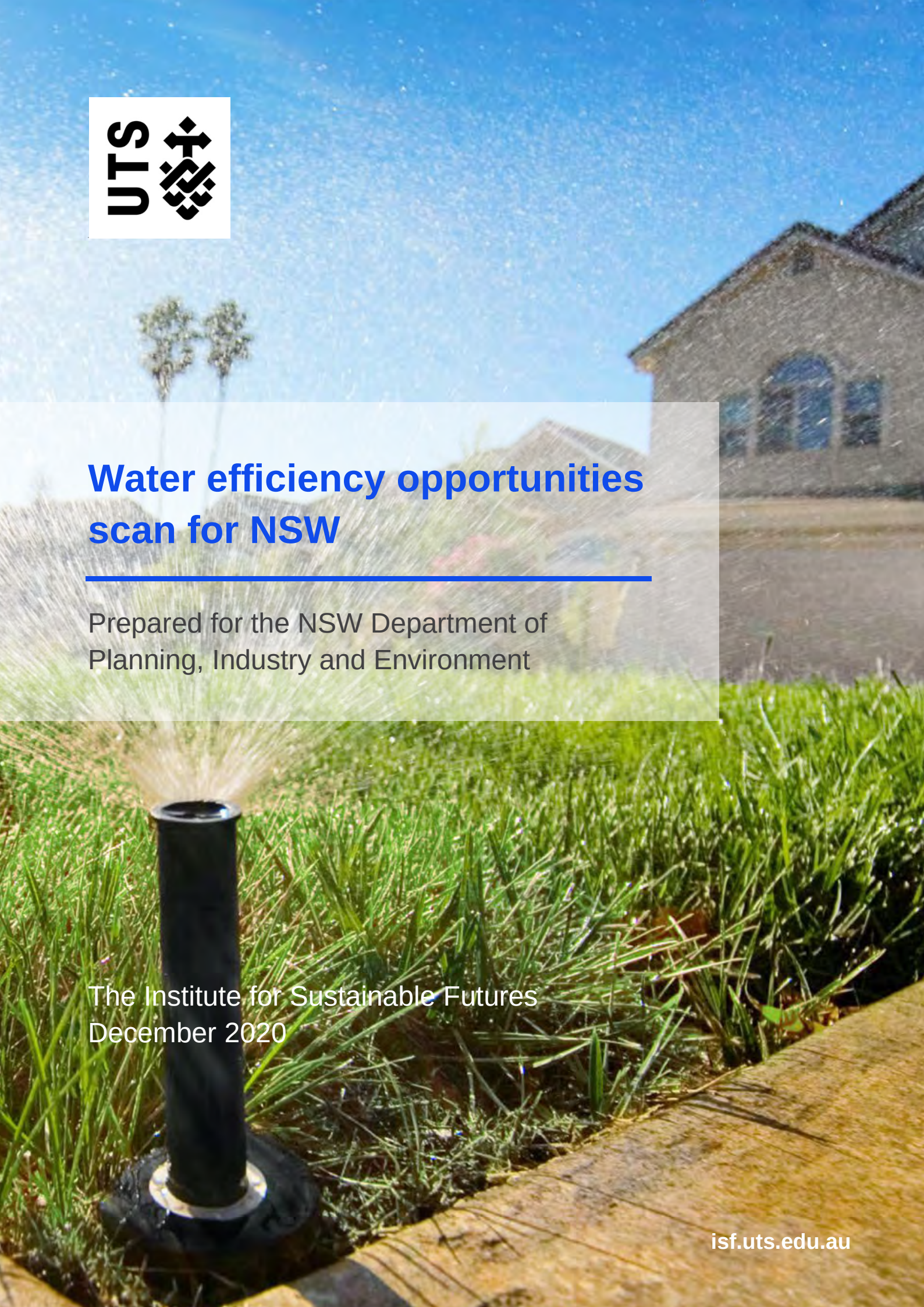

Water efficiency opportunities scan for NSW

Prepared for the NSW Department of Planning, Industry and Environment

The Institute for Sustainable Futures

December 2020

isf.uts.edu.au

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Citation

Watson R, Fane S, Butler A and Liu A (2020) Water Efficiency Framework for NSW, prepared for the Department of Planning, Industry and Environment NSW, December 2020

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Executive Summary

This scan identifies water efficiency opportunities across all end users and a wide variety of end uses. Key opportunities for increased water efficiency in NSW include:

- the increased efficiency of water using fixtures and fittings, particularly showers, toilets and washing machines
- the emergence of technologies that use digital control to reduce water use, particularly cooling, irrigation and leakage control
- the ability to leverage data and digital analytics to design programs that maximise water savings and minimise cost
- targeting programs to maximise water savings opportunities
- designing water efficiency standards and regulations to promote ongoing efficiency gains.

Developments across fixture and fittings efficiency, digital control, data analytics and program design mean there are opportunities to revisit previous programs and/or design new programs that will save water. The uptake of these opportunities would be increased with well-designed incentive mechanisms, ongoing funding and co-ordinated resourcing, knowledge capture and dissemination.

The case for water efficiency

Water security is critical to economic, social, and environmental sustainability. Population growth, climate change, climate variability and drought are ongoing challenges for the urban water sector in Australia. Recent severe climate variations across NSW have reinforced the importance of long-term supply and demand planning and investment across the full spectrum of options.

Ongoing investment in water efficiency has been proven to drive sustained reductions in average and peak water demands. Reduced average demand helps to increase water security within current supply limits and delay the need for short-term water restrictions or longer-term infrastructure augmentations.

However, the nearly decade-long period of inaction between 2009-2019 has left a gap in water efficiency capacity and capability across Australia**,** including NSW.

The NSW Government is seeking to ensure that water is being used efficiently before imposing costs on the community for additional water infrastructure. The efficient use of water will contribute to the sustainability of long-term supplies as population increases, build resilience to drought and support readiness to respond to future extremes in weather.

The process

The Department of Planning, Industry and Environment (DPIE) has developed a draft Water Efficiency Framework (Figure A). The best practice framework allows the consistent design, implementation, management and review of water efficiency programs across NSW, while also allowing flexibility to meet local conditions. Identifying potential options is a key step in developing a response.

This report identifies and categorises a broad range of currently viable water efficiency options and provides best practice examples wherever possible. These options will provide a useful starting point for identifying and evaluating water efficiency opportunities that meet local supply and demand conditions, as required as part of the NSW Water Efficiency Framework.

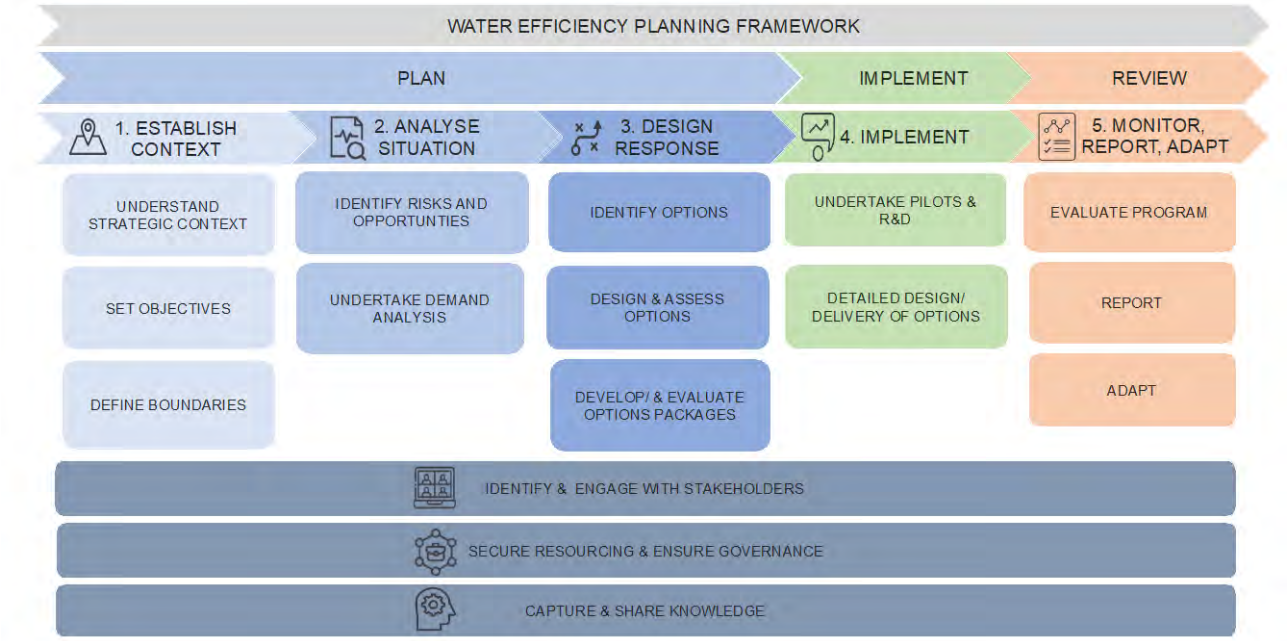

Figure A: Best Practice Water Efficiency Framework overview

Water efficiency options overview

A total of approximately 300 previously implemented demand management programs and 150 emerging technologies were found. The options were grouped together to synthesize and to assist with selection and analysis. The options have been grouped according to the customer group, the delivery mechanism and the targeted end use.

A broad range of water efficiency options were identified, as provided in Figure B. Some of these options target demand generally (orange); some measures focus on leakage and alternative sources (blue); whereas others focus on specific products and end uses (green).

Figure B: Overview of water efficiency option types

Key emerging water efficiency opportunities

Since 2013, there have been a number of product developments which provide viable water efficiency opportunities. Figure C illustrates some examples of emerging water-efficient technology opportunities.

Figure C: Emerging water efficiency opportunities

Specifically, viable opportunities exist due to:

- the increased efficiency of water using fixtures and fittings, particularly showers, toilets and washing machines
- the emergence of technologies that use digital control to reduce water use, particularly cooling, irrigation and leakage control
- the ability to leverage data and digital analytics to design programs that maximise water savings and minimise cost
- targeting programs to maximise water savings opportunities
- designing water efficiency standards and regulations to promote ongoing efficiency gains.

These developments mean there are opportunities to revisit previous programs and/or design new programs that will save water. The uptake of these opportunities would be increased with well-designed incentive mechanisms, ongoing funding and co-ordinated resourcing, knowledge capture and dissemination.

Creating step change in the market using multi-faceted approaches

One of the key opportunities for improving water efficiency across NSW lies in creating step changes in the market for water using fixtures and fittings. During the Millennium drought, multi-faceted approaches to water efficiency created step changes in the uptake of WELS 3-star rated showerheads, dual flush toilets and front-loading washing machines. The ongoing improvements in market share of efficient stock have not been sustained in the last 15 years, despite more efficient stock having come onto the market. Combining rebates, upgrades of housing stock through retrofit programs and regulatory change would help to create the next wave of step change in the market. Specific examples include:

- showerheads: There is the opportunity to create significant and lasting market transformation by combining a showerhead swap with an intention to move to WELS four-star rated showerheads in the Plumbing Code and Tenancy Act over a specific time period, and/or changing BASIX requirements.
- toilets: There are opportunities to revisit segments where old toilet stock may still be present. The opportunity exists to continue to increase requirements for toilet efficiency in standards and include waterless options in the standards.
- washing machines: There are opportunities to continue to shift the washing machine market to more efficient WELs 4.5-star to 5-star rated machines, which result in water, energy and detergent savings by using rebates and incentives for low income, large households and small businesses.

Adopting digital control

Digital control of water using fixtures can increase water efficiency, particularly by overcoming behavioural barriers to water use change. Key opportunities include the following:

- digital control can be used to minimise irrigation time in relation to weather and soil moisture; and the Internet of Things (IoT) and artificial intelligence can be used to minimise irrigation time by predicting future weather events
- digital salt sensors can be used to control the frequency and length of cooling tower bleed rates
- smart fixtures and fittings can be used to automatically detect and report leaks and shut off flow to faulty devices until they are fixed
- pressure and/or flow can be varied within a building or fixture to minimise leakage and water use.

Using digital analytics to better design, target and evaluate programs

In the energy sector there has been a rapid growth in the options for measuring and managing energy use through consumer accessible applications (“apps”). The water sector is poised to move in the same direction.

The availability of low-cost widespread sensors and the IoT will enable a transformation of controls for irrigation, timing and control of water use, monitoring and control of leakage and pressure and automation of water and wastewater systems. These technologies provide the capacity to collect large amounts of data to help direct water efficiency efforts, both in targeting programs and changing customer behaviour.

Utilities are being challenged to consider how to best manage and analyse large data sets that digital metering provides and engage with customers in the longer term. Understanding how to manage and utilise this data will enable the next generation of demand management programs. In particular, we could see a step change in the sophistication of customer segmentation targeting and interaction.

To maximise the value of the available data future strategies, digital metering platforms need to be accompanied by capacity and capability in data analytics and customer behaviour change.

Targeting programs to specific customer segments

Analysis at multiple utilities has demonstrated that previous demand management efforts were far from uniform in coverage, both geographically and within a local area. There are opportunities to design more efficient and effective water efficiency programs. This includes revisiting past successful programs for segments of the market that were missed and targeting programs at specific customers to maximise water savings opportunities.

While using average demand to determine water efficiency opportunities within a target sector may seem reasonable, examining the demand distribution can provide insights for creating targeted programs. The best non-residential programs target particular sub-sectors and particular high-water using end uses. Billing data can be used to identify specific high users to target.

While the market will naturally drive some change in water-efficient appliances and fixtures, this change is focused in areas of new housing and higher socioeconomics where renovations and replacements happen more frequently. This may leave large segments of some communities with much lower water efficiencies that others.

Overall, there are significant opportunities to design more efficient and effective water efficiency programs using targeting.

Keeping standards and regulations up to date with market advancements

Despite increased efficiency in fixtures, there has been minimal market change in the last 10-15 years, particularly for showers and washing machines. BASIX water ratings were established in 2006 and have not been changed since. In the same period there have been several advancements in the BASIX energy requirements. Similarly, the Plumbing Code has required plumbers install WELS 3-star rated showerheads since 2006. Recent changes to the NSW Residential Tenancy Act require minimum WELS 3-star rated toilets to be installed in tenanted properties in NSW from 2025, despite WELS 4-star rated toilets being the dominant stock on the market.

Regularly reviewing the standards, or constantly reviewing the ratings in relation to product innovations would help to promote ongoing improvements. For example, between 2009 and 2019 Singapore has transitioned from a minimum of ‘1-tick’ rated appliances for all new developments and renovations to a minimum 2 tick ratings. Alternatively, the UAE water rating scheme makes it cheaper to register more efficient products, which creates an incentive for manufacturers to create the most efficient products they can.

Demand in some areas can be dominated by large users. Having regulatory mechanisms in place to understand this demand and encourage water efficiency would help to increase water security, particularly in areas with more variable supply. Mandatory Water Savings Action Plans and mandatory reporting of ratings are two tools which could be adopted.

Incentivising water efficiency

The energy sector has sought to overcome inherent supply side infrastructure biases by creating a demand management incentive scheme. This scheme provides the utilities with financial payments to implement efficient non-network options which are expected to lower costs to consumers, helping to overcome the financial disincentives (specifically revenue loss and capex bias) of investing in demand management. Similar mechanisms could be considered in the water sector to encourage investment in demand management measures by utilities.

While many water efficiency projects prove to be cost effective, upfront funding is often identified as a barrier to implementation. There are a number of mechanisms that can help to overcome initial barriers to investment across all sectors.

Rebates and grants have been successful in incentivising water efficiency uptake by customers. However, it is also important to ensure customers value their programs. A review of one utility's programs suggested that when programs are offered for free, savings are not often achieved or sustained as they have little buy-in, or the program is taken advantage of.

In the non-residential sector, cost effective, short payback opportunities are often not taken up due to the financial barrier of upfront investment. Revolving loan and grant mechanisms have been successful in overcoming these barriers.

Pre-selection and bulk purchasing of efficient appliances can also help to overcome information and financial barriers. Similar programs are being conducted in the energy sector at a state level and could be emulated for water-efficient appliances.

Conclusion

Water efficiency opportunities are available across all end users and a wide variety of end uses. Specific opportunities for increased water efficiency exist due to:

- efficiency gains in fixtures, particularly showerheads, toilets and washing machines
- advances in digital control, particularly for irrigation, cooling and leak detection
- targeting of previously missed sectors and high users within a sector.

Adopting lessons learnt from past programs will help to most effectively design and deliver programs.

Digital analytics and metering provide opportunities to understand demand and target, tailor, rapidly evaluate and refine water efficiency programs.

Water efficiency programs can help to trigger market and behavioural changes, but often regulatory programs and standards are required to lock in and continue to expand the efficiencies. Current regulatory programs, such as WELS and BASIX, have not adapted to changes in efficiency opportunities. Regularly reviewing the standards, or constantly reviewing the ratings in relation to product innovations would help to promote ongoing improvements.

Finally, water efficiency programs themselves, are only one part of the water efficiency equation. The ongoing identification and uptake of water efficiency will only be realised if all aspects of the water efficiency framework are addressed.

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Chapter 1 The case for water efficiency

This chapter outlines the case for water efficiency and the project context. It also describes the key elements of this report and how the report can be used.

1.1 What is water efficiency?

Water efficiency, demand management and water conservation are often used interchangeably. Water efficiency and water conservation focus on ensuring that the least amount of water is used to provide the required service. Demand management is broader and refers to strategies that actively manage demand but may change the service provided to customers.

In 2000, the NSW Government stated that water conservation was working towards greater efficiency in the use of water in a manner that recognises its true value, is economically viable and environmentally sustainable (New South Wales Department of Land and Water Conservation 2000).

Water efficiency is defined by the Australian Water Association (AWA) and the Water Services Association of Australia (WSAA) as:

> *"the suite of practices and policies that maximises the benefit gained from every unit of water used"* (AWA 2012); and
>
> *"any measure that reduces the amount of water used per unit of given activity, without compromising the achievement of the value expected from that activity"* (WSAA 2013).

Water conservation refers to preventing the waste and/or excessive use of water, and is therefore similar to water efficiency, as wasting water produces no benefit.

Demand management can include water efficiency but may also include regulations that limit how or when water can be used, changes to price and infrastructure (pressure management, alternative supplies) to reduce demand on the system. Water restrictions are a demand management technique that can help to reduce demand during temporary supply shortages.

1.2 What is the difference between water efficiency and water restrictions?

Water efficiency and demand management should not be confused with short-term water restrictions. Water efficiency in this report focuses on long-term changes in the way water is used without reducing the service the customer receives by using the water. Some options and opportunities identified in this report may have the added benefit of helping to delay or offset the impact of short-term restrictions.

1.3 Why is water efficiency important?

Water security is critical to economic, social and environmental sustainability. Population growth, climate change, climate variability and drought are ongoing challenges for the urban water sector in Australia. Recent severe climate variations across NSW have reinforced the importance of long-term supply-demand planning and investment across the full spectrum of options.

Ongoing investment in water efficiency has been proven to drive sustained reductions in average and peak water demands. Reduced average demand helps to increase water security within current supply limits and delay the need for short-term water restrictions or longer-term infrastructure augmentations. Reduced peak demand can reduce infrastructure costs and help with managing infrastructure performance.

Increasingly, using water to cool and green urban environments is seen as an effective way of mitigating the impacts of climate change and urban heat stress. There is a perception in some segments of the water industry that water efficiency options compete with urban liveability and greening objectives. However, this is not the case. Investing in water efficiency helps to support urban liveability,

by focusing on saving water if the same outcomes can still be achieved. This allows the saved water to be allocated to other uses including urban cooling and greening.

The NSW Government is seeking to ensure that water is being used efficiently before imposing costs on the community for additional water infrastructure. The efficient use of water will contribute to the sustainability of long-term supplies as population increases, build resilience to drought and support readiness to respond to future extremes in weather. This is particularly important in regional NSW, where smaller water utilities may have less resources and options available to increase supply.

1.4 The planning context for water efficiency in NSW

There are a number of government policies, agreements, strategies, frameworks, and plans that set the context for water efficiency in NSW, as outlined in Figure 1 and detailed in Appendix 1.

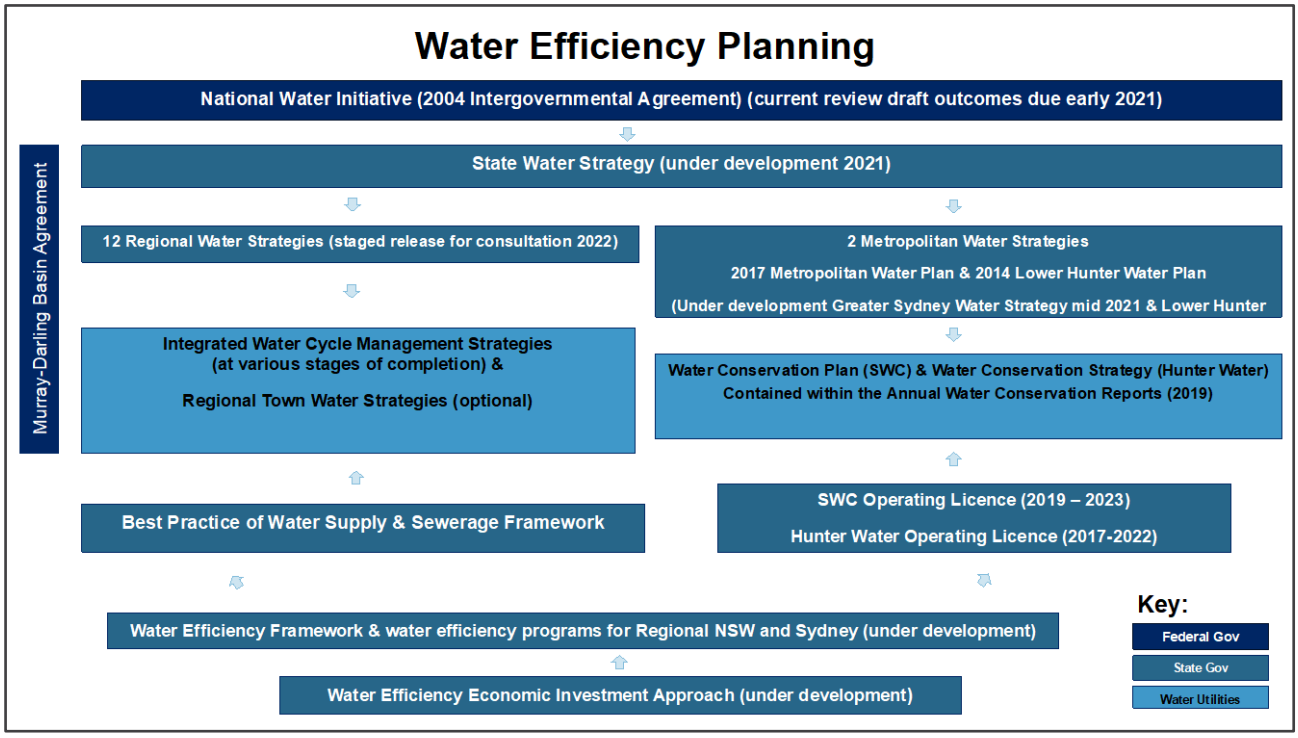


Figure 1: Water efficiency planning framework in NSW

The Department of Planning, Industry and Environment (DPIE) has developed a Draft Water Efficiency Framework, to be used consistently across NSW (Figure 2**Error! Reference source not found.**). The best practice framework allows the consistent design, implementation, management and review of water efficiency programs across NSW, while also allowing flexibility to meet local conditions. Identifying potential options is a key step in developing a successful water efficiency program.

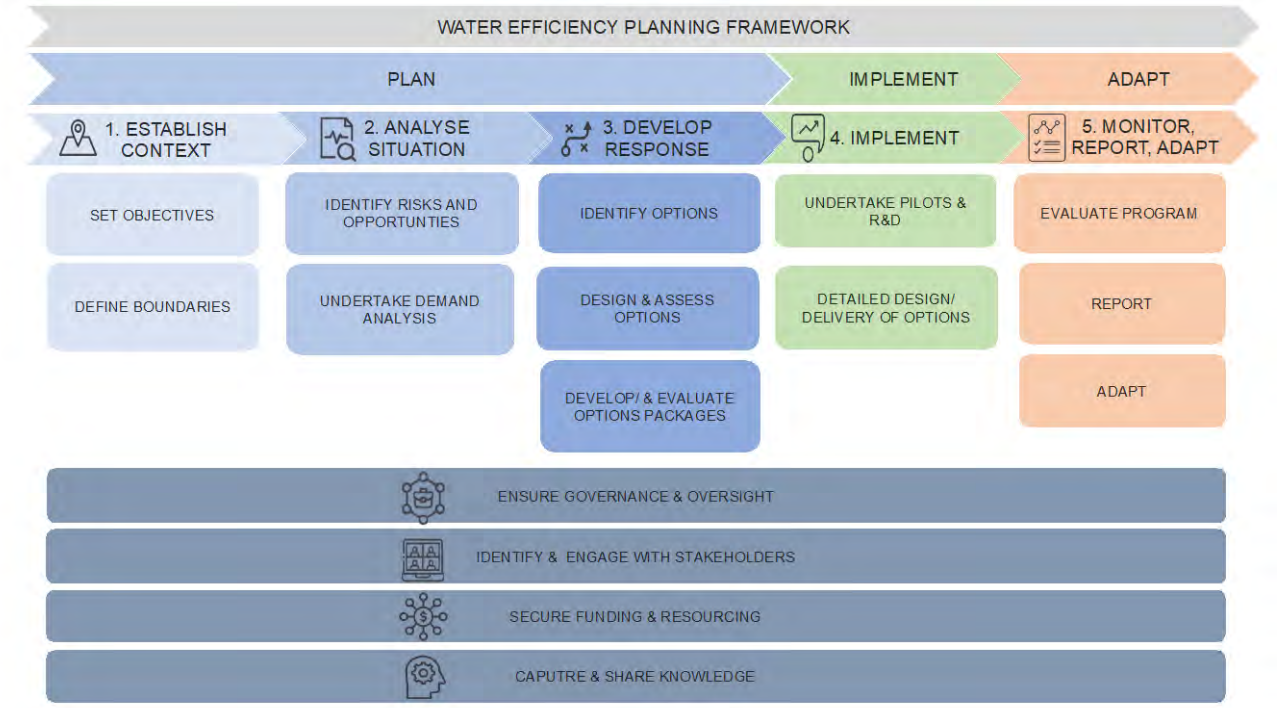


Figure 2: NSW Draft Water Efficiency Framework

1.5 Why has this scan been undertaken?

The nearly decade-long period of inaction between 2009-2019 has left a gap in water efficiency capacity and capability across Australia. The NSW Audit Office report (2020) investigating water conservation in Greater Sydney found that a detailed analysis of water conservation options had not been undertaken by the Department in Sydney since 2013. This scan addresses recommendation 4a of the report, namely:

“The Department, working with Sydney Water, should assess the viability of current and future water conservation initiatives, including commissioning a detailed options study to inform a water conservation program”.

1.6 Why is the scan useful and how can it be used?

The scan identifies and categorises a broad range of currently viable water efficiency options and provides best practice examples wherever possible. These options will provide a useful starting point for identifying and evaluating water efficiency opportunities that meet local supply and demand conditions, as required as part of the NSW Water Efficiency Framework.

For regional LWUs, the options scan will provide a starting point for meeting best practice for Water Conservation and Demand Management under the Best Practice of Water Supply and Sewerage Guidelines. This scan has provided the basis for the options in the System Water Efficiency Estimator Tool v1 that LWUs can use to estimate water savings and carry out a cost-benefit analysis of a range of water efficiency options. It can also be used to identify other options that may better suit the local context.

1.7 Scope of the scan

The scan was undertaken at a desktop level only. The scan covers urban water efficiency options and highlights best practice examples of options (where available). It does not cover agricultural and other non-urban options nor recycled water and stormwater harvesting opportunities.

1.8 Report outline

The remainder of the report is set out as follows:

Chapter 2: outlines the process for the water efficiency scan.

Chapter 3: provides an overview of the options identified and outlines the technology and program opportunities that have emerged since 2013.

Chapter 4: provides fact sheets on a range of viable options, summarising the key elements and variations of the option, opportunities, constraints and best practice examples.

Chapter 5: outlines conclusions and next steps.

Appendix 1: details the government policies, agreements, strategies, frameworks, and plans that set the context for water efficiency in NSW

Appendix 2: provides further information on water efficiency options.

Chapter 2 Process for the water efficiency scan

This section details the process that was used to scan for water efficiency opportunities.

ISF undertook a desktop study of previously implemented water efficiency programs across Australia and internationally. The scan builds upon previous scans conducted by ISF and others including:

- ISF (2019) Water savings rebate review and design, developed for Hunter Water
- ISF (2017) Assessment of Future Water Efficiency Measures, developed for the Melbourne Water Utilities
- ISF (2013) Advisory Study on the Next Generation of Water Efficiency Program for Greater Sydney developed for Metro Water
- ISF (2017) Digital Metering and Change in Water Consumption, developed for the Melbourne water utilities.

2.1 Process

A desktop scan of potential emerging water savings technologies was also undertaken.

Water efficiency options were identified using key search terms, a scan of relevant websites, and investigation into emerging technology databases.

The following search terms were successful in producing examples of water efficiency opportunities. The terms were used when doing general searches via a search engine and were also employed to sift through the information in the databases. An example of how these terms were used is shown in the adapting of the phrase 'Water efficient bathroom appliances in NSW, Australia'. This included a search topic i.e., 'water efficiency', a search use and type i.e., 'bathroom appliances' and defined the search location i.e., 'NSW, Australia'. Results for different opportunities appeared in various forms of case studies, articles, and product websites.

Search terms used are as follows:

- **Search topics:** Water efficient / demand management / water reducing / water saving / water avoidance / clean water / wastewater / urban resilience / resource recovery / sensors / monitoring / reuse
- **Uses:** Bathrooms / kitchens / irrigation / laundry / outdoor
- **Types:** Case studies / products / fixtures / appliances
- **Search locations:**
  - Australia
  - US, Texas
  - Europe
  - Residential / Domestic / Home / Internal
  - Non-Residential / Commercial
  - Outdoor / external / open space

The following websites were additionally scoured to investigate their recommendations for water saving opportunities and technologies currently on the market. These sites provided multiple examples of a broad range of opportunities that are currently being implemented.

- Smart Approved WaterMark
- Government websites promoting water-efficient practices and technologies

- Water Sense – US EPA
- Alliance for Water Efficiency

2.2 Data collection

Data was collected on each program, option or technology. The data available varied for each opportunity but broadly covered the following aspects:

1. Sector water saving strategy
2. Program, description and source / reference
3. Target i.e., Residential / Non-Residential / Open space
4. Expected water savings, if available; qualitative or quantitative depending on the source
5. Expected costs, if available
6. Assumed uptake, if available.

2.3 Outcomes

A total of approximately 300 previously implemented demand management programs and 150 emerging technologies were found.

Where there was overlap in program types, these options were grouped in order to synthesize and to assist with selection and analysis. The options have thus been grouped according to the target group, the delivery mechanism and the targeted end use.

The option groups were then reviewed by ISF to determine the distinctness, viability and robustness of each opportunity and any associated savings. These emerging opportunities for savings are discussed in Chapter 3.

In addition, a set of 16 Factsheets were created in order to communicate at a high level a broader range of options for water efficiency. The Factsheets broadly cover the end user and end uses targeted and examples of the specific subsets of options (i.e., where they have been adopted, savings (if known), best case examples where possible and opportunities and constraints).

The key water efficiency emerging technologies found throughout this scan trended towards certain key focus areas of innovation. Broadly speaking, emerging technologies are trending towards smart or digitised technologies. These involve the addition of flow meters to devices to monitor volumes of water, the integration of sensors within appliances to allow for the automatic adjustment of settings including shut off and start sensors, as well as control and display systems which attempt to influence behaviour and use.

Notable products include Hydroloop’s in-situ wastewater treatment technologies, smart irrigation including weather sensing technology and smart water meters with integrated leak detection systems. These are particularly focused at a residential level allowing customers to have more control and ownership of their water use. While such technologies are already available on the market, some are not yet widely affordable.

Chapter 3 Overview of water efficiency options

This chapter covers:

- an overview of the full range of opportunities identified in the scan (section 3.1)
- a review of changes and innovations in technology since the last scan in 2013 (section 3.2)
- a synthesis of the current opportunities for water efficiency in NSW (section 3.3).

Specifically, key opportunities exist to:

- create significant and lasting market transformation to WELS 4-star rated showerheads, more efficient toilet stock and efficient front loading washing machines using a combination of programs that encourage replacement and regulatory minimums standard requirements
- use emerging advances in digital control to reduce the behavioural aspect of water wastage, particularly in cooling, irrigation and detection and isolation of leaks
- leverage the vast amounts of available digital data to better design, target, evaluate and evolve water efficiency programs
- incorporate behavioural insights into program design.

3.1 Range of options identified

A broad range of water efficiency options were identified, as provided in Figure 3. The range of options available is discussed in more detail in Chapter 4 and Appendix 2. Some of these options target demand generally (orange); some measures focus on leakage and alternative sources (blue); whereas others focus on specific products and end uses (green).

Figure 3: Categorisation of water efficiency options

3.2 Biggest changes and innovations since 2013

Since 2013, there have been a number of key developments in relation to:

- the efficiency of water using fixtures and fittings
- digital control to reduce water use
- the ability to design better programs to maximise water savings and minimise cost (targeting, program design and delivery and evaluation).

These developments mean that there are now opportunities to revisit previous programs and/or design new programs that will save water.

There are also changes emerging in terms of:

- the assessment of the value of water efficiency options
- the availability of data to identify potential options and measure the success of options
- incentivising behavioural change.

These developments and their significance for improving urban water efficiency are highlighted and discussed in more detail in Figure 4 below.

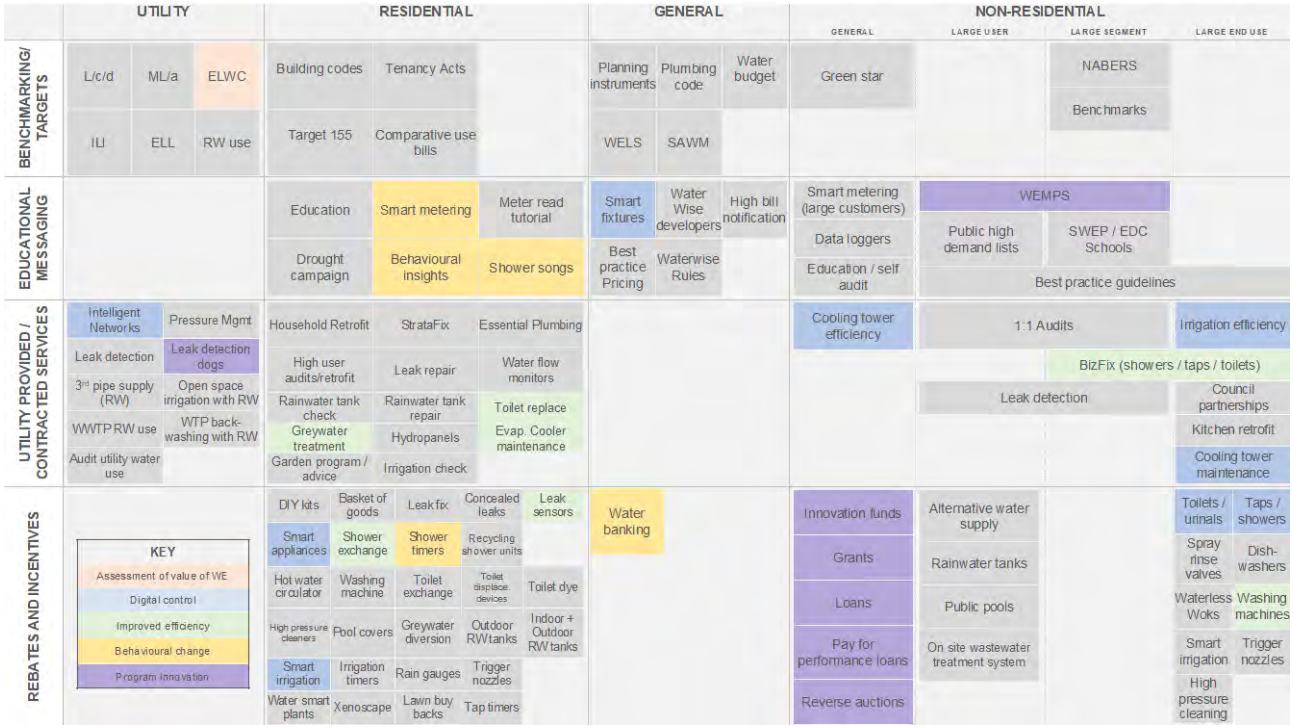


Figure 4: Options innovations since 2013

Increased efficiency of appliances and fixtures

Since water efficiency programs were first rolled out at scale over 15 years ago, there have been continuing changes in the efficiency and effectiveness of different water using appliances. This can easily be seen in the new fixtures and appliances coming onto the market. Technological product types that have increased water use efficiency include:

Indoor

- WELS 4-star rated showerheads.
- Showers with rotating water dome technology e.g., 'Altered: Shower' which uses 75% less water at 3.8 litres per minute.
- Toilets with vacuum technology or widespread rollouts of waterless toilets, tankless toilets
- Efficient tap fixtures, tap aerators and water blade taps e.g., 'Waterblade Easy' which save up to 50% more water compared with conventional aerators operating at 2.4L/min compared to a standard aerating nozzle using 5L/min and a standard tap using greater than 10 L/min.
- Water avoidance cooling options such as refrigerated air conditioners instead of evaporative coolers and geothermal heat pumps which consume no water.
- Cost effective greywater recycling systems, e.g., 'Mimbox' that senses water quality, connectivity, water recycling and microplastic filtration.
- Smart washing machines with load sensing technology to adjust the amount of water used for a cycle.

Outdoor

- Smart irrigation, weather sensing technology, shut off devices, smart tap timers, irrigation controls, micro-spray irrigation.

Leak detection

- Electronic data loggers.
- Smart water meters, automatic shut off devices, leak detection systems.

Alternate sources

- Smart rainwater tank systems.

Key opportunities for showerheads, toilets and washing machines are discussed below.

Another trend has been towards smart or digitised technologies. These technologies include flow meters integrated in devices to monitor volumes of water; the integration of sensors within appliances to allow for the automatic adjustment of settings including shut off and start sensors; as well as control and display systems which attempt to influence behaviour and use. Examples of emerging water-efficient technology can be seen in Figure 5.

Figure 5: Examples of emerging water-efficient technology

Showerheads

There is the opportunity to create significant and lasting market transformation by combining a showerhead swap with an intention to move to WELS 4-star rated showerheads in the Plumbing Code and Tenancy Act over a specific time period.

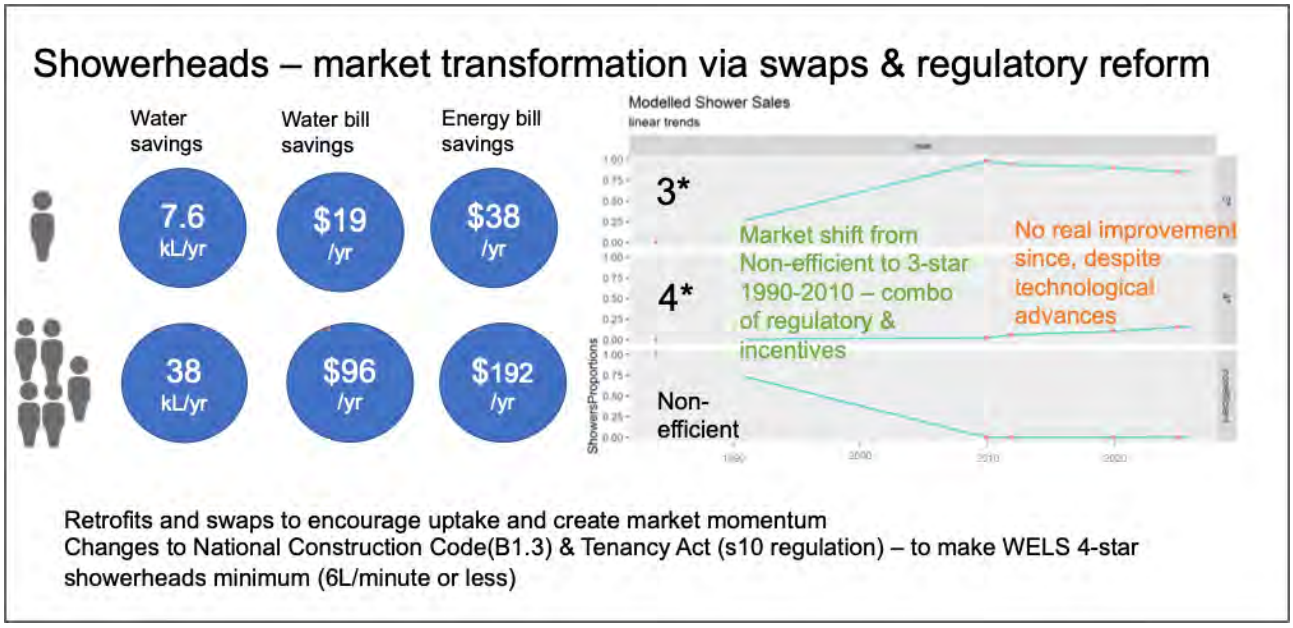


Figure 6: Showerhead opportunities in NSW

Showers account for nearly a quarter of residential end use. Shower use is also prevalent in certain non-residential sectors including hotels, pools and gyms. Reducing water use in the shower has the potential to save water and energy, due to reductions in the use of hot water.

The extensive showerhead exchange programs which were run during the Millennium drought, in conjunction with WELS labelling and a requirement in the Plumbing Code to only allow plumbers to install WELS 3-star rated showerheads, successfully shifted the market from inefficient showerheads to WELS 3-star rated showerheads over a 20-year period (Figure 6).

Over the last 10 years there has been very little change in the uptake of WELS 4-star rated showerheads. However, product development has continued and there are currently over 700 WELS 4-star rated showerhead models and 153 models that use less than 6L/min.[1]

One of the current barriers to WELS 4-star showerhead uptake is the high cost. The WELS 4-star options are significantly more expensive than WELS 3-star rated options ($180 for a 4-star showerhead versus $30 for 3-star).

Changing from a WELS 3-star rated showerhead to a WELS 4-star rated showerhead for a 7-minute shower can save 7.6kL/p/yr and also provide energy savings of just under $40/yr/person.

Showerheads can also account for a major portion of some non-residential businesses. An end use metering study at Bold Park Aquatic Centre, WA found that 28% of its total water use was due to showers. By changing to more efficient showerheads, they saved 30% of their shower water use (Water Corporation n.d.). Showerhead programs should be designed so as to reach all segments with large shower water use.

Toilets

There are opportunities to revisit segments where old toilet stock may still be present. There is also an opportunity to continue to increase requirements for toilet efficiency in standards and include waterless options in standards.

Toilets account for around 18% of residential end use. Older stock not only has greater per flush water use but is also more likely to be worn out and leak. Replacing toilets is more expensive than replacing either showerheads or tap fittings. To maximise the efficiency of programs, an understanding needs to be applied of how a region has developed. Generally, the uptake of toilet programs during the Millennium drought was much more limited than other programs (Figure 7) (Watson et al. 2019b).

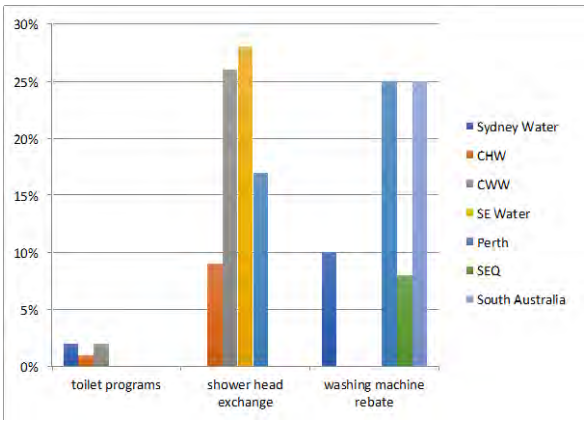


Figure 7: Uptake of a variety of water efficiency programs as a proportion of customers (adapted from Liu et al. 2017)

Efficient WELS 4-star toilets are now becoming the dominant stock in Australian houses and buildings but were still emerging during the drought (Figure 8). These toilets can lead to substantial water savings (Figure 9) and have the additional benefit of replacing older stock, which is more likely to leak. Changes to the NSW Residential Tenancy Act in March 2020 this year made WELS 3-star toilets the minimum standard for rental properties from 2025, even though WELs 4-star toilets are now the dominant stock

[1] As of 30 November 2020 there were 725 registered WELS 4-star rated showerheads

sold and even more efficient toilets are coming onto the market. Another impediment to more efficient toilet stock uptake is that current WELS standards do not recognise or rate non-water using appliances, this means that waterless urinals cannot be rated. The lack of a rating can potentially minimise the uptake of waterless options, for example where a contract requires the installation of fixtures with a minimum WELS rating.

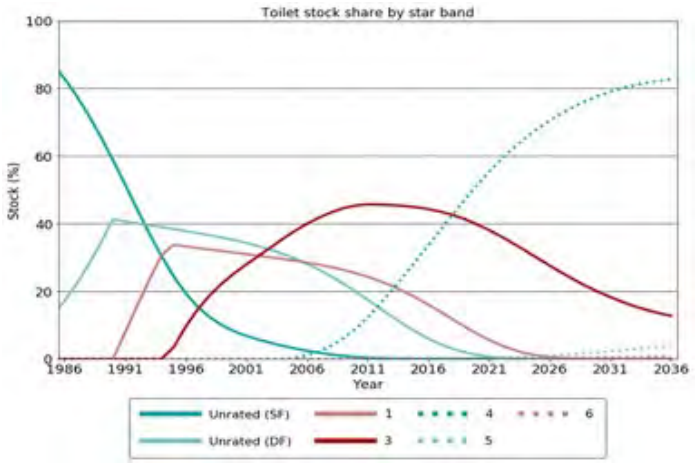


Figure 8: Stock of toilet models in Australia by star WELS band (Watson et al. 2018b)

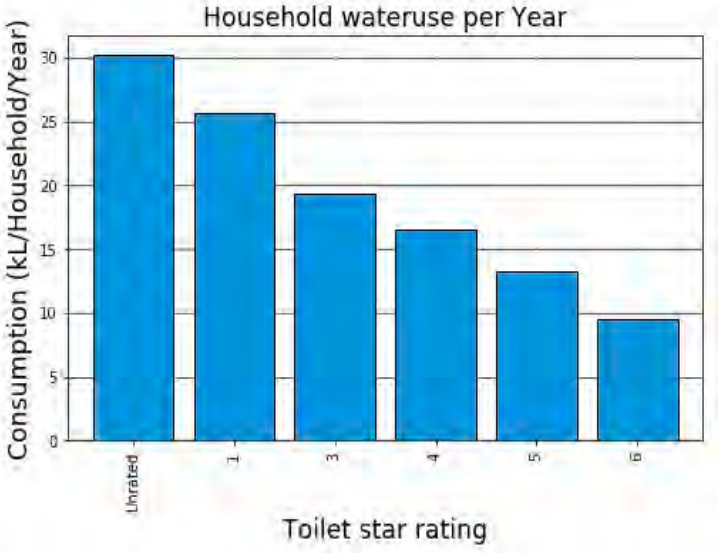


Figure 9: Comparative savings of toilets (Watson et al. 2018b)

Overall, increasing efficiency and limited stock changeover in certain market segments provides an opportunity for revisiting toilet replacement programs. This should be supported by changes in the regulatory standards and ratings tools. The inclusion of waterless options in standards and WELS would increase the visibility of these options and reduce unintended barriers to uptake.

Washing machines

There are opportunities to continue to shift the washing machine market, which results in water, energy and detergent savings. These opportunities exist in both the residential and non-residential sectors.

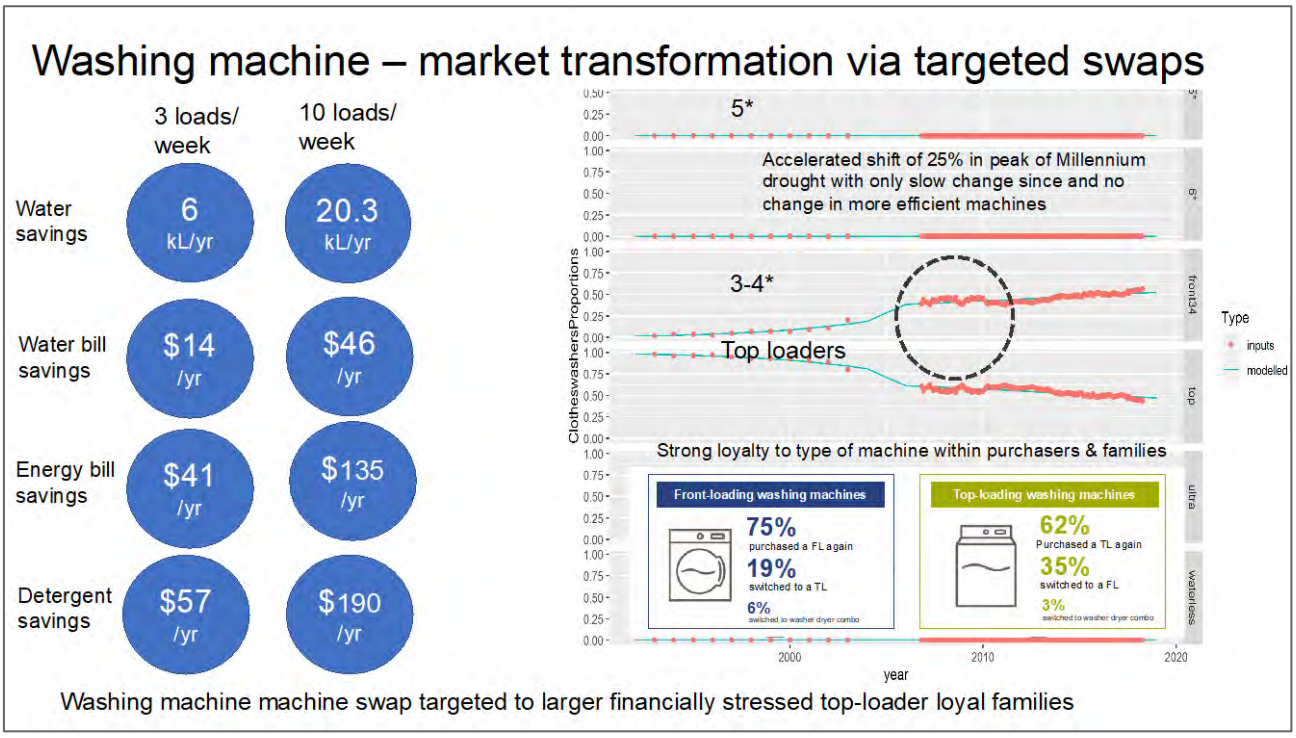


Figure 10: Washing machine market transformation opportunities

Washing machines account for around 18% of residential water use. The incentives provided during the Millennium drought created substantial and rapid market shifts, which have been sustained but not improved upon (Figure 10).

There are a large number of water and energy efficient machines on the market, with increased water efficiency usually correlating with increased energy efficiency (Figure 11). The water and energy savings from more energy efficient machines can quickly add up, particularly in larger households. As demonstrated in Table 1, even small households can recoup the cost of a water-efficient machine, which costs $400, over the lifetime of a water-efficient machine from just energy and water savings. If detergent savings are included, the cost difference would be recovered in four years. For larger households the value of a better machine is even greater.

There is emerging evidence that demonstrates top loading machines use more water than front loading machines, even when they are of similar ages (Sydney Water, pers com) and data from the WELS website shows a small difference in water use (approximately 3L/wash) between front and top loading 4-WELS star rated machines. Market loyalty to front or top loading machines is very strong. Using incentives to shift the market from top to front loaders is, therefore, likely to have long lasting impacts.

Table 1: Water Energy and Detergent shifting between different washing machines

Old machine	*New machine*	*3 loads/ week*				*8 loads/ week*			
		Water saved kL/yr	*Water bill saved $/yr*	*Energy bill saved* $/yr	*Detergent saved* $/yr	*Water saved* kL/yr	*Water bill saved* $/yr	*Energy bill saved* $/yr	*Detergent saved* $/yr
Top load 3* water 2* energy	***Front load 4.5* water 4* energy***	*6*	*$14*	*$40*	*$48*	*16*	*$37*	*$108*	*$129*
			*$102/yr or **$816 over average life***				*$274/yr or **$2192** over average life*		

Notes water price assumed $2.30/kL; energy prices assumed $0.3/kWh

In addition, learning from recent health studies demonstrates the need for periods of higher temperature washes to protect public health. This increases the benefits of upgrading the washing machine stock to more energy and water-efficient models, and not doing cost benefit calculation using cold wash only scenarios.

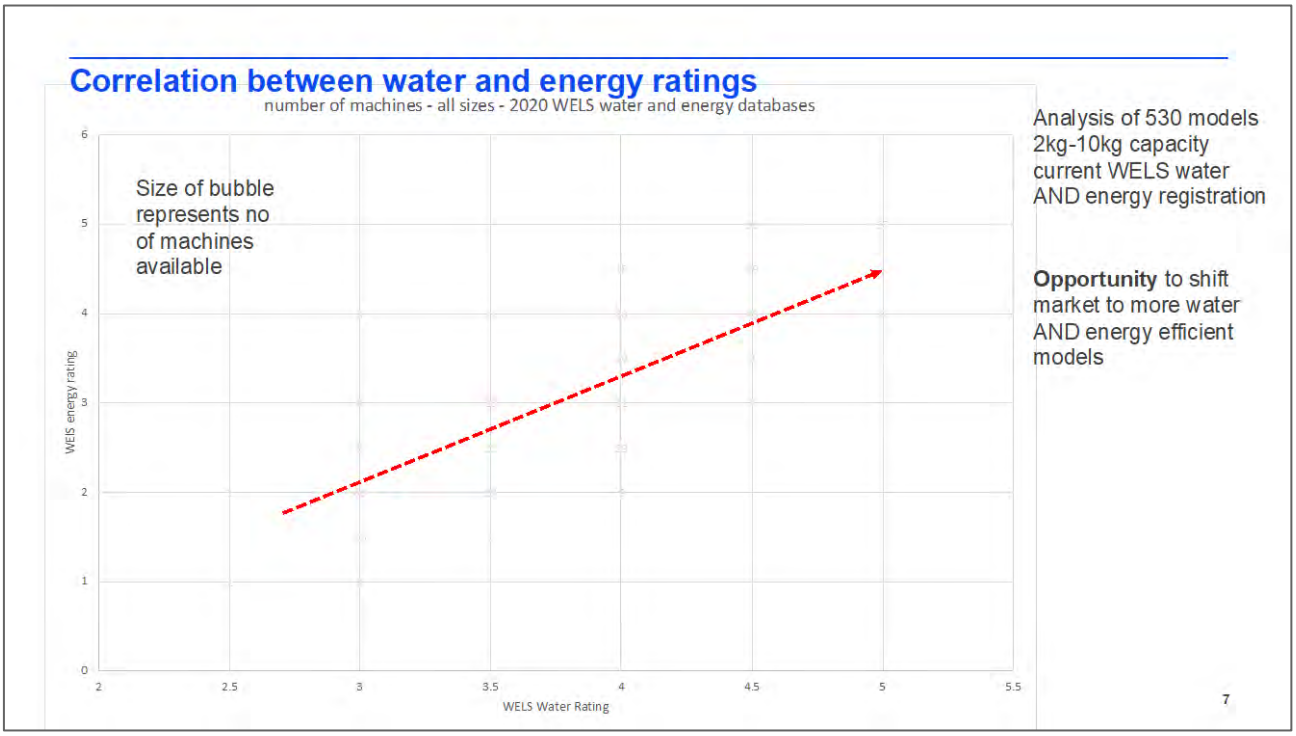


Figure 11: There is a strong correlation between the water and energy efficiency of machines.

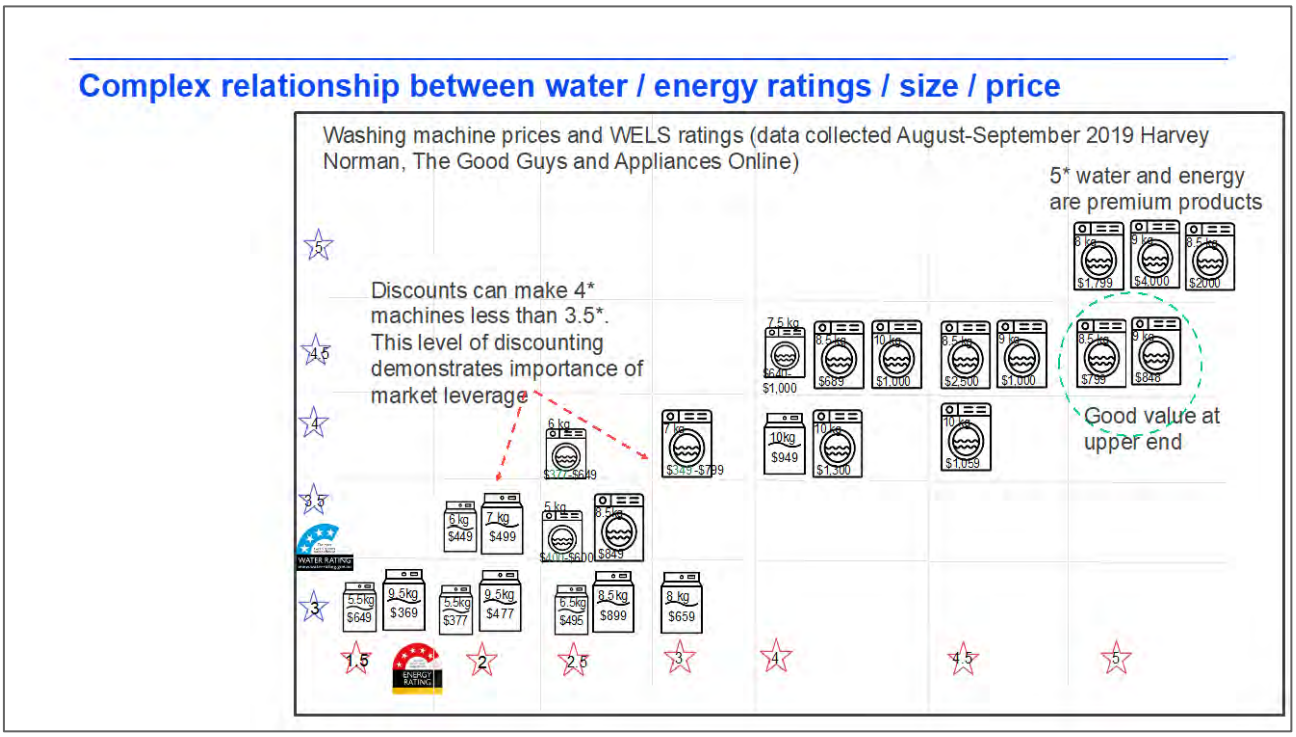


Figure 12: Complex pricing for washing machines makes determining the subsidy challenging

One of the key challenges with washing machine replacement programs is designing interventions that assist low income and income stressed household and cash flow restricted businesses to choose higher priced more efficient products (Figure 12). At point of sale, they often are unable to provide any additional funds. Previous programs which were run in region regional areas have demonstrated a poor uptake of rebates in the range of $250 among low-income households.

Many lessons can be learnt from the NSW Energy Savers program, where incentives were provided for low-income households to replace fridges and televisions (Figure 13). The incentives for fridges were in the range of $300-$600 and distributed across the state, but focussed on Metropolitan Sydney, North Coast, Hunter, Central Coast and Illawarra-Shoalhaven (Figure 14).

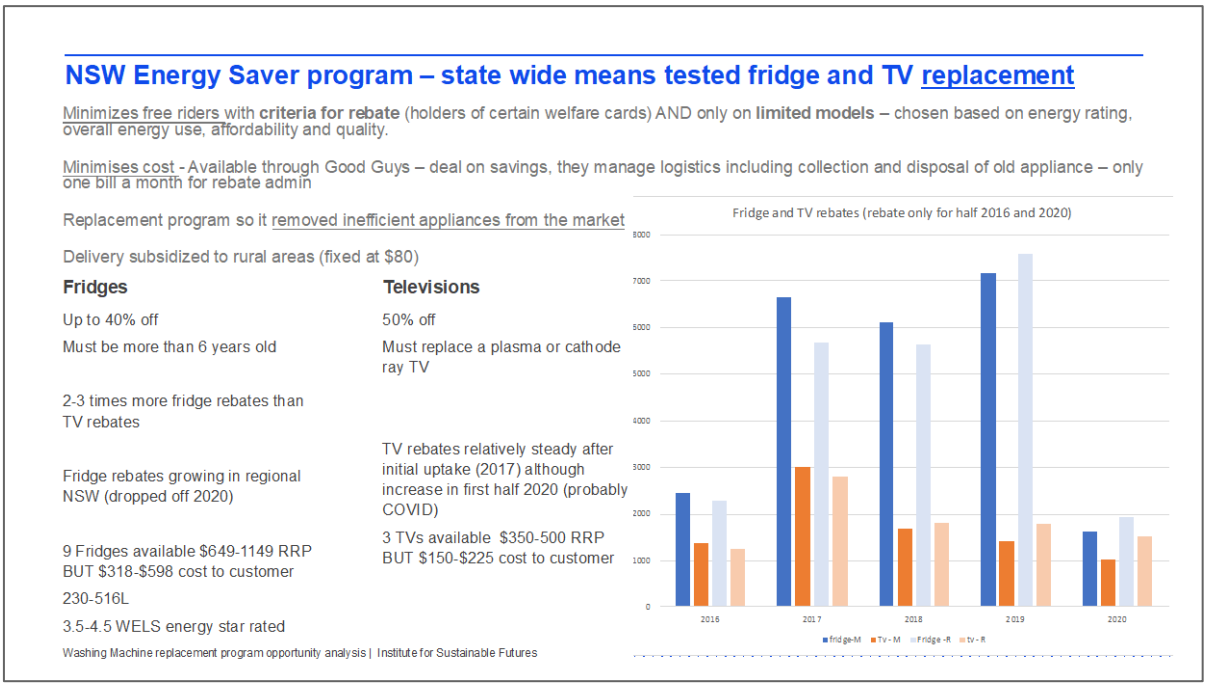


Figure 13: Comparisons to energy saver program for fridges

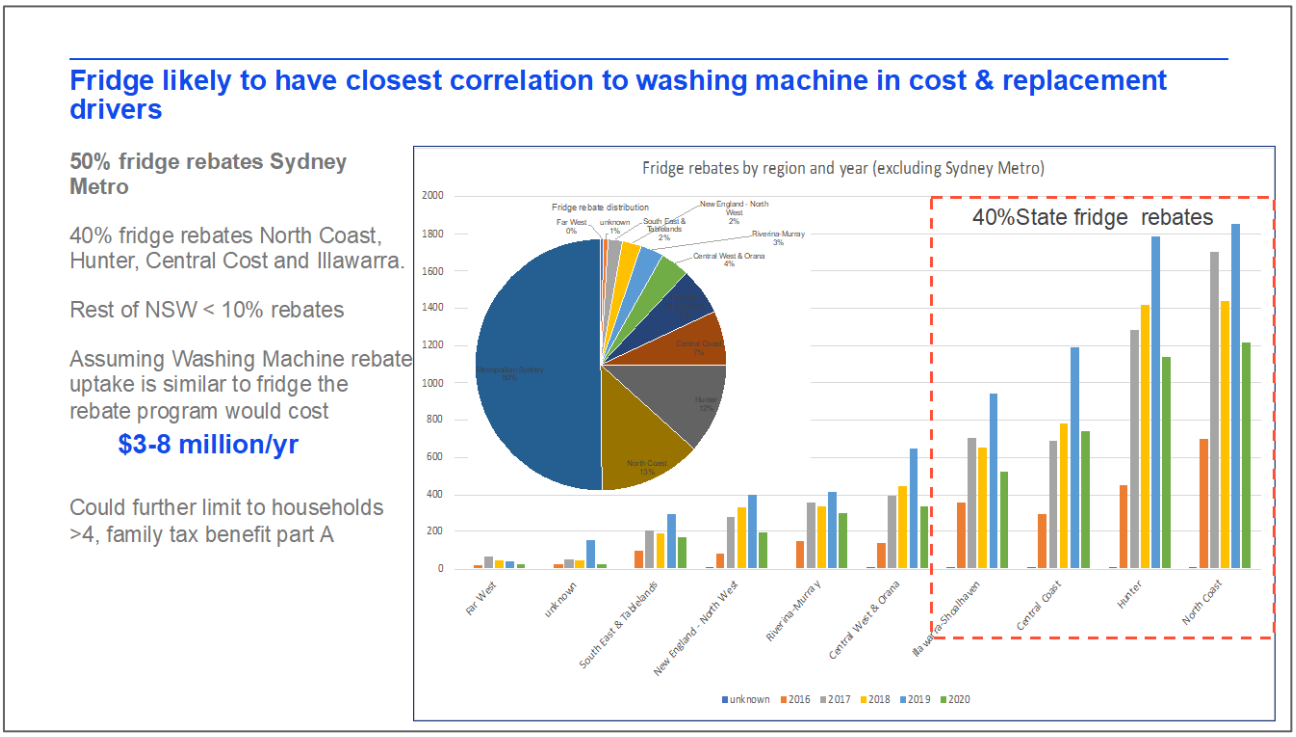


Figure 14: Distribution of fridge rebates for NSW Energy Savers Program

3.3 Key opportunities and limitations for new water efficiency programs

Appliances and technologies have the potential to shape practices. The command-and-control aspects of many of these digital devices provide significant opportunities for engagement beyond the benefits of water savings. They offer the potential for building management, intelligent monitoring control, energy savings and improvements towards occupant's health and wellbeing. This is on top of the potential for improved hygiene outcomes during a pandemic.

Digital control of water using devices to improve water efficiency

Digital control to minimise the behavioural aspect of demand

Advances in digital technology at a device level including command and control appliances are providing an opportunity for improved resource efficiencies, facilities management and user experiences. In particular, digital control of water using fixtures can help to increase water efficiency. This is useful in overcoming behavioural barriers to water use change, for example in reducing irrigation times, adapting cooling tower bleed, automatic detection and reporting of leaks. For example, the next generation of cooling towers have salt meters that control the frequency and length of bleed rates.

Digital controls using cloud software and predictive watering adjustments can be used with irrigation equipment to improve water efficiency using data collected from evapotranspiration sensors, soil moisture detection and weather forecasting. There are many practical benefits to smart irrigation systems including scheduling for watering in the evening rather than at the hottest point of the day; and integrating dynamic responses to changing conditions to further improve garden water efficiency. Box 1 provides an example the potential benefits of digital irrigation control.

Digital controls can also minimise behavioural aspects of water wastage in fixtures and fittings. Early examples of this were hand basin taps with automatic shut off. Box 2 provides emerging examples of the potential water savings benefits of digital shower control.

Technology focus: Smart Irrigation

Irrigation accounts for 70% of all freshwater use worldwide. Technological advances that are driving efficiencies in the agricultural sector are also benefiting other water users such as homes, schools and businesses.

Residential sector

With up to 40% of household water consumption directed to the garden, smart irrigation controllers have the potential to deliver big savings.

In 2015-16 the Water Corporation held a trial of weather-based smart irrigation controllers across 60 households. This trial indicated a reduction in total household water use by 15% or 95,000 litres in the first year (Water Corporation 2019).

Weather-based smart irrigation controllers can monitor meteorological data and conduct in-situ measurements. As seasons and temperatures change or when rain falls, smart irrigation control can take into consideration site-specific variables such as soil type, using feedback from soil moisture sensors to suspend irrigation.

Industrial scale irrigation

Industrial property giant Goodman has deployed smart irrigation systems in its Australian sites over 2020 following a successful technology pilot. The pilot achieved a 160,000 litre or a 35 % reduction in water usage over a three-month period in Sydney's outer west (Goodman n.d.).

This irrigation system uses smart devices to provide real-time fault detection and usage data, and to enable remote control of irrigation systems. Goodman estimates the system may significantly reduce operating expenses by saving 1,900 hours of work yearly and remove about $100,000 in capital costs per annum associated with plant replacement.

The technology employs a wireless based adjustment control system; water program adjustment at an asset or entire portfolio made remotely; and predictive watering adjustments based on local weather forecasting and soil moisture levels.

Technology focus: Smart Showers

Showers account for nearly 25% of household water use. Digitally controlled showers are emerging that help to influence or control behaviour.

The Eco Shop Direct shower timer can switch off the water flow after a pre-programed period of time.

The Showerguard actually stops the flow of hot water to the shower after a pre-set time, with a warning with one minute and 30 seconds to go (Showerguard n.d.). Aqualisa Q uses proximity technology to reduce water flow when there is no one within half a meter of the shower (Aqualisa 2018). These three products are examples of how digital technologies save water by forcing behaviour change.

The Amphiro provides information on water and energy savings, but it is not currently available in Australia (Amphiro n.d.). This product doesn't change behaviour but is designed to influence shower behaviour using behavioural insights and gaming theory.

Example of a digital shower timer: the Eco Shop Direct device

Example of a digital shower timer: the Amphiro device and interface

Digital control to manage leaks and volume usage based on pressure

Digital control can also reduce leaks due to very high pressure, or inefficient water use due to large pressure fluctuations.

Reducing hydraulic pressures can substantially reduce leaks and also extend the useful life of water related appliances (Liu et al. 2017). Water pressure can fluctuate with reservoir levels and when high, the risk of leakage may increase. Intelligent metering can be employed to understand and manage network pressure and mitigate leakage through pressure reduction during low flow periods.

The practice of using digital control to manage inefficient water use due to pressure fluctuations can be extended to building networks. Pressure can fluctuate between the floors of buildings and throughout the day depending on the demands on the network. By monitoring the flows and pressures across the building, pressures can be reduced in some parts, and boosted in other parts.

New taps, showers and urinals are being designed with flow regulators that adjust the volume of the flow based on pressure. A lack of pressure can create flushing issues resulting in multiple flushes. Conversely, too much pressure can cause undue strain on tapware, causing maintenance issues such as leakage. Detecting and controlling for pressure at a fixture level can prolong the life of fixtures and

provide water savings through reduced leaks. If higher pressure is detected in a urinal for example, the volume of the flush could be reduced while still achieving adequate cleaning flows.

While not currently widely commercially viable in the water sector, fixtures that have digital fault detection would also help to improve water efficiency and reduce water loss through leaks or ineffective use. For street lighting, automatic outage detection and remote monitoring allows operating and maintenance costs to be reduced by reporting exactly where faulty lights are, while also improving safety for pedestrians and vehicular traffic (Mahoor et al. 2017). Developments in smart urinals and toilets will allow external isolation of faulty fixtures, improving efficiency and cost savings by allowing facilities managers to identify the specific fault allowing the correct technician to be called (Watson et al. 2018b).

Digital control is also being adapted to integrate water quality and quantity outcomes. At the Aquarevo development in Victoria, Australia rainwater tanks are digitally controlled based on artificial intelligence and Bureau of Meteorology data. When rain is predicted the tanks can pre-release water to ensure there is still room in the tank to capture rainwater. The software has been designed to learn and self-correct following each rain event as each roof and tank combination reacts differently to the volume and intensity of a storm. Modelling suggests that using rainwater tanks to both supply water and provide storage that can be used to attenuate storm peaks can reduce stormwater by up to 55% from the Aquarevo development, with minimal impact on the yield reliability (<10%) of the rainwater tank (Cooperative Research Centre for Water Sensitive Cities 2017).

Designing more efficient and effective programs through digital metering and data analytics

In the energy sector, there has been a rapid growth in the options for measuring and managing energy use through consumer accessible apps. The water sector is poised to move in the same direction.

The availability of low-cost widespread sensors and the IoT will enable a transformation of controls for irrigation, timing and control of water use, monitoring and control of leakage and pressure and automation of water and wastewater systems. These technologies provide the capacity to collect large amounts of data to help direct water efficiency efforts, both in targeting programs and changing customer behaviour.

Since the Millennium drought, there has been an increase in digital metering, monitoring and feedback system options on the market (Liu et al. 2017). Across the water industry, organisations are embarking on major investments in becoming digital utilities. In 2014, a total of 48 water utilities across Australia indicated that they were actively using, installing or considering smart meters (Beal & Flynn 2015).

While there are studies to demonstrate the short-term water savings of engaging with digital metering, there are no longer-term studies. Utilities are being challenged to consider how to best manage and analyse large data sets metering provides and engage with customers in the longer term. Understanding how to manage and utilise this data will enable the next generation of demand management programs. In particular, we could see a revolution in the sophistication of targeting, customer segmentation and customer interaction.

To maximise the value of the available data future strategies, the digital metering platforms need to be accompanied by capacity and capability in data analytics and customer behaviour change.

Digital metering to understand customer behaviour to help design water efficiency programs

The reducing cost of both permanent and temporary digital meters provides an opportunity to better understand customer behaviour. Ongoing studies by utilities such as Yarra Valley Water and Sydney Water provide insights into what is driving water demand in different customer segments, which is invaluable for designing and targeting water efficiency programs. Initial comparisons comparison between utilities highlighted some key differences in stock and usage patterns for a number of different end uses demonstrating the importance of designing water efficiency programs based on local demand data and customer segmentation.

Digital metering to target specific market segments and change customer behaviour

With new technologies on the market and new data analytics available to distinguish rapidly between end uses and various market segments, it may be possible to target programs and communications to specific customer segments. The role of targeting customer segments and end uses will be particularly relevant in cities that conducted extensive programs in the Millennium drought.

A review of 27 digital metering projects in 2017 found savings of around 5% of residential consumption a year (Liu et al. 2017). There are no studies that support the longevity of the water savings due to the relatively new nature of smart water meters and they often cannot be justified on water savings potential alone.

Substantial opportunities for digital technologies and associated data analytics lie with the non-residential sector, particularly with larger customers. For example, the successful Schools Water Efficiency Program (SWEP) that integrates digital metering with educational tools in Victorian schools has demonstrated savings of 7.5 GL since it began, providing bill savings and easy to use educational materials.

Digital metering for rapid program evaluation

Digital metering also provides the platform for more rapid, sophisticated evaluation, and the potential for optimisation of water efficiency programs.

The IoT and increasing digital connectivity may allow utilities to communicate with customers within a particular program and rapidly detect changes in demand through online apps and websites with sophisticated tailored programs enabled by data analytics (Liu et al. 2017; Turner & White 2017). This will allow evaluation and adaption of programs to provide overall better outcomes.

Digital data collection means pilots can be designed to both test interventions and collect data. This could mean that, as well as identifying potential water savings and implementation issues, the piloting process could collect data on other aspects. These might include data on water usage by other end uses, appliances and fixtures, or behaviour aspects and information critical to program design such as socio demographics, “take-back” rates by customers choosing high levels of service (such as taking longer showers with more water-efficient showerheads installed) and problems with new technologies.

Assessing the value of water efficiency

The economic value of water efficiency, based on a least cost approach to water planning, was established in the early 1990s. The economic viability of water efficiency options was demonstrated during the Millennium drought, where the majority of water efficiency opportunities pursued provided cheaper and faster water (savings) than other more traditional infrastructure solutions (Coombes et al. 2012; Turner et al. 2016).

The environmental benefits of water efficiency, including reducing water extractions from natural ecosystems and reducing wastewater treatment and discharge, have been well recognised. Research emerging at the end of the Millennium drought identified and measured additional benefits of water efficiency including:

- greenhouse gas reductions due to reduced hot water demand and reduced treatment and movement of water and wastewater around the network (Bors 2018)
- reduced infrastructure and peak energy requirements due to reduced peak demand (Beal et al. 2016; Gurung et al. 2015)
- economic efficiencies due to delaying and deferring “lumpy” infrastructure augmentation decisions (Mukheibir et al. 2013; Rust et al. 2020)

- the spatial variation in the value of water efficiency due to the variation of operating costs across the network spatially (Sydney Water 2015b, see also energy sector[2])
- the time variation in the value of water efficiency due to declines in supplies (Hunter Water 2020; Sydney Water 2015a), both in the value of keeping options open (Rust et al. 2020) and in relation to increased operating costs as additional temporary options (such as desalination and cross catchment pumping) were brought online and greater levels of water treatment were required.

While levelized cost is relatively simple to apply and commonly used to compare water supply and demand options, it is limited in its ability to capture other benefits of water efficiency. Understanding how these additional benefits apply to options individually, programs of options and developing robust and agreed measurement techniques helps identify the full range of economic water efficiency opportunities.

Designing more efficient and effective programs through sub-sectoral analysis and targeting

There are opportunities to design more efficient and effective water efficiency programs. This includes revisiting past successful programs for segments of the market that were missed and targeting programs at specific customers to maximise water savings opportunities.

Identifying missed opportunities

There is a perception in some parts of the water industry that the substantial efforts made during the Millennium drought minimise future opportunities to reduce water demand. Alternatively, some argue that water efficiency is not economic any longer. Recent analysis at a number of utilities demonstrates that this perception is not true, particularly as previous demand management efforts were far from uniform in coverage, both geographically and within a local area.

There is an opportunity to revisit successful programs in specific locations that previously had low uptake. Across Australia the key focus of water efficiency efforts varied greatly. For example, as shown in Figure 15 South East Queensland had a very high up-take of rainwater tank rebates, whereas Sydney Water invested heavily in household retrofit programs (Figure 16). However, even within Sydney there was a much lower uptake of rainwater tank rebates (Figure 15) and washing machine rebates (Figure 17).

Although the form of the rebate programs varied between jurisdictions, overall toilet retrofits and rebates were much lower than other more easily replaceable fixtures, fittings and appliances, such as showerheads and washing machines (Figure 17).

The comparison of uptake rates can help identify missed program types and reveal programs that had low uptake in comparison to other regions. Regions without a history of retrofit programs, for example, may have significant numbers of older housing stock with inefficient fixtures still in place.

Review of past program participants may identify opportunities for redirecting or refocusing past programs. For example, an evaluation of a toilet retrofit program in one area found much lower than expected savings. The lower savings were significantly influenced by single person households dominating the program uptake.

[2] https://www.energynetworks.com.au/projects/network-opportunity-maps/

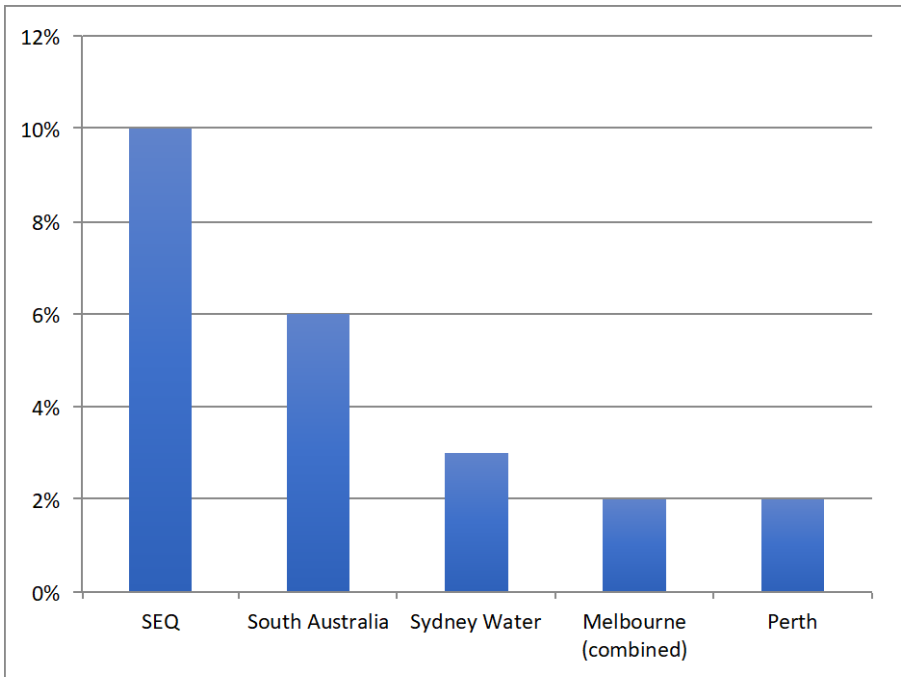


Figure 15: Uptake of rainwater tank rebates as a proportion of customers (Liu et al. 2017)

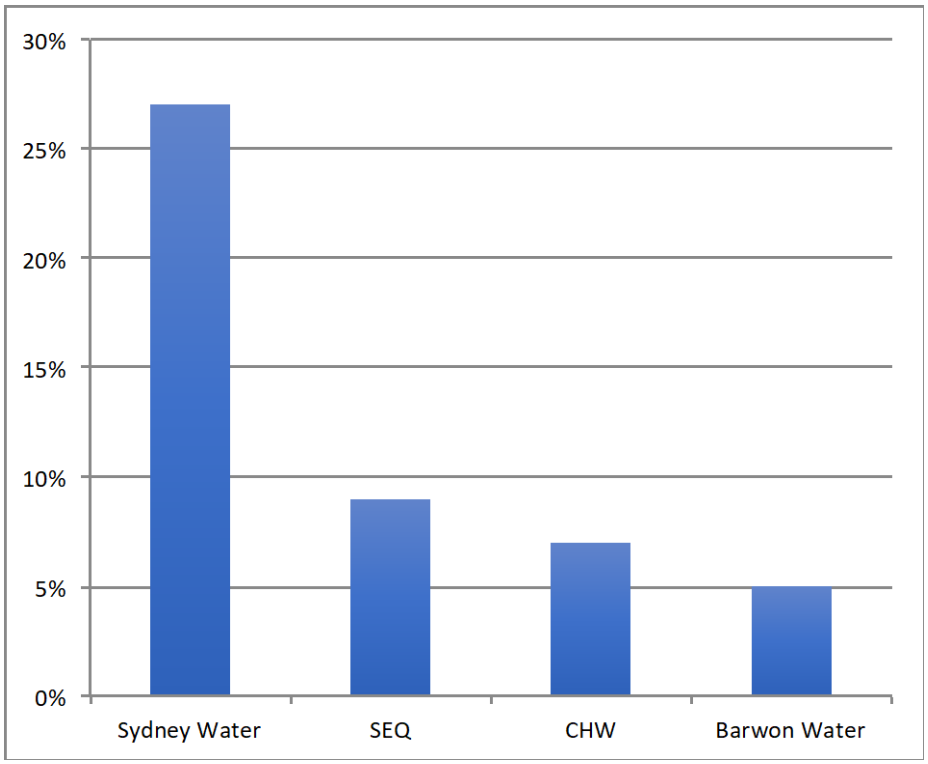


Figure 16: Uptake of indoor retrofits as a proportion of customers (Liu et al. 2017)

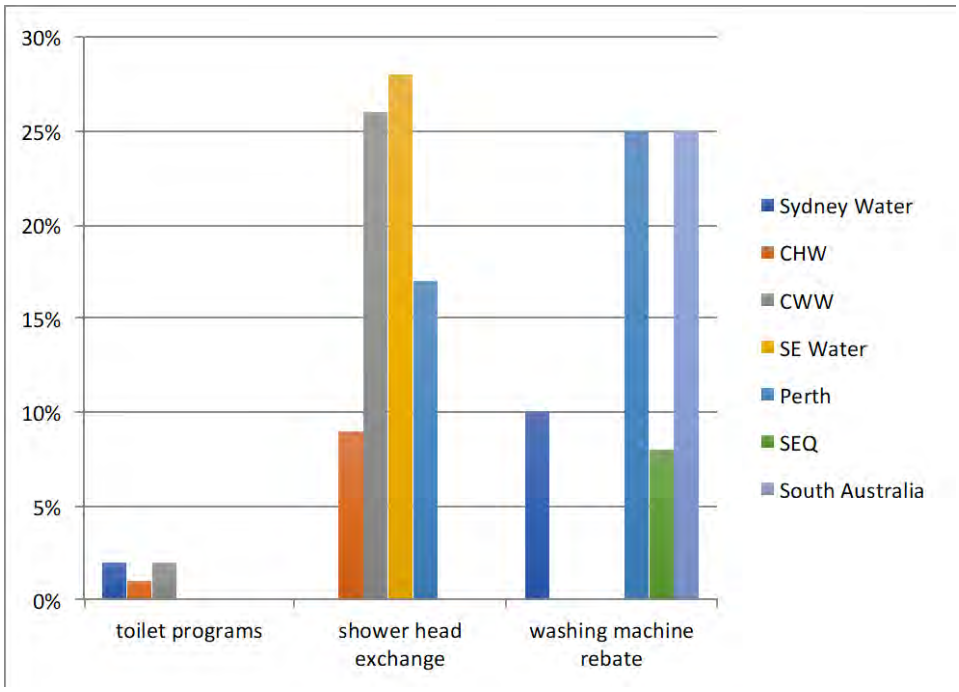


Figure 17: Uptake of water efficiency programs as a proportion of customers (Liu et al. 2017)

Targeting specific customer segments based on sophisticated data analytics

During the peak of the Millennium drought many large-scale programs were implemented. However, towards the end of the drought, the need for greater sophistication in the design and targeting of demand management programs became increasingly apparent. The demand distribution within a segment or sector and analysis of end uses that contribute to high demand can be used to target water efficiency programs.

The best non-residential programs sought to target particular sub-sectors and particular high-water using end uses (i.e., glass washers and water-cooled woks). Some utilities used billing data to target specific high users (for example Hunter Water during the most recent drought) and others conducted detailed surveys to target high water users in both the residential and non-residential sectors (for example the SEQ One to One Water Savings program).

While average demand within a target sector may seem reasonable, examining the demand distribution can provide insights for targeting programs. For example, Figure 18 demonstrates the significant demand distribution and tail of high-water residential users for two separate locations. The curves illustrate the value of targeting high use customers and not relying on averages.

Depending on the underlying drivers of the high demand, a range of targeted programs can be considered. For example, if high demand is driven by large properties, outdoor education and rainwater tanks could be considered. However, if the high demand was driven by leaks and inefficient water use by large low-income families, there may be substantial efficiency gains from leak repair and rebate programs for high water using appliances (such as showerheads and washing machines).

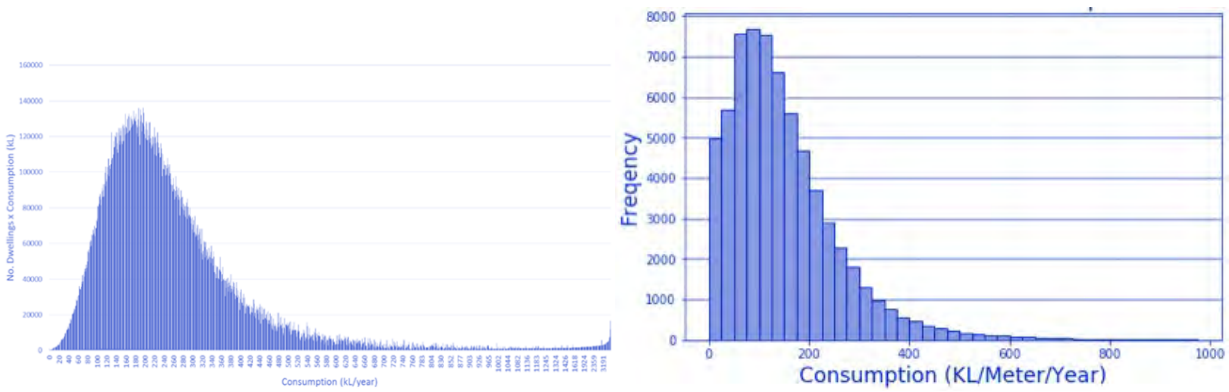


Figure 18: Demand distributions for households showing substantial differences from the average

Programs designed to target the top 5% of users can have significant potential for water savings. During the most recent drought Hunter Water knocked on the doors of its highest water using customers, engaging with them directly to identify water savings. Many of these customers were not aware of their high-water use. In Darwin, meter readers were engaged to detect night flows and identify properties with high leakage (Watson et al. 2018a).

These programs can often also be justified on hardship grounds as a proportion of high-water demand customers have been found to also be facing bill stress.

In the non-residential sector, past experience has demonstrated significant savings in targeting the very highest users, who account for the majority of non-residential demand.

Similar to the residential sector, understanding profiles within a non-residential demand segment can help further target programs. For example, as demonstrated in Figure 19 , there is significant variation in average demand and seasonal fluctuation between schools, providing a starting point for targeting irrigation programs.

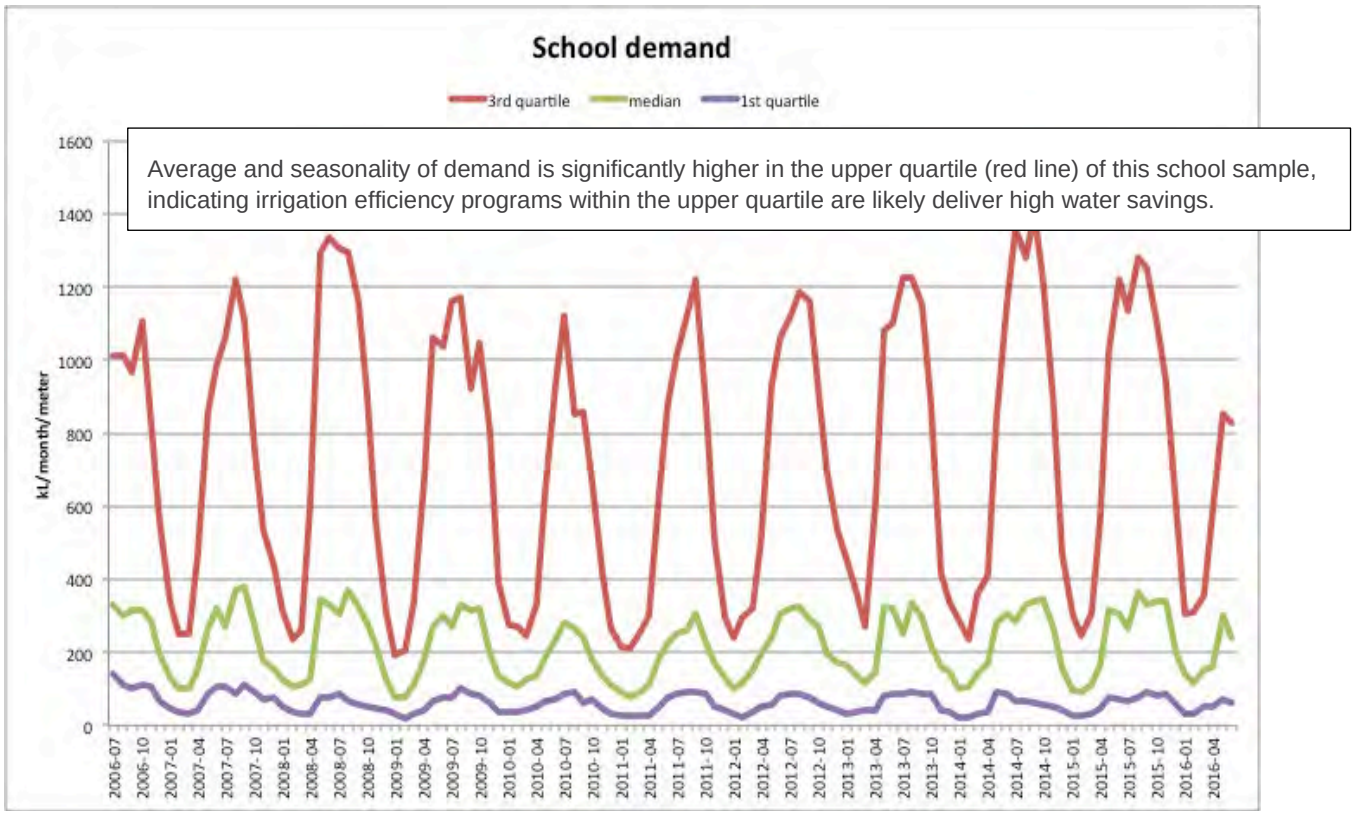


Figure 19: Seasonal and average variations in demand can vary greatly within a sector

However, new programs must be carefully designed to target customers with the largest potential for water savings. Using end use data, customer segmentation, sub-sectoral data analysis and program targeting are essential to maximise the water savings and the value achieved from the program.

Targeting to overcome barriers to market change

While the market will naturally drive some change, the change is focused in areas of new housing and higher socioeconomics where renovations and replacement happen more predominantly. This may leave large segments of some communities with much lower levels of water efficiency than others.

Past rebate programs were not always structured so as to be accessible to lower socio-economic groups. Washing machines are a good example of how the structure of the rebate can bias against socio-economic groups. To encourage change, rebates for higher efficiency washing machines were paid after purchase and often only covered the gap between a WELS 4 or 4.5 star machine and a 5 star machine. In contrast, sales of machines occur in the WELS 3-4 to 5 star range (Watson et al. 2018b). Reviews of these programs (even ones targeted at concession customers) have highlighted that customers facing financial hardship do not have the finances available to purchase more expensive machines, despite savings from water and energy bills for more efficient machines paying back the additional cost in less than 2 years.

Understanding actual local stock (as opposed to global sales data), eliciting drivers for higher water use and matching program type and structure to the specific customer is critical. Buying local sales data combined with end use surveys can help to create a clearer picture of where water savings might be realised.

Barriers to market change do not just apply to the residential sector. High upfront costs of replacing fixtures can result in more efficient options not being adopted. For example, a recent survey of childcare centres in Blacktown found the majority of washing machines were water and energy inefficient. These machines were high use and replacing them with efficient machines would payback in just under 3.5 years. Providing some form of a revolving loan fund would assist in these opportunities being adopted.

A lack of focus on water as a key input to business processes can also mean that water efficiency options are not adopted. For example, school and hospital maintenance contracts often replace like for like and do repairs on an “as- broken” basis. Assisting in developing and proving the value of more proactive maintenance contracts would help to overcome these barriers.

Where the program is targeted can also help overcome barriers to change. A key example of this is Hunter Water’s School Water Efficiency Program. In this program, schools were provided with data loggers and access to the data for three years. After the three years they were required to pay for the loggers themselves. Hunter Water found that the contracts were not renewed and large leaks that would have been picked up by the loggers had been missed. They found the lack of renewal was due to staff moving on and a lack of momentum. In contrast, the same program was targeted at the diocese level for Catholic schools and the longevity of engagement in that segment has been much greater.

Designing better programs using project management

The broad range of programs undertaken during the Millennium drought tested and refined a number of different project management and project delivery mechanisms. Unfortunately, much of this knowledge was not captured and many organisations have lost key capacity in water efficiency. Some areas of learning included:

- incentivising contractors and reducing overheads, for example requiring contractors replace all the washers if a few are leaking. This reduces the chance of a new leak developing in the following months. This increases water savings and reduces overheads as the largest portion of the cost is often the appointment booking administration and the plumber call out fee.
- ensuring customers value their programs. History has shown that when programs are offered for free, savings are not often achieved or sustained as they have little buy-in, or the program is taken

advantage of. One utility's review of its historical water efficiency program recommended that the subsidy for any water efficiency activity does not exceed 90% of the expected customers costs.

- mechanisms to incentivize actions arising out of audits. For example, the Sydney Water business program used to get CEO agreement to undertake cost effective water savings before they conducted an audit.
- developing a community of best practice and having a centralised repository for knowledge capture and dissemination would help to improve the value of water efficiency programs across the State.

It is critical to consider how a program will be evaluated and reviewed before the program is rolled out. An analysis of why programs are not reaching their potential can provide valuable inputs into program evaluation and redesign. This involves not just a straight numerical analysis but talking to people who are working with customers. For example, two separate hardship programs subsidizing high efficiency washing machines both had very limited uptake. Although these programs could provide significant water and energy savings, the implementation model made it unfavourable to customers. By talking to both customers and local retail suppliers, a more nuanced explanation than "there is no interest in rebates" could be found (Watson & Fane 2019). In another example, tap products installed as part of a retrofit program were reviewed. Talking to customers about the program identified that the standard tap, although efficient, was difficult to turn off for elderly customers, a key target segment. This led to even relatively new taps leaking as they could not be turned off tightly (Watson et al. 2018d). Upgrading to a leaver tap would provide much better outcomes and customer satisfaction for a minimal additional investment.

At an individual site and company level, including water efficiency in maintenance contracts is one way of driving ongoing water efficiency. For example, a local council included ongoing water efficiency requirements (5% per year) in their facilities management and parks contracts (Watson et al. 2019a).

Behavioural change

Behaviour change

Information or education and rational choices alone do not drive behaviours. Instead, many unconscious cues have a strong impact on actual behaviour. Many or most of our decisions are made 'fast' and are intuitive, automatic and experience-based, or involve relatively unconscious judgements and 'rules of thumb' (heuristics). Such decision-making is based on cognitive shortcuts or impressions and is prone to unconscious bias. There is commonly a 'behaviour gap' between people's intention and action. For example, people procrastinate, are impatient, go out of their way to avoid 'loss' rather than being motivated by gain, care about fairness and reciprocation, are subject to a range of psychological biases and cues when interpreting information. Specifically understanding behavioural change theory when designing education materials and programs is critical.

Some of the examples of commonly identified 'behavioural insights' or nudges from the literature that may be of relevance to water efficiency are provided in Table 2 below.

Table 2: Examples of behavioural insights relevant to water efficiency education and programs

Insight	Description	Examples of potential relevance to water conservation behaviours
Social Norms	Individuals looks to the behaviour of peers to inform decision-making, and tend to conform to the same behaviour their peers engaged in	*Turning the tap off while cleaning teeth.* Images showing this behaviour have potential to make it a behavioural norm in the community. *Garden Watering*. Images showing watering of green gardens can be expected to 'norm' the practice of watering. Alternatively, if everyone has a brown lawn when it is dry then that becomes a norm. *Show relative high-water users their use.* Information on bills could be used to indicate relative water use to high users e.g., how much above average consumption they are; and/or to compare to households in their area or businesses in their sector. Conversely, there is no advantage telling low water uses they are using less than is normal.
Personalisation	Including people's names gains attention and may significantly impact uptake of programs. Even including a suburb, town or profession/business sector can have a measurable impact in many contexts.	Trial personalization in messaging to customers for potential programs.
Simplification	Too much information in the environment prevents the individual from evaluating and making a good decision.	Trial simplification of messaging and the removal of unnecessary information. Provide information in 'bite sized chunks' and only provide the information needed at that point to move to the next stage of a process.
Status Quo Bias or default rules	The preference to maintain current state even if a change in circumstances would provide better options. Choices can be nudged by making the preferred option the default.	The impact of changing the default can be seen in customers now needing to choose not to have 3- star showerhead and toilet as these are now normal in stores. This might be actively extended into non-residential sectors with equipment choice. Conversely, changing established habits such as washing down hard surfaces may be difficult and require more than information/education.

Insight	Description	Examples of potential relevance to water conservation behaviours
Incentives	Lotteries have a much stronger impact to incentivise behaviour than flat rebates.	Could lotteries (or other prizes) be considered to incentivise uptake of programs or best practice water use in both the residential and non-residential sectors? Sydney Water found that to incentivise behaviour change for reduced water, less than $100 will be sufficient to change a large proportion of the community.
Loss Aversion	The tendency to be more attuned to losses (e.g., costs) than to gains (e.g., benefits).	Avoiding inconvenience now (a cost to ourselves) will be more important than gaining in future. Therefore, make being involved in any program as easy as possible and overcome the initial investment barrier.
Authority or Messenger bias	In some contexts, there is a predisposition to accept information from an 'authority', while in others the trusted messenger will draw on social cues.	One example cited in the literature is for home energy reports signed by the utility's CEO significantly impacted the subsequent uptake and reduction in consumption.
Eliciting implementation intentions and commitment	People are more likely to engage in an activity if someone has elicited the implementation intention. Going further, getting someone to make a plan of action that includes a specific time or committing to an action in some meaningful way can strongly influence behaviours.	This means simply asking someone about their intention to change their behaviour or install water saving appliances will make them more likely to act. For example, signs in hardware stores asking people 'how will you save water today?' could have an impact on the products they then buy. For non-residential customers thinking about the type of commitment asked of customers before an audit and how it is delivered may impact subsequent uptake.

Chapter 4 Detailed analysis of water efficiency opportunities

The chapter provides fact sheets on the different water efficiency options emerging from the scan. Table 3 provides a list of all the factsheets that were produced to provide an easy reference to water efficiency options.

The factsheets outline who the end users are, what the targeted end uses are and provide examples of the specific subsets of water efficiency options (i.e., where they have been adopted, savings (if known), best case examples where possible, as well as opportunities and constraints). Further details on the options can be found in Appendix 1.

Table 3: List of Factsheets for Water efficiency options

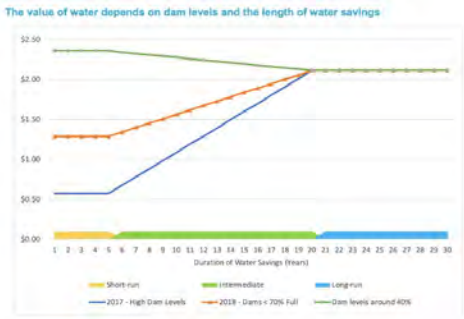
Factsheet no.	**Factsheet title**
No. 1	Utility targets
No. 2	Network management
No. 3	Smart metering
No. 4	Benchmarking – Residential
No. 5	Benchmarking & Standards
No. 6	Education
No. 7	Residential audits
No. 8	Leak detection and repair
No. 9	Garden programs
No. 10	Smart household water supply
No. 11	Toilet programs
No. 12	General rebates – Residential
No. 13	General rebates – Non-residential
No. 14	Specialised audits
No. 15	SME business programs
No. 16	Irrigation efficiency

FACT SHEET

OPTIONS FACTSHEET no. 1

WATER UTILITY TARGETS

Performance indicators to guide utility operations



https://www.sydneywater.com.au/

Water utilities operate with various performance indicators as part of their operational and strategic plans. Regulations and policies stipulate either targets or methodologies for determining the targets and cover outcomes such as water leakage, water recycling, and water efficiency (including demand management).

UTILITY TARGETS OPTIONS

* L/c/d or L/p/d
* ML/a
* ELWC
* ILI
* ELL and SELL
* Recycled Water targets

TARGET USERS

Utilities

TARGET END USES

N/A

OPPORTUNITIES

- Review the ELWC methodology and the way in which it is being applied by water utilities

- Combine simple targets as a floor with ELWC to reflect short term changes in the value of water efficiency

- Overcoming financial disincentives for utilities to invest in water efficiency

CONSTRAINTS

- Challenges estimating SELL and comparing estimates between utilities.

L/c/d or L/p/d

Litres per capita or per person per day is a commonly used target. For 2019-20, YVW set a target of 217 L/c/d with its world-leading commitment to voluntarily return funds to customers via an annual $1.5 M community rebate through pricing if this or any of its other service targets are not met.

ML/a

Some utilities have employed targets for the total volume of water delivered and volume of water recycled, both measured in megalitres per annum (ML/a). These targets re the simplest to understand, but inflexible if demand varies due to uncertain growth or climate.

Recycled Water targets

Targets are used for recycled water - either in terms of the volume or the percentage of recycled water substituting potable supply. Israel is the world's no.1 and recycles 90% of wastewater, followed by Spain at 30%.

ELWC

The Economic Level of Water Conservation (ELWC) method developed by Sydney Water identifies potential water-saving programs, considers the community-wide costs and benefits of each, assesses its respective levelized cost (cost per kL) and implements programs where the levelized cost is less than (or equal to) the value of water. The ELWC is the volume of water that will be saved from all programs with a levelized cost less than (or equal to) the value of water. The method should result in increased investments in water conservation as dam storage levels drop, but can be complex to calculate and understand.

ILI

The Infrastructure Leakage Index (ILI) was developed by the International Water Association (IWA) Water Loss Task Force (WLTF) and measures real water loss from the distribution system. First published in 1999, ILI has been applied in at least 50 countries worldwide.
ILI = Current Annual Real Losses (CARL) / Unavoidable Annual Real Losses (UARL). An ILI of 1.0 is considered world class and has been achieved by various jurisdictions around the world. See: https://www.leakssuitelibrary.com/ili-overviews-by-country/

ELL and SELL

The Economic Level of Leakage (ELL) is the optimum level of leakage; the point at which the cost of reducing leakage is equal to the benefit gained from further leakage reductions". ELL is used by many water utilities. More recently the concept of the SELL (Sustainable Economic Level of Leakage) was developed to incorporate externalities – indirect social and environmental costs and benefits. The SELL has been used in the UK to establish regulatory leakage targets but has been criticised for not necessarily incentivising efficiency and innovation.

FACT SHEET

OPTIONS FACTSHEET no. 2

NETWORK MANAGEMENT

To reduce losses in the water distribution system

NETWORK MANAGEMENT OPTIONS

* Active leak management
* Pressure management
* Intelligent networks
* Leak detection programs
* Detection dogs

TARGET USERS

Utilities

TARGET END USES

Network

https://www.watercorporation.com.au/About-us/Media-releases/2017/June-2017/Dogs-enlisted-to-sniff-out-water-leaks-in-Australian-first

Non-revenue water can often account for up to 25% of water usage and is a major concern for many utilities. Network management is thus critical to avoiding losses through pipe bursts and leaks, especially in ageing networks. Optimal water pressure and minimising leakage in the network remain key activities. A variety of approaches – ranging from digital data and technologies to the natural sniffing abilities of detection dogs – are used to significantly improve supply network reliability and decrease operating costs.

OPPORTUNITIES

Leak detection dogs can be deployed in hard-to-reach e.g. rural areas and offer a proactive method of detection.
Active leak management, detection and repair, especially where the economic benefits outweigh the costs, e.g.: older water infrastructure and/or where water is scarce.
Reduced operating costs

CONSTRAINTS

Utilities with an abundance of water or a shortage of staff or funding may be not be incentivised to actively optimise their network management.
Poor metering and real time analysis make detecting leaks difficult.
Fixing leaks in one section of an older network may just move the problem downstream.

Active leakage management

Leakage management aims to reduce the amount of water lost due to leaks and burst water mains. Reactive approaches to leakage management involve responding to identified leaks and water audits. Proactive approaches include isolating smaller zones(district metered areas – DMAs), quantifying their water losses (by analysing the night flows), and then deploying more intensive methods of leak detection in targeted areas.

Intelligent Water Networks

Water sector digitisation has been accelerating in recent years with utilities adopting disruptive technologies that are transforming water, wastewater and stormwater system management. Intelligent Water Systems (IWS) or Smart Water Networks are associated with Big Data, the Internet of Things (IoT), machine learning, artificial intelligence (AI) and predictive analytics, which empower utilities to monitor, manage and control their networks using real-time data.

Pressure Management

Water network pressure management can reduce the amount of water lost due to leaks and burst water mains. Pressure management (e.g. via the use of pressure reducing valves), can lower system pressures, especially during times of low demand; and help to reduce the volumes lost through leaks and bursts in the network. It also reduces the volume of leakage on the customer side of the meter in the event of a breakage.

Detection dogs

In 2017, Water Corporation was the first Australian water utility to trial sniffer dogs to detect hidden leaks in underground water mains. Two spaniels were specifically trained for the R&D trial. In Queensland, Urban Utilities also ran a 12-month trial, in which their two spaniels detected 12 leaks. In 2020, Sydney Water began work with dogs to detect underground wastewater leaks.

FACT SHEET

OPTIONS FACTSHEET no. 3

Smart Water Metering

Frequent and automated meter reads transmitted via wireless communication devices for improved means of water use monitoring and management

[1] https://www.pub.gov.sg/smartwatermeterprogramme/benefits
[2] https://www.yvw.com.au/faults-works/planned-works/works-my-area/digital-water-meter-trial

SMART METERING OPTIONS

* City-scale rollouts vs trials vs targeted customers
* Network monitoring, leak detection and notifications
* Detailed customer water use information feedback via portals/apps: time of use data, end-use breakdowns, comparisons, saving tips

TARGET USERS

Residential

Commercial

TARGET END USES

Behaviour

All fixtures & fittings

Smart / digital metering offers improved visibility and automation. Smart meters provide more frequent and detailed water use data than conventional meters, which can be used to use to analyse and understand water usage patterns to promote more efficient water use, detect leaks and improve network management. City-scale rollouts began from 2013 in New York, Toronto and London. Today, many utilities are trialling meters prior to broader rollouts.

OPPORTUNITIES

- Improved customer engagement and satisfaction via the provision of access to detailed water use information.
- Ongoing opportunities for engagement in water education e.g. via smart metering programs in schools/universities.
- The provision of direct links to leak repair services.
- Improved evaluations to assess water savings and the business case.

CONSTRAINTS

- Large upfront capital costs associated with smart water meter deployments.
- Limited industry experience and knowledge of rollouts.
- Unknown longevity of customer engagement & savings.
- Risks of outdated technologies.
- Difficulties with monetising the benefits for the business case for smart water metering.
- Challenges with managing large data sets created and turning them into useful information.

Leak detection: Mackay

One of the main selling points of smart water metering is leak detection. Mackay Regional Council who has installed smart water metering for more than 110,000 homes and businesses was able to identify and send 35,000 leak notifications in 2018 alone.

Singapore rollout

After two successful trials in Punggol and Yuhua in 2016 and 2018 (with 5% savings across 800 homes), Singapore is rolling out Phase 1 of its Smart Water Meter Program. Starting in early 2021, 300,000 smart water meters will be installed in new and existing residential, commercial and industrial premises by 2023 to encourage behavioural change towards water conservation (via a customer water use portal and app), optimise demand management, and improve operational efficiencies. PUB will review the rollout, build up its capabilities and expertise, and factor in advances in technology to proceed for the rest of Singapore. See: https://www.pub.gov.sg/smartwatermeterprogramme

Digital Metering Joint Program research trials

CWW, SEW and YVW are working together to explore whether and when upgrading Melbourne to digital water meters will provide value to customers, the community and the utilities. To support their decision making, the DMJP is conducting: customer research to understand customer views; metering and communication technology trials and testing the market; financial implications; and analysis to assess the viability and benefits of digital metering.

Starting from Sep 2019, YVW has been replacing meters in 1500 homes for a trial in Vermont South; and CWW has trials in Richmond and Docklands until April 2021. Earlier trials by SEW in 2013 led to the discovery of leaks totalling to 10% of total water use in Seaford and 12% in Belgrave South.

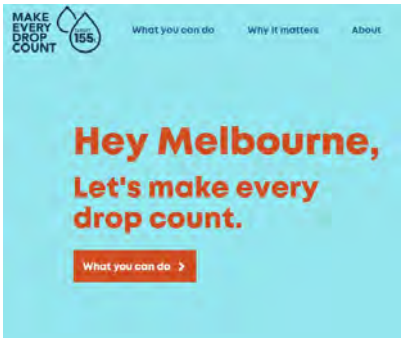
The Melbourne utilities are trialling LoRaWAN and Narrowband Internet of Things (NB-IoT) and various other LPWAN standards.

FACT SHEET

OPTIONS FACTSHEET no. 4

BENCHMARKING: RESIDENTIAL

To measure and compare water usage performance against a standard or target



[1] https://www.makeeverydropcount.com.au/ [2] https://www.citywestwater.com.au/

Water efficiency benchmarks provide information e.g. a numerical value to denote a specific level or target for performance in terms of water usage. Residential targets (e.g. a daily target or budget) with the provision of usage information / estimates allow householders to measure how well they are managing their water usage against a recommended amount. Legislation e.g. BASIX sets out requirements for how new homes/alterations must perform including in terms of sustainable water use.

BENCHMARKING OPTIONS

* Residential Targets e.g. Target 155
* Comparative water bills
* Water budgets
* BASIX
* Information e.g. on target setting
* Larger residential user audits

TARGET USERS

Residential

TARGET END USES

Behaviour

All fixtures & fittings

OPPORTUNITIES

- Improve and optimise the communication of customer water usage information together with water-efficiency targets.
- With digital metering, more and more customers can be granted near real-time access to their water usage data via digital interfaces such as online water-use portals and apps.
- Enhance BASIX further to DPIE's 2013 review by revisiting water saving targets, recycling initiatives and the use of rainwater tanks.

CONSTRAINTS

- The challenge to provide meaningful like-for-like comparisons.
- Targets signalling efficiency levels may adversely increase use among users who find themselves below a target.

General residential targets: Target 155

The Target 155 water efficiency program encourages Melburnians to voluntarily limit water consumption to 155 litres per person per day. Residents can use an online water calculator to estimate their usage or refer to their water bill to see how their usage compares to the 155 target.

Water budgets

A water budget is calculated for a given customer to signal the maximum use that is considered efficient. Budgets may involve an indoor allocation (based on occupancy) and outdoor allocation (based on land size, weather conditions) and higher pricing for any use beyond a designated budget.

Info on target-setting

SWC provides info on how to establish a target for your home based on time of year, number of people and property size. See: https://www.sydneywater.com.au/SW/your-home/using-water-wisely/water-efficiency-targets/index.htm

Large user audits

Hunter Water has been targeting large residential users (those using more than 4 times the average over the last 3 years). Audits and repairs are provided to those interested in support.

BASIX

The Building Sustainability Index (BASIX) is a NSW Government initiative which applies to all new residential dwellings; alterations/additions to dwellings that cost $50,000 or more; pools of 40,000 L or more. The water component of a BASIX assessment examines the water efficiency of fixtures, the design of the landscaping and the use of alternative water sources in the development and aims to reduce potable water consumption. The benchmark is 90,340L per person per year (or 247 L/p/d), the average drinking water consumption of a pre-BASIX home. The water reduction target ranges from 40% to 0% depending on the climatic zone. The 40% reduction target applies to 90% of new residential development and 98% of high-growth areas.

Comparative info on water bills / smart interfaces

Historical comparisons show a household how their water usage compares with previous quarters. Average daily use can also be compared with other households of different sizes in the same region and with a "water-efficient" household. Comparative water bills are now widely used, and the provision of web-based consumption feedback is growing with digital metering.

FACT SHEET

OPTIONS FACTSHEET no. 5

BENCHMARKING & STANDARDS

To measure and compare water usage performance of a building / an operation against a standard or target

OPTIONS FOR BENCHMARKING & STANDARDS

* Best practice benchmarks
* Ratings / Certification:
  - NABERS
  - Green Star
  - LEED

TARGET USERS

Commercial

TARGET END USES

Behaviour

All fixtures & fittings

Best practice benchmarks

SWC has developed commercial benchmarks as a basic indication of the water consumption e.g. shopping centres. Values are provided for 'median market practice' (an average with no leaks); 'economic best practice' (the performance achievable via a 2-year return on water efficiency investment); and 'very well managed'.

OPPORTUNITIES

- Develop best practice benchmarks for other sectors.
- Expansion of rating scheme participation among existing buildings.

CONSTRAINTS

- Cost as a barrier to uptake.
- Challenges associated with comparing building performance across different climatic zones.
- Access to and sharing data.
- Data required to develop.
- Encouraging uptake.

https://www.usgbc.org/articles/first-leed-zero-water-building-uses-multiple-strategies-get-zero

Benchmarks and standards including building certification / rating schemes are used to measure and communicate how a building or an operation performs in comparison to others in the same sector in terms of sustainable water use. Benchmarks help building owners or operators assess the potential for and ways to achieve water savings. For water-efficient buildings, a benchmark confirms the building is operating efficiently.

Ratings: NABERS

NABERS (National Australian Built Environment Rating System) measures and communicates the environmental performance of a building (i.e. entire office buildings, shopping centres, apartment buildings, public hospitals and hotels) across four areas, including water, using star ratings from 1 ('poor') to 6 ('market leading') and identifies opportunities for cost savings and improvements.
The scheme encourages building operators to share their sustainability credentials among customers, staff and investors and to continue to improve for their next yearly rating. For more information see:
https://www.nabers.gov.au/

Certification: Green Star

Launched in 2003 by the Green Building Council of Australia (GBCA), Green Star is a voluntary sustainability rating system for both new and existing buildings. The scale rates the sustainability of building projects at different phases (design, "as is" and interior fittings) against the nine Green Star categories, one of which is water with star ratings ranging from 1 ('minimum practice') to 6 ('world leadership').
In Australia, 40% of CBD space is Green Star certified, as is 40% of retail space, 60,000 people live in Green Star rated apartments and 1.3M people visit a Green Star rated shopping centre each day. Overall, Green Star rated buildings use 51% less than the average Australian building.
https://www.gbca.org.au/uploads/91/2139/Introducing_Green_Star.pdf and https://gbca-web.s3.amazonaws.com/media/documents/introducing-green-star.pdf

LEED certification

In the USA, Leadership in Energy and Environmental Design is a standard for the design, construction and operation of high-performance green buildings. LEED covers five areas, including water consumption. 'LEED Zero resources - water' recognises buildings that achieve a potable water use balance of zero over a period of 12 months.
See: https://www.usgbc.org/programs/leed-zero

FACT SHEET

OPTIONS FACTSHEET no. 6

EDUCATION

For public awareness, acceptance and engagement

EDUCATION OPTIONS

* Websites / Social media
* Campaigns
* Tutorials
* Best practice guidelines
* Usage comparisons
* High user lists
* Digital meter interfaces
* TV and printed media

TARGET USERS

Residential

Commercial

TARGET END USES

Behaviour

All fixtures & fittings

Education and community communication campaigns can be used to educate customers about the value of water and the need for water conservation. Communicating about everyday ways to save water via a range of different approaches and methods of engagement can be used to help change water-using behaviours.

Websites & Social media

Utility websites and social media are being used to provide customers with the latest information including on
- current restrictions
- water storage (dam levels)
- practical ways to save water.

E.g. https://twitter.com/hunterwater
The SmartWatermark site also has useful links: https://smartwatermark.org

Targeting high users

SEQ Water initiated the largest high-water users program in 2007 to identify high water-using households (>800 L/h/d). A household survey was used to gauge usage patterns and a personalised Water Savings Plan was developed to advise each household on how to save water.

Usage comparisons

The provision of usage comparisons e.g. previous use or other similar sized households such as on water bills, online portals or apps can act as a signal of opportunities for water savings.

Best practice examples

Best practice programs and guidelines were developed by Sydney Water from 1999 to 2013 to support large water-using customers in the industrial, commercial and institutional sectors to achieve water and cost savings. See: https://www.sydneywater.com.au/sw/your-business/managing-your-water-use/programs-and-resources/index.htm

Tutorials

Unitywater's video tutorial shows how to read a water meter to monitor usage and check for leaks. See: https://www.youtube.com/watch?v=Rh3-uiyLoEg
CityWestWater has a tutorial on how to to check toilets for leaks using food dye: https://www.youtube.com/watch?v=YAdQamQQpKo

Drought Campaigns

Sydney Water's "Love water, don't waste it" campaign used posters with portraits of real Sydney-siders to bring a sense of community and social responsibility, essentially using water conservation messaging from neighbours. See: https://darrenmartin.online/projects/7014406

Changing practices

QLD Urban Utilities have created playlists for residents to download and use while taking their shower. Each song lasts less than 4 minutes to promote 4-minute showers.
In Cape Town, South Africa, 2-minute showers are encouraged with playlists of 2-minute songs (https://2minuteshowersongs.com/).

OPPORTUNITIES

Embed insights from behavioural economics in education programs and campaigns
Develop best practice examples for sub-sectors and end uses

CONSTRAINTS

Lost web links with good resources (removed webpages can only be accessed via the Wayback machine)
Ease of access to information e.g. resources buried deep in a website.
Reaching tenants (material only comes with bills)
Sustaining savings post campaign

FACT SHEET

OPTIONS FACTSHEET no. 7

RESIDENTIAL AUDITS

To assess home water usage and introduce water-saving fittings/fixtures

RESIDENTIAL AUDIT OPTIONS

* General home audits
* Targeted audits
  - indoor and/or outdoor
  - low-income users
  - high users
  - strata homes

TARGET USERS

Residential

TARGET END USES

Behaviour

All fixtures & fittings

OPPORTUNITIES

For more cost-effective audits Key considerations include:
- Program design/scope, advertising and funding arrangements
- Links to current rebates
- Targeting of specific users (e.g. larger families, multi-residential homes)
- Links to other programs e.g. plumbing assistance programs to better target and assist vulnerable customers.

CONSTRAINTS

- Savings potential may be less for customers who have already participated in other water-saving programs.
-There is a trade-off between uptake rates and provision of program funding.

$ Initially, home audit programs cost around $180 per service with the customer paying only around $20. More recently, utilities have used full cost recovery which greatly reduces uptake. Still first-time participants are being offered a free WaterFix ® consultation.

https://water.org.mt/audit/

Home water audit programs typically involve a visit by a qualified plumber to carry out water-efficient installations (e.g. showerheads, tap flow regulators / aerators on kitchen and bathroom sink taps, and a toilet cistern flush arrestor in single flush toilets) and check for and repair minor leaks. Advice and educational materials are often provided e.g. on other programs of potential benefit.

HIGH WATER USERS

SEQ Water's High Water Users and One to One program involved identifying high water users, (>800 L/household/day), and providing a survey form of >50 questions to 80,000 households to find out why each household was using so much water. The survey received a 92% response rate. A follow-up One to One personalised Water Savings Plan was provided to those households using >140 lcd to advise on how to save water (linked to the rebate scheme at that time). 70,000 homes were involved in survey and follow-up personalised plans.

GARDEN AUDITS

Garden audits have targeted high outdoor users. "Love Your Garden" in Sydney had a qualified horticulturalist review gardens to develop a detailed watering plan and offer an array of tools (i.e. tap timers, rain gauges and tap tags). The $180 service was provided for only $33. Estimated overall savings of 174ML/yr across 23,500 homes.

LOW INCOME PROGRAMS

At certain times, fully funded audits have been kept for vulnerable customers. Sydney Water has offered its Plumb Assist audit program to customers unable to afford essential plumbing services. In 2015-16 it cost $926,693 to resolve 329 plumbing issues with estimates of around 8.9ML/yr (SWC 2016). An additional benefit of these programs is customers are often able to pay their bill, meaning utilities are now collecting revenue rather than debt.

WATERFIX® HOME AUDITS

Over the past 20+ years, Sydney Water has helped customers save over 300 million litres of water through their WaterFix ® Plumbing service. The average single residential dwelling saved 21 kL/hh/yr (Turner et al 2005). Multi-residential WaterFix® targets high-rise apartment buildings with good potential for water savings (i.e. consuming 500L/bedroom/day – less than 300L is considered efficient). The program assists strata management in addressing inefficient fittings and leaks and overcomes the tendency for individuals to not address leaks given pooled costs.

FACT SHEET

OPTIONS FACTSHEET no. 8

LEAK DETECTION & REPAIR

To reduce water loss by locating the source of leaks

LEAK DETECTION OPTIONS

* Education (e.g. websites, video tutorials, guides, campaigns)
* Digital metering, monitoring and leak alerts
* Home audits
* Concealed leak detection
* Leak detection rebates

TARGET USERS

Residential

Commercial

TARGET END USES

Behaviour

All fixtures & fittings

OPPORTUNITIES

Link high water user programs directly to leak detection and repair services so that potential water savings identified are secured.

Educational materials in other community languages.

Linking leaks to bill savings

Assisting with upfront costs of leak repairs

Innovative incentivised maintenance contracts for schools etc

CONSTRAINTS

Resource constraints have limited the number of large customer audits despite the high potential for water savings.

Hidden leaks can be difficult to find and expensive to fix upfront

http://www.smarthomewaterguide.org/

Leaks from pipes, fixtures and fittings can be a significant source of water loss. Water utilities play an important role in educating customers on how to find and repair leaks as leak detection can begin with simple steps by customers (e.g. visual inspections and meter reading). With digital metering, water utilities can detect leaks / provide customer alerts. Advanced sound detection equipment can identify concealed leaks.

EDUCATION

Arizona Municipal Water Users Association (AMWUA) has developed an online "Smart Home Water Guide" to help residential customers to "find and fix leaks".

The step-by-step guide available at: http://www.smarthomewaterguide.org/ in English and Spanish introduces how to check for leaks using a variety of approaches (meter readings, indoor and outdoor visual inspections and isolation methods). The guide includes detailed information on water efficiency and a glossary of terms and list of resources.

AUDITS

Hunter Water has been carrying out large non-residential customer water efficiency audits (approx. three per year) and subsequent leak repairs / monitoring e.g. at Western Suburbs Leagues Club and Hunter Stadium.

DIGITAL METERING

Digital meters offer water utilities access to real-time water consumption data, enabling them to monitor for leaks and provide customer notifications about potential leaks.

LEAK REBATES

Hunter Water offers customers an "Undetected Leak Rebate". The program grants an allowance of 50% of the increase in water usage caused by a hidden leak. Eligibility requires a plumber to fix the leak within 60 days of receiving the bill, confirm it was undetectable without the bill.

FACT SHEET

OPTIONS FACTSHEET no. 9

GARDEN PROGRAMS

Initiatives to reduce water use by gardens

https://www.glendaleaz.com/cms/One.aspx?portalId=15209085&pageId=15489471

GARDEN PROGRAM OPTIONS

* Information / advice
* Xeriscaping
* Greywater re-use
* Smart irrigation
* Lawn buy-backs
* Garden audits
* Rebate programs
* Watering times: restrictions

TARGET USERS

Residential

TARGET END USES

Behaviour

Outdoor use / irrigation

OPPORTUNITIES

- There is still a significant opportunity to ramp up outdoor water programs and link them to for example, the Smart Approved Water Mark website.
- Better reporting on the cost effectiveness of garden programs, savings and participation rates.
- Benefits of managing peak demand given the high share of water on outdoor use.

CONSTRAINTS

- Large turf rebate programs reported as lacking sufficient planning and oversight, leading to fraud (e.g. California's $340M program in 2014-15).
- Programs may trigger an increased interest in gardening leading to higher overall demand.

In Australia, outdoor water usage has traditionally been the highest end use in single residential dwellings, varying significantly with climate conditions and lot sizes. Many jurisdictions have implemented multi-pronged water usage programs targeting gardens e.g. via educational initiatives, garden rebates and audits.

Information / advice

Many utilities have linked their water conservation messaging to the Smart Approved Water Mark website to guide their customers on more water-efficient gardening products and services. See: https://www.smartwatermark.org/

Watering restrictions

The use of rules on watering times make watering more efficient. Cairns restricts watering days based on house numbers.

Rebates

Many jurisdictions have provided thousands of dollars' worth of rebates with baskets of goods containing rain sensors, catch cups, tap timers, soil wetting agents, mulch and money off irrigation systems. There is limited evaluation of savings from these programs.

Smart irrigation

Smart controllers are an emerging technology to automatically adjust irrigation applications based on current weather, soil, evaporation and plant water use, rather than operating with a preset watering schedule. Living Water Smart by Power and Water Corporation in NT provide a 'Weather web' of 30 weather stations and lots of information on smart irrigation practices.
https://www.livingwatersmart.com.au/articles
https://www.livingwatersmart.com.au/weather-web-and-smart-irrigation-controllers-faqs

Xeriscaping & Lawn buy-backs

Xeriscaping is landscape design which aims to reduce the need for watering by using native, drought-resistant plants, with irrigation methods and strategies to save water. The City of Glendale, AZ has a xeriscaping demonstration garden open to the public to display varieties of low-water-use plants for a water-conserving garden (see page inset above). A landscape rebate is also offered of up to $750 USD for converting grass to low-water-use landscape.

Garden Audits

The Sydney Water "Love Your Garden" program targeted homes with high outdoor use. A horticulturalist reviewed garden water demand to develop a watering plan and provide e.g. tap timers, rain gauges and tap tags). Estimated overall savings were 174ML/ yr across 23,500+ homes.

Greywater re-use

Greywater diversion devices can be installed to divert greywater from a laundry or bathroom for sub-surface irrigation. New technologies include Hydroloop's decentralised water-recycling and reuse systems: www.hydraloop.com

FACT SHEET

OPTIONS FACTSHEET no. 10

SMART HOUSEHOLD WATER SUPPLY

Technologies to reduce the need for the supply of potable water via alternative sources of supply

https://watersensitivecities.org.au/wp-content/uploads/2017/09/Case_Study_Aquarevo_FORWEB_170912.pdf

SMART HOUSEHOLD WATER SUPPLY OPTIONS

* Smart rainwater tanks
* Decentralised greywater recycling: Hydroloop

TARGET USERS

Residential

Commercial

TARGET END USES

Behaviour

Showers

Washing Machines

Outdoor Use Irrigation

Various of the latest technological innovations harness rainwater and greywater supplies as alternative sources of water supply to substitute away from the use of drinking water supplies for bathing, clothes washing machines and/or garden irrigation. Smart phone apps further enable the consumer to monitor savings.

OPPORTUNITIES

- Buildings with smart water supply systems can be marketed for their sustainability credentials to attract customers who value these qualities.

- Hydroloop systems may particularly benefit commercial buildings and hotels which consume large volumes of water.

CONSTRAINTS

Hydroloop systems cost around $4,000 USD which is a large and prohibitive investment for many homeowners.
Smart homes add operational complexity and duplication of assets

SMART RAINWATER TANKS

Homes in the Aquarevo residential development, a unique collaboration between South East Water and Villawood Properties, demonstrate a range of unprecedented water-savings features including smart rainwater tanks.

The rainwater tanks have the following features:
- Rainwater utilised as a supply for hot water
- Real-time monitoring via OneBox® technology in each home which allows Residents and SEW to monitor water systems and optimise performance of the rainwater tanks, the hot water system and the wastewater system.
- The integration of Tank Talk® technology allows the tanks to be emptied when a rain event is predicted, which provides on-site detention of stormwater while optimising the supply of rainwater to the home.

See: https://watersensitivecities.org.au/wp-content/uploads/2017/09/Case_Study_Aquarevo_FORWEB_170912.pdf

HYDROLOOP GREYWATER RECYCLING

Hydraloop presents technologies for the decentralised recycling & reusing of greywater as an effective and economical alternative source of water. Its next-generation water treatment products recycle water 'at the source' to make it clean, clear and safe so that it can be used twice in order to decrease the demand for potable water.

For individual residences, there are distinct Hydroloop products available for recycling water for the home, pool and garden. At a building level, applications include recycling water collected centrally from basins and showers in commercial buildings, fitness centres, sports clubs and student houses. Reuse covers toilet flushing, washing machine, pool top ups and garden irrigation, with advertised mains water savings at >45%, as well as >45% on sewage emissions.
See: https://www.hydraloop.com/

FACT SHEET

OPTIONS FACTSHEET no. 11

TOILET PROGRAMS

Schemes and technologies to reduce water used by toilets

TOILET PROGRAM OPTIONS

* Toilet replacement programs / rebates
* Efficiency ratings (WELS)
* Legislation:
  - Building codes (BASIX)
  - Tenancy Act NSW
* Education / Behaviour change programs
* Toilet leak detection

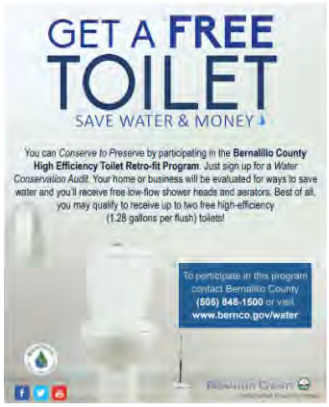
TARGET USERS

Residential

TARGET END USES

Behaviour

Toilets



[1] https://www.bernco.gov/public-works/high-efficiency-toilet-program.aspx
[2] https://waterchatter.wordpress.com/2018/10/04/5176/

A variety of programs have been run to target reductions in the amounts of water used for toilet flushing. Many water utilities have offered toilet replacement programs with varying amounts of rebates to incentivise the replacement of less water-efficient toilets. Legislation covering building codes and tenancy laws also set requirements for the installation of water-efficient toilets. WELS efficiency ratings assist by showing how water-efficient different toilet pedestals are. Education also has a role to play in changing toilet flushing behaviours and in leak detection.

OPPORTUNITIES

A better understanding of the levelised costs of different toilet replacement programs and the cost to utilities which can vary greatly depending on the model of implementation

Including waterless urinals in standards

Inbuilt efficiency improvements built into standards and regulations

CONSTRAINTS

Uptake of dual flush toilets offers lower savings in low occupancy dwellings.

Replacing toilets can crack tiles and cause other issues

Some wastewater systems with low grades struggle with low flush toilets

Toilet replacements/rebates

Toilet retrofits programs have been implemented as a rebate and installation of a water-efficient toilet; a third party service provided as part of a subsidised audit program; or a commercial service provided by the utility at full cost recovery.

Under QLD's "Home WaterWise Rebate Scheme", some 42,000 households upgraded their toilet(s) 6/3L or better dual flush toilets with a rebate of up to $150 per toilet (max. 2 per household). Savings are estimated at 1,509 ML/year at a cost of $6M. (Aurecon, 2020)

Efficiency ratings (WELS)

The Commonwealth's Water Efficiency Labelling and Standards (WELS) scheme uses star rating labels on products to inform consumers about their water efficiency.

Legislation: Building codes (BASIX) & the Tenancy Act

The Building Sustainability Index or BASIX, a NSW Government initiative, has required new homes to have efficient fixtures including toilets since 2004.

From 23 March 2025, all toilets in rented properties must be dual flush with a minimum three-star WELS rating. All toilets must also be checked for leaks at the start of any tenancy and whenever water-related installations/repairs are undertaken.

Education / Behaviour Change Programs

Educational methods e.g. via information on websites and targeted campaigns are commonly used to communicate ways to save water. These include promoting use of the half flush button on dual flush toilets (see page insert above from Singapore PUB) and checking for leaking toilets.

FACT SHEET

OPTIONS FACTSHEET no. 12

GENERAL REBATES
Residential

Discounts offered to customers to incentivise them to purchase water efficient fixtures/fittings

https://socalwatersmart.com/en/residential/#

Various rebate programs have already been provided in all major Australian cities to update efficient showerheads, toilets, clothes washers, rainwater tanks and garden products. Additional rebates have included tap flow regulators, hot water recirculatory, dishwashers, toilet flush interrupters, pool covers, high pressure cleaning systems, waterless car cleaners, rainwater diverters, garden bores, greywater systems and aerobic treatment units. Participation rates and savings, where reported, have varied significantly but savings for many of the additional rebates are not publicly reported.

GENERAL RESIDENTIAL REBATE OPTIONS

* Indoor rebates e.g. for showerheads, toilets, clothes washers
* Outdoor rebates e.g. for rainwater tanks, garden products.

TARGET USERS

Residential

TARGET END USES

Behaviour

All fixtures & fittings

OPPORTUNITIES

- Research and collaboration to identify cost-effectiveness of different rebates.
- A servicing and optimisation program for rainwater tanks to audit and provide measures to improve savings (e.g. owner education, connection to indoor end uses, and pressure vessel installation).
- Targeted rebates to address the cost-gap for large / low income families to choose an efficient washer.

CONSTRAINTS

- The savings for many of the additional rebates is not publicly reported.
- Problem with 'free riders' who would buy the product irrespective of the availability of a rebate.
- Reaching low income households.

SoCal Water$mart in Southern California

The MWD of Southern California and its 26 member agencies provide its comprehensive SoCal Water$mart rebate program. Through its website: socalwatersmart.com, residents can make rebate applications, learn rebate rules, calculate amounts and check the status of rebate applications. Its indoor program includes high-efficiency clothes washers and toilets. Its outdoor program includes weather irrigation controllers, rotating sprinkler nozzles and rain barrels & cisterns, soil moisture sensor system and turf replacement program. https://socalwatersmart.com/en/residential/#

Clothes washer rebates:

Clothes washer rebates (typically of $150) have been provided for 4-star and more recently for 5-star washers. Measured savings were 18-23 kL/hh/a (Turner et al. 2014). Uptake was 186,00 in Sydnet (2006-10); 19,214 in Melbourne (2011-15), 210,000 in Perth (2003-09) and >188,000 in QLD (2006-08).

Rainwater tank rebates:

Rainwater tank rebates have been highly popular in Australia across all the major cities and many regional areas. Rebates have varied for tanks of different sizes, with additional rebates for indoor end use connections e.g. to toilets/washers.

Weather smart irrigation controller rebate

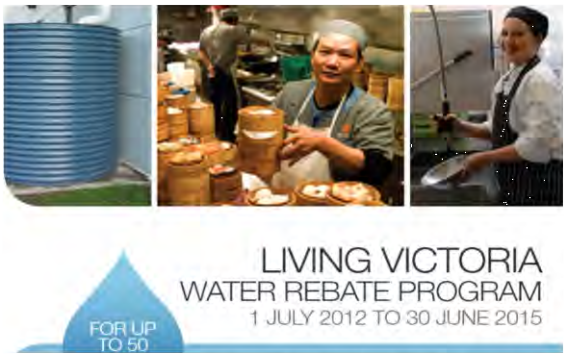
Due to the large share of water used outdoors, from Sep 2019, the WA State Government, through the Water Corporation, provided 600 x $200 rebates on the purchase and installation of a weather smart irrigation controller using local weather data to adjust sprinkler watering times / reduce over-watering. A previous trial of 60 homes (2015-16) showed homes reduced total water use by 15% on average or 95,000 L. See: https://www.watercorporation.com.au

FACT SHEET

OPTIONS FACTSHEET no. 13

GENERAL REBATES – Non-residential

Discounts offered to commercial/institutional customers to incentivise them to purchase water efficient fixtures/fittings



https://docplayer.net/3730703-Living-victoria-water-rebate-program-1-july-2012-to-30-june-2015-for-up-to-50-employees-small-business.html

COMMERCIAL REBATE OPTIONS

* Dishwashers/glasswashers
* Washing machines
* Commercial pre-rinse spray/mixer/nozzle ware
* Steam/chemical cleaner
* Waterless urinal
* Medical/dental equipment
* HVAC equipment
* Turf replacement
* Landscaping

TARGET USERS

Commercial

TARGET END USES

Behaviour

All fixtures & fittings

Water utilities around the world provide commercial rebate programs covering indoor and/or outdoor applications. The value and availability of the rebates has varied, as has uptake. While some rebates focus on specific commercial devices such as plumbing fixtures, landscaping equipment, food equipment, HVAC Equipment, medical and dental equipment, others provide a tailored program with a capped rebate value which can be used on a wide range of water-efficient appliances/equipment according to the customer's needs.

OPPORTUNITIES

- Commercial rebates on water-using equipment in kitchens / laundries can offer significant savings, relatively short implementation times and quick payback for customers

- Provision of Chinese and other language educational brochures (e.g. as in the Sydney Waterless wok rebate program)

- Support via interest-free loans.

CONSTRAINTS

- Upfront costs of more expensive commercial water-efficient equipment

Tamworth's 2019-2022 Water Saving Rebate Scheme

Tamworth Regional Council currently provides a water rebate program to commercial operators. 50 % rebates can be claimed via its online application form for a commercial dishwasher/glasswasher (up to $250), commercial washing machine (up to $500), commercial Pre Rinse Spray/Mixer/Nozzle Ware (up to $150), commercial steam/chemical cleaner (up to $200) and waterless urinal (up to $150).
https://www.tamworth.nsw.gov.au/about/forms/2019-2022-water-saving-rebate-scheme-application

Living Victoria Water Rebate Program

From 2012-15, the 'Living Victoria Water Rebate Program' provided rebates on a range of water-efficient products and appliances including for small business. A small business connected to a reticulated water supply as a non-residential customer with 50 or fewer employees could receive rebates of up to $2,000.

SoCal Water$mart Commercial Rebate in Southern California

The Metropolitan Water District of Southern California and its 26 member agencies provides SoCal Water$mart commercial rebates for a wide variety of water-saving technologies, its commercial turf replacement program, public agency landscape program and on-site retrofit program. SoCal Water$mart also provides the water savings incentive program for non-residential customers who do not qualify for standard rebates, for any project saving at least 10 million gallons of water per year, for example, replacing water-using equipment with higher efficiency models in kitchens or laundries.
https://socalwatersmart.com/en/commercial/

FACT SHEET

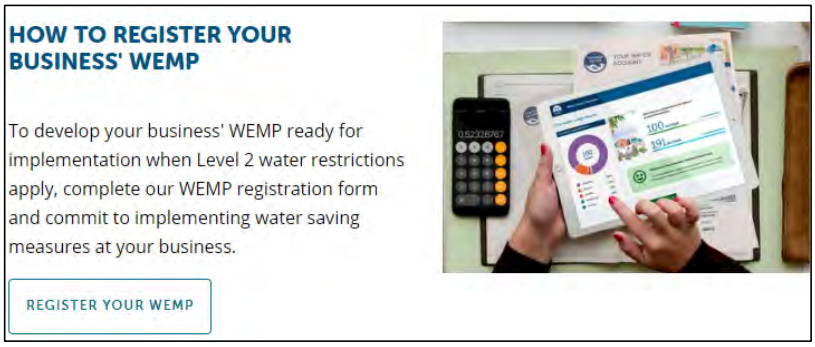
OPTIONS FACTSHEET no. 14

SPECIALISED AUDITS

One-to-one, site-specific assessments to provide water-saving recommendations

SPECIALISED AUDIT OPTIONS

* Business Water Efficiency Management Plans / Action plans: WEMPs / WaterMaps
* Large customer audits
* Landscape efficiency audits
* Cooling tower audits



https://www.hunterwater.com.au/our-water/water-supply/smart-water-choices/information-for-businesses/water-efficiency-management-plans-registration

TARGET USERS

Commercial

TARGET END USES

Behaviour

All fixtures & fittings

Specialised audits target specific business segments and especially high water-using customers or high using end-uses. Such audits enable water utilities to work together with large commercial customers to identify water-saving opportunities onsite with the savings potential associated with different efficiency measures and their respective costs; and to develop implementation plans to secure the savings identified.

OPPORTUNITIES

- Bring forward the development of WEMPS e.g. via incentives or regulatory requirements.
- Development of model WEMPS for certain high-using segments.
- Provide resources to help develop WEMPS with loans for the adoption of low-payback options.
- Scope for audits and work with more open spaces / sites to achieve potential savings.

CONSTRAINTS

- Encouragement may be required in order to achieve savings potential identified.

WEMPS / WaterMaps

High-using non-residential customers were targeted during drought in 2007 via Water Efficiency Management Plans (WEMPs). Water utilities helped businesses to assess their current usage, identify savings measures and prepare an implementation plan. In Perth, the WEMP program required users of > 20 ML/a to submit an annual WEMP showing progress in reducing water usage. In SEQ, businesses using >10 ML/a, nurseries, public swimming pools, buildings with cooling towers and areas using potable water to irrigate >500m2 were targeted, requiring savings of >25% or best practice. In Melbourne, each business site using >10 ML had to submit a “WaterMAP” to its utility.

Large customer audits

For customers using >50ML/a, SWC offered one to one audit programs with prioritised savings options and benchmark ratings. Savings were 10-30% and there was a general willingness to implement savings with less than a 2-4 year payback (MWH 2013).

Landscape efficiency audits

The Irrigation and Landscape Efficiency Project (ILEP) addressed water efficiency and turf and soil management of Greater Sydney’s open spaces. Savings were achieved via technology and a various land and site management practices at over 133 parks/sports facilities. The knowledge gained led to the ‘Best practice guidelines for holistic open space turf management in Sydney’: https://www.sydneywater.com.au/SW/your-business/managing-your-water-use/programs-and-resources/index.htm

Cooling tower audits

Cooling tower audits help to identify the ways in which a cooling tower consumes water and to provide best practice recommendations to achieve an overall reduction in water consumption. A best practice guideline by AIRAH is available at: https://mycoolingtower.com.au/wp-content/uploads/2011/11/BPG_Cooling_Towers.pdf

FACT SHEET

OPTIONS FACTSHEET no. 15

SME business programs

Schemes targeting reductions in water use by businesses

OPTIONS FOR SMEs

* General advice e.g. via websites, DIY guides
* Water use audits
* Water efficiency benchmarks
* Best practice guidelines for different sectors
* Council partnerships
* Business retrofits e.g. Bizfix, Smart Rinse.

https://www.sydneywater.com.au/sw/your-business/managing-your-water-use/programs-and-resources/index.htm

TARGET USERS

Commercial

TARGET END USES

Behaviour

All fixtures & fittings

Small and medium enterprises can also be large consumers of water, so targeted water efficiency programs can be used to help them to understand and monitor their water use and to implement water saving opportunities. By reviewing and refining schemes, customers can be targeted appropriately for the ongoing cost effectiveness of the programs offered.

OPPORTUNITIES

- The review of past programs and the savings results achieved.

- The design of new SME programs for once market saturation is achieved.

- Bulk purchasing

CONSTRAINTS

- Encouragement may be required to encourage program participation and implementations to achieve savings potential identified.

Water efficiency benchmarks

SWC provides information for companies on how to benchmark their water use and sector specific benchmarks. For example, for hotels, 'best practice' is 0.4 KL/room/day and an 'efficient' benchmark is 0.4 to 0.45 KL/room/day. See: https://www.sydneywater.com.au/SW/your-business/managing-your-water-use/benchmarks-for-water-use/index.htm

Process audits

Welsh Water offers process audits to its business customers, of which SMEs are the majority. An experienced engineer conducts a site walkover to look at water (and waste and energy usage) to identify savings, conduct data analysis and a mass balance and cost benefit analysis of the different options for savings and provide a report with bespoke recommendations and benchmarks. See: https://business.dwrcymru.com/en/business-services/process-audit

Smart Rinse: spray rinse nozzle scheme

Under its 'Smart Rinse', SWC supplied and installed Low Flow Pre Rinse Spray Valves (LFPRSVs) with a 6 star WELS rating and flow rate of 6 L/min valves at no cost to SMEs. Cafes, restaurants and hotels typically saved 42-50% as a result. See: https://www.sydneywater.com.au/web/groups/publicwebcontent/documents/document/zgrf/mty4/~edisp/dd_168949.pdf

Participation of restaurants reached market saturation (4,707) from 2006-11, with savings estimated at $1,189 ML/a at a cost of $3.01M.

Council partnerships

SWC worked with local councils to engage SMEs to achieve sustainable water savings via bathroom and kitchenette retrofits (toilets, taps and showers). 500 SMEs participated from 2014-19 with total savings of 1,683ML/a at a cost of $3.04M.

Business retrofits: BizFix

Under BizFix, SWC retrofitted businesses with water-efficient fittings. Uptake was 327 businesses (2009-11) with savings of 373ML/a at a cost of $1.6M.

FACT SHEET

OPTIONS FACTSHEET no. 16

IRRIGATION EFFICIENCY

Watering measures to reduce water consumption

OPTIONS

* Permanent Water Saving Rules / Water Wise Rules
* Smart irrigation systems with real-time control and optimisation
* Landscape irrigation evaluations

TARGET USERS

Residential

Commercial

TARGET END USES

Behaviour

Outdoor use / Irrigation

[1] https://www.facebook.com/CairnsRegionalCouncil/posts/level-1-water-restrictions-are-now-in-place-for-the-cairns-regional-council-area/1245670502121220/

[2] http://www.cityofwoodland.org/713/Weather-based-Irrigation-Controller

Irrigation consumes the overall greatest share of water. Irrigation efficiency refers to the water that is used productively or beneficially i.e. water retained by plants rather than lost either via the conveyance/distributions system or transpiration. Another dimension to irrigation efficiency is economic efficiency, i.e. the payback a new water supply system offers in terms of water savings.

Landscape irrigation surveys

In the US, many utilities provide landscape irrigation evaluations at no cost to customers. In Southern California, eligible landscapes (>1 acre of irrigated land) include residential and commercial and institutional sites like schools, parks and government facilities. Checks are made on system pressure, controllers, irrigation scheduling and any issues causing high water use. See: http://www.bewaterwise.com/landscape-irrigation-survey.html

The Irrigation and Landscape Efficiency (ILEP) project achieved water savings of 1,090 ML/a across 133 outdoor spaces (parks/sports facilities) in Greater Sydney. See: http://www.water.nsw.gov.au/__data/assets/pdf_file/0010/548506/recovery_lin-hnmp-final-report-irrigation-and-landscape-efficiency-project-section.pdf

Permanent Water Saving Rules / Water Wise Rules

Permanent Water Saving Rules (PWSR) or Water Wise Rules have been implemented in many jurisdictions in Australia. The rules target efficient water behaviour rather than restricting uses, and generally target residential irrigation. Water efficient behaviours include restricting watering with automatic devices and sprinklers to the early morning or evening to reduce evaporation, using trigger nozzles on hoses and not hosing hard surfaces.

Cairns has "odds and evens" permanent measures which only permit garden watering with sprinklers at specified times of the day and additionally on different weekdays for odd and even house numbers.

Real-time control and optimisation: smart irrigation systems

Smart controllers are an emerging technology designed to automatically optimise irrigation. Rather than operating with a preset watering schedule (based on historical measurements), applications are adjusted in real-time according to the current weather, soil, evaporation and plant water use. Advances in computations and simulations are used to help the process of optimization. In the US, many water utilities provide rebates for smart irrigation systems with a WaterSense label see: https://lookforwatersense.epa.gov/rebates/

OPPORTUNITIES

- The provision of incentives and knowledge exchange may support the exploitation of new efficient technologies.

CONSTRAINTS

- Limited adoption of smart technologies due to their cost and complexity.
- Subsidies for investments may not be cost effective compared to other alternatives.
- Grounds keeper KPIs may not include water use.

Chapter 5 Conclusions and Recommendations

This chapter synthesizes the outcomes of the project and identifies the key next steps for improving the identification, evaluation and uptake of water efficiency options across NSW.

This scan has identified water efficiency opportunities across all end users and a wide variety of end uses. These opportunities include:

- the increased efficiency of water using fixtures and fittings, particularly showers, toilets and washing machines
- the emergence of technologies that use digital control to reduce water use, particularly cooling, irrigation and leakage control
- the ability to leverage data and digital analytics to design programs that maximise water savings and minimise cost
- targeting programs to maximise water savings opportunities
- designing water efficiency standards and regulations to promote ongoing efficiency gains.

5.1 Transitioning to more efficient fixtures and fittings

Opportunities exist to improve the uptake of water-efficient fixtures and fittings in the residential and non-residential sectors. These opportunities arise due to ongoing water efficiency gains in fixtures and fittings since the last tranche of water efficiency programs were rolled out and segments of the market that did not take up water efficiency opportunities in the last tranche of programs. The greatest immediate opportunities exist for showers, toilets and washing machines. Specifically:

- showers account for nearly a quarter of residential end use. Shower use is also prevalent in certain non-residential sectors including hotels, pools and gyms. Reducing water use in the shower has the potential to save water and energy, due to reductions in the use of hot water. There is the opportunity to create significant and lasting market transformation by combining a showerhead swap with an intention to move to WELS 4-star rated showerheads in the Plumbing Code and Tenancy Act over a specific time period.
- toilets account for around 18% of residential end use. Older stock not only has greater per flush water use but is also more likely to be worn out and leak. There are opportunities to revisit segments where old toilet stock may still be present. There is also an opportunity to continue to increase requirements for toilet efficiency in standards and include waterless options in standards.
- washing machines account for around 18% of residential water use. The incentives provided during the Millennium drought created substantial and rapid market shifts, which have been sustained but not improved upon. There are opportunities to continue to shift the washing machine market, which results in water, energy and detergent savings. These opportunities exist in both the residential and non-residential sectors.

Other opportunities for sector specific fixtures and fittings, such as spray rinse values and waterless woks are also likely to exist, although there is a lack of contemporary data on the non-residential sector to make specific recommendations. Programs that work with businesses to identify opportunities and incentivise their uptake should be considered.

5.2 Adopting digital control technologies to maximise water efficiency by minimise the behavioural aspect of water use

Technologies have emerged that use digital control to maximise the efficiency of water use, particularly for cooling, irrigation and leakage control.

Advances in cooling tower management and home evaporative coolers mean that bleed rates can be controlled to meet specific conditions and minimise water dumping. For example, the next generation of cooling towers have salt meters that control the frequency and length of bleed rates.

Technological advances that are driving efficiencies in the agricultural sector are also benefiting other water users such as homes, schools and businesses. Digital controls using cloud software and predictive watering adjustments can be used with irrigation equipment to improve water efficiency using data collected from evapotranspiration sensors, soil moisture detection and weather forecasting.

Reducing hydraulic pressures can substantially reduce leaks and also extend the useful life of water related appliances. Pressure reduction has been used across utilities to reduce water loss. The practice of using digital control to manage inefficient water use due to pressure fluctuations can be extended to building networks. The emergence of smart fixtures and fittings is making managing pressure and controlling leakage easier and more viable at a building and an individual fixture level.

Showers account for nearly 25% of household water use. Digitally controlled showers are emerging that help to influence or control behaviour, for example by switching off the water flow after a pre-programed period of time, reducing water flow when there is no one within half a meter of the shower. Although not mainstream, these three products are examples of how digital technologies may save water in the future by forcing behaviour change. They may be particularly useful at communal facilities such as gyms and pools.

5.3 Leveraging data analytics to design programs that maximise water savings and minimise cost

There are opportunities to leverage data to design more efficient and effective water efficiency programs, through better understanding of end use, better customer segmenting and engagement with customers and better targeting of programs.

In the energy sector, there has been a rapid growth in the options for measuring and managing energy use through consumer accessible apps. The water sector is poised to move in the same direction. Since the Millennium drought, there has been an increase in digital metering, monitoring and feedback system options on the market. The reducing cost of both permanent and temporary digital meters provides an opportunity to better understand customer behaviour. It is unclear how many utilities across NSW are planning to use or are using digital meters.

While there are studies to demonstrate the short-term water savings of engaging with digital metering, there are no longer term studies. Utilities are being challenged to consider how to best manage and analyse large data sets metering provides and engage with customers in the longer-term. Understanding how to manage and utilise this data will enable the next generation of demand management programs.

Previous demand management efforts were far from uniform in coverage, both geographically and within a local area. There is an opportunity to revisit successful programs in specific locations that previously had low uptake.

This includes revisiting past successful programs for segments of the market that were missed and targeting programs at specific customers (such as high users, or a specific end use) to maximise water savings opportunities.

The demand distribution within a segment or sector and analysis of end uses that contribute to high demand can be used to target water efficiency programs. Using end use data, customer segmentation, sub-sectoral data analysis and program targeting are essential to maximise the water savings and the value achieved from the program.

5.4 Designing water efficiency standards and regulations to promote ongoing efficiency gains

Despite increased efficiency in fixtures, there has been minimal market change in the last 10-15 years, particularly for showers and washing machines. BASIX water ratings were established in 2006 and have not been changed since. In the same period there have been several advancements in the BASIX energy requirements. Similarly, the Plumbing Code has required plumbers install WELS 3-star rated showerheads since 2006. Recent changes to the NSW Residential Tenancy Act require minimum WELS 3-star rated toilets to be installed in tenanted properties in NSW from 2025, despite WELS 4-star rated toilets being the dominant stock on the market.

Regularly reviewing the standards, or constantly reviewing the ratings in relation to product innovations, would help to promote ongoing improvements.

Demand in some areas can be dominated by large users. Having regulatory mechanisms in place to understand this demand and encourage water efficiency would help to increase water security, particularly in areas with more variable supply. Mandatory Water Savings Action Plans and mandatory reporting of ratings are two tools which could be adopted.

5.5 Incentivising water efficiency

The energy sector has sought to overcome inherent supply side infrastructure biases by creating a demand management incentive scheme. This scheme provides the utilities with financial payments to implement efficient non-network options which are expected to lower costs to consumers, helping to overcome the financial disincentives (specifically revenue loss and capex bias) of investing in demand management. Similar mechanisms could be considered in the water sector to encourage investment in demand management measures by utilities.

While many water efficiency projects prove to be cost effective, upfront funding often is identified as a barrier to implementation. There are a number of mechanisms that can help to overcome initial barriers to investment across all sectors.

Rebates and grants have been successful in incentivising water efficiency uptake by customers. However, it is also important to ensure customers value their programs. History has shown that when programs are offered for free, savings are not often achieved or sustained as they have little buy-in, or the program is taken advantage of.

In the non-residential sector, cost effective, short payback opportunities are often not taken up due to the financial barrier of upfront investment. Here, a number of revolving loan and grant mechanisms have been successful in overcoming these barriers.

Pre-selection and bulk purchasing of efficient appliances can also help to overcome information and financial barriers. Similar programs are being conducted in the energy sector at a state level and could be emulated for water-efficient appliances.

5.6 Consideration and adoption of options identified in this report

This report identifies a broad range of options that have immediate or future potential to save water. Water efficiency programs themselves, are only one part of the water efficiency equation. The ongoing efficient identification and uptake of water efficiency will only be realised if all aspects of the water efficiency framework are addressed. In particular, the uptake water efficiency opportunities could be increased with well-designed incentive mechanisms, ongoing funding and co-ordinated resourcing, knowledge capture and dissemination.

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Appendix 1:

Table 4: Key Policy documents and regulatory requirements relevant to Water Efficiency in NSW

	Current	Review status	Current / proposed requirements for water efficiency
National Water Initiative	2004	Productivity commission review draft findings due early 2021	Item 91: States and Territories agree to undertake the following actions in regard to demand management by 2006: iii) review the effectiveness of temporary water restrictions and associated public education strategies, and assess the scope for extending low level restrictions as standard practice iv) prioritise and implement, where cost effective, management responses to water supply and discharge system losses including leakage, excess pressure, overflows and other maintenance needs. Item 90: The Parties agree that the outcome for urban water reform is to: i) provide healthy, safe and reliable water supplies ii) increase water use efficiency in domestic and commercial settings iii) encourage the re-use and recycling of wastewater where cost effective. Item 64: The Parties agree to implement water pricing and institutional arrangements which: i) promote economically efficient and sustainable use of: a) water resources b) water infrastructure assets c) government resources devoted to the management of water.

	Current	Review status	Current / proposed requirements for water efficiency
State Water Strategy		2021	The State Water Strategy includes: Action 6.6 A new state-wide Water Efficiency Framework and Program The Government will implement a state-wide Water Efficiency Framework and Program in mid-2021 following consultation with key stakeholders, including water utilities in early 2021. The framework and program will: • involve collaboration between all levels of government, water utilities, the private sector and the wider community • focus on building water efficiency capacity, gaining a greater understanding of water use, improving the evaluation of water efficiency initiatives and increasing private sector involvement • consider the total water cycle (from water supply through to wastewater treatment and reuse or discharge to oceans and waterways) • embrace adaptive management and continual improvement and provide clear governance • provide a clear statement of NSW Government policy and messaging of the need to support and invest in water efficiency across all sectors • consider the effectiveness of BASIX (the Building Sustainability Index) in driving and sustaining water efficiency.
Water Management Act	2000		Section 24(a) states: The water use provisions of a management plan for a water management area may also deal with the following matters • best practice for water conservation, water efficiency and total water cycle management.
Murray-Darling Basin Plan	2012		The Murray-Darling Basin Plan holistically manages water, with the aim of improving the environmental health of the basin by using water more sustainably.

	Current	Review status	Current / proposed requirements for water efficiency
			Over $1.5 billion is available to improve water efficiency and deliver 450 gigalitres of water for the environment by 2024. Water saving projects must demonstrate a neutral or positive social and economic impact for the community. Funding for projects is provided at up to 1.75 times the current market value of the water rights that are transferred. This helps to improve the viability of many water efficiency projects.
Regional Water Strategies		Under development, with the aim of having a final strategy in each region by mid-2022	The twelve regional water strategies are to align and work within the State Water Strategy and LWU Integrated Water Cycle Management Strategies, including their water efficiency objectives and actions and the equal consideration of the full range of supply and demand measures, including water conservation
Water NSW Operating Licence	2017-2022		Section 2.7 requires Water NSW to develop a Water Conservation Strategy that: • identifies and documents existing water conservation activities • sets out a process for identifying additional options for conserving water • sets out a process for comparing and selecting options for implementation.
Integrated water cycle management strategies		Various stages of completion	Requires the assessment of the current and future supply-demand balance and the equal consideration of the full range of supply and demand measures, including water conservation.
Regional town water strategies		Optional – currently no regional town water strategies are in place.	Regional town water strategies are intended to assess and plan for regional solutions to town water supply and treatment across multiple local water utility boundaries, and to align with regional water strategies and integrated water cycle management strategies.

	Current	Review status	Current / proposed requirements for water efficiency
Best Practice of Water Supply & Sewerage Guidelines	Updated 2007		Following these guidelines is optional, although if a Local Water Utility (LWU) wish to qualify for a dividend payment they must meet best practice for 6 criteria including: Best practice pricing water usage based on LRMC. Residential usage charges must recover 75% of residential revenue (50% for utilities under 4,000 customers). Step price of at least 50% for high residential customers (>450kL/a or 600kL/a depending on climate zone) LWUs should identify all and implement at least 2 appropriate demand management measures to achieve cost and energy savings and reduce wastewater flows and to protect vulnerable customers (e.g., targeted retrofits and rebates). Requires metering and demand analysis. Consider: implementation of permanent water savings measures, active intervention measures, water pricing reform, community education and water loss and leakage reduction. Demand management measures should be reviewed every 2 years.
Metropolitan Water Strategies	SW 2017 HW 2014	New strategies under development	Water conservation and efficiency considered as part of the full suite of options.
SW / Hunter Water Operating Licence		SW (2019-2023)	Requires investment in water conservation consistent with the economic method (cl3) Annual reporting (cl10.2 and s2 of reporting manual).

Appendix 2: Details of water efficiency options

Benchmarking and targets

Both regulatory and voluntary benchmarks and targets have been adopted across a wide range of jurisdictions to incentivise water efficiency. A summary of benchmarking and target opportunities across sectors is presented in Table 5 below.

Table 5: Summary of benchmarking and target opportunities

Utility	Residential	General	Non-Residential
L/c/d	Target 155	Planning instruments	**General**
ML/a	Comparative use bills	Water budget	Green star
RW use	Tenancy Acts	Plumbing code	Large segment
ILI	Building codes	WELS	NABERS
ELL		SAWM	Benchmarks
ELWC			

Utility benchmarking and targets

Targets can be set in a number of different ways and can target different users. Litres per capita per day (L/c/d) targets have been incorporated into Sydney Water and Hunter Water's operating licences in the past. These targets were designed to incentivise water savings and promote water-efficient behaviour and practices. Targets themselves do not automatically create water savings, but they are simple to understand and can create a focus for action within a utility. They can also help to overcome the revenue disincentives to encourage and invest in water efficiency. A mega litres per annum (ML/a) target operates in a similar way and does not automatically adapt to changes in population. Although this approach is less easily conceptualised than L/c/d for widespread uptake and promotion of a target in the public.

Recycled water targets also align with this approach. They incentivise a transition away from potable water sources. The reduction of water use in new residential homes form an important part of the BASIX initiative. A residential property proposal must show how the new home will use up to 40% less potable water than the average "pre-BASIX" home. Rainwater tanks are a prominent way to achieve BASIX certification for a proposed development.

Targets set using an Infrastructure Leakage Index (ILI) and Economic Leakage Level (ELL) focus on lowering leakage within a utility to reduce wasted water. A lower ILI is achieved by reducing the amount of leakage and real losses that exist in the system. Complementing this is the need to quantify what leakage levels are economic to pursue and to repair and those levels that are non-economic, which is what ELL targets define. Setting targets like these prompt utilities to undertake leak detection investigations and leak fixing initiatives. These include pressure management, active leakage control, speedy and quality repairs as well as pipeline and asset management.

Well set targets can align with least cost planning approaches provide a simple and transparent basis for ongoing investment in water efficiency. An Economic Level of Water Conservation (ELWC) approach might also work if a fuller estimate of the scarcity value of water is included together with other benefits (network constraints, energy / GHG savings etc.) and an investment is made in a foundation capacity to provide the required information on potential programs. However, hybrid approaches that include a robust

minimum target and additional expenditure based on ELWC calculations has the potential to capture the benefits of both approaches, while minimizing the risks of under or over investment in water conservation.

Residential benchmarking and targets

In the residential space, Target 155 is an example of a voluntary water efficiency program which was introduced to incentivise the reduction of personal daily water use to 155 litres per person across Victoria. This initiative complements permanent water saving rules that were introduced across the state in 2011.

Benchmarking can also be beneficial through providing comparative or average water use bills to residents to conceptualise their comparative water use and indicating how neighbouring properties may be using less water. Pricing comparisons provide tangible measures for residents and lowering water use to achieve lower bills.

Building codes and regulations can have a significant influence on the efficiency of properties by mandating the use of efficient products. In the 1980s the national plumbing code mandated the use of dual flush toilets in new and renovated dwellings sparking a dramatic shift in toilet efficiency.

Builders and plumbers are considered suppliers under the Water Efficiency Labelling and Standards Act 2005 (WELS Act). Building and plumbing codes ensure that WELS regulated, registered and labelled products are installed in new builds or supplied as part of repair work by suppliers. If this requirement is not met, suppliers can be subject to legal penalties or compliance and enforcement action. These benchmarking strategies ensure that minimum water-efficient practices are met in the residential sector.

In many instances Tenancy Acts state that the water usage component of a bill can be passed onto tenants. This is to provide an incentive to tenants to use water efficiently and identify any leaks. In some states, such as NSW and QLD the water usage component of the bill can be passed on to tenants via rental agreements only if water efficiency standards are met. This provides an incentive to landlords to install efficient fixtures and systems.

General benchmarks

Market based planning instruments can be used alongside regulation to influence customers to adopt better practices. Their main role is in rewarding the exceedance of a duty of care and encouraging outcomes which exceed the baseline. These are often funded through enactment of water budgets across the state. The NSW Government's 2020-21 Budget allows more than $700 million in 2020-21 to support sustainable, secure and healthy water resources across the State, including about $290 million over four years for vital water infrastructure projects in regional NSW.

Programs such as the Smart Approved Water Mark (SAWM) complement public rating schemes, such as WELS, to certify water-efficient products and services. Approved products and services are licensed to use the Smart WaterMark logo on packaging, point of sale information, website and marketing materials. Such certifications can provide market advantage to businesses and can be recognised or endorsed during national water efficiency campaigns to promote efficient appliances.

Non-Residential benchmarks

In the non-residential space, certifications such as Green Star or National Australian Built Environment Rating System (NABERS) provide quantifiable goals that businesses can strive towards. These ratings look at the amount of water used and recycled within a building. They can be used to understand a building's water efficiency, savings potential, track progress, understand impact of changes and communicate performance. These measures impact more than environmental standards, they can influence business reputation, building valuations and the work environment. Some legislation, such as the Building Energy Efficiency Disclosure Act 2010 (BEED Act), requires such certifications to endorse the Energy efficiency of a building.

Benchmarking has been used in a number of sectors to help businesses understand the drivers of their water demand. These benchmarks are designed to allow comparison between different sized

businesses. The Water Compare tool allows businesses to compare their water use to industry averages and be able to identify their own ways to use water in the most efficient manner and therefore save costs.

Educational messaging

Educational messaging can be effective in re-invigorating water efficiency education and communication. A summary of educational messaging opportunities across sectors is presented in Table 6 below.

Table 6: Summary of educational messaging opportunities

Residential	General	Non-Residential
Education	Smart fixtures	**General**
Behavioural insights	Water Wise developers	Smart metering (large customers)
Drought campaign	High bill notification	Data loggers
Smart metering	Best practice pricing	Education / self-audit
Meter read tutorial	Waterwise rules	**Large user**
Shower songs		Public high demand lists
		Large segment
		SWEP/EDC Schools
		Large user and segment
		WEMPS
		Large user, segment and end use
		Best practice guidelines

Residential educational messaging

Extensive communication campaigns were used across Australia during the height of the Millennium drought to encourage a reduction in household water use. South East Queensland had a target of 140 L/p/d and Melbourne had a target of 155 L/p/d. With severe outdoor restrictions already in place, voluntary indoor water savings were seen as an opportunity to further reduce demand. These campaigns were highly successful.

Educational campaigns serve to re-write and re-enforce social norms and set expectations of societal expected water use practices. Individuals adhere to social norms, look to the behaviour of peers to inform decision-making, and tend to conform to the same behaviour as their peers do. For example, showing images of turning the tap off while cleaning teeth in an advertisement has the potential increase the norm of this behaviour in the community. This technique is effective and often employed during drought campaigns.

Personalisation of programs also significantly impacts upon uptake of programs. Providing information to customers of products that they may have but do not know how to efficiently use personalises water-efficient practices. An example of this would be employing meter read tutorials. Programs like this also require little additional resourcing if the products (i.e., meters) are already installed. Simplification of messaging is another effective behavioural influencing strategy.

Too much information in the environment prevents an individual from effective evaluation and good decision making. Shower songs, as employed by Queensland Urban Utilities, are a simple and effective way of influencing behaviour and reducing water consumption. Strategies like this reduce water using activities in a way that does not require direct input or effort from a user.

General educational messaging

Permanent water savings measures, or water wise rules, have been implemented in many areas across Australia, including a regime consistent across Victoria, Sydney, Adelaide, the ACT, the Lower Hunter Region, the Central Coast and Cairns. The rules generally target efficient water behaviour rather than restricting uses, and in general still target residential irrigation.

Social norms also apply on a larger scale than just the individual level. For example, showing relatively high-water users their demand establishes norms and expectations, particularly when benchmarked across sectors. Bills and smart meters could be used to indicate relative water use to high users and show by how far they exceed average consumption. This would be in comparison to other households, businesses or themselves at a previous point in time. Conversely, there is no advantage telling low water uses they are using less than average.

Non-Residential educational messaging

Name and shame lists that publicly identify high demand users have been used to incentivise water-efficient practices amongst large non-residential users. Water use can also be made public through programs such as the Schools Water Efficiency Program (SWEP) in Victoria which creates awareness of water consumption on a community level. Most regions across Australia have engaged in some form of school water efficiency program. Such programs have ranged from developing education materials for children, assisting schools to find leaks through sub-metering and digital meters, assisting schools to upgrade inefficient appliances around the school premises and advising on irrigation equipment and practices. During audits of schools, significant water losses and wastage have been found, providing significant opportunities in this sector. The implementation processes used are broad, differing in each location and over time but typically include the utility working closely with government education departments and individual public and private schools. One very successful program was in Sydney where Sydney Water partnered with the Department of Education to retrofit amenities in the highest water using schools. This initiative saved around 9.1 ML/yr over the 26 highest water using schools (Sydney Water 2010).

Water Efficiency Management Plans (WEMPs) are developed by non-residential customers and administered by water service providers. They are created to help businesses and other non-residential water users assess their current water use and identify additional water savings. In Melbourne, during the Millennium drought, all business and industrial customers were required to develop and submit to their water utility a “waterMAP” for each site using >10 ML/a. The Victorian Government program built on and extended the voluntary scheme introduced in 2003, in which Melbourne’s top 200 non-residential consumers developed water management plans with their water utility. The program has been voluntary since the end of the drought. In the ACT, the permanent water conservation measures require Water Efficiency Management Plans (under certain conditions) for public sports amenities, public parks and gardens, public open spaces, public pools, nurseries, market gardens and turf growing businesses (Icon Water n.d.).

Utility provided contracted services

A summary of utility provided contracted service opportunities across sectors is presented in Table 7 below.

Table 7: Summary of utility provided contracted services opportunities

Utility	Residential	Non-Residential
Intelligent networks	Household retrofit	**Large user and segment**
Leak detection	Evap. Cooler maintenance	1:1 Audits
Pressure management	Garden program/advice	Leak detection
	Retrofits in strata buildings	**Large end use**
	High user audits/retrofit	Irrigation efficiency
	Essential plumbing	Business fixture replacement in small to medium business (showers/taps/toilets) *(also large segment)*
	Toilet replacement	
	Irrigation check	
	Leak repair	Cooling tower maintenance
	Rainwater tank check	Council partnerships
	Rainwater tank repair	Kitchen retrofits

Utility

Pipelines degrade over time, causing leakages and pipe bursts, incurring significant economic losses. Mitigating these losses are important to allow consumers to have adequate and consistent water supply, especially in areas with water scarcity. Intelligent networks, with constant feedback and smart metered data (Skowron 2016) inform system of where leakages may have occurred in real time. These intelligent systems integrate time-series information collected from a water network such as flow, pressure, storage level, customer demand, and water quality and apply analytics to provide insights into network behaviour and optimise planning and investment.

Leak detection crews often complement an intelligent network solution by completing the cycle of network event management. Technologies that identify events or alerts often require field crews to perform leak detection activities to precisely confirm where leaks or bursts are located.

Pressure management is recognized as a foundation for the optimal management of water supply and distribution systems within water networks. Sydney Water runs a general Water Pressure Management program across all areas of Greater Sydney which uses pressure reduction valves to achieve more consistent water pressure levels. A pressure management program such as this reduces demand and leaks, assists in meeting conservation targets, improves continuity of supply, reduces pressure fluctuations to achieve more consistent pressure and extends the life of infrastructure.

Residential

Audits and fixture replacements

Audit programs have been implemented at various scales since the 1990s. At a residential scale they typically involve a qualified plumber going to a participating house and installing, where appropriate, a new water-efficient showerhead, tap flow regulators/aerators on kitchen and bathroom sink taps, and a toilet cistern flush arrestor in single flush toilets. Minor leaks are often checked and repaired, and additional showerheads offered for an extra fee. Advice and educational materials are also often provided to customers by the plumber.

Since the end of the drought and the reduction in spending on water efficiency, many residential audit programs have ended. Some utilities still have programs available but run them at either full cost recovery or for people in financial hardship.

Full cost recovery of audits tends to dramatically reduce participations rates (Turner et al. 2016). For example, Sydney Water runs a WaterFix program, which is a commercial offering for its customers and run at full cost recovery. A site inspection costs $99, and a range of water efficiency fixtures and fittings are offered at full cost recovery.

Targeted audits and fixture replacements for multi-residential properties

Multi-unit dwellings are often not separately metered, so there are limited incentives to pay for water efficiency on an individual level. However, large, fast payback savings are often achievable. A trial program targeting high rise apartment buildings has achieved water savings of 30% and payback periods of under 4 years (Boerema 2018). One of the factors to success was benchmarking buildings (on a L/bedroom basis) to determine where there were the highest savings. A payment plan to help strata buildings overcome the barrier has been particularly successful in Sydney.

Targeted audits and fixtures for customers facing hardship

Programs that assist customers facing financial hardship to become more water efficient have multiple benefits. CHW currently runs an effective and compassionate Community Rebate Plumbing Program. In one year, over 90% of audits resulted in fixing leaking taps and more than 20% had leaks in their pipes. Water savings of around 60-70% were observed for this program. The coordinators of the program visit community groups and organisations to discuss the services they provide. These meetings have received very positive community feedback and usually result in a number of follow up referrals. As well as saving water, programs such as these can result in the bills becoming affordable for customers, reducing the assistance they require in the future.

Expanding the end uses targeted – rainwater tank repairs, evaporative coolers, hidden leaks and gardens.

Traditionally residential and audit retrofit programs have targeted minor leaks, taps and showers, with some including toilets. Other opportunities arise in the residential sector including:

- ensuring rainwater tanks, particularly those associated with building standards are operating effectively
- reducing the demand from evaporative coolers
- efficient gardening and irrigation practices.

Rainwater tanks remain a popular initiative both for rebates and as a water efficiency measure in building codes. However, it is not clear whether the long-term costs, actual savings, maintenance requirements and implications of indoor connections during restrictions are well understood by customers. A study of tanks in Melbourne found that around 5% of tanks pumps were not working, 13% were not level, leading to cracks and leaks, 9% had faulty switches resulting in total reliance on mains water and 25% had cleaning issues (Moglia et al. 2015). Mukheibir et al. (2014) reported that people who have a mandated tank are less likely to maintain them, and this has been confirmed in the Hunter and Sydney Water regions with audits of rainwater tank conditions demonstrating failures in over 60%

of tanks. Rainwater tank maintenance programs have been trialled, but current feedback is customers are unwilling to pay for tanks to be repaired.

Evaporative coolers can use a substantial portion of water in particular climate zones. Tamworth City Council estimates that 50% of homes in their area have evaporative air conditioning units. A Victorian study found evaporation rates of 60-100L/hour and bleed and dump rates of an additional 25% of evaporative demand (on average 20L/hr). It was possible to save 17% of demand just by modifying the bleed rate (Wilkinson 2011). Barwon Water included evaporative coolers in its home retrofit program (2009-2012). Tamworth City Council current runs a rebate program for services on evaporative cooler or 50% of the value of the service (up to $200).

Outdoor water usage has traditionally been the highest end use in single residential dwellings in Australia, varying significantly depending on climate conditions and lot size. There has been high uncertainty around the savings provided by garden programs.

Non-Residential

The highest non-residential water users can be best targeted through site specific audits. Sydney Water offered one to one programs for customers that used more than 50ML/yr, which included audits and prioritised recommendations on savings, and ratings based on benchmarking.

A number of fixture and fittings programs have successfully targeted water savings in defined sectors including specific devices and general business programs. General fixtures retrofit programs target specific high water using sectors to replace inefficient fixtures and fittings such as taps, showers and toilets. For example, the BizFix program in Sydney provided 50:50 co-funding to retrofit water-efficient fittings in bathrooms and kitchenettes. Yarra Valley Water (YVW) has targeted pubs, clubs and hotels with efficient appliances, Australian Capital Territory (ACT) has targeted commercial bathrooms with a retrofit program. Partnering with department of education a program targeted at retrofitting public school amenities in Sydney saved around 9.1 ML/yr at the highest water using schools.

Rebates and incentives

Over the period of the Millennium Drought a range of residential water efficiency programs were implemented. While the programs mainly targeted indoor use, a few programs also targeted outdoor use. A range of free or subsidised fixture and appliance programs have been run across Australia. A summary of utility provided rebates and incentives is presented in Table 8 below.

Table 8: Summary of rebates and incentives opportunities

Residential	Non-Residential
End use	
Washing machine	**Large User**
Showerhead exchange	Rainwater tanks
Indoor + Outdoor RW tanks	Public pools
Outdoor RW tanks	Alternative water supply
Pool covers	**Large end use**
DIY kits	Toilets/urinals
Lawn buy backs	Taps/showers
Smart irrigation	High pressure cleaning
Rain gauges	Spray rinse valves

Tap timers	Waterless woks
Irrigation timers	Trigger Nozzles
Xenoscape	Washing machines
Water smart plants	Dishwashers
Basket of goods	Smart irrigation
Toilet exchange	
Greywater diversion	
Trigger nozzles	
Hot water circulator	
Toilet dye	
High pressure checkers	
Toilet displacement devices	
Leak fix	
Shower timers	
Concealed leaks	

Residential

The residential rebate and incentive programs adopted a variety of different implementation models: the provision of free or low-cost DIY fixture giveaways; subsidised audits and minor repairs; rebates for efficient appliances; and the supply and installation of efficient fixtures through a range of cost recovery mechanisms.

Rebate schemes in all major Australian cities have provided millions of dollars of incentives for customer to purchase efficient showerheads, toilets, clothes washers, rainwater tanks (with indoor connections) and garden products as indicated above.

Other rebates have included items such as tap flow regulators, hot water re-circulators, dishwashers, toilet flush interrupters, pool covers, high pressure cleaning systems, waterless car cleaners, rainwater diverters, garden bores (in WA), greywater systems and aerobic treatment units. Participation rates and savings for such products have varied significantly.

Some utilities provide rebates to incentivise the swift rectification of concealed leaks and to minimise “bill shock” from an un unusually large bill. For example, Hunter Water provides a rebate, providing the leak is repaired within 6 weeks of getting bill a rebate of 50% of the increased usage may be claimed (once every 5 years). Water Corporation provides a $100 rebate for eligible leak repair (Department of Industry, Science, Energy and Resources n.d.a). Undetected leaks are common in households. For example, Sydney Water’s intelligent metering trial identified leaks in 80% of participating households (Doolan 2011).

Non-Residential

The Irrigation and Landscape Efficiency Project (ILEP) was a successful cooperative program in Sydney (run by Hawkesbury-Nepean River Recovery Program (HNRRP) with Sydney Water assistance, funded by the Australian Government). The program aimed to improve water efficiency and turf and soil management for Greater Sydney’s open spaces (i.e., parks and sporting facilities). Savings were achieved by using improved technology and a range of land and site management practices for over 33 sites. The knowledge gained was used to develop the ‘Best practice guidelines for holistic open space turf management in Sydney’

Low-cost water savings have been identified with the replacement of washdown / general cleaning demand (Watson et al. 2018c). For example, in the Hunter region, savings with a levelized cost of $0.19/kL were identified. The Waterless wok replacement program was highly successful in Sydney with savings of up to 90% of the water used by traditional wok stoves (Sydney Water 2007) and a payback period of less than 1 year. YVW provided pre-rinse spray valves as part of their target 155 program during the drought. Sydney Water also conducted a SmartRinse program that replaced pre-rinse spray valves in commercial kitchens and retail food shops between 2006-2011. The Sydney Water program cost around $3million, for savings of around 1,200ML/yr (Turner et al. 2013).

Building standards

Building standards are an effective way of securing demand reductions. It is important standards are reviewed and updated to align with the current market. For example, the water requirements for the NSW BASIX standard have not changed since 2006, despite market advancements in water-efficient appliances. By contrast, there have been at least two changes in the energy requirements under BASIX over the same time period.

It is also important to understand how the standard will drive behaviour. For example, building standards in Victoria required maximum flow rates for showerheads and taps, and have a maximum water pressure of 73 psi (500kPa). In addition, new houses must install **either** (1) a rainwater tank with a capacity of at least 2 kL for toilet flushing serviced by a 50m2 roof area, (2) a solar hot water system, or (3) be connected to a reticulated recycled water system where available (ABCB 2005). BASIX in Sydney requires an alternate source of water for a free-standing home. The outcomes of these two different policies (in conjunction with other programs such as rebates) are demonstrated in recent end use comparison that showed Melbourne had a much higher rate of tank ownership than Sydney, but a much lower indoor connection rate.

NABERS is a national voluntary non-residential program that is funded via registration costs. The rating tool provides water and energy ratings (and in some cases waste and indoor environment) for apartment buildings (common areas) office buildings, shopping centres, hotels and public hospitals. There are plans to expand the NABERS rating tool to seven additional sectors by 2023.

Commercial office space over 1000 square meters requires a NABERS energy rating when offered for sale or lease under *Building Energy Efficiency Disclosure Act 2010* (BEED Act). There have been substantial improvements in the energy intensity of office space since mandatory ratings were introduced. There is the potential to expand these requirements to cover water.

Mandatory ratings (with a grace period) may help to target previously unengaged sectors. For example, past Sydney Water programs have found engaging health facilities particularly challenging although they are high water users. There are currently no NSW hospitals with NABERS ratings.

Digital metering

In 2017, ISF conducted a review of 25 customer water-use information feedback studies undertaken worldwide in order to identify impacts on water consumption of digital metering and associated feedback to customers (Liu et al. 2017). From the limited data available for analysis, it appeared that feedback programs could generate average water savings of 5.5%, within a range of 3-8%. No single intervention approach could be clearly identified as “best practice” from the studies conducted to date and further research is warranted.

Examples of the use of digital meters that both inform the utility and customer include, for example, Mackay Regional Council in Queensland. This deployment includes an internal utility management portal, MiWater, which provides a suite of functions for the utility to access from the one-hour interval meter reads from their 40,000 metered properties. It also includes the MiH20 online portal accessible to individual customers by smartphone app and computer, which highlights anomalous water usage such as leaks.

Further examples of more detailed behaviour interfaces include, for example, Home Water Updates that provide detailed end use level feedback to customers on their water usage, (Liu et al. 2016). Other examples use innovative incentive schemes to promote water savings. For example, the Thames Water Greenredeem pilot of 3,000 homes in the UK. The program uses digital meters to inform an individual customer web portal that promotes water savings by rewarding residents with redeemable points for engaging in a web portal and for saving water (Liu et al. 2017).

As digital metering customer interface platforms are developed, it is recommended that there is specific attention lent to the integration of water efficiency messaging. This requires flexibility to include push messages to customers (such as leak notification, notifications of significant changes in demand and targeted comparison messages). To maximise the value of the available data, future strategies that underpin the design of digital metering platforms must be designed using robust data interrogation, leverage the improvements in plumbing fixtures and appliances, and harness the power of digital technologies.

Funding incentives

While many water efficiency projects prove to be cost effective, upfront funding often is identified as a barrier to implementation. There are a number of mechanisms that can help to overcome initial barriers to investment.

Table 9: Mechanisms that can help to overcome initial barriers to investment in water efficiency

Residential	General	Non-Residential
Leak repair	Water Banking	Innovation funds
		Grants
		Loans
		Pay for performance loans
		Reverse auctions
		Bulk purchasing discounts

Incentivising utilities to invest in demand management rather than supply

Like in the water sector, network businesses in the energy sector have generally focused on supply-side solutions to meet demand. It is acknowledged that the regulatory settings encourage investment in supply side solutions, particularly as they preface network capex over non-network options.

To help overcome this barrier the Australian Energy Regulator introduced the ‘Demand Management Incentive Scheme’ (Australian Energy Regulator 2017). The Scheme’s objective is to provide electricity distribution businesses with an incentive to undertake efficient expenditure on non-network options relating to demand management. By providing the service operator with financial payments to implement efficient non-network options which are expected to lower costs to consumers it helps to overcome the financial disincentives (specifically the revenue loss and capex bias) of investing in demand management (Dunstan et al. 2017).

The Demand Management Incentive Scheme also includes a separate mechanism to provide the distribution businesses with funding specifically for demand management research and development projects. Similar mechanisms could be considered in the water sector to incentivise investments in demand management over supply-side measures.

General Loans

Sydney Water offers payment plans to assist customers when purchasing additional fixtures and fittings that cost over $200 to make their home more water efficient. The cost is recovered through additional charges on the customer's water bills.

Environmental Upgrade Finance (EUF) / Environmental Upgrade Agreements (EUA) is a program where no deposit fixed rate finance is available for upgrades that improve the energy, water and environmental efficiency or sustainability of a building. An EUF is an agreement between a property owner, a bank and local government. The loan is repaid through a local council charge on the land as part of the rates system. They are currently available in certain local government areas in Victoria, NSW and South Australia. The loans are usually for values over $15,000 and can be for a period of 4-15 years (Sustainability Victoria 2021).

Innovation Funds

Innovation funds are a variation on loans. These often have additional criteria to demonstrate innovation and require an agreement to have lessons learnt from the innovation shared to encourage broader adoption of water savings.

Water Corporation has established a water innovation fund to assist with projects for customers who use more than 15ML/year. The 'Innovation Partnership Project' provides upfront funding that is then recovered through bill savings (Water Corporation 2020).

The NSW Government Farm Innovation Fund provides low interest rate loans of up to $1 million for farms to improve water efficiency (Department of Industry, Science, Energy and Resources n.d.b).

Loans for Government agencies

The ACT Zero Emissions Government Fund provides interest free loans to Government agencies to support emissions reduction projects. Energy bill savings are used to repay loans, continually replenishing the Fund (Environment, Planning and Sustainable Development Directorate – Environment n.d).

The NSW Treasury Loan Fund makes available up to $40 million per year in low interest loans to NSW Government agencies to implement energy and water efficiency projects. The NSW Treasury Loan Fund program is administered by the OEH on behalf of Treasury. Since it was established in 1998 about $52 million has been invested in 44 projects as a result of the program (OEH, 2013).

The NSW Treasury Loan Fund program has investment criteria that include an internal rate of return threshold of 12% and at least 75% of benefits must come from the water, energy or GHG savings. Where agencies have the capacity to implement projects themselves the loans are between $10,000 and $500,000 or for NSW Health up to $1 million. For larger projects delivery needs to be via a performance contract (OEH, 2013).

The NSW Treasury Loan Fund program remains in place. This provides the potential for a new program that utilise the NSW Treasury Loan Fund as a source of funding to increase water efficiency in government buildings.

Grants

Across Sydney, the Green Business, Public Facilities and Community Savers programs, the Water Savings Fund and the Climate Change Fund have all been used to provide water efficiency grants.

The Climate Change Fund program spent about $123 million and saved an estimated 19.8 GL per year across the state (OEH, 2011). The estimated water savings and costs of projects undertaken with the assistance of the Climate Change Fund are provided in Table . Without empirical evaluations of savings based on customer metering data it is difficult to evaluate the actual cost effectiveness of the various Climate Change Fund funded programs. However, from the available information, the most cost-effective programs from the OEH perspective appear to have been:

- grants to Business for improving water efficiency projects ($0.31/kL saved)
- washing machine rebates to households ($0.55/kL saved)
- rebates for dual flush toilets ($0.71/kL saved).

Table 10: Summary of Projects funded through the Climate Change Fund (adapted from OEH 2011)

Funding recipient	**Allocation**	**Estimated ML/a saved in 2011**	**Unit cost ($/kL) to funding agency** (for comparison only)
Households	$53,224,000	5,210	$ 0.90
Business	$31,578,000	11,551	$ 0.24
Government facilities	$22,785,000	1,665	$ 1.21
Community facilities	$15,287,000	1,374	$ 0.98
Total	$122,874,000	19,800	$ 0.55

Reverse Auctions

The sellers put in a bid for an amount of water savings and a price, and the buyer usually selects the lowest bids, although criteria for effectiveness is often applied. Over 100 separate tenders have been held in Australia across multiple programs between 2001 and 2012 (Rolfe et al. 2017). For example, as part of the Victorian Bush Tender auction, landholders competitively bid for government investment in return for providing improved biodiversity outcomes on their land.

Bulk purchasing

Efficiencies can be gained through bulk purchasing. The sustained and bulk programs for showerheads during the Millennium drought saw a rapid drop in price and an improvement in performance in WELS 3-star rated showerheads. The current NSW Energy Savers Program uses bulk purchasing power to secure discounts on a number of selected televisions and fridges. A similar program could be used to secure discounts on water-efficient devices such as washing machines, woks and spray rinse values.

Water banking

The City of Santa Fe has developed some innovative mechanisms to support water efficiency including water banking (City of Santa Fe n.d.). City Water Bank was established which keeps a record of public and private accounts, much like a traditional bank, except instead of $ values, they record kL. To be eligible for a credit, a customer creates verified water savings (confirmed via metering data). These are then either sold directly or ‘banked’ to be sold at a later date. The program works because the city requires all new developments to off-set their water demands before the development can be approved.

A similar system exists in Prescot Valley Arizona, where all new developments are required to secure their water resources for 100 years. In Prescott Valley they auctioned off their wastewater resources as rights for developers to buy so they could develop land. The wastewater is then recharged back into the aquifer for extraction. The funding gained through selling off rights is also used to help support the development of new water resources (pipeline).

Customer benefits

Korea has an Eco-label for its water using products. When customers buy water-efficient products, they are eligible for rewards on a special ‘green credit card’, for example, being able to use national parks and museums free of charge or at a reduced price (Burton et al. 2019).


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