solar analytics

Monitoring for Better Energy Outcomes Final Report

June 2021

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Executive Summary

This project has increased the availability and affordability of active solar monitoring to many thousands of Australian solar owners, giving them the opportunity to visualise and optimise both their solar energy production and energy usage, helping them to maximise the output of their solar investment. They have been able to save significantly by detecting system faults, shifting their loads to increase their solar self-consumption and analysing their usage to select the best electricity tariff. At the same time the energy data generated through this project has provided researchers, retailers, electricity grid providers and regulators with valuable data, contributing towards the drive to better manage the electricity grid and enable more efficient integration of renewable energy sources.

Over the four years of this ARENA backed project, Solar Analytics has delivered our rooftop solar monitoring service to over 40,000 customers across Australia. Through ARENA's support, Solar Analytics has been able to give Australian solar owners the opportunity to visualise and optimise both their solar energy production and energy usage, spearheading the movement towards providing insights and information directly to the solar owner about their solar system, to help them better manage their solar and increase their financial return.

As well as facilitating the uptake of affordable solar monitoring, the project has also focussed on analysing the data collected through monitoring and using it to provide evidence to support and encourage the uptake of solar monitoring, by identifying possible savings and disseminating this information to solar buyers, retailers and researchers.

The key outcomes of the analyses conducted as part of this project are:

1) Active performance monitoring increased solar generation by 14% (or an average of $132 pa for residential customers) due to faster fault detection and rectification.
2) By monitoring both solar generation and electricity consumption, residential customers also save up to $350 pa by shifting their loads to times of high solar generation.
3) Time of use electricity tariff structures can generate savings of $200 pa for solar customers
4) High quality near real-time data from solar system monitoring provides electricity networks with critical information to better manage our electricity networks.

Project Overview

Project scope

Solar Analytics' mission is to provide the world's most accurate and consumer-friendly residential PV monitoring service. At the time of project commencement, Australia had a significant resource in energy generation from distributed residential solar PV, with 1.5 million

systems installed across the country. However, while utility and commercial scale systems were being monitored for performance, less than 7,000 of the close to 1.5 million residential solar PV systems in Australia were being actively monitored. This meant that the performance and energy delivery from the many small systems being installed was largely unknown. At the same time, the owners of these systems were not being given the opportunity to maximise their energy output by monitoring their systems' performance or to optimise their energy usage.

This project was therefore designed to accelerate the deployment of cost-effective monitoring of residential solar by Solar Analytics, opening up the benefits of energy visibility to a broader group of solar system owners. In addition, the data generated by the actively-monitored solar systems would be analysed to demonstrate the value of residential solar monitoring to the householder, solar retailers and the wider energy industry. This data would also be made available to industry participants, such as solar retailers and energy providers, to access markets and improve their service offerings and by researchers/analysts to improve the understanding of grid-integration of renewables.

Outcomes

Over the four years of this ARENA backed project, Solar Analytics has delivered our rooftop solar monitoring service to over 40,000 customers across Australia, including over 8000 through our partner energy retailers including Horizon, Mojo, Energy Locals, Mercury (NZ) and AGL . Throughout this period Solar Analytics have been at the forefront of increasing the value solar owners receive from their solar system by providing insights and information to help them better manage their solar and increase their financial return.

A number of key learnings have resulted from this project, demonstrating that an increased visibility over solar systems can be highly beneficial to both consumers and the management of the electricity network.

Performance monitoring of rooftop solar saves customers $132 pa

Overall, this project has enabled Solar Analytics to deliver 37 GWh of distributed rooftop solar electricity per year, with an energy production valued at $9.1 million per year.

The key benefits of active solar monitoring are detailed below.

1) Increased solar generation
2) Use of monitoring allows for early identification of solar system issues in the first 6 months leading to an increase in solar production of 4.8% for small systems and 7.6% for large systems.
3) A further increase of 3% for small systems and 11.9% for large systems can be attributed to the detection of zero generation faults.

4) Together, this increase in solar generation leads to annual savings of $132 per site.[1]

5) Better management of energy consumption. Solar owners were able to increase their savings through shifting the energy load of major load appliances such as hot water, air-conditioning, pool pumps and electric vehicles. This active management of load patterns saved customers up to $350 pa, however it was highly variable across customer segments based on their ability and inclination to shift these energy appliances.

The costs of Active Monitoring are paid for by the system owner. The costs are around $800 for standard residential and $1500 for commercial solar systems across 10 years. This includes the monitoring device, installation of the device, and ten years of active monitoring.

In addition to saving business and households thousands of dollars in electricity costs, increasing our total renewable energy generation and helping us meet our climate change commitments, rooftop solar has been demonstrated to provide savings for all energy consumers through:

a) reduced severity and length of peak demand periods, and
b) reduced wholesale electricity costs[2] - saving $2.2-3.3 billion for NSW electricity customers alone in 2016/17[3], and
c) increased grid resilience through autonomous DER response[4].

Monitoring solar generation and electricity consumption saves up to $350pa

The key for a consumer to be able to better manage their electricity costs is visibility and readily actionable information of what actions they can take. Empowering the solar owners to better manage their solar and energy profile includes the following.

a) Savings can be made from increasing self-consumption and lowering the amount of energy imported from the grid. For example, by changing large energy using appliances such as hot-water heaters and pool pumps to be operating during daytime hours rather than at night. Detailed savings expected in each state can be seen in a Solar Analytics blog post on energy shifting[5].
b) Active monitoring with additional measurement of these large energy appliances allows for identification of an appliance fault that otherwise would have gone detected. An example is given in a recent Solar Analytics blog post in which leakage from a hot water was identified early and rectified[6].

[1] M6_D_SolA_Performance_Report_Feb_2020
[2] Electricity prices falling across the whole supply chain for first time, AEMC Jan 2020
[3] Impact of small solar PV on the NSW wholesale electricity market, Oct 2017, Energy Synapse
[4] Technical Integration of Distributed Energy Resources, Apr 2019, AEMO

[5] https://www.solaranalytics.com/au/blog/energy-load-shifting-made-easy

[6] https://www.solaranalytics.com/au/blog/how-checking-in-on-your-energy-usage-from-time-to-time-can-save-you-money

c) Active monitoring gives the customer a better overview of their energy usage, making it easier to choose the best electricity tariff to match their consumption. Once the customer can see how much energy they are using in shoulder and peak times, and how much of the this is a shiftable load, they can pick a tariff to maximise their savings.
d) A further benefit of this visibility is the provision of an accurate assessment of what the ideal battery size would be for the customers specific energy profile. Once the optimal battery size is determined, the cost and savings (in both energy and $) can be presented, enabling the customer to make an informed choice of if and when to add battery storage to their solar system.
e) The ability to see live and historical energy production and consumption in a clear and easily understandable format, also enables customers to become for energy knowledgeable. For example, live energy data allows a customer to see exactly which appliances draw greater amounts of electricity.

Time of use (TOU) electricity tariffs can generate savings of $200 pa

There are two main types of electricity tariff – flat and Time of Use (TOU). A flat tariff has the same price of electricity throughout the day. A TOU tariff will vary the price of electricity depending on the time of day, ie more expensive during the period of high national electricity usage (typically 3pm – 10pm), and cheaper during periods of low electricity usage (typically 10pm-6am).

A further complication is that the time of use charges vary depending on the location and may be different for both the energy purchased from the grid (energy retailer tariff), and the energy sold back to the grid (Feed-in tariff).

By analysing the fleet of solar systems monitored throughout this project, it was shown that the orientation of a solar system (ie the direction the solar panels on the roof are facing) can determine which electricity tariff will generate the most savings for the customer.

With flat feed-in-tariffs, the profits from solar energy being sold back to the grid is directly in proportion to the amount of solar energy exported.

However, when the feed-in-tariffs are time-of use, the orientation of the solar system has a significant impact on the energy savings. The below tables show the typical tariffs available from energy retailers, and a comparison of the savings achievable for three common tariff types.

Table 1: Typical retailer tariff and feed in tariffs

	Retailer tariff	Feed-in Tariff
Flat	$0.29/kWh	$0.11/kWh

TOU	Peak: $0.37/kWh Shoulder: $0.25/kWh Off peak: $0.15/kWh	Peak: 29c/kWh Shoulder:10.3c/kWh Off peak:7.2c/kWh

Table 2: Comparison of different tariff structures (all systems)

	Scenario 1	Scenario 2	Scenario 3
Retailer Tariff	Flat	Flat	TOU
Feed in Tariff	Flat	TOU	TOU
Costs from energy import	$1,266	$1,266	$1,141
Savings from energy export	$408	$488	$488
Total costs	**$858**	**$778**	**$653**

Table 3 shows how a time-of-use tariff can save a typical solar home owner $205pa, however for West facing systems this increases to $240pa, and for East facing system reduces to $143pa.

Table 3: Comparison of different tariff structures for different solar system orientations

Orientation	North	West	South	East	All sites
Scenario 1 - Flat	$867	$844	$730	$791	**$858**
Scenario 2 - Flat/TOU	$739	$719	$651	$690	**$733**
Scenario 3 - TOU	$663	$604	$536	$648	**$653**
TOU savings vs Flat	**$204**	**$240**	**$194**	**$143**	**$205**

Note that the actual savings achieved from TOU tariff will vary between households, and is heavily dependent on the following factors:

- The specific electricity tariffs available
- The proportion of electricity generated that is consumed by the household, ie % self consumption (the average is 42% of solar being consumed on site)
- The energy usage patterns of the household, ie how much energy is consumed during peak periods
- The ability of the household to shift loads away from peak periods

Real-time data enables better management of our electricity networks

On 11 Oct 2020 rooftop solar provided over 75% of the electricity for the South Australia electricity grid. The network organisations that have the responsibility of managing the electricity grid currently have little visibility of how their network is operating. With the increasing amounts of rooftop solar, network operators now urgently require this visibility to effectively and safely mange the grid.

On example of the need for visibility is the operating voltage of the network. The preferred and outer limits of the safe operating range is shown in Figure 2. As shown in this figure, analysis from Solar Analytics through this project found that many parts of the grid were operating in the upper operating zone.

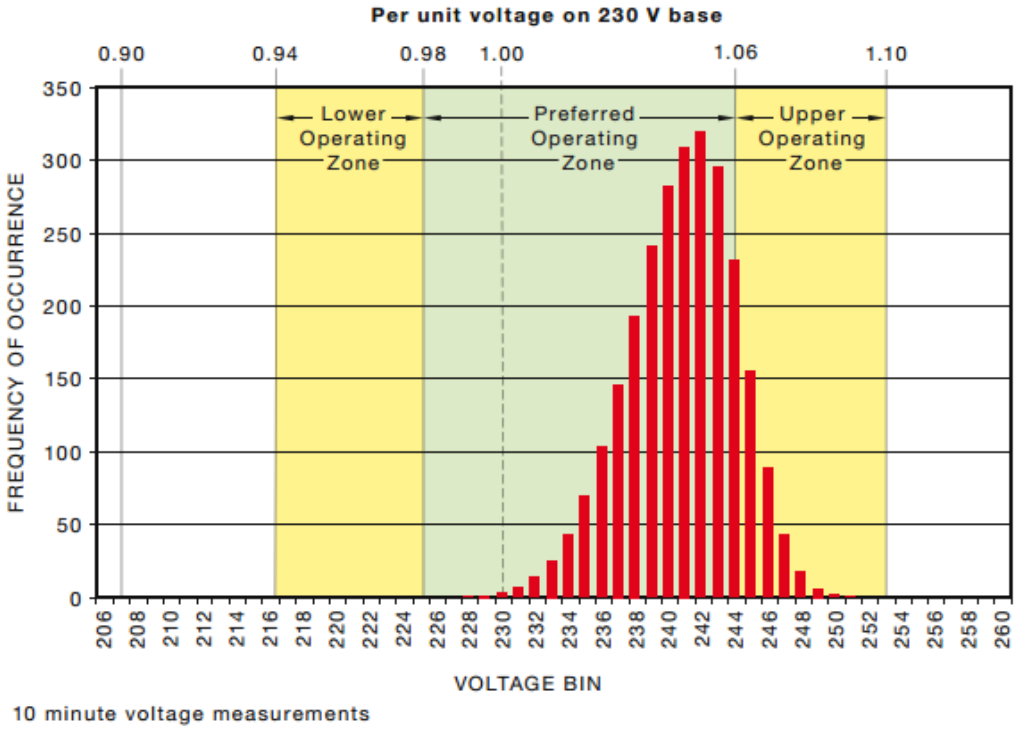

Figure 2: Analysis of network voltages data courtesy of CEEM UNSW and AusNet

The types of data that were provided to network operators by Solar Analytics to assist with grid management include:

- Solar system capacity
- Power factor at the point of grid connection
- Total solar generated
- Frequency
- Solar system responses under real world grid disturbance events
- Load consumption profiles

Based on the benefits and increased visibility over the network enjoyed by network operators through monitoring, general energy consumers (both solar owners and non-solar owners) across Australia also benefit. Monitoring potentially enables:

1. equitable access to solar savings for people who have not yet installed rooftop solar (including renters).
2. Reduced electricity costs from reduced network constraints (peak demand periods, wholesale electricity costs).
3. Reduced electricity costs from minimising network upgrade costs due to the enhanced NSP network visibility improving their network modelling and O&M programs.

Conclusion and next steps

This project has increased the availability and affordability of active solar monitoring to many thousands of Australian solar owners, giving them the opportunity to visualise and optimise both their solar energy production and energy usage, helping them to maximise the output of their solar investment. They have been able to save significantly by detecting system faults, shifting their loads to increase their solar self-consumption and analysing their usage to select the best electricity tariff. At the same time the energy data generated through this project has provided researchers, retailers, electricity grid providers and regulators with valuable data, contributing towards the drive to better manage the electricity grid and enable more efficient integration of renewable energy sources.

While the uptake of solar monitoring has increased dramatically since the project's commencement, there is still significant work to be done to understand how to educate consumers further and help them to understand the benefits of active solar monitoring. Solar Analytics will continue to build on the knowledge gained as part of this project to reach and convert more solar buyers. This could include lower upfront cost for the consumer, improved messaging at point of sale, or integration with other products and services so that the benefit is inherently included. This will increase the total amount of rooftop solar electricity generated and provide these benefits to more solar owners.

Consumer education remains a key barrier to better electricity outcomes and lower costs for both solar and non-solar owners. Future projects could build on this work by refining how the message is delivered to the customer, with specific focus on providing readily actionable insights with estimated financial benefit.

The introduction of widespread smart meters as well as third party monitoring services such as Solar Analytics has increased the amount and quality of data available to network operators. However, sourcing sufficient quantities of real-time network data to enable them to effectively and safely operate the grid remains a key challenge. Further work could optimise the aggregation of disparate data sources, or provide a pathway to establishing a common network visibility requirement that would enable this data to be provided to the network operators in a simple and cost-effective way.