Salisbury Residential Energy Storage Trial

Summary Report

SA Power Networks

Empowering South Australia

Project Overview

From 2015–2020 SA Power Networks undertook a Virtual Power Plant (VPP) trial of solar photovoltaic (PV) energy generation and battery storage technology with 100 residential customers in the metropolitan suburb of Salisbury, South Australia.

Aims

- Defer the need for a new 11kV feeder
- Understand the customer experience & benefits from distributed energy resources (DER)
- Determine network impacts

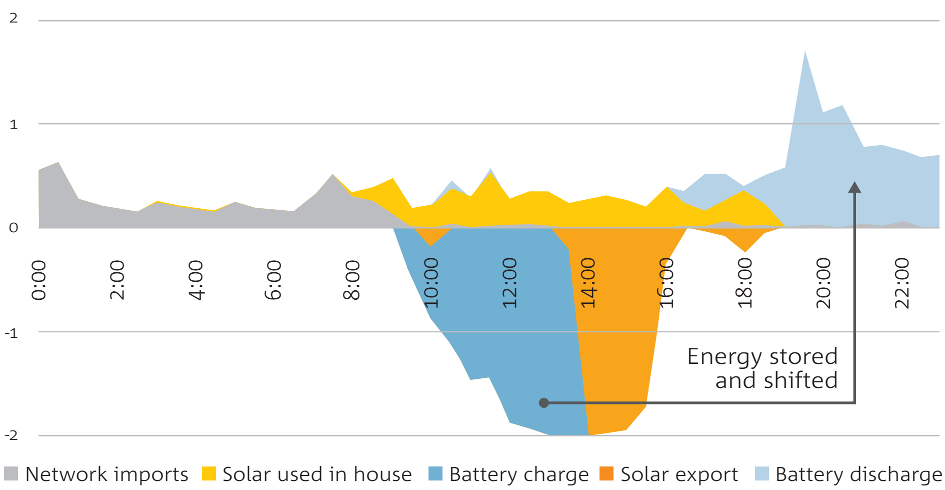
Network
Feeders SA13, SA14, SA17

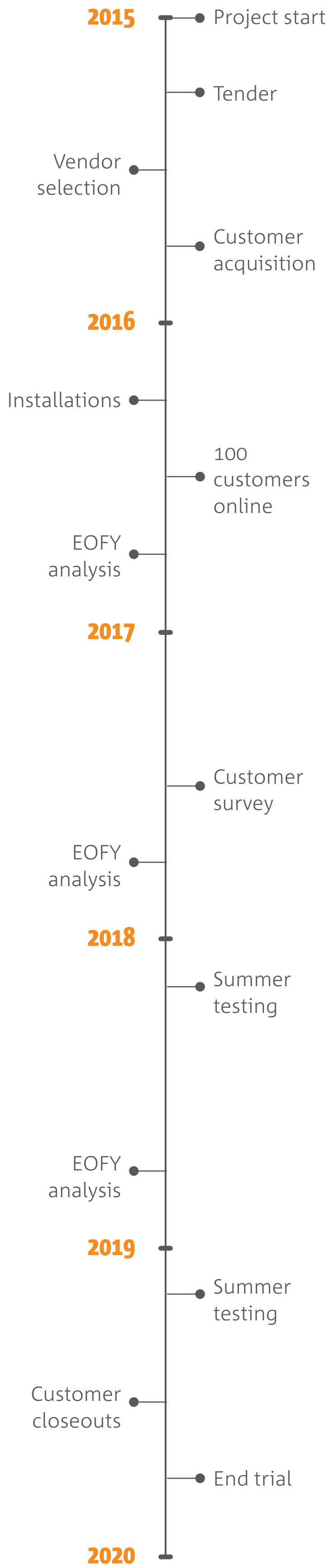
Customers
100 residential customers

Kit
90 Tesla batteries (6.4kWh)
10 Samsung batteries (7.2kWh)
New & existing solar (4kW average)
Local Reposit controllers via customer internet
Aggregate VPP capability 350kW, 650kWh

Salisbury Trial Area

Basic 'solar-shifting' system behaviour on a typical day (when not under VPP control)





Key Learnings

An aggregate view of all customers

Chart 1 - Traditional network demand

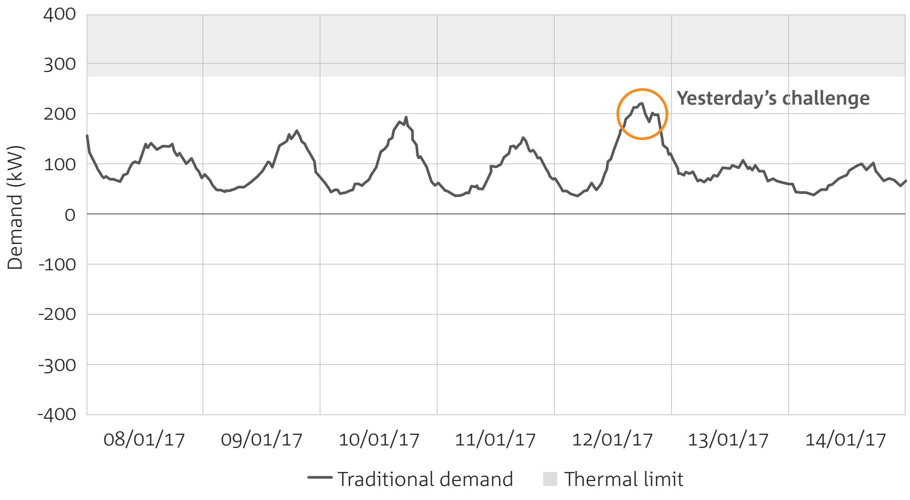
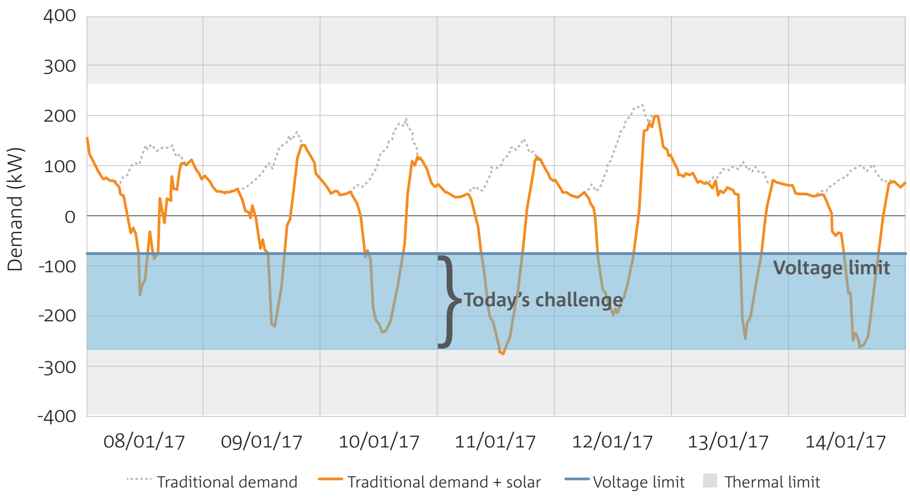
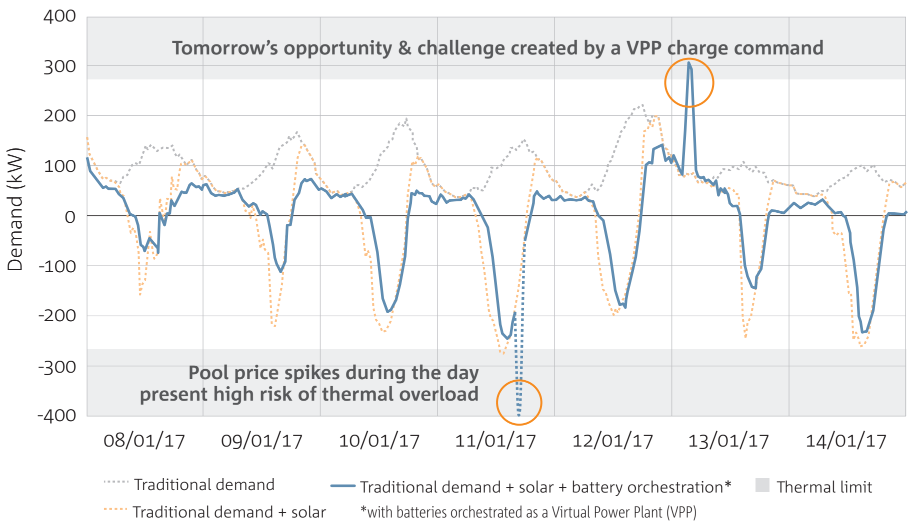


Chart 2 - Traditional network demand + solar



The addition of large amounts of distributed solar PV introduces significant reverse power flow during the day.

Chart 3 - Traditional network demand + solar + battery + orchestration*



Battery capacity and option is not significant enough to resolve the issues created by significant reverse power flow.

The network was historically designed for one-way power flow (Chart 1).

The addition of large amounts of distributed solar PV introduces significant reverse power flow during the day (Chart 2). This results in quality of supply issues where PV is concentrated, or or where the network has reduced hosting capacity.

With large amounts of distributed generation, the distribution network becomes a net source of energy and transports more energy in total.

Battery capacity and operation is not significant enough to resolve the issues created by significant reverse power flow (Chart 3). Orchestrated control of the batteries (like that coordinated through a Virtual Power Plant) can result in network limits being breached when not coordinated with network capacity.

Customer thoughts and sentiment

Mid-trial a survey was conducted of trial participants. 84/100 customers responded with 64 complete responses recorded indicating a high degree of engagement.

Generally, customers were very happy with the system installation, trial operation and response by SA Power Networks.

Customers however had trouble understanding the complexity of the system operation but were very happy with the financial outcomes.

Customers wanted more control of their system, in particular how and when the system prepared for storm events.

Some quotes:

"SA Power Networks has been fantastic throughout the entire process, and continue to be so. Would not hesitate to recommend."

"Our system had some teething problems (which is to be expected with such new technology). The inverter was causing interference with our TV reception and internet. We were so impressed with the level of service from SAPN in working with us to find solutions, and their commitment to making sure we weren't disadvantaged by having installed the battery system. Such great service."

"I think the ongoing support has been better than "very good" it has been excellent. The few emails that I have sent have been answered promptly and with the answer that I needed to know."

"In the early days, I had lots of questions, all handled well by SAPN staff."

Customer Experience on the Trial

Customer proposition

Customers received a heavily discounted battery through outright purchase or lease arrangement. In exchange the battery could be operated on demand for network support for which the customer was compensated with a network support payment (also known as Grid-Credit).

Customers also received a per-annum financial guarantee, a weekly report which tracked costs and savings, an app which displayed historical and live system performance, as well as backup power in-case of a network power outage.

Customer proposition

Retail battery purchase including installation	$9,500 to $13,500
Commitment options	1. $3,600 outright battery ownership 2. $40/month, 3 year lease
Network support period	3 years
Guaranteed saving during period	$500 p.a.
Grid-Credits (network support payment)	$1/kWh

Impact on customer's bill

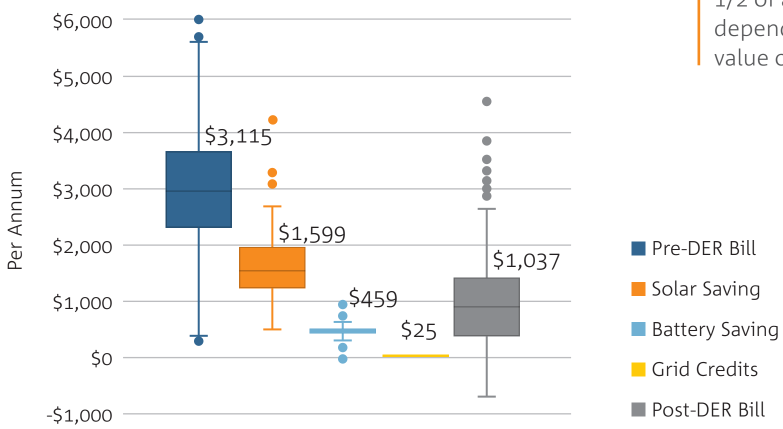
Underlying customer energy use varied significantly, driving large variability in pre-DER (pre solar and battery) bill.

Savings attributed to solar also varied depending on the size of PV system. Approximately half of the trial customers had PV prior to the trial and the average installed size was 4kW.

Customer battery savings were relatively consistent amongst customers as all batteries were the same capacity, and customers generally had enough solar and load to cycle the battery.

Network support was rarely called upon therefore payments for network support did not meaningfully contribute to customer's savings.

Impact on customer's bill



In general, adding solar saved between 1/3 and 1/2 of annual bill depending on the value of feed-in.

How much do you save by adding a battery?

Batteries save money by reducing the amount of energy which needs to be purchased from the grid by storing excess solar generation and shifting it to later household usage. The amount the battery saves is a function of the cost and quantity of energy cycled through the battery. In this trial it was calculated as:

(import energy price – feed in)
× energy discharged through battery

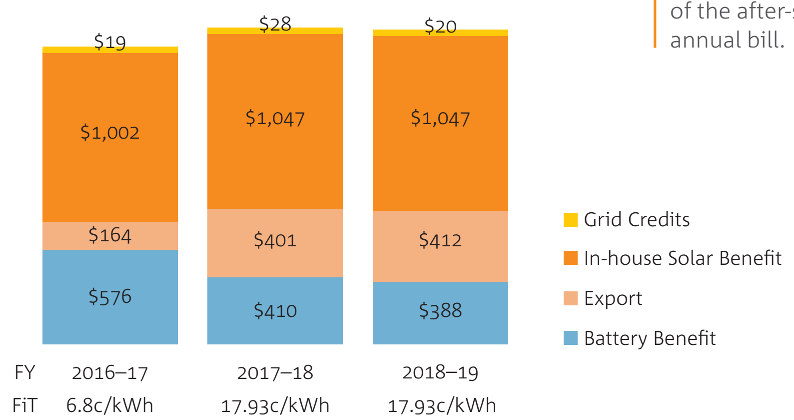
Feed-in Tariffs (FiT) offered by the market standing contract increased over the trial period. This increased the total system saving customers received (Export); however it decreased the saving attributed to the battery (Battery Benefit).

Battery utilisation was the most important factor in determining the savings seen by each household. Customers able to completely cycle their batteries daily benefited the most.

Payback

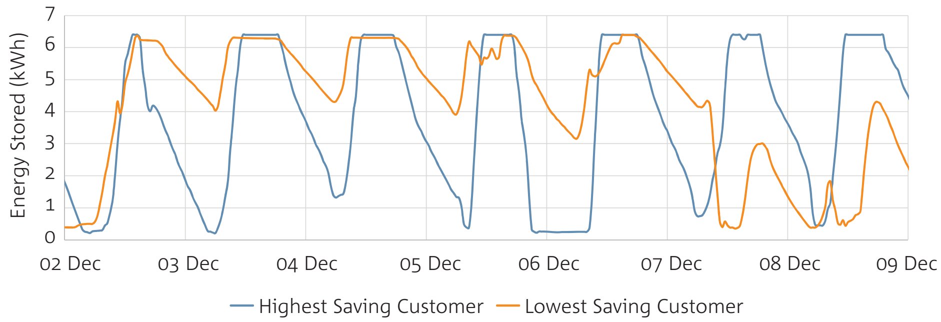
With an average saving of $459 per year and original purchase price of $3,600, the simple payback for customers on the trial is estimated at about 8 years. The factors which influence the payback and value proposition of a battery include customer load and generation, as well as earnings from market participation (e.g. FiT, or participation in a VPP).

Annual savings from solar + battery storage



In general, adding a battery saved 1/3 of the after-solar annual bill.

A week of battery cycling

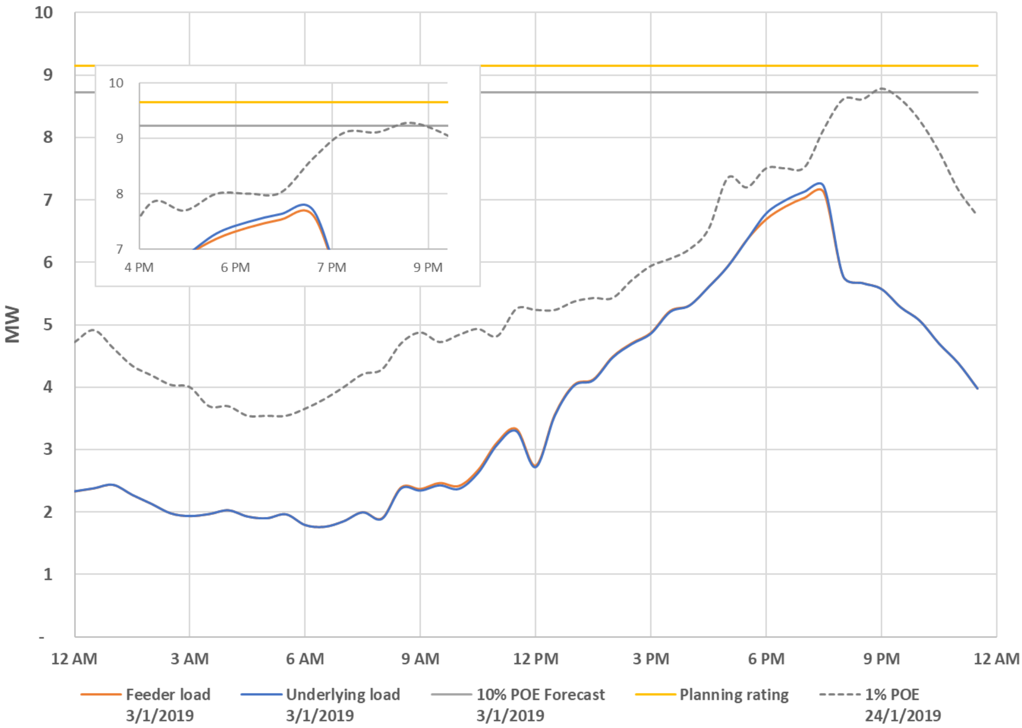


A Network Perspective

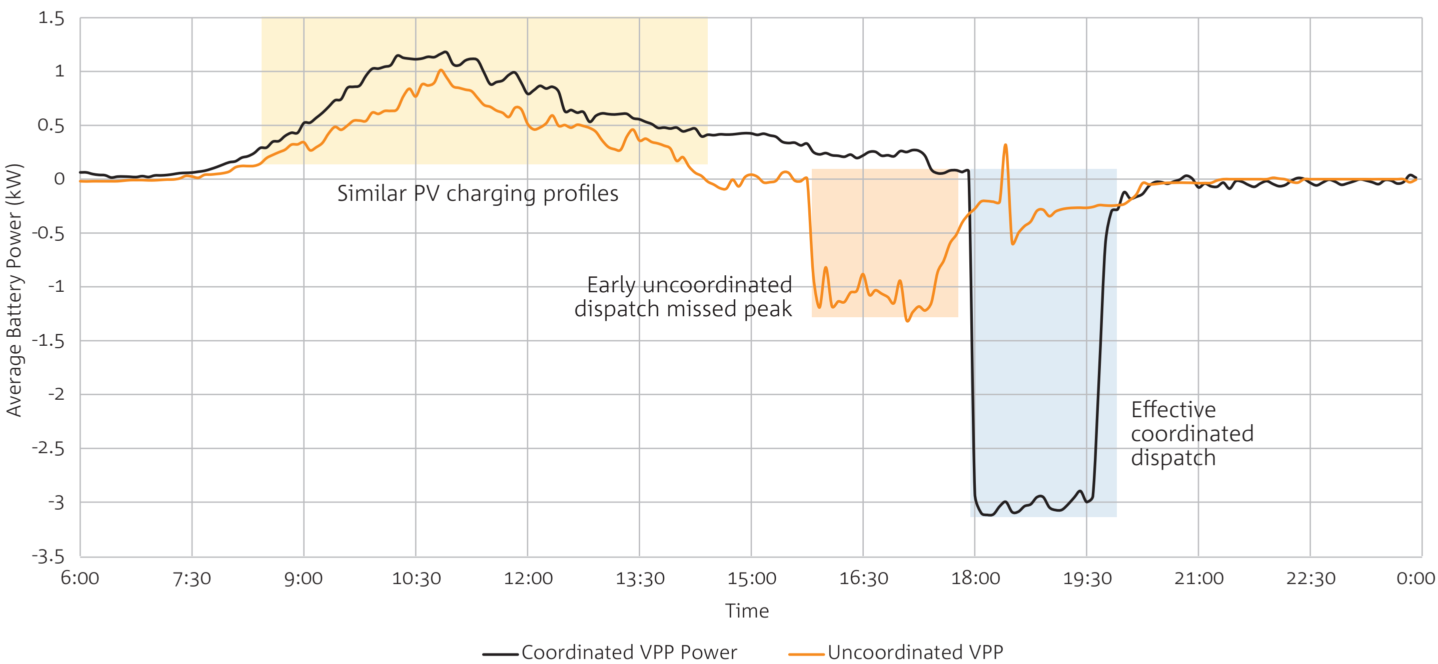
The trial developed our understanding of the technical and economic realities of using distributed resources to defer network augmentation. The fleet of batteries was controlled using Reposit Power's software platform which provided visibility and the ability to schedule battery behaviour. Scheduling of peak demand dispatch proved challenging due to the varied timing and shape of network peak demand. In the chart alongside you can see the timing and shape difference between a regular 1-in-10-year peak (10% POE) and a 1-in-100-year peak (1% POE). In practice, this meant dispatching needed to be targeted for the type and duration of the specific demand event. These challenges reduced the effectiveness of peak reduction which could be achieved.

Economically, the value in network augmentation deferral achieved was approximately 20% of the total cost incurred. This confirmed that this type and scale of network deferral opportunity will not provide sufficient value to justify funding a rollout of customer batteries by a network operator in today's market. In coming years, we expect the most economic model for network operators to access customer batteries for network support will be by procuring services from third-party aggregators who can 'value stack' with other revenue streams from wholesale and ancillary services markets.

Network support dispatch on a peak day



Coordinated vs uncoordinated response



A common assumption regarding the effects of residential battery storage on network load is that a set of *uncoordinated* batteries will provide a similar level of demand response as a *coordinated response*, through the 'natural' load reduction provided by battery-powered households during times of peak load, as opposed to a planned network dispatch during that time.

To test this assumption, approximately half the fleet was set to dispatch at full power during forecast peak load, while the other half was left to operate under the battery's basic solar-shifting behaviour.

This test highlights the importance of coordinated battery control for network support, with the coordinated systems providing more than twice the amount of load reduction as the uncoordinated systems.

Project Management

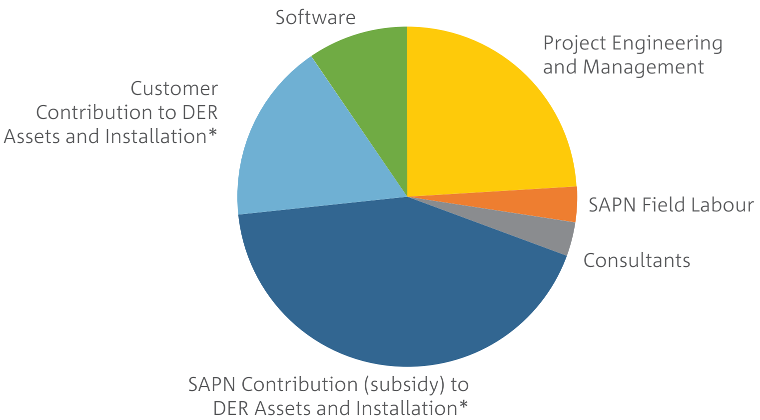
Project resourcing
The trial was run in-house by the delivery team at SA Power Networks' Network Innovation Centre.

In-house project management, procurement, and external consultation was used during the project initiation. External electrical contractors were also used to perform the equipment installations.

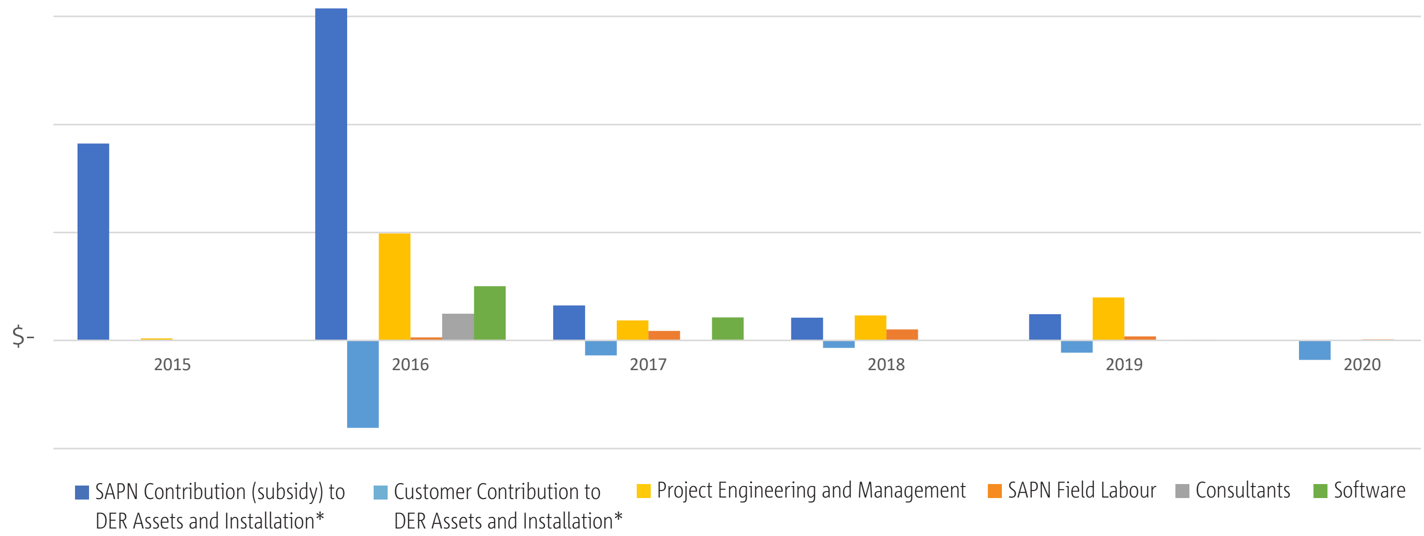
SAPN network and field support was used to support the project throughout its life.

Ongoing support post-trial is required to honour warranty claims as SAPN directly sold equipment to customers.

Project costs



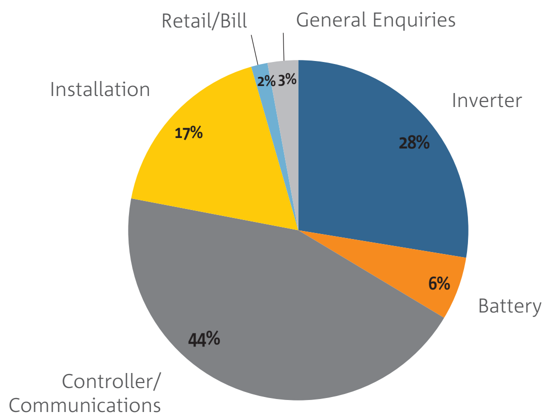
Costs per year



*Includes battery and inverter systems as well as installation, switchboard upgrades and additonal solar where necessary

Project support
A number of issues emerged during the life of the project which resulted in notable support requirements. Those included:

- Teething issues with the integration and operation of the systems. This resulted in significant investigations, call-outs and equipment replacement.
- Batteries were affected by a minimum state of charge issue. This resulted in failure and replacement of a number of batteries.
- A defect batch of inverters requiring replacement at approximately 50% of sites.
- A recall on controllers due to an electrical isolation issue which affected all sites.
- A recall on DC isolator switches resulting in inspection of all DC isolators at all sites.
- Migration of customers to the National Broadband Network, resulting in communications outages, increased investigations and call-outs with additional remote and on-site troubleshooting.



Disclaimer
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