Smart CER Consumer Uptake Tool Project

2022/ARP027

Apr 2024 Technical Report

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Acknowledgements and disclaimer

The views expressed herein are not necessarily the views of the Australian Government. The Australian Government does not accept responsibility for any information or advice contained within this document.

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List of Abbreviations

CER	Consumer Energy Resources
DNSP	Distributed Network Service Provider
EV	Electric Vehicle
OEM	Original Equipment Manufacturer
Tool	Smart CER Consumer Uptake Tool
v1	Version 1
VPP	Virtual Power Plant

Executive Summary

This report presents key findings of the ARENA-funded "Smart CER Consumer Uptake Tool Project" (the Project). CER are Consumer Energy Resources such as rooftop solar, residential batteries and controlled hot water heating.

The Project has developed an online consumer smart energy tool (the Tool) that provides residential customers with an economic assessment of consumer energy resources (CER), including solar PV, smart electric hot water, batteries, and electric vehicle (EV) smart chargers.

The Project has also integrated with a partner, Solar Thermal Australia (STA, trading under the name "Reclaim Energy") original equipment manufacturer's (OEM's) heat pump hot water technology to control customers' hot water systems (Smart Hot Water). The project has developed and assessed methods of controlling heat pumps in an optimum way to maximise consumer savings, and ultimately incorporated them into a "smart hot water fleet" of 1000 electric hot water systems, to illustrate the potential for flexible demand capacity with smart hot water.

This technical report covers the period from Sept 2023 to Apr 2024 (described in more detail in **Project objectives and progress** on page 14); key findings are summarised below.

Project technology and developments

Solar Analytics developed the Tool user interface which can be accessed online at the Solar Analytics website[1], and the core algorithms to power the Tool, including:

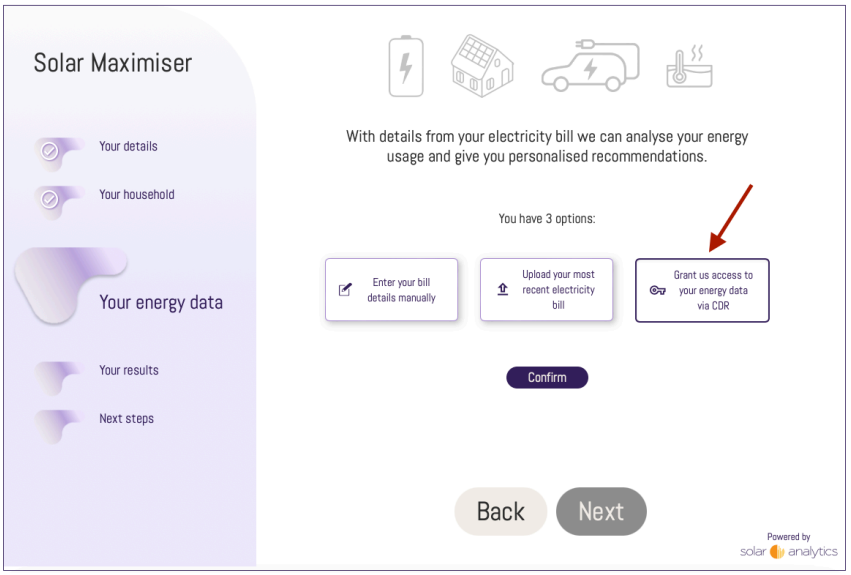
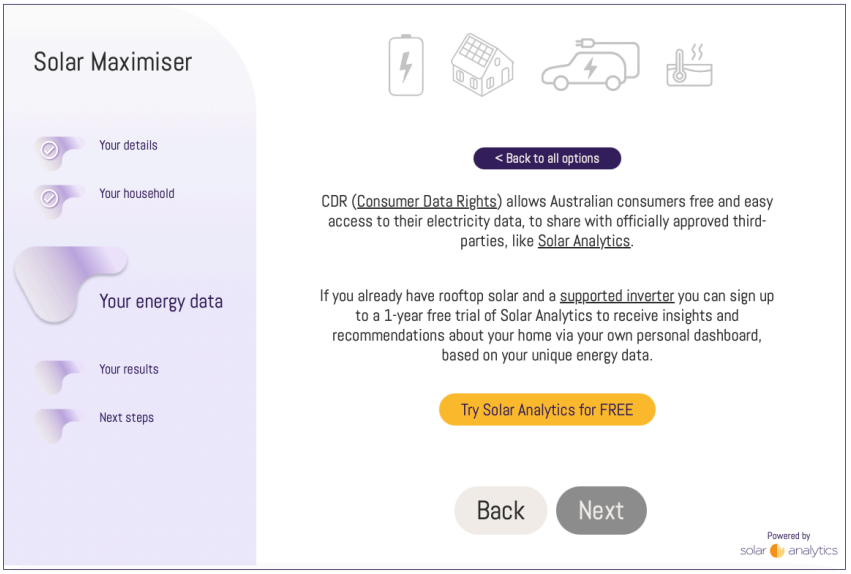
1. Rooftop solar recommendation algorithm
2. Rooftop solar + battery recommendation algorithm
3. Rooftop solar + heat pump recommendation algorithm

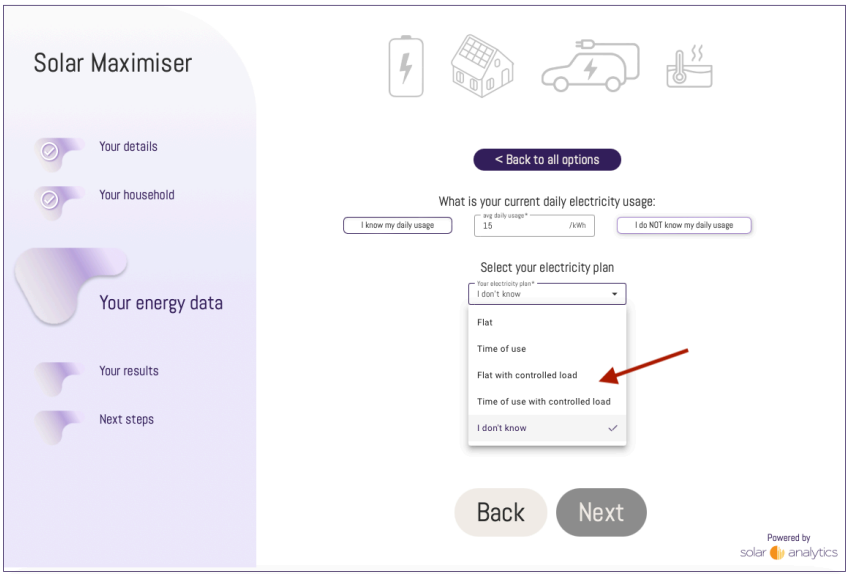
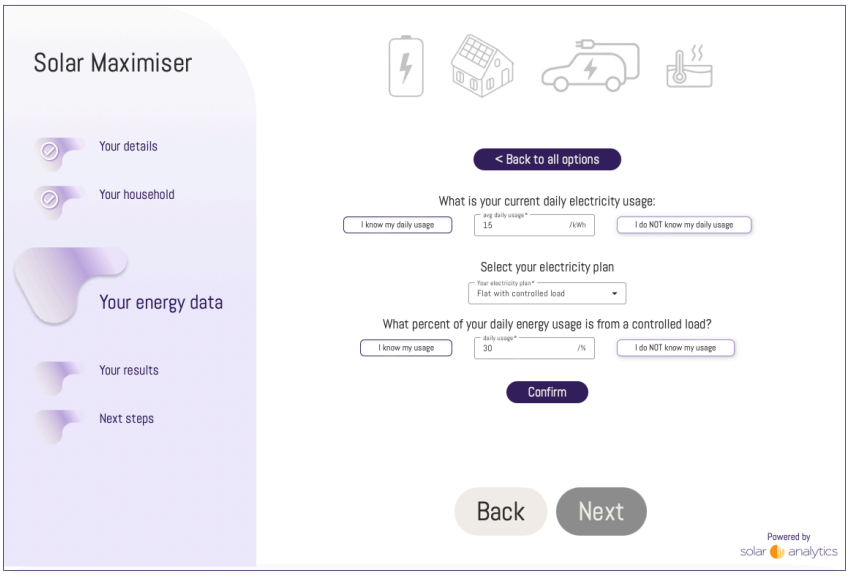
The Tool was first released to NSW residents only in Apr 2023. This was followed by a national rollout in June 2023. From June 2023 to Aug 2023, the Project focussed on developing and supporting the heat pump integration with Reclaim Energy heat pumps. Continuous improvements to the Tool's user interface, accuracy, and capabilities have continued throughout the Project.

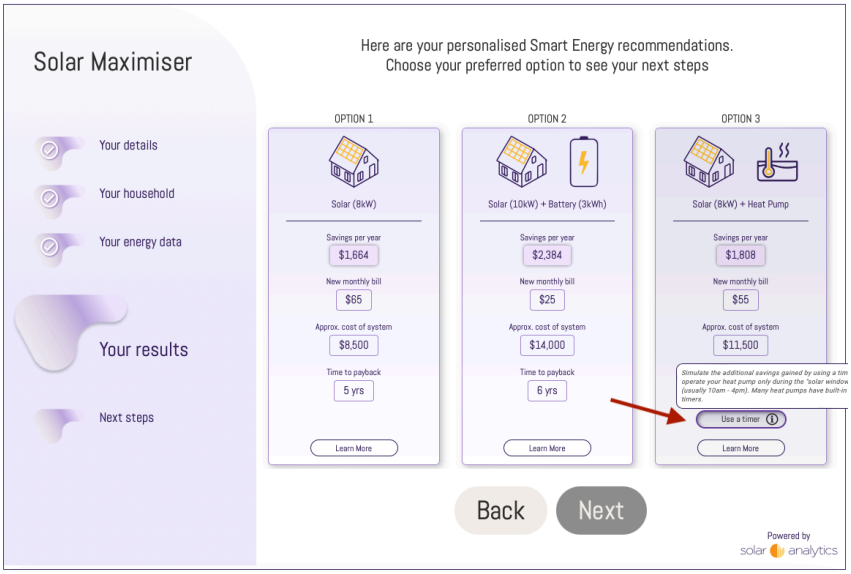
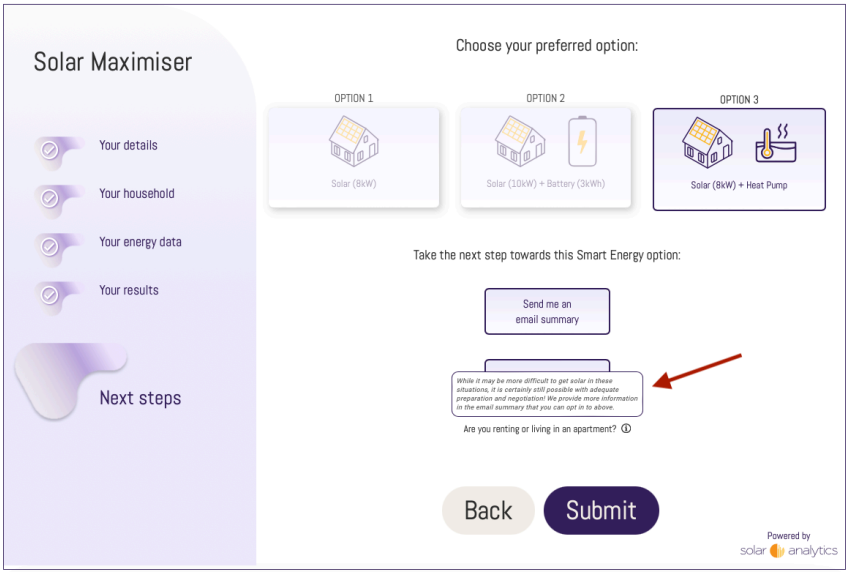
Key Tool developments completed between Sep 2023 and Apr 2024 are presented in Table 1 below.

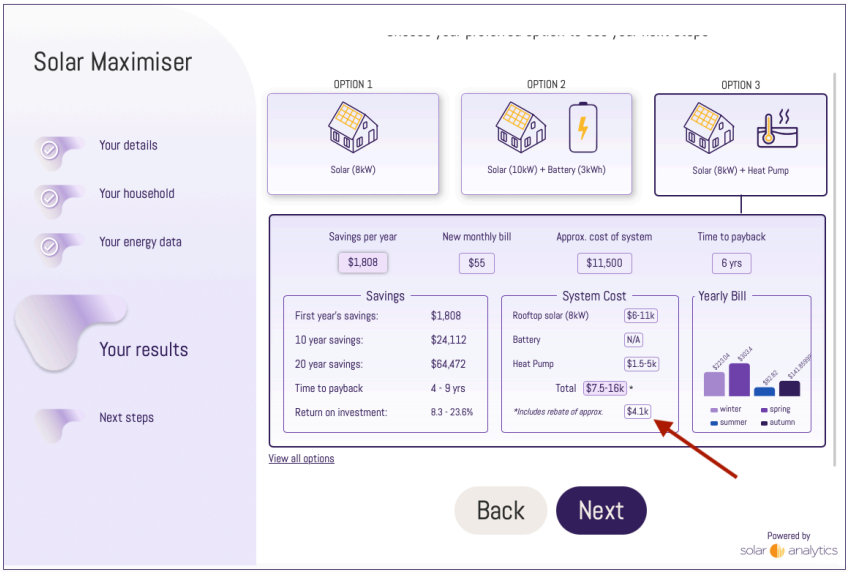
[1] https://www.solaranalytics.com.au/smart-energy-tool

Table 1. Key Tool developments.

Improvement	Description
CDR integration	The Tool now directs eligible users to provide their energy data to Solar Analytics via Consumer Data Rights (CDR), for more accurate recommendations.  

Improvement	**Description**
Support Controlled Load tariffs	The Tool now supports the options of controlled load tariffs.  

Improvement	**Description**
Add the option of running heat pump on a timer	The Tool now supports the option of opting to use a timer in the heat pump recommendation, to improve savings and payback. 
Add additional information for renters or those living in an apartment complex	The Tool now directs users who are renters or living in an apartment to relevant information on how to get solar in their situation. 

Improvement	**Description**
Updated rebate information	The Tool now includes updated rebate information in the CER recommendations. 
Embedable retailer version of the Tool	A “retailer version” of the Tool has been created that can be customised with different links and information that suit the company wanting to host the tool. Improvements have been made since Aug 2023 to improve uptake and ease of embedding. Some examples of the Tool in use include: • Aztech solar retailer[2] • Your Energy Answers Tool[3] • Solar Citizens switch campaign[4] • 1 Million Women Tool hosting[5] • Media article in Renew Economy[6] • Reclaim Energy partnership[7]

[2] https://www.aztechsolar.com.au/solar-monitoring/
[3] https://yourenergyanswers.com/solar-analytics/
[4] https://www.solarcitizens.org.au/switch_and_save
[5] https://www.1millionwomen.com.au/blog/considering-rooftop-solar-battery-or-hot-water-heat-pump-tool-does-customised-cost-effective-analysis-you/
[6] https://switchedon.reneweconomy.com.au/content/online-tools-show-how-you-can-save-with-electrification-and-efficiency
[7] https://reclaimenergy.com.au/portfolio-items/reclaim-heat-pump-partners-with-solar-analytics-through-wifi-integration/

Solar Analytics has also integrated with Reclaim Energy heat pumps and can get data from their heat pumps and control them (turn them on/off). This is achieved through a cloud based integration with the Reclaim Energy heat pump. With customer authorization, Solar Analytics receives energy data from the Reclaim heat pump, and is able to remotely control the heat pump to optimise operating periods to maximise use of solar energy.

For example, Figure 1 below shows the temperature and power of a heat pump increase after a control "on" signal was sent at 3pm on 4th September 2023, lasting for approximately 2 hours (the point at which the heat pump reaches its configured set temperature of 60°C).

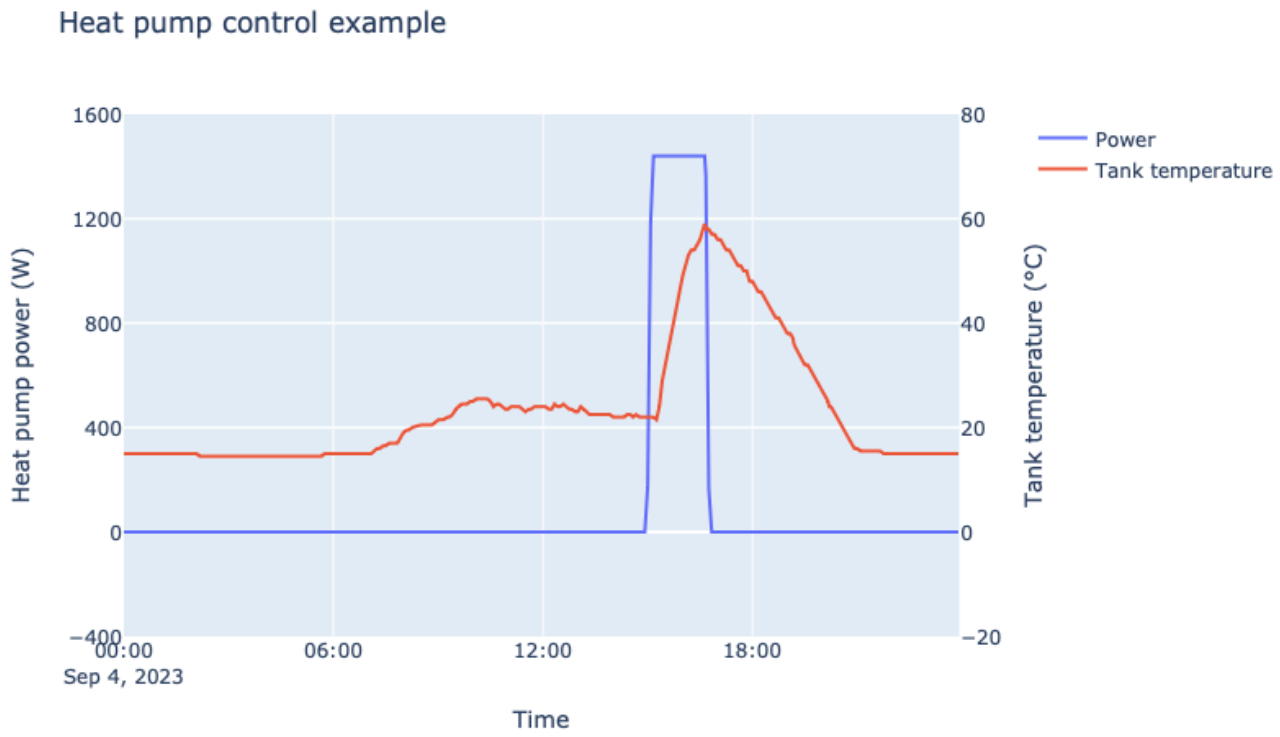


Figure 1. Example of heat pump remote control via API.

Finally, Solar Analytics has also become an accredited Consumer Data Recipient (CDR) and is able to obtain data from household utility smart meters (with the owner's consent). This online customer authorisation provides Solar Analytics with energy and tariff data from the utility smart meter. In the context of this project, CDR is critical for obtaining hot water controlled load data - enabling Solar Analytics to provide transparency about controlled load usage to the owner, as well as recommend electricity plans to help them save more (ideally, plans that focus on solar-soaking that pass on associated savings to the customer).

This combination of actively monitored heat pumps and controlled load circuits helps Solar Analytics monitor a smart hot water fleet of over 1000 systems with a total shiftable load of ~5MWh per day,

which can be shifted by either direct API control (heat pumps) or via the energy retailer (controlled load circuits), as summarised in Table 2 below.

Table 2. Current state of Solar Analytics' smart hot water fleet.

Hot water	Number of systems in Solar Analytics' fleet	Shiftable load in fleet	Shiftable load per site
Control of Reclaim heat pumps via API	119	274 kWh	2.3 kWh
Energy retailer control of resistive hot water	886	4696 kWh	5.3 kWh
Total	**1005 systems**	**4970 kWh / day in fleet**	**-**

Customer acquisition and findings

The Tool has received over 100,000 users to date. The primary source of these users are from:

- Meta/Facebook (from posts and shares on the platform, or paid advertising conducted by Solar Analytics) - 36.2%
- Direct (people coming from an email campaign, entering the URL direct in their browser, coming from a bookmark, or some other untrackable source) - 27.6%
- Google (people searching for related content and clicking the link) - 18.5%
- Solar Analytics (from Solar Analytics' website) - 11.3%
- Instagram (from posts and shares) - 1.2%

Approximately 10% of these users fully completed the Tool; i.e., completed all steps and chose an action at the end (such as getting a quote, or an emailed summary report). That's not to say that the remaining 90% received no value from the Tool, they just didn't proceed to choose an action after seeing their CER results. Notable insights about the 10% of users that did are summarised below:

- Of these users without existing solar:
  - 41% chose getting solar
  - 35% chose getting solar with a battery
  - 24% chose getting solar with a heat pump
- Of these users with existing solar:
  - 40% chose upgrading solar with a battery
  - 35% chose upgrading solar with a heat pump
  - 25% chose upgrading solar
- 20% chose to get information on how to get a quote for their preferred CER recommendation.

- There was no significant difference in the savings presented to the 10% of users that fully completed the Tool and choose an action, and those who did not.

1. Project objectives and progress

Section Content: Document progress towards the Project's key Outcomes, especially regarding the effectiveness of the Tool in terms of uptake of flexible CER and customer perceptions.

Project progress

Table 3. Project progress.

Objective	Due Date	Status
Tool development and V1 release	31 May 2023	Completed
Tool Version 2 and Smart Hot Water control	31 Oct 2023	Completed
Smart Hot Water Control Growth	31 January 2024	Completed
Tool growth and Project completion	31 May 2024	Completed

May 2024 objectives

Table 4. May 2024 objectives.

Key activities	Status	Notes
Demonstrate the Tool has had 100,000 uses.	Completed	The Tool supports all Australian postcodes and DNSPs. Tool released national and available on Solar Analytics website[8]. Analysis and evidence of Tool users is presented in **Customer acquisition and findings** (page 13).
Improve the accuracy of the Tool algorithms	Completed	See **Project technology and developments** (page 7) for more information.
Demonstrate a "Smart Hot Water fleet" of 1000 systems.	Completed	See **Project technology and developments** (page 7) for more information.

[8] https://www.solaranalytics.com.au/smart-energy-tool

Project key outcome(s) progress

Outcome 1

Increase the value delivered by renewable energy by:

I. *increasing the uptake of flexible CER within the residential market; and*
II. *developing systems to integrate with STA heat pumps and optimise its operation*.

Since the national release of the Tool to all Australian postcodes, there has been clear demand for information regarding CER. In the roughly 10 months since national release (June, 2023), the Tool has had over 100,000 users. Significant paid and organic marketing and media attention (listed below under **Outcome 2** on page 16) has helped to spread awareness of the Tool, and CER more generally across Australia. In a recent survey (March, 2024) Solar Analytics asked users of the Tool where they were on their solar journey since using the Tool for the first time, with the following results:

- Yes, I've gotten solar: 28%
- No, but I'm still considering it: 32%
- No: 40%

Overall, based on survey results collected throughout the project via a prompt on the Tool website, around 80% of Tool users said that they found the Tool useful in their journey towards getting or upgrading their existing solar system (with a battery, heat pump, or EV). The remaining 20% cited issues related to missing capabilities (some of which have been addressed throughout the life of the Tool), such as support for particular tariff types (e.g., demand tariffs).

It is interesting to observe the trend of preferred CER by Tool users over the life of the Tool. When progressing through the Tool, a user is eventually prompted to select the CER they want to receive more information and/or quotes for, out of solar only, solar with a battery, or solar with a heat pump. As shown in the figure below, trends have been relatively stable over the life of the Tool so far, except for a spike in preference for solar only by non-solar owners in November 2023. It's unclear exactly what caused this anomaly, but it could be a result of increasing electricity prices from July - November 2023 combined with a news article in the Daily Telegraph[9] about Solar Maximiser, which was released in November and may have attracted a large number of users who are not as familiar with solar, and thus are more likely to select the simplest "solar only" CER option versus the battery or heat pump options. In the figure, it's also worth noting the spike in battery interest for those who already own solar in February/March 2024 - likely due to the new Queensland battery rebate[10].

[9] https://www.dailytelegraph.com.au/subscribe/news/1/?sourceCode=DTWEB_WRE170_a&dest=https%3A%2F%2Fwww.dailytelegraph.com.au%2Fnewslocal%2Fmacarthur%2Fcampbelltown-mum-samantha-ho-reveals-how-she-cut-her-power-bills-down-to-zero-in-cost-of-living-crisis%2Fnews-story%2F43ccf223001e1a0483962b4ba7a0b579&memtype=anonymous&mode=premium&v21=HIGH-Segment-1-SCORE (paywall)
[10] https://www.epw.qld.gov.au/about/initiatives/battery-booster-program

Figure 2. Chosen CER options by Tool users over time.

Finally, Solar Analytics has integrated with Reclaim Energy and can get data from Reclaim heat pumps to control them (turn them on/off). This is achieved through a cloud based integration with the Reclaim Energy heat pump. With customer authorization, Solar Analytics receives energy data from the Reclaim heat pump, and is able to remotely control the heat pump to optimise the heat pump operating periods to maximise use of solar energy.

Solar Analytics is now managing a fleet of 119 Reclaim heat pumps comprising a shiftable load of 274 kWh (on average, 2.3kWh / day / heat pump - see Table 1 for detail). An optimisation algorithm was developed to maximise the financial savings of a heat pump by optimising when it should run, considering a household's energy usage, solar generation, and energy plan. However, as described in detail in **Project Technology** on page 7**,** the optimisation algorithm provides no significant financial benefit over using a simple timer, but is significantly more complex in terms of software and hardware to implement.

Outcome 2

Reduction in or removal of barriers to renewable energy uptake through the delivery of a free, publicly available consumer smart energy tool that enables solar consumers to find the optimal smart CER solution.

It is Solar Analytics' experience that the vast majority of people are not (renewable) energy experts, and have minimal time and attention to dedicate to thinking about energy. The goal of the Tool is to provide simple, easy, and clear recommendations in less than 60 seconds.

As described above, the Tool has been released nationally with rapid uptake and a positive response, with users indicating its usefulness in their journey to get or upgrade their solar. Marketing of the Tool is ongoing to help spread the Tool to a wider audience in an effort to further disseminate practical information and recommendations for CER uptake. Recent publicity includes:

- ARENA Solar Maximiser news release 6 Jun 2023[11]
- 7 News Sunrise segment, 12 Sep 2023[12]
- 4BC, 6PR, 3AW, 2GB radio interviews on Life and Technology, 2 Sep 2023
- The Australian, 20 Jul 2023[13]
- Renew Economy, Jun 2023[14]
- ABC radio, Getting off the gas, 4 Aug 2023 (not available online)
- Channel 7 news segment, 9 Jun 2023[15]
- Solar Citizens partner campaign, Aug 2023[16]
- 1millionwomen partner campaign, Aug 2023[17]
- One Step Off The Grid blog post, 9 Jun 2023[18]
- 1millionwomen blog post, Dec 2023[19]
- Daily Telegraph news article, Nov 2023[20]
- Solar Citizens blog post, Feb 2024[21]

Solar Analytics has also continued to promote the Tool through its own sources (website, social media, blog posts, webinars, etc.), at conferences, and through self-funded promotions. For example, Solar Analytics ran a competition from 12th - 29th March, 2024, for which anyone who used the Tool (and consented to the competition terms and conditions) went into the draw to win a share of $2000 towards their next CER purchase.

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[11] https://arena.gov.au/news/consumer-smart-energy-tool-to-assist-households-in-reducing-energy-bills/

[12] https://fb.watch/n0__lpqfl7/

[13] https://www.theaustralian.com.au/subscribe/news/1/?sourceCode=TAWEB_WRE170_a_GGL&dest=https%3A%2F%2Fwww.theaustralian.com.au%2Fbusiness%2Ftechnology%2Fconsumers-will-save-hundreds-thanks-to-open-energy-data-says-solar-analytics%2Fnews-story%2F84c8a1b79bac7993372f648106cf423a&memtype=anonymous&mode=premium&v21=dynamic-high-test-score&V21spcbehaviour=appendend (paywalled)

[14] https://reneweconomy.com.au/web-stories/solar-maximiser-to-help-go-electric/

[15] https://twitter.com/7NewsSydney/status/1667097226932518912?s=21

[16] https://www.solarcitizens.org.au/switch_and_save

[17] https://www.1millionwomen.com.au/electrification-partners-1m-transforming-my-home/

[18] https://onestepoffthegrid.com.au/free-online-calculator-to-count-huge-savings-from-going-electric-and-quitting-gas/

[19] https://www.1millionwomen.com.au/blog/considering-rooftop-solar-battery-or-hot-water-heat-pump-tool-does-customised-cost-effective-analysis-you/

[20] https://www.dailytelegraph.com.au/subscribe/news/1/?sourceCode=DTWEB_WRE170_a&dest=https%3A%2F%2Fwww.dailytelegraph.com.au%2Fnewslocal%2Fmacarthur%2Fcampbelltown-mum-samantha-ho-reveals-how-she-cut-her-power-bills-down-to-zero-in-cost-of-living-crisis%2Fnews-story%2F43ccf223001e1a0483962b4ba7a0b579&memtype=anonymous&mode=premium&v21=HIGH-Segment-1-SCORE (paywall)

[21] https://www.solarcitizens.org.au/savings_with_solar_batteries_and_heat_pump

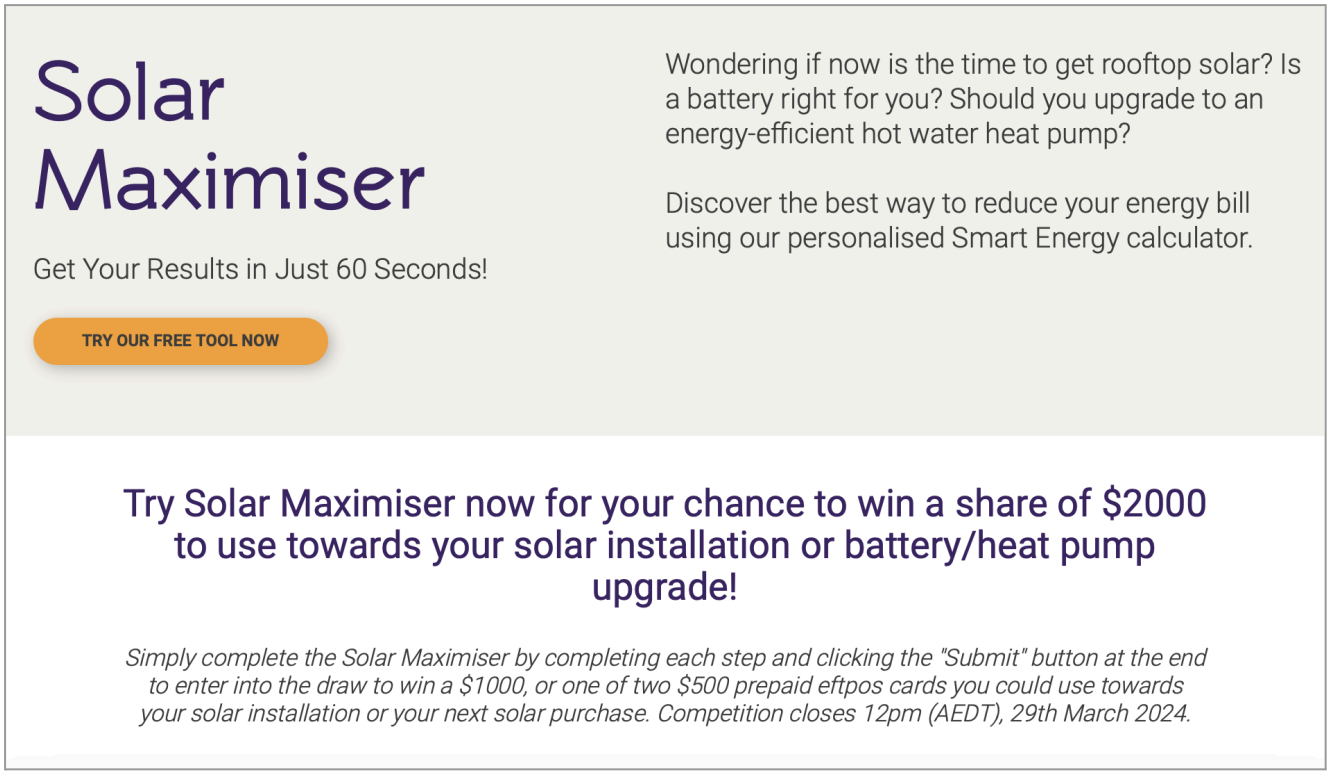

Figure 3. Solar Maximiser competition run in March, 2024.

Another example is the public webinar Solar Analytics hosted with its knowledge sharing agent, University of New South Wales Sydney (UNSW), titled: "*The state of electrifying everything; consumer trends and heat pump control*".

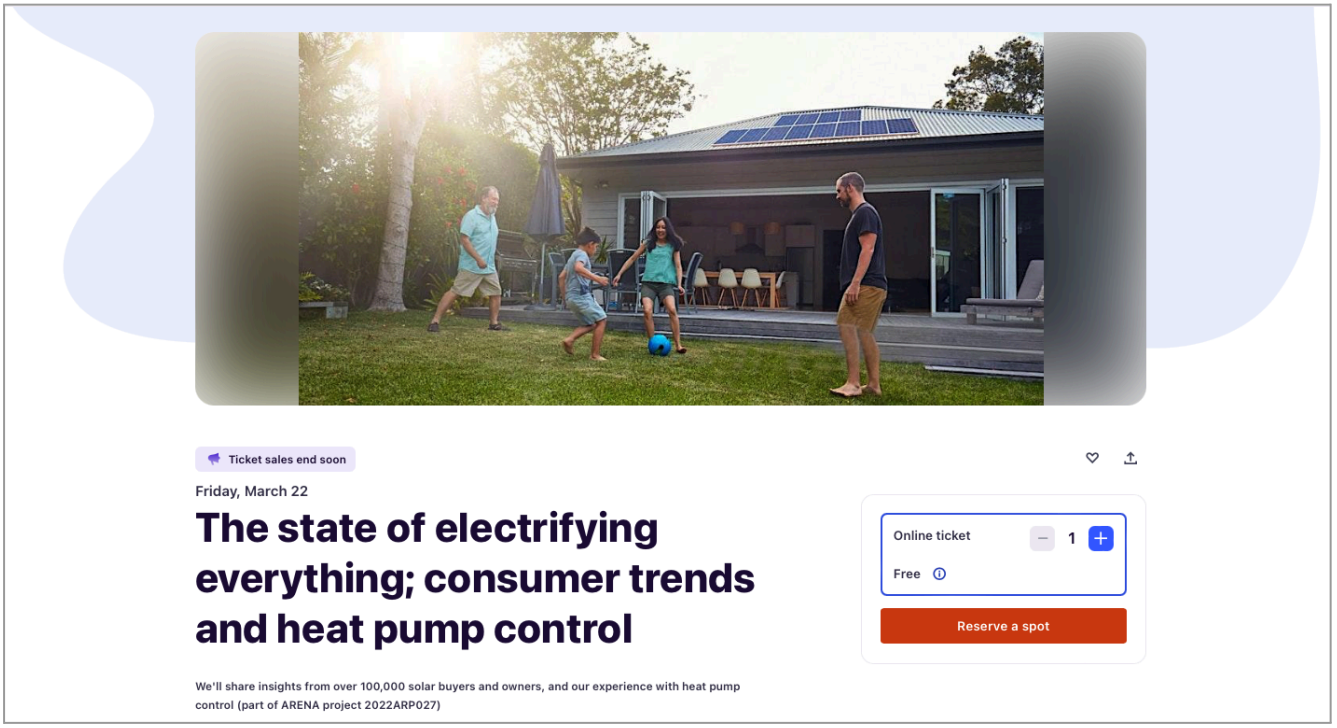

Figure 4. Project webinar held in March, 2024.

The culmination of the work conducted in this project and associated marketing and publicity has resulted in the positive statistics related to CER uptake noted in Outcome 1 (page 16).

Outcome 3

Increased skills, capacity and knowledge relevant to Renewable Energy Technologies by providing CER owners with a sophisticated and independent software portal that demonstrates the savings achieved from their smart hot water.

The existing Solar Analytics portal provides sophisticated insights into savings achieved from rooftop solar. Insights gained from this Smart CER Consumer Uptake Tool Project will be used to further refine and improve upon the knowledge and insights the Solar Analytics platform provides to users.

Already, through its CDR integration, Solar Analytics has been able to integrate controlled load data (obtained from smart meters via CDR) into its dashboard and Plan Optimiser tool - to provide greater transparency and more accurate savings information to users.

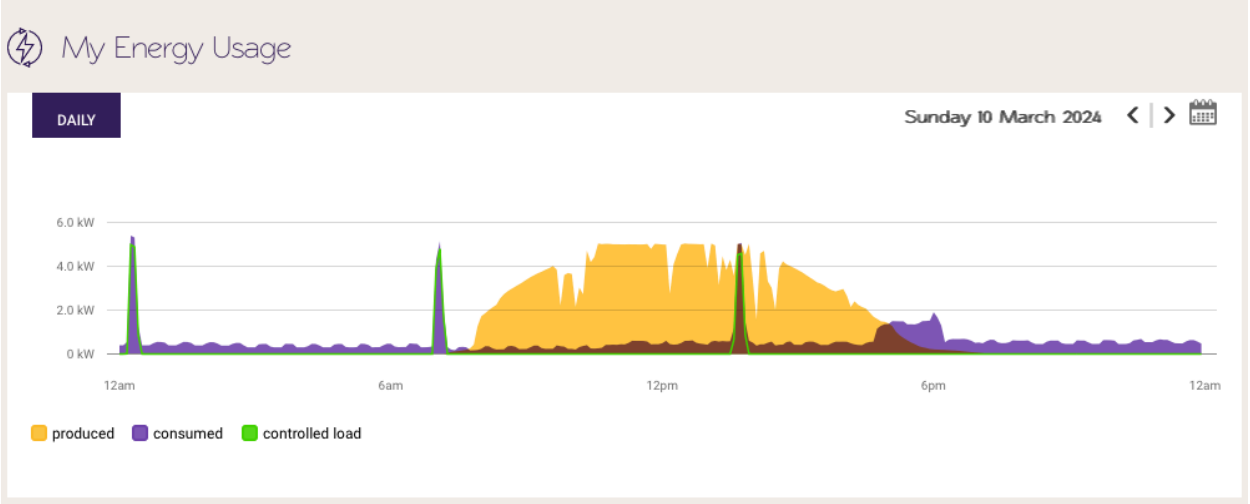

Figure 5. Example of resistive hot water controlled load (from CDR) shown on the Solar Analytics dashboard.

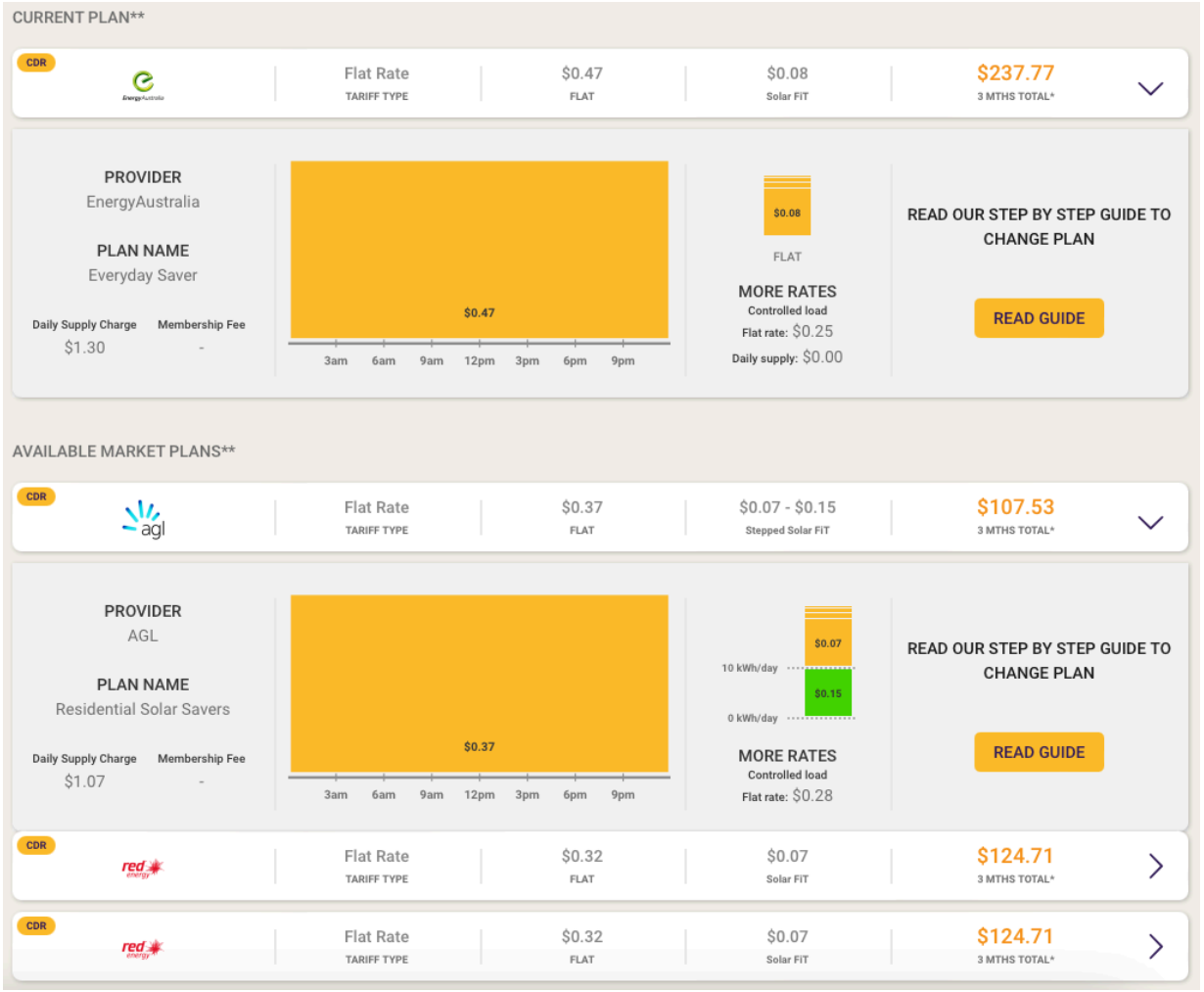

Figure 6. Example of energy plan recommendations taking into account controlled load usage.

During the project, Solar Analytics has developed algorithms and techniques for recommending various CER configurations. Solar Analytics is now particularly interested in leveraging this IP and knowledge to develop an interactive "Home Electrification" tool for its users that leverages their high resolution energy data, energy plan information, and household information to help customers understand the next best step on their electrification journey - and ultimately, to continue the uptake of CER.

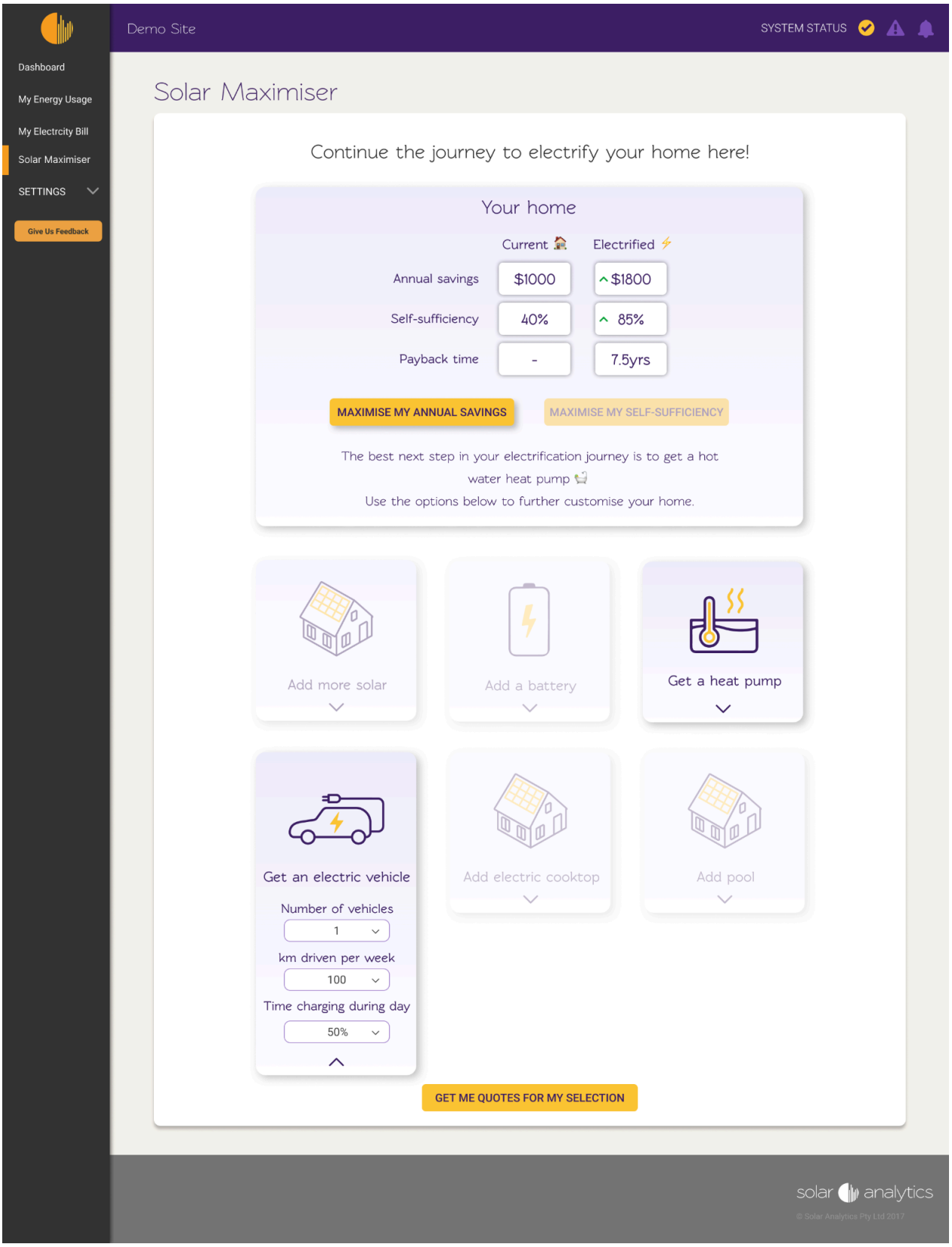

Figure 7. Concept design for an interactive "home electrification" Tool Solar Analytics is considering to integrate into its current dashboard.

2. Project value

The objective of this project was to quantify the value of flexible demand available to the market and customer, and to assess the following: a) criteria used for economic assessment of CER; b) capability to optimise financial returns for customers; c) accessibility of value streams to customers; and d) expected vs realised benefits and costs to customers.

Flexible demand

In this project, Solar Analytics was particularly focussed on flexible demand of hot water systems (heat pumps and resistive) through its Reclaim heat pump integration and monitoring of resistive hot water controlled loads (via CDR). Table 5 below quantifies the flexible demand available, based on data collected in the project.

Table 5. Current state of Solar Analytics' smart hot water fleet.

Hot water	Number of systems in Solar Analytics' fleet	Shiftable load in fleet	Shiftable load per site
Control of Reclaim heat pumps via API	119	274 kWh	2.3 kWh
Energy retailer control of resistive hot water	886	4696 kWh	5.3 kWh
Total	**1005 systems**	**4970 kWh / day in fleet**	**-**

Economic assessment of CER and expected vs realised benefits and costs to customers

In the Tool, economic assessment of CER is based on the Return on Investment (RoI) and annual savings. To quantify these measures, the following data is collected either through the Tool or Solar Analytics' existing databases and solar management portal:

- Household details (e.g., number of people, postcode, etc.)
- CER system cost
- Electricity tariffs
- Rebates and incentives
- Current energy usage profile
- Gas costs
- Energy generated and consumed
- Sub load energy usage
- Export and inverter size limits (and curtailment)

Solar Analytics has developed algorithms to model CER and its economic impact, calibrated against tens of thousands of real customers in its databases. Benchmarking experiments showed that the

annual savings predicted by the Tool for different CER options accurately matched the true savings currently achieved for thousands of Solar Analytics' customers; with a median discrepancy in Tool-predicted vs actual annual savings of -0.92%.

This is significant, considering that in the Tool, economic assessment of CER is achieved based on high-level information (such as daily energy usage), whereas true savings for Solar Analytics customers is quantified based on 5-minute resolution energy data and exact plan information. This result indicates that even basic, high-level information can be useful in making reasonable economic assessments of CER (certainly reasonable enough to help in initiating a purchasing decision).

Capability to optimise financial returns for customers and accessibility to value streams

In this project, Solar Analytics developed algorithms to recommend the optimum CER for a specific customer. As described above, these algorithms, on average, accurately represent the economic impact different CER options will have for the consumer.

But once a consumer has purchased CER - how can we continue to optimise their financial returns? In this project, additional work was conducted on optimising financial returns for heat pump owners via the integration with Reclaim heat pumps. As is described in detail in section **Project technology and developments: Lesson learnt #2** (page 25), perfect optimisation of heat pump loads (based on a household's energy usage, PV generation, and tariff structure), produced savings of $61 per year on average. However, additional experiments showed that 85% of the savings from the control algorithm ($51 on average), could be achieved with a seasonally-adjusted timer (something the household could do themselves, without third-party control). Regardless, these results show that a monitoring and control service can continue to help customers optimise financial returns for their CER after installation, either passively (via advice based on monitoring data), or actively (via direct control).

Solar Analytics currently focuses their product mainly on the former: passive optimisation via monitoring and advice. That's because the latter requires significant work to develop and maintain integrations, optimisation algorithms, and orchestration infrastructure. These challenges are discussed further in section **Project technology and developments: Lesson learnt #3** (page 26).

3. Project technology and developments

The key deliverables for the period Sep 2023 to May 2024 were: Development and ongoing refinement of the Tool; improving the capability and accuracy of the Tool; Refining Tool–device interoperability; development of algorithm to optimise CER devices; CER selection, uptake criteria, operating conditions and outcomes; key data set access, integration and analysis; and assessing what further innovations are required to unlock demand flex.

The project work from Sep 2023 to Apr 2024 focussed on several key technical developments:

1. Improving the user interface of the Tool and the accuracy of the CER algorithms used to generate recommendations;
2. Maintaining integration with Solar Thermal Australia (STA), the project's heat pump OEM partner;
3. Developing and maintaining CDR integration, with particular focus on accessing controlled load data via smart meters and pursuing integrations that would allow control of controlled loads via the use of CDR data.

Key lessons learned from these technical areas are described below.

Lesson learnt #1

Maintaining accurate CER recommendations, with particular regard to return on investment and financial incentives is difficult amongst a constantly changing government, retail, and OEM landscape.

Detail:

- As discussed in the section above, **Project Value** (page 22), making an accurate economic assessment and recommendation for CER requires a significant amount of information, including but not limited to:
    - Available energy plans and costs associated with changing (e.g., cost to remove a controlled load circuit)
    - State and federal rebate information
    - DNSP-specific inverter size and export limits
    - Hardware constraints (e.g., can a hot water system be turned on-and-off, how does tank size or ambient temperature affect operation, etc.)
    - CER costs
- Data to power this information needed to be obtained from many different sources; e.g., extracted from Solar Analytics existing databases, or scraped from sources belonging to government, local council, DNSPs, energy retailers, solar inverters, etc. During this process, conflicting information on things such as rebate amounts or availability was common.
- In addition, discussions with Solar Analytics existing retailer customers often revealed that things like inverter size limits or export limits defined by DNSPs across Australia were routinely ignored or not considered during system installation, without repercussion.

- There are also constant changes to account for during the project such as changes to gas connection fees, rebates, new CER technologies, energy plans changing on a weekly basis, etc.

Conclusion and implications for future projects:

An accurate economic assessment of CER requires information from a range of different sources. However, this information is difficult to acquire, constantly changing, and varies by geographic region (e.g., rebates may be federal, state, or even local council specific).

A centralised database of information relevant to making economic assessments of CER options would dramatically improve the ability to accurately estimate CER costs and financial returns for the consumer and drive uptake.

Lesson learnt #2

Optimising the daily operation of heat pumps based on a household's energy usage, solar generation, and energy plan does not have significant financial benefit over using a simple timer, but is significantly more complex in terms of software and hardware to implement.

Detail:

- Solar Analytics has finished developing and testing an optimisation control algorithm for heat pump operation - which orchestrates operation based on household load, PV generation and energy plan structure to maximise savings. Note that the algorithm requires forecasts for load and PV generation to orchestrate control ahead of time.
- On Solar Analytics' existing fleet of >150 customers with heat pumps, the control algorithm could save on average $61 per year (around 5-10% of their energy bill).
- However, additional experiments were run to simulate running heat pumps on a simple timer (e.g., between 11am - 3pm) and these simulations could produce up to 85% of the savings from the control algorithm ($51 on average), but without the overhead of complex control algorithms, the need to forecast load and PV data, or the need to purchase expensive hardware.
- In timer simulations it was found that the optimum timer period differed for summer and winter:
    - Summer: 11pm - 3pm
    - Winter: 9am - 4pm
- Furthermore, discussion with STA's (the project's heat pump OEM partner) engineers suggested that it is impractical, inefficient and not advisable to turn heat pumps on and off mid-cycle (something the optimisation algorithm was prone to do).

Conclusion and implications for future projects:

Because modern heat pumps draw very little power (unlike more traditional electric resistive systems), they can often be powered solely by excess solar during the day, and it was found that when tested on >150 real systems in Solar Analytics' existing fleet, optimising the operation based on household load, PV generation, and energy plan provided no significant financial benefit over using a

timer, but would be far more difficult to implement. Overall, these results indicate that while heat pumps are an excellent technology for the consumer in terms of using less energy and saving money, they are a less than ideal CER for supporting demand response (with little financial gain to be made with flexible or optimised control).

Lesson learnt #3

Integration with modern CER is becoming easier due to most modern hardware now connecting to the internet via WiFi or SIM card. However, acquisition, management, and orchestration of customers details and hardware remains a challenge, particular when considering future scenarios where a single entity may wish to manage a household of many different brands of CER.

While CDR is a key initiative for providing accurate information about CER to a greater range of households (making it easier for third parties like Solar Analytics to access their energy data), the next step will be to allow third parties like Solar Analytics to control the smart meter (particularly controlled loads). This is not currently possible and Solar Analytics is not aware of any legislation or policy concerned with making it so.

Detail:

- Solar Analytics has successfully integrated with Solar Thermal Australia's (STA) heat pumps and can get data from heat pumps and control them (turn them on/off).
- The integration process was straight-forward and reliable with STA's modern heat pumps being connected to the internet via WiFi. However, an unforeseen issue in controlling heat pumps was contacting customers and acquiring consent for data access and control - as STA do not store customer information.

Conclusion and implications for future projects:

Optimised electrification of households in the future will require orchestration of multiple CER devices. While the barrier to integration appears to be reducing with modern hardware and connectivity, a future issue will likely be the acquisition and integration of customer details and consents for accessing CER devices from different manufacturers.

Almost all homes with CER have a smart meter. Smart meter consent via CDR already provides day behind energy data (net PV and load), but it is not real time and does not provide any control. There is an AEMC rule request in process to require the smart meter to make on site real time data available at no cost, and 5min real time via API at a nominal cost. However, this may not be accepted and is likely to take several years to proceed if it is approved.

There is no rule change proposed to allow third parties (other than the energy retailer or DNSP) to control a load, and this can only be applied to dedicated controlled load circuits. This may change in the future but will require co-ordination of details, legals, and consents amongst the customers, the smart meter manufacturer, the third-party conducting the control, and potentially the energy retailer and network provider. Given the competing priorities of these parties, this seems unlikely to occur.

Control is available via some smart meters now, e.g., Intellihub's smart meters. But it requires integration and approval from the Meter Data Agent and the Energy Retailer. Solar Analytics has

been exploring this path recently and there is also a lot of bureaucracy around permissions, sharing customer details, and keeping all the various parties happy. And it will only apply to customers served by the agreeing parties.

Ultimately, a single source of data and control would be ideal for smart CER in the future, but the path to get there will be difficult. This is why Solar Analytics continues to take the approach of providing universal data analysis, and specific control where the customer has equipment we can control.

4. Business models

Effectiveness of baselines for measuring demand flex (e.g. calculations, settlement procedures, verification).

Data collected during the Project indicate that the Reclaim Energy heat pump hot water systems monitored by Solar Analytics have significantly lower demand response capacity (avg. 2.3 kWh) versus traditional resistive systems (avg. 5 - 7 kWh) monitored by Solar Analytics. Heat pumps are also less flexible - most heat pump technology is not currently conducive to multiple stop-starts, or stops mid-cycle, and heat pumps prefer to run during the warmest daylight hours for optimum efficiency (although this is not essential). Furthermore, the low power draw of heat pumps means that most consumers (with solar) prefer to operate their heat pump during the day, when it can be powered for free by their solar, even on low-solar days, and there would be minimal financial incentive to treat the load as a flexible demand. Considering this information, it is Solar Analytics' opinion that heat pumps, while an excellent technology for the consumer in terms of saving money, are a less than ideal CER for supporting demand response.

However, in terms of developing general baselines for measuring residential demand flex, Solar Analytics collects relevant data such as:

- Energy generated and consumed
- Sub load energy usage (and generation for battery)
- Export limits (and curtailment)
- Changes in energy profile
- Available electricity plans (includes flexible plans)
- Changes in energy plans, eg switch from static to flexible plan
- Changes in load behaviour, eg shifting loads into daytime
- Addition or changes in CER installed, eg adding heat pump, shifting hot water timing

While not a focus of this project, it is Solar Analytics' opinion (based on experience with this data) that baselines for residential households are difficult to set in the context of growing solar and CER uptake. The more CER in a household, the more difficult the financial implications and energy usage patterns are to quantify; and this is only made more complex when considering each household's specific energy needs (e.g., when does the household require hot water, when is an EV available to be charged, etc.).

5. Regulatory framework

How are current metering and tariff arrangements impacting the use of demand flexibility; implications of Consumer Data Rights (CDR).

Through Solar Maximiser, Solar Analytics is educating consumers about the benefits of CER. At the end of the day, consumers care about financial return, not the intricacies of the energy market. Solar Analytics takes all of the CER options into account, then provides the best available solutions to the customer. This project demonstrated that the financial outcome able to be achieved by a customer depends on many factors, including the available energy tariffs, CER costs, government incentives, and any limitations imposed on the CER by the local energy network operator (DNSP). This project also quantified the savings available for different customers from different CER.

Each residential customer has a retail energy meter that measures their household electricity consumption. For customers with rooftop solar, this meter also measures energy generation and will be a "smart" meter, which means it measures data every 5-30 minutes. Customers with a smart retail energy meter can be offered the standard flat rate energy plan (constant $ per kWh regardless of when the energy is used), or more flexible energy tariffs such as Time Of Use (ToU - set rate for different periods of the day, ie higher during peak evening period of 3-9pm), Stepped (rate increases as more energy is consumed throughout the month), Demand (additional charge for the peak demand drawn in a given period during the month) or other more innovative tariffs that charge a different rate depending on other factors such as dynamic wholesale electricity costs or network capacity.

Through CDR and this project, Solar Analytics is able to have access to this smart retail energy meter data with customer authorisation. This enables Solar Analytics to provide customers with more accurate guidance on their optimal CER, and to show them all available energy plans and which one is the best based on their actual energy usage patterns.

To date almost all energy plans are either flat rate or Time of Use (ToU). The problem with these simple tariffs is that they do not reflect the actual cost of electricity, and do not effectively incentive consumers to shift loads into the middle of the day when there is often excess energy generation from solar.

Hence, the energy industry has been exploring more innovative tariffs that incentivise consumers to use energy most when it is cheapest, which is increasingly during the middle of the day due to increasing solar power. This includes energy plans that pass through the real time wholesale cost of electricity, and plans that encourage flexible control of rooftop solar or demand flexibility of large loads like hot water. This project has shown how the control of residential hot water heating can shift energy consumption into these cheaper daytime periods.

One limitation of the smart retail meter is that the energy data is only provided a day behind, ie 24 hours after. This means that this data that is obtained through CDR cannot be used for the more innovative flexible control solutions that require real time control of the CER to match loads and generation with actual energy costs throughout the day.

If real time data access was available, this would open up the ability for companies to use this CDR data to provide flexible demand to cost effectively control CER such as solar, hot water heating, or EV charging. The CER can either be controlled through the dedicated retail Controlled Load Meter, or

through the CER hardware directly. The Controlled Load Meter is an additional retail energy meter that measures a separate dedicated circuit for specific energy loads. The most common residential use of a Controlled Load meter is for hot water, which was typically placed on an off-peak tariff and only active overnight, eg the hot water can only be charged between 10pm-6am.

For flexible demand to become widely available and implemented, there are four key regulatory issues:

1. The first hurdle is who gets to decide when a Controlled Load Meter is active. Historically the Controlled Load Meters were managed by the DNSPs, however under the market restructure they are now mostly operated by privately run Meter Data Agents (MDAs), who provide their services to energy retailers. Under the NEM rules the energy retailer is apportioned as the Financially Responsible Market Participant (FRMP) who is the entity that controls the consumer energy bill and interactions, including accessing the energy meter data from the MDA.

   This means that while the consumer pays for 100% of the cost of the retail energy meter, the MDA has only one customer - the energy retailer. Each MDA signs contracts with many energy retailers to provide their metering services. This means that the MDA who controls the Controlled Load meter is unwilling to provide any third party or the consumer any access to their meters without the written authorization from each energy retailer. And the energy retailer has no incentive to provide this consent.

   Newer Controlled Load meters are able to dynamically control when they are active in real time. In 2021 as part of a RACE 2030 SolarShift project, Intellihub and Endeavour Energy announced that they will make 2,500 controlled load meters with hot water able to be dynamically controlled and shifted from evening to daytime operation. Solar Analytics is also part of this project. This ability has since been extended to hundreds of thousands of Controlled Load meters by several MDAs.

   In the RACE 2030 SolarShift project, Endeavour Energy in mid 2023 released a trial controlled load tariff 'Off Peak Plus', that provides for much cheaper DNSP charges during daylight hours of 10am - 4pm. However, despite liaising with many energy retailers they have been unable to get a single energy retailer to pass on this tariff to consumers through a new energy plan offer.

   While Solar Analytics can get access to the retailer energy meter data through Consumer Data Rights (CDR), the Meter Data Agent (MDA) controls the retail meter. This includes the Controlled Load meter. To date none of these parties have been willing to allow either the consumer or Solar Analytics to access the Controlled Load meter to shift the hot water load into the daytime. The MDAs are willing to allow the incumbent energy retailer to control the Controlled Load meter, however to our knowledge the DNSP is not afforded this ability (nor any third party, like Solar Analytics).

   In summary, our current understanding is that due to the market structure Solar Analytics and the consumer are prevented from shifting their controlled hot water load (or any other controlled appliance load) into the daytime, or otherwise, to maximise financial gain, as this

can only be authorised by the energy retailer. It is noted that some energy retailers are offering their own energy plans to promote consumption during the day.

2. Not being able to net off PV production against controlled load (which is done for all other household loads). For a customer with a Controlled Load meter, they are unable to use their rooftop solar to power this controlled load. The customer must sell their solar energy back to the energy retailer for typically for ~$6c/kWh, then buy that same energy back from the energy retailer for typically 22c/kWh.

   It is Solar Analytics' understanding that this has already caused ~20% of customers to shift their electric storage hot water from a controlled load circuit to the main meter so that they can self consume their solar. In fact, following Solar Analytics recent capability to pull controlled load data via CDR, we are seeing 35% of controlled load circuits not in use. The issue for the networks is that they now lose both visibility and control of this CER, which reduces their ability to increase solar hosting capacity and effectively manage their network.

3. Static limits by DNSPs. Typically DNSPs have set a flat 5kW maximum export limit for rooftop solar (and sometimes it is set at zero export). This reduces the size of the solar installed by the customer, and any incentive to make their CER controllable. Customers should be allowed to install any CER they want, but have a flexible export (and maybe even import) limit that is imposed by the DNSP to maintain grid security. For example, Sth Australia is offering up to 10kW of solar can be exported back to the grid most of the time, however at times when there is too much generation to maintain grid security, the DNSP can reduce this to zero export. This provides a more cost effective outcome for both consumers and DNSPs.

6. Customer acquisition and findings

The project sought the following customer research: a) effectiveness of customer acquisition approach; b) customers' stated vs revealed preferences, c) decision making and behaviours at all stages of lifecycle; d) customers' experiences with device installation, e) operation and maintenance; and f) perceived vs actual implications for customers.

There have been over 100,000 users of the Tool to date as shown in the figures below.

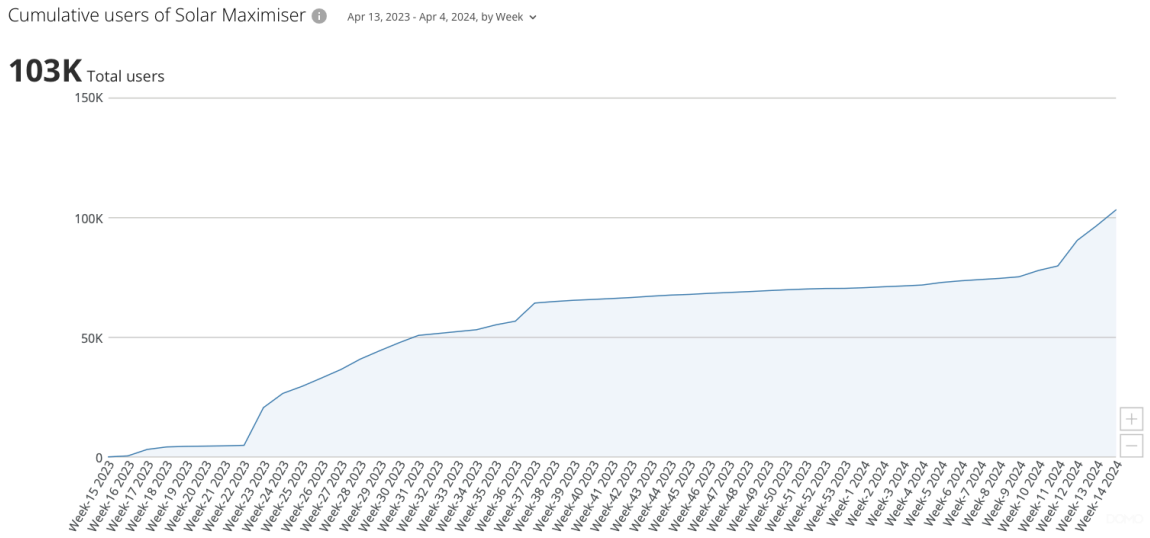

Figure 8. Cumulative Tool users since release in April 2023 (from Google Analytics).

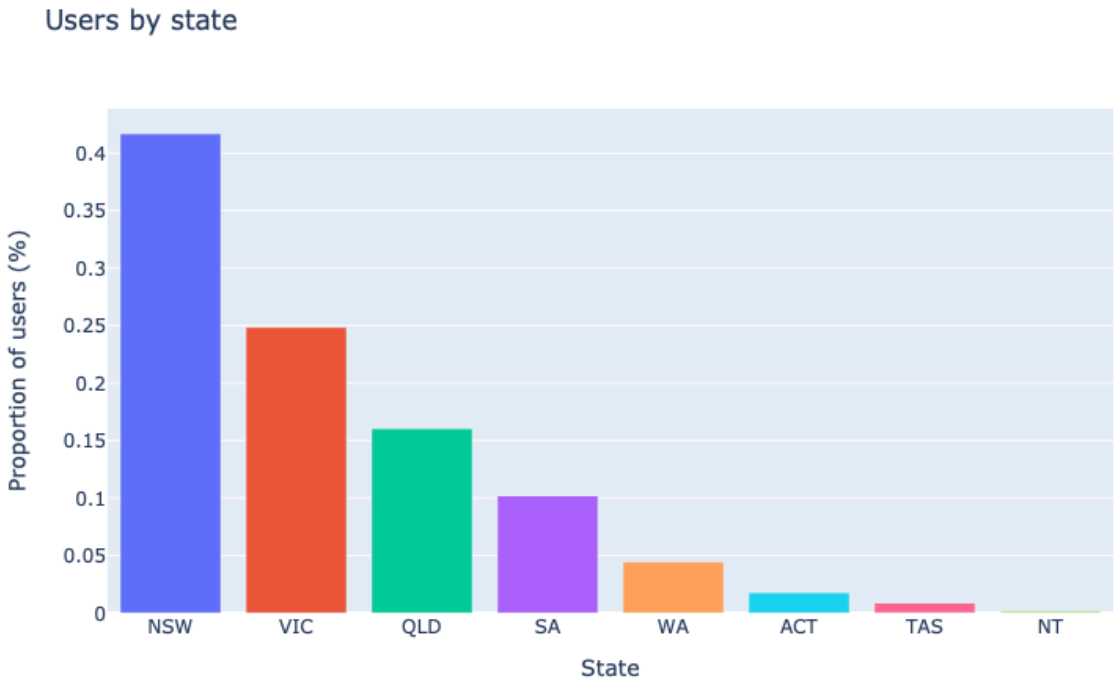

Figure 9. Tool users by state.

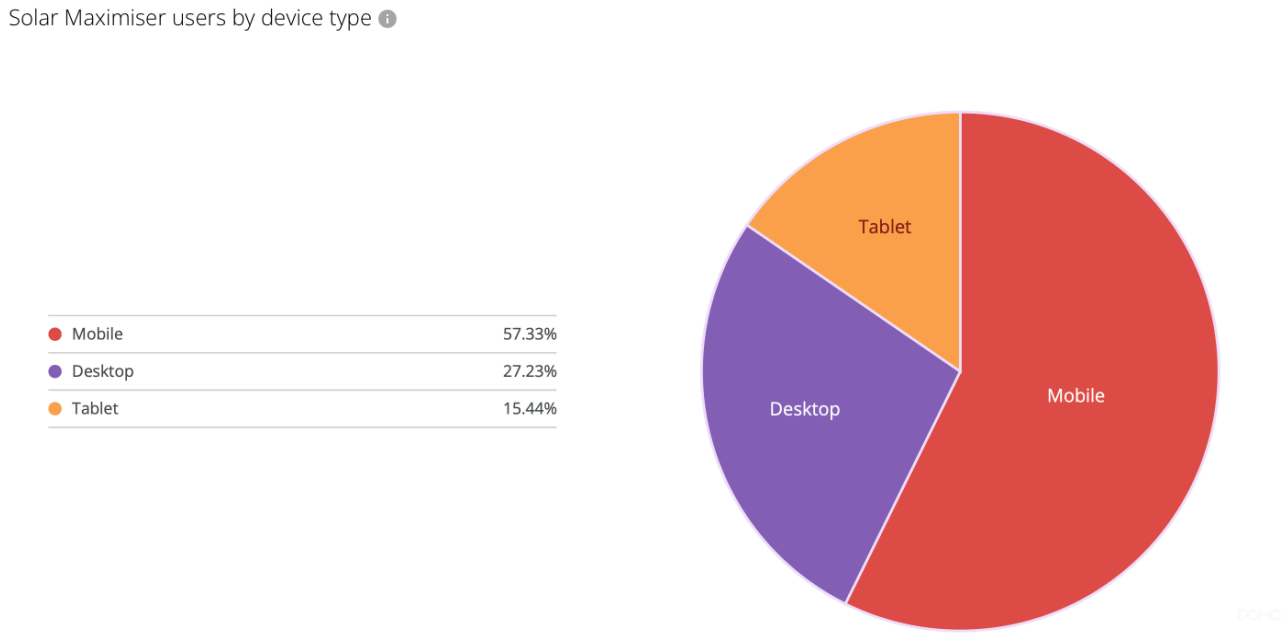

Figure 10. Tool users by device type.

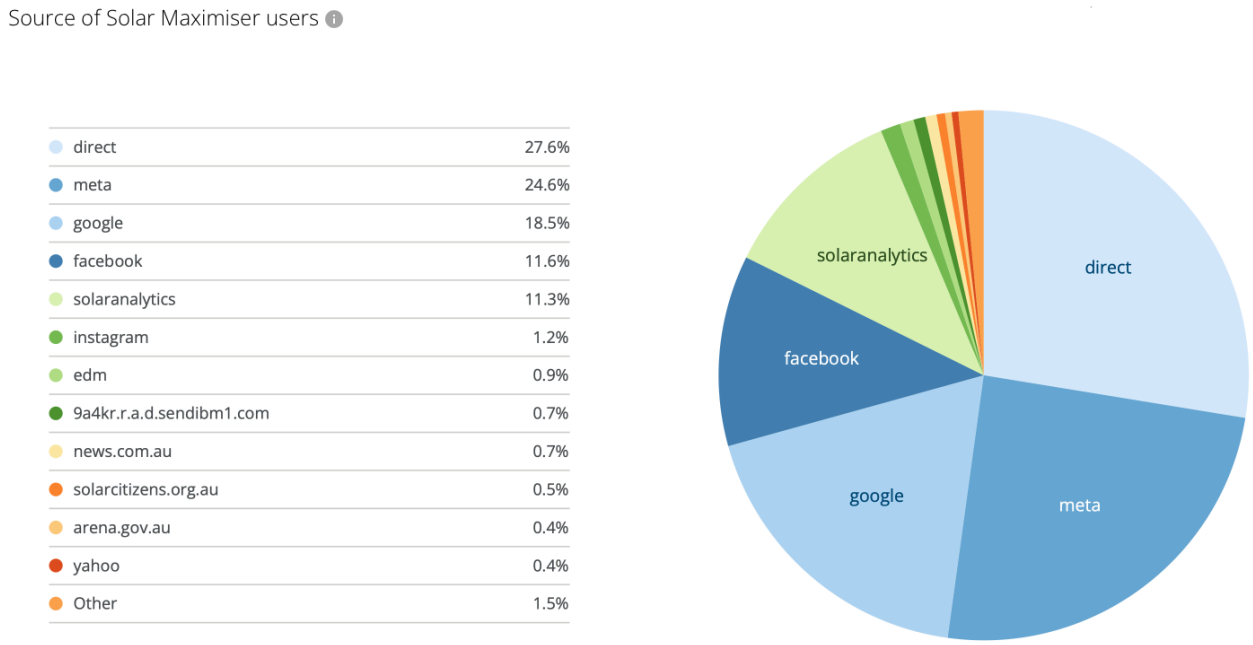

Figure 11. Tool users by source.

Interesting insights about these 100,000 users include:

- Around 10% of users fully completed the Tool (i.e., completed all steps and chose an action at the end):

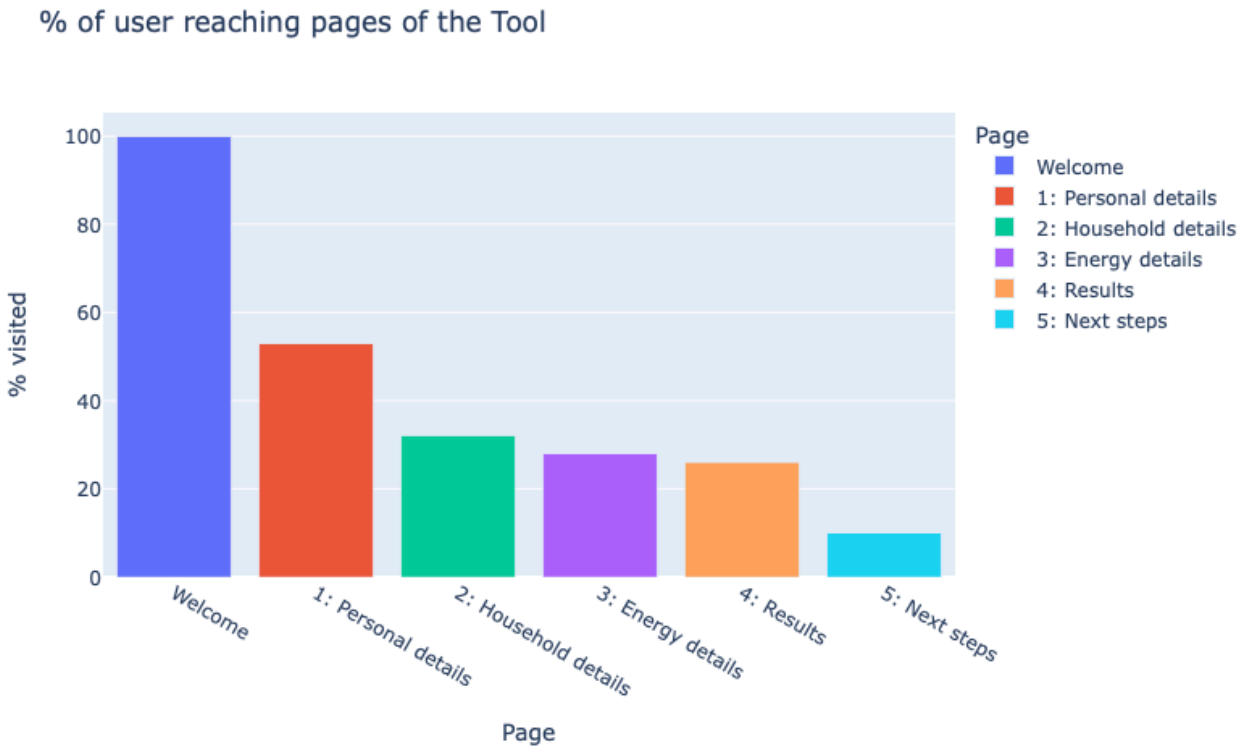

Figure 12. User flow through the Tool pages.

- Of these users:
  - 20% chose to get a summary report emailed and be directed to Solar Quotes to get a quote for their chosen CER.
  - 11% chose to just get a summary report emailed to them.
  - 7% chose to just be directed to Solar Quotes to get a quote for their chosen CER option.
  - The remainder chose no action.
- There was no significant difference in the savings presented to the 10% of users that fully completed the Tool, and those who did not, as shown in the figure below.

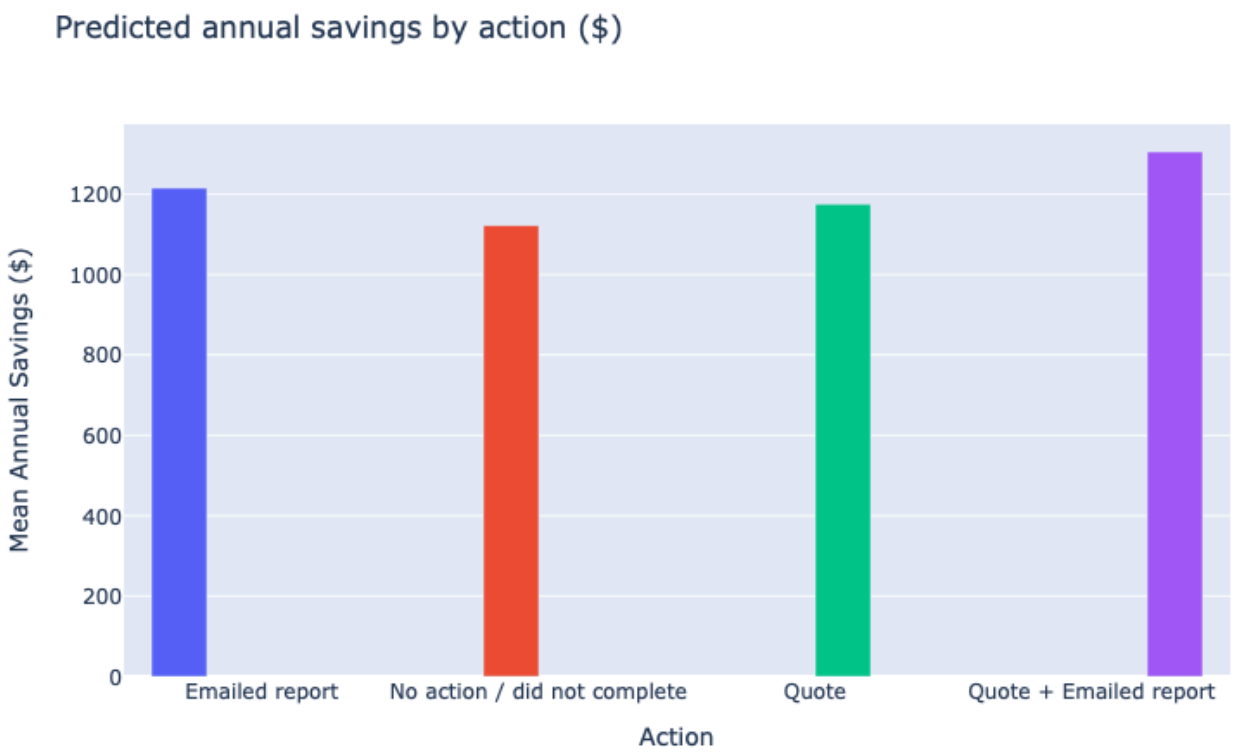

Figure 13. Tool-predicted annual savings for different user actions.

- Of these users without existing solar, the chosen CER option was:
  - 41% chose solar
  - 35% chose solar with a battery
  - 24% chose solar with a heat pump
- Of these users with existing solar:
  - 40% chose upgrading solar with a battery
  - 35% chose upgrading solar with a heat pump
  - 25% chose upgrading solar
- The current hot water system distribution of users was primarily gas:

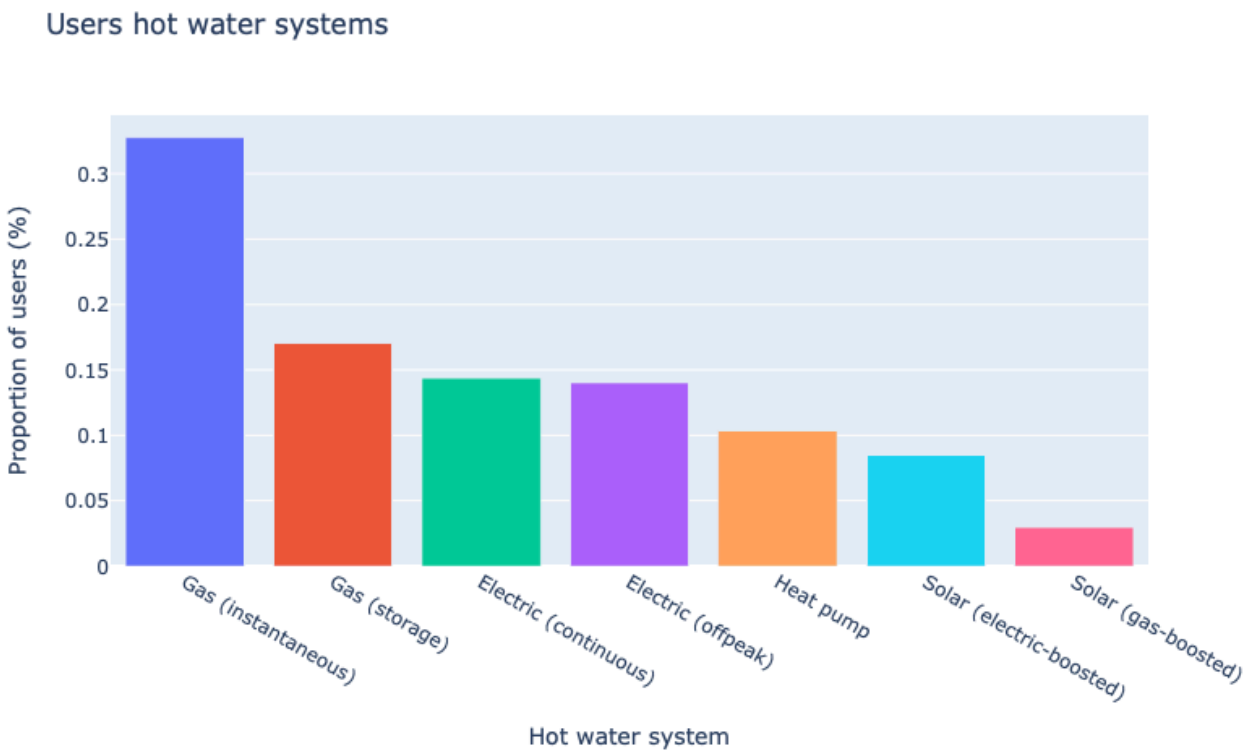

Figure 14. Distribution of hot water systems from Tool users to date.

- Daily energy usage of users varies between 5kWh to >60kWh:

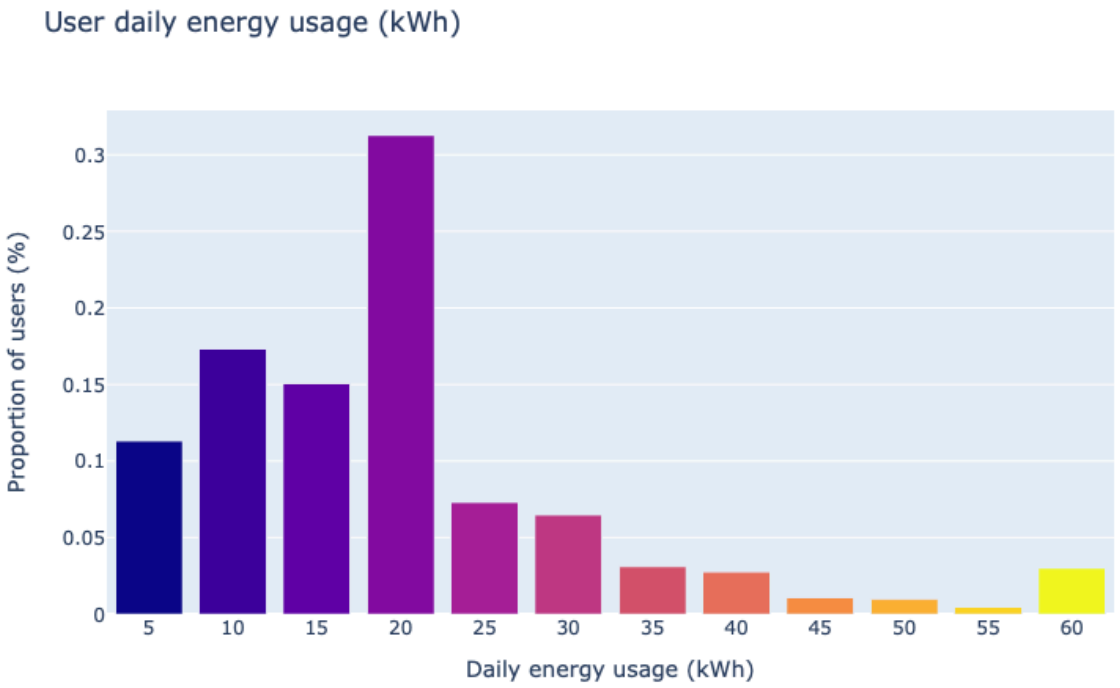

Figure 15. Distribution of daily energy usage from Tool users to date

- Almost 40% of users had no existing solar and for those with solar, the most common sizes were 6kW - 10kW:

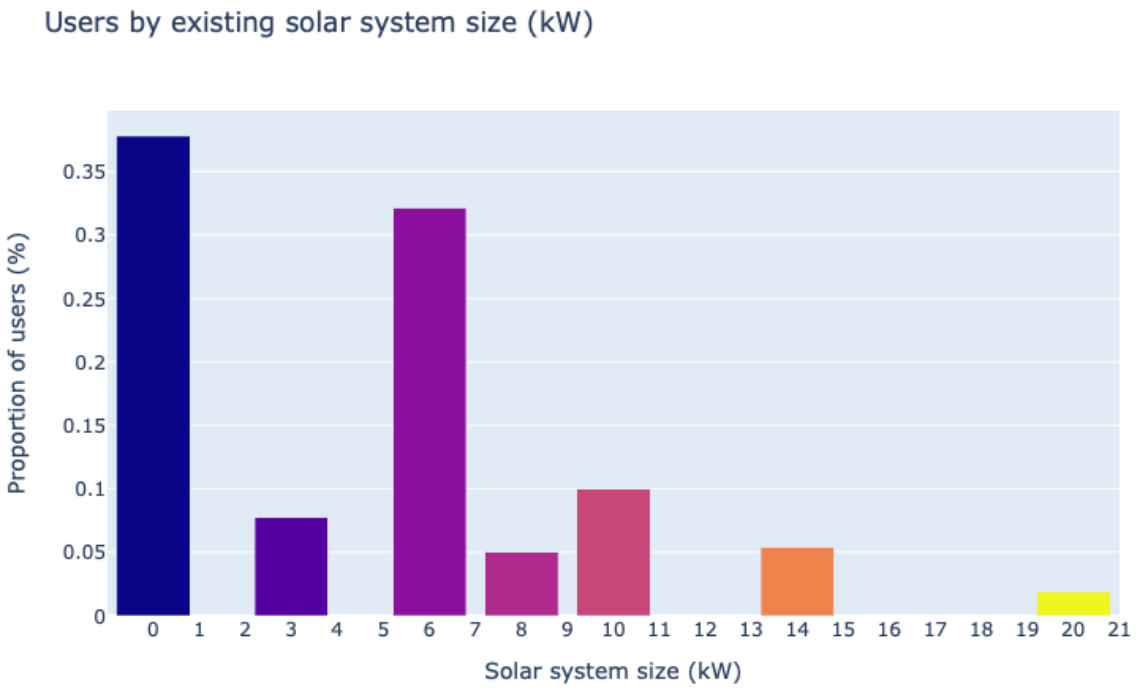

Figure 16. Distribution of solar system sizes from Tool users to date.

Rather than financial incentive, Solar Analytics believes there are two key reasons for user drop-off when using the Tool:

1. The UX needs to be improved to keep customers engaged and flowing through the Tool. Solar Analytics is continuously improving the UX as the project progresses and user feedback is received.
2. The Tool does not yet offer all the CER options users want to see. For example, the only hot water option currently shown is a heat pump, but many users have asked for alternative hot water options (such as a PV diverter, or solar hot water). Solar Analytics is currently developing these capabilities.

Solar Analytics is also developing a "Stats in your postcode" section to potentially integrate into the Tool to show users relatable and relevant statistics about solar and smart CER uptake and savings in their area. Seeing what is happening in their community may encourage more users to take action. A concept design of this feature is shown in Figure 17 below.

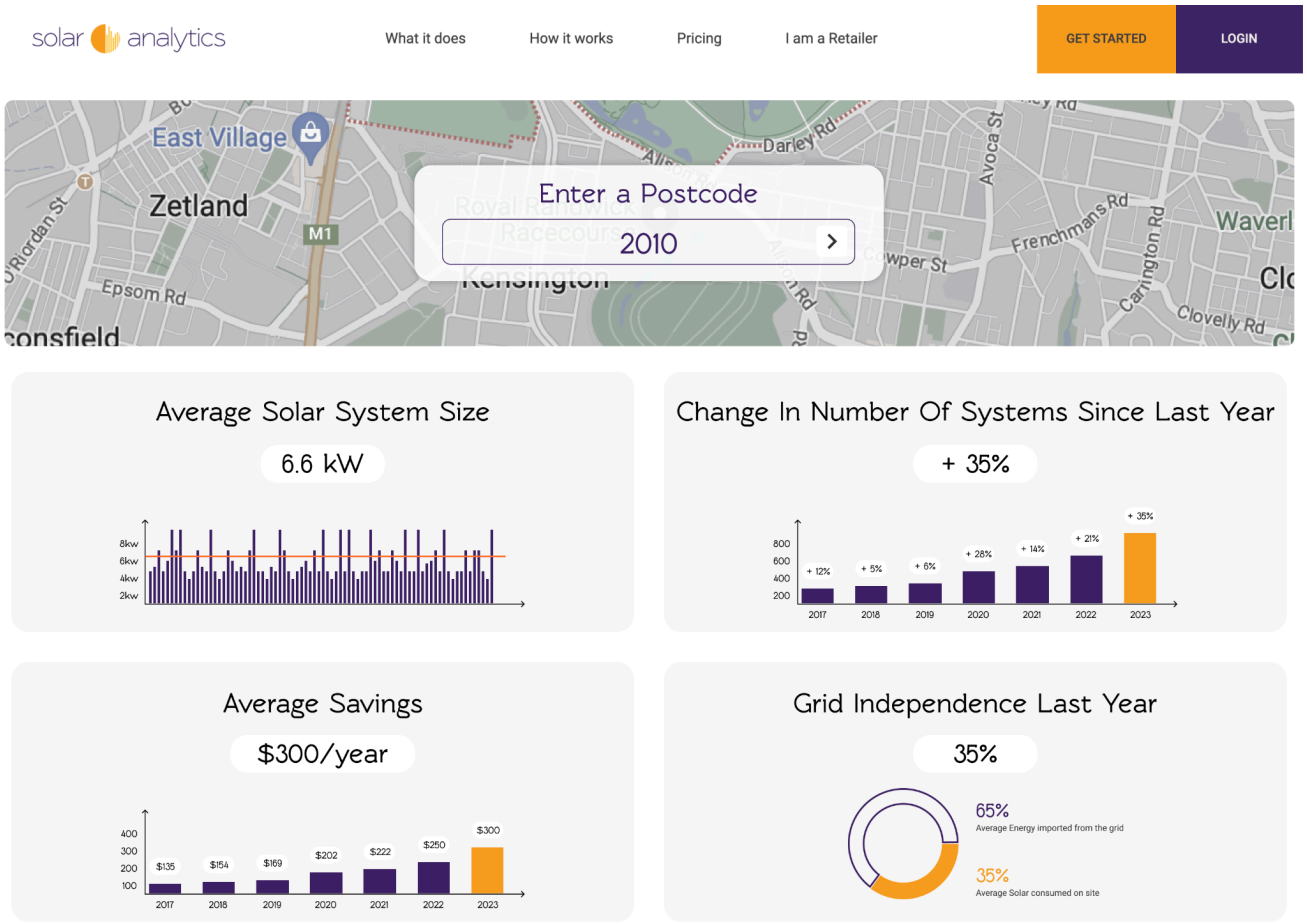

Figure 17. Concept of "stats in your area" feature to encourage users to take action.