

ShowerStar Field Trial: Data analysis



Executive Summary

Globally, there is pressure on water resources and Western Australia faces unique water challenges in the face of climate change. Downward trends in the availability of traditional water sources are likely to continue, whilst population is forecast to increase. In the last 20 years, average inflow to dams in the Perth region has decreased by 40%, while the population has nearly doubled. To combat this, Water Corporation has employed a range of solutions including alternative water sources, and improved water efficiency. Ongoing innovation is necessary, and water efficiency represents a relatively low-cost opportunity to solve the problem of increasing demand and reducing supply.

This report presents the results of data analysis conducted by The University of Queensland (UQ) for a field trial of a potential water efficiency solution: ShowerStar (developed by TouchGrid) is a modern shower timer which records shower duration and provides feedback to users. The primary aim of the device in this context is to reduce water consumption; however, it also has flow on effects including reduced energy, carbon emissions as well as beneficial reductions in cost of living as a result of the water and energy use reduction. The device records the time and duration of each shower and makes this information available to users via an app. It also provides visual alerts to users while they shower, to encourage them to take shorter showers.

The trial design was led by Water Corporation with input from TouchGrid. Data analysis was carried out by UQ. Trial participants were recruited by Water Corporation, with 95 households participating. Recruitment surveys were sent out in May 2025, and 149 devices were subsequently distributed. Participants installed their devices between June and August 2026, and devices were configured to run in 'field trial' mode for the first 30 showering events, to provide a baseline of showering duration without feedback from the device. After field trial mode, the devices automatically shifted to the normal operating mode, and data was collected through to December 2025. A second survey was sent out in October 2025 to collect feedback on user experiences.

Across 9218 shower events, the mean duration in field trial mode was 8.5 minutes, and the mean duration in normal operating mode was 6.5 minutes. This suggests that the feedback from the device helped users to reduce shower duration by 2 minutes. Users with a higher baseline water use appeared to benefit the most from the device, however the trial was not specifically designed to test this variability. Households with average field trial duration greater than 10 minutes accounted for 25% of participants, but the summed duration of events from these households was 56% of the total shower duration for the study.

The study identifies other specific segments where the device is most effective. Devices in households without children showed the greatest overall savings. Furthermore, households that self-reported as "somewhat motivated" achieved notably higher savings than those who reported "very motivated", suggesting the device may help to successfully bridge the gap for those lacking the tools to trigger behaviour change.

Whilst these results are promising, further investigation is recommended to a) build evidence of savings in a larger and more representative sample, b) assess the user experience independently of savings, c) scale up to estimate city-wide savings. In particular:

- Recruitment surveys could collect wider demographic information to select a participant pool that is representative of Perth / Western Australia, with respect to key factors such as age, household size, income, water literacy etc.
- Separation of the user experience from the savings in experimental design could be achieved by use of alternative metering (e.g. paired with smart meter rollout) for the field trial period before distributing the devices, or conducting separate experiments to test savings and user experience.
- Linking experience survey responses to ShowerStar device data is crucial to assess impact
- Sample size can be increased through both a wider recruitment pool, and also by using automatic syncing between the device and the app to reduce reliance on users' uploading data (an automatic syncing feature has recently been added by TouchGrid).

Version History

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1. Introduction

The aim of this project was to support Water Corporation to conduct a preliminary investigation into the potential of the ShowerStar device (TouchGrid) to influence savings of water, energy and carbon emissions. The trial design was led by Water Corporation with input from TouchGrid.

The specific objectives of the UQ analysis (the UQ-Water Corporation contract) were:

- To evaluate the effectiveness of ShowerStar to save water in residential bathrooms.
- To evaluate the effectiveness of ShowerStar to save water in Aquatic Centres.
- To evaluate if residents can install the device and use the ShowerStar app and to evaluate their feedback.
- To evaluate if aquatic centre managers can download and evaluate data from changeroom showers.

The following research questions were developed by UQ to inform the analysis:

- Is there evidence of water savings across the study sites due to ShowerStar?
- Based on observed water savings, what are the energy and greenhouse gas emissions savings for the households or the aquatic centres?

1.1 Background

Per capita water supply to the Perth region decreased from 540 L/person/day in 2001 to 350 L/person/day in 2021 (35% decrease) (Yan et al., 2024). However, total water supply remained relatively steady during this period because the population increased from 1.4 million in 2001 to 2.2 million in 2021 (50% increase) (Australian Bureau of Statistics, 2026). At the same time, climate-related events have reduced traditional water sources, with the average inflow into dams reduced by 40% over the last 20 years (Water Corporation, 2026). Desalination now represents 38% of Perth's water supply, compared to just 7% during the early 2000s.

Households have historically proved to be pivotal for water utilities seeking to manage water demand. In Perth, 69% of water supplied is consumed by residential properties (Water Corporation, 2024). Over the last 20 years, Water Corporation has successfully implemented a number of programs targeting residential water conservation. For example, Perth residents have rostered days for watering gardens, and violation of this roster results in an on-the-spot fine (Water Corporation, 2025). The challenge facing water utilities in the coming decades is substantial, as forecasts expect continuing increase in population with decrease in traditional water sources. Continuous improvement in residential water efficiency will be essential to meeting the challenge.

Water efficiency has major co-benefits relating to energy consumption, carbon emissions and cost-of-living. As a result of the shift away from surface water toward more desalinated water, the overall water supply system in Perth has become more energy-intensive and costly. Energy consumption to support water services has more than doubled, reaching 281.9 kWh per person per year in 2020 (Yan et al., 2025). Additionally, water and energy consumption is deeply interconnected in residential properties. For example, hot water in residential properties typically represents about 40% of total household energy consumption (Pomianowski et al., 2020). Therefore, water utilities can influence the carbon emissions of their water cycle and the cost-of-living for their communities through water efficiency measures.

1.2 Reducing shower duration and informing customers to save water and energy

One of the most critical intervention points within households are showers, which represented 24% of residential water consumption in Perth in 2021/2022 (Water Corporation, 2024). Options to reduce the water and energy consumption of showers include reduced shower duration, installation of low-flow showerheads and improved insulation, among others. Any intervention to reduce water consumption of showers will also influence energy, as it reduces the volume of hot water that needs to be heated, as well as energy required for production of the water (e.g. energy used in the production and pumping of water).

Shower duration has been consistently shown to have a significant impact on residential water and energy consumption. A reduction in shower duration from 10 mins to 4 mins in a typical Perth household could reduce indoor water use by 25%. For five households in Melbourne, this change has been shown to reduce household energy consumption by 10-15%. (Binks et al., 2017). To influence user behaviours such as shower duration, it is helpful to provide feedback to users in the form of information or alerts.

1.3 ShowerStar

ShowerStar is a patent-pending device created by TouchGrid (Figure 1), designed to provide user feedback to customers on shower duration, with the goal of reducing water and energy consumption. The device records information on users' showering habits and makes this information accessible to users via an app. The device also provides visual alerts to users while they shower, to encourage them to meet reduction targets. ShowerStar is mounted externally to the shower pipe, so is easy for users to install without needing to engage a plumber.

In 2025, UQ delivered a small pilot study of the ShowerStar product for TouchGrid. The study involved preliminary data analysis of shower events, discussion on water and energy saving capability of the device, and recommendations to improve communications and experimental design for future studies.

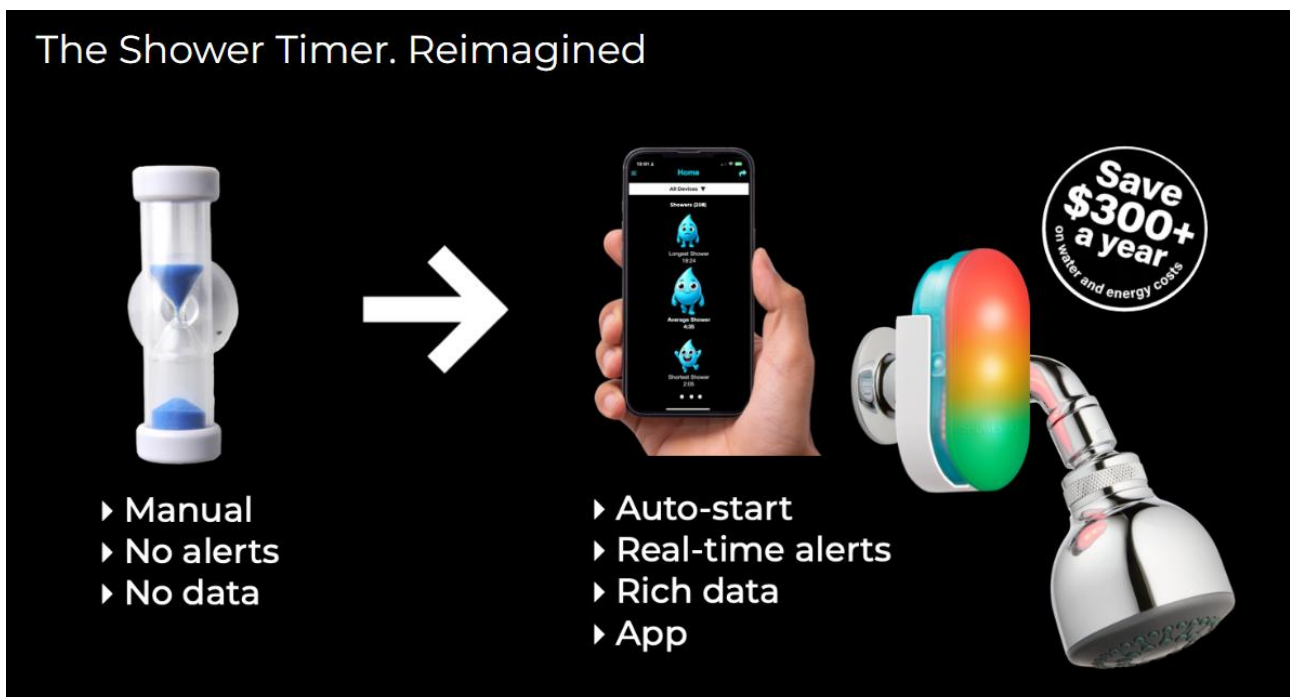


Figure 1 ShowerStar concept (TouchGrid, 2025a)



Figure 2 ShowerStar features (TouchGrid, 2025a)

2. Field trial method

The data collected from the ShowerStar devices was used to assess the impact of the device on the duration of the participating households' showers, and the subsequent estimated impact on water and energy consumption, and carbon emissions. 149 ShowerStar devices were distributed to the 95 homes. Devices were also installed in 10 male shower cubicles and 10 female shower cubicles in the bathrooms of an aquatic centre.

2.1 Data collection

Data collection for the field trial, including recruitment, distribution surveys, was completed by Water Corporation. Data from the ShowerStar devices was retrieved, stored and aggregated by TouchGrid. An overview of the data collection processes is provided in this section to give context to the data analysis conducted by UQ.

Recruitment surveys were sent to potential trial participants on 21st May 2025. All respondents were sent one or two ShowerStar devices, except for one respondent who pulled out of the trial. 149 ShowerStar devices were sent to 95 participating households. An additional 20 devices were installed in the Aquatic Centre. Participants were provided with two A5 flyers from TouchGrid, as well as TouchGrid's instructions for installing and configuring the device.

The ShowerStar device recorded the time and duration of shower events based on readings from a vibration sensor. Events shorter than 30 seconds were discarded by the device, in order to prevent false recordings of shower events due to vibrations in the pipe caused by nearby water appliances, such as toilets. ShowerStar device data was collected over a period of 7 months between June and December 2025. Devices were installed by households over an extended period, with first events for each device recorded between June and August 2025.

Three households informed Water Corporation that they did not install their devices. One household had a change in circumstance and pulled out. One returned their two devices due to it

being too complex. One had a water leak and couldn't install as the bathroom was renovated. Several moved house mid-trial.

Surveys were used to understand the demographics of the households, as well as the participants' impression of their showering habits and their experience of using / interacting with the ShowerStar device. The recruitment survey responses were later linked to devices. The experience survey was sent out on 10th October 2025, and responses were collected anonymously.

All data received by UQ was stored securely on an internal OneDrive and was tracked using a data register to ensure the most up to date versions were used to inform the analysis. ShowerStar data was shared with UQ via a PowerBI dashboard. The dataset used in the analysis presented in this report was downloaded on 7th January 2026. Survey data was emailed by Water Corporation.

2.2 ShowerStar configuration

For the purpose of this study, the household devices were configured to operate in 'field trial mode' by default. 'Field trial mode' is a feature of the device that records the 'baseline' shower duration of a household. In this mode, the device records shower information as it normally would, but does not provide any feedback to the user through visual or audio cues. This enabled comparison between the baseline and the intervention. Devices installed at the aquatic centre did not run in field trial mode.

The devices were configured to run for 3 events in 'normal mode' to allow the user to check the device was working, then 30 events in 'field trial mode' to establish a baseline, then change back to 'normal mode' for the rest of the experiment. However, users could change the operating mode at any time in the settings of the mobile app.

In 'normal mode' the devices provide visual and/or audio alerts to users at certain points throughout the shower. By default, the devices were configured to operate with 'traffic light' alerts (Figure 3). By default, the device is configured with a 30 second 'warm-up' period, between when flow is detected (blue) and when the timer starts (green). The half time (yellow) and full time (red) are 2 and 4 minutes respectively. Users can adjust these settings in the mobile app.

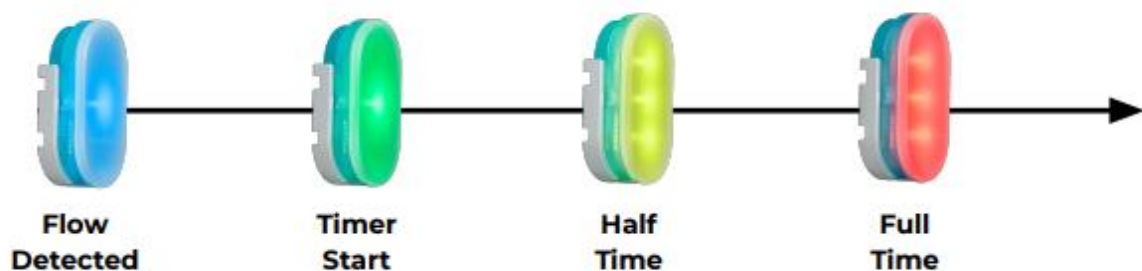


Figure 3 Lighting schedule for 'traffic light' alerts (TouchGrid, 2025b).

2.3 Data analysis

2.3.1 Data cleaning and checking for households

To ensure quality of the data analysis, the raw data for the ShowerStar devices and surveys was assessed using Python code to identify any anomalies or unexpected behaviour in the data. Details of checks performed are provided in Appendix A.

Notably, 85 devices (~60% of total devices) from 69 households (~70% of total households) logged a shower event. At least 3 households were known to have withdrawn and others were no longer contactable.. It is possible that these households did not continue to participate in the trial. Other potential reasons to explain households/devices without data are discussed with the survey results in Section 3.1.4.

As part of the data cleaning process, transcription errors in the device IDs for the survey responses were identified (e.g. B in place of 8, O in place of 0). An algorithm was developed to systematically rectify these errors, however 17 IDs from survey responses were unable to be matched uniquely with known device IDs. Similarly, 12 devices with data were unable to be matched uniquely to survey responses.

2.3.2 Summary statistics and survey breakdowns

Summary statistics were generated for field trial mode events and normal operating mode events across all devices. The events were also broken down by their usage (e.g. adults or children), the number of devices installed in the household, the households' self-reported motivation to save water, and the baseline shower duration (low, moderate, high). Device usage and number of devices were obtained from the recruitment survey and the ShowerStar dataset. Motivation to save water was obtained from the recruitment survey.

Households were assigned as 'low' shower duration if their mean shower duration in field trial mode was lower than the median shower duration for all devices in field trial mode. They were assigned to 'moderate' if their mean shower duration in field trial mode was less than the 75th percentile of all devices in field trial mode, and to the 'high' group if above the 75th percentile.

2.3.3 Statistical testing

To determine whether the field trial influenced shower duration and, by extension, potential water savings, a non-parametric statistical approach was applied using Python. The Mann-Whitney U test was selected because it does not assume normal distribution and is suitable for comparing two independent samples.

For each device, the Mann–Whitney U test was performed to compare the events in 'field trial mode' with those in 'normal mode'. The Mann-Whitney test produced a P-value, which indicates whether the observed difference is statistically significant. A threshold for the P-value of 0.05 was used to indicate a statistically significant difference in the shower durations for each mode.

2.3.4 Calculation of estimated water, energy and greenhouse gas emissions savings

Water savings associated with the reduction in shower duration were calculated according to Equation 1, where t is the duration change between 'field trial mode' and 'normal mode', F is the shower flowrate.

$$W = t \times F \quad (\text{Equation 1})$$

Energy savings associated with water heating were calculated based on the estimated water savings using Equation 2, where C_p is the heat capacity of water, T_{shower} is the temperature of water for the shower (after mixing), and T_{cold} is the temperature of cold water out of the tap.

$$E = W \times C_p \times (T_{shower} - T_{cold}) \quad (\text{Equation 2})$$

Values for the reduction in shower duration were derived from the statistical testing of data from the ShowerStar devices. Values for shower flowrate, shower temperature and cold water temperature were estimated based on publicly available data for Perth / Australia. Details of the values used and their sources are included in Appendix B.

A factor for carbon emissions associated with water heating (f_1) was applied based on natural gas in Western Australia (51.5 kgCO₂-e/GJ) (Australian Government, 2023). Additionally, a factor for carbon emissions associated with water and wastewater treatment (f_2) was applied to the water savings (1.5 and 0.7 gCO₂/L) (Yan et al., 2025). Thus, the carbon emissions savings are represented in Equation 3.

$$C = E \times f_1 + W \times f_2 \quad (\text{Equation 3})$$

3. Results

3.1 Households

3.1.1 Summary statistics for ShowerStar data

Aggregating the shower events across all households demonstrated that the mean shower duration of events recorded in field trial mode (i.e. no alerts) was 8.5 mins (Figure 4). In contrast, the mean shower duration in normal mode (i.e. with alerts) was 6.5 mins, demonstrating a reduction of 25% (2 mins). These preliminary results showing aggregated statistics suggest that shorter showers were observed in normal mode compared to the baseline in field trial mode.

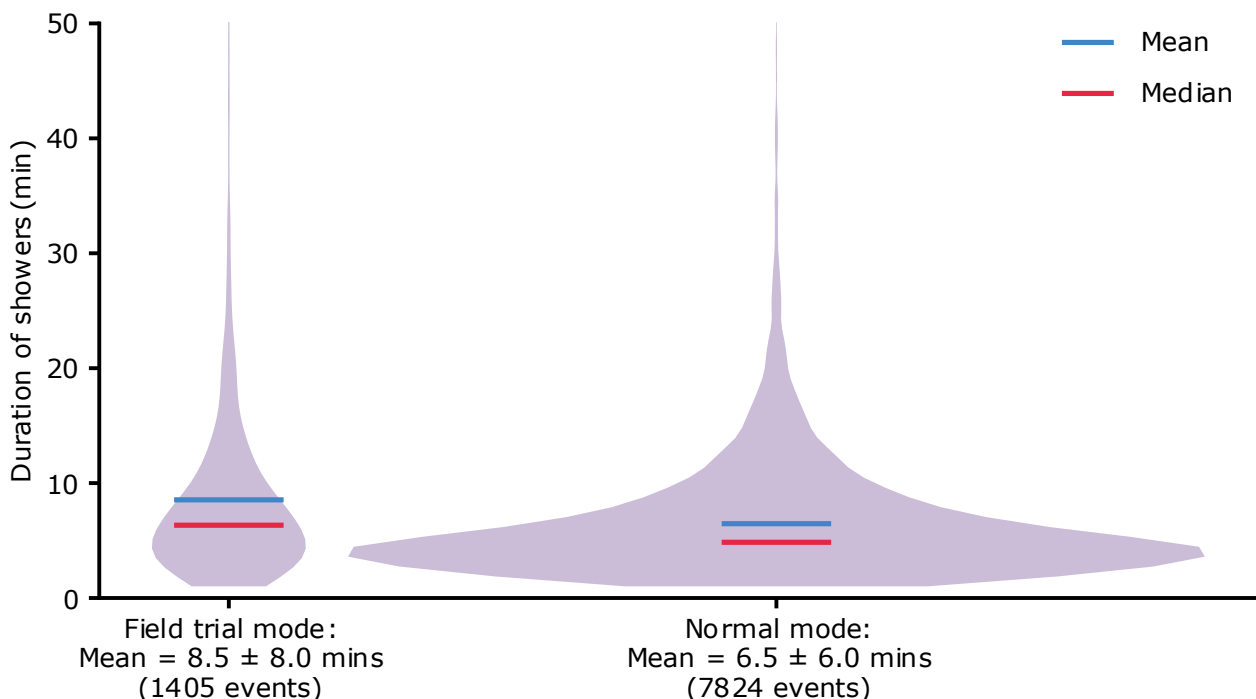


Figure 4 Distribution of all recorded household showers in field trial mode and normal mode. Variance reported with the mean is standard deviation.

Within the overall group of 85 devices with data, 72 were able to be linked to survey responses. Breaking down the savings based on survey responses showed that devices located in adult only households showed the greatest savings, compared to devices in households with children (Figure 5a). For households with children, devices that were used by adults only showed limited savings, while devices used by children only or both children and adults (mixed) showed moderate savings.

Regarding the self-reported motivation for water savings within the household, the most notable savings were observed amongst households that were 'somewhat motivated' to save water (Figure 5c). Interestingly, this was much higher than those who were 'very motivated' to save water. It is possible that the 'somewhat motivated' households represent the highest discrepancy between water literacy and ability to take action. For example, households who reported 'very motivated' appeared to already be taking shorter showers, thus despite high motivation, there is limited room for further improvement. However, those reporting 'somewhat motivated' had higher starting durations but were evidently aware that this was not ideal, and were perhaps lacking the tools to trigger effective behaviour change.

Devices that recorded the highest shower durations during field trial mode demonstrated the greatest savings when the device was switched to normal operating mode (Figure 5d). Events with a duration greater than 10 minutes accounted for 26% of events in field trial mode but 56% of the total shower duration summed across all events in field trial mode. In normal mode, showers greater than 10 minutes accounted for only 16% of events and 39% of total shower duration.

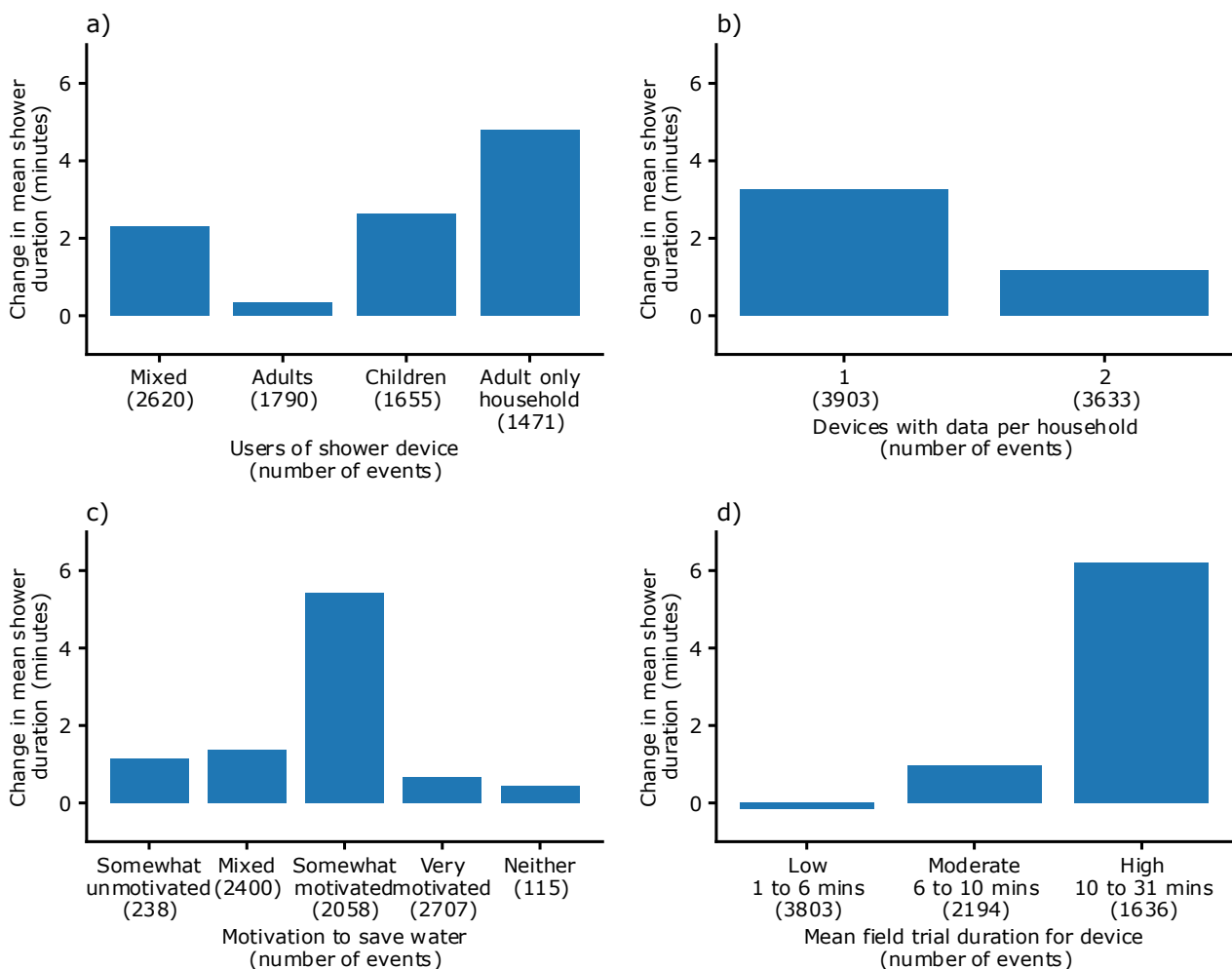


Figure 5 Reductions in mean shower duration between field trial mode and normal mode for groups of interest

Preliminary findings from this study also suggest that the behaviour change persisted throughout the trial. The aggregated mean duration for each week (relative to the switch from field trial mode to normal operating mode) continued to decrease until 25 weeks post-change (Figure 6). However, further testing and investigation would be required to confirm this finding, particularly to establish whether this finding holds for all key groups, such as high water users.

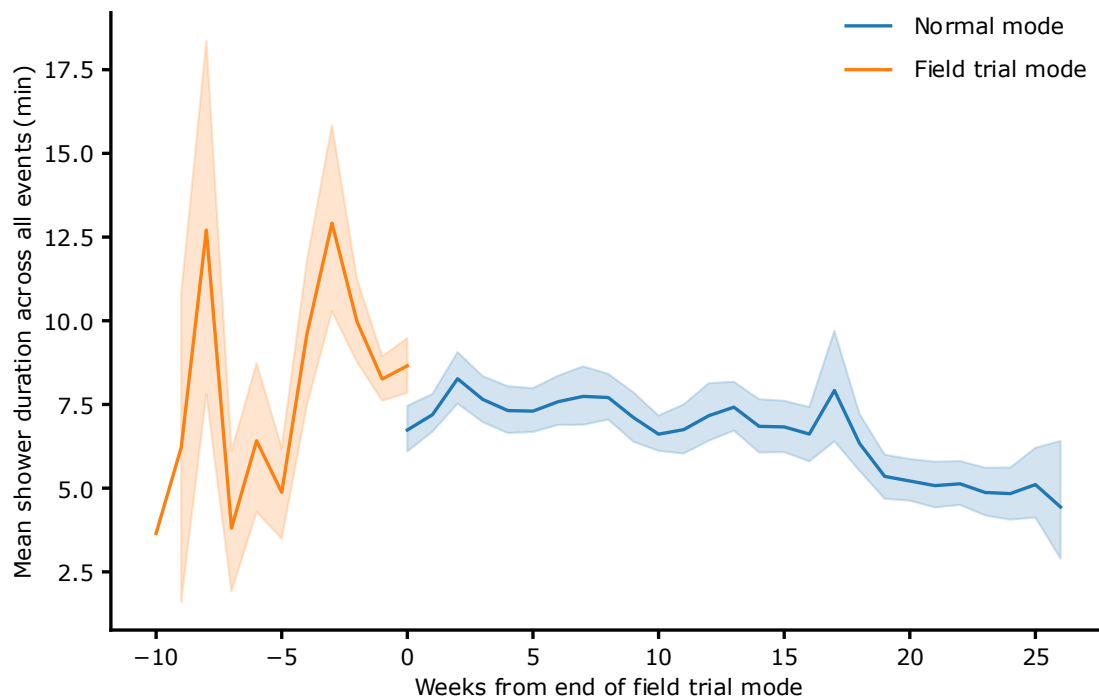


Figure 6 Duration of showers appears to continue to remain lower than field trial mode for many weeks after switching to normal mode. Graph shows 8002 events from 80 households (5 households were dropped because they had more than one field trial period)

However, it is important to consider that only 53 devices recorded events in field trial mode, compared to 85 devices that recorded any events. Thus, 38% of devices did not record a baseline for comparison. Therefore, the following section conducts more detailed analysis into the savings at a household level. Please refer to Appendix C for a more comprehensive overview.

3.1.2 Statistical testing of household level savings

Across the full set of data, 42 households recorded events in both field trial mode and normal mode. The difference in shower duration between the two modes was statistically significant in 18 households (i.e. 43% of households with data in both modes). Sample size is an important factor in determining statistical significance, so households with a low number of measurements in either field trial or normal mode would not register as being statistically significant, even if they showed a large change in duration between the two modes. Whilst this method provides a more detailed comparison of savings on a per-household basis, the sample size is smaller than the sample size of the full fleet so is less representative.

Across the 18 households that demonstrated a statistically significant change in shower duration, average duration in field trial mode was 9.8 minutes, compared to 5.8 minutes in normal mode. This is equivalent to a mean change of 4 minutes. The median reduced from 7.5 to 4.6 minutes, a change of 2.9 minutes. The data is skewed, so the median gives a better indicator of central tendency (i.e. where most households fall), however, the mean captures the impact of larger savings. It is important to capture these larger savings because households with high water use will benefit the most from the ShowerStar device.

3.1.3 Water, energy and carbon emissions savings

Using the mean reduction of 2 minutes across the whole fleet would correspond to water savings between 12 and 25 L per shower, depending on the flowrate of the showerhead. The mean reduction of 4 minutes in shower duration results in 24 to 48 L of water saved per shower. The resulting energy savings would be between 0.3 and 1.2 kWh per shower (1.2 to 4.4 MJ per shower) for the 4 minute reduction, or 0.2 and 0.6 kWh (0.6 to 2.3 MJ) per shower for the 2 minute reduction, depending on the temperature of cold water. Finally, the anticipated GHG savings would be between 116 and 335 gCO₂ per shower for the 4 minute reduction or 60 to 173 gCO₂ per shower for the 2 minute reduction. Refer to Appendix D for the water, energy and GHG savings associated with the median duration change.

3.1.4 Overview of experience survey responses

Of the 95 participating households, 57 completed the experience survey (60%). Multiple choice questions from the experience survey demonstrated that most participants who responded to the survey engaged with the product and found it easy to use and setup. 88% of users who completed the experience survey ranked ease of installation as a 4 or 5, and 59% ranked the ease of using the app as a 4 or 5.

User impressions of efficacy were mixed. Only 34% of respondents indicated that they believed the device had encouraged members of their household to take shorter showers, 28% of respondents believed they did not take shorter showers, and 38% of respondents were unsure. In the open-ended questions, respondents reported a range of attitudes towards the device within the household, from excited engagement, to apathy, through to serious concerns regarding privacy.

A key theme out of the open-ended survey responses (Table 1) was that the use of field trial mode complicated the user experience. Notably, the ShowerStar data showed that 51 devices did not record the expected number of field trial events (Table 2). This would fit with users resetting the device because they have not observed flashing and don't realise that is expected, triggering field trial mode to start again. This could also explain why several users did not believe that the device was accurately capturing data.

Please refer to Appendix E for more details on the survey responses.

Table 1 Overview of survey responses for open-ended questions

Question	# ¹	Key themes in responses
If not installed, what do you think was the main reason/s?	9	<ul style="list-style-type: none"> - Shower out of action for unrelated reason such as leaks - Issues with setup in specific situations
Any suggestions for improvement of the installation process?	15	<ul style="list-style-type: none"> - Calibration of sensitivity / tightness / location took time - Some concerns with aesthetics - Some respondents found the installation process too complicated - Lack of understanding regarding field trial mode
Any suggestions for improvement of the app?	24	<ul style="list-style-type: none"> - More options for data visualisation would be helpful - Some respondents had trouble using the app
Any suggestions to improve the process of downloading data to the app?	22	<ul style="list-style-type: none"> - Many respondents suggested allowing an option for more automated connection between the device and the app - Some respondents reported lost or inaccurate data

Question	# ¹	Key themes in responses
Were you surprised by the results presented on your app?	37	<ul style="list-style-type: none"> - Most respondents were surprised by the results, usually because the showers were longer than expected - Some users did not believe the shower had recorded events accurately
Any suggestions for feedback on the traffic light system?	30	<ul style="list-style-type: none"> - Audio alerts such as a beep would be helpful - Some users reported that the lights didn't work (however this was possibly due to a misunderstanding of the field trial mode) - Some users reported flashing patterns that suggested the sensitivity was not properly calibrated, however they appeared unaware of this - Some users found the flashing lights jarring and would prefer a more subtle option
Any feedback from other household members?	33	<ul style="list-style-type: none"> - Some issues with overnight flashing - Some families found it very helpful to manage children's shower times, others reported that children found the device too intrusive and/or stressful

1. Number of responses to the question

3.2 Aquatic centre

For each device, the median duration of all events was less than 5 minutes, and all devices recorded showers as long as 25 minutes (Figure 7). Only 12 devices are shown here because 8 recorded less than 10 events in total. During the trial, the aquatic centre reported vandalism of the devices in the male bathrooms. This was later resolved by the addition of theft proof mounting devices. Therefore, the data for the male bathrooms has significant gaps.

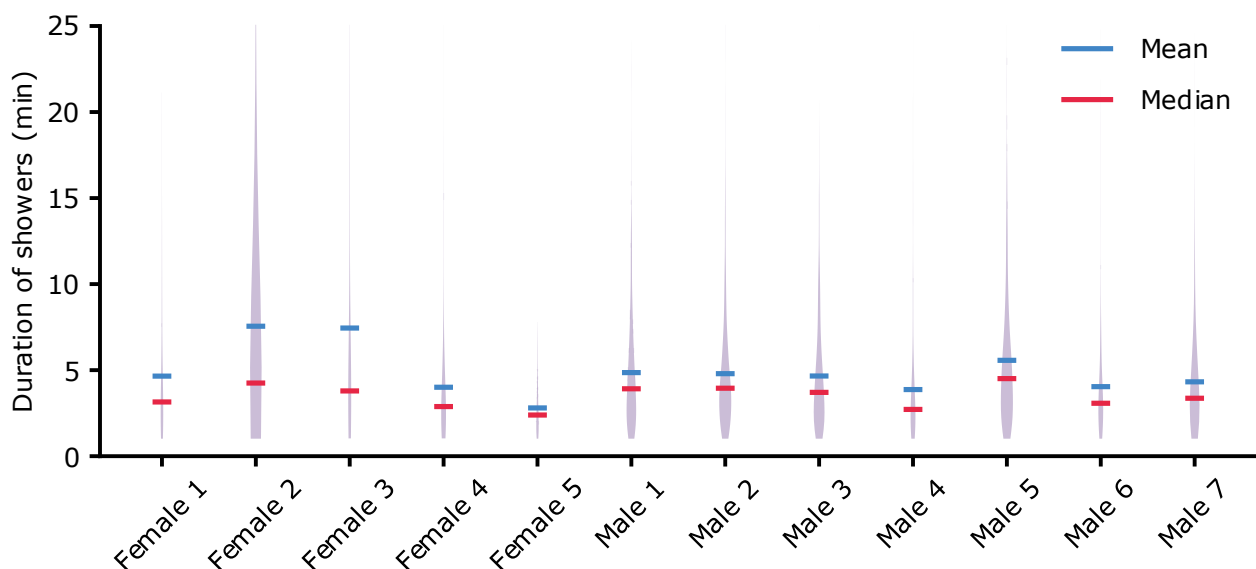


Figure 7 Distribution of shower durations for each aquatic centre device

The aquatic centre devices did not test field trial mode. The concern was that providing patrons with information about the device would compromise the baseline indication, however patrons may be worried about cameras in the device if they were not provided with information. Therefore, comparison with a baseline was not possible.

4. Recommendations and limitations

This section provides recommendations for water utilities seeking to better understand the impact of the device (such as Water Corporation). The focus of the recommendations is to improve experimental design of future studies to build the qualitative evidence for the user experience with ShowerStar, and quantitative evidence base for water savings associated with ShowerStar. The recommendations would also improve uptake of the device (and thus the potential water savings).

4.1 Building qualitative evidence of user experience

The field trial study was primarily designed to test the savings generated by the ShowerStar device, however it also considered high level user experience through surveys. Future studies would be advised to separate experimental design for testing of user experience and testing of shower duration. Whilst these two factors are important to understanding and ensuring the efficacy of the device, separate investigation would be beneficial because the field trial mode (which is necessary to test changes to shower duration) appears to significantly impact the user experience. Thus, the results of the study should not be used to draw conclusions on user experience as it relates to a 'normal' situation in which users would purchase the device off the shelf. However, the following sub-sections will discuss some feedback and recommendations relating to the user experience observed in this study, particularly as it pertains to guidance for future studies.

Feedback from the field trial study was mixed with regards to the user experience of the devices. Whilst a majority of survey respondents appeared to view the experience positively, several experienced issues with either the app or the longer-term function of the device. Reviewing the feedback in open-ended questions, it appears likely that users often misunderstood how the device was meant to function (particularly with regards to field trial mode), or were unaware of features that already exist in the app. Many of the users that reported issues flagged that the issues were a barrier to them using the device on a regular basis.

A specific study on user experience with the device programmed to run in normal operating mode from day 1 by default would be beneficial because field trial mode creates issues with the user experience. In the current study, it was difficult to tease out how field trial mode might have impacted the user experience. Key features of a study into user experience would include:

- Default settings the same as a typical 'off-the-shelf' product
- Very limited additional communication compared to the standard materials provided by TouchGrid (users could test field trial mode if it was of interest to them)
- Additional demographic data collected through the surveys (such as age of household members) would help to pinpoint users that are more likely to have difficulty with the device
- Follow up workshops in addition to the surveys would be particularly helpful to understand the user experience more fully and get to the root of any issues/concerns

4.2 Building quantitative evidence for ShowerStar duration change

To build the quantitative evidence for the reduction in shower duration as a result of the ShowerStar device, it would be necessary to obtain more complete sets of data for both field trial mode and normal operating mode. Due to the additional complexities that result from using field trial mode, this would likely require a much higher degree of communication with participants compared to what would be expected if they were to purchase a product themselves. Specifically, this would include:

- Clearer communication about the operation of field trial mode (including things that trigger it to reset, such as some updates)
- More guidance on how to determine if the device is working correctly in field trial mode (users reported uncertainty due to the lack of feedback from the device in field trial mode)
 - This may require collaboration between water utilities and manufacturers

The following additions to the experimental design would enhance the confidence in the results:

- Linking between survey responses and ShowerStar data
- Smart meter data to validate water and/or energy consumption
- Manual shower logs to validate the accuracy of the device
- Automatic data syncing between device and app (TouchGrid has recently added this feature)

As the experience survey responses were not linked to the ShowerStar data, we were unable to identify relationships between these results. For example, it would be helpful to know how much crossover there was between devices that did not record much data and survey respondents who reported struggling with the setup or use of the device.

We also note that while field trial mode provides a good indicator of baseline shower duration, the use of the devices potentially has an impact on user behaviour even in field trial mode. Therefore, additional data would help to build a better baseline. In this study, data from participants' water bills was available, however due to high use of irrigation, the noise in the data was too high to observe any changes as a result of the shower. Alternatively, future projects would benefit from collecting smart meter water consumption data (at high resolutions e.g. less than 30 minute intervals) to support quantification of the baseline, as well as verification of the durations observed in normal mode. Another option for future studies could be to conduct the study in winter and compare the bill data for the study period with bill data from the same time of year in previous years. In this study, the field trial period was June to August, and the normal operating mode period was from July to December, depending on the device.

4.3 Improving accuracy of water, energy and GHG savings

Accurate quantification of water, energy and GHG savings of specific measures (such as ShowerStar) within households requires additional information (Kenway et al., 2023). This study primarily focussed on quantifying the reduction in shower duration from the ShowerStar device. When calculating the water savings from the reduction in shower duration, additional uncertainty is introduced from other variables such as shower flowrate, frequency of showering, shower temperature etc. Consequently, measures to quantify the flowrate (e.g. having independent testing of shower flowrate) and other variables would improve savings quantification. For energy, further uncertainty is introduced from the shower temperature and cold water temperature. Hence improved data on these parameters improves savings quantification.

An option to improve data inputs and reduce uncertainty is the use of additional technologies including end-use capable water meters (e.g. high resolution household metering with end-use disaggregation, or end-use flow meters) as implemented in the Net Zero Carbon Water Cycle Program (Kenway et al., 2023) (NZCWC). High-resolution models (e.g. DYNAREHO (Kenway et al., 2019)) that draw on these inputs is a way to convert the raw data into higher-resolution savings estimates. The NZCWC program drew on high resolution metering, end-use disaggregation algorithms, end-use flow meters at the shower, and high-resolution models to quantify water and energy savings. The report provides additional recommendations for the use of these methodologies in the implementation of wider programs (Kenway et al., 2023).

4.4 Scaling up results to estimate city-wide savings

This project was not specifically designed to enable city-wide savings. Additional information about the sampled population would be needed to guide “upscaling”. However, as a point of discussion we attempt to estimate this. For example, if every person in Perth was taking one shower per day and reduced their shower duration by 2 minutes, they would save 12 to 25 L per day (refer Table 8), which is 3-7% of Perth’s water supply of 350 L/person/day (Water Corporation, 2024). The resulting energy savings (including energy for water supply, treatment, and on-site heating) would be equivalent to 60-173 gCO₂/person/day, 9-26% of the carbon emissions associated with water supply and wastewater treatment in Perth in 2022 (660 gCO₂/person/day) (Yan et al., 2025). Upscaling the results to suburb or city scale introduces further uncertainty, due to uncertainty in the representativeness of the results, and in the overall demographic of the area being upscaled (Kenway et al., 2023). To increase the accuracy of upscaling, it is important to consider both the size of the sample, and the representativeness of the sample. For example, if the sample is taken from a high-income group with high water literacy, this is unlikely to be indicative of the savings achieved in a low income, or low water literacy group.

To enable more accurate and representative upscaling of results in future projects, additional data about the households and their demographics would be helpful, in particular:

- Shower flowrates for each device tested would improve accuracy of water savings
 - These could be obtained by the users, or by a household audit
 - Flowrates are also important for understanding the participating households and whether they are representative of the wider context in Perth. For example, if there is an observed relationship between the flowrate and duration of showers, this can potentially be scaled based on known flowrates in wider regions.
- Household demographics collected through surveys etc. can help to verify the representativeness of the sample households:
 - Age breakdown of household
 - Income bracket for household
 - Renter / owner status
 - Type and age of dwelling

Ideally, future research would leverage off of existing projects such as smart meter rollout or water audit programmes. This would enable additional data to be collected in parallel to the ShowerStar installation, without requiring significant additional resources. An option to obtain flowrates is to pair high resolution water consumption data from smart meters with models that can extract an end-use pattern from the data (Nguyen et al., 2015).

4.5 Improving uptake of devices

Improving the uptake of devices, and the user experience, are likely to increase the savings that can feasibly be obtained with devices like ShowerStar. Previous studies in this area have identified the importance of communication in enabling greater uptake and savings. In particular, they highlight the importance of engaging householders in thinking about their hot water use and related GHG emissions of showering e.g. messaging, information sharing, and awareness of cost savings (Kenway et al., 2023). It is recommended that future studies have a greater focus on behavioural and social aspects of the intervention, including strategies to improve uptake.

Practical steps to improve uptake in future studies could include:

- Automatic syncing between the device and the app, as many users highlighted that the requirement for manual connections was tedious, and a barrier to uploading data
 - TouchGrid has recently added automatic syncing as a feature. If the app has not seen data downloaded for a specified period, it will connect to the ShowerStar to retrieve data. This does not require any input from the user.
- Combined delivery method of ShowerStar devices, with the option for users to select DIY install, or have someone come out to install if they are having difficulty with the process
- Charging participants the off-the-shelf price for the devices, as some users may be more likely to commit to using the device if they have committed funds

In terms of the feasibility for utilities to roll out programs like this, the role of regulations and policy is critical. Partner utilities would need to be well supported by their regulator and ideally, regulators would recognise the wide benefits of shower efficiency improvements (i.e. savings of water, energy, and GHG, reduced wastewater flows and associated financial savings). Therefore, it is recommended that future projects partner with relevant government / regulatory organisations to collaborate on solutions to enable this and to conduct the necessary research and consultation to develop options for implementation.

Uptake of water efficiency measures such as ShowerStar could be greatly improved if the least cost (whole of life cycle) across consumers, water utilities and energy utilities is used to compare against other capital improvement options (e.g. new supply options, long-run marginal costs, and the cost of providing an additional unit of supply). To enable least cost comparisons, greater work understanding the savings and related uncertainties of their management would be required but work in Victoria suggests a social return on investment of over 500% (Kenway et al., 2023).

4.6 Other recommendations and investigation needs

A range of other measures could also be undertaken to better understand options to reduce household (and industry) water use and related energy use, carbon emissions and related costs to households, industries and water businesses. For example,

- **Sustaining long-term efficiency:** Understanding the customer user-experience (4.1 above) is just one step in a wider need to better understand how to encourage and sustain new shower technology adoption and behaviour change more widely. Much of this depends not just on the technology but also the communications and messaging surrounding the deployment of the technology.
- **Enabling Environment:** The behaviour, and efficiency measures adopted both by households, and the utilities that send signals to those households are influenced by institutional and regulatory processes spanning a range of systems including water and energy. Better understanding of that environment (for example fixed and variable prices for water, electricity and other forms of energy, rebate options available (e.g. Federally) for GHG reduction options etc), impact strategies and practices at multiple levels.
- **Least-cost water and energy infrastructure systems:** Understanding the water savings, and related energy and GHG savings in households from efficiency options is a first step in comparing least-cost solutions across new supply and demand management strategies for both water and energy, and in the determination of least-cost carbon mitigation strategies.
- **Social Equality:** Improved knowledge and practices are important for customising water efficiency in different social contexts (home ownership vs rental, group households, households with specific health requirements or socio-demographic conditions etc).

- **Representivity:** In order to scale up the results from this study to estimate wider system impacts, it would be very important to better understand the representivity of the sample population. Future experimental design would ideally have this as a strong priority and help interrelate and interpolate across (a) high-resolution end use studies (of water and energy) often at ~1minute resolution (b) wider fleets of digital metering (often at 30 or 60 minutes resolution) and (c) analogue water meters typically covering entire cities.
- **Energy sector collaboration:** Due to the complexity of energy (and GHG) impacts of different water system and efficiency options, it would be highly beneficial to engage the energy sector (and GHG emissions strategies) in this study. International studies (eg by the Californian Energy Commission and Kenway et al 2023) show that water efficiency is often the least cost way to reduce energy use and GHG emissions.
- **Tools and Capacity Building:** At present, there is relatively little understanding – and very few operational tools – to help industry and regulators understand the very substantial savings of energy and GHG emissions from improved water management and higher levels of water efficiency in particular. Wider development, training and uptake of tools, models, software, and training could support this.

There are multiple benefits in improving practice and knowledge of all elements listed in Chapter 4. Collectively this knowledge can provide a much stronger driver for water efficiency and much lower cost options for meeting future water and energy needs at lower GHG emissions levels.

4.7 Limitations of the study

This was a preliminary study focussed on reduction of shower duration, with a small sample size. It was intended quantify the potential savings of a device like ShowerStar, with preliminary quantification of flow-on savings of energy, GHG and cost. Whilst the study considered the user experience, this was not the primary focus, and the user experience was heavily influenced by the use of field trial mode. To summarise, the key limitations of the study include:

- Small sample size, noting assessing representativity of Perth / Western Australia was not a specific part of the survey design, or analysis, however it is possible to be representative in some aspects. Hence, “scaling up” needs to be done cautiously with limitations noted.
- Experience survey data was not able to be linked to ShowerStar data
- Many users struggled with field trial mode, influencing the uptake of the device
- Water, energy and GHG savings are based on typical household characteristics in the region, and are not reflective of the specific households in this study
- Upscaling of water, energy and GHG savings does not take into account the representativeness of the study sample for the wider context of Perth. These numbers are intended to be an indicative indication of the scale of the potential impact only

Another limitation of the study was that many users did not remember to connect their app to their devices at frequent (or any) intervals. Therefore, it was not possible to determine whether devices that didn't record data were because users weren't using the device, or they simply weren't connecting their device to the app to update the data. A new feature was recently released to enable this, and future studies would be advised to take full advantage of this.

This study provides important information on the potential savings achieved by using the ShowerStar technology. Further analysis would be needed to make more definitive conclusions about potential savings for Perth. These water savings are the fundamental starting point for determining associated potential savings of energy, GHG and costs to households and utilities.

5. Conclusions

Overall, the results of the study have demonstrated a mean difference of 2 minutes per shower between the sample collected in field trial mode and the sample collected in the ShowerStar devices' normal operating mode. Across the full dataset of 9,218 events for 85 devices, the mean shower duration in field trial mode was 8.5 minutes, compared to 6.5 minutes when the device was operating with full functionality. For eighteen households that displayed statistically significant savings, the mean reduction in shower duration was 4 minutes, and the median reduction was 2.9 minutes. Users with high baseline duration appeared to benefit the most from the device, with a reduction from a mean shower duration of 16 minutes in field trial mode to a mean of 10 minutes in normal operating mode amongst the top 25% of users.

Based on existing knowledge of the water network and typical household appliances in Perth, the mean reduction in shower duration of 2 minutes per shower could result in water savings between 12 and 25 L per shower, energy savings between 0.2 and 0.6 kWh per shower and GHG savings between 60 and 173 gCO₂ per shower, accounting for water supply, wastewater treatment and water heating on premises. There is large potential benefit for water and energy utilities such as Water Corporation considering programs relating to the ShowerStar device for either water savings, energy savings or carbon emissions reduction.

The study has provided valuable learnings regarding the potential for significant water savings from use of devices such as Showerstar. The report also provides substantial information relevant for water and / or energy utilities to conduct future studies to better improve the significant savings of water, energy, GHG and costs through efficiency measures. Our report notes multiple areas where improved experimental and analytical design would enable more rigorous conclusions. We commend the Water Corporation and TouchGrid for their proactive analysis of potential water efficiency conservation measures and the related savings. This study provides information which can help with efficiency and security options which have additional benefits of contributing to improved energy security and reducing carbon emissions and household costs.

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Appendix A: Data cleaning

Table 2 Data cleaning and checking for ShowerStar devices installed in households

Parameter	Expected value	Number of devices / events deviating from expected value	Median observed value among deviating devices / events	Range of observed values among deviating devices / events		Notes
				Min	Max	
Duration of data collection	>30 days	33	2	0	29	
Total number of events	>10	23	2	1	7	
Number of field trial events	30	51	17	1	54	
Number of field trial events	>0	33				
Number of pre-field trial events	3	38	0	0	7	Pre-field trial events removed ¹
Shower duration	>30 seconds	0				
Shower duration	<60 minutes	4	84	68	86	
Date of final event recorded by device	Prior to most recent date of data upload from device to app	11				Anomalies removed ²
Number of showers per day	<8	1	12	12	12	
Time elapsed since previous shower event	<3 days	70	7	4	137	

1. Normal operating events are logged by the device prior to field trial mode to allow the user to check the device is working. These events were removed because they are likely to deviate from normal behaviour.
2. The anomaly events that were recorded with a date after the most recent upload had other unexpected features and were thus removed.

Table 3 Data cleaning and checking for ShowerStar devices installed in aquatic centres

Parameter	Expected value	Number of devices / events deviating from expected value	Median observed value among deviating devices / events	Range of observed values among deviating devices / events		Notes
				Min	Max	
Duration of data collection	>30 days	8	0	0	17	
Total number of events	>10	8	4	2	8	Anomalies removed
Shower duration	>30 seconds	0				
Shower duration	<60 minutes	7	145	62	410	
Date of final event recorded by device	Prior to most recent date of data upload from device to app	10				Anomalies removed ¹
Number of showers per day	<8	199	21	9	43	
Time elapsed since previous shower event	<3 days	39	10	4	118	

1. The anomaly events that were recorded with a date after the most recent upload had other unexpected features and were thus removed.

Appendix B: Input values for savings calculations

Table 4 Inputs for water, energy, and GHG savings calculations

Variable description	Symbol	Minimum value	Maximum value	Reference
Reduction in duration of shower (mins)	t	Median and mean savings from households with statistically significant savings (Section 3.1.3)		
Flowrate of shower (L/min)	F	6	12	WELS thresholds for 2-4 stars
Heat capacity of water (kJ/kgK)	C_p		4.2	(Çengel et al., 2019)
Density of water (kg/L)	ρ		1	(Çengel et al., 2019)
Shower temperature (°C)	T_{shower}		37	(Binks et al., 2017)
Cold water temperature (°C)	T_{cold}	15	25	(Bors et al., 2017)

Appendix C: Summary statistics

Table 5 Summary statistics for all recorded household showers in field trial mode and normal mode

		Normal	Field trial	All
Total showers (all devices)		7824	1405	9218
Shower duration (minutes)	Mean	6.5	8.5	6.8
	Standard deviation	5.6	8.0	6.0
	Minimum	1.0	1.0	1.0
	25 th percentile	3.3	3.8	3.3
	Median	4.9	6.3	5.0
	75 th percentile	7.8	10	8.2
	Maximum	86	82	86
Total devices with data		74	53	85
Showers per device per day	Mean	2.0	1.8	2.0
	Standard deviation	1.1	1.0	1.1
	Minimum	1	1	1
	Median	2	2	2
	Maximum	12	8	12

Table 6 Summary statistics for showers in households that displayed a statistically significant difference between field trial mode and normal mode

		Normal	Field trial	All
Total showers (all devices)		2896	589	3485
Shower duration (minutes)	Mean	5.8	9.8	6.5
	Standard deviation	4.2	8.9	5.5
	Minimum	1.0	1.0	1.0
	25 th percentile	3.4	4.6	3.6
	Median	4.6	7.5	4.9
	75 th percentile	6.9	12.0	7.6
	Maximum	55.2	82.4	82.4
Total devices with data		18	18	18
Showers per device per day	Mean	1.9	1.8	1.9
	Standard deviation	1.0	0.9	1.0
	Minimum	1	1	1
	Median	2	2	2
	Maximum	12	5	12

Table 7 Summary statistics for all recorded aquatic centre showers for male and female devices with more than 10 events recorded

		Female	Male	All
Total showers (all devices)		1294	3405	4699
Shower duration (minutes)	Mean	6.5	6.1	4.7
	Standard deviation	5.6	16.6	4.1
	Minimum	1.0	1.0	1.0
	25 th percentile	3.3	2.1	2.3
	Median	4.9	3.5	3.7
	75 th percentile	7.8	5.9	5.9
	Maximum	86	410	98
Total devices with more than 10 data points		5	7	12
Showers per device per day	Mean	9	17	14
	Standard deviation	9	10	10
	Minimum	1	1	1
	Median	4.5	19	14
	Maximum	40	43	43

Appendix D: Savings

Table 8 Overview of estimated savings based on observed changes in duration within the trial

Savings per shower event	Mean change between field trial and normal mode for the 9218 events in the whole dataset (2 minutes) ¹		Mean change between field trial and normal mode for 3485 events in the 18 households with a statistically significant change (4 minutes) ¹	
	Min ²	Max ²	Min ²	Max ²
Water savings (L)	12	25	24	48
Energy savings (kWh)	0.2	0.6	0.3	1.2
GHG savings (heating) (gCO ₂)	32	118	62	228
GHG savings (water supply and treatment) (gCO ₂)	28	55	54	107
GHG savings (total) (gCO ₂)	60	173	116	335

1. Fixed values were used for the mean duration changes in this calculation i.e. the variability reflected in min/max columns does not include variability in duration change.
2. Refer to Table 4 for details of the maximum and minimum inputs used for all calculation parameters other than duration change.

Appendix E: Multiple choice survey responses

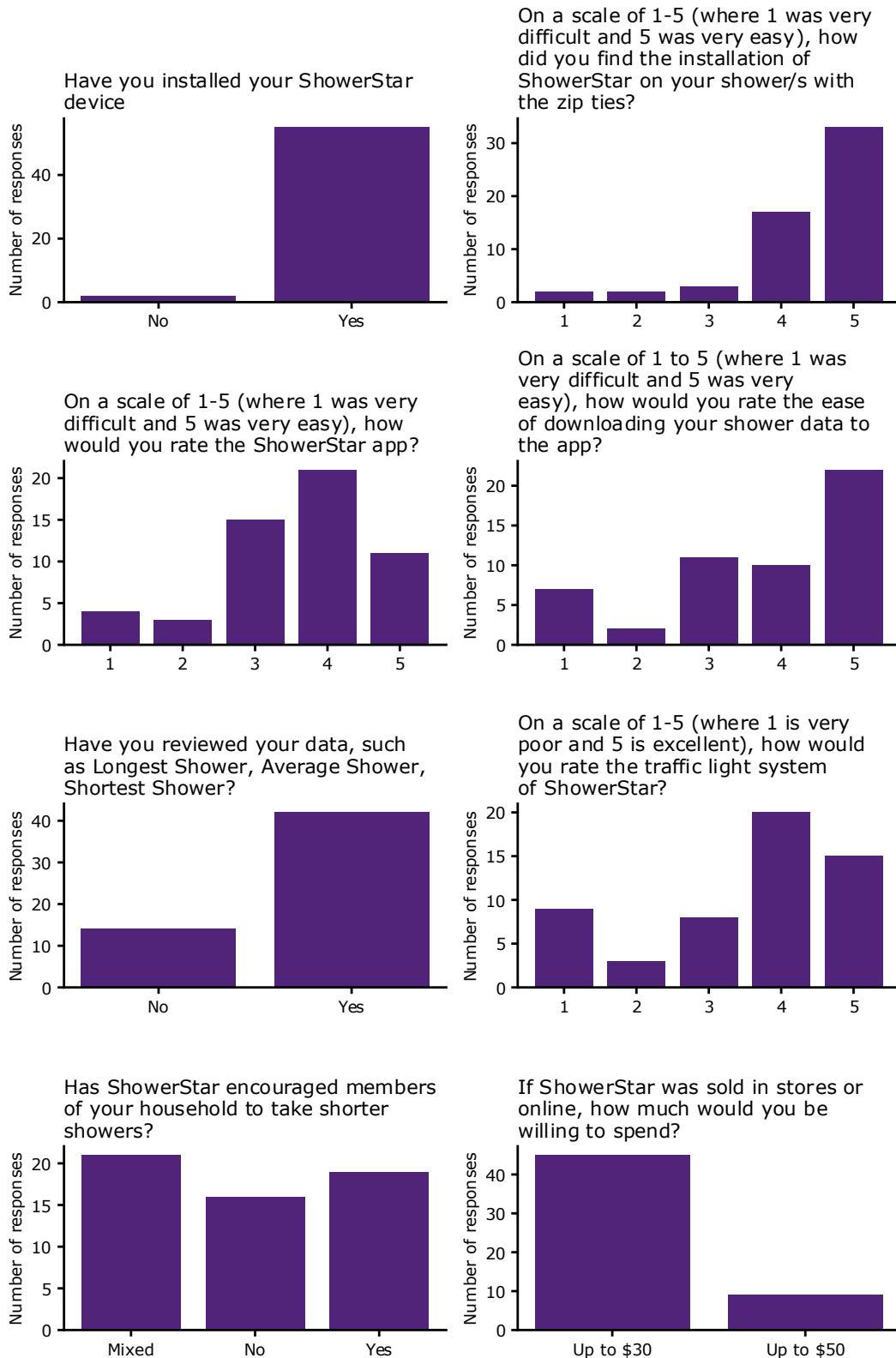


Figure 8 Overview of survey responses for multiple choice questions



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