10.02.12 Standalone Power Systems Investment Case

Essential Energy's Standalone Power Systems Strategy addresses high cost to serve / grid edge customers, bushfire prone areas, emergency response and difficult to access assets that can be more economically supplied by a SAPS.

Scope

Standalone power systems (SAPS) aim to improve grid economics at extreme fringe-of-grid areas that have high operational or investment costs per customer served and the emergency response to restore power in remote locations.

Analysis has found that the network contains over 2,000 customers who are connected to network assets carrying less than one customer per 3km of the network. While these customers equate to approximately 0.5% of our customer base, they require around 17% of the installed network (cross-subsidisation).

The new asset class investment is required to meet the capital expenditure efficiency objectives (NER 6.5.7) for quality, reliability, safety and security of electricity supply and to meet regulatory and legislative obligations for standard control services.

Standalone Power Systems

- **Solar Arrays**
- **Energy Storage**
- **Generator**
- **Control Equipment**
- **Inverters**

Forecast $FY24

The SAPS forecast accounts for 4.46% of the total Repex portfolio for FY25 to FY29.

FY25	FY26	FY27	FY28	FY29
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]

Risk Analysis

This section provides an overview of the preliminary SAPS risk model. It is supported by documents and **6.03.02 Managing Network Risks, 6.03.03 Appraisal Value Framework and 6.03.04 System Capital Risk and Value Based Investment** methodology.

Network Risk by Asset Class

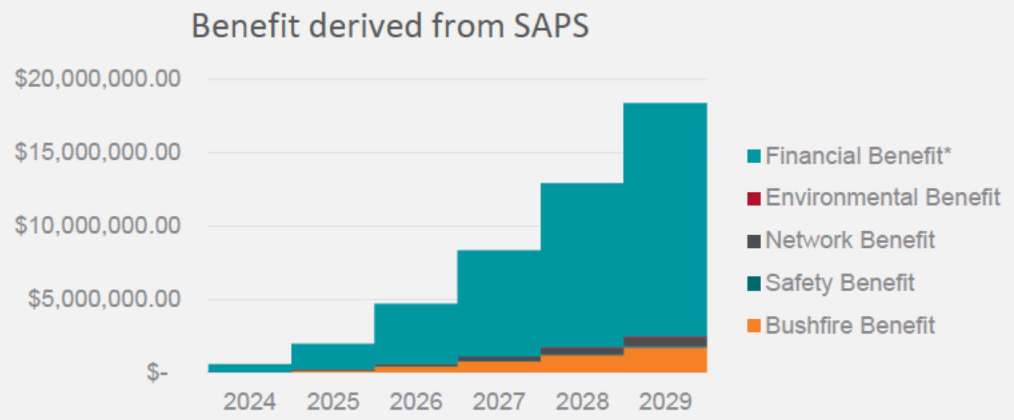
Essential Energy has not yet deployed SAPS at scale to enable risk based research on reliability, CoF and PoF. Over the mid term deployment of SAPS updates to the system strategy will be required to document the performance, reliability and consequences of failure. In lieu of performance data PoF has been estimated at 1 failure per annum based on industry data. CoF values have been calculated utilising VCR and energy consumption with a reputational risk during initial years of install.

A SAPS value model has been used to calculate values for an example site at East Kunderang – 5MWh/year - 10kw solar, 20kwh of battery storage and a 15kva generator. There were 192 poles in the segment with 19 being removed from the network (including [redacted] decommissioning costs). This example is shown in the table to the right.

Network		SAPS	OH
Average Customer Load	kWh	0.2594	19.79
Network Asset Failure			
Cost of Outage to EE		$1,500	$1,500
Lost Load VCR		$51.24	$319.24
Total Network Asset Failure Consequence		$1,551.24	$1,819.24
Total Network Asset Failure Risk		$77.56	$15,682.56
Network Destruction from Non-network instigated bushfire			
Average Customer Load	kWh	0.2594	0.2594
Long Outage Duration	mins	4320	4320
Cost of Outage to EE		$46,500	$46,500
		$47,290.49	$47,290.49
Bushfire Network Risk		$2,430.73	$2,430.73
Total Network Risk		**$2,508.29**	**$18,113.29**

For the areas of investment for SAPS the overhead network risk is mainly contributed by Network (45%), Bushfire (27%) and Safety (12%). This is dramatically reduced with the introduction of SAPS at selected sites.
The example site forecasts that there will be a decrease of 86% Network, 99% bushfire, and 99% safety.
Financial risk is not a flat line as represented by the overhead network rather it has cyclical costs that are SAPS component end of life costs.
Reputation risk is assumed at $15K for year one & two and reduces to $0 ongoing.
Overall this site, using a 40 year lifecycle, represents an 86% reduction in total risk (as shown in graph on next page).

Risk Analysis, cont



*Fiscal benefit includes opex, risk and other benefits from SAPS

The high cost to install and implement SAPS represents a significant risk for project installations. The Bulahdelah trial provided good insight into system design and implementation and the importance of communications to drive down unit costs into the future.

Over the 2019-21 fiscal year Essential Energy commissioned a number of sites in response to widespread bushfire damaged assets. Through a combination of experience from the Bulahdelah SAPS installation and reduction in material supply costs the installation costs have seen a large improvement that is forecast to continue.

Forecasting Approach

The forecast expenditure for SAPS has been developed with a combination of inputs from the customer engagement strategy, customer engagement research project, regulatory consultation forums and site identification analytics which determines high cost to serve connections on the network.

Essential Energy's customer engagement strategy establishes the requirement that all potential SAPS sites will require the customer's consent to proceed. The customer engagement research found 43% of surveyed customers fall into the interested or very interested categories, and this is the basis of the forecast for customer acceptance values.

Currently, >2000 locations have been identified across the network where SAPS can be considered economically viable and a cheaper alternative to operating the poles and wires network. The deployment of SAPS addresses a cost to serve constraint for fringe of grid, low consumption connections. The forecast quantities are multiplied by a unit rate that has been informed by the learnings of previous trials and is sized appropriately based on the annual consumption level at a distribution substation level.

Three categories of unit rate costs have been used:

- Essential Energy owned SAPS [redacted] – 158 sites
- Essential Energy owned SAPS for low consumption sites [redacted] – 176 sites
- Off Grid Support SAPS [redacted] – 67 sites

Investment Options

There are two main asset solutions for SAPS:

1. Essential Energy owned utility grade SAPS which is compliant with the Priority 1 Distributor led SAPS national framework.
2. A privately owned SAPS which customers will own under the Off Grid Support program, these sites are identified by very low consumption (less than 3kwh per day) or random use or seasonal connections where the installation of a utility grade SAPS is overengineered.

SAPS are only considered for existing network connected customers as an alternative to a standard NEM supply arrangement. Strategically identified sites will be prioritised based on risk, value and customer acceptance. SAPS may also be considered as alternatives in optioneering for reactive projects where SAPS can be considered as an alternative non-network solution to resolve other constraints.

Strategic Investment / Constraint Options

Initial internal modelling suggests that over the next 10 years SAPS are likely to be the lowest cost to serve technology for over 2,000 customers.

Site selection has been identified based on bushfire prone areas, highest cost to serve and asset retirement 10 year forecasts. These sites have been selected as viable as they satisfy the following criteria:

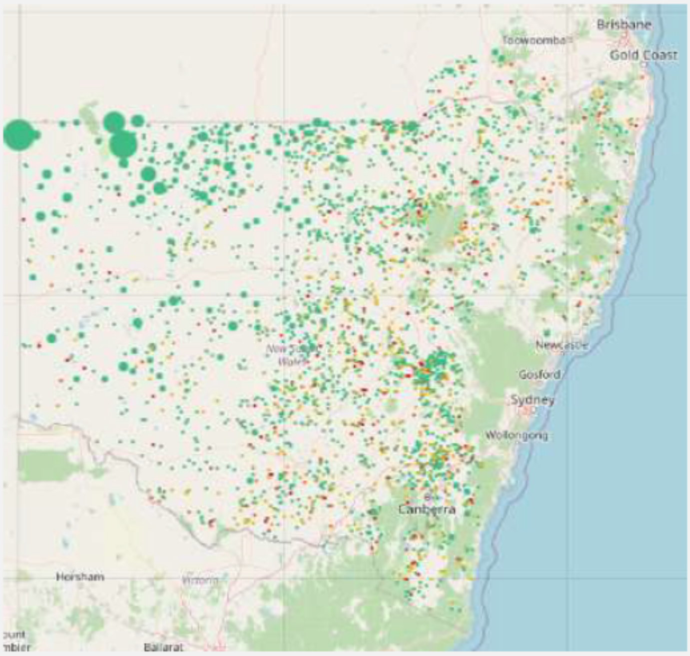
- Locations with low load (~30MWh/year)
- Locations with high level of solar export
- Distribution substation with single customer connections
- Large lengths of network (>7km) for single customers
- Lengths of network (>2km) are also viable through heavily vegetated areas with bushfire risk
- Minimise repex expenditure on network segments
- Locations with low power quality consider SAPS as potential solutions
- Locations with low reliability should consider SAPS as potential solutions
- Remote/difficult access locations with high asset density locations should consider SAPS as potential solutions.

The SAPS program implementation strategy has been developed to commence in FY23 and continue into the 2024-29 regulatory period resulting in:

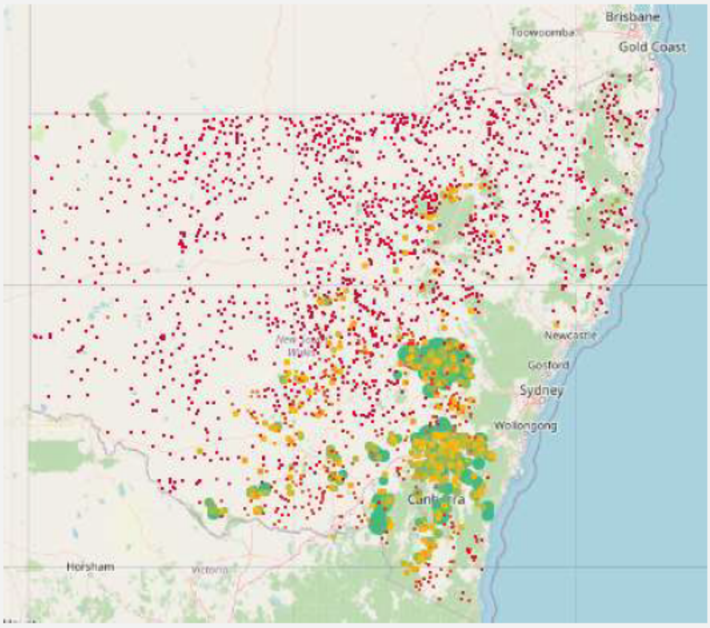
- Installations of 5 SAPS in FY23
- Incrementally increasing installations from [redacted] units per year in the 2024-29 regulatory period
- Development of procurement plans in place for diesel free solutions (e.g. hydrogen or vanadium) by FY25. This will provide a lower opex cost (e.g. removal of generators and >20 life expectancy from energy storage) and achieve 100% renewable energy status
- Fault and emergency response SAPS acquisition - Essential Energy to purchase emergency response SAPS for deployment during planned and unplanned outages.

Essential Energy will comply with CEOS5061 SAPS Performance and Supply Standards which have been developed to comply with IPART obligations.

Potential SAPS savings
(green = more savings)



Bushfire risk reduction
(green = larger benefit)



Example SAPS Site supplied by long run HV OH line

5 Year Capex Forecast

Forecast repex expenditure for SAPS across the 24-29 period is [redacted]
SAPS is a new asset category and funding has not been sought in previous regulatory periods.

[redacted]

Data source: Copperleaf
Note: All values are in FY2023-24 real dollar terms

Justification

We are confident that our approach delivers an efficient and prudent level of investment because:

- **Clear, prudent drivers from Asset Management Objectives (detailed in Attachment 10.01 SAMP) for Reliability, Quality, Safety and Compliance:** To establish the capability to deploy non-network solutions at scale. Demonstrate prudency and efficiency in network-related decision making, supporting downward pressure on prices by addressing a cost to serve constraint. Demonstrate network safety risk is managed SFAIRP and achieve corporate network safety targets by removing high risk assets in low resilient areas of the network.
- **Review and moderation:** Our forecasts have been tested by our customers during regulatory engagement sessions resulting in support for a deployment of 400 SAPS in the 2024-29 regulatory period. This will provide a full deployment of SAPS over 3 regulatory periods (on current sites identified).
- **Deliverable:** Adequate resources are available to deliver the work, market testing of suppliers and creation of an approved supplier list with multiple companies available to procure SAPS from the private sector.

The major benefits expected from these investments are:

- **Reduced network risk:** Investments will remove overhead networks which have a high safety, bushfire and environment risk profile compared to SAPS.
- **Improved maintainability:** Removing high cost to serve network connections reduces operating expenditure and provides energy to customers with a fit for purpose asset.
- **Improved service to customers:** SAPS have the ability to improve reliability at the fringe of grid and improve resilience outcomes for targeted customers.
- **Reduced cross-subsidisation**: Two main target areas are:
    - Lower costs over time: Maintenance and vegetation management of supporting line will be removed, as is the associated bushfire risk. SAPS will reduce the duration and effort for emergency calls involving rural and grid edge areas which are typically larger due to distances and the environment.
    - Better Asset Utilisation: By implementing SAPS, Essential Energy may decommission supporting connection assets which over the midterm will allow for better asset utilisation. The individual system can be configured to meet specific individual customer demand, so specific SAPS systems asset utilisation can be extremely high, enabling Essential Energy to minimise over-investment. Also due to generation being placed closer to consumption, energy loss will be minimised.

This investment will provide 400 SAPS with a staged deployment and line removal as shown below.

	FY25	FY26	FY27	FY28	FY29
SAPS Installed	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
Network removed km (following year)	239	257	277	300	354

Key Assumptions

- All SAPS installations will be subject to customer acceptance and approval to transition off grid.
- Battery life expectancy of 15 years.
- SAPS units have warranties in line with manufacturers' specifications and suppliers will respond to warranty claims in a timely manner.
- Expected reliability data for SAPS has been taken as an average of [redacted] FY17/18 failure data over 5 different SAPS units.
- A diesel price of $1.80 has been used. 2200L used @ $1.80 and $1100 delivery cost. Diesel discount rate of 42c has been applied per litre.
- Fault and emergency costs are estimates provided from discussions with vendors.
- An assumption that there will be no ongoing vegetation management activities should SAPS be deployed.
- Forecast SAPS locations have been identified on estimated loads and historical meter data; detailed analysis of load profile will be required during design after on site data logging has been completed.

Cost

- Capital costs based on submission from the open market EOI that was completed in 2020, [redacted] analysis, and subsequent RFQ's submitted to suppliers.
- Maintenance costs have been calculated based on the costs experienced during the emergency SAPS deployments during the 2019/20 bushfire season.
- Hydrogen SAPS costs have been provided as part of the trial project commissioned in FY22.
- Removal of line will occur at least 6 months after satisfactory service of the installed SAPS.

Supply Chain

- [redacted]
- Currently there are no suppliers that have a physical local presence across Essential Energy's territory. While all have shown interest in supplying support/maintenance services for the SAPS units and are willing to enter contracts if they were selected, they will require EE to support ongoing stable procurement pipelines to develop manufacturing locations within NSW.
- [redacted]
- [redacted]

[redacted]

Lifecycle Operation & Maintenance Strategy

Lifecycle

- General inspections (12M)
- Electrical Test (12M)
- SAPS Functional Testing (12M)
- PV Array & Inverter (12M)
- Battery (Standalone) Inverter (12M)
- Battery Storage System (12M)
- Generator (250/500hrs) in addition to refuelling

SAPS Component or System Economic End of Life

• Overall SAPS System	40 Years
• PV Panels	25 Years
• Inverters	15 Years
• Control Equipment	10 Years
• Batteries	15 Years
• Generator	20 Years

General

- Visual inspections of all equipment, vegetation, clearances, signage, labelling and documentation
- Verify installed equipment complies to as-builts/designs
- Verify all hardware and fasteners are secure
- Inspect and verify integrity of isolation devices (switches and removable links), earth fault protection systems, circuit breakers,fuses
- Check for vermin ingress, damage or vandalism, integrity of signage/labelling and security of locking facilities on electrical devices
- Clean and touch up as necessary
- Check device for alarms, error messages (including error message log) and that the overall operation of the inverter is as expected
- Clear and clean ventilation grills
- Repair/restore any damage or vandalism

Electrical

- Validate all test equipment, confirm all calibration is compliant to standards, and all documents are present on site
- Wiring integrity and compliance with AS/NZS 3000, AS/NZS 5139, AS 4509 part 1 and AS/NZS 5033.
- Check earth bonding connections, conduct earth loop impedance and continuity test
- Test short circuit current and open circuit voltages test PV array total output curve
- Functional tests for circuit breakers, rotary switches, push buttons etc
- Tests must include checking of continuity and entirety of the cabling and wiring, including earth wires and screen, general inspection of terminals and checking of terminations
- IR cameras to inspect cables/components to identify any electrical stresses or defects

SAPS

- Ensure all equipment interfaces are operational
- Noise compliance check
- Functioning and verification of all hardwired alarms locally on all equipment
- Programming/setpoints of all components
- Check, validate and ensure all protection settings adhere to requirements
- Checking of plant inter-tripping circuits including emergency inter-trip and protection shunt trip
- PV array tests as per AS/NZS 5033
- Energy storage tests as per AS/NZS 5139
- Load bank testing of varying loads demonstrating the ability to supply changing loads including step loads and step load rejection up to 50% of the SAPS design maximum load without exceeding power quality limits
- SAPS cycle tests under a range of load conditions up to the SAPS design maximum load to verify both discharge commencement and the cumulative output profile of battery system and PV array. Cycle tests must include but not be limited to the following scenarios:
    - Battery recharge control via both PV and generator
    - Load bank testing to confirm generator dispatch, control and battery charging functionality
    - Verify system set points for generator operation
    - SAPS handling of surge loads (motor starting)
    - Check shut-down and start-up functions aligned to signage
    - Check of any user-accessible operational elements – change-over switches, access to refuelling, etc

Generator

- Check genset for alarms, error messages (including error message log) and that the overall operation of the genset is as expected
- Check fuel level and re fill
- Inspect fuel storage for leaks/integrity
- Inspect genset and its cabinet/enclosure for debris, dirt and water accumulation
- Inspect genset switchboard cabinet/enclosure for debris, dirt and water accumulation
- For the genset switchboard, verify the integrity and, where appropriate, the operation of all electrical protection devices where applicable and the general condition of the assembly
- Check fan belt for correct tension and adjust as required
- Inspect radiator for dust build up and clean as required
- Check coolant levels – replace coolant as required
- Check oil levels – top up as required and record oil used or replace oil where due and applicable
- Replace oil, fuel and air filters
- Record start battery voltage, check terminals and top electrolyte as applicable and necessary
- Collect old oil and parts for safe disposal
- Start and place generator on load, witness 30 minutes of operation
- Inspect all hoses connections for oil/coolant leaks before and during operation

Lifecycle Operation & Maintenance Strategy		
	Monitoring	• Confirm remote access and validate the IP connections to system controller and/or system monitoring • Check and validate the latest firmware updates on all the system components • Inspect cabinet/enclosure for debris, dirt, and water accumulation • Verify the integrity of the antenna and connections and, where appropriate, the operation of all communication and monitoring devices and the general condition of the assembly • Check operation of router, data acquisition device, DC power supply (if applicable), and comms battery backup (if applicable)
	PV Array	• Inspect panels and PV racks for defects including cracks, moisture penetration and corrosion • Inspect all PV cabling for integrity • If defects are present, undertake a detailed evaluation; report on recommended action • Clean PV array in accordance with manufacturer's specifications where agreed required • Clear foliage, obstacles and obstructions that may have accumulated around the PV array • Voc checks of PV strings where agreed required • Inspect DC isolators and fused/CB combiner box(es) located at the PV array for debris, dirt and water accumulation • For the DC isolators and fused combiner box(es) at the PV arrays verify the integrity and, where appropriate, the operation of all electrical protection devices and the general condition of the assembly • Earth fault protection systems including pits
	Batt Inverter	• Inspect inverters/controllers and their cabinets/enclosures for debris, dirt and water accumulation • Inspect DC isolators and fused/CB combiner box(es) located at the inverters for debris, dirt and water accumulation • For the DC isolators and fused/CB combiner box(es) at the inverters, verify the integrity and, where appropriate, the operation of all electrical protection devices and the general condition of the assembly
	PV Inverter	• Inspect DC isolators and fused/CB combiner box(es) located at the inverters for debris, dirt and water accumulation • Inspect inverters/controllers and their cabinets/enclosures for debris, dirt and water accumulation • For the DC isolators and fused combiner box(es) at the inverters, verify the integrity and, where appropriate, the operation of all electrical protection devices and the general condition of the assembly
	Batt Storage	• Visual inspection of battery storage system indicator lights, BMS units, battery modules and connections where accessible and applicable • Review of data and alerts message log recorded by the battery inverters • Check that the overall operation of the battery storage system is as expected • Inspect battery storage system and its cabinets/enclosures for debris, dirt and water accumulation. Clear, clean and touch up (eg paint) as necessary. • Inspect DC isolators and fused/CB combiner box(es) located at the battery storage system for debris, dirt and water accumulation • For the DC isolators and fused/CB combiner box(es) at the battery storage system, verify the integrity and, where appropriate, the operation of all electrical protection devices and the general condition of the assembly • Inspect for proper operation of the air conditioning unit(s) where applicable • Inspect the evaporator and condenser for debris, dirt and water accumulation where accessible and applicable • Clean ventilation filter(s) where accessible and applicable • Inspect for proper operation of the air conditioning ventilation systems where accessible and applicable • Inspect the fans and ducts for debris, dirt and water accumulation • Remove any accumulated build-up and/or blockages
	Disposal	• Dispose of assets as per CECP8074.01 Company Policy Asset Disposal. • Disposal of hazardous materials shall be carried out through approved recycling or disposal firm outlining their acceptance of disposal of all parts of the battery system at the end of its economic life.