Stand-alone Power System Pilot
One Year On

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Contents

Overview

Like many electricity networks around the world, significant sections at the edge of Western Power's grid are progressively scheduled for replacement. Many are over 30 years old. We have been researching alternatives to replace traditional poles and wires in these areas. In some circumstances stand-alone power systems (SPS) provide an exciting new approach to energy supply, utilising renewable energy and battery storage to provide safer and more reliable electricity for our customers.

In July 2016 we installed stand-alone power systems on six rural farms as part of a 12-month pilot to test the suitability of this technology. Given current legislative restrictions on Western Power's operations, we worked with regional electricity provider Horizon Power and retailer Synergy to develop the strategy and designs for the systems.

Energy Made Clean (EMC) were engaged to procure, install and run the systems.

Positive results and feedback from customers have encouraged us to continue using SPS to supply these customers for at least the next 3 years. Some of those key findings are:

- participants experienced significantly fewer power interruptions than customers on the network in the same area
- participants reported greater satisfaction compared to the network service
- the stand-alone systems were robust enough to survive extreme weather events
- more than 90 per cent of electricity generated during the pilot was generated from the sun.

Our customers and unique network

- We service more than 1.1 million customers
- Our network spans an area greater than the size of the United Kingdom, with about one thirtieth of the population
- 85 per cent of our customers believe we should use emerging technologies to deliver improved customer outcomes.

Business challenge

Low customer density and relatively low energy use presents significant challenges to the operation, and upkeep of our network.

We currently have an obligation to connect customers to the network and maintain a network service. This means ongoing investment to maintain, replace and build network assets such as poles, wires, substations and transformers.

Our business objective is to apply technical learnings and safely deploy innovative non-network solutions as they become cost-competitive relative to centralised grid supply.

Customer challenge

The frequency and duration of outages for customers in remote locations is significantly higher than their urban neighbours. In addition, long feeder lines that traverse hundreds of kilometres also present a bush fire risk that ultimately may result in these customers experiencing longer outages than would otherwise be the case.

In rebuilding network infrastructure customers want more resilient power alternatives.

Pilot objective

The 2016 pilot sought to expand on learnings from a single property SPS trial in 2009. We acknowledge that customer perception and experience ultimately determines whether SPS can be a viable alternative to network replacement.

The objective of the pilot is to ensure customers have the same, if not improved, electricity experience compared to being grid connected.

Selecting customers

Given the importance of the customer experience during the pilot, a specifically designed engagement process was required. Engagement was split into two phases – recruitment and commissioning. The recruitment phase focused on selecting suitable customers living and working in areas of the network with ageing assets, low customer density and low energy use. Other candidate criteria included:

- sites had to be more than 50 per cent cheaper to install and operate a SPS 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.

A total of 87 customers were identified in the Ravensthorpe, Lake King, Jerramungup, Lake Grace and Kondinin localities. Interval meters were installed at each of these sites in June 2015 to gather a wider range of energy consumption data across winter.

After assessing data, direct engagement began with 40 eligible customers, starting with people at the end of the spur lines. If those at the end of the line were not interested in participating, the line was no longer eligible for the pilot.

In addition to technical suitability, we considered customer willingness to be part of an ongoing research program.

Table 1: SPS participant details

Site No	Spur No	Spur Length to retire (km)	Average Daily Usage (kWh)	Locality	Average Asset Age	
					Pole	Conductor
SPS-01	1	13.8	42.4	WEST RIVER	34	31
SPS-02	1	13.8	47.9	WEST RIVER	34	31
SPS-03	1	13.8	28.0	WEST RIVER	34	31
SPS-04	2	5.9	28.3	LAKE KING	24	29
SPS-05	2	5.9	12.8	LAKE KING	24	29
SPS-06	3	10.4	28.7	ONGERUP	30	30

Figure 1: SPS participant locations

Designing and installing systems

We sized systems to customers' needs, as grid-independent energy-generating units with solar photovoltaic (PV) panels, lithium batteries, an inverter and backup diesel generator. They were located in a restricted area on each customer's property.

SPS units were deliberately sized with greater capacity than a typical SPS installation so that participating customers experienced a level of electricity supply consistent with the grid and to allow a contingency for increased customer demand.

Customers were charged the same rates for energy consumption as others within the South West Interconnected Network, so no direct incentive was offered for behaviour changes.

Different sized properties meant systems needed to meet a typical customer load of 10, 20, 30 and 40 kilowatt hours (kWh). Batteries were sized to supply customers for two days if the sun wasn't shining. PV array sizes were also varied to match to the load size and installed battery sizes (Table 2).

Table 2: SPS system size specifications

SPS Type	SPS 10	SPS 20	SPS 30	SPS 40
30 minute Maximum Demand (Amps/Phase)	32	32	32	32
PV Nominal Output (kW)	4.5	9	13.5	18
Usable Battery Capacity (kWh @ 20 hour discharge rate)	20	40	60	80
Diesel Generator (kW) Prime Rating	12	24	24	24

System performance

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 SPS versus the known network outages affecting customers in the area
- analysis of voltage and frequency levels to confirm that SPS meets the requirements within the Technical Rules.

Power quality

The Technical Rules classify an SPS as an islanded system. Therefore, they must operate in a 49.5 – 50.5 Hz frequency band for 99 per cent of the time. In addition the systems must have an AC voltage operating range of +/- 6 per cent of the 240 V nominal voltage during normal operating states.

The base system met these requirements and the site voltage remained within tolerances at all times.

All sites remain connected to the grid, but did not draw power from the network.

Reliability

One simple but important performance metric for a power system is reliability of supply. Network outages are known outages on the same spur that SPS participants were on.

In January 2017 a major storm event occurred in the region with storms and flooding washing away major road arteries, isolating communities and causing power outages of up to 24 hours. The SPS sites were unaffected, albeit with significantly reduced renewable generation.

Table 3 shows pilot customers experienced a significant reliability improvement with an average outage duration of 4.66 hours for this period versus 69.59 hours had the same customers been network connected.

Table 3: Supply reliability of network vs. SPS (July 2016 – July 2017)

Site No	Network		SPS	
	Number of outages	Hours	Number of outages	Hours
SPS-01	20	72.19	1	14.95
SPS-02	20	72.19	0	0
SPS-03	20	72.19	0	0
SPS-04	19	71.87	1	6.73
SPS-05	19	71.87	2	2.78
SPS-06	10	57.24	2	3.48
Average		**69.59**		**4.66**

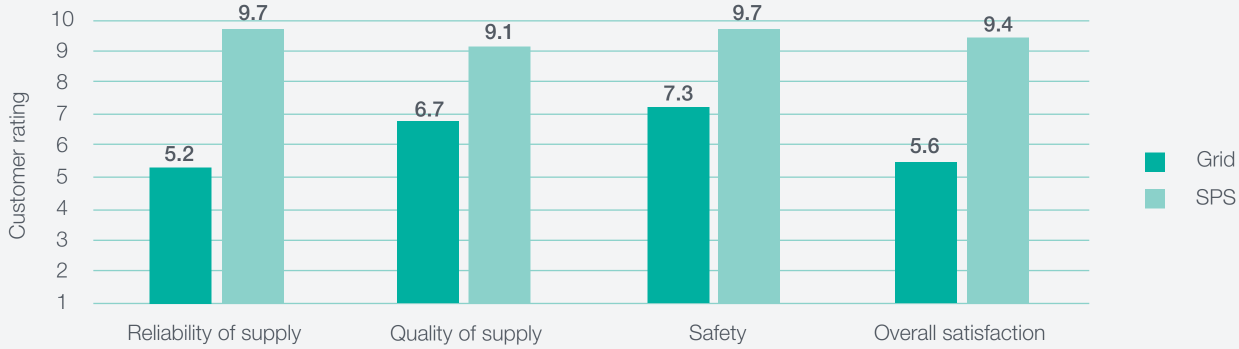
Tim and Sadie, Ongerup

Customer experience

In July 2017 we surveyed participants to compare their experience while connected to the SPS to their traditional network supply. Ratings indicate that customers have preferred their SPS experience with an overall satisfaction rating of 9.4/10 for the SPS supply.

Bernie, Amanda and Ros, West River

Figure 2: Customer satisfaction of SPS vs network supply



Owen, Aimee and family, West River

Network of the future

Many "meshed" or integrated networks around the world are evolving to become modular i.e. dynamically connected microgrids interacting with centralised electricity networks. We also consider islanded infrastructure solutions, such as SPS, to be another critical part of our network's evolution.

Integrated network

Current SWIS model

- Central mesh network with radial transmission line branches
- Fully integrated, shared generation capacity
- All customers connected

Modular network

Future model with variable network types

- Supply is less homogeneous
- SPS and microgrids in the periphery of the network
- Thinner transmission lines to areas with local generation and storage

Applying learnings to support customer choice

Initial modelling by Western Power has shown we could install more than 3,000 SPS units to avoid spending hundreds of millions of dollars over the next 50 years replacing traditional poles and wires. The quantum of the savings may be bolstered as technology improves and costs fall.

We are already investigating the potential wider roll out of SPS, pending the resolution of statutory and regulatory barriers. Some of these barriers define a battery as a generator, which we – as a network operator – are not permitted to be.

This technology was not contemplated when the electricity legislative framework was developed.

The pilot plays a critical role in helping to boost the case for legislative changes for the deployment of these systems, as part of improving electricity supply in regional areas.

In 2016, we submitted a rule change request to the Australian Energy Market Commission for emerging technology solutions to be reclassified as part of the network planner's solutions toolset. Similar discussions have taken place with Western Australian regulatory bodies, to allow our customers greater choice in how they receive energy in the future.

To learn more about how we're embracing new technologies to improve service and reliability to our customers visit: www.westernpower.com.au/about/energy-solutions

363 Wellington Street Perth WA 6000
GPO Box L921 Perth WA 6842

13 10 87
westernpower.com.au

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