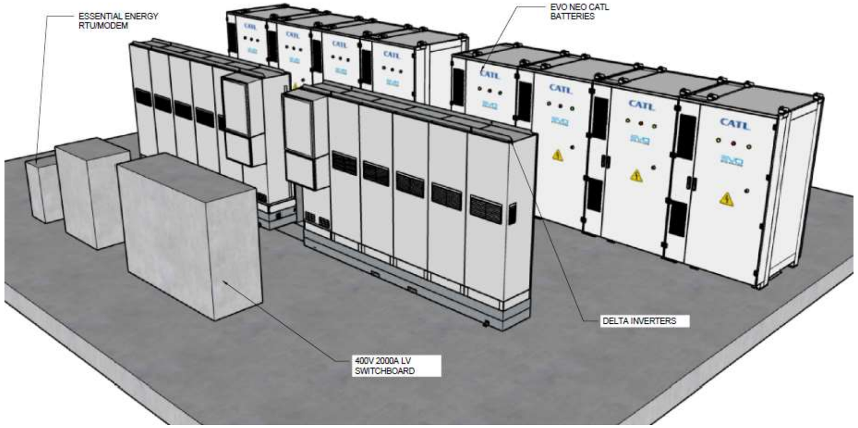
Location on Winery Drive west of Port Macquarie

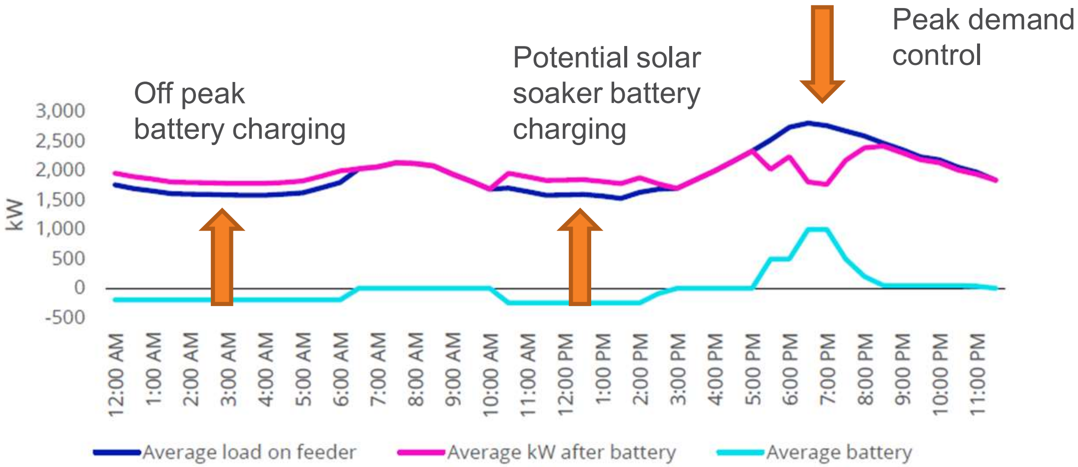
Network services	Congestion relief	Deferring network investments (generation or demand-driven)	Material value streams with more direct monetisation paths
	Reliability	Avoiding outage penalties	
Value streams that would require additional data and modelling to be accounted for	Impact on losses	Reduce network technical losses	
	Dist. voltage control	Prevent voltage drop (or rise) in specific locations	
	Bushfire risk reduction	Avoid network asset failure leading to bushfire	
Energy services	Energy arbitrage	Trading in the electricity spot market	
	Generation capacity	Ensuring generation capacity meets maximum demand[1]	
Ancillary services	Frequency reserves	Maintaining system frequency	
	Voltage support	Maintaining system voltage[2]	
	Black start	Restoring supply following full or partial outage[2]	

Battery value stack

Case study - Sovereign Hills network battery, cont.

- The solution chosen by our project partner AGL for the battery trial is the Evo Power Neo Series solution. Each Neo BESS comprises a 1000A breaker connecting a 500kw/1000kwh packs, with two of the Neo BESS installed for combined energy capacity of 1MW 2MWh solution. The battery is connected to the distribution network via a dedicated 1500kva padmount substation to the 11kv network
- Two control methods will be used to manage voltage and thermal constraints:
  - Voltage via a fixed operating envelope placed in the inverters
  - Thermal via closed loop dynamic control through our SCADA system





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Case study - AS60038 Taree zone substation 230V

> Initiative to transition Essential Energy to the 230V standard. The first stage is a trial at Kanangra Drive zone substation in Taree. It is expected that the trial will deliver a reduction in over-voltage complaints, increased capacity to export for new and existing connections, as well as reducing overall demand through a concept known as “conservation voltage reduction”, thereby freeing capacity in the order of 327kW and reducing line losses in the order of 171MWh/year (at this site alone)

> Australian Standard AS60038 replaced the prior 240V standard with 230V in February 2000

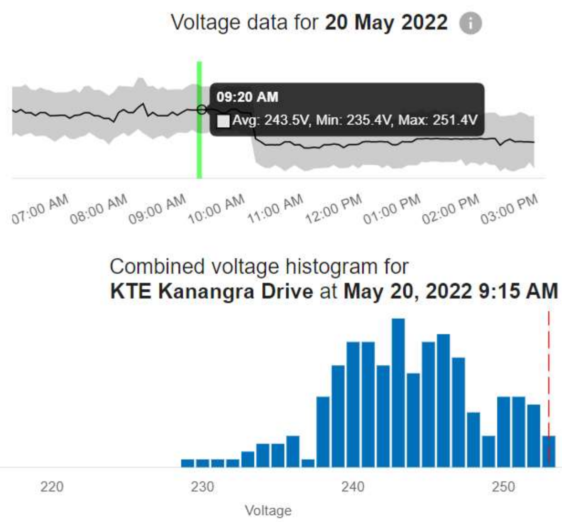
> As over voltage issues have become increasingly prevalent due to continued growth in solar, the firmer transition to 230V has been tabled

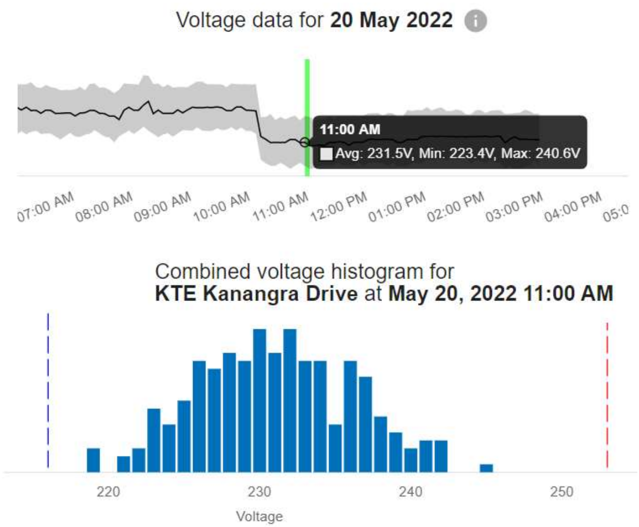
> The trial consists of reducing the setpoint for voltage regulation at the zone substation to align the voltage at all distribution substations closer to the 230V nominal voltage

> The intent of the trial is to observe the effectiveness of this measure at aligning the voltages at customers with the Australian Standard, impact on PQ complaints, as well as identifying controls which may need to be put in place to prevent possible issues due to lower voltages

> Graphs on right show voltage distribution before and after for all smart meters linked to the zone substation. We can see the voltage at customer premises more closely aligned with the standard supply voltage of 230V, with no over-voltages present and no under-voltages materialising

> To date there have been no customer complaints in relation to under-voltage





Case Study - Hydrogen SAPS

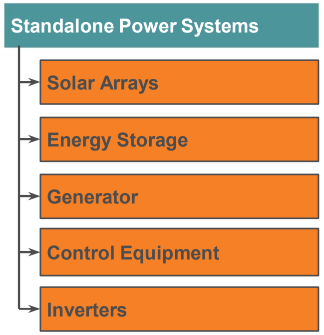
> Standalone Power Systems (SAPS) are being installed to ensure we deliver a constant resilient power supply to fringe of grid customers, and to reduce the maintenance cost in view of the recurring natural disasters and place downward pressure on electricity prices

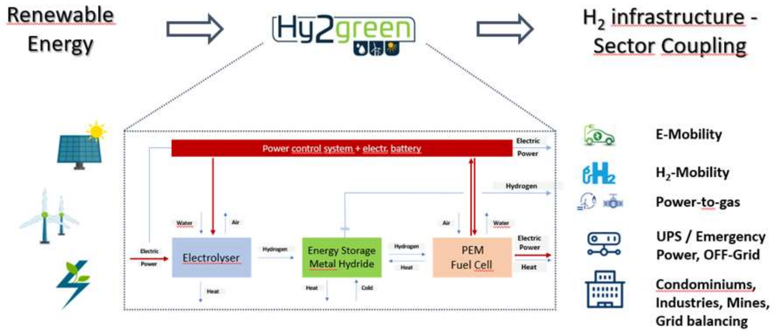
> The existing asset class includes a diesel generator as a backup supply due to the high cost of increasing battery storage to levels of autonomy which enable compliance with reliability standards

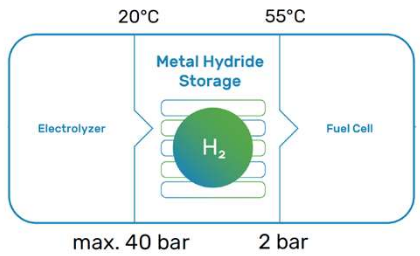
> The future of SAPS will be an asset class with an energy storage means capable of meeting reliability standards without a diesel generator. Hydrogen SAPS could be that solution

> The system energy concept is summarised in the following steps:

– Solar panel power is the INPUT energy to the system
– The INPUT energy is consumed directly to meet the customer demand
– The Excess INPUT energy is stored first in a small Li battery until fully charged
– When battery is charged, the excess INPUT energy is used to power the electrolysis unit to produce hydrogen and fill up the metal hydride (MH) storage
– When power is required at night, during high demand periods or times when solar generation is reduced, the fuel cell operates to convert hydrogen into electricity to supply the customer
– The hydrogen storage is equivalent to 425kwh of energy, enough to supply a small cottage for weeks with reduced solar generation







Case Study - Hydrogen SAPS, cont.

> SAPS site details load profile Feb-May 2019 (on right):
  – Average daily load: 16kWh
  – Peak daily consumption: 41kWh
  – Peak 5-minute load: 7.28kW
  – Peak instantaneous load: 10.1kW

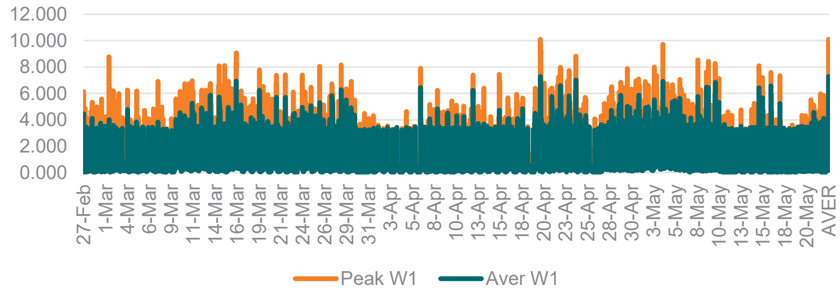
> Hydrogen serves as an alternative to diesel generator backup by providing in excess of 15 days autonomy

> Hydrogen storage is managed through a heat management system, which in some use cases can be used to heat customers water heaters

> As the electrolyser is operating, the hydrogen storage is heated to bond the hydrogen to the metal hydride which is stored as a solid compound

> As the temperature of the storage is cooled, hydrogen is released into the fuel cell to generate electricity

> By testing this solution, we are one step closer to developing a diesel free solution, which becomes 100% renewable, silent, environmentally friendly, and reduces opex costs for maintenance and refuelling



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