RACE for 2030

RELIABLE AFFORDABLE CLEAN ENERGY

Final report

Hot water pathways for social housing

Evaluating electric domestic hot water system performance in social housing to inform guidelines and specifications

September 2025

Australian Government
Department of Industry, Science and Resources

Cooperative Research Centres Program

RACE for Homes Program

Hot water pathways for social housing

Evaluating electric domestic hot water system performance in social housing to inform guidelines and specifications

Project Code: 23.HT3.R.0538

ISBN: 978-1-922746-73-3

September 2025

Citation

Roche, D., Phansalkar, A., Ashraf, C., Langham, E., Mendonca Severiano, B. (2025). Hot water pathways for social housing. Evaluating electric domestic hot water system performance in social housing to inform guidelines and specifications. Final report. RACE for 2030 CRC.

Acknowledgement of Country

The authors of this report would like to respectfully acknowledge the Traditional Owners of the ancestral lands throughout Australia and their connection to land, sea and community. We recognise their continuing connection to the land, waters and culture and pay our respects to them, their cultures and to their Elders past, present, and emerging.

Disclaimer

Project team

University of Technology Sydney

- David Roche
- Aditi Phansalkar
- Cynthujah Ashraf
- Ed Langham
- Bernardo Mendonca Severiano

Acknowledgements

The authors would also like to thank the following individuals and organisations who provided support for this project through its Industry Reference Group: Jenniy Gregory and Scott Barnes (RACE for 2030), Susanna Savolainen and David Jeavons (Homes NSW), Yanlin Aung, Jaysson Guerrero and Oli Morgan-Williams (Ausgrid), Kersten Schmidt (Essential Energy), Baran Yildiz (UNSW), Rachael Wilkinson (Energy Efficiency Council), Paul Corkill (Solar Victoria), Laura Hill, Douglas Thompson, Rachel Haley, David Pryor and Rupa Nair (NSW Department of Climate Change, Energy, the Environment and Water), Rana Havard and Bianca Nichele (Housing Choices Australia). The authors would also like to thank the following individuals and organisations for their assistance with this project: Muhammad Abdulrahman (RMIT), Leon Bogers (Rinnai), Michael Carnuccio (Community Housing Industry Association NSW), Ken Guthrie (Sustainable Energy Transformations), Darren Jackson (Darren Jackson Electrical), Trent Jones (Want a Heat Pump), Alexander Mitchel (Homes NSW), Alan Pears (RMIT University), Gary Peters (GP Electrical Solutions), Anoop Philip (Dux Industries), Michael Siddons (Ecogenica), Saeed Tehrani (Reclaim Energy), and Simon Terry (Dux Industries).

Project partners

UTS · Aboriginal Housing Office · NSW Government · Homes NSW · Ausgrid · essential energy

What is RACE for 2030?

Reliable, Affordable Clean Energy for 2030 (RACE for 2030) is an innovative cooperative research centre for energy and carbon transition. We were funded with $68.5 million of Commonwealth funds and commitments of $280 million of cash and in-kind contributions from our partners. Our aim is to deliver $3.8 billion of energy savings and 20 megatonnes of cumulative carbon emission savings by 2030.

racefor2030.com.au

Contents

Executive summary

In this project, we set out to address the challenges associated with upgrading domestic hot water systems in social housing to enhance their efficiency and flexibility. Social housing providers are aware of the significant economic and environmental benefits of transitioning to more efficient heat pump water heaters and moving from gas to electricity. Despite these advantages, providers face several challenges including market uncertainty, varying technology availability, uncertainty of tenant bill savings, and a fluid policy environment. The core objectives of this project are to enhance market clarity and influence provider practices, thereby facilitating a swift transition to more efficient, flexible, sustainable and cost-effective domestic hot water systems.

The main project findings are summarised in this report alongside an accompanying guideline document—*Hot water pathways for social housing—Guidelines for housing providers*. The Guidelines are designed to assist decision-making across a broad spectrum of housing contexts.

Insights from market scan and interviews

Our project was informed by a market scan and series of interviews. Through these we noted the following market trends in heat pump hot water systems:

- a shift from R134A to **R290 refrigerants**, which greatly reduce greenhouse warming potential
- an average **efficiency improvement** rate of about **11% per decade**
- a trend towards **more integrated systems**
- a **wider range of products**
- **timers**, **Wi-Fi controllers** and **eco-mode** options becoming common features
- **simplified installations** using quick-connect systems
- demand for smarter management and solar soaking, leading to emerging features such as **inverter signal cables**.

We also identified several market opportunities for heat pump hot water systems, including:

- **solutions for apartments**, such as smaller, wall-mountable and/or indoor systems
- **product improvements** such as further efficiency improvements, quieter units, and designs that allow easier maintenance
- **smarter adaptive control systems** that are simple to use while optimising performance, and
- **variable speed compressors** that can vary demand to maximise solar soaking and minimise operating costs.

The interviews highlighted significant differences between models in terms of their overall quality; however, these differences are not always visible though basic product specifications such as energy performance, materials and warranty periods, and are therefore not easy to discern for consumers. There is also a lack of good information on product reliability for heat pump water heaters.

Issues with installation quality were also noted, with the EEC Heat Pump Roadmap (EEC, 2024) including several recommendations intended to improve installation standards.

The suitability of heat pumps to be operated as controlled loads is an area requiring further research, since:

- not all products are control-load compatible
- upgrading resistance water heaters to heat pumps on controlled load circuits requires switching from CL1 to CL2 to maintain hot water availability, which requires tenants to engage with their energy retails and poses challenges for housing providers
- there is a lack of good data on how products behave when operated as controlled loads, leading to significant risks associated with *Legionella*.

Our provisional recommendation is therefore to avoid installing heat pumps on controlled load circuits until some of these issues can be fully resolved.

Heat pump pilot

The project included a pilot of heat pump water heaters installed across 172 properties managed by Homes NSW, the state social housing provider. Of these, 59 were fitted with Wattwatchers devices for energy monitoring and switching. Following are some of the key insights derived from the pilot:

- **Daily operating times** were measured at 3.7 hours (median) in winter (up to 1.7× greater than for resistance heaters), with significant variation around this figure, both day-to-day and across the cohort. However, 14 of 58 devices (24%) operated for longer than 6 hours per day on average while 66% of devices operated for more than 6 hours on at least one day in winter. This means Controlled Load 1 (6-hour) schedules are not suitable for a large proportion of the cohort and are not recommended for heat pump water heaters generally.
- **Energy use** is substantially lower for heat pumps compared to resistance waters heaters, as expected, with annual energy savings of 74–78% measured at three properties for which use of boost elements was minimal.
- **Bill savings** from heat pump upgrades can be significant, ranging from 51–59%, assuming a flat tariff, to 67–72% for a controlled system on a time-of-use tariff. Even greater bill savings are possible for users with solar.
- **Boost elements** may be necessary for some installations in colder climates but can more than double energy use if the standard program is varied to operate via ‘hybrid’ or ‘electric’ modes, eliminating much of the bill saving from a heat pump upgrade.
- **Emissions reductions** from heat pump upgrades are estimated at 74–78%, with a range of 0.93–3.15 t/year CO_2-e per home estimated for a small sample of homes.
- **Control** of heat pump water heaters was demonstrated to largely eliminate demand at peak times, as expected. While a Controlled Load 2 type schedule appears to be suitable for most homes, we recommend against installing heat pumps on controlled load circuits for the reasons cited above.
- **Solar self-consumption**, i.e. the proportion of energy used by a heat pump that comes from rooftop solar, is low without control of heat pump operating times, at 31% on average. Operating heat pumps during the solar window increased the average level of solar self-consumption significantly to 88%.
- **Electrification** of two units previously using a very inefficient centralised gas system reduced energy use by 86–89% (11.6–14.6 GJ/year per home), resulting in estimated annual bill reductions of $636–737 and annual emissions reductions of 362–530 kg CO_2-e per home.

Tenant surveys

A survey of tenants participating in the heat pump pilot was conducted in late 2024 and provided the following insights:

- **High satisfaction**—Respondents were generally satisfied with their hot water system, with only 7% being dissatisfied or very dissatisfied and 94–97% being happy with the installation process and tradespeople.
- **Increased hot water availability**—Much fewer respondents reported running out of hot water after the upgrade compared to before, albeit after a shorter observation period.
- **Noise a potential issue**—Noise remains a concern for some respondents, with about 39% reporting they could hear their systems and 10% (7 of 73) reporting noise levels as 'unacceptable'.
- **High rates of early maintenance**—One third (24 of 72) of respondents reported experiencing a maintenance issue, such as water not being hot enough, noise from vibration, water leaks, system resets and other minor problems, many of which were able to be quickly rectified.
- **Better information is required**—Many respondents felt underinformed about their new hot water system and expressed a desire for more detail about expected bill savings and how to minimise operating costs.
- **Energy bill savings not readily apparent**—As many social housing tenants receive government subsidies and/or pay energy bills through fixed fortnightly debits, bill savings are often not readily apparent.

Conclusion and recommendations

Heat pump water heaters offer significant benefits. They can significantly reduce energy bills for tenants while also helping housing providers reduce greenhouse gas emissions.

We found that overreliance on boost elements can negate much of the cost benefit of heat pumps. We therefore recommend using settings that largely avoid use of boost elements.

Tenants with access to solar can further reduce their energy bills by using the built-in controls of their heat pump to increase solar self-consumption.

In theory, tenants without solar could benefit from using controlled load (CL) tariffs. However, realising these additional savings presents some specific challenges, since:

- Not all heat pump models are CL-compatible
- Not all heat pump models behave as expected on CL, which may present an increased *Legionella* risk
- Switching from CL1 to CL2 is difficult and poses additional risks for housing providers.

Given the challenges and relatively modest benefit of switching from a flat to CL tariff, we recommend that heat pumps usually be installed on a continuous circuit.

Tenants without solar could also benefit from using controls to access time-of-use tariffs. As with the switch from CL1 to CL2, there are challenges in getting a tenant to switch from a flat to time-of-use tariff. However, unlike the switch from CL1 to CL2, a switch to ToU tariffs can be completed any time after the heat pump has been installed.

We identified several avenues for future research, including:

- **Smart timers**—there is an opportunity to work with a water heater manufacturer to implement and pilot such a feature in social housing, alongside addressing some of the challenges with tenant engagement.
- **Electrification**—including energy, bill and GHG savings from gas to heat pump conversions, tenant experiences, and barriers
- **Use of booster elements**—Further investigation and testing to better understand the need for and use of booster elements.
- **Behaviour of hard-switched heat pumps**—Further investigation and testing to identify which heat pumps are fully controlled-load compatible.
- **Solving the challenge of switching tenants from CL1 to CL2**—Further investigation to explore simpler options for addressing this challenge.
- **Network impacts**—Further investigation to better understand the likely network impacts of large-scale heat pump upgrades.
- **Piloting heat pumps for apartments**—Working with a supplier to develop and pilot such products.
- **Resistance water heaters with smart controls**—Working with a supplier to implement and test such a feature.
- **Hot water as a service**—Piloting a novel business model whereby housing providers pay a service provider to install, own and maintain tenants' hot water systems.

Glossary of terms

AEST	Australian Eastern Standard Time
AHO	Aboriginal Housing Office (now part of Homes NSW)
AS/NZS	Australian Standard/New Zealand Standard
CER	Clean Energy Regulator
CL	controlled load
CO_2	carbon dioxide
CO_2-e	carbon dioxide equivalent
COP	coefficient of performance
CRC	Cooperative Research Centre
DCCEEW	Department of Climate Change, Energy, the Environment and Water (NSW)
EEC	Energy Efficiency Council
ESC	Energy Saving Certificate
FiT	feed-in tariff
GEMS	Greenhouse and Energy Minimum Standards
GHG	greenhouse gas
GJ	gigajoule
GSM	Global System for Mobiles
GWP	greenhouse warming potential
HPHWS	heap pump hot water system
IRG	Industry Reference Group
ISF	Institute for Sustainable Futures (UTS)
kg	kilogram
kW	kilowatt
kWh	kilowatt-hour
L	litre
LAHC	Land and Housing Corporation (now part of Homes NSW)
m^3	cubic metres
MEEH	My Efficient Electric Home (Facebook group)
MEPS	Minimum Energy Performance Standard(s)
MJ	megajoule
MW	megawatt
MWh	megawatt-hour
NCC	National Construction Code
ND	no data
NSW	New South Wales
PCA	Plumbing Code of Australia
PV	photovoltaic
RACE for 2030	Reliable Affordable Clean Energy for 2030 Cooperative Research Centre
RMIT	RMIT University (formerly the Royal Melbourne Institute of Technology)
STC	Small-scale Technology Certificate
ToU	time of use
UD	unreliable data
UNSW	University of New South Wales
UTS	University of Technology Sydney
V	volts
VEEC	Victorian Energy Efficiency Certificate

1 Introduction

1.1 Project objectives

In this project we addressed the challenges of upgrading domestic hot water systems in social housing to make them more efficient and flexible.

Social housing providers recognise the economic and environmental benefits of upgrading to more efficient heat pump water heaters and transitioning from gas to electricity. However, these providers face challenges such as market uncertainty, varying technology availability, uncertainty of tenant bill savings, and a changing policy landscape.

The key objectives of this project are to improve market clarity and influence provider practices to support a rapid shift towards more efficient, flexible, sustainable and cost-effective domestic hot water.

The project combined a market scan of domestic [1] heat pump water heaters with pilot testing of units, performance modelling and detailed analysis.

The project findings are summarised in this report alongside a separate guideline document: *Hot water pathways for social housing—Guidelines for housing providers*. This document is referred to throughout this report as the Guidelines. The Guidelines are intended to assist decision-making across a diverse range of housing contexts.

1.2 Research questions

Through the desktop review and market scan, the project set out to answer some basic questions about heat pump water heaters, such as:

- What domestic heat pump water heaters are currently available?
- How mature is the current market, and what alternative water heating products are currently or likely to be available in the foreseeable future?
- What are the key specifications of heat pump domestic water heaters that are likely to affect their performance in terms of cost, user experience, environmental impact and network impact, and how do currently available products differ across these key specifications?

Through modelling and analysis and pilot data, the project also addressed some deeper research questions:

- Which key variables (e.g. household size, climate zone, available photovoltaic solar) and decision points (e.g. product selection, timer settings) need to be considered to deliver best practice solutions?
- What are the consequences of the various decision options in terms of cost, user experience, environmental impact and network impact? For example, what are the consequences of operating a heat pump water heater as a controlled/flexible load?

[1] Domestic units typically range in size from 150 to 400 L. Larger units intended for commercial applications were not included.

2 Background and review

2.1 Electrification

The two main competing fuel sources for domestic water heaters are electricity and gas (both natural gas and liquified petroleum gas).

There is a growing consensus that electrification is an important element in decarbonising residential energy use. The reasons for this are spelled out in the Guidelines and include:

- the higher operating costs of gas appliances compared to electric counterparts
- the additional greenhouse gas emissions of using gas versus electric appliances, especially as the grid is decarbonised, coupled with the lack of carbon-neutral alternatives to gas, and
- the health impacts of indoor combustion, which is relevant to gas cooking and unflued gas heating (Ewald *et al.*, 2022).

Replacing gas water heaters with electric options is a major step along the pathway to decarbonising homes. For housing providers, electrification requires a coordinated and strategic approach involving planned (rather than responsive) upgrades to avoid like-for-like replacements.

2.2 Hot water and demand flexibility

A storage water heater can provide demand flexibility. That is, its operation can be scheduled to take advantage of local photovoltaic (PV) solar or lower electricity prices, or to provide network services by shifting demand away from peak periods (typically early evenings).

The ability to control a water heater, either through user or network controls, is an important factor in minimising its operating cost for the tenant. This issue is becoming more relevant as penetration of residential solar increases and daytime wholesale electricity prices continue to fall (Roche *et al.*, 2023).

The heat pump pilot included a controlled load intervention, discussed in Section 4.7. Demand flexibility is explored in detail in Section 8 of the Guidelines.

2.3 Barriers to best practice

The Guidelines are an attempt to provide a detailed roadmap for delivering best practice in relation to domestic water heating from the perspective of a housing provider.

Several barriers to delivering best practice are identified in the Guidelines. These include:

- the higher capital costs of more efficient options (notably heat pumps) compared to alternatives
- a lack of consumer awareness of the benefits of a heat pump water heater
- a lack of Minimum Energy Performance Standards (MEPS) to enable easier comparison between products, and ensure better concordance between expected and actual performance
- lack of suitable solutions that activate demand flexibility in heat pump water heaters while rewarding tenants, and
- existing government policies that may promote the use of more polluting technologies, notably gas.

2.4 Standards and the EEC Heat Pump Roadmap

Identifying high-quality heat pump water heaters is hampered by the lack of any minimum industry performance standards (MEPS) or Greenhouse and Energy Minimum Standards (GEMS) in Australia.

On 19 July 2024, the Energy Efficiency Council (EEC) released its Heat Pump Roadmap report (EEC, 2024). The report is based on 20 interviews with heat pump industry participants and feedback through an Industry Reference Group (IRG) consisting of 29 organisations. On the same day, Australia's federal and state energy and climate ministers committed to fast tracking the introduction of MEPS for heat pump water heaters "as a high priority" (ECCMC, 2024).

3 Market scan and interviews

3.1 Market scan

We conducted a comprehensive market scan of domestic heat pump water heater models commonly available in Australia. Data were drawn from several sources, which include the following:

- Basic specifications, including refrigerant type, storage tank size, temperature ranges, COP, power, warranties and noise, were primarily sourced from supplier websites and documents.
- STC values were sourced from the register of devices maintained by the Clean Energy Regulator (CER).
- Product review scores were sourced from productreview.com.au.
- Controlled load compatibility data were sourced from installation manuals, supplemented by direct contact with suppliers. See also *Controlled load compatibility* on page 15.
- Retail prices were primarily sourced from Same Day Hot Water Service (samedayhotwaterservice.com.au), supplemented by other retailer websites where required.

In total, 72 models were included in the market scan across 20 brands.

A comprehensive summary of the market scan is contained in the Guidelines.

3.2 Interviews

Semi-structured interviews were undertaken with about 12 key stakeholders drawn from ISF's network of contacts and supplemented with those suggested by previous interviewees. Those sought for interview included manufacturers, installers, industry experts, policymakers and other researchers.

Together with the market scan, the interviews were used to derive the following insights into the current heat pump market status, trends and opportunities.

3.3 Product quality and reliability

Although our interviews indicate that there are clear differences in quality between the various heat pump water heater models in the market, these differences are not easy to discern for consumers. Differences in performance, as measured through efficiency measures such as STCs, are relatively modest, and do not correlate with price (see Section 3.6 of the Guidelines).

The market scan was limited to more 'visible' specifications such as basic energy performance, materials, and warranty periods. The scan identified essentially two tiers of product:

- **High tier**—represented by Sanden, Reclaim Energy and Thermann. These offer low GWP CO_2 refrigerants, good performance and very quiet operation. Both Sanden and Reclaim also offer (optional) stainless-steel tanks with longer (10–15 year) warranties, compared to the 5–7-year warranties typical for glass-lined (vitreous enamel) steel tanks.
- **Low/middle tier**—represented by everything else. These cover a range of brands and refrigerant types. Among this tier there is also surprisingly little correlation between models in terms of price and the key performance metrics quoted by suppliers (COP, noise and warranties).

While product specifications are a reasonable indicator of in-field energy performance, they may be a poor indicator of product reliability and longevity.

Our interviews strongly suggested that there is a marked difference in quality and reliability between very cheap heat pump models that were introduced into the market some years ago and the current range of models, indicating that the average quality level across the market has improved somewhat. However, there is a lack of good information on product reliability for heat pump water heaters. Several interviewees referred to "cheap overseas products flooding the market" and "some retailers only in the market for rebates". While some quality differences are evident between locally made products and cheaper imported products, hard data is lacking. As noted in the EEC Roadmap, "publicly available data on the pervasiveness of [these] issues is hard to obtain, making an objective assessment difficult" (EEC, 2024).

Quality issues noted through our interviews are listed in Section 3.12 of the Guidelines. These overlap with the product quality and reliability issues raised in the EEC Roadmap, which include:

- early breakdown of compressors
- rattling and noisy compressors
- tanks rusting owing to inadequate corrosion protection measures (e.g. poor tank inner wall lining)
- missing washers in fittings
- controller covers not being weatherproof, and
- poor quality fittings and sensor cables.

Our heat pump market scan included Product Review scores from productreview.com.au. Aggregated results are presented in Figure 1. [2] The Produce Review data should be treated with caution, not least because not all brands have a significant number of reviews. Nevertheless, seven brands were identified as having average scores over 4.5 from at least 50 reviews: Haier (5.0 from 78 reviews), iStore (4.9/114), Evoheat (4.8/909), Reclaim Energy (4.8/84), Aquatech (4.7/1371), Hydrotherm (4.7/315), and Emerald Energy (4.6/135).

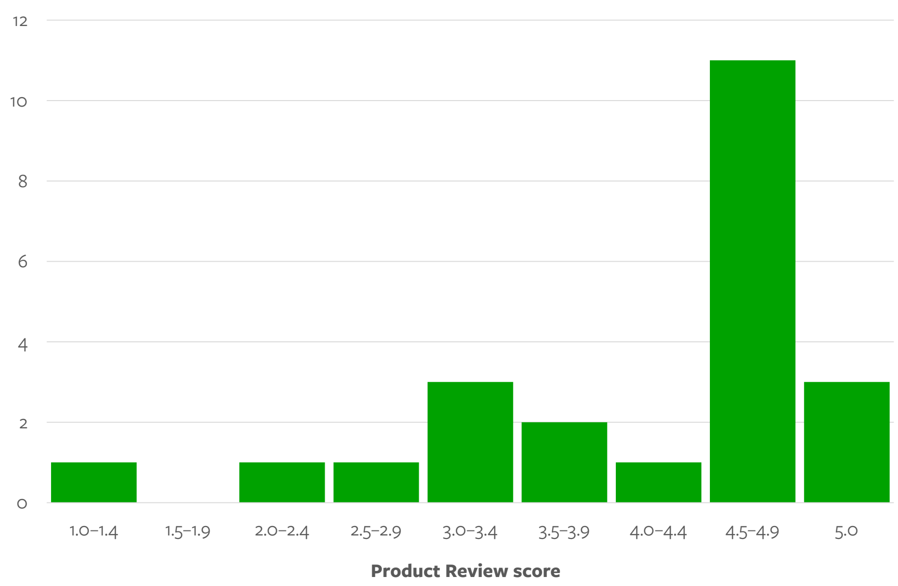


Figure 1. Aggregated Product Review scores from productreview.com.au.

[2] One heat pump with a very low Product Review score is no longer available for sale and has been removed from the market scan.

3.4 Installation quality

The Guidelines provide some general guidance on installation requirements; notably that all heat pump water heaters should be installed in accordance with recommendations from equipment manufacturers, and existing Australian standards, codes or other legislative requirements, including, but not limited to, current versions of the National Construction Code (NCC), the Plumbing Code of Australia (PCA), AS/NZS 3500, AS/NZS 5149.1 and AS/NZS 3000.

A 2023 investigation by the Victorian Essential Services Commission uncovered evidence of poor-quality installations among 10 businesses (ESC, 2023). The issues identified included hot water pipes not being thermally insulated and water tanks not being appropriately secured, both of which are issues of both performance and safety. The commission refused registration of certificates created in relation to non-compliant water heater activities and ordered the surrender of any certificates that had been registered for those activities by these businesses.

During consultations for its Heat Pump Roadmap (EEC, 2024), the EEC heard that installation issues associated with heat pump water heaters include:

- no or poor lagging (insulation of pipes)
- no approved point of discharge on relief drain lines
- using of Blue Line polyethylene piping without protection or being buried
- lack of appropriate support bases
- high supply voltages (up to 253 V allowed under Australian standards)
- inappropriate siting
- incorrect sizing of systems
- inadequate refrigeration work associated with refrigerant-coupled split systems, and
- water tanks not being appropriately secured.

Similarly, Solar Victoria (Krpan, 2024) has identified common compliance issues with installations during audits, including:

- inadequate insulation to protect systems from freezing
- switchboard wiring
- unsafe termination points for pressure relief valves, and
- inappropriately secured water tanks.

Plumbers in different jurisdictions have different interpretations of national requirements, even when referring to national standards.

We used various sources, including the reports cited above, Australian standards, personal communications and the My Efficient Electric Home (MEEH) Facebook group to identify and document some common installation problems. These problems formed part of the installer information guide for this project, which is reproduced in Section 7 of the Guidelines.

Steps are being taken to improve installation quality. The EEC heat pump road map includes various recommendations that are intended to improve:

- coordination between industry and government (Recommendation 0)

- oversight of installations through auditing and reporting (Recommendations 2.1–2.3), and
- industry capacity and skills around installation (Recommendations 3.1–3.4).

Both the NSW and Victorian governments have committed to developing a consultation group of industry representatives to support and oversee the development of systems and standards to progress the key recommendation of the EEC roadmap (Sharpe & D'Ambrosio, 2024). The NSW government is also consulting on the option of including a five-year installation warranty as a requirement for ESC eligibility (NSW DCCEEW, 2025).

Solar Victoria has developed several resources to assist heat pump installers, including a checklist and guidance sheets, available at the following links:

- solar.vic.gov.au/hot-water-audit-checklist#download-the-hot-water-audit-checklist
- solar.vic.gov.au/choosing-a-hot-water-system
- solar.vic.gov.au/upskilling-plumbers
- solar.vic.gov.au/hot-water-audit-checklist.

Solar Victoria has also been working with the Essential Services Commission, the Victorian Building Authority, Energy Safe Victoria and WorkSafe Victoria on a Heat Pump Hot Water Systems Compliance Plan and is working towards "joint inspections and compliance activities to ensure heat pump hot water systems are being installed safely and without fault." (Krpan, 2024)

3.5 Controlled load compatibility

A critical issue addressed through this project is the suitability of heat pumps to be operated as controlled loads. Installing a heat pump on a controlled load (CL) circuit means it will be switched on and off at least once per day through an external control switch. In NSW and Queensland, controlled load may be classified as either CL1 or CL2:

- **Controlled Load 1**—typically provides supply for at least 6 h/day. This was previously limited to an overnight window of operation (e.g. 10pm–7am) but is being increasingly changed to allow operation at any time of day.
- **Controlled Load 2**—typically provides supply for at least 16 h/day. This may be limited to two windows; a nighttime window similar to CL1, and a daytime window that avoids the morning and evening peaks.

The market scan includes controlled load compatibility data for each model, sourced from installation manuals and supplemented by direct contact with suppliers. Several manufacturers noted their units are not CL compatible, cited the potential for damage from frequent hard switching of devices. Others were unconcerned with hard switching but concerned about the ability of units to deliver an adequate amount of hot water or to reliably attain the temperatures required to control growth of *Legionella* bacteria. Such issues are exacerbated by the lack of adequate product standards. For example, it is more difficult to guarantee delivery of adequate hot water if that water is stored for extended periods in a poorly insulated tank.

The CL compatibility of several products was caveated with a minimum operating period, such as 16 hours per day (i.e. compatible with CL2 but not CL1). Our pilot confirmed that CL1 is not suitable for all households, and we recommend it be avoided (see *Daily energy consumption and duration of operation* on page 20).

A further complication that emerged through our interviews is that some models may not behave as expected when operated on a CL circuit. Testing by Dux has found that a some models reset their internal seven-day timer whenever there is a power outage and thus never complete a seven-day *Legionella* disinfection cycle when on a CL circuit. Others complete a disinfection cycle whenever the unit is restarted, resulting in higher-than-expected energy use. While data from our pilot showed evidence of weekly disinfection cycles, the data does not include temperature monitoring and was insufficient to detect such behaviour reliably.

When upgrading from a resistance water heater on a controlled load circuit with a CL1 tariff to a heat pump water heater, to comply with the above recommendation about avoiding CL1, the heat pump must either be installed on the main continuous circuit, or the tenant must be moved from CL1 to CL2. However, there are practical challenges involved in moving tenants from CL1 to CL2 as this requires the tenant to engage with their electricity retailer. Unless a simpler process for moving tenants from CL1 to CL2 can be developed, the safest option is to install the heat pump on a continuous circuit and explore other control options to benefit the tenant, such as programming the internal timer.

In the Guidelines we therefore recommend that when upgrading a resistance water heater on CL1 to a heat pump, the heat pump should usually be installed on a continuous circuit. This recommendation may change if a simpler process for moving tenants from CL1 to CL2 can be developed. If such a process is developed, any recommendations on use of CL would be heavily caveated to include:

- ensuring a product is fully CL-compatible as confirmed by the manufacturer, and
- noting that not all products cited as CL-compatible by manufacturers are considered suitable for CL, which might require further investigation to avoid the significant risks associated with *Legionella*.

3.6 Current market trends

Through the market scan and interviews, we identified the following key market trends:

- **Units have been getting more efficient**, with more recent models offering higher COPs and STCs, on average, than older models. As shown in Figure 2, the rate of improvement in efficiency is about 11% per decade, or a little over 1% per year).

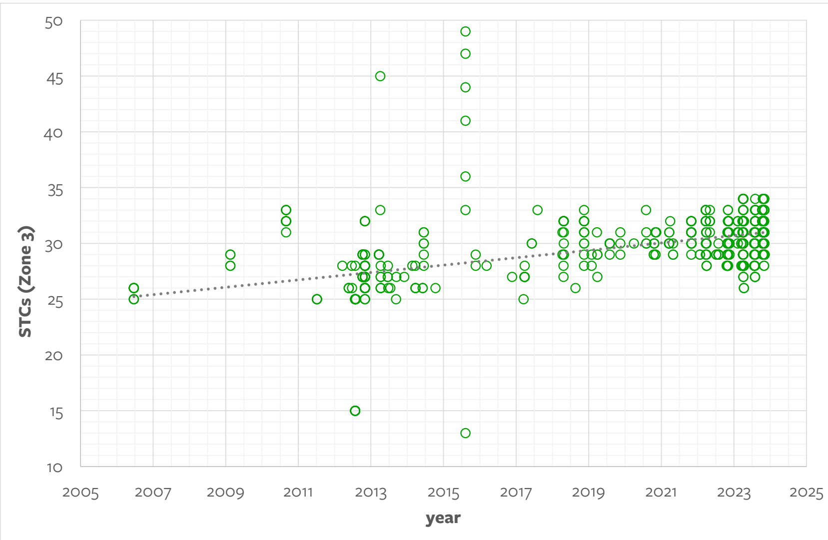


Figure 2. Residential heat pump units have been getting more efficient over time. Shown are the 10-year STCs for Zone 3 versus date of eligibility for all air source heat pump models with a capacity of up to and including 425 litres in the CER database.

- **A wider range of products** is now available than in previous years.
- **Products have been moving from R134A to R290 refrigerants** to address the high greenhouse warming potential of R134A. As discussed in Section 3.9 of the Guidelines, R290 is a near ideal refrigerant for outdoor, domestic heat pump applications. It offers high efficiency, moderate pressures, no ozone depletion and negligible greenhouse warming potential. Its main limiting attribute is its flammability.

While the relatively small charge of propane in domestic water heaters poses little risk for most installations, its use in some commercial settings is limited.

- **More integrated units** are being introduced to the market, which are easier to install, provide a smaller footprint and offer a similar-looking replacement for an existing storage water heater, compared to split systems. The Guidelines recommend integrated systems where possible.
- **Timers and Wi-Fi controllers are becoming more common**. Timers are required for accessing all incentives in Victoria. Wi-Fi controllers were once reserved for only high-end units but are now widely available across a wide range of products, driven by the low cost of Wi-Fi modules and the advantages for user control and troubleshooting.
- **Eco-mode type options** are becoming more common, which can increase energy efficiency by lowering the set point operating temperature (while heating to 60°C for at least 32 minutes every seven days to prevent *Legionella*), increasing the 'dead band' (i.e. the difference between the temperatures at which the thermostat is switched on and off) and reducing or eliminating use of any boost element.
- **Quick connect systems** use hoses pre-charged with refrigerant to more easily connect a compressor and tank, allowing split systems to be installed without an on-site refrigeration mechanic.
- **Demand for smarter management and solar soaking** is driving inclusion of timers and Wi-Fi controllers, and is leading to emerging features such inverter signal cables.

3.7 Future market opportunities

Future market opportunities for heat pumps identified through the project include:

- **Solutions for apartments**—These would include smaller systems, and wall-mountable and/or split systems with a tank that can fit in a cupboard.
- **Product improvements**—These are likely to include further shifts towards low GWP refrigerants, non-flammable refrigerants, further efficiency improvements, quieter units, and designs that allow easier maintenance (e.g. removing the need for five-year anode replacement).
- **Smarter adaptive control systems**—Timers offer a relatively simple but limited control option. Future models are expected to include more sophisticated timer options. The idea of a simple-to-use 'adaptive' timer that uses machine learning to optimise performance has been discussed with manufacturers and is a noted area requiring future research.
- **Variable speed compressors**—Much like residential air conditioners, which have shifted away from fixed load units towards more efficient variable load units through inverter control, air source heat pumps may move towards variable speed compressors. This would enable units to vary their demand, much like a resistive water heater fitted with a solar diverter, to maximise solar soaking and minimise operating costs. However, the benefit of this for residents is likely small, which may curtail demand for such technology.
- **Placing heating elements at the top of the tank**—This can offer faster recovery times, better energy efficiency (compared to bottom heating elements), and improved performance in cold climates.
- **Indoor units**—The ability to install a heat pump indoors offers advantages for apartments and other locations where outdoor installation is challenging. Indoor installation is relatively common in other countries and can provide some space cooling, which is a benefit in warmer months. For example, Stiebel Eltron claims its WWK 222 and WWK 302 units can be installed indoors provided there is a clear space of at least 13 m^3.

4 Heat pump pilot

4.1 Details of pilot

The project included a pilot of heat pump water heaters installed across 172 properties owned and managed by Homes NSW. Fifty-eight properties were upgraded in 2023. The remaining 114 were upgraded in June and July 2024. Of these, 59 were fitted with Wattwatchers Auditor 6M devices, illustrated in Figure 3, which allowed for detailed power monitoring and switching of the heat pumps.

Figure 3. Wattwatchers Auditor 6M devices were installed in 59 properties.

Figure 4 shows a breakdown of the 172 properties included in the pilot across a range of variables. The properties included in the pilot cover:

- two housing providers—the former NSW Aboriginal Housing Office (AHO) and the former Land and Housing Corporation (LAHC), which are now combined as Homes NSW
- four house sizes—1, 2, 3 and 4 bedrooms
- five heat pump brands—Ecogenica, Reclaim, Rheem, Rinnai and Thermann
- nine heat pump models—Rheem 551E280, Ecogenica EG-215FR290, Ecogenica EG-260FR290, Ecogenica EG-290FR290, Rinnai EHPA250VMA, Rinnai EHPS215VM, Rinnai EHPS265VM, Reclaim REHP-CO2-315SST, and Thermann THP45x315.
- 19 NSW local government areas—Armidale, Bathurst, Blacktown, Canada Bay, Canterbury-Bankstown, Coffs Harbour, Cumberland, Dubbo, Fairfield, Liverpool, Maitland, Mid coast, Moree Plains, Narrabri, Newcastle, Parramatta, Penrith, Port Macquarie and Tamworth.
- 46 NSW postcodes—2115, 2117, 2137, 2137, 2144, 2147, 2148, 2152, 2160, 2161, 2165, 2166, 2170, 2192, 2192, 2197, 2199, 2200, 2287, 2289, 2295, 2298, 2299, 2304, 2305, 2320, 2322, 2323, 2324, 2340, 2350, 2390, 2400, 2430, 2444, 2450, 2452, 2747, 2750, 2760, 2766, 2770, 2795, 2795, 2820 and 2830
- all three NSW distribution network areas—Ausgrid, Essential Energy and Endeavour Energy, and
- five NCC climate zones—2, 4, 5, 6 and 7 (see Table 1 and Figure 5).

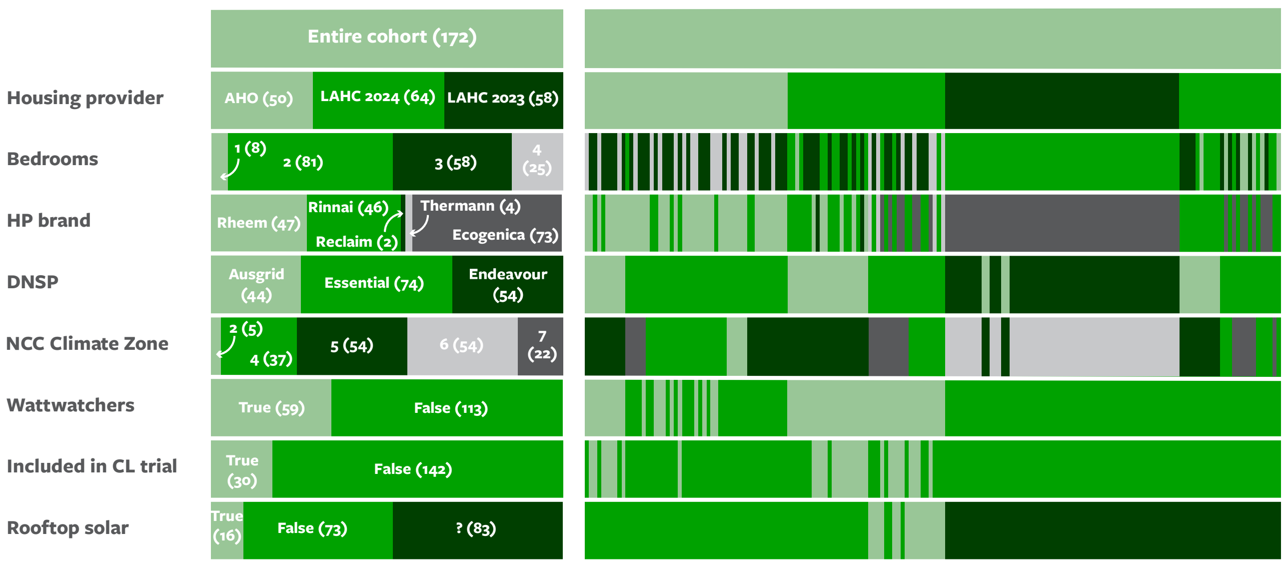


Figure 4. Breakdown of the 172 properties included in the pilot by housing provider, number of bedrooms, heat pump brand, network area (DNSP), climate zone, inclusion of Wattwatchers, inclusion in controlled load trial, and presence of rooftop solar.

Table 1. Number of monitored and unmonitored heat pump units included in pilot for each NCC Climate Zone.

Zone	Climate description	Example location(s)	Heat pump units		
			Monitored[3]	Not monitored	Total
1	High humidity summer, warm winter	–	–	–	–
2	Warm humid summer, mild winter	Coffs Harbour	–	5	5
3	Hot dry summer, warm winter	–	–	–	–
4	Hot dry summer, cool winter	Dubbo, Moree, Narrabri, Tamworth	18	19	37
5	Warm temperate	Newcastle, Port Macquarie, Sydney	30	24	54
6	Mild temperate[4]	Western Sydney	–	54	54
7	Cool temperate	Armidale, Bathurst	11	11	22
8	Alpine	–	–	–	–
Total			**59**	**113**	**172**

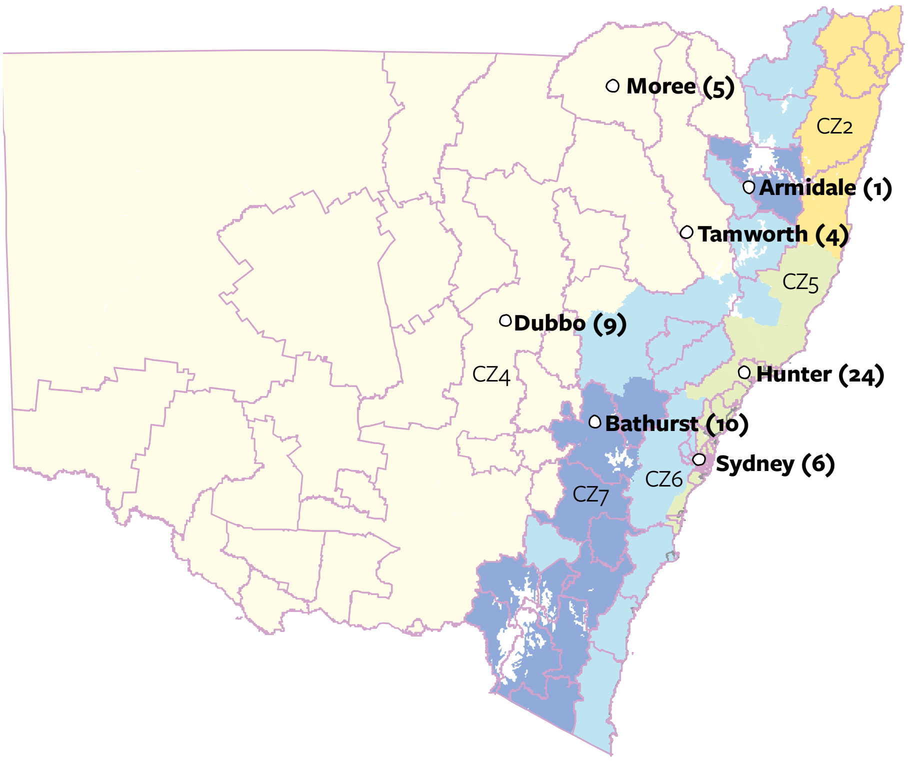


Figure 5. The 59 monitored heat pump water heaters across NSW span NCC climate zones 4, 5 and 7.

While 59 devices were monitored in total, data for all devices was not available for all months, owing to communication problems with some Wattwatchers devices. The number of devices monitored in each month is provided in Table 2.

3 Figures refer to the number of units where a Wattwatchers device was installed. Per Table 2, not all units were monitored in each month because of various installation and data monitoring issues.

4 All Climate Zone 6 heat pump units are from the LAHC 2023 cohort. None of these are monitored.

Table 2. Number of devices monitored in each month.

Winter		Spring		Summer		Autumn	
Month	**Devices**	**Month**	**Devices**	**Month**	**Devices**	**Month**	**Devices**
June 2025	38	September 2024	58	December 2024	54	March 2025	50
July 2024	59	October 2024	56	January 2025	54	April 2025	46
August 2024	58	November 2024	54	February 2025	54	May 2025	40

Much of the following analysis is broken down by season. These are defined per the meteorological seasons used across temperate Australasia: June–August (winter), September–November (spring), December–February (summer) and March–May (autumn). As pilot implementation occurred in June and July 2024, winter results are based on a combination of data from July and August 2024 and June 2025.

Attempts were made to analyse sub-cohorts based on climate zones and number of bedrooms in terms of measures such as use of boost elements and overall energy use for water heating. Some results on use of boost elements in different climate zones are presented in Section 4.3. However, given the relatively small size of the dataset and the large variations in energy use between households, driven largely by behavioural differences, it is difficult to draw firm conclusions about these sub-cohorts.

For comparison purposes, pre-intervention data was obtained for four properties in Maitland that were upgraded from electric resistance to heat pump water heaters fitted with Wattwatchers monitoring devices. While comparisons were intended to be made with additional properties, detailed pre- and post-intervention data could only be obtained for these four properties. Details of the four properties are summarised in Table 3. All were upgraded from resistance units with 3.6 kW elements on controlled load circuits to Rheem 551E280 280L heat pumps.

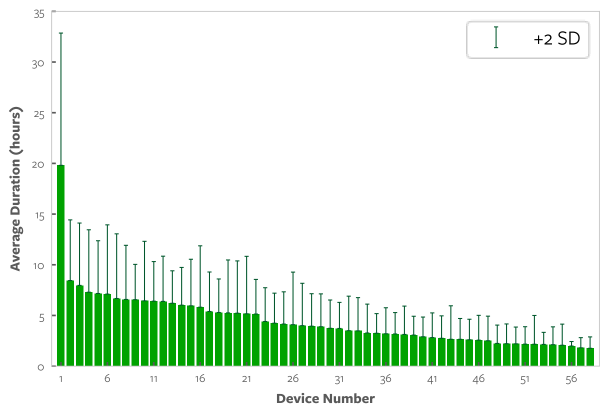
Table 3. Details of four Maitland properties used for comparative analysis. ND = no data.

		Resident ages (years)					
Property no.	**Bedrooms**	**3–10**	**20–70**	**Total**	**Showers**	**Baths**	**Clothes washing**
					(per day)	(per day)	(per week)
1	3	1	3	4	3	1	(cold water inlet)
2	3	–	2	2	1	1	2
3	4	ND	ND	ND	ND	ND	ND
4	3	ND	ND	ND	ND	ND	ND

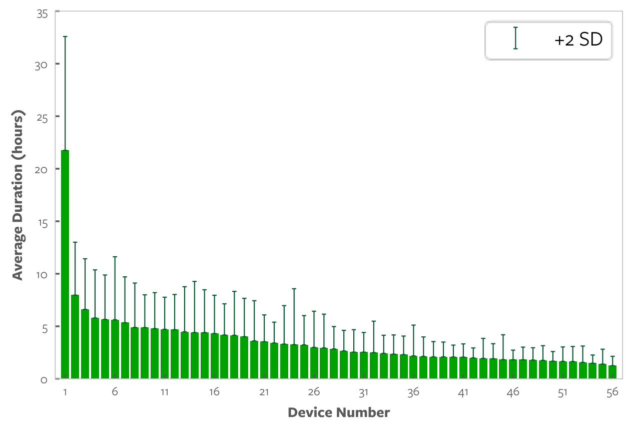
4.2 Daily energy consumption and duration of operation

For each season, the average daily energy consumption and duration of operation for each monitored heat pump unit were calculated, together with the 2× standard deviations from the average duration of operation. The results are shown in Figure 6 and summarised in Table 4 (with one high-use outlier removed[5]).

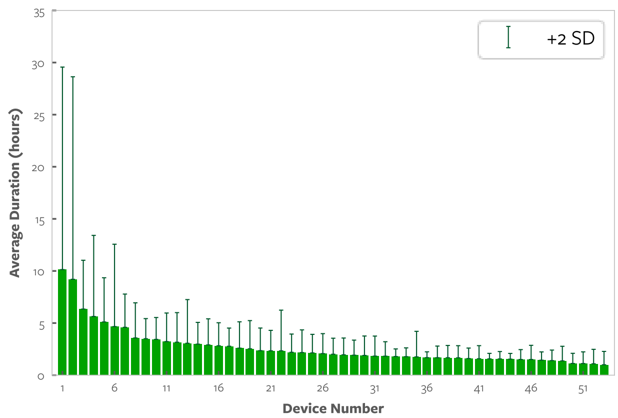
5 This residence did not participate in the tenant survey, so the reasons for this very high energy usage are not known. Average operating times returned to more normal levels in summer (<10 hours/day), so likely causes include a water leak or simply very high hot water demand in winter and spring.



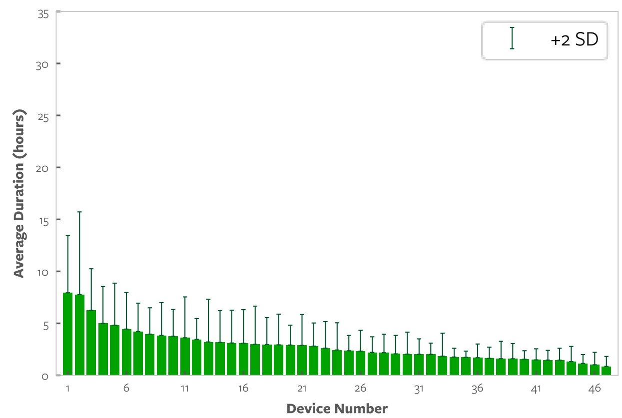
Winter



Spring



Summer



Autumn

Figure 6. Average daily duration of operation by season for each monitored heat pump water heater.

Table 4. Seasonal energy consumption and operation duration statistics for the 58 monitored heat pump water heaters. Data for all devices not available for all seasons. Outlier removed with winter and spring.

Statistic	Win.	Spr.	Sum.	Aut.	Ann.	Units
Average daily energy consumption	3.66	2.70	2.04	2.31	2.76	kWh
Median daily energy consumption	2.91	2.08	1.45	1.75	1.93	kWh
Average daily duration of operation	4.46	3.52	2.65	2.84	3.47	hours
Median daily duration of operation	3.71	2.46	1.75	2.25	2.42	hours
Average standard deviation of duration of operation	40.2	41.5	44.5	41.9	49.6	%
Smallest average duration of operation	1.76	1.25	1.00	0.86	1.28	hours
Largest average duration of operation (excluding device 1)	8.44	7.97	9.20	7.77	7.4	hours
Number of devices included in analysis	58	56	53	47	58	

As expected, the average and median daily hours of operation across the cohort were greatest in winter (4.46 and 3.71 hours, respectively), with 14 of 58 devices (24%) operating for longer than 6 hours per day on average. There are also large daily variances, with 38 of 58 devices (66%) operating for more than 6 hours on at least one day in winter.

These results clearly show that a Controlled Load 1 (6-hour) schedule is not suitable for a large proportion of the cohort. We therefore recommended avoiding CL1 for heat pump water heaters.

The average operating duration plus two standard deviations was less than 15 hours across all seasons for all but two devices. These results indicate that a Controlled Load 2 (16-hour) schedule is suitable for nearly all the cohort.

The tenant survey data (see *Tenant surveys* on page 38) was used to estimate hot water use for each household. A plot of the estimated values against daily energy use in winter is shown in Figure 7. The correlation between these two variables is weak, with a correlation coefficient of 0.45. Similar results were obtained for summer. Given this weak correlation, using survey data is not considered a reliable method for estimating hot water use.

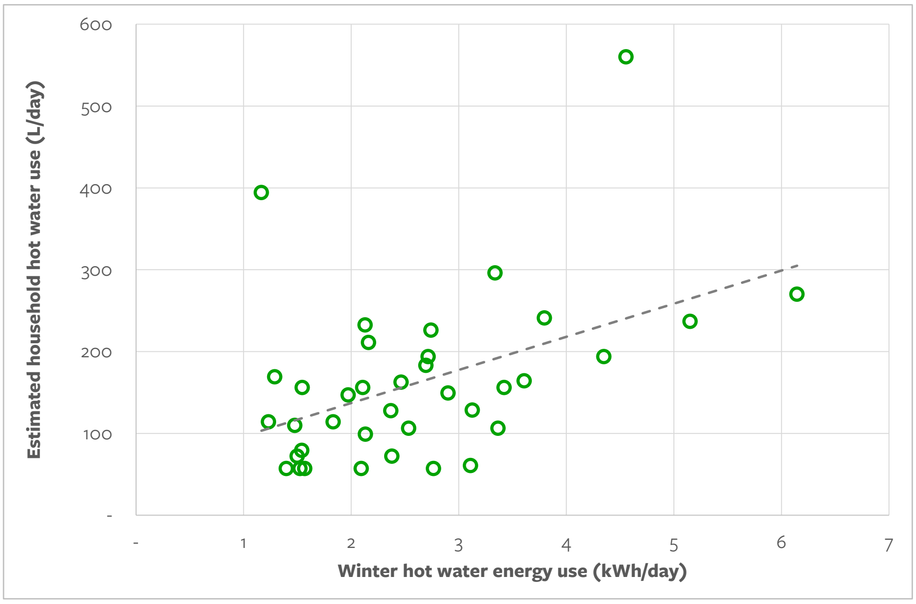


Figure 7. Household hot water use, estimated from tenant surveys plotted against measured hot water energy use for winter.

Average operating times for four properties in Maitland that were upgraded from electric resistance to heat pump water heaters are summarised in Table 5. Over the whole year, average operating times were 4–29% greater for the three heat pump water heaters for which full data was available, compared to their resistance predecessors. However, operating times were up 30–75% greater than for resistance units in winter and 3–61% greater in spring. Operating times were about the same in summer, while results for Autumn are mixed.

Compared to the entire cohort, use of boost elements by the heat pumps at these four Maitland properties was relatively limited. Heat pumps at Properties 1, 3 and 4 never used their boost elements. The heat pump at Property 2 did not use its boost element in winter or spring but used it on nine days in summer and eight days in autumn. This suggests the settings of this unit may have been changed over summer.

Table 5. Average daily operating times for four properties in Maitland that were upgraded from electric resistance to heat pump water heaters. Data for autumn are not yet available. ND = no data.

Maitland Property	Electric resistance average operating times					Heat pump average operating times					Ratio of heat pump to resistance operating times				
	Win.	Spr.	Sum.	Aut.	Ann.	Win.	Spr.	Sum.	Aut.	Ann.	Win.	Spr.	Sum.	Aut.	Ann.
	(h/day)					(h/day)									
1	1.96	1.76	1.69	1.70	1.78	3.19	2.30	1.78	2.02	2.32	1.63	1.31	1.05	1.19	1.29
2	3.26	2.76	2.31	2.51	2.71	4.24	2.84	2.14	2.37	2.90	1.30	1.03	0.93	0.94	1.05
3	6.14	5.45	3.61	5.78	5.25	8.44	6.61	3.57	3.46	5.52	1.38	1.21	0.99	0.60	1.04
4	3.44	3.03	2.24	3.07	2.95	6.01	4.88	ND	ND	ND	1.75	1.61	ND	ND	ND

4.3 Boost elements

The Rheem and Rinnai heat pump units used for the pilot include boost elements with power ratings of 2.4 and 2.1 kW, respectively. Figure 8 shows a typical load curve for a heat pump water heater using a boost element. From analysis of such load curves, we were able to determine when boost elements were operating and separate out the amount of energy used by the units when the boost elements were operating versus when only the heat pump was operating.

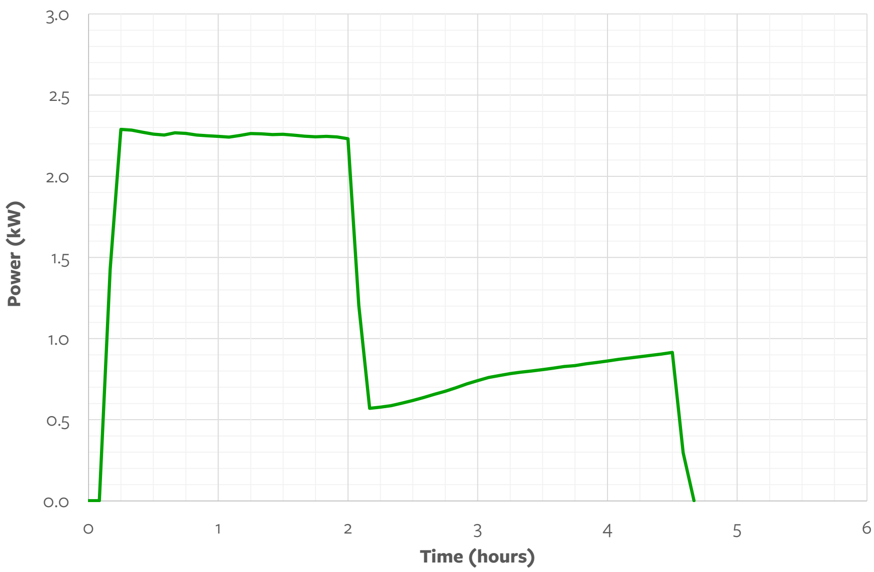


Figure 8. Typical load curve for a heat pump water heater using a boost element for about 105 min. The remainder of the curve shows just the heat pump.

Table 6 shows the total number of days when boost elements operated between 1 July 2024 and 30 June 2025, broken down by installer and brand, while Figure 9 shows energy use by source for each season.

Table 6. Analysis showing total number of days when boost elements operated between installation and 30 June 2025, broken down by installer and brand.

	Total days		Total HPs		Days/HP	
	Rheem	Rinnai	Rheem	Rinnai	Rheem	Rinnai
Installer 1	132	450	14	6	9.4	75.0
Installer 2	–	693	–	9	–	77.0
Installer 3	240	–	6	6	40.0	–
Installer 4	–	238	–	6	–	39.7
Total	**372**	**1,381**	**20**	**27**	**18.6**	**51.1**

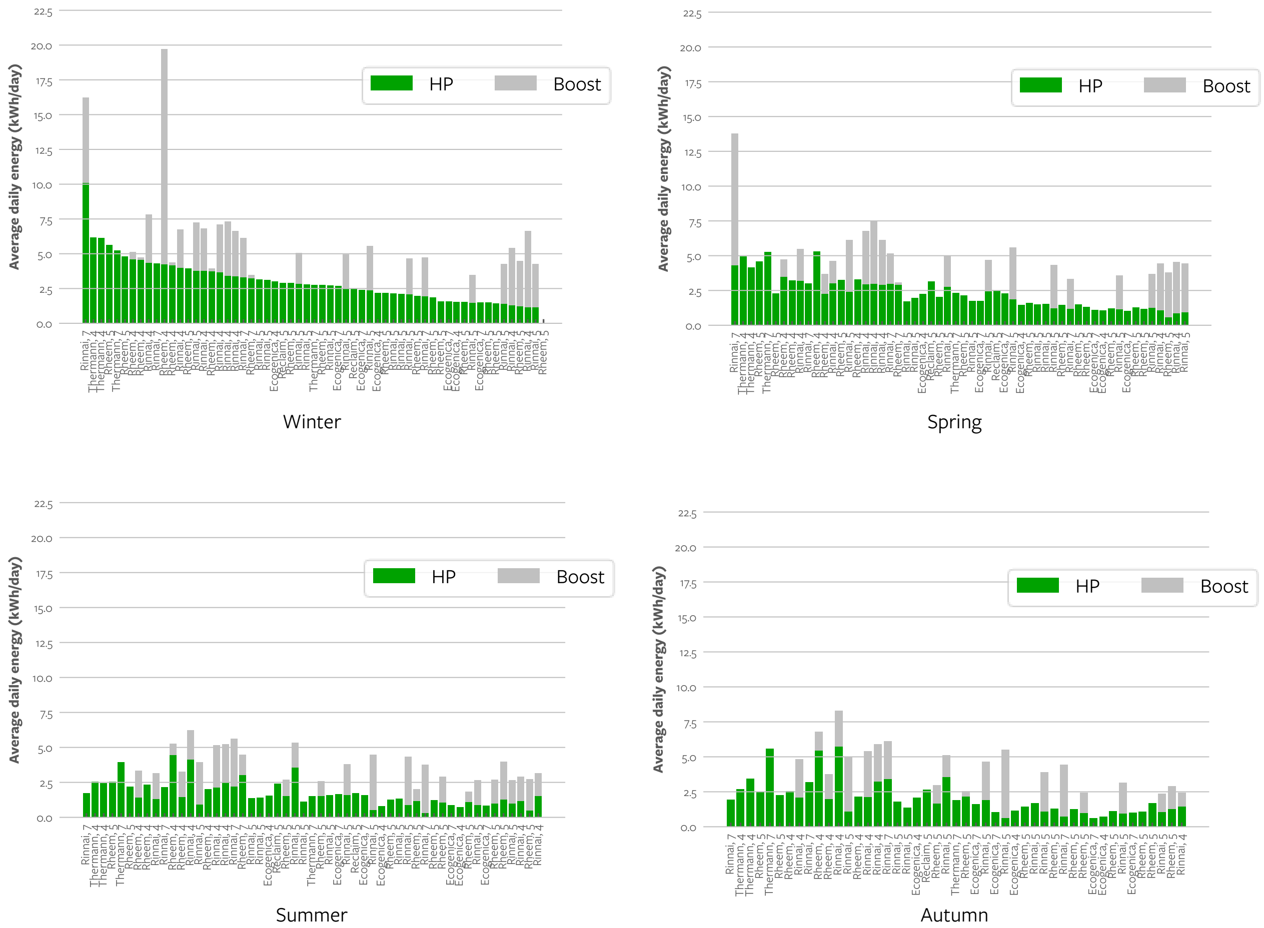


Figure 9. Seasonal average daily energy consumption for heat pumps with and without boost elements. The *x*-axis shows the brand and climate zone.

Many units frequently use their boost element across all seasons. This was more prevalent for the Rinnai units (19 of 27) than the Rheem units (4 of 20). Of these units, energy use by the boost element accounts for more than half of total energy use for over 11 units (24%) in winter, 14 (33%) in spring, 19 (48%) in summer and 11 (31%) in autumn, which runs somewhat counter to expectations. In contrast, many units fitted with boost elements did not use these boost elements at all.

In addition to the differences between brands noted above, there were marked differences in use of boost elements between installers. Boost element use was universal for Installer 4 (100%), very high for Installer 2 (88%), and still common for Installer 1 (75%), but much lower for Installer 3 (42%). These results indicate that installation practices may play a substantial role regarding use of boost elements.

Much of these seasonal differences may be a result of how the units were programmed, either at installation or subsequently. As noted in the Guidelines, the Rinnai EHPS215VM model, for example, offers four operating modes—Standard, Economy, Hybrid and Electric. The first two modes use the boost element only when ambient temperatures are outside the operating range of the heat pump. The Hybrid and Electric modes use the boost element more freely (and should therefore be avoided at installation, as recommended in the Guidelines). The Rheem model uses an ECO mode as standard. Users have access to the water heater settings and may also have changed device settings after installation.

We also looked for correlations between the use of boost elements and NCC climate zone. Only data for units in climate zones 4, 5 and 7 are available, per Table 1. The results are shown in Figure 10. As expected, boost elements operate a little more often in winter, particularly in CZ4 and CZ7, which have cooler winters. However, this does not always translate into an increase in the proportion of energy use by the boost elements, perhaps because of the continued use of a boost element with decreased use of the heat pump in warmer months. Apart from these observations, a reliable correlation between climate zone and use of booster elements is difficult to detect given the limited size of the dataset.

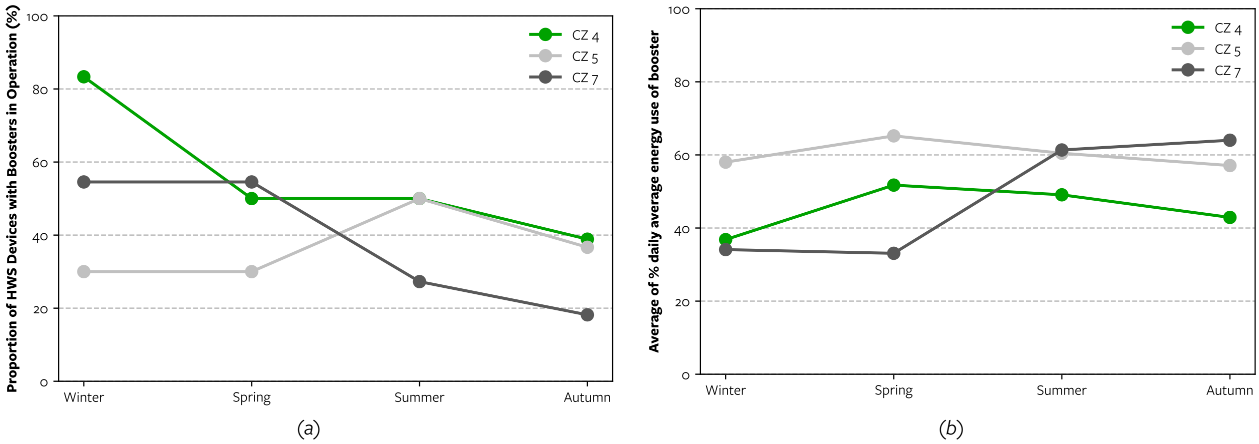


Figure 10. Analysis of seasonal boost element use for NCC Climate Zones 4, 5 and 7. (a) Proportion of devices using boost elements. (b) Average percentage daily energy used when boost element is operating.

Some of the above results are surprising and warrant further investigation through subsequent research to better understand the behaviour of heat pumps with boost elements. Would programming at installation be sufficient to address over-reliance on boost elements? To what extent could a larger size tank or more powerful heat pump prevent use of boost elements? And what are the likely impacts of different options on user experience?

While boost elements are likely necessary for some installations in colder climates, they are clearly not necessary for all homes. The results of the tenant survey show only four complaints about hot water shortages, three of which were for homes fitted with heat pumps with boost elements. This is despite 21 properties in the 2024 cohort having heat pump units with no boost elements and many more having units whose boost elements have never been activated. Given the higher operating costs associated with boost elements, we recommend that units be programmed at installation to avoid their use where possible. In most cases this should involve selecting the default operating mode.

4.4 Average daily load profiles

Individual heat pump daily load profiles vary significantly between devices, depending on household hot water usage patterns. However, by averaging across multiple devices, an average daily load profile can be generated. This is useful for understanding grid impacts of residential electrification and heat pump upgrades.

Figure 11 shows the daily average power profile for each season for the entire cohort. As the controlled load interventions were conducted in spring (see Section 4.8), the plot for spring shows a mixture of controlled and uncontrolled devices. The plots for other seasons show results for uncontrolled devices only. These results show that when devices are uncontrolled, the average power tends to peak in the middle of the day and again in the evening.

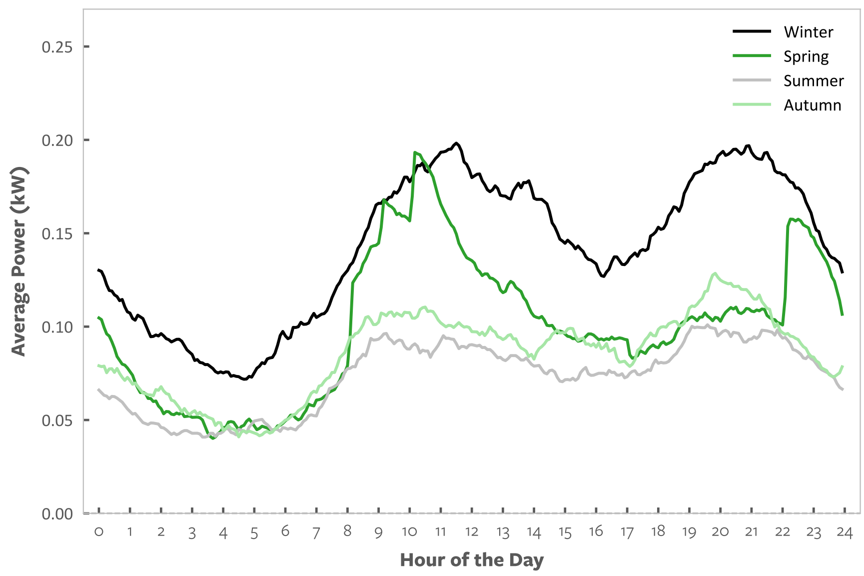


Figure 11. Average daily power profile across all monitored heat pump water heaters for each season. Plots for Winter and Autumn use incomplete data. Plot for Spring includes devices subject to CL interventions.

Figure 12 shows the daily average power profile for each season for each of two cohorts:

- those where boost elements were activated, and
- those without boost elements or where boost elements did not operate.

The number of units where boost elements were activated varies for each season. The results show that boost elements:

- increase overall power use, and
- make the average power profile peakier in winter.

Figure 12. Average power consumption versus time of day across all monitored heat pump water heaters for each season, with and without boosters. Numbers of units with operating boost elements are 26 (winter), 22 (spring), 27 (summer) and 20 (autumn).

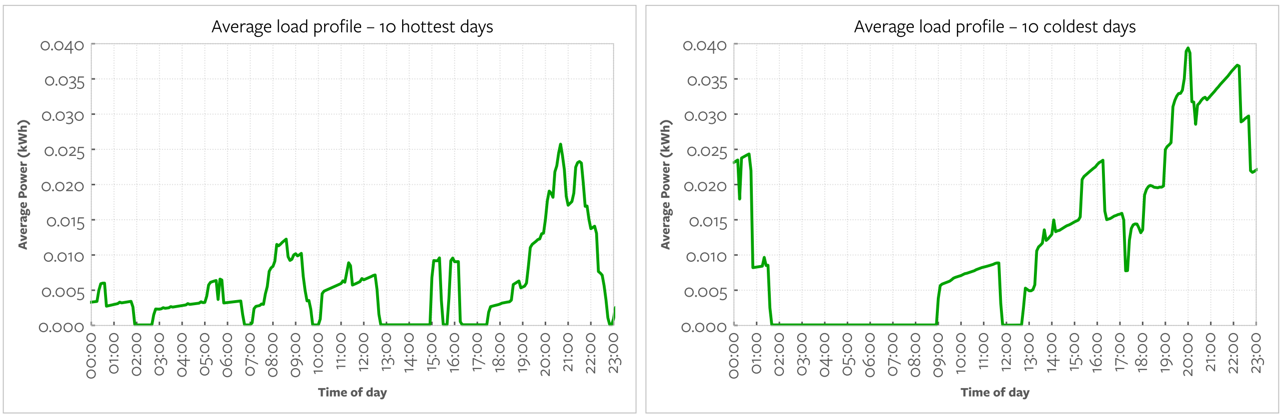
4.5 Hot and cold days

To better understanding the expected load from heat pump hot water systems on network peak days, we looked at the average power profile of the monitored cohort for the 10 hottest and coldest days during the period 1 July 2024 to 30 June 2025. Days were selected based on the temperatures recorded at Maitland airport. Maitland is both relatively central to the monitored cohort (see Figure 5) and provides a reference for comparison with resistance water heater data discussed in later sections.

The hottest and coldest days are listed in Table 7. The average power consumption versus time of day across all monitored heat pump water heaters for these hottest and coldest days are shown in Figure 13.

Table 7. Hottest (left) and coldest (right) days recorded at Maitland airport between 1 July 2024 and 30 June 2025. (Source: BoM)

Date	T_{max}	T_{min}	T_{av}	Date	T_{max}	T_{min}	T_{av}
	(°C)	(°C)	(°C)		(°C)	(°C)	(°C)
28 Jan 2025	40.10	22.30	31.20	19 Jun 2025	17.20	0.50	8.85
8 Dec 2024	35.10	23.00	29.05	27 Jun 2025	15.40	3.40	9.40
7 Nov 2024	38.90	18.80	28.85	4 Aug 2024	17.50	1.90	9.70
7 Dec 2024	36.50	21.20	28.85	9 Jun 2025	13.20	6.50	9.85
15 Jan 2025	38.00	19.70	28.85	30 Jun 2025	15.80	3.90	9.85
16 Dec 2024	34.40	23.20	28.80	17 Jun 2025	16.90	2.90	9.90
27 Jan 2025	36.90	20.10	28.50	20 Jun 2025	18.30	1.50	9.90
17 Dec 2024	40.40	16.20	28.30	6 Jun 2025	15.60	5.00	10.30
27 Dec 2024	37.80	18.50	28.15	18 Jun 2025	16.00	4.60	10.30
27 Nov 2024	37.50	18.40	27.95	15 Jul 2024	14.60	6.50	10.55
Average	**37.56**	**20.14**	**28.85**	**Average**	**16.05**	**3.67**	**9.86**



(a) (b)

Figure 13. Average power consumption versus time of day across all monitored heat pump water heaters for (a) 10 hottest and (b) 10 coldest days in the period 1 July 2024 – 30 June 2025.

4.6 Energy savings from heat pump upgrades

Energy use comparisons were made between 2023 and 2024 for the four Maitland properties cited above, which were upgraded from electric resistance to Rheem heat pump water heaters. The results are shown in Table 8 and Figure 14. As noted above, use of boost elements was very limited for these properties.

Pre-intervention average daily water heater energy use for the four Maitland properties spans 5.6 to 17.7 kW/h. Based on existing ISF modelling, typical usage rates for this climate zone range from 4.3 kWh/day for a single-person household to 14.8 kWh for a 5+ person household.

As expected, energy use is substantially lower for the heat pumps compared to the resistance waters heaters, with energy savings of 74–78%.

Table 8. Average daily energy use for four properties in Maitland that were upgraded from electric resistance to heat pump water heaters. ND = no data.

Maitland Property	Electric resistance average energy use					Heat pump average energy use					Energy savings from heat pump water heater				
	Win.	Spr.	Sum.	Aut.	Ann.	Win.	Spr.	Sum.	Aut.	Ann.	Win.	Spr.	Sum.	Aut.	Ann.
	(kWh/day)					(kWh/day)					(%)				
1	6.4	5.6	4.8	5.3	5.6	2.0	1.4	1.0	1.3	1.5	69	75	79	76	74
2	10.5	8.4	6.3	8.2	8.4	2.0	2.0	1.5	1.8	1.9	81	76	76	77	78
3	21.2	18.5	11.8	18.7	17.7	5.6	4.6	2.4	2.5	4.0	73	75	79	86	77
4	11.4	9.9	7.1	10.1	9.7	3.8	3.1	ND	ND	ND	67	69	ND	ND	ND

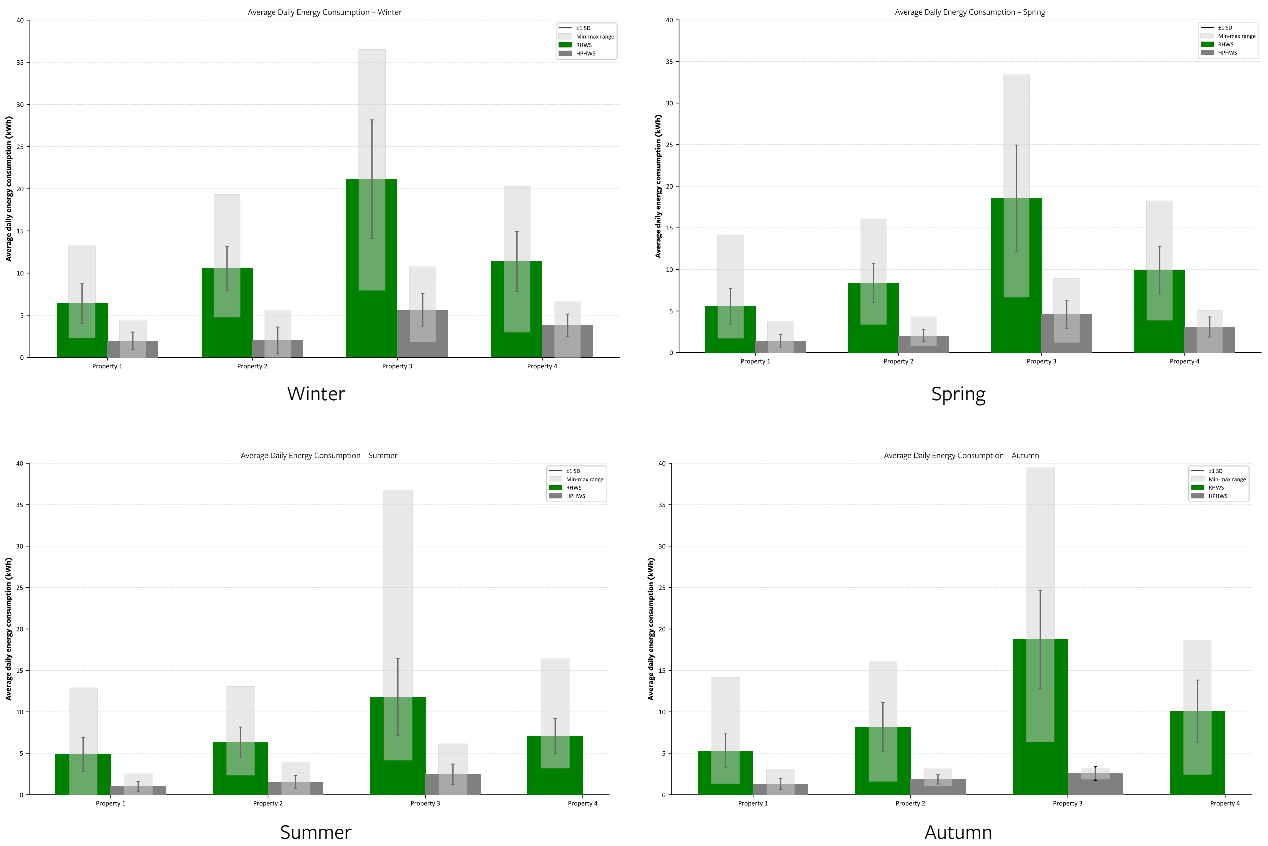


Figure 14. Seasonal energy savings for the four Maitland properties comparing 2023/24 to 2024/25. Heat pump data is unavailable for Property 4 after 20 September 2024.

4.7 Bill savings

To convert the measured energy savings into estimated bills savings, Red Energy's Living Energy Saver tariffs were used, as provided in Table 9 and illustrated in Figure 15. These include flat, time-of-use, solar feed-in and controlled load tariffs.

For comparison purposes, resistance water heaters were assumed to operate on a Controlled Load 1 (CL1) tariff. For heat pumps, four different tariff scenarios were modelled:

- flat tariff: 29.87 ¢/kWh
- time-of-use tariff with no control: 20.15, 29.87 or 48.24 ¢/kWh, depending on time of day
- time-of-use tariff with control—20.15 ¢/kWh (i.e. always the off-peak tariff rate)
- solar self-consumption—5.00 ¢/kWh (i.e. always the solar feed-in-tariff rate).

The resulting estimated annual energy costs and bill savings ranges are provided in Figure 16 and Table 10, respectively. A detailed breakdown of daily operating costs is provided in Table 12.

Under all scenarios, estimated annual bill savings are significant, ranging from $162 for the lowest hot water user moving to a flat tariff, to $931 for the highest hot water user moving to a solar feed-in tariff.

Table 9. Red Energy's Living Energy Saver tariffs (Ausgrid network) used for bill savings analysis.

Tariff	Peak [7]	Shoulder	Off-peak	Supply charge	Solar FiT	Controlled Load [6] CL1	Controlled Load [6] CL2
	(¢/kWh)	(¢/kWh)	(¢/kWh)	(¢/day)	(¢/kWh)	(¢/kWh)	(¢/kWh)
Flat tariff—Living Energy Saver	29.87	29.87	29.87	73.96	5.00	15.86	17.05
ToU Tariff—Living Energy Saver ToU	48.24	29.87	20.15	87.45	5.00	15.86	17.05

[6] CL1 tariff provides supply for at least 6 h/day. This was previously limited to overnight operation but has recently been changed to allow operation at any time of day. CL2 tariff provides supply for 16 h/day, with at least 4 h/day 0700–1700.

[7] Peak: 1400–1959 Mon–Fri; Shoulder: 0700–1359, 2000–2159 Mon–Fri, 0700–2159 Sat–Sun; Off-Peak: 2200–0659 Mon–Sun.

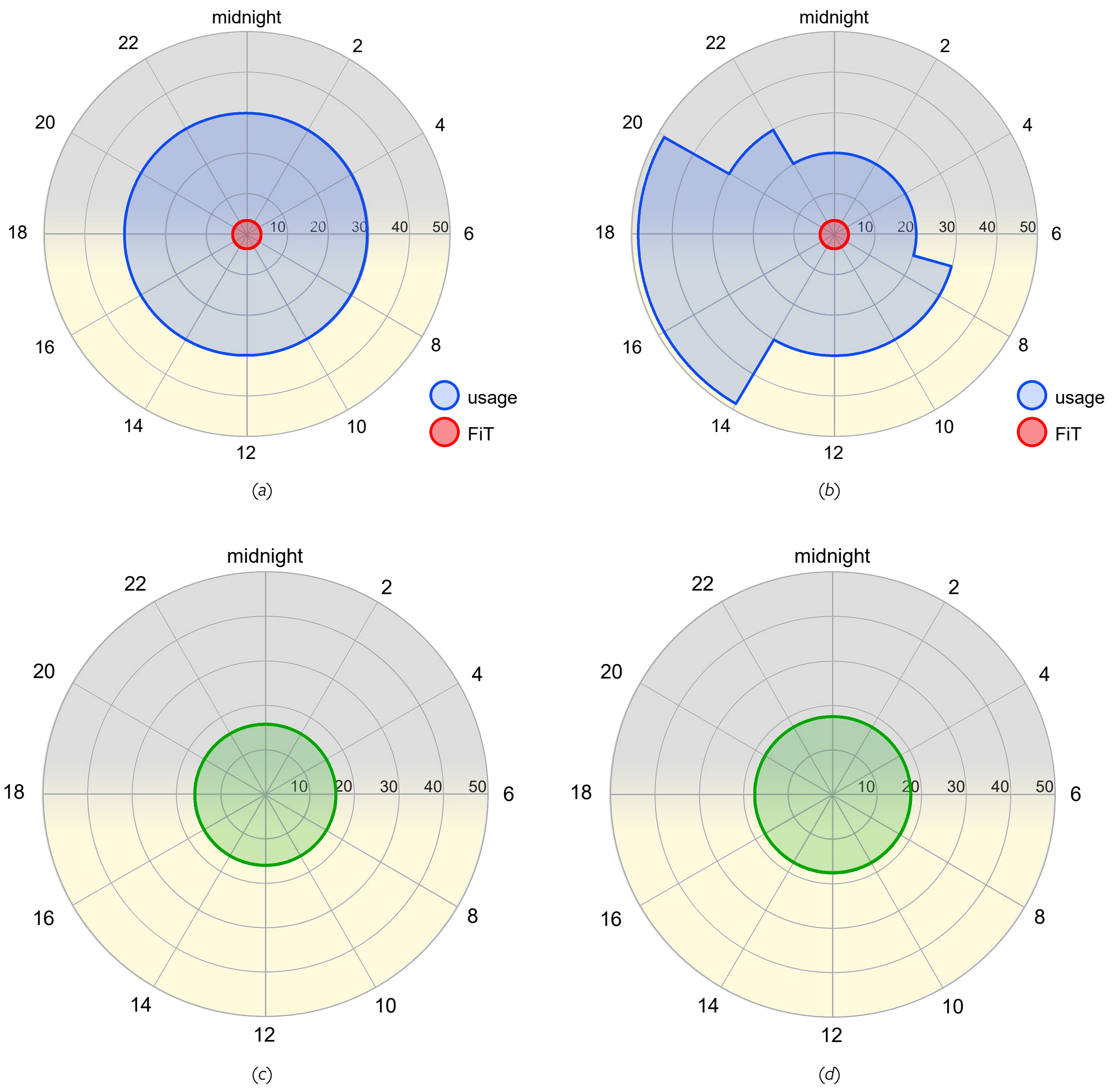


Figure 15. Variations of Red Energy's Living Energy Saver tariffs, used for tariff analysis. Time of day (0–24 h) is represented on the polar axis and the tariff rate (0–50 ¢/kWh) on the radial axis. (a) Flat tariff for Ausgrid region. (b) Weekday time-of-use tariff for Ausgrid region. (c and d) Controlled Load 1 and 2 tariffs for Ausgrid region. Tariff data derived from energymadeeasy.gov.au. FiT = Feed-in Tariff for solar export.

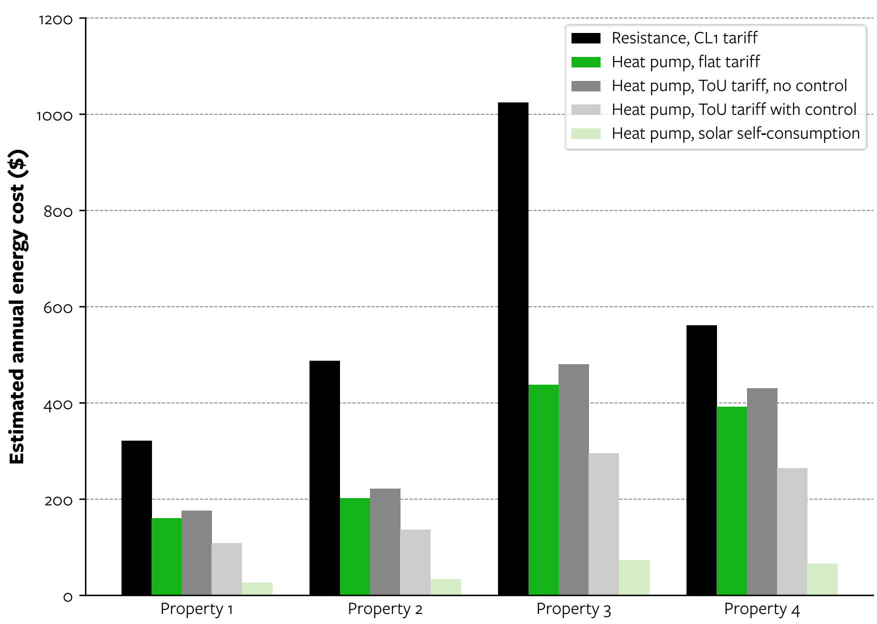


Figure 16. Estimated annual water-heating energy costs for the four Maitland properties under various tariff scenarios.

Table 10. Estimated seasonal bill savings for the four Maitland properties that were upgraded from electric resistance to heat pump water heaters, based on four different tariff scenarios. ND = no data. For comparison, resistance water heaters were assumed to operate on CL1. For context, estimated seasonal contributions of hot water to electricity bills in Maitland for different household sizes are provided in Table 11.

	Bill savings				
Tariff scenario	**Winter**	**Spring**	**Summer**	**Autumn**	**Annual**
	($)	($)	($)	($)	($)
Flat tariff	39–154	42–143	42–102	42–203	121–603
ToU tariff—uncontrolled	33–139	38–131	39–96	38–197	103–563
ToU tariff—controlled	56-204	54–184	51–124	53–226	182–738
Solar self-consumption	84–283	74–247	64–157	71–262	277–949

Table 11. Estimated seasonal contributions of resistance hot water to electricity bills for various household sizes in Maitland. Based on existing ISF modelling. Assumes daily average hot water use of 50 L/person and CL1 rate of 15.86 ¢/kWh.

	Typical water heating bill				
Household size	**Winter**	**Spring**	**Summer**	**Autumn**	**Annual**
(persons)	($)	($)	($)	($)	($)
1	72	64	51	61	249
2	115	103	79	96	393
3	163	145	110	135	553
4	211	188	141	174	713
5+	254	226	168	208	856
(persons)	($/day)	($/day)	($/day)	($/day)	($/day)
1	0.78	0.71	0.57	0.67	0.68
2	1.25	1.13	0.88	1.04	1.08
3	1.77	1.60	1.22	1.46	1.52
4	2.29	2.06	1.57	1.89	1.95
5+	2.76	2.48	1.87	2.26	2.35

Table 12. Estimated daily bill savings for four Maitland properties. Assumes moving from Controlled Load 1 (CL1) tariff to flat, time-of-use or solar feed-in tariffs. ND = no data. UD = unreliable data.

Property	Electric resistance average daily cost					Heat pump average energy use					Energy savings from heat pump water heater				
	Win.	Spr.	Sum.	Aut.	Ann.	Win.	Spr.	Sum.	Aut.	Ann.	Win.	Spr.	Sum.	Aut.	Ann.
	Controlled Load 1 ($/day)					**Flat tariff** ($/day)					**Cost savings** (%)				
Property 1	1.01	0.88	0.77	0.84	0.88	0.59	0.42	0.30	0.39	0.43	41	52	61	54	51
Property 2	1.67	1.33	1.00	1.29	1.33	0.60	0.61	0.46	0.55	0.56	64	54	54	57	58
Property 3	3.36	2.94	1.87	2.97	2.79	1.68	1.37	0.73	0.76	1.14	50	53	61	74	59
Property 4	1.80	1.57	1.13	1.60	1.53	1.13	0.92	ND	ND	ND	37	41	ND	ND	ND
	Controlled Load 1 ($/day)					**ToU tariff (no control)** ($/day)					**Cost savings** (%)				
Property 1	1.01	0.88	0.77	0.84	0.88	0.65	0.46	0.33	0.43	0.47	36	47	57	49	47
Property 2	1.67	1.33	1.00	1.29	1.33	0.66	0.67	0.50	0.60	0.61	61	50	50	53	54
Property 3	3.36	2.94	1.87	2.97	2.79	1.85	1.50	0.80	0.83	1.25	45	49	57	72	55
Property 4	1.80	1.57	1.13	1.60	1.53	1.24	1.01	ND	ND	ND	31	36	ND	ND	ND
	Controlled Load 1 ($/day)					**ToU tariff (controlled)** ($/day)					**Cost savings** (%)				
Property 1	1.01	0.88	0.77	0.84	0.88	0.40	0.29	0.20	0.26	0.29	61	68	73	69	67
Property 2	1.67	1.33	1.00	1.29	1.33	0.41	0.41	0.31	0.37	0.37	76	69	69	71	72
Property 3	3.36	2.94	1.87	2.97	2.79	1.14	0.92	0.49	0.51	0.77	66	69	74	83	72
Property 4	1.80	1.57	1.13	1.60	1.53	0.76	0.62	ND	ND	ND	58	60	ND	ND	ND
	Controlled Load 1 ($/day)					**Solar self-consumption** ($/day)					**Cost savings** (%)				
Property 1	1.01	0.88	0.77	0.84	0.88	0.10	0.07	0.05	0.07	0.07	90	92	93	92	92
Property 2	1.67	1.33	1.00	1.29	1.33	0.10	0.10	0.08	0.09	0.09	94	92	92	93	93
Property 3	3.36	2.94	1.87	2.97	2.79	0.28	0.23	0.12	0.13	0.19	92	92	93	96	93
Property 4	1.80	1.57	1.13	1.60	1.53	0.19	0.15	ND	ND	ND	89	90	ND	ND	ND

4.8 Emissions reductions

Seasonal emissions reductions for the above cohort were calculated for 2023/24 versus 2024/25. To calculate emissions, we used two years (1 Oct 2022 – 30 Sep 2024) of data for the real-time carbon emissions intensity of the NEM (CSIRO, n.d.) and calculated a set of average 24-hourly emissions profiles for NSW for each calendar month. Seasonal examples are shown in Figure 17 below.

Estimated emissions reductions for the four Maitland properties are shown in Figure 18 and Table 13. Estimated annual emission reductions were 74–78% (0.93–3.15 t CO_2-e).

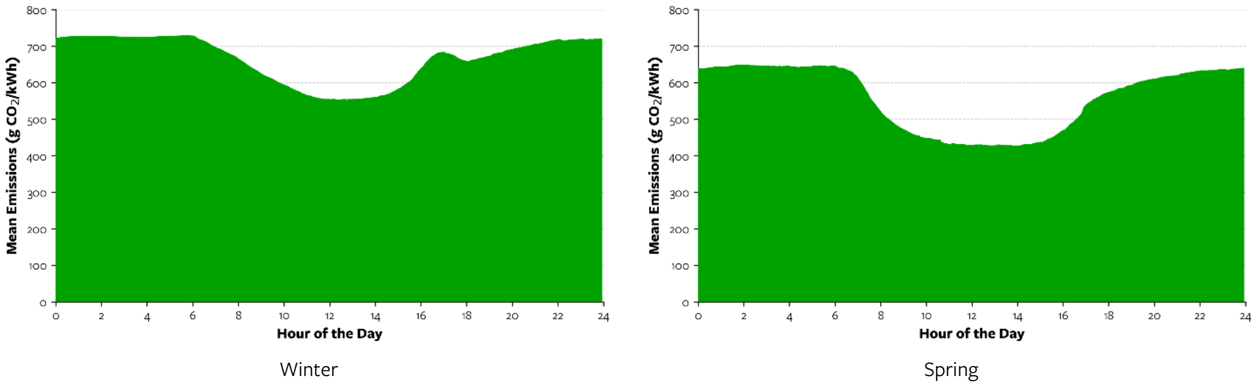


Figure 17. Examples of average 24-hourly emissions profiles for NSW for winter and spring.

Figure 18. Estimated annual emissions for resistance and heat pump water heaters for four Maitland properties. Heat pump data is unavailable for property 4 after 20 September 2024.

Table 13. Estimated emissions reductions for four Maitland properties. ND = no data.

Property	Electric resistance GHG emissions (kg CO_2-e)					Heat pump GHG emissions (kg CO_2-e)					Emissions savings from heat pump water heater (%)				
	Win.	Spr.	Sum.	Aut.	Ann.	Win.	Spr.	Sum.	Aut.	Ann.	Win.	Spr.	Sum.	Aut.	Ann.
Property 1	390	282	272	316	1260	121	72	57	77	328	69	74	79	76	74
Property 2	644	424	355	485	1909	123	103	86	110	422	81	76	76	77	78
Property 3	1293	941	664	1114	4012	344	232	138	152	866	73	75	79	86	78
Property 4	695	502	400	601	2197	232	157	ND	ND	ND	67	69	ND	ND	ND

4.9 Simulated controlled load interventions

The pilot included two simulated controlled load interventions:

- 30 units in a CL1 trial: 0800–1600 AEST (8-hours), 19 Sep–16 Oct 2024 (28 days)—see Figure 19(a).
- 45 units in a CL2 trial: 0900–1600 and 2100–0600 AEST (16-hours), 23 Oct–19 Nov 2024 (28 days)—see Figure 19(b).

Time was also allowed for units to transition from uncontrolled to controlled operation, and back again, as illustrated in Figure 20.

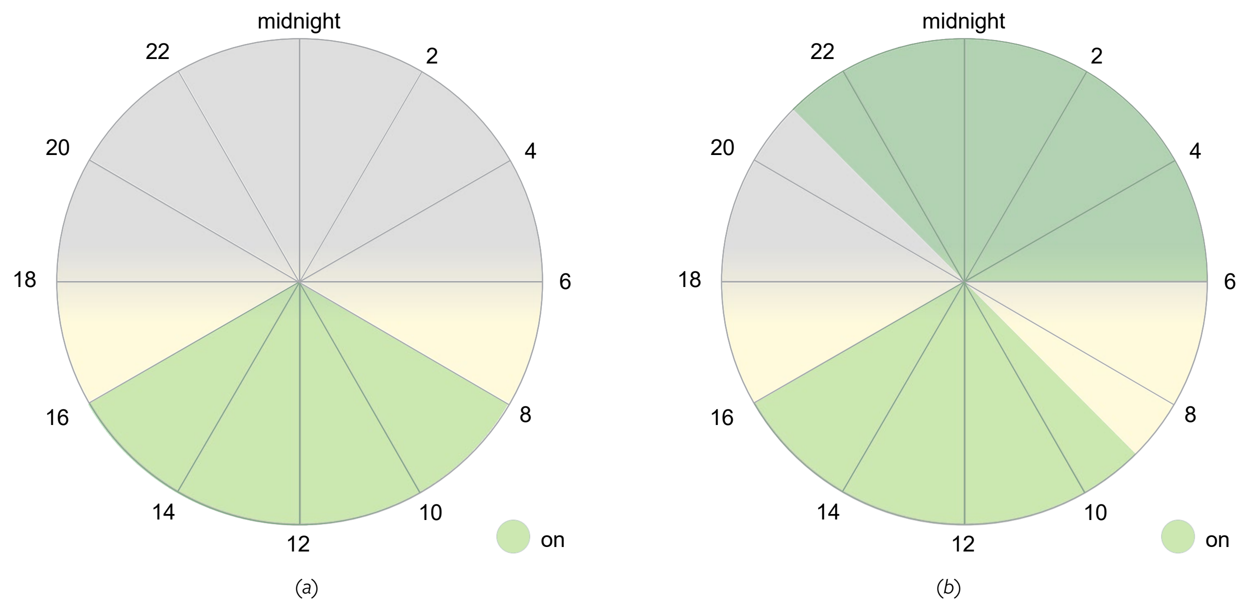


Figure 19. The two simulated controlled load interventions used the illustrated operating windows. (a) Controlled Load 1: 0800–1600 AEST (8-hours). (b) Controlled Load 2: 0900–1600 and 2100–0600 AEST (16-hours).

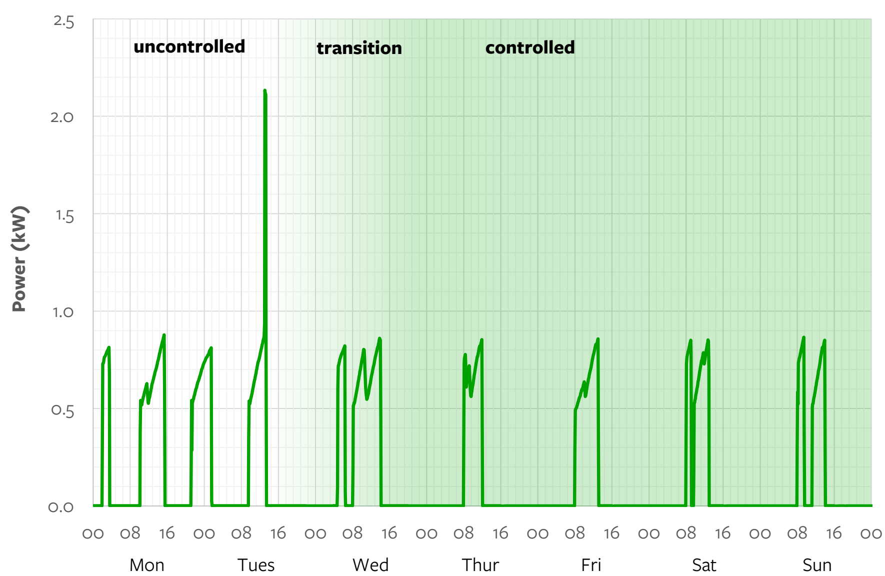


Figure 20. Power consumption versus time of day for a single unit as it transitions from uncontrolled to simulated Controlled Load 1 operation.

In preparation for the CL interventions, one complaint was received about loss of hot water, which resulted from incorrect installation of a Wattwatchers device. Hot water was able to be quickly restored to this property and several properties affected by the same Wattwatchers problem were excluded from the trials.

No specific complaints from tenants appear to be linked to the CL interventions. See Section 5.3 for further analysis of the few complaints received during the pilot.

The results of the CL1 and CL2 controlled load interventions are illustrated in Figure 21 and Figure 22, respectively. As expected, the resulting peaks occur during the CL windows.

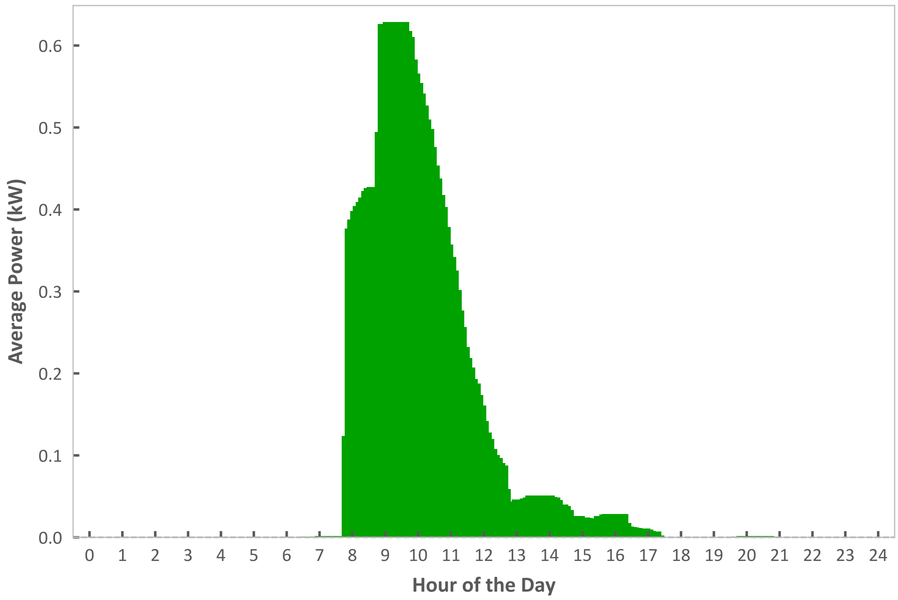


Figure 21. Average power consumption versus time of day (AEST) across all 18 monitored heat pump water heaters in the four-week CL1 intervention trial, 19 Sep – 16 Oct 2024.

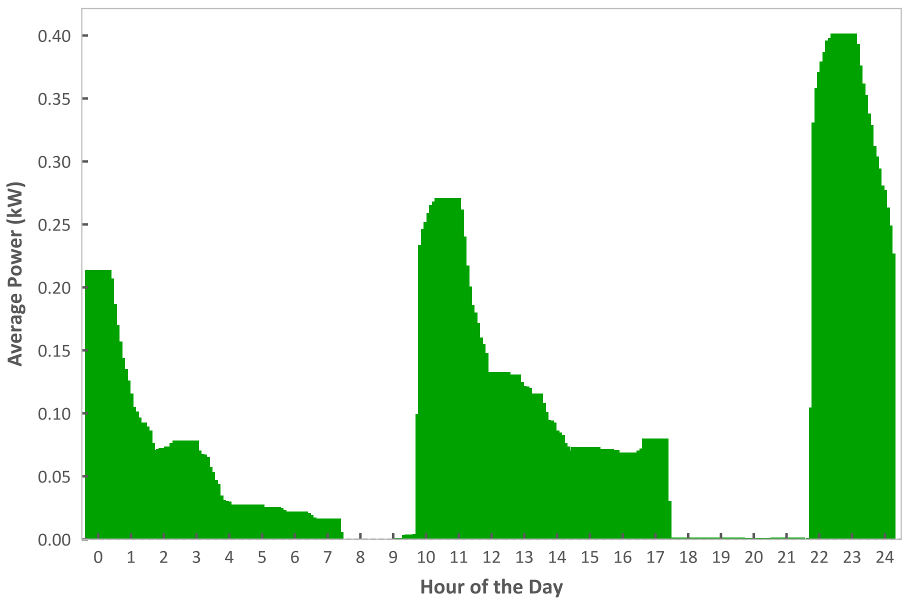


Figure 22. Average power consumption versus time of day (AEST) across all 21 monitored heat pump water heaters in the four-week CL2 intervention trial, 23 Oct – 19 Nov 2024

4.10 Solar self-consumption

Sixteen homes with rooftop photovoltaic solar were analysed to measure the proportion of energy supplied to the heat pump water heater that came from the solar system. For the period 1 Jul 2024 – 30 Jun 2025, when all systems were left to operate uncontrolled, the percentage ranged from 11% to 59%, with an average value of 32%.

Of the above 16 homes with solar, only six were identified as participating in both controlled load intervention trials. Of this group, the average level of solar self-consumption for the period 1 Jul 2024 – 30 Jun 2025 was 31%, with a range of 21–37%.

Table 14 shows the levels of solar self-consumption for these six homes during both controlled load intervention trials. During the CL2 trial, results were mixed. For one home, solar self-consumption fell to about a quarter of its uncontrolled value, while another dropped to roughly two-thirds. For the remaining homes, self-consumption was similar or higher compared to uncontrolled operation. This variation was reflected in the average values, which rose only modestly from 31% under uncontrolled operation to 33%. However, for the CL1 trial, when all heat pumps were operated during the solar window (0800–1600 AEST), the average solar self-consumption rose to over 87%, with five of the six homes above 84% and the remaining home just under 80%. [8]

Table 14. Amount of solar self-consumption for six heat pump hot water systems when operated uncontrolled and controlled during the CL1 and CL2 trials.

		Solar self-consumption		
Control status	**Operation period**	**Average**	**Minimum**	**Maximum**
		(%)	(%)	(%)
Uncontrolled, 1 Jul 2024 – 30 Jun 2025	Uncontrolled	31.1	20.6	37.0
Controlled load intervention 1	0800–1600 AEST	87.5	79.3	96.6
Controlled load intervention 2	0900–1600 & 2100–0600 AEST	33.3	7.0	58.2

4.11 Gas electrification

Six of the properties included in the pilot were spread across two two-storey unit complexes in the Sydney suburbs of Burwood and Concord. These complexes were upgraded from common [9] gas-fired hot water systems to individual heat pumps, as illustrated in Figure 23.

(a) (b)

Figure 23. (a) Common gas-fired hot water systems were replaced with (b) individual heat pumps for two unit complexes in Sydney as part of an electrification upgrade.

[8] The homes in this sample all have modest hot water needs, as this was one of the selection criteria for the CL1 trial. For a larger sample of homes, a more modest increase in average solar self-consumption would be expected.

[9] Meaning a centralised hot water system at each site supplying hot water to all units, as opposed to individual hot water systems supplying each property.

Billing data and Wattwatchers monitoring data were available for two of these properties, which allowed for energy, bill and emissions savings to be estimated, as shown in Table 15 and Figure 24. The gas bill data includes conversion factors, which allow the efficiency of the previous gas system to be estimated at ~26%.[10] The estimated energy use reductions are 86–89% (11.6–14.6 GJ/year), resulting in estimated bill reductions of 636–737 $/year per unit and emissions reductions of 362–530 kg/year CO_2-e per unit.

Table 15. Extrapolated energy, bill and emissions savings from switching from gas to heat pump electric water heating for two residential apartments.

	Unit 1	Unit 2	
Previous average gas use	44.8	37.1	MJ/day
Current average electricity use	4.9	5.3	MJ/day
Average daily energy savings	39.9	31.9	MJ/day
Average daily energy savings	89.1	85.8	%
Extrapolated energy savings	**14.6**	**11.6**	**GJ/year**
Estimated gas costs (Red Energy, Jemena coastal network)	1.60	1.35	$/day
Estimated gas costs with daily gas supply charge ($0.825/day)	2.42	2.18	$/day
Estimated electricity costs ($0.2987/kWh)	0.41	0.44	$/day
Estimated bill savings (with daily gas supply charge)	2.02	1.74	$/day
Extrapolated bill savings	**737**	**636**	**$/year**
Previous GHG emissions (51.53 g/MJ CO_2-e)	2.31	1.91	kg/day CO_2-e
Current GHG emissions (630 g/kWh CO_2-e for NSW, 2024/25)	0.86	0.92	kg/day CO_2-e
GHG emissions reduction	1.45	0.99	kg/day CO_2-e
Extrapolated GHG emissions reduction	**530**	**362**	**kg/year CO_2-e**

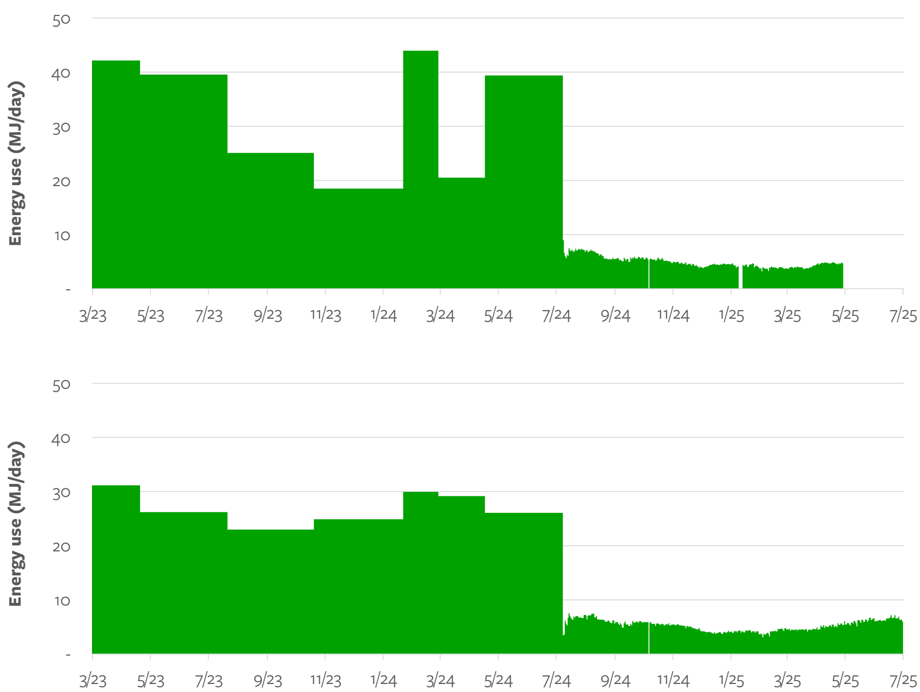


Figure 24. Hot water energy use for two properties before and after replacement of centralised gas boilers with heat pumps in early July 2024.

[10] This very low figure is likely due to a combination of the system's age and high distribution losses.

5 Tenant surveys

5.1 Survey overview

In late November and early December 2024, a phone survey was conducted by Homes NSW with tenants who participated in the 2024 heat pump pilot. The overall response rate was *n* = 73 of 114 (64%), comprising 43 of 64 (67%) from LAHC and 30 of 50 (60%) from AHO. Gifts cards of $100 were issued to each of the participants who responded.

Data is also available for a more limited survey conducted by Homes NSW with tenants who participated in their 2023 heat pump pilot. The overall response rate for the 2023 survey was *n* = 24 of 33 (73%).

The results of both surveys are provided in *Appendix B—Tenant survey results* on page 50.

The 2024 survey was designed to collect information including:

- basic household size and demographics
- hot water usage (frequency of showers, etc.) to enable estimation of household hot water demand,[11] and
- user experience, including satisfaction, noise, hot water availability, energy bills and wellbeing.

The 2023 survey collected only basic information about household composition and satisfaction.

5.2 Main insights

Following are some of the main insights from the surveys.

- **High proportion of one- and two-person households**—One-person (38%) and two-person (23%) households made up over 60% of 2024 survey respondents, with the proportions being higher in LAHC properties. The 2023 pilot was limited to smaller homes, with all 2023 survey respondents being one-person (68%) or two-person (32%) households.
- **Relatively high overall satisfaction**—Respondents to the 2024 survey were generally satisfied with their hot water system and the installation process. Over 88% were satisfied or very satisfied with the new hot water system (up from 67% in 2023), with 7% either dissatisfied or very dissatisfied and 4% neither. Over 97% thought the tradespeople that installed the system did a good job (up from 86% in 2023), 94% were happy with the process of booking an appointment to install the hot water system and 96% thought the tradespeople who installed the hot water system were friendly, polite and helpful. About 92% were happy with the location of the hot water system (with an additional 4% offering no response), up from 45% in 2023.
- **Increase in reported hot water availability**—Over half (53%) of respondents reported running out of hot water *before* the new heat pump was installed, while only 5.5% (4 of 73) reported this occurring after installation (albeit with only about six months' experience). See *Analysis of hot water deficits* on page 40 for further details.
- **Noise a concern for some**—About 39% of respondents reported hearing noise from their systems, with 24% hearing this both day and night and 10% (7 of 73) reporting noise levels as 'unacceptable', although two of these complained about noise caused by rainwater from leaky gutters falling onto the

[11] As noted in Section 5.2, the survey data proved unreliable for estimating hot water use and was not used in the analysis.

unit. Similar results were found from the 2023 survey. All respondents who complained about noise received Rheem or Rinnai heat pumps, which comprised about 82% of the 2024 cohort—47 and 46, respectively, of 114 devices.

- **High rates of early maintenance**—One third (33%) of respondents reported experiencing an early maintenance issue with their heat pump system, almost double the rate in 2023 (18%). Three respondents cited that the water temperature was not hot enough. [12] Others reported issues such as:
  - noise from vibration
  - water leaks
  - system resets and other minor problems that were able to be quickly rectified.

  In 2023, water leaks were the most reported issue.
- **Better information is required**—More than one quarter (29%) of respondents felt only moderately or less well informed about their new hot water system. An information sheet was prepared for tenants by the research team, but this was not always provided by installers. Some additional comments from respondents indicate the need for more detailed information to be provided covering expected bill savings and how to minimise operating costs:
  - *"Would like to know more about the LED screen and how it works. Sometimes it locks."*
  - *"Could be better explained. Would like to know how much money I will save."*
  - *"Taught me the basics. Taught me how to turn it off and on and set a temp to a point. Would like to know how to make it run at night more."*
  - *"No instructions were provided."*
  - *"Didn't leave a manual or fact sheet."*
- **Energy bill savings not always apparent**—Respondents exhibited high levels of energy bill stress, with 34% indicting they have found it difficult to pay an energy bill in the past 12 months and 39% agreeing they have found it difficult to heat or cool their home in the past 12 months due to high running costs (these proportions were markedly higher for LAHC compared to AHO properties). About 32% noted a decrease in their energy bills since the heat pump was installed, though several mentioned their bills have been reduced through receipt of a government subsidy. Many respondents also pay their bills through a fixed fortnightly debit and do not regularly look at their bills, so any energy savings would not be apparent. For tenants moving from gas to electric hot water, their electricity bills are expected to increase, though this would be more than offset by a reduction in (or elimination of) their gas bill.

[12] Upgrading older hot water systems may involve installing a tempering valve for safety and compliance, which is likely to reduce the delivery temperature to which tenants are accustomed.

5.3 Analysis of hot water deficits

As noted above, four of 73 (5.5%) 2024 survey respondents reported running out of hot water after the new heat pump was installed. Further details of these four respondents are provided in Table 16.

In summary, the hot water deficits appear to be largely related to plumbing issues or early equipment failures. None of the deficits appear to be related to the CL trials.

Table 16. Details of four 2024 survey respondents who reported running out of hot water after new heat pump installed. All Rinnai HP units have 2.4 kW boost elements. The Ecogencia units do not have a boost element. Two properties were included in both CL trials. Satisfaction is based on answer to the question "How satisfied are you with the new hot water system installed at your property?"

Location	HP brand	Bed-rooms	Occ.	In CL trials	Satis-fied	Notes
Maitland	Rinnai	3	1	Yes	Yes	Previous hot water system was instant gas, which frequently suffered pilot light failures. Suffered a period of inadequate hot water owing to a connection issue, which was unrelated to the CL trials and resolved within 24 hours.
Dubbo	Ecogencia	4	3	Yes	No	HP reportedly broke down about two months after it was installed. Reported ongoing problems, which appear to be largely plumbing-related and unrelated to the CL trials, as the tenant claims they "run out of hot water when taking a shower if we use hot water to wash the dishes." They also claim the system "runs out very quickly. Two kids are able to get hot water but not me."
Dubbo	Rinnai	2	1	No	Yes	Reported HP operating fine for three weeks before running out of hot water, after which they "swap[ped] it to automatic because manual burnt itself out." A service visit resulted in inspection, testing, servicing and replacement of a circuit breaker. According to the tenant, "now it works. However if I go away for two days and don't use the hot water for some reason it shuts itself down ... Would like a new home." They were also dissatisfied with their previous hot water system as they could "only take a 10-minute shower in the morning in winter" or "14-minute shower in summer before it would run cold."
Belmore	Rinnai	3	1	No	Neither	HP replaced a centralised gas system. Reported running out of hot water both before and after the upgrade. Noted their bills have decreased. No other details provided, with a language barrier cited in interview notes.

6 Conclusion and recommendations

Heat pump water heaters present many more decision points than other water heating technologies in product selection, installation and operation. Decision making is further complicated by an evolving market of products with a wide range of features, combined with a lack of suitable standards or market transparency. This report and the accompanying Guidelines can assist housing providers with this decision making by providing insights into the selection and operation of electric water heaters generally, and heat pumps specifically.

Heat pumps can significantly benefit housing tenants

Replacing an electric resistance water heater with a heat pump can significantly benefit the housing tenant by reducing their energy bills. In out pilot, the amount of energy used by heat pumps was measured to be about four times (74–78%) less than that used by resistance water heaters.[13] This results in typical bill savings of around 50–60% of water heating costs, assuming a shift from controlled load to flat tariffs. In the Guidelines, we estimate annual bill saving for a four-person home of about $442 (based on a reduction in operating costs from $800 to $358).

Replacing a gas water heater with a heat pump can also significantly benefit the housing tenant by reducing their energy bills. In the Guidelines, we estimate annual bill saving for a four-person home of about $602 (from $960 to $358), assuming a switch from instantaneous natural gas with a daily supply charge to a heat pump on a flat tariff. In our pilot, the amount of energy used by heat pumps was measured to be 5–7 times less than that used by an inefficient centralised gas heater, resulting in annual energy bill savings of around $600.

Heat pumps can significantly reduce greenhouse gas emissions

Based simply on the energy savings demonstrated in our pilot, upgrading a resistance water heater to a heat pump can reduce GHG emissions from operation of the water heater by about 74–78%. Based on modelling in the Guidelines, upgrading a gas water heater to a heat pump results in a similar 3–4 times reduction in lifetime greenhouse gas emissions. Using local solar to power an electric water heater can largely eliminate emissions from water heating.

Overreliance on boost elements can negate much of the cost benefit of heat pumps

Many heat pump water heaters include boost elements. In our pilot we found widely different behaviours, from boost elements never being activated to comprising over half of all energy consumption across all seasons. We attribute these divergent behaviours to different program settings, and recommend using settings that largely avoid use of boost elements. Given that moving from a controlled to continuous load can significantly increase the electricity tariff, overreliance on boost elements can negate much of the cost benefit for tenants of heat pumps and significantly erode reductions in GHG emissions.

Tenants with access to solar can benefit from using controls to increase solar self-consumption

Solar self-consumption provides the lowest operating cost option for electric water heaters. However, without some form of water heater control, the benefits of solar are mitigated. We showed that operating heat pumps during the solar window increased the average level of solar self-consumption significantly from 31 to 88%.

---

13 Provided use of boost elements is minimal.

Based on this level of self-consumption and the annual hot water operating costs for a four-person home as estimated in the Guidelines, using solar instead of a flat tariff results in additional annual bill savings of about $260 (from $358 to $98).

There are multiple challenges to operating heat pumps as controlled load

In theory, additional cost savings are available to tenants without solar by installing their heat pump hot water system on a controlled load circuit and accessing controlled load tariffs. As estimated in the Guidelines, for a four-person household this would result in annual bill savings of about $154 (from $358 to $204 for CL2). The magnitude of this additional saving is about 35% of the bill savings from the heat pump upgrade itself (with a flat tariff).

However, realising these additional savings presents some specific challenges:

- **Not all heat pump models are CL-compatible**—A minority of heat pump manufacturers recommend against installing their products on CL circuits because of concerns about hard switching.
- **Not all heat pump models behave as expected on CL**—Our stakeholder interviews revealed that some heat pump models are reported not to operate as expected when switched daily and may present an increased *Legionella* risk. We therefore recommend against installing devices on controlled load circuits without prior thorough investigation to ensure the selected unit is fully CL compatible. This might involve discussions with trusted manufacturers and/or testing of units.
- **Switching to CL2 is difficult**—For heat pump models that are CL-compatible, we recommend against using CL1 as it substantially increases the risk of hot water deficits for many homes. Use of CL2 substantially reduces this risk and is deemed acceptable. However, for customers on CL1, switching to CL2 presents several challenges. For homes without a smart meter, a site visit may be required. Even for homes with smart meters, switching requires asking the tenant to engage with their energy retailer. Such engagement can be challenging and poses additional risks for housing providers. We recommended this issue be further explored to develop potential solutions.

Given the challenges and relatively modest benefit of switching from a flat to CL tariff, we recommend that heat pumps usually be installed on a continuous circuit. This recommendation may change, particularly if a simpler process for moving tenants from CL1 to CL2 can be developed.

Internal timers can be used to access ToU tariffs, though switching tenants to ToU tariffs is challenging

Additional cost savings are available to tenants without solar by controlling their hot water system to access time-of-use tariffs. As estimated in the Guidelines, for a four-person household this would result in annual bill savings of about $116 (from $358 to $242 for off-peak ToU). The magnitude of this additional saving is about 26% of the bill savings from the heat pump upgrade itself (with a flat tariff).

As with the switch from CL1 to CL2, there are similar challenges in getting a tenant to switch from a flat to time-of-use tariff. This also requires tenant engagement and trust to explain the benefits of switching, and requires the tenant to follow through on engaging with their energy retailer to make the switch. However, unlike the switch from CL1 to CL2, a switch to ToU tariffs can be completed any time after the heat pump has been installed (on a continuous circuit), such as through provision of an information sheet about the benefits of switching and instructions on how to enable timers on their heat pump to access off-peak ToU tariffs.

Future research

Through this project we have identified several avenues for future research. These include:

- **Smart timers**—For tenants with solar or ToU tariffs, there is a strong need for simple set-and-forget water heater control solutions, such as a smart timer that can be programmed at installation and that can adapt operating times to maximise solar self-consumption or take advantage of ToU tariffs. There is an opportunity to work with a water heater manufacturer to implement and pilot such a feature in social housing, alongside addressing some of the challenges with tenant engagement.
- **Electrification**—The pilot included only a few homes where a heat pump was replaced with a gas water heater, and only two of these were monitored. Further electrification studies on gas to heat pump conversions are warranted to better understand the magnitude of energy and bill savings, tenant experiences, and barriers to electrification.
- **Use of booster elements**—Further investigation and testing is required to better understand the need for and use of booster elements. This could be used to help develop best practice recommendations for specifying heat pumps and programming them at installation.
- **Behaviour of hard-switched heat pumps**—Further investigation and testing is required to identify which heat pumps are fully controlled-load compatible, which would also allow us to provide clearer and simpler recommendations on best practice for installing heat pumps as controlled loads or other hard-scenarios that involve hard switching.
- **Solving the challenge of switching from CL1 to CL2**—Further investigation is warranted to explore options for solving this challenge, which could include finding ways to avoid the need to switch to CL2 (e.g. more powerful heat pumps with larger tanks) or developing simplified pathways in collaboration with DNSPs and retailers.
- **Network impacts**—Further investigation is required to better understand the likely network impacts of large-scale heat pump upgrades.
- **Piloting heat pumps for apartments**—There is a need for smaller heat pumps suitable for apartments. Future research could include working with a supplier to develop and pilot such products.
- **Controlled resistance water heaters as alternatives to heat pumps**—For a home without suitable space for a heat pump, a resistance water heater is a viable alternative. Given the much higher energy consumption of resistance water heaters compared to heat pumps, better solutions are required to make such water heaters more flexible and cheaper to operate. Options could include:
  - **Resistance water heaters with smart controls**—There is an opportunity to work with a water heater manufacturer to implement such a feature and test its ability to maximise solar self-consumption or take advantage of time-of-use tariffs.
  - **Hot water as a service**—A pilot could be used to test novel business models such as supplying hot water as a service, whereby housing providers pay a service provider to install, own and maintain tenants' hot water systems. The service provider would work with an energy retailer to charge tenants through their energy bills, while being incentivised to deploy least-cost options that maximise benefits from demand flexibility.

7 References

1. Alexander, D., Brinsmead, T. S. & Bransden, C. (2021). *Flexible Demand and Demand Control. Research State of the Art Industry Report for Research Theme B4.* RACE for 2030 CRC. https://www.eec.org.au/uploads/B4-Opportunity-Assessment-Rapid-Review.pdf

2. AIRAH (2014). *Residential AC Noise Issues. Allowable Noise Levels.* HVAC&R Skills Workshop Module 77. Australian Institute of Refrigeration Air Conditioning and Heating. https://airah.org.au/Common/Uploaded files/Resources/SkillsWorkshop/sw077.pdf

3. Australian Building Codes Board (2022). *National Construction Code 2022.* https://ncc.abcb.gov.au

4. Bourke, G. & Bansal, P. (2010). Energy consumption modeling of air source electric heat pump water heaters. *Applied Thermal Engineering*. 30. 1769–1774. https://doi.org/10.1016/j.applthermaleng.2010.04.008

5. Briggs, C., Roche, D. & Ibrahim, I. (2024). *Flexible Demand – the Current State of Play in Australia*. Institute for Sustainable Futures, UTS. Report prepared for ARENA. https://arena.gov.au/assets/2024/06/UTS-Flexible-Demand-State-of-Play-in-Aust-Report.pdf

6. Brinsmead, T.S., White, S., Bransden, C., Stanley, C. Hasan, K., Alexander, D., Sprague, M., Northey, J., Walgenwitz, G., Nagrath, K., Briggs, C., Leak, J., Harkins-Small, L., Murray-Leach, R. & Jennings, K. (2021). *Flexible Demand and Demand Control. Final Report of Opportunity Assessment for Research Theme B4.* RACE for 2030 CRC. https://racefor2030.com.au/wp-content/uploads/2023/03/RACE-B4-OA-Final-report.pdf

7. CSIRO (2024). Hot Water: Solar and Heat Pump Installs. https://ahd.csiro.au/dashboards/appliances/hot-water. Retrieved 24 July 2024.

8. CSIRO (n.d.). Real-time carbon emissions intensity of the National Electricity Market (API Access). https://agdatashop.csiro.au/real-time-carbon-emissions-intensity-of-the-national-electricity-market

9. DCCEEW (2022). *Your Home: Australia's Guide to Environmentally Sustainable Homes.* Sixth edition. Australian Government, Department of Climate Change, Energy, the Environment and Water. https://www.yourhome.gov.au/

10. ECCMC (2024). Meeting Communique, Energy and Climate Change Ministerial Council, 19 July 2024. https://www.energy.gov.au/sites/default/files/2024-07/ECMC Communique 19 July 2024.docx

11. EEC (2024). *Heat Pump Hot Water Systems in Australia: Building Quality, Confidence, and the Market*. Energy Efficiency Council. https://www.eec.org.au/uploads/Projects/HPHWS_Report_Digital.pdf

12. ESC (2023). Regulator takes action against businesses following allegedly non-compliant water heater installations. Essential Services Commission media release. https://www.esc.vic.gov.au/media-centre/regulator-takes-action-against-businesses-following-allegedly-non-compliant-water-heater

13. Ewald, B., Crisp, G. & Carey, M. (2022). Health risks from indoor gas appliances. *Australian Journal of General Practice*, 51(12). https://www1.racgp.org.au/ajgp/2022/december/health-risks-from-indoor-gas-appliances

14. Fieberg, C., & Van Asselt, A. (2024). Optimized control and aggregation of existing electric water heaters to enable solar PV grid integration. *Science and Technology for the Built Environment*, 30(8):959–971. https://doi.org/10.1080/23744731.2024.2324624

15. Kim, B., Lee, D., Lee, S. H. & Kim, Y. (2020). Performance assessment of optimized heat pump water heaters using low-GWP refrigerants for high- and low-temperature applications. *Appl. Therm. Eng.*, 181: 115954. https://doi.org/10.1016/j.applthermaleng.2020.115954

16. Krpan, S. (2024). Making sure every heat pump hot water system is safe. *Utility Magazine*. https://utilitymagazine.com.au/making-sure-every-heat-pump-hot-water-system-is-safe

17. Kuiper, G. (2024). Smart air conditioners could reduce energy bills for consumers. Briefing note. Institute for Energy Economics and Financial Analysis. https://ieefa.org/sites/default/files/2024-10/BN-Smart air conditioners could slash energy bills for consumers_Oct24.pdf

18. Lévesque, B., Lavoie, M. & Joly, J. (2004). Residential water heater temperature: 49 or 60 degrees Celsius? *The Canadian Journal of Infectious Diseases*, 15(1):11–12. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2094925/

19. NSW DCCEEW (2025). *Energy Savings Scheme Rule and Regulation Change 2025.* Energy Security Safeguard, NSW Department of Climate Change, Energy, the Environment and Water. https://www.energy.nsw.gov.au/sites/default/files/2025-02/DCCEEW_Energy_Savings_Scheme_Consultation_Mar_2025.pdf

20. Pears, A. (2024*a*). Why we need urgent action to solve the heat pump dilemma. *SwitchedOn*. 29 April 2024. https://switchedon.reneweconomy.com.au/content/why-we-need-urgent-action-to-solve-the-heat-pump-dilemma

21. Pears, A. (2024*b*). Ignore the efficiency claims made by heat pump manufacturers. *SwitchedOn*. 29 April 2024. https://switchedon.reneweconomy.com.au/content/ignore-the-efficiency-claims-made-by-heat-pump-manufacturers

22. Rendall, J., Nawaz, K., Elatar, A., Asher, W. & Worek, W. (2022). Performance evaluation of a wrapped around condenser for heat pump water heater applications. *Applied Thermal Engineering*, 207:118097. https://doi.org/10.1016/j.applthermaleng.2022.118097

23. Roberts, M., Passey, R., Adams, S., Whittaker, L., Russell-Bennett, R., McAndrew, R., & Caton, S. (2021). *Rewarding Flexible Demand. Customer Friendly Cost Reflective Tariffs and Incentives.* Opportunity Assessment Report for RACE for 2030 CRC. https://racefor2030.com.au/wp-content/uploads/2023/03/H4-OA-final-report-17.11.21.pdf

24. Roche, D., Dwyer, S., Rispler, J., Chatterjee, A., Fane, S. & White, S. (2023). *Domestic Hot Water and Flexibility*. Report prepared for ARENA by UTS Institute for Sustainable Futures. https://www.uts.edu.au/sites/default/files/2023-06/Domestic Hot Water and Flexibility.pdf

25. Saunders, M., Denniss, R. & Roussac, C. (2024). *Off-peak Hot Water in the 21st Century. Smarter Load Shifting in the NEM.* Discussion paper. The Australia Institute. https://australiainstitute.org.au/wp-content/uploads/2024/08/P1686-Off-peak-hot-water-in-the-21st-century.pdf

26. Sharpe, P. & D'Ambrosio, L. (2024). Driving cleaner and cheaper solutions for households with heat pump technology. Joint media release of the NSW Minister for Climate Change, Energy, Environment, and Heritage, and the Victorian Minister for Climate Action, Energy and Resources, and the State Electricity Commission. 22 July 2024. https://content.premier.vic.gov.au/sites/default/files/2024-07/240722-Driving-Cleaner-And-Cheaper-Solutions-For-Households-With-Heat-Pump-Technology.pdf

27. WHO (2002). *Guidelines for Drinking Water Quality. Addendum: Microbiological Agents in Drinking Water*. 2nd edn. World Health Organization. https://iris.who.int/bitstream/handle/10665/42361/9241545356_eng.pdf

28. Yildiz, B., Roberts, M., Bilbao, J.I., Heslop, S., Bruce, A., Dore, J., MacGill, I., Egan, R.J. & Sproul, A.B. (2021a). Assessment of control tools for utilizing excess distributed photovoltaic generation in domestic electric water heating systems. *Applied Energy*. 300:117411. https://doi.org/10.1016/j.apenergy.2021.117411

29. Yildiz, B., Bilbao, J.I., Roberts, M., Heslop, S., Dore, J., Bruce, A., MacGill, I., Egan, R.J. & Sproul, A.B. (2021b). Analysis of electricity consumption and thermal storage of domestic electric water heating systems to utilize excess PV generation. *Energy*. 235:121325. https://doi.org/10.1016/j.energy.2021.121325

30. Yildiz B., Salazar D., Saberi H., Klisser R., Bruce A., and Sproul A. (2025). *SolarShift: Turning household water heating systems into MW batteries. Final Report*, H3 Homes RACE for 2030. https://www.racefor2030.com.au/content/uploads/SolarShift-final-V4-compressed_1.pdf

Appendix A—Simulating controlled load

The project included periods during which a portion of heat pump water heaters were completely switched off and on again using the switches build into the Wattwatchers Auditor 6M devices.

Intervention protocols

First intervention protocol and selection criteria

An initial period of 31 days was used to test a controlled load scenario and collect data, commencing on 17 September and ending on 16 October 2024. The intervention included two days to transition to the final switching protocol, with 28 days (19 September – 16 October inclusive) for full monitoring and data collection. During this period, devices were switched on at 8 am AEST and switched off at 4 pm AEST, for an 8-hour operating window, centred on noon. The average solar noon for the intervention period for a representative central-NSW location (Ilford, 32.9623° S, 149.8579° E) is 11:49 AEST.

The 8-hour operating window was intended to simulate a basic controlled-load operating period, akin to Controlled Load 1 in NSW, but with an 8-hour rather than 6-hour window to reduce the chances of hot water shortages.

The following selection criteria were used to select devices for inclusion in the first intervention trial:

- {model suitable for controlled load operation (as recommended by manufacturer)} [14] AND
- {(maximum daily operating hours < 10) OR (average daily operating hours + 2SD <10)} [15] AND
- {Wattwatchers online and no problems detected with installation} [16] AND
- {consent provided by tenant}. [17]

Second intervention protocol and selection criteria

A second period of 30 days was used to test a second controlled load scenario and collect data, commencing on 22 October and ending on 20 November 2024. The intervention included one day to transition to the second switching protocol and one day to transition back to uncontrolled operation, with 28 days (23 October – 19 November inclusive) for full monitoring and data collection. During this period, devices were switched on at 9 am AEST, switched off at 4 pm AEST, switched on again at 9 pm AEST and switched off again at 6 am AEST, for a total of 16 hours of operating windows. The average solar noon for the intervention period for the same representative central-NSW location (Ilford) is 11:44 AEST.

The following selection criteria were used to select devices for inclusion in the first intervention trial:

- {HPHWS model suitable for controlled load operation (as recommended by manufacturer)} AND
- {(maximum daily operating hours < 16) OR (average daily operating hours + 2 × SD < 16)} AND
- {Wattwatchers online and no problems detected with installation} AND
- {consent provided by tenant}.

[14] This excluded all Thermann devices.

[15] This excluded properties with a higher risk of hot water shortages during the intervention trial.

[16] This excluded several properties that were offline or had problems with installation of their Wattwatchers.

[17] Consent from all tenants was sought prior to the intervention.

Automation

The Wattwatchers Auditor 6M devices operates with two switch states:

- **Closed (ON)**—the circuit is complete, allowing current to flow.
- **Open (OFF)**—the circuit is broken, stopping current flow.

The Wattwatchers portal provides manual control of switches but does not provide a straightforward way to automate this switching. For this project, we developed a series of Python scripts to automate switching of the HPHWSs. A description of each script and its function is provided in Table 17 below.

Table 17. A description of each script and its function.

File	Description
close_switches.py	This script turns ON the specified Wattwatchers devices. A retry mechanism is implemented to enhance reliability, with up to three attempts to connect to the switch over a period of slightly more than two minutes.
open_switches.py	This script turns OFF the specified Wattwatchers devices. The same retry mechanism is employed.
devices.py	This file contains a list of devices and their corresponding switch identifiers, allowing the automation to target specific devices.
get_devices_and_switches.ipynb	Auxiliary Jupyter notebook that includes useful functions for analysing individual devices.

The scripts **close_switches.py** and **open_switches.py** are responsible for managing the ON and OFF states. The scripts can be run on the loud service *PythonAnywhere* or locally on any system. Importantly, the automation relies on the Wattwatchers API, which requires an API key for authentication. This key is stored securely using environment variables.

After implementing the first intervention protocol, problems were detected with devices not being switching on and/or off when requested. This problem was determined to be caused by devices being offline at the time of the switching event. To minimise the impacts of this issue and to prevent HPHWSs from inadvertently being left off for extended periods, the protocol was modified to include additional attempts to switch units on or off one and two hours after the allotted time.

Problems with automation

Automated switching was affected by several Wattwatchers devices being offline at the time of switching. This problem affected 11 of 30 devices (37%) during the first intervention and 24 of 45 devices (53%) during the second intervention. Affected device were removed from subsequent analysis.

These and other devices errors are illustrated in Figure 25 and Figure 26.

One step taken to reduce the level of failed switching was to send the switching signal multiple times—three times at the designated switching time, three times one hour after this time, and three times two hours after this time.

The reasons for failed switching are unclear, but are most likely related to communications failures, particularly for more remote properties with weak access to the 4G GSM network.

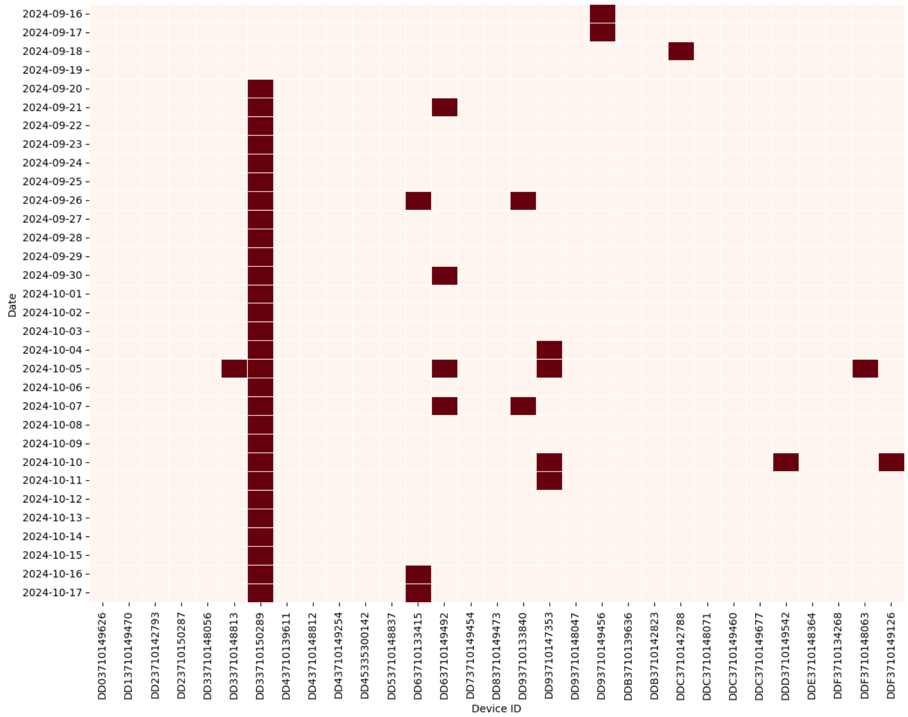


Figure 25. Device errors during the CL1 trial.

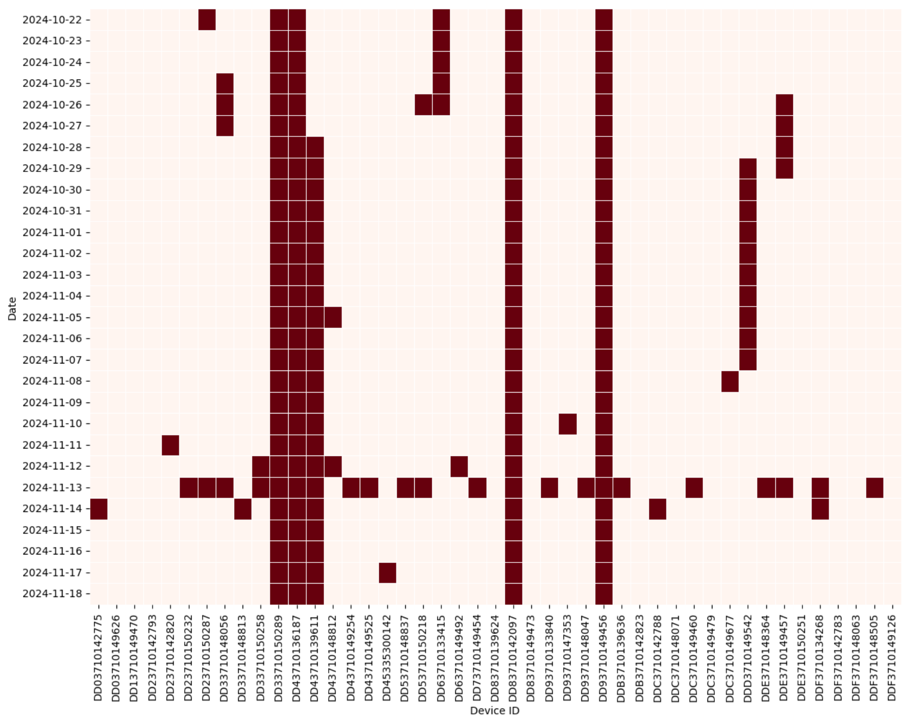


Figure 26. Device errors during the CL2 trial.

Appendix B—Tenant survey results

Part 1—Basic information

	2023		2024	
	No.	(%)	No.	(%)
Number of tenants participating in the survey				
Survey respondents	24	72.7	73	64.0
No response/unable to contact	9	27.3	41	36.0
Total installed	**33**	**100.0**	**114**	**100.0**
How many people (including you and any children or guests staying longer than 6 months) usually live in your home?				
1 person	13	64.4	28	38.4
2 people	6	31.6	16	21.9
3 people	–	–	9	12.3
4 people	–	–	7	9.6
5 people	–	–	8	11.0
6 people	–	–	3	4.1
7 people			2	2.7
Total	**19**	**100.0**	**73**	**100.0**

How many people living in your home are in the following age groups? (2024)

No.	<3	3–10	11–19	20–70	70+	Total
1	–	3	2	2	–	7
1	–	3	–	4	–	7
1	2	2	–	2	–	6
1	–	–	3	3	–	6
1	–	–	5	1	–	6
1	1	1	2	1	–	5
1	2	1	1	1	–	5
1	2	–	1	2	–	5
1	4	–	–	1	–	5
2	–	2	2	1	–	5
1	–	3	–	2	–	5
1	–	–	2	3	–	5
1	1	1	1	1	–	4
1	–	1	2	1	–	4
3	–	1	–	3	–	4
1	–	2	–	2	–	4
1	–	–	1	3	–	4
1	–	1	1	1	–	3
1	–	2	–	1	–	3
3	–	–	1	2	–	3
2	–	–	2	1	–	3
1	–	–	–	3	–	3
2	1	–	–	1	–	2
1	–	1	–	1	–	2
1	–	–	1	1	–	2
3	–	–	–	1	1	2
9	–	–	–	2	–	2
19	–	–	–	1	–	1
9	–	–	–	–	1	1
Total	**14**	**28**	**33**	**97**	**12**	**184**
%	7.6	15.2	17.9	52.7	6.5	100.0

Part 2—Hot water usage

	2024 No.	2024 (%)
On average how many showers per day are taken in your household?		
1	22	30.1
2	16	21.9
3	15	20.5
4	8	11.0
5	5	6.8
6	1	1.4
7	2	2.7
8+	4	5.5
Total	**73**	**100.0**

	2024 No.	2024 (%)
On average how many baths per day are taken in your household?		
0	48	65.8
1	18	24.7
2	5	6.8
3+	2	2.7
Total	**73**	**100.0**

	2024 No.	2024 (%)
How many times per day do you hand wash your dishes, cutlery etc. using hot water?		
0	–	–
1	27	37.0
2	27	37.0
3	7	9.6
4	2	2.7
5	2	2.7
6+	8	11.0
Total	**73**	**100.0**

	2024 No.	2024 (%)
Do you have a washing machine?		
No	1	1.4
Yes	72	98.6
Total	**73**	**100.0**

	2024 No.	2024 (%)
Is your washing machine connected to one water tap (cold water only) or two water taps (cold and hot water)?		
One tap – cold water only	38	52.8
Two taps – cold and hot water	29	40.3
Unsure	5	6.9
Total	**72**	**100.0**

	2024 No.	2024 (%)
How many loads of washing does your household do on an average per week?		
1	9	12.3
2	17	23.3
3	11	15.1
4	8	11.0
5	4	5.5
6	5	6.8
7	3	4.1
8	1	1.4
9+	11	15.1
No answer	3	5.5
Total	**73**	**100.0**

Part 3—Hot water system installation

	2023 No.	2023 (%)	2024 No.	2024 (%)
Overall, do you think the tradespeople installing the hot water system did a good job?				
Yes	19	86.4	70	97.2
No	3	13.6	2	2.8
Total	**22**	**100.0**	**72**	**100.0**
Were you happy with the process of booking an appointment to install the hot water system?				
Yes			68	94.4
No (Note 1)			3	4.2
No response			1	1.4
Total			**72**	**100.0**
Were the tradespeople that installed the hot water system friendly, polite and helpful?				
Yes			70	95.9
No (Note 2)			2	2.7
No response			1	1.4
Total			**73**	**100.0**
Are you happy with the location of the hot water system?				
Yes	15	45.5	67	91.8
No	8	24.2	3	4.1
No response	10	30.3	3	4.1
Total	**33**	**100.0**	**73**	**100.0**

	2024	
	No.	(%)
How well informed did you feel about using your new hot water system? (Note 3)		
Well informed	37	53.6
Very well informed	12	17.4
Moderately well informed	7	10.1
Slightly well informed	9	13.0
Not at all well informed	4	5.8
Total	**69**	**100.0**

Part 4—Operation and satisfaction

	2023		2024	
	No.	(%)	No.	(%)
Before the new hot water system was installed, did you ever run out of hot water?				
Yes			39	53.4
No			31	42.5
Unsure			3	4.1
Total			**73**	**100.0**
Since the new hot water system was installed, have you ever run out of hot water?				
Yes	3	9.1	4	5.5
No	20	60.6	67	91.8
Unsure	–	–	1	1.4
No response	10	30.3	1	1.4
Total	**33**	**100.0**	**73.0**	**100.0**
Do you hear any noise from your new hot water system? (Note 4)				
No	13	39.4	44	61.1
Yes	11	33.3	1	1.4
Yes – day and night			17	23.6
Yes – day only			3	4.2
Yes – night only			7	9.7
No response	9	27.3	–	–
Total	**33**	**100.0**	**72**	**100.0**
Is the noise level acceptable (i.e. not disturbing your sleep or wellbeing)? (Note 5)				
Yes	21	63.6	29	39.7
No	3	9.1	7	9.6
No response	9	27.3	37	50.7
Total	**33**	**100.0**	**73**	**100.0**

	2023		2024	
	No.	(%)	No.	(%)
Have you had any maintenance problems with your new hot water system? (Note 6)				
Yes	6	18.2	24	33.3
No	18	54.5	47	65.3
No response	9	27.3	1	1.4
Total	**33**	**100.0**	**72**	**100.0**
How satisfied are you with the new hot water system installed at your property?				
Very satisfied	8	33.3	43	62.3
Satisfied	8	33.3	18	26.1
Neither satisfied nor dissatisfied	4	16.7	3	4.3
Dissatisfied	1	4.2	2	2.9
Very dissatisfied	3	12.5	3	4.3
Total	**24**	**100.0**	**69**	**100.0**

Part 5—Energy bills and wellbeing

	2024	
	No.	(%)
Have you found it difficult to pay your energy bills in the past 12 months?		
Yes	25	34.2
No	47	64.4
Unsure	1	1.4
Total	**73**	**100.0**
Have you found it difficult to heat or cool your home in the past 12 months due to high running costs?		
Yes	28	38.9
No	44	61.1
Unsure	–	–
Total	**72**	**100.0**
Have you noticed a change in your energy bills since the hot water system was installed?		
My bills have decreased	23	31.5
My bills have increased	8	11.0
No change	16	21.9
Unsure (Note 7)	26	35.6
Total	**73**	**100.0**

	2024	
	No.	(%)
Since receiving your hot water upgrade, have you noticed an improvement to your health or wellbeing?		
Yes	23	31.9
No	29	40.3
Unsure	20	27.8
Total	**72**	**100.0**

Part 6—Demographics

	2024	
	No.	(%)
What is your age range?		
25–34	8	11.0
35–44	10	13.7
45–54	15	20.5
55–64	19	26.0
65–74	13	17.8
75+	7	9.6
No response	1	1.4
Total	**73**	**100.0**
What is your gender?		
Female	54	74.0
Male	19	26.0
Self-described	–	–
Total	**73**	**100.0**
Do you speak other languages other than English at home?		
English only	59	80.8
Other language	10	13.7
No response	4	5.5
Total	**73**	**100.0**

Notes

1. Several tenants complained about not receiving prior notice of the installation other than a text message from the installers.
2. The main complaint was that installers did not clean up after installation.
3. Several tenants expressed a desire to know more about the system. Comments include:
   - *"Would like to know more about the LED screen and how it works. Sometimes it locks."*
   - *"Would like to know how much money I will save."*
   - *"Would like to know how to make it run at night more."*
   - *"Didn't leave a manual or fact sheet."*
4. In addition to noise from the fan, two tenants complained about noise from rain falling from gutters onto the top of the heat pump unit.
5. Most respondents who answered No to the previous question were not asked this question. Two respondents complained about noise caused by rainwater from leaky gutters falling onto the unit.
6. Problems reported in 2024 include:
   - water temperature not hot enough
   - water leaks
   - noise from vibration
   - running out of hot water
   - system resets and other minor problems that were quickly rectified.

   In 2023, water leaks were the most reported problem.
7. Responses to this question are considered unreliable. Many respondents have a fixed fortnightly debit set up and do not look at their bills. Others receive government subsidies to reduce their bills. Tenants moved off gas would have higher electricity bills but no gas bills following full electrification.

RACE for 2030

www.racefor2030.com.au

Australian Government
Department of Industry, Science and Resources

Cooperative Research Centres Program