WATER SERVICES
ASSOCIATION OF AUSTRALIA

TOWARDS RESILIENCE

CLIMATE CHANGE AND THE URBAN WATER INDUSTRY IN AUSTRALIA AND NEW ZEALAND

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NOVEMBER 2021

Water Services Association of Australia (WSAA) is the peak industry body representing the urban water industry. Our members provide water and sewerage services to over 20 million customers in Australia and New Zealand and many of Australia's largest industrial and commercial enterprises.

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Acknowledgement of Country

In the spirit of reconciliation, the urban water industry recognises that water extraction, operations, infrastructure and wastewater impacts on our environment and can reduce cultural values. We recognise that climate change will exacerbate these challenges. The strategies contained in this paper are designed to mitigate that impact, optimise value for customers, including future customers and the future community, and repair and improve cultural values where possible. WSAA acknowledges and pays respect to the past, present and future Traditional Custodians and Elders of this nation. We recognise their continuing connection to land and waters and thank them for protecting our waterways and environment since time immemorial.

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Foreword

Adam Lovell

EXECUTIVE DIRECTOR
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The IPCC 6th Assessment Report's stark message, 'Code red for humanity' has catapulted climate change to the front pages more than ever before and spurred a new global urgency on adaptation and mitigation. The urban water industry, and indeed the world, is poised at a critical juncture to avert the current trajectory.

This paper represents the first time the full range of impacts of climate change on water utilities in Australia and New Zealand, and the breadth and diversity of their climate change mitigation, adaptation and resilience strategies have been brought together in one place. It illustrates how the urban water industry is impacted now by climate change and extreme events, our role in emissions generation, and how we are responding and becoming more resilient.

Water utilities are enabled and challenged by the resource we manage. We stand to be impacted more than most sectors, but we also have an opportunity to use water in smarter ways, to cut emissions and adapt in ways that build resilience for us, our communities and urban environments. This will also improve the liveability of our cities and towns, boosting public health and economic prosperity.

Now is the time to confront the global climate challenge. It has been heartening to see the global discourse on climate change shift and accelerate with the COP26 global climate conference in Glasgow, to a focus on Net Zero by 2050. The water industry has committed to align with that trajectory.

In parts of Australia and New Zealand, our customers may want us to make faster and deeper cuts to our emissions and reach Net Zero sooner. In WSAA's 2021 National Customer Perceptions Survey, nearly 9000 responses across Australia and New Zealand indicated that three-quarters of people believe climate change is a serious threat, with young people the most concerned.

Strong emissions reduction targets are important, because they give us a race to the top. In the context of COP26, organisations with Net Zero commitments can showcase how they are striving for ambitious targets.

The stakes could not be higher for the water industry. In Australia, the 2018/19 summer broke over 206 records, across all states and territories. This was followed in the 2019/20 summer by the worst bushfires on record. Bushfires in many of our water catchments, and the floods that followed them drive home the risks to our industry. However, during the unprecedented 2019/20 bushfire season, our water utility sector worked day and night to ensure any impacts on our water services were minor and short-lived.

Working with the rest of the world to meet and exceed global emissions targets is vital. To avoid catastrophic climate change, we need to do things very differently. We must reduce our emissions in ways that sustain value for customers and shareholders, grow our business and assist the community to adapt to climate change.

This paper showcases the comprehensive activities our sector has implemented to manage our emissions and adapt to our new reality. We hope it will be of interest to water industry stakeholders, governments, the energy sector, and the land-use planning and development sectors.

Contents

Executive summary

The water industry is more impacted by climate change than most sectors, but water is able to be harnessed in smarter and better ways to both reduce our emissions, and adapt to climate change at the same time. This improves our resilience, and that of our communities and our environment to a changing climate.

This paper is the first time that any sector has put forward the range of ways that it is impacted by climate change, its current emissions profile and ambition to be Net Zero, as well as the breadth and diversity of its adaptation actions.

With this report we:

- Clearly illustrate the range of climate challenges we face to our stakeholders, shareholders and customers, enabling more informed communication and engagement
- Share knowledge on leading practice emissions reduction measures so that the industry can increase its Net Zero ambition over time as the policy context evolves – this may lead to WSAA refining the industry's Climate Change Position Statement
- Build greater understanding of the trade-offs and complementary actions between emissions reduction, water security and climate adaptation
- Improve clarity on the water industry's role in adapting our own businesses to the impacts of climate change, but also in using water for community-wide climate adaptation to ensure regional prosperity
- Progress from focussing on climate mitigation and adaptation separately, to a whole of business strategic approach to reduce trade-offs and improve complementary actions, such as through investment in green-blue infrastructure
- Improve understanding of rarely discussed impacts of climate change such as on customers and service standards, health and safety, and financial risk in a water sector specific context
- Build understanding of the research, policy and regulatory gaps that should be addressed to enable the strongest ambition and the most cost effective, whole of community benefit solutions to be adopted in the swiftest timeframe
- Highlight a continued program of work through the WSAA collective to address some of these gaps.

Our role in emissions generation and mitigation

The urban water industry delivers outcomes for the community, protecting public health and amenity through its core services including:

- Safe, affordable and reliable supply of water to meet the needs of households, business and irrigated green space
- Effective and affordable resource recovery, with human health and environmental benefits
- Effective stormwater management to protect waterway health and manage risks of floods to people and property (only some water utilities have this responsibility).

In recent times our role has come to be understood in a broader context that includes urban liveability – this is a result of our role in managing water, which can support a variety of better outcomes for urban environments and the communities that live in them (Figure 1).

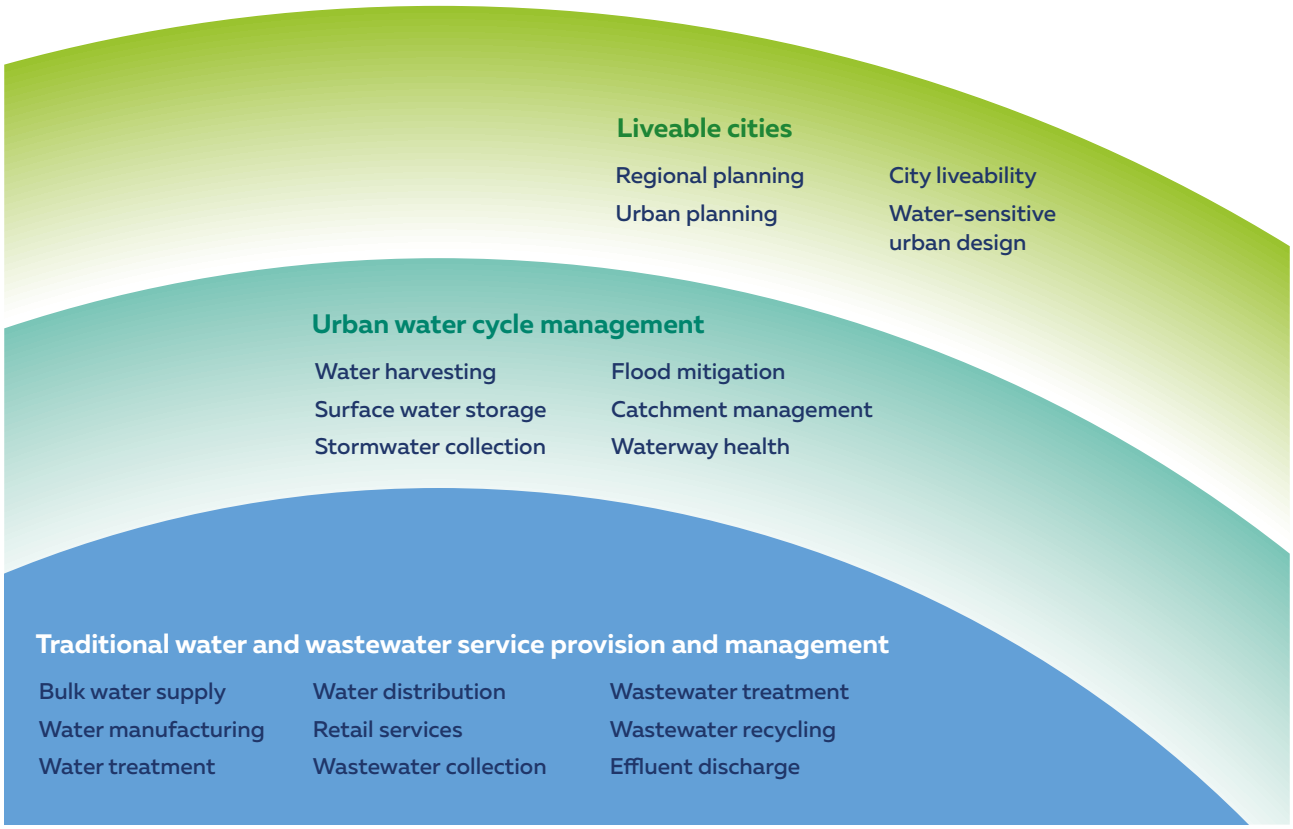
How climate change impacts us

Climate change arguably impacts our business more than most sectors. Infrastructure Australia notes that "of all the forms of infrastructure, the potential risks and costs of climate change are greatest in the water sector", (IA 2019). This creates challenges for our operations through:

- Decreased rainfall, drought and water scarcity
- Increased rainfall intensity and flooding
- Higher temperatures and extreme heat
- Bushfires
- Sea level rise.

Water utilities can expect the challenges associated with climate change in protecting assets and providing consistency and quality of service, to increase in both frequency and magnitude as warming progresses. Water utilities will have to cope with events not previously experienced. It is clear that the past is not a reliable indicator of the future as the probability of extreme events is rapidly changing, making conventional approaches to the estimation of risks unreliable. This has major implications and challenges for water industry planners and decision makers.

FIGURE 1 The expanding role of urban water utilities



SOURCE NWC 2012

Water utilities contribute to climate change through their greenhouse gas emissions:

Scope 1

All direct emissions: directly produced as a result of water and wastewater treatment and other activities under the control of the organisation, (eg. fugitive emissions from wastewater treatment; fleet vehicles)

Scope 2

All indirect emissions: indirectly by using energy in the production, transport and treatment of water and wastewater

Scope 3

All other indirect emissions: indirectly arising from supply chain and other business activities.

Water is also used 'behind the meter' by customers, and emissions are generated when water is heated or used in evaporative cooling. Water heating contributes potentially even more to the Australian and New Zealand emissions profile than the entire water industry.

Overall, the water industry's Scope 1 and 2 activities contribute approximately 0.8% to Australia's total annual emissions profile (BOM 2020).

However, our emissions as an industry are growing, with the 2019-20 National Performance Report indicating a record 4.25 million tonnes of emissions were produced, a 32% increase on the preceding year (BOM 2020).

Drought can increase our emissions in some years due to increased pumping requirements (BOM 2020). Investment in alternative water sources can also increase our emissions, as sources such as desalination, recycled water and stormwater harvesting and reuse are energy intensive. However, by using renewable energy and/or carbon offsets, these emissions can be reduced.

The industry has a responsibility to our shareholders, customers, and future generations to do as much as we can to reduce our emissions. There are a range of ways we do this, including:

- Adopting new technologies in water and wastewater treatment to reduce fugitive emissions
- Building or purchasing renewable energy
- Improving energy efficiency of our processes and operations
- Implementing a circular economy approach and recovering resources
- Self-generating or purchasing carbon offset products.

Many water utilities have adopted Net Zero emissions targets to help drive further reductions in emissions. These range from as early as 2022 (Logan City Council), to the majority being out to 2050.

As an industry, we commit to achieving Net Zero emissions by 2050 or earlier where our customers support it.

How we are adapting to our future climate and improving our resilience

Australian and New Zealand water utilities are already adapting to significant changes in their operating environment from reduced inflows, the impacts of extreme events and other disruptions. This is forming an ever-larger part of our business, as well as the broader sector, which is increasingly galvanised around providing leading edge advice, knowledge sharing, tools, frameworks and other resources to support our industry's shift.

We are increasingly investing in rainfall-independent supplies to boost water security, and considering the likely impacts of climate change on our large and ageing asset base from both a risk and financial perspective.

We are adapting our assets and recognising that the performance of our assets across their life cycle is likely to be impacted by climate change. This may lead to redesigning of our assets, their materials, optimal locations, sizing, and timing.

Water utilities will need to do more with less water, so continuing to invest in water efficiency and conservation is critical. Managing leakage is one way the industry is meeting both our water security challenges and reducing emissions from undelivered water at the same time. Innovation such as acoustic pipe sensing is just one example of leading practice in this space.

The urban water industry is also developing its capability in adaptive and integrated planning across sectors and particularly with the land-use planning sector, through an Integrated Water Management approach with all organisations involved in the urban water cycle (Skinner and Satur 2020). Success here will increase our resilience and the liveability of our cities and towns in the face of our future climate.

We are combining this with a circular economy (Jazbec, Mukheibir and Turner 2020) mindset that views by-products as a resource and finds innovative and cost-effective solutions to reusing those by-products. This can reduce the demand for primary products (such as chemicals used in water treatment, nitrogen, phosphorus and oxygen) and thus contribute to emissions reduction in the extractive industries sector (a Scope 3 emissions reduction for water utilities).

Key enablers for the future

Climate change is just one of several major challenges that water utilities are faced with. A strategic, integrated and whole of business approach is needed.

1 Developing a strategic approach

Taking a whole of business approach to climate change, and including both mitigation and adaptation strategy together, should not be traded off. Well planned climate adaptation, embedded across all business areas, can reduce climate risk for assets, workforce and the community, and increase resilience and the liveability of our cities and towns.

New technology and digital innovation holds many opportunities for water utilities. The disruption from the COVID-19 pandemic has accelerated the identification and uptake of new technologies that are supporting water utilities' responses to the impacts of climate change across a range of business areas. Examples include utilising big data, smart assets such as sensors and smart meters, as well as upgrades to existing assets, such as through WSAA's Smart Linings for Pipe and Infrastructure CRC project.

Over-arching climate legislation can provide the frameworks and financing for meeting emissions reduction targets at least cost. They also provide clear signals to customers, investors (where external financing is being sought for particular projects with a climate change benefit), help build community consensus and navigate political challenges, meet shareholder expectations more easily (and possibly more quickly) and encourage an evidence-based rather than a purely financial approach to climate action.

States that have legislated targets (eg. ACT, Victoria) have seen those targets be firmly adopted by government-owned water utilities, and enable the utility to plan with more certainty across pricing submissions in terms of how fast and how deep the emissions cuts need to be to meet the final Net Zero target.

The urban water industry understands, despite its total emissions being less than 1% of Australia's national emissions profile, faster and deeper cuts to emissions are very likely necessary to keep global temperature rise below 2°C. As an industry, our business stands to be more affected than most sectors, and so we welcome stronger and legislated targets by state, local and federal governments.

2 Better understanding our customers and community

Recent customer sentiment research shows that our customers expect water utilities to take a much bigger role in addressing a range of societal issues (Edelman 2021), with the environment and climate change re-emerging as a high level of concern (Edelman 2021).

However, beyond water efficient behaviours, many customers do not a make a connection with how climate change may impact service reliability, water quality, environmental outcomes and most importantly, the size of their water bill.

In response we are looking to better understand our customers' climate change beliefs, preferences and willingness to pay for climate-change related services, educating our communities on what their service standards may look like and cost in the future, and ensuring equity in our actions.

3 Building the capability of our people

Our staff are our number one asset, and climate change is exacerbating both the strategic and operational issues that staff may have to manage. Global research recognises the mental health toll this can take on staff (Cianconi, Betro and Janiri 2020), as well as the physical risks staff may experience while they are at work, to their personal property or those of their friends and family during extreme weather events.

One way the industry is ensuring the health, safety and wellbeing of our people, communities and workplaces, is by applying the industry's commitment to Zero Harm in WSAA's Water Industry Mental Health Framework (WSAA and EY, 2019), to climate change.

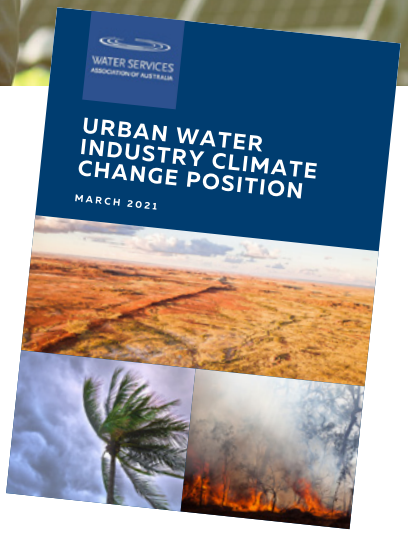
4 Managing our financial risk

Financial resilience is fundamental to meeting industry challenges, while maintaining affordability. Climate change will compound the financial trends already occurring in the industry:

- High demand for capital from renewal of assets and new investment in water security assets to manage population growth and lower inflows to surface water storages, as well as digital innovation in the industry
- Policy and regulatory expectations for downward pressure on prices at the same time as having high investment levels is increasing debt
- Likelihood of increasing interest rates after a benign period with record low rates will increase debt servicing costs.

Recent legal opinions demonstrate that climate change litigation is a material risk for public sector Boards. There is likely to be increased scrutiny on the public sector's role in accounting for climate risk (Dibley, Hurley and Sheppard 2019). These risks can be reduced by adhering to the Taskforce on Climate-Related Financial Disclosure (TCFD) Framework.

Water utilities are rising to meet these associated financial challenges in a number of innovative ways, including developing shadow prices for carbon (see Case Study 15), participating in sustainability or green bonds programs (see Case Study 16), and better valuing our green infrastructure contribution.



OUR POSITION ON CLIMATE CHANGE

Net zero greenhouse gas emissions by 2050

In March 2021, WSAA released a position statement outlining the urban water industry's Net Zero emissions commitment, and a range of associated activities designed to meet it. WSAA expects this statement will be updated in 2022 as ambition increases.

To contribute to global and national efforts to limit climate change and keep global temperature rise this century well below 2°C, and preferably to 1.5°C, the urban water industry will achieve Net Zero greenhouse gas emissions by 2050. In many cases water utilities will achieve this target earlier than 2050, particularly where shareholder and customer expectations support a faster reduction in emissions.

We will achieve Net Zero greenhouse gas emissions by pursuing opportunities such as:

- Avoiding energy use and emissions through innovative smart design of new and renewed assets
- Minimising energy and emissions through efficiency and optimisation
- Recovering and generating renewable energy and local upcycled materials from our activities
- Substituting emissions-intensive energy with zero-emissions renewable energy sources
- Embracing new technologies and innovative solutions that reduce emissions
- Sequestering carbon
- Offsetting residual emissions, using local offsets where possible and exploring initiatives that enhance liveability and climate change adaptation for our communities and environment.

We acknowledge that working towards Net Zero is not always least cost. However, the costs of achieving Net Zero emissions should be balanced with the cost of emissions impacting future generations.

Through collaboration and partnership with our customers, communities, Traditional Owners, government stakeholders and other sectors, the urban water industry also commits to:

- Conserving water and encouraging efficient use of water by our customers.
- Building resilience in water supply systems through diversifying water sources and improving treatment processes.
- Recognising the importance of cultural flows and the benefits of integrating Indigenous knowledge and practice in water management.
- Supporting green, cool and healthy environments.
- Implementing circular economy principles in our management of water, waste and energy.
- Supporting healthy waterways to protect and restore ecological and community values.
- Engaging with customers and communities to achieve a balance between climate change action costs and outcomes, including respecting the needs of current and future generations.

Urban water industry climate change position

WATER SERVICES ASSOCIATION OF AUSTRALIA

The climate is changing and so are we. Through collaboration and partnership we commit to:

The urban water industry will achieve net zero greenhouse gas emissions by 2050.

We are achieving net zero sooner where it aligns with customer expectations.

CONSERVE WATER

Reduce water loss in our networks and encourage efficient water use by our customers.

BUILD RESILIENCE

Build resilience in water infrastructure through holistic adaptation to climate change, including diversifying water sources and improving treatment processes.

CUSTOMERS AND COMMUNITIES

Engage with customers and communities to achieve a balance between climate change action costs and outcomes, including the needs of current and future generations.

HEALTHY WATERWAYS

Support healthy waterways to protect and restore ecological and community values.

CIRCULAR ECONOMY

Implement circular economy principles in our management of water, waste and energy.

INDIGENOUS VALUES

Recognise the importance of cultural flows and benefits of integrating Indigenous knowledge and practice in water management.

GREENING AND COOLING

Support green, cool and healthy environments.

Water utilities face different circumstances, capacity and capabilities to achieve these commitments. The industry will continue to work together and collaborate with our stakeholders to meet the challenges of a changing climate.

The urban water industry's commitment to the 17 Sustainable Development Goals provides a framework for achieving these commitments.

We understand that these commitments are likely to increase scrutiny on the urban water industry.

Water utilities face different circumstances, capacity and capabilities to achieve these commitments. The industry will continue to work together in cooperation to meet the challenges of a changing climate.

Climate variability and climate change

Climate change is with us now. Australia and New Zealand will continue to experience ongoing, long-term climate change interacting with underlying natural variability, posing a number of acute and chronic risks to the urban water industry.

Natural variability

Australia's climate is highly variable with strongly seasonal rainfall patterns that can vary greatly from year to year or decade to decade. Large scale atmospheric circulation drivers such as the El Niño Southern Oscillation (ENSO), Interdecadal Pacific Oscillation (IPO), the Indian Ocean Dipole (IOD), and the Southern Annual Mode (SAM) can increase the variability and the occurrence of droughts and floods. Interactions can occur between these drivers, magnifying or reducing their individual influence.

The formation of East Coast Lows can also result in cyclones and episodic large rainfall events.

The instrumental record of historical climate data (streamflow, rainfall and evaporation) for Australia is relatively short, covering a 120-year period. Investigations into the paleoclimate looking at the past 1000 years suggest that the instrumental record does not capture the full range of variability that has occurred. These studies have found that all centuries in the past 1000 years have a different frequency and duration of wet and dry periods, and that worse droughts than the Millennium Drought have occurred several times prior to 1900 (Kiem et al 2020).

Climate change

Climate is the average weather in a place over many years. Climate change is a shift in those average conditions, understood to be caused by a rise in global greenhouse gas levels caused by human activity, including carbon dioxide, methane and nitrous oxide. These gases become trapped in the Earth's atmosphere and cause global temperatures to rise.

The IPCC 6th Assessment Report (IPCC 2021) examines updates to the physical basis of climate change, and reiterates that human influence on the climate is unequivocal, and unprecedented in over 2000 years.

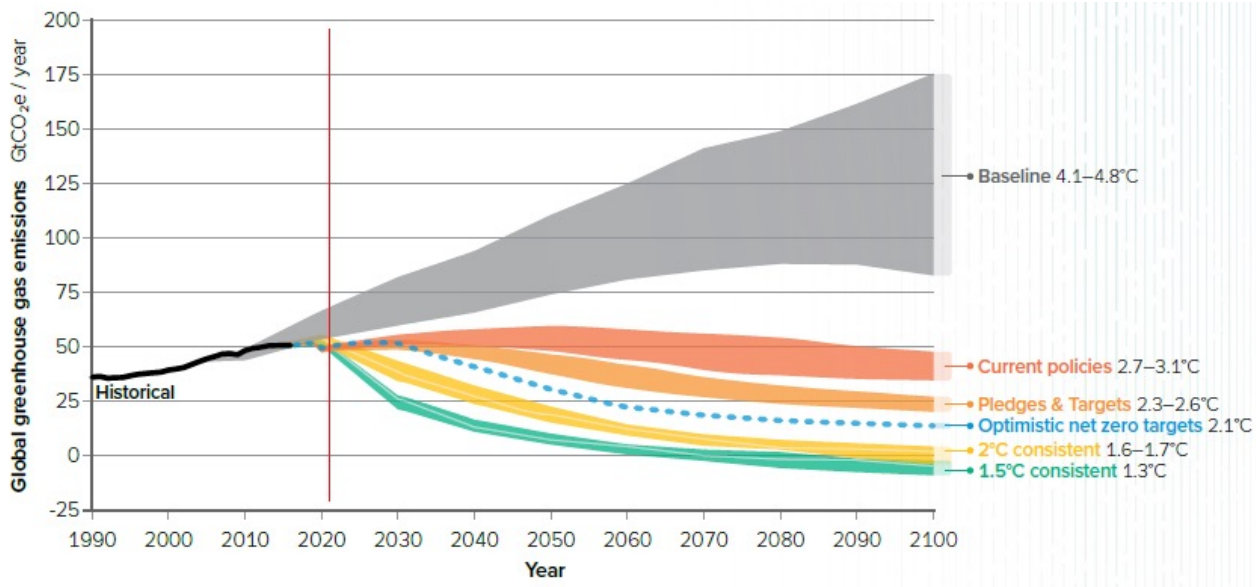
IPCC 6th Assessment Report findings include:

- Current global average temperatures are warmer than any time in the last 100,000 years
- CO_2 is highest in the last 2 million years
- Sea levels are rising faster than any time in the last 3000 years
- Arctic sea ice is the lowest for 1000 years
- Glaciers are retreating faster than any time in the last 2000 years
- The impact of warming is resulting in changes we are already observing around the world – extreme temperatures, fires, floods, extreme weather events, drought, ocean acidification.

Figure 2 shows projected global warming by 2100 under various emissions scenarios. If emissions are not curbed significantly, by 2100 global temperature rise could be nearly 5°C.

Australia has warmed on average by 1.44 ± 0.24°C since national records began in 1910 and Australia's warmest year on record was 2019 (Figure 3). New Zealand's temperature has increased by 1.13°C over the period 1909 to 2019, and in the 22 years to 2019, New Zealand had its five warmest years on record (Ministry for the Environment and Stats NZ, 2020).

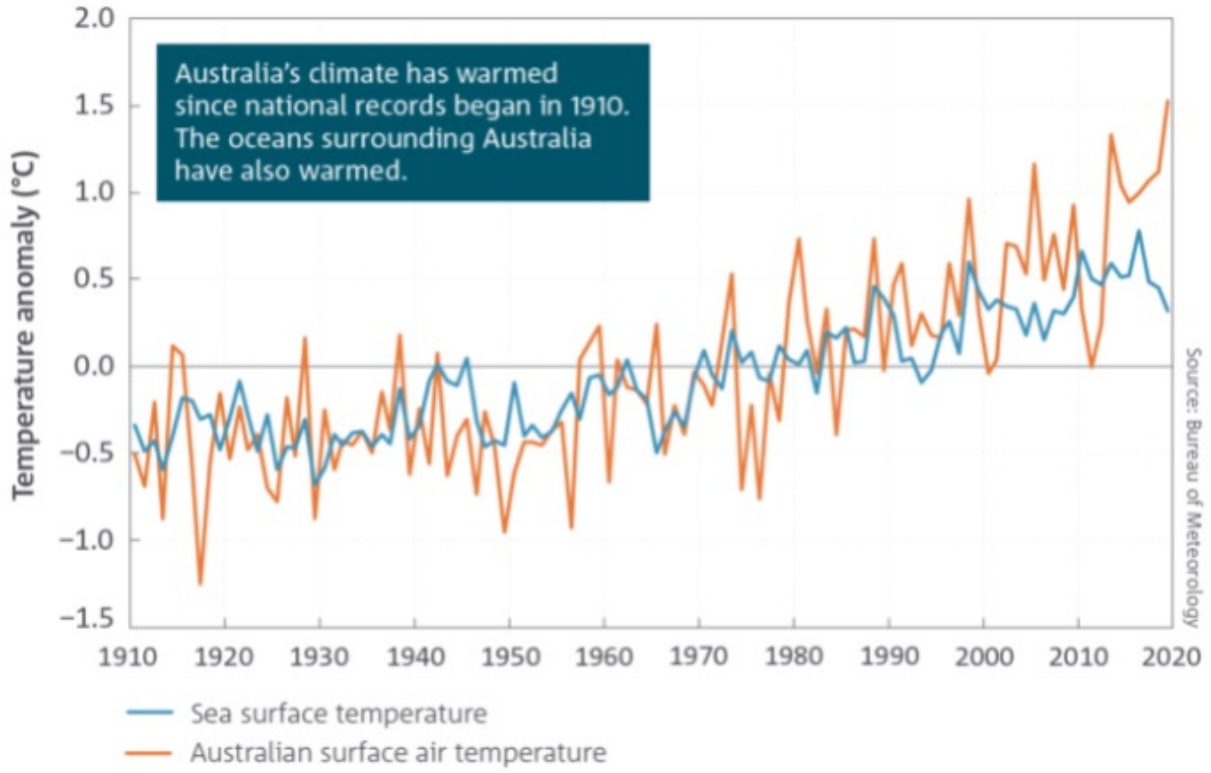
FIGURE 2 Projected warming by 2100 under various scenarios



Projected warming by 2100 under various scenarios from top to bottom (Climate Action Tracker 2020; Revill and Harris 2017): 'Baseline' models assume no action on reducing GHG emissions while 'current polices' are based on current commitments and policies made by the international community. 'Optimistic polices' include additional pledges that governments have made as of December 2019. 'Pledges and Targets' are conditional and have not yet been implemented. Pathways for '1.5°C' and '2°C' are scenarios based on models run for IPCC Special Report on 1.5°C (IPCC 2018). Temperatures of each scenario are shown as a range arising from different climate models.

SOURCE Australian Academy of Science, 2021

FIGURE 3 Australian sea and land surface temperature anomalies 1910–2020



SOURCE BOM and CSIRO 2020

Despite increasing global ambition from governments and industry, global emissions are set to rise by 16% to 2030, while to limit warming to 1.5°C they must fall by at least 45% by 2030 (IPCC 2021). Global lockdowns during the COVID-19 pandemic only caused a slight dip in this trajectory.

Water is at the centre of the impacts of climate change globally, from changes in rainfall patterns and water scarcity, to the way water is managed in the landscape, to the frequency of storms and other major weather events.

In Australia and New Zealand, the impacts from climate change are expected to include (BOM and CSIRO, 2020; Ministry for the Environment and Stats NZ, 2020):

- More variable rainfall patterns and river and dam inflows
- Continued increases in air temperatures, more heat extremes and fewer cold extremes
- More frequent and intense storms
- A consequential increase in the number of dangerous fire weather days and a longer fire season for southern and eastern Australia, and New Zealand
- A gradual increase in sea level, along with storm surges.

TABLE 1 Chronic and acute climate hazards for the water industry

CHRONIC	ACUTE
Sea level rise	Heatwaves
Long term decline in rainfall and reduction of inflows to storages	Drought, bushfires
Increased evaporation from storages	Floods
Soil moisture	Storms and intense rainfall, hail
Reduced water quality in urban waterways and receiving waters	

The size, severity, timing, location and impacts of climate hazards are difficult to predict, and our changing climate is increasing the uncertainty about future risks (Table 1). The increasing complexity and interdependencies of water infrastructure with third party critical infrastructure (such as the electricity network) is also creating additional risk and uncertainty associated with climate change.

Climate risks

Drought and lower inflows

Australia and New Zealand are experiencing more variable rainfall patterns and decreasing inflows into rivers and dams. In some parts of Australia and New Zealand decreases in rainfall are observed with future reductions predicted, and an associated increase in water scarcity and drought.

There has been a decline of around 16 per cent in April to October rainfall in the southwest of Australia since 1970. Across the same region May to July rainfall has seen the largest decrease, by around 20 per cent since 1970. In the southeast of Australia there has been a decline of around 12 per cent in April to October rainfall since the late 1990s. (BOM and CSIRO 2020).

In New Zealand (NZ Ministry for the Environment and Stats NZ, 2020):

- Annual rainfall was below average in nine of the fourteen years between 2000 and 2014
- Auckland suffered severe drought in 2020, with dam levels dropping below 50% for the first time in 50 years.

Some catchments in Victoria have not responded to increased rainfall following the end of the Millennium Drought. As an example, the Victorian Department of Environment, Land, Water and Planning (DELWP) has findings showing that although some catchments have responded with runoff as expected in response to rainfall following the end of the Millennium Drought, some catchments, particularly in central and western Victoria, still have less streamflow than expected given the increase in rainfall (Figure 4).

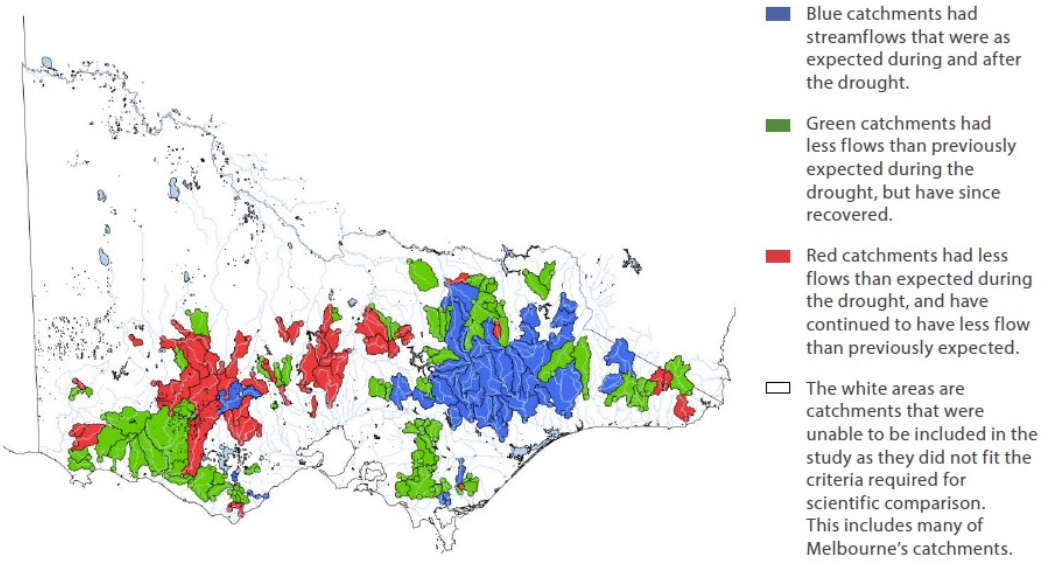
Several large water utilities have already seen a reduction in inflows to their storages, and in Perth's case this has been a dramatic step change for Water Corporation (Figure 5). Streamflow at some sites that flow into Perth's main dams have recorded a 90% decrease in annual average streamflow since the 1970s.

TABLE 2 Impacts to the urban water industry of drought and lower inflows to dams

Reduced streamflow, decreasing water supply, which can lead to restrictions
Increased pollution concentrations.
Re-suspension of dam/river sediments due to low water level and possible liberation of toxic compounds.
Increased groundwater use as surface water availability declines.
Reduced precipitation decreases groundwater recharge, leading to falling groundwater tables, decreased river baseflow, and saltwater intrusion into coastal or inland aquifers.
Increased water withdrawals from low quality sources due to shortages will increase treatment requirements.
Reduced available soil moisture, leading to degradation of water and wastewater pipes, leakage and mains breaks.

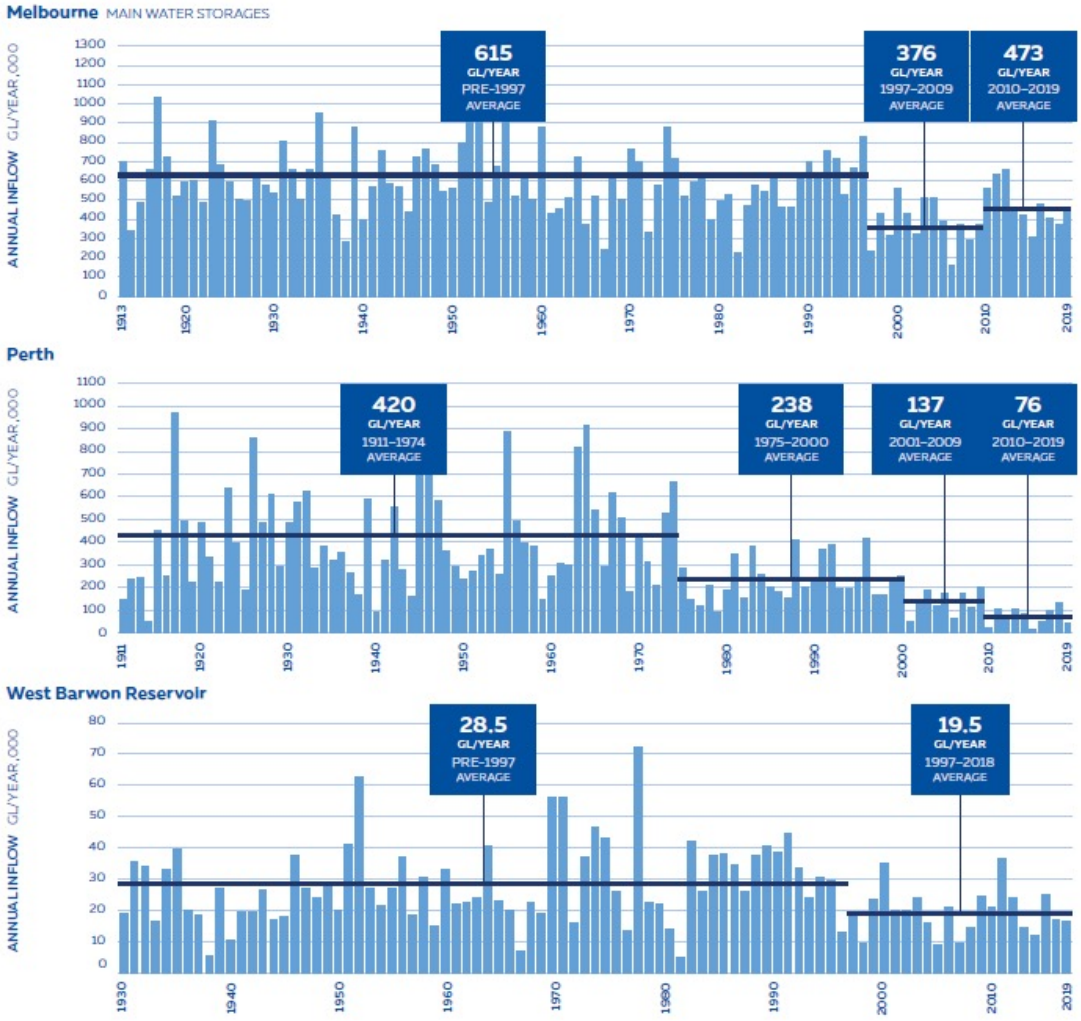
SOURCE National Water Commission, 2012

FIGURE 4 How Victorian catchments responded during and after the Millenium Drought



SOURCE DELWP, 2018a

FIGURE 5 Declining streamflow over time



SOURCE WSAA 2020b, Melbourne Water sta; Water Corporation data, Barwon Water data

Increased rainfall intensity and flooding

Extreme weather events such as storms are likely to increase with climate change, with some regional variation. The water industry's response to other challenges, such as water security, will assist in responding and recovering quickly from the impacts of severe storms.

Australia and New Zealand are experiencing more variable rainfall patterns, and in some regions this means increases to rainfall, particularly heavy precipitation and associated flooding. For example, rainfall and streamflow have increased across parts of northern Australia since the 1970s (BOM and CSIRO, 2020). Cyclones may also become more intense and occur further south than previously.

The impact of flooding, particularly after drought, can be very significant for water utilities in terms of water security and management operations.

The Bureau of Meteorology acknowledges there is uncertainty around future flood impacts, as there may be less flood risk for some areas of Australia in the future, despite more intense rainfall events, because of drier overall soil conditions.

TABLE 3 Impacts of increased rainfall intensity and flooding on the urban water industry

Soil erosion, causing an increase in suspended solids. This turbidity can affect water supply by interfering with disinfection processes, increasing the need for coagulant use, and increasing handling costs. It can also lead to sedimentation of reservoirs and reduced water storage capacity.
Drinking water storage capacity decrease, because of the need to maintain more flood storage capacity (ie. keeping dams less than full).
Increased pollution loading to groundwater.
Decrease in groundwater recharge, as heavy precipitation exceeds soil infiltration capacity and increases surface runoff.
Flooding of water intake and treatment facilities causing contamination and damage, due to being often located on floodplains.
Capacity overload of water treatment plants and wastewater treatment plants.
Erosion of pipelines due to heavy rainfall.
Sewer and stormwater overflows, causing urban flooding and increased discharge to the environment.

SOURCE National Water Commission (2012)

Water utilities across Australia and New Zealand are utilising a range of strategies to manage storm risk and the impacts of storm events, including (Khan et. al. 2016):

- Building redundancy into water supply systems, including back-up power generators to ensure service continuity and to prevent sewer overflows
- Additional or increased disinfection processes
- Implementation of enhanced treatment options prior to a forecast event
- Managing impacts from storms on source water quality
- Issuing of boil water advisories
- Alternate delivery of drinking water (e.g., tankers)
- Supply of point-of-use filtration devices, personal water quality testing kits and bottled water to customers
- Pre-filtration of surface waters prior to intake in drinking water plants
- Upgrading dams to meet latest ANCOLD requirements, recognising increasing risks of flooding from extreme rainfall events (eg. SA Water)
- Diversifying water supply options and having them available.

Higher average temperatures and extreme heat events

Australia's and New Zealand's annual average temperatures will continue to increase, along with an increase in the frequency of extreme heat events. This will require significant adaptation responses across water utilites, including for operations and staff.

TABLE 4 Impacts of higher average temperatures and extreme heat on the urban water industry

Reduced source water quality and quantity due to:
Reduced oxygen concentrations, release of phosphorus from sediments and altered mixing.
Increased evaporation.
Increased occurrence of eutrophication and algae blooms in water bodies.
Snow and ice cover changes, leading to reduced or earlier peak streamflow and/or extension of low flow periods.

Increased water and wastewater treatment challenges, including:
Increased microbiological activity and risk from new species with changing water temperatures, leading to an increase in disinfection by-product levels.
Impact on temperature-related wastewater treatment processes (for example, reduction of oxygen levels and transfer rates).

Increased asset challenges, including:
Corrosion of sewers and stormwater pipes.
Reduced oxygen content in wastewater effluent receiving waters, leading to additional wastewater treatment requirements.

Energy challenges including:
Increased risk of blackouts/brownouts
Heat-related impacts to buildings such as increased use of air conditioning and associated costs and emissions impact.

Health and wellbeing challenges, such as:
Risks to water industry workers' health and lives during heatwave events.

Customer challenges
Complaints to service providers.
Increased demand due to outdoor use during heatwaves.
Increased recreation on storages.

SOURCE National Water Commission (2012).

Bushfire

In large parts of Australia and New Zealand, there has been an increase in extreme fire weather, and in the length of the fire season, since the 1950s, especially in southern Australia.

In New Zealand, by 2040, days with very high or extreme fire danger are projected to increase by an average of 70 per cent, due to hotter, drier and windier conditions. The largest increases are projected for areas that are not accustomed to fire (Ministry of Environment and Stats NZ, 2020).

Many of our industry's main water supply catchments are located in forested areas, and many of the urban areas we service are also located in forested areas, which means the water industry is more exposed to bushfire risks than many other sectors.

TABLE 5 Impacts of bushfire on the urban water industry

Longer fire seasons.
Damage to water and wastewater infrastructure.
Post-bushfire runoff of dissolved materials into receiving waters, changes in turbidity and chemistry of water.
Post-bushfire increased occurrence of eutrophication and toxic algae blooms in rivers, reservoirs and lakes, requiring additional treatment to remove odour and taste.
Risks to water industry workers' health and lives during bushfire events.
Emergency services use of water from reservoirs to fight fires.

SOURCE National Water Commission (2012)

Sea level rise

Sea levels are rising around the world, including in Australia and New Zealand, and in some places more than others. The impact for water utilities is increased risk of inundation and damage to our coastal assets, many of which are long-lived, as well as saltwater intrusion.

Water industry responses to sea level rise and saltwater intrusion depend on the strength and nature of the risk, and the types of assets affected, or likely to be affected in the future as a result of climate change impacts.

TABLE 6 Impacts of sea level rise on the urban water industry

Saltwater intrusion at river mouths, into aquifers and into water supply pipe networks, reducing the available drinking water supply.
Saltwater intrusion into coastal wastewater treatment lagoons.
Sewer outfalls into sea exposed to damage during coastal flooding.
Coastal wastewater pipe networks and treatment infrastructure damaged.
Coastal flooding: temporary increases in salinity of influent to wastewater treatment plants, leading to disruption of biological processes and corrosion of equipment.
Salinisation of recycled water.
Driving the relocation or adaptation of assets because they are close to the coast and will be affected by sea level rise, or in positions with heightened flood levels.

SOURCE National Water Commission (2012)

Impacts on customers and service standards

Climate hazards, and chronic or acute weather events can impact on service standards set by regulators. The link between these climate hazards and service standards are not usually obvious to the broader customer base.

As these events become more frequent, and impacts on service continuity are felt by more customers more often, water utilities will need to engage with their customers about how these events will impact their service standards, their expectations, and their bills in the future.

Climate hazards, and both chronic and acute weather events will test our service standards, and our relationships with customers.

Customer service standards are set by regulators and include aspects such as frequency and duration of service interruptions, and dry and wet weather sewer overflows. Both chronic and acute weather events can impact on water utilities' performance against these service standards, particularly if they become more frequent.

Maintaining current service standards may cost more in the future. The industry may also need to increase standards to meet new regulatory or policy conditions or customer preferences, and some standards may become too expensive to meet and need to be revised.

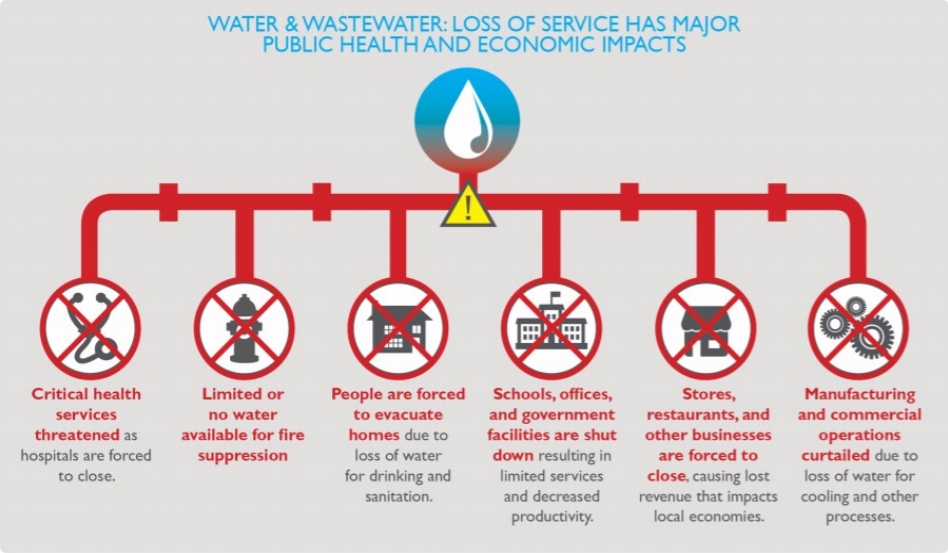
TABLE 7 Impacts of climate change on customers and service standards.

Storm surges and flooding will more frequently inundate assets, in particular sewers resulting in the potential for more sewer overflows, both into properties and to receiving waterways. This may also impact on the aesthetic quality of waterways due to increased litter, and maintenance of Gross Pollutant Traps.
Changing periods of wet and dry soil conditions, particularly in clay soil areas may increase the frequency of leaks and breaks, resulting in outages to services.
Bushfires can increase erosion in catchments and reduce source water quality, and in extreme cases this may overwhelm the treatment plant capacity, potentially impacting services.
Floods such as the 2011 flood event in South East Queensland caused increased sediment to a water treatment plant, putting it offline which impacted water supply for much of Brisbane and the Gold Coast. The Gold Coast desalination plant was an essential resilience asset in this case as it provided an emergency supply.
Drought and lower inflows to storages will lead to a different water supply mix that can include desalination, groundwater, stormwater, purified recycled water and recycled water. This may cause taste, colour, hardness, aesthetic changes, and generate cultural considerations as some customers may not be used to this.
Water restrictions impact on customers' ability to use water.

Water utilities will need to have important conversations with their customers about where their water will come from in the future, as well as a range of other possible impacts to their service standards and bills.

Customers may need to consider their willingness to pay more to maintain existing standards or be more resilient in being able to adapt and accept lower levels of service during these events.

FIGURE 6 Example impacts of service disruption for customers



SOURCE US National Infrastructure Advisory Council 2016

CASE STUDY 1 CAIRNS REGIONAL COUNCIL

Impact of cyclones on customer and service standards

Several cyclones will form in northern Australia each year, however they may not all make landfall (cross the coast) or impact the Cairns area. Active cyclones in the broader region may also bring periods of strong winds, heavy rain and flash flooding to Cairns. The most challenging impact of cyclones for water and wastewater infrastructure is the loss of telecommunications resulting in the inability to remotely control treatment processes. With the impact of climate change, Cairns is predicted to have less frequent but more intense cyclones, and so preparing for cyclones is a core business continuity requirement for the Council.

CLIMATE THEMES ADDRESSED

SERVICE STANDARDS

BUSINESS CONTINUITY

Climate change mitigation

Reducing our emissions

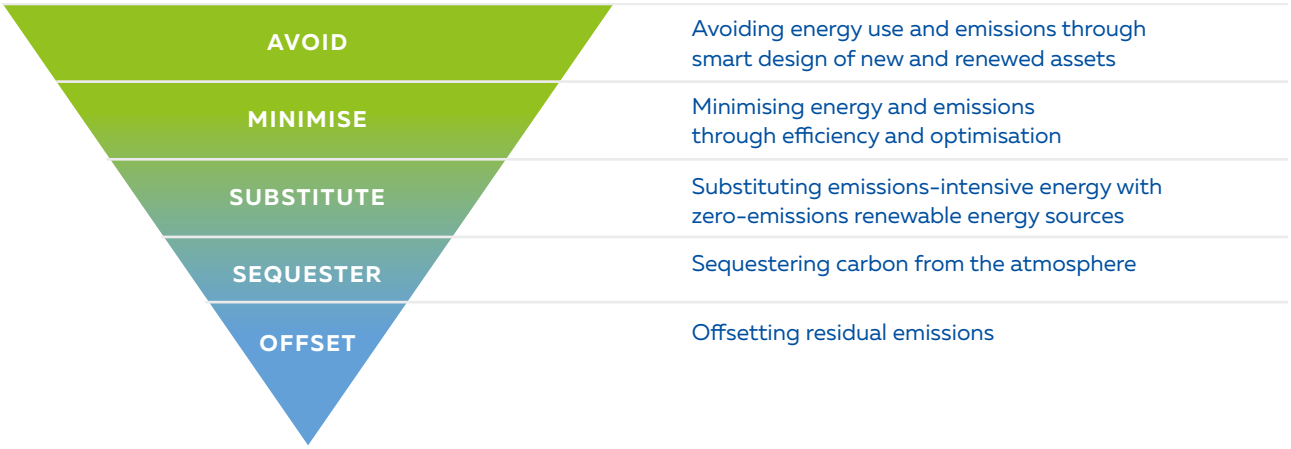
Delivering effective and reliable water services is energy and emissions intensive. The urban water industry is also vulnerable to the impacts of climate change because of the effect of global warming on water resources. The industry therefore has a responsibility to do its part to reduce emissions as quickly as possible – yet there are important trade-offs in simultaneously meeting our water security challenges, which can increase our emissions at times.

The urban water industry will achieve Net Zero greenhouse gas emissions by 2050 or earlier. We are achieving Net Zero earlier where it aligns with customer expectations.

Overall, the water industry's activities contribute approximately 0.8% to Australia's total annual emissions profile (BOM 2020), and around 0.45% of New Zealand's.

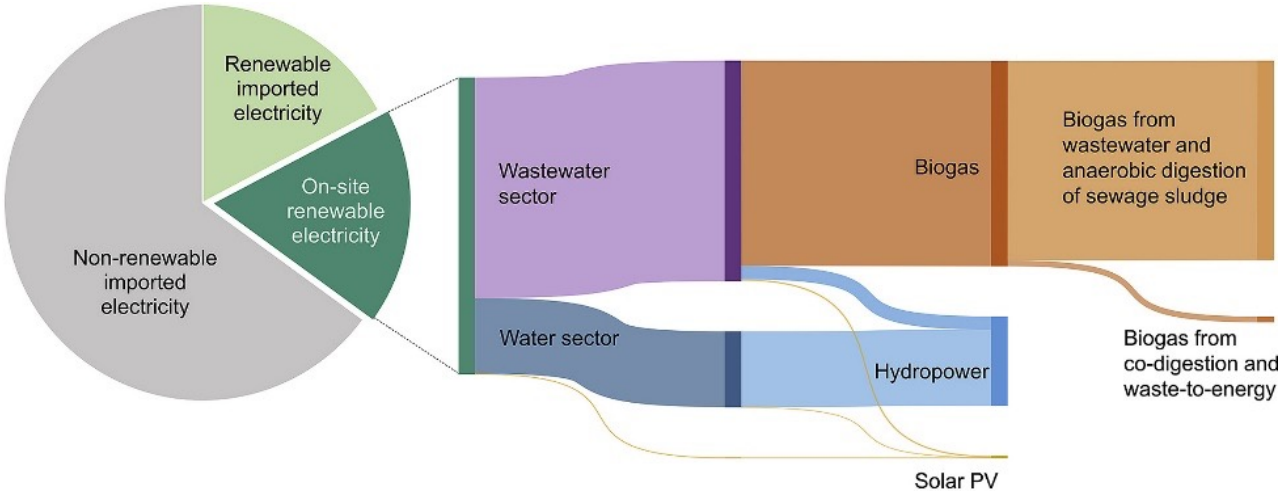
To reduce emissions and progress towards Net Zero emissions targets, water utilities generally identify initiatives following the emissions management hierarchy (Figure 7).

FIGURE 7 Emissions management hierarchy



In 2018, the Australian water industry generated 18% (279 GWh/y) of its electricity demand from onsite renewable sources, the majority (67%) being from biogas (Figure 8).

FIGURE 8 Australian water utilities energy mix 2018



SOURCE Strazzabosco et al 2020

Using biogas as an energy source has an additional benefit in that it reduces fugitive methane emissions as well as reducing the use of imported grid electricity (Kenway et. al. 2008).

There are times when emissions from the water industry can increase, and some of this is outside the industry's control.

Reasons why water utility emissions can increase include:

- Population growth
- Water security measures
- Desludging activities
- Meeting more stringent regulatory conditions, for example EPA license requirements
- Increasing volumes of trade waste from industrial customers that requires more treatment.

Water security measures are driving investment in new sources of water supply such as desalination, recycled water and rainwater tanks, which have greater energy intensity than traditional sources.

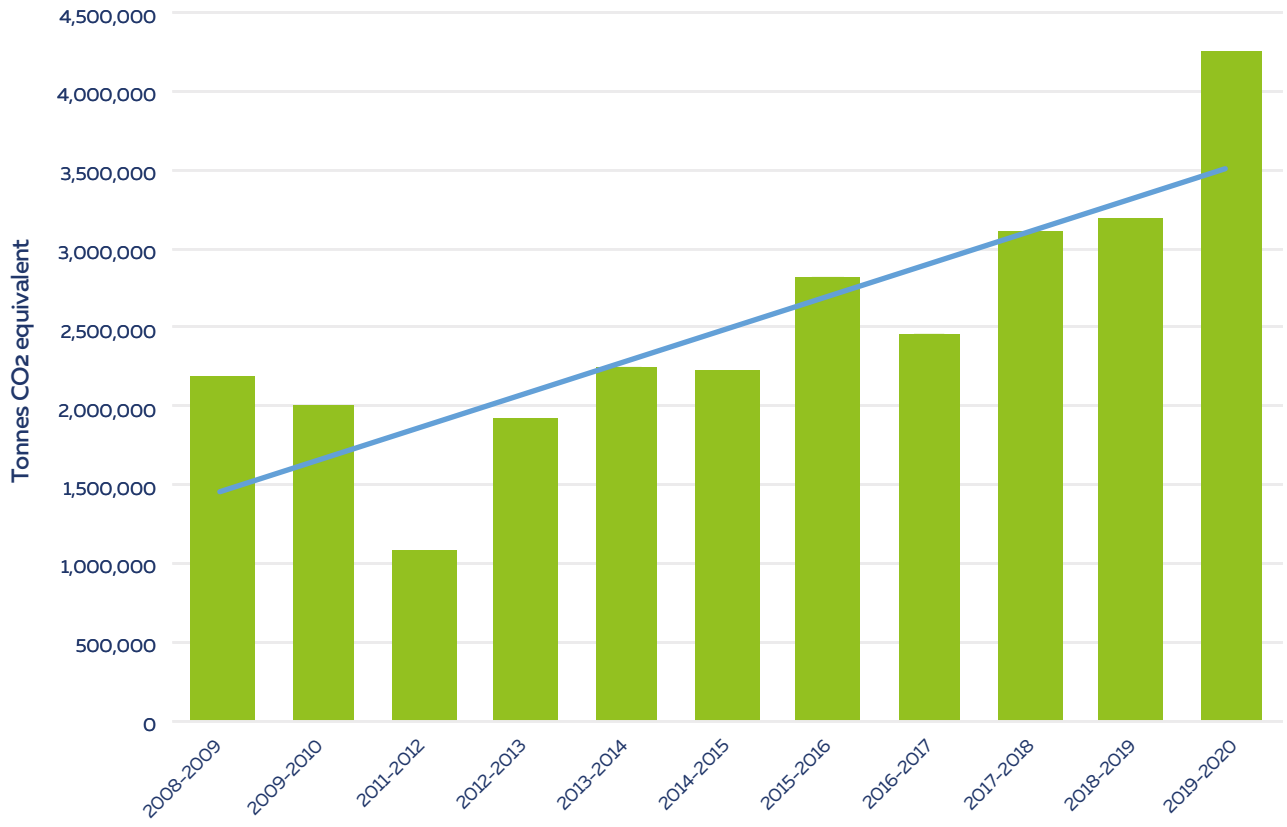
Comparing water utilities' emissions profiles is difficult, given the large variability in water sources, geographic locations and topography (which influences the need for pumping), and is also influenced by local emissions reduction policies, regulations and legislation.

However, overall sector emissions are increasing; despite much work in the industry to reduce our emissions, as well as legislated targets in some jurisdictions (Figure 9).

In the future, drought and the ongoing need for diversification of supply (being driven by water security objectives) are likely to increase energy use, which will increase our emissions unless that energy is drawn from renewable sources.

Other factors increasing emissions include rainfall infiltration to sewer systems, which results in extra emissions from pumping and treatment.

FIGURE 9 Trend in total net greenhouse gas emissions, from 85 Australian water utilities

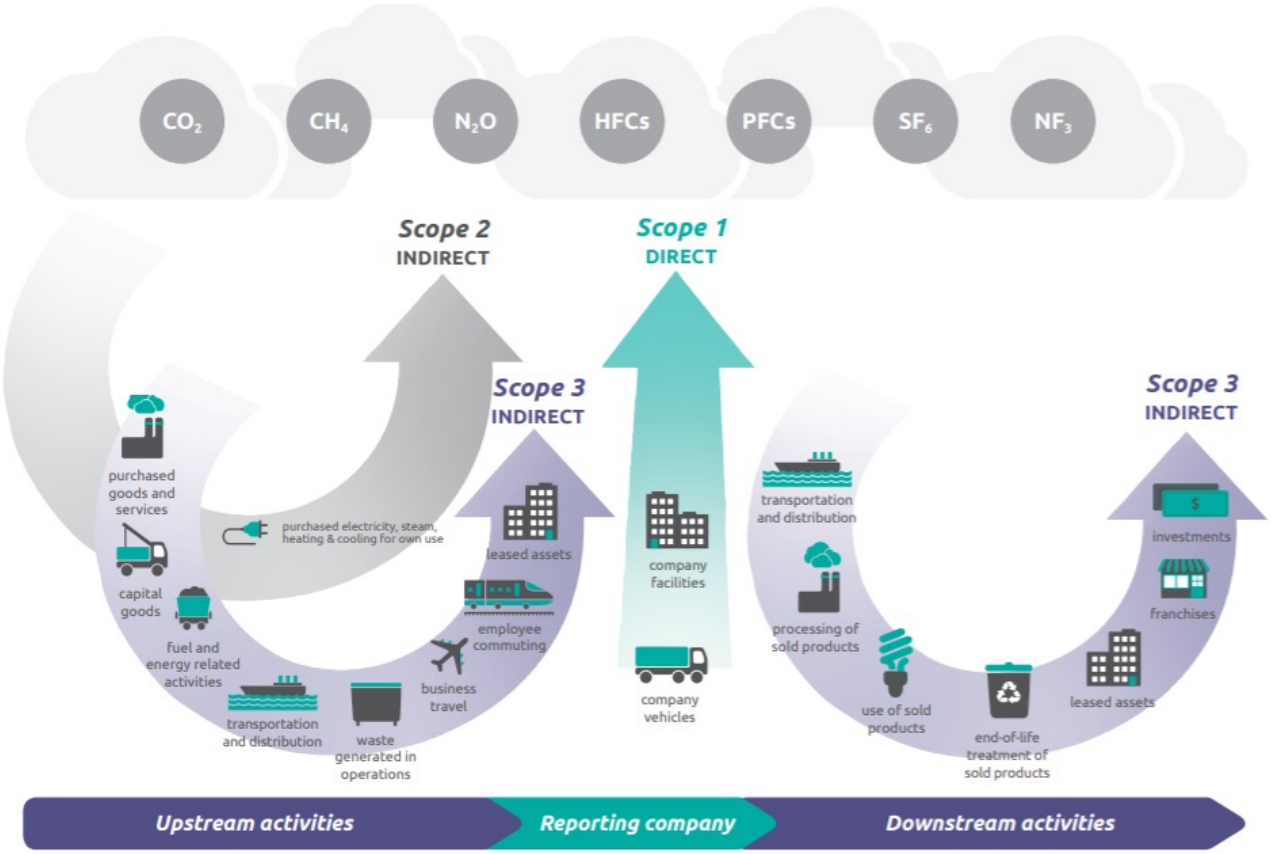


SOURCE BOM (2020)

How we are reducing emissions

Carbon emissions are generally categorised in terms of 'scopes' (Figure 10).

FIGURE 10 Scope 1, 2 and 3 emissions explained



SOURCE https://www.ghgprotocol.org/sites/default/files/ghgp/standards/Scope3_Calculation_Guidance_0.pdf

Scope 1 emissions

These are the most difficult emissions to reduce for the water industry. They include fugitive or process emissions that are created as a result of aerobic digestion of wastewater during wastewater transportation and treatment, as well as methane emissions from dams[1]. They generally comprise a large proportion of water utilities' Scope 1 emissions profiles.

Fugitive emissions include:	
Carbon dioxide CO_2	
Methane CH_4	Approximately 25 times more potent GHG than CO_2
Nitrous oxide N_2O	Approximately 250–300 times more potent GHG than CO_2

Accurately quantifying these emissions is a major challenge – NGERs currently uses a method that estimates both methane and nitrous oxide from wastewater treatment. Methane emissions from dams are not currently included in NGERs.

It is unclear how accurate these estimates are, and accurate quantification is an important first step to developing ways to mitigate fugitive emissions. A key piece of work for the industry may be to develop a direct measurement method for fugitive emissions under NGERs.

There are competing interests and trade-offs to be considered in reducing Scope 1 emissions, for example in wastewater treatment with lagoon-based systems having lower energy intensity but taking up more land than chemical-based treatment.

Improving the efficiency of the wastewater treatment process is one of the first ways to reduce fugitive emissions.

Gasification is another method of reducing fugitive emissions, which converts methane into carbon dioxide – a less harmful GHG, and produces energy at the same time. Logan City Council's ambitious Carbon Neutral by 2022 program includes a gasification plant to reduce their fugitive emissions (see Case Study 3).

Progress is also being made with new wastewater treatment technologies such as:

- Membrane Aerated Biofilm Reactor technology – utilises gas permeable membranes to provide oxygen for wastewater treatment, significantly reducing energy inputs
- Optimisation of existing wastewater treatment processes, for example:
  - Process covers, emission capture and treatment
  - Real-time control system for process optimisation to minimise emissions
  - Alternative process configurations
  - Side-stream nutrient removal that results in emissions reduction
  - Gasification of methane into carbon dioxide (less harmful GHG)
- Emerging technologies such as:
  - Decoupling nitrogen removal from aerobic processes
  - Algae processes
  - Decentralised treatment
  - Other anaerobic processes
- Purchasing offsets can reduce the remainder of hard-to-abate emissions.

Inspiring innovation to reduce fugitive emissions

The majority of Melbourne Water's Scope 1 emissions are generated through wastewater treatment – fugitive emissions – and are approximately half of their total emissions profile. Finding ways to reduce these direct emissions is a priority for the utility, and an area of science where real innovation is required to help find solutions. In 2018, as part of their Net Zero Emissions by 2030 pledge, Melbourne Water ran a competition to uncover innovative ideas to reduce their Scope 1 emissions.

After a highly competitive process involving Australian and international entrants, Melbourne Water selected the submission by Cranfield University/AECOM/RMIT as the winner. The submission proposed an alternative treatment methodology based on non-biological processes and anaerobic treatment, which has the potential to reduce the production of fugitive emissions from wastewater treatment by up to 90%.

Competition funding will be used to test aspects of the proposal at laboratory scale at RMIT in Melbourne, working closely with Cranfield University (UK) and other global entities which are considering aspects of this new technology.

1 Australian water utilities are not required to report these under NGERs as at time of publishing.

Scope 2 emissions

Water utilities have generally tackled these emissions first, and can be reduced in a number of ways:

- Energy efficiency measures (detailed in the next section)
- Energy conservation measures
- Wholesale power purchase agreements from renewable energy sources
- Self-generated ('behind the meter') renewable energy, for example solar PV on utility assets and biogas cogeneration
- Battery storage
- Demand management/operational flexibility/ load shifting.

Generally, the energy used in pumping is much greater than that used for water and wastewater treatment, however that changes when desalination plants are being used, which are more energy intensive due to pumping under pressure through reverse osmosis membranes (see Diversifying our water supplies).

Scope 3 emissions

These emissions are hard to define, measure, and as a result, reduce. They are not currently required to be reported by water utilities under NGERs, however many water utilities do calculate them. They include emissions from both suppliers (upstream) and consumers (downstream), and for some water utilities they can be most of their emissions profile. Methods to reduce these emissions include:

- Working with suppliers to reduce their emissions
- Choosing suppliers that have emissions reduction targets and are making progress towards them
- Using low emissions vehicles or electric vehicles for business travel, and reducing unnecessary air travel (or offsetting air travel).

What's leading practice?

Water utilities signing joint Power Purchasing Agreements (PPAs) can make reducing emissions more cost-effective – a great example of this is in Victoria with the Zero Emissions Water project (see Case Study 2).

Wannon Water Carbon Neutrality Action Plan

As part of their Carbon Neutrality Action Plan, Wannon Water in southwest Victoria has achieved net-zero-plus emissions for the town of Portland, from locally generated renewable power (wind turbines) at its water and sewage treatment facilities. This assists Wannon Water to meet their Net Zero Emissions by 2050 target, and provides future savings for customers with the $4.2 million capital cost paid back within 10 years through reduced power bills (Wannon Water 2020).

Developing an Energy Management Strategy, and benchmarking energy management systems with other water utilities can also assist in reducing emissions with a more holistic approach.

Water utilities can assist customers to reduce their own emissions through smarter and better ways of managing water once it is 'behind the meter'. This includes through better water heating choices, and using water outdoors to cool houses and reduce energy use from air-conditioning.

Water heating is the largest single source of greenhouse emissions from the average Australian home and accounts for about a quarter of household energy use (Clean Energy Council, 2021).

In the US, emissions from hot water heating have been estimated at 3.8 per cent of the nation's annual emissions, which is greater than the entire emissions of their water industry including water and wastewater treatment and transportation (Hong and Howarth 2016). This study estimated that transitioning to modern high efficiency heat pump hot water systems could reduce emissions from hot water heating from 3.8 per cent to less than 1 per cent of national emissions.

CASE STUDY 2 BARWON WATER, CENTRAL HIGHLANDS WATER, GREATER WESTERN WATER, COLIBAN WATER, EAST GIPPSLAND WATER, LOWER MURRAY WATER, SOUTH EAST WATER, SOUTH GIPPSLAND WATER, SOUTHERN RURAL WATER, WANNON WATER, WESTERNPORT WATER, YARRA VALLEY WATER

Zero Emissions Water

Zero Emissions Water (ZEW) Ltd started as a joint project between 13 water utilities in Victoria (now consolidated to 12), to purchase renewable energy from the Kiamal Solar Farm, Victoria's largest solar farm located in Ouyen in the north west of the state.

This novel partnership between so many water utilities results in cheaper renewable power than if purchased individually. Participating water utilities benefit through lower emissions, while the contract also provides a hedge against rising grid-sourced energy costs. The outcome benefits the environment and creates savings for customers, helping to maintain steady water bills.

This unique arrangement is the first of its kind in Australia, and a major step forward for the participating utilities reaching Net Zero Emissions.

CLIMATE THEMES ADDRESSED

CASE STUDY 3 LOGAN CITY COUNCIL

Carbon neutral Logan

In 2017, Logan City Council committed to a Carbon Reduction Strategy and action plan with an objective to be carbon neutral by 2022. Projects that Logan Water have implemented to align with the strategy to reduce carbon emissions include the Cedar Grove Environmental Centre and the Loganholme WWTP Biosolids Gasification Facility.

CLIMATE THEMES ADDRESSED

CASE STUDY 4 WATERCARE, NZ

1MW floating solar array, Rosedale Wastewater Treatment Plant

The 1MW floating solar array at the Rosedale WWTP will help Watercare achieve its operational emissions reduction targets and realise operational cost savings. The floating array creates value from an otherwise marginal land asset (the pond), and provides a testbed for future deployments on other reservoirs and dams. The array is a real, visible example of an exciting green energy solution in the heart of Auckland. The Rosedale Wastewater Treatment Plant (WWTP) is Watercare's second largest wastewater treatment facility and among the largest in New Zealand. The plant serves a population of approximately 220,000.

FIGURE 11 Drone picture of floating solar array

SOURCE Vector Powersmart

CLIMATE THEMES ADDRESSED

NET ZERO EMISSIONS

SOLAR PV ON ASSETS

RENEWABLE ENERGY

WHOLE OF BUSINESS CLIMATE CHANGE STRATEGY

LAND USE

RESILIENCE

Energy efficiency

Energy efficiency is one of the earliest steps for water utilities in reducing both their input costs, and their Scope 2 emissions. For the majority of water utilities, investment in energy efficiency will generate the highest return on investment, as reducing energy use generally saves money.

Water services is an energy intensive industry, and energy use in the urban water cycle as a whole is driven in three important ways (Kenway et al. 2008):

- When pumping needs are greater than normal, for example during drought, electricity use and associated carbon emissions increases (around 10% of total energy use)
- Customer heating of water (around 80% of total energy use)
- Impact of managing alternative, higher energy-intensive water supply sources such as desalination and recycled water.

Improving energy efficiency leads to lower energy costs and reduced vulnerability to future price increases. The resulting operating cost reductions help water utilities improve cost recovery and lead to better operational performance.

How we are improving energy efficiency

Water utilities are implementing energy efficiency measures in a range of ways, including:

- Retrofits to pumps and pump upgrades to improve energy efficiency
- Process and network optimisation (including pump flow rates, operational flexibility in pumping and storage).

What's leading practice?

Energy efficiency should be considered holistically over the lifecycle of an asset. For example, gravity sewerage options will have less pumping but may cost substantially more and perhaps use more energy in construction.

The important point is that there are trade-offs to be considered in the benefits of emissions reduction, safety, waste and the environment.

Circular economy and resource recovery

All water on Earth is used and reused endlessly. Water utilities have tapped into this process to mimic nature's processes and reduce our environmental impact, as well as recover valuable resources. This saves costs and reduces emissions.

The urban water industry commits to implementing circular economy principles in our management of water, waste and energy

Resource recovery is an important way for water utilities to reduce Scope 1 emissions. A good example is in the production of biogas and hydrogen from the wastewater treatment process. This reduces or offsets emissions from imported energy to run those processes. Hydrogen production can also produce the oxygen needed for the wastewater treatment process, reducing emissions in the production and transport of oxygen in the supply chain (a Scope 3 emissions reduction for water utilities).

Reducing water industry Scope 3 emissions also supports the circular economy and emissions reductions in other sectors, such as extractive industries and households.

The transformation to a circular economy approach brings many challenges and the shift requires a multi-pronged and widespread cross-sector collaborative approach.

It is currently difficult to make business cases for resource recovery in some areas, and scale is important – for example, the more wastewater produced, the greater the biogas or other resources that can be recovered, and the more likely the project will have a positive business case.

How we are reducing emissions through resource recovery

Reusing resources such as nitrogen, phosphorus, hydrogen, graphite, cellulose, heat, plastic, organic waste and biosolids are some of the ways water utilities are transitioning towards a circular economy (Jazbec, Mukheibir and Turner 2020) while also reducing carbon emissions.

Areas that water utilities are making progress in resource recovery include:

- Soil and spoil reuse
- Biosolids as fertiliser
- Recovered glass sand as pipe embedment material
- Biochar as soil conditioner
- Biomethane injection into the gas network from wastewater treatment
- Hydrogen production from electrolysing recycled water (producing hydrogen and oxygen), and from the Hazer process (cracking methane into hydrogen and graphite).

What's leading practice?

Emerging contaminants such as micro-plastics and PFAS are potential impediments to effluent and biosolids reuse. Gasification is one way to remove these sorts of contaminants from biosolids, and produces biochar, a useful soil remediation additive and carbon sequestration method (see Case Study 3).

Hydrogen projects are showing much promise, especially when the production is powered by renewable energy or the associated energy emissions are offset – this is known as 'Green Hydrogen' (Figure 12).

Hydrogen exists in the product that the urban water industry is built around. The broad utilisation of hydrogen can play a critical role in helping to create a decarbonised, sustainable future.

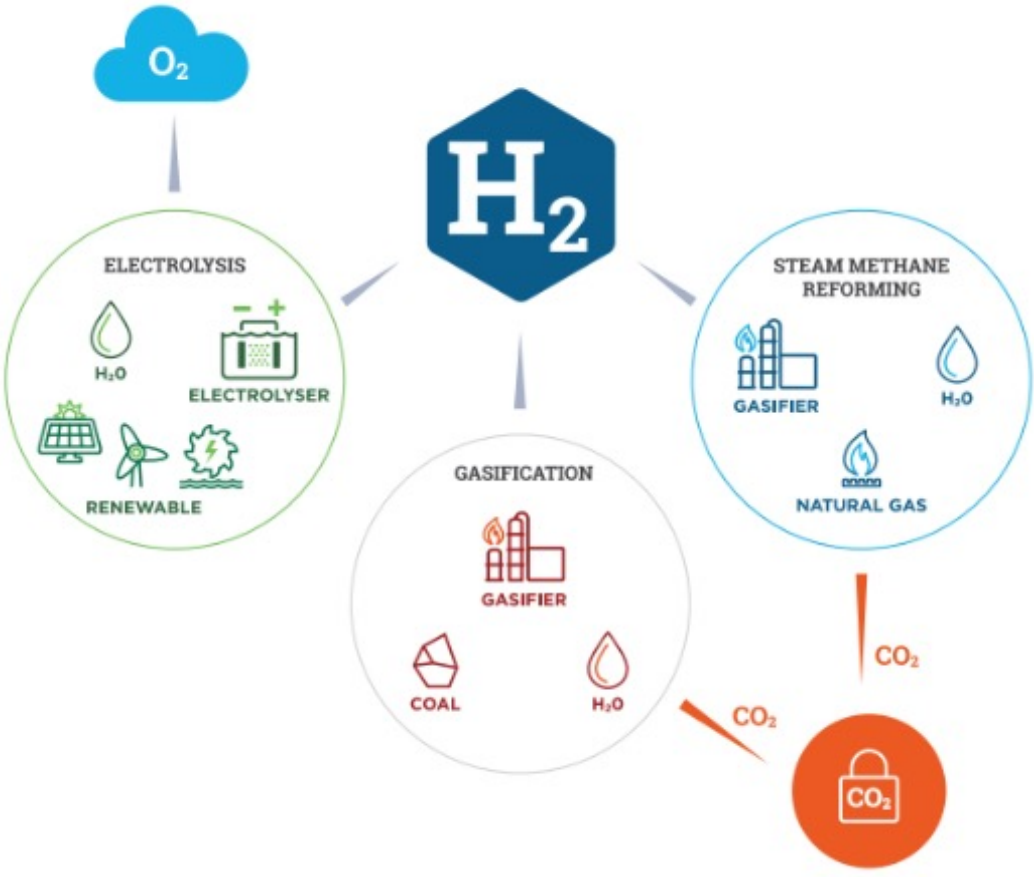
The Australian Renewable Energy Agency (ARENA) believes that with the right conditions, hydrogen exports could be worth $1.7 billion annually and generate 2800 jobs in Australia by 2030.

The value proposition for hydrogen projects is profoundly circular, where all by-products of the process are marketable commodities. For electrolytic production of hydrogen, the oxygen produced can be reused in the wastewater treatment process, saving costs and energy, and excess oxygen can be sold on the market. For pyrolosis and gasification production of hydrogen, the carbon black that is produced can be sold as graphite.

Co-locating hydrogen plants with wastewater treatment plants, and downstream users of hydrogen such as logistics facilities can also deliver net capital and operating cost savings, supporting the business case (see Case Study 6).

WSAA's 2021 report Water: Fueling the path to a hydrogen future: the role of the urban water industry in Australia and New Zealand's renewable energy future, is a detailed look at how the water industry can participate in the emerging hydrogen economy.

FIGURE 12 Three different ways of producing hydrogen



SOURCE COAG Energy Council (2019)

CASE STUDY 5 BARWON WATER

Renewable Organics Network

Barwon Water's Australian-first Renewable Organics Network (RON) is a cogeneration facility supplying renewable electricity to Barwon Water's Colac Water Reclamation Plant, and renewable hot water to several industrial customers in Colac. The RON initiatives provide renewable energy, reduced waste and carbon emissions. It demonstrates how strong and dynamic strategic partnerships with businesses, councils and agencies can play a critical role in the success of circular economy projects, by leveraging the strengths and value of all partners to contribute to regional prosperity.

CLIMATE THEMES ADDRESSED

NET ZERO EMISSIONS

RENEWABLE ENERGY

RESOURCE RECOVERY/ REUSE

CROSS-SECTORAL PARTNERSHIPS

CASE STUDY 6 YARRA VALLEY WATER WATER CORPORATION

Hydrogen opportunities for water utilities

Globally, hydrogen is undergoing a renaissance as the world seeks to decarbonise. Water utilities can play a potentially large role in decarbonising the economy through both biogas, which is produced in wastewater treatment, and hydrogen, which can be both an energy source and a fuel. Water utilities are in a unique position of competitive advantage with regard to the requirements of production, including having access to water, land away from population centres but close to markets, and renewable energy. Two Australian examples of water utility hydrogen projects are Yarra Valley Water in Melbourne, and Water Corporation in Western Australia, which have used their particular circumstances to participate in the hydrogen value chain in different ways.

CLIMATE THEMES ADDRESSED

NET ZERO EMISSIONS

ENERGY MANAGEMENT

FUGITIVE EMISSIONS

ENERGY EFFICIENCY

EMERGING TECHNOLOGY

RENEWABLE ENERGY

RESOURCE RECOVERY/ REUSE

Carbon offsets and sequestration

Purchasing or self-generating carbon offsets can assist to reduce hard-to-abate emissions in the water industry, such as fugitive emissions. This is best considered as part of a comprehensive emissions reduction strategy, and it is important to be aware of the reputational risks inherent in different offset products on the market.

Carbon can be sequestered in the environment using a variety of land use strategies that often come with additional benefits, which also improves catchment health and resilience to both the chronic and acute effects of climate change.

By purchasing offset credits (one credit for every tonne of emissions), water utilities can 'cancel out' their emissions to meet emissions reduction targets and ultimately to claim carbon neutrality/Net Zero emissions.

There are risks for water utilities considering using carbon offsets, such as reputational risks from offsets that don't meet the Climate Active Carbon Neutral Standard. There are a large range of offset products available, with various benefits, modelling and assumptions that sit behind them. Aligning to this standard provides consistency and confidence to regulators, customers and shareholders that the carbon offsets being purchased and/or self-generated are genuine and of the highest integrity.

In line with the Emissions Management Hierarchy (Figure 7), carbon offsets should ideally only be used for hard-to-abate emissions, as opposed to offsetting an organisation's entire emissions profile as the first step.

Afforestation, reforestation and the integration of trees into other land uses (such as urban environments) can reduce atmospheric carbon dioxide levels by sequestering carbon in tree biomass. Additionally, younger trees sequester more carbon than mature trees. When delivered by the water utility these projects can be termed 'self-generated' carbon offsets.

Carbon sequestration projects bring many additional public benefits, including to climate change adaptation for both the water utility and the broader community, that may appeal to investors and stakeholders and assist in generating a positive business case. For example, reforestation can prevent erosion in dry and flood-prone areas, reduce urban water treatment requirements (itself reducing emissions), remediate brownfield sites and filter urban air pollution. These benefits can attract co-investment from local government, sustainability bonds holders, property developers and insurance companies.

How we are reducing emissions through carbon offsets and carbon sequestration

The way water utilities across Australia and New Zealand approach carbon offsets depends on the jurisdiction they are in, and their associated regulations.

In Victoria, the reputational risk for the water industry around the range of carbon offset products available on the market is managed through regulation by the Victorian Government.

Under Ministerial direction, all water utilities in Victoria except Melbourne Water, are restricted to using self-generated carbon offsets only. That is, they can only claim carbon offsets against their emissions profiles from projects they have completed themselves (as opposed to buying them on the open market). Melbourne Water is allowed to purchase offsets, as their emissions profile is much larger than all other water utilities in the state.

Some water utilities purchase offsets to ensure particular assets are Net Zero – for example SA Water does this for the Adelaide Desalination Plant.

Currently there is no national dataset for the amount and type of offsets purchased by water utilities, and they are not required to be reported on under NGERs, however some information is available in individual annual reports.

Carbon offset credits can also be generated for carbon sequestration projects, and other urban greening or liveability projects that involve tree planting, however the administration costs in calculating them are often prohibitive.

The primary strategies being explored by the water industry in the land use space include:

- Afforestation, reforestation and urban tree planting
- Soil carbon sequestration
- Blue carbon sequestration - refers to stored carbon in coastal ecosystems like mangroves, seagrass and salt marshes

While many water utilities sequester carbon by using their own land to grow plantation timber, some water utilities (such as Urban Utilities in South East Queensland) are going further by investigating opportunities to improve biodiversity and ecosystem services with local and diverse tree species selection.

FIGURE 13 Helidon irrigated agroforestry project, Lockyer Valley, South East Queensland

SOURCE Urban Utilities

What's leading practice?

In 2020, VicWater produced a Decision Making Framework for Carbon Offsets, to assist the Victorian water industry in developing their approach to carbon offsetting (VicWater, 2020). These principles can be broadly applied in other jurisdictions to guide water utilities in their use of offsets.

The University of Oxford in the UK has produced guidance for Net Zero-aligned carbon offsetting, with five principles that echo both the VicWater work and the Emissions Management Hierarchy (Figure 7):

- Cut emissions first, use high quality offsets, and regularly revise offsetting strategies as best practice evolves
- Shift to carbon removal offsetting (as opposed to carbon reduction which just moves carbon from one place to another)
- Shift to long lived storage
- Support the development of net-zero aligned offsetting.

Blue carbon is an emerging area of interest for the water industry. While trees are able to draw down carbon dioxide from the atmosphere and store it for the duration of their lives, blue carbon ecosystems can sequester carbon up to 40 times faster, and can potentially lock away carbon for 1,000 years or more (Moritsch et. al., 2021). Progress is increasing on measuring and advocating for blue carbon, with the Clean Energy Regulator developing a method to account for it. At the time of writing, at least three Australian states (QLD, WA, SA) are at varying levels of development of strategies and funding programs are supporting it.

Like planting trees, restoring coastal ecosystems has other benefits like boosting fish stocks and buffering coastlines from storm surges and sea-level rise. These climate adaptation measures are beneficial to both water utilities and local communities.

Clearer guidance for water utilities from both shareholders and regulators on the use of offsets, and a national reporting framework will assist in a more consistent approach to their use in the urban water industry.

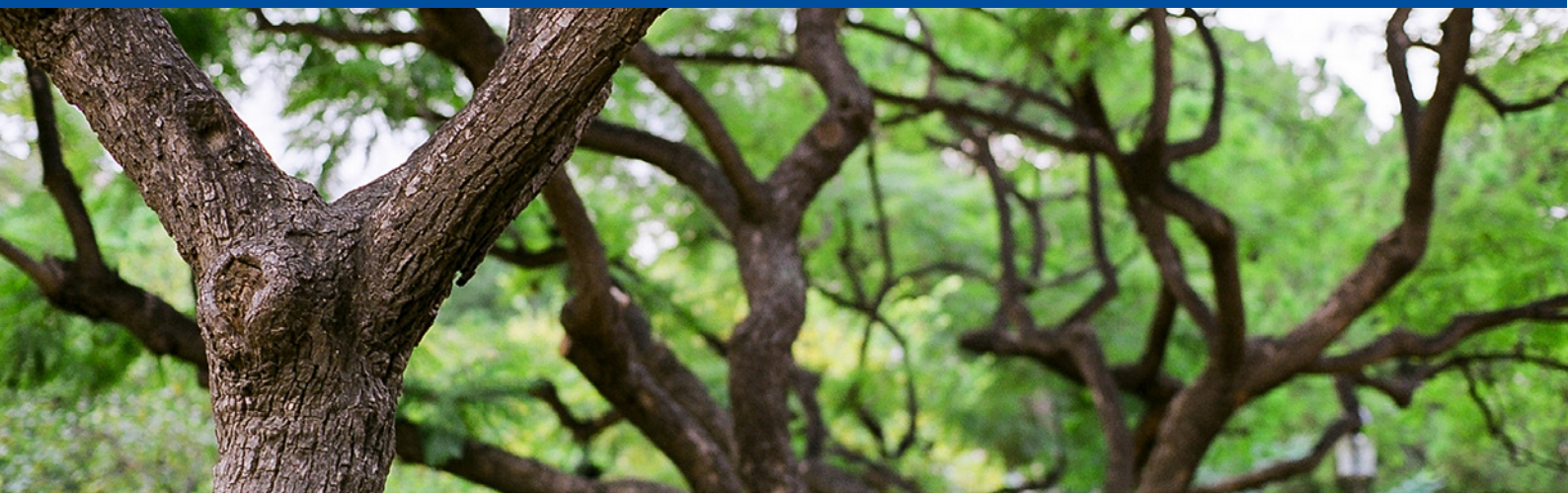
Urban Utilities Helidon irrigated agroforestry project

Urban Utilities' Helidon Sewage Treatment Plant in the Lockyer Valley west of Brisbane releases approximately 40 tonnes CO_2e to the atmosphere each year, and has a zero discharge licence to the local waterway. In 2017, Urban Utilities purchased an adjacent farm, and planted a 4 hectare forest on cleared farm land adjacent to a creek and 100 hectares of protected forest. Once fully established, the new forest will be QLD compliant (Bluegum floodplain forest, currently endangered with > 85% cleared) - a mix of three local native tree species and native grasses. While this project was primarily planned to cost effectively recycle >90% of treated effluent from the treatment plant, the trees also sequester carbon at around 28 tonnes CO_2e per year (initial 25 years). This effectively offsets 70% of the treatment plant's GHG emissions, whilst improving local ecosystem services such as biodiversity, koala habitat and microclimate. The irrigated grassed inter-rows will be harvested during years 3 to 20 of the project to remove sequestered nutrients and sold to generate revenue, which offsets operational costs.

FIGURE 14 Helidon project

SOURCE Urban Utilities

Adapting and improving our resilience



Climate adaptation and adaptive planning

The water industry recognises that climate change presents current and future risks to our infrastructure and service delivery, as well as our customers and staff, our communities and the environment.

Conventional approaches to managing these risks are becoming less reliable as our climate changes, and our efforts are made more difficult with competing priorities and trade-offs. An adaptive approach is needed to develop effective responses under this deep uncertainty.

Well planned and strategic climate adaptation, and adaptive planning approaches embedded across all business areas, including asset management in particular, can help to approach this dilemma in a systematic, cost-effective and holistic way.

One of the basic tenets of asset management is using past performance as an indication of future performance – but climate change is affecting the ability for that to remain the case.

> For water utilities, a big question is how to redesign our assets, both existing and planned, for the future climate rather than the climate of today.

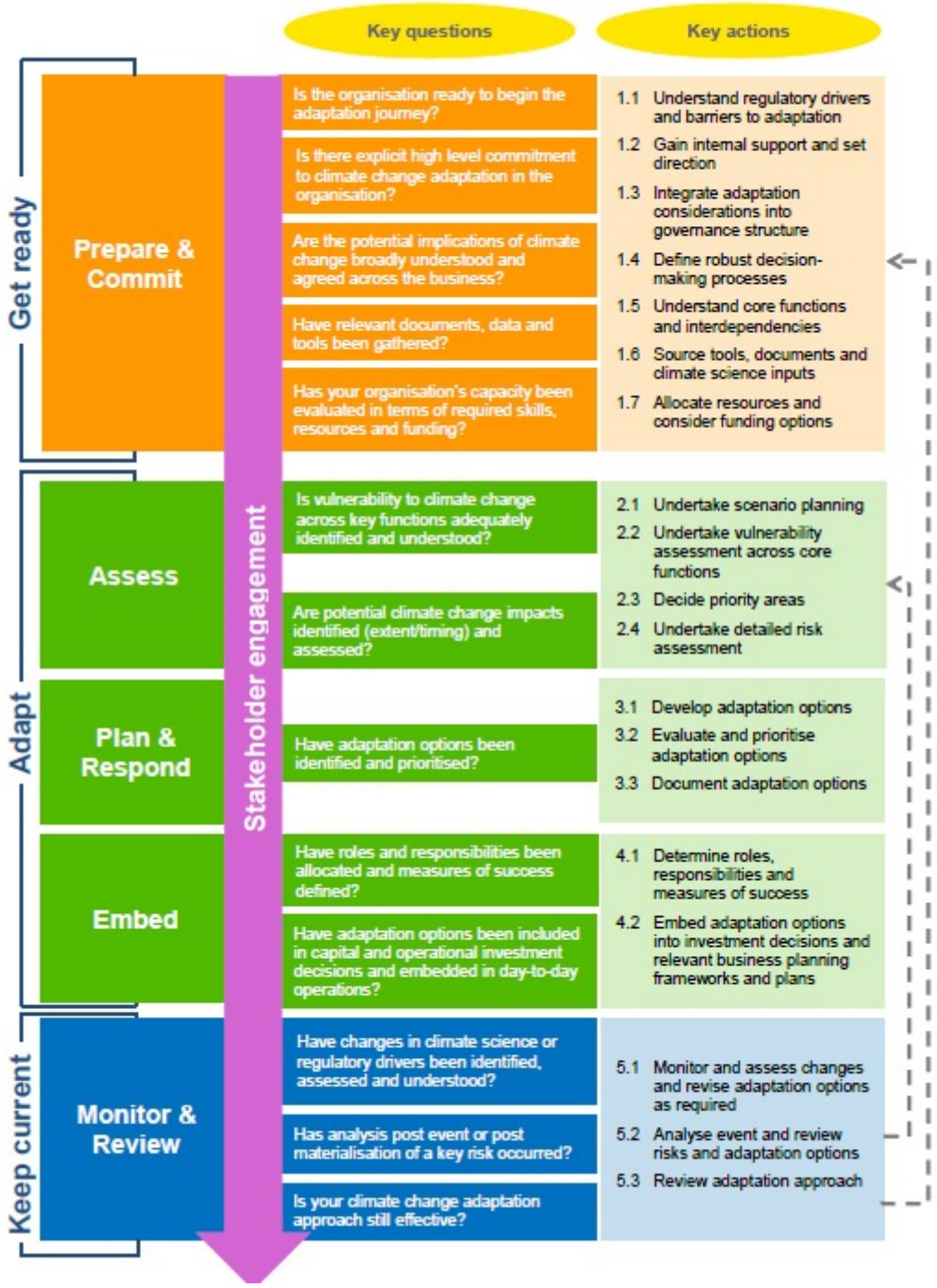
Water utilities face a challenge to adapt to climate change as part of ongoing management of existing infrastructure, and develop improved decision making for new infrastructure. Trade-offs must be considered between developing smarter adaptation measures during the planning and construction stages, or adapting progressively during refurbishment and renewal of infrastructure. Understanding the likelihoods of possible impacts is important to achieve the best economic value adaptation to performance and servicing standards.

WSAA's Climate Change Adaptation Guidelines (WSAA, 2016) provide a framework for approaching climate adaptation planning (Figure 15).

Challenges that water utilities face when undertaking this include:

- Addressing barriers to adaptation:
  - The nature of climate change as a 'wicked' problem – cross cutting and with no easy solutions
  - The tendency to deprioritise adaptation actions because of their long timeframes
  - Impediments to working together such as siloed working practices and poor communication
  - Budgetary, capacity and resourcing constraints
- Executive and Board support and resourcing for change across the business
- Support from all business areas of the organisation
- Strong governance so that commitment and momentum are not lost
- Stakeholder engagement (internal and external) at all stages of climate adaptation
- Difficulties in keeping up with current science in static planning documents – supports an adaptive and dynamic approach
- Decision making processes need to be able to respond to the inherent uncertainty.

FIGURE 15 Climate change adaptation decision making framework



SOURCE WSAA, 2016

Adaptive planning is a key method for water utilities to use to understand and make decisions under deep uncertainty, assisting their climate change adaptation programs. It is best described as a 'no regrets' mindset, that builds in the value of optionality to develop multiple adaptive pathways, reducing path dependency on a deterministic and linear investment pathway.

The water industry's long-term plans can benefit from adaptive processes to better understand and plan for uncertainty. This approach supports water utilities to ensure prudent and efficient investment, and continued, sustainable growth, despite large uncertainties. When triggers or signposts are met, investment pathways can be changed, to ensure the best value for the community is maintained at the lowest overall cost.

Climate change-related triggers and signposts include:

- Water availability (for example dam levels)
- Change in demand as a result of climate change
- Shareholder expectations of water security
- Extreme events eg. bushfires and storms.

Water utilities differ significantly in their knowledge of, approach to, and use of adaptive planning.

How we are planning for climate adaptation

Climate adaptation can occur during long term strategic planning as well as asset planning, design and ongoing management. Water utilities are working in a number of ways to mitigate these risks, and adapt their frameworks to account for the impacts of climate change. The aim is to develop more informed decision making with real time understanding of changes, which assists quicker adaptation.

Many water utilities are developing Climate Change Adaptation Plans (CCAPs), and each will account for their unique geographic, environmental, economic and social circumstances.

Common objectives of CCAPs for water utilities include:

- Reducing vulnerability to the direct and indirect consequences of climate change
- Building resilience to climate change impacts and extreme weather events
- Innovating to take advantage of new and emerging opportunities presented by changes in climate
- Continuously grow capacity and capability for adaptation
- Supporting the implementation of relevant shareholder, state and federal policy.

Adaptive planning approaches are being used by water utilities for different business needs, including:

- Long term strategic planning
- Strategic asset management planning (see section on Asset Adaptation)
- Individual projects.

A range of techniques are being tested and applied including:

- Megatrend analysis
- Scenario planning
- Environmental scanning
- Stress testing
- Cynefin model
- Dynamic Adaptive Policy Pathways (DAPP).

What's leading practice?

Climate adaptation is a process of building understanding and capacity to transition towards resilient and adaptive organisations.

Leading practice here is underpinned by strong foundations and a good understanding of the problems, risks, and effective decision making about portfolio-wide adaptation measures.

Strong foundations are built upon human resources that are climate-literate (see Climate literacy and climate-ready skills), funded and enabled to develop measures that cut across the whole business.

This could include:

- Embedding climate adaptation needs into asset management strategies and plans
- Using consistent risk assessment frameworks, methodologies and climate scenarios
- Establishing a new base case for asset design, not based on current climate, but on an appropriate downscaled climate scenario
- Considering network supply system changes and interdependencies
- Considering communication needs and working to build internal capacity
- Gaining senior management buy-in
- Knowledge-brokering across organisations and with stakeholders, shareholders and customers, particularly around levels of service and trade-offs.

The water industry is currently in a period of trialling various adaptive planning techniques, tools and approaches for different business needs. A key gap that is emerging is an understanding of adaptive planning across a full strategy, project or asset lifecycle, from idea to implementation. Challenges include ensuring Boards are comfortable with pursing an investment option that costs more now, but saves money in several years time as the adaptive planning trigger is met.

Some states have policy and legislative requirements that support the use of adaptive planning in climate adaptation, which in turn has driven water utilities to explore adaptive planning further.

CASE STUDY 7 ICON WATER NORTH EAST WATER HUNTER WATER

Water sector climate adaptation planning

Given water utilities are so heavily reliant on weather and the water cycle, resilience to climate change and variability is critical to ensure essential services to communities can continue to be met under these increasingly changing conditions.

Many utilities are developing climate adaptation plans, in response to business risk as a result of climate change, as well as regulatory drivers. Importantly, some also recognise that a whole of organisational approach is needed to achieve the actions.

This case study showcases three utilities' approaches in this space, and demonstrates both climate adaptation planning as well as adaptive planning approaches.

CLIMATE THEMES ADDRESSED

- NET ZERO EMISSIONS
- CUSTOMERS + COMMUNITY
- ADAPTIVE PLANNING
- CLIMATE ADAPTATION PLANS
- CLIMATE RISK ASSESSMENT
- EXTREME EVENT PREPAREDNESS
- WHOLE OF BUSINESS CLIMATE CHANGE STRATEGY
- INVESTMENT IN CLIMATE RESILIENT WATER SUPPLIES
- SUPPLY CHAIN RISKS
- WORKFORCE RISKS
- WORKFORCE ADAPTATION
- CLIMATE CHANGE PROJECTIONS IN DECISION MAKING
- RESILIENCE

Climate risk assessments

Water utilities are adept at assessing risk to their assets and services. A climate risk assessment adds climate scenarios to existing asset management and decision-making frameworks, to identify and assess the chronic and acute risks posed by climate change to utility assets and services.

A changing climate means our corporate risk registers may not be capturing the full extent of current risks. Water utilities already manage risk, but sometimes the modelling constraints do not allow for adequate integration of complex risks with multiple time horizons such as climate change. Climate risk assessments set out a process to assist water utilities as they plan for this uncertainty, and prioritise actions for decision making, adaptation planning and budgeting.

When considered over long time horizons and regularly conducted to ensure up to date science and climate scenarios, they can increase our resilience to current and future impacts of climate change.

This should be iterative – identifying impacts and challenges, assessing risks from these impacts, selecting and implementing adaptation options and then revisiting assessments when new information is available, or when additional capacity to implement options is in place.

A regular review cycle will ensure the latest science is captured, and risks are incorporated into corporate risk registers and the utility's strategic planning.

Climate risks can be classified into three categories, and can be both chronic and acute:

1 Physical risks	Impacts on the built environment (gradual onset and extreme)
2 Transition risks	Impacts driven by policy, technology and social responses to the physical risks
3 Liability risks	Impacts driven by the failure to mitigate or adapt.

Water utilities consider these risks when:

- Creating short and long term plans for the organisation or business unit
- Applying risk management procedures to planned activities and functions
- Making longer term investment decisions, for example in assets, and staff skills needed to adapt to future climate.

The benefits of regularly conducting climate risk assessments include:

- Normalising climate change adaptation across the whole business
- Reducing Boards' exposure under the Taskforce on Climate-related Financial Disclosures (TCFD) framework
- Potentially stabilising/reducing insurance premiums or at least risks of claims.

There are risks from climate change impacts to both water utilities' operations, and to the wider community – a climate risk assessment would usually address the former.

A vulnerability assessment is a common starting point for a subsequent climate risk assessment (WSAA, 2016).

How we are developing our climate risk assessment capability

There are a number of ways to develop climate risk assessments, including though private sector tools such as the Cross-Dependency Initiative (XDI), and the work of CSIRO through a Digital Twins platform.

The use of Digital Twins shows much promise in assisting rapid assessment of operational and planning changes on climate risks with a digital interface modelled on the real world. Some utilities are using this software to develop their climate risk assessment capability.

Resources and tools currently being used in the urban water industry include:

- WSAA's Climate Change Adaptation Guidelines (WSAA, 2016)
- Australian Standard AS 5534:2013 Climate Change Adaptation for settlements and infrastructure: a risk-based approach
- Risk management framework consistent with Australian Standard ISO 31000:2018 Risk Management Guidelines
- NSW Government, DPIE, Guide to Climate Change Risk Assessment for NSW Local Government: 2019 Revision (DPIE, 2019)
- Coast Adapt three-tier climate risk assessment framework.

Elements of climate risk assessment that are important for water utilities to consider are:

Consultation	More than for non-climate risks, engagement with external stakeholders, customers, local government, emergency response agencies and other community support agencies is critical as they may bear part of the risk or be part of the response.
Continuous improvement	Climatic events, crossing of trigger points or warning thresholds should trigger reviews of risk estimations and adaptation responses.
Risk context	Climate risks have specific characteristics in terms of time lag, uncertainty, and cumulative factors (climate events of different nature occurring in rapid succession).
Risk analysis	Climate trends are a key input, and scenario planning techniques can be used to avoid being locked into one specific climatic future.
Screening and evaluation	This can be more complex than for other risks, due to the complex cumulative and interdependent relationships between risks and the various time horizons to consider.

What's leading practice?

Climate risk assessment is an emerging area of work for the water industry, and water utilities are at differing levels of maturity. A major challenge for all water utilities is in translating climate projections into risks at their local level.

Guidance from state governments and utility shareholders is critical to enable water utilities to efficiently incorporate climate risk into their asset management and strategic planning.

The water industry also has interdependencies with critical infrastructure owned and operated by other sectors including electricity, telecommunications, roads and gas. These are discussed in the following section.

Whatever tools are used, it is important to consistently consider climate risk within and between these sectors, using transparent assumptions and consistent application of climate change projections to develop our understanding of hazards.

Interdependencies

The urban water industry is part of a suite of interdependent critical infrastructure that keeps our societies, cities and economies going. There are both risks and opportunities that arise as a result, and the water-energy nexus is arguably the most critical. Risks include cascading failures from third party infrastructure such as the energy grid, and opportunities include water utilities as energy producers and batteries.

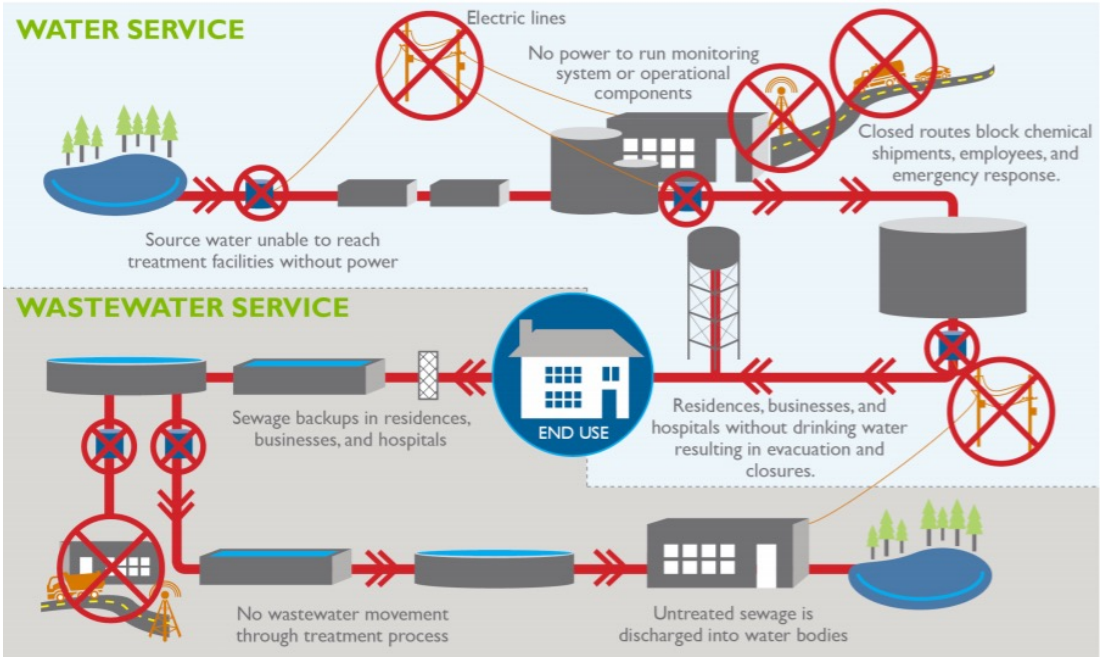
The water industry is considered a 'lifeline' sector by the US National Infrastructure Advisory Council (NAIC) because its functions are essential to core operations in nearly every other sector.

While other sectors are heavily dependent upon water and sewerage services, significant points of interdependency for the water industry include (US NAIC 2016):

Chemical sector	Chemicals are required to operate water and wastewater treatment facilities and water is often necessary in chemical manufacturing processes.
Energy sector	The energy sector relies on water services for different aspects of energy production and generation. The water industry relies on energy, specifically electricity, to operate its pumps, treatment facilities, delivery systems, and processing.
Telecommunications sector	These sectors rely on water services for equipment cooling and facility operations, while the water industry relies on communications and IT for their operations and control systems, monitoring systems, internal communications, and communications with the public and emergency responders.
Transportation sector	Chemicals and other supplies are delivered by truck and rail. Water industry personnel also rely on transportation to get to and from work.

While these interdependencies are well known in the water industry, what is harder to know is how those risks are changing within those sectors themselves (US NAIC 2016), including as a result of climate change.

FIGURE 16 Example of impacts of loss of critical infrastructure on water and wastewater services



SOURCE US NAIC 2016

How we are managing our interdependencies

As an industry, our understanding of the risks from these interdependencies is maturing. Managing these risks requires a more integrated and collaborative planning approach between water and energy water utilities in particular, to coordinate efforts to understand each sector's risk management plans, and share resources and knowledge.

There are also opportunities arising for water utilities as a result of their interdependencies, especially with regard to the water-energy nexus. Such opportunities include:

- Water utilities as energy producers (biogas, hydrogen, solar PV) and energy storage facilities (eg. batteries)
- Being able to send price signals to energy suppliers as the grid changes
- Private sector business opportunities for example in hydrogen and biomethane.

What's leading practice?

The US NAIC (2016) identified six areas of findings that encompass the challenges, needs and strategies for improving security and resilience in the US water sector, in relation to climate change and interdependencies:

1 Poor understanding of the criticality of the water sector

Water is not given appropriately high priority as a critical lifeline sector by public officials and dependent sectors during disaster planning, prevention, and response.

2 Inadequate valuation of water services

Water services are often undervalued and taken for granted because they are typically highly reliable, inexpensive, and hidden from view.

3 Wide disparity of capabilities and resources

Technical capabilities and resources vary widely among water utilities. Smaller water utilities in particular often lack the qualified staff, tools, technical expertise, and reliable information needed to manage new risks.

4 Significant underinvestment in water sector resilience

There is significant, chronic underinvestment in water infrastructure and resilience due in part to widespread public ownership and a reluctance to raise rates.

5 Fragmented and weak federal support for water resilience

Resilience has not been substantially integrated into the actions of federal agencies, and resilient outcomes are not part of federal guidance and resources.

6 Regional collaboration not broadly applied

Limited regional coordination across jurisdictions and water systems leads to inefficient, siloed decision-making that can hamper resilience.

Though it would be incorrect to characterise the Australian and New Zealand sectors as "chronically underinvested", some of these findings are broadly applicable to our industry and provide food for thought.

Texas water-energy interdependencies during extreme weather

SOURCE Associated Press

In February 2021, an extreme cold weather event hit Texas in the United States, driving temperatures down to record lows in a state more used to extreme heat. Subsequent soaring demand for electricity caused one of the worst power outages in US history. At its peak, 4.5 million people were without power for days in a row. This included many of the state's water utilities.

One quarter of the state's population, 7 million people, were advised to boil water, and ten days after the blackout started, more than 1 million people were still under boil-water alerts.

Water pipes burst from extreme cold, and water and water pressure was also lost as taps were left running to prevent freezing over, while treatment plants and pumping stations had to be shut down due to lack of power. Where power was still available, for four days the wholesale price of electricity was USD$9,000 per megawatt hour, 30,000% higher than before the storm, particularly affecting water utilities with exposure to the spot price market ("Texas was a warning. Australia needs to rethink the design of its electricity market". Mountain, B. 2021).

The extreme cold also led to shortages in chemical supply needed for water treatment, illustrating the supply chain interdependencies that water utilities are also exposed to. Risks are magnified where suppliers are monopoly producers.

Resilience

Resilience planning is made more urgent and complicated by the current and projected impacts of climate change. Efforts to build resilience to the effects of climate change must be paired with efforts to promote urban liveability and sustainability. Improving our resilience through smarter and better use of water is one of the key challenges for the urban water industry.

Resilience is a term that has come into use more recently than climate adaptation, but encompasses it and is broader, bringing in social, community and environmental resilience.

Improving resilience doesn't always lead to uniform improvements, but can sometimes reduce resilience in other areas. A good water industry example is desalinating water, which uses large amounts of electricity – adding to our carbon emissions if not generated from renewable sources or offset.

Crises such as climate change and extreme weather events can lead to a reassessment of deeply rooted practices, and can be major opportunities to improve resilience. Water utilities can influence this transformation in their jurisdictions, both internally and with other organisations managing aspects of the water cycle and related areas (such as land use planning). Figure 17 is an example of such an approach that is used by some water utilities.

FIGURE 17 Resilience is defined here as consisting of three components, based on hypothetical water infrastructure systems

Resilience by design

Persistence	Adaptability	Transformability
Fixed design and reactive recovery	Monitoring and detection and proactive recovery	Monitoring and detection and redesign
EXAMPLE	EXAMPLES	EXAMPLES
Lake levels control works and regulation plan optimized to provide acceptable levels over wide range of future conditions	Monitoring of lake levels and incurred damages Switching to alternative regulation plans when thresholds exceeded	Initiate new regulation plan design if damages exceed thresholds Consider abandonment of functions if design costs exceed thresholds (e.g. navigation)

SOURCE Brown et al (2020)

How we are becoming more resilient

Water utilities are actively improving resilience to climate change in important and inter-related ways:

- Participating in the Australian Government's Trusted Information Sharing Network (TISN) for Critical Infrastructure Resilience, for example through WSAA's Water Sector Services Group
- Developing climate risk assessments
- Optimising water cycle management and improving water supply resilience through diversification of sources
- Optimising energy management to save costs, reduce emissions and reduce risk of grid instability
- Improving urban liveability, environment and community resilience through providing fit for purpose water for urban greening and cooling, which also reduces GHG emissions, energy demand and risk of power outages
- Improving infrastructure resilience to expected climate change and extreme event impacts
- Assisting regional emergency management responses.

Many of the outcomes above are a result of pursuing multi-benefit projects developed with multiple stakeholders, for example through Integrated Water Management programs. Water utilities are participating in, and in many cases driving these projects that are designed to identify the best whole of community value options. This is driving improvements in resilience, liveability and the circular economy (Skinner and Satur 2020).

What's leading practice?

Water utilities can work towards improving their resilience to climate change and extreme weather events by focusing on resistance, recovery and transformation of approach.

Table 8 and Table 9 describe a framework for some of the conditions that enable resilience, faster recovery and a transformation of response to climate change and extreme events. Some water utilities such as Sydney Water and Yarra Valley Water are now capturing this intent by developing resilience policies.

TABLE 8 Framework for enabling resilience to the effects of climate change and extreme events for water utilities

CONDITION	SUB-CONDITION	EXAMPLE
Predict	Research	Being able to operationalise research rapidly
	Socio-economic	Predict the depth and duration of the crisis; map vulnerable assets and customers
Enhance capacity	Organisational	Embed collaboration within the organisation and between critical service providers, to enhance capacity to predict, translate into action, monitor/ evaluate outcomes and adapt
	Systematic	Embed systems thinking, formulate adaptive plans, ensure capacity, collect data and enhance integrated networks across multiple business areas, stakeholders and customers
	Social	Map vulnerable customers and staff; improve community resilience through information, reducing service disruptions, and developing partnerships
Increase independence	Compartmentalisation	Ensure that assets can be backed up and service delivered maintained; improve redundancy – reduce dependency on single assets
	Supply chains	Spread risk across multiple suppliers where possible
Make use of diversity	Organisational	Encourage diversity of approach to solutions
	Sources of supply	Increase range of supply sources to spread risk and reduce vulnerability

SOURCE Adapted from Fransen and Edelenbos (2020) and NSW Dept. of Justice (2018)

TABLE 9 Framework for recovering faster and transforming future response to climate change and extreme events

CONDITION	SUB-CONDITION	EXPLANATION
Service delivery	Maintain service delivery	Ensure that basic service delivery stays available
	Networks	Flexibility in networks, assets and supply sources allows faster recovery
Organisational capacity	Integrated service delivery	Integrated planning within the organisation and with land-use planners and other critical service sectors, and an adaptive, multiple benefits approach to service delivery
	Crisis teams	Ensure staff are trained in working effectively in an Incident Management Team
	Knowledge gathering	Good data management systems, network data collection
	Monitoring	Constant learning, adjustment and improvement
Networks	Collaboration	Horizontal (within organisations) and vertical (between organisations)
Safety	Developing plans	Clear plans that are understood by all enhances trust
	Upholding plans	Leadership and trust from executives and staff
	Mapping needs	Needs can change quickly during crises and need to be constantly re-evaluated and communicated effectively
Relationships	Influencing policy	Utilising strong relationships with stakeholders and shareholders to influence policy change that transforms approach to resilience
	Reflection	Constant monitoring, evaluation and adjustment, and communication of changes with staff, stakeholders, customers and community
Innovation and opportunity	Governance	Innovative and adaptive governance arrangements can reduce barriers and transform resilience
	Mapping innovation and experimentation	Identify and communicate staff initiatives. Support experimentation and 'no wrong answers' approaches
	Creativity	Stimulate and promote creative problem solving to improve resilience

SOURCE Adapted from Fransen and Edelenbos (2020)

Water efficiency and conservation

To manage our inter-related challenges of a drying climate, emissions reduction and population growth, we must do more with less water. A significant amount of energy is consumed in the capture, treatment and delivery of water throughout Australia and New Zealand's cities and towns. It makes conserving water important from an emissions reduction, water security and customer bills perspective.

The urban water industry commits to conserving water and encouraging efficient use of water by our customers.

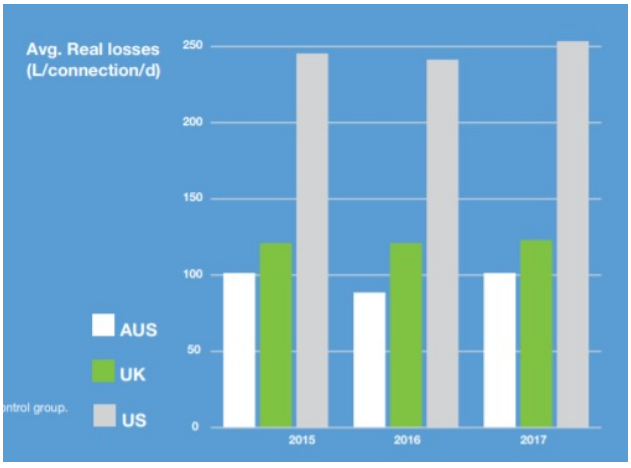
A base level of water efficiency is critical for both customers and water utilities to ensure we are prepared for our future hotter and drier climate.

Water efficiency is likely to become more important as the impacts of climate change on demand become better understood.

Leakage (termed 'non-revenue' water) in Australia and New Zealand is low by world standards, averaging around 10% of the water supplied by water utilities across Australia (Figure 18, WSAA, 2019b) and in 2019-20 was 21% in New Zealand (Water New Zealand, 2021).

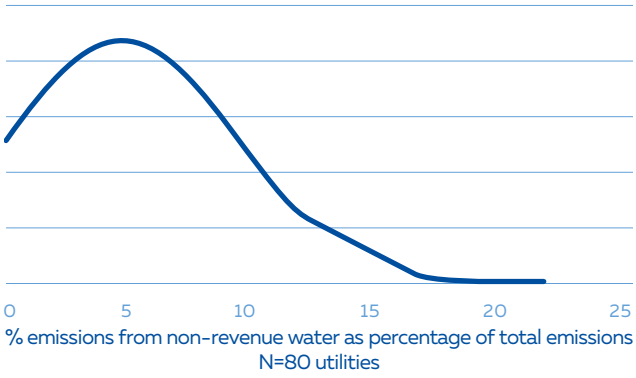
The climate impact of leakage goes to the heart of the water-energy nexus. Analysis of the 2019-20 National Performance Report data for Australian water utilities shows that the average emissions impact of leakage equates to around 4.5% of total water industry emissions (BOM 2020).

FIGURE 18 Non-revenue water in Australia 2015-2017



SOURCE WSAA, 2019b

FIGURE 19 Normal distribution of GHG emissions from 80 Australian water utilities' non-revenue water as a percentage of their total emissions



SOURCE BOM (2020).

Figure 19 shows that the majority of water utilities' emissions from non-revenue water equates to between 1-8% of their total emissions profiles. This increases with increasing non-revenue water rates, with some water utilities having over 20% of their total emissions from leakage.

While other factors such as age of assets and maintenance can affect leakage rates, climate change can increase leakage and the risk of mains breaks in two important ways:

- Reactive soils can dry out, cracking water pipes and leading to leakage. Freezing and excessively wet weather can cause ground swelling and lead to pipes shifting, resulting in bursts. If leaks aren't addressed they can lead to major mains breaks.
- Drought can lead trees to increase their search for water, which can lead to leakage and mains breaks as their roots enter the pipe network. Certain species of trees are more prone to this occurring. This can happen to both water and sewer pipes.

How we are conserving water

While leakages will always be a problem to some extent due to diminishing returns on investment to fix them, strategies that are currently employed include:

- Pressure management
- Mains renewals
- Active leakage control through monitoring
- Pipeline and assets management
- Speed and quality of repairs.

When employed simultaneously, these strategies positively influence each other, increasing the cumulative benefit.

Water restrictions are another method of conserving water during drought and dry periods. However, the water industry does not have a consistent definition of water restrictions. While it makes sense that levels of restrictions are different to account for the large range of climates in Australia, and to a lesser extent New Zealand, there are no national principles to determine how these decisions may be made with the customer and the community's best interests at heart. This has resulted in states going in different directions, and in some jurisdictions this has led to inefficiencies and inconsistencies in planning approaches, including towards investments that may not represent the best community value option.

A renewed National Water Initiative would set a national framework for water security and avoid the sorts of perverse outcomes associated with the current water restrictions regime nationwide.

Some urban areas use more water per capita than others – while this is driven in part by a warmer, drier climate there are still opportunities for water utilities to manage leakage to conserve water, and support our customers to be more water efficient.

Darwin is the only capital to never experience water restrictions, and Power and Water Corporation's customers use twice the amount of water per capita than other Australian cities with similar climates. With population growth in Darwin, demand is growing and this has led Power and Water Corporation to place a high priority on encouraging waterwise behaviours in their communities through the 'Living Water Smart' program (WSAA and Smart Approved Water Mark 2019).

Some states have permanent water saving rules mandated by the state government. In Victoria, this is aimed at achieving a target of 155 litres per person or less (demand in 2020 was around 161 litres per person).

Smart linings for pipe and infrastructure CRC-P project

WSAA is leading an international set of project partners in this RandD project aimed at developing innovative pipe lining technology that can dramatically increase asset life expectancy and reduce the risk of leakage. Through this project new materials and technologies, including smart robotics and sensors are being investigated and tested through field trials.

Other measures that water utilities are taking to improve water conservation and reduce leakage include:

- Ensuring communities participate in decision making around water conservation and water restrictions
- Community engagement and customer research campaigns including through social media and television advertisements (for example, Water Corporation's 'Nature Knows Best' campaign), support an emotional connection from customers with water
- Integrating water efficiency messages into sponsorship, community grants and learning programs (for example, Hunter Water's Love Water campaign)
- Enacting drought response/water security plans to reduce demand
- Utilising an integrated water management approach to investing in diverse sources of supply to reduce demand on surface water supplies (see next section).

What's leading practice?

Two reports released by WSAA in 2019 showcase how water utilities are helping customers and communities save water, as well as their efforts to reduce leakage in their own systems:

- Water Efficient Australia (WSAA and Smart Approved Water Mark, 2019)
- Reducing Leakage in Australia (WSAA, 2019b).

Appropriate product labelling for water-using products can assist customers to help make better, more water-wise choices. The Smart Approved WaterMark label ensures the most water efficient products are easily identifiable for consumers, while also providing tools such as Smart Water Advice and Smart Water Audits to water utilities, councils and businesses to keep water use and bills to a minimum.

Customers across Australia and New Zealand generally expect water utilities to inform the community about water saving solutions, increase their water literacy and monitor, manage and help them to reduce their water usage (WSAA and Smart Approved Water Mark, 2019).

CASE STUDY 8 SYDNEY WATER

Conserving water through advances in leak prevention

Leaks and breaks pose an issue for all water utilities, and may increase with climate change's influence on soil moisture and tree root ingress. Advances in leak prevention to minimise unaccounted for water by Sydney Water and the University Technology of Sydney is a leading example of using acoustic sensing to detect leaks and breaks. This has resulted in a total of 70 likely leaks detected, with a total of 44 leaks confirmed and repaired since deployment.

FIGURE 20 A Von Roll acoustic sensor and logger in the Sydney CBD

SOURCE Sydney Water

CLIMATE THEMES ADDRESSED

CUSTOMERS + COMMUNITY

ADAPTIVE PLANNING

TECHNOLOGY + DIGITAL INNOVATION

Diversifying our water supplies

Meeting our water security challenges requires diversifying our supply sources. However, surface water supplies are often the least energy intensive sources. This is a critical consideration for water utilities – how do we meet our water security challenges, reduce our emissions, and keep bills affordable simultaneously?

The water industry commits to building resilience in water supply systems through diversifying water sources and improving treatment processes.

Surface water provides 82% of urban water in Australia (WSAA, 2020b), and 76% in New Zealand (Stats NZ, 2020). Desalinated water and various classes of recycled water (including purified recycled water for drinking) are examples of rainfall and climate independent water supplies (Figure 21).

There are climate mitigation trade-offs to be considered when adapting our water supplies - energy use for water supply varies significantly, depending on local conditions including water use, topography, water sources and water treatment. The intensity of energy consumption depends on the specific technologies and activities applied, and Figure 22 shows the typical energy intensity of different water sources.

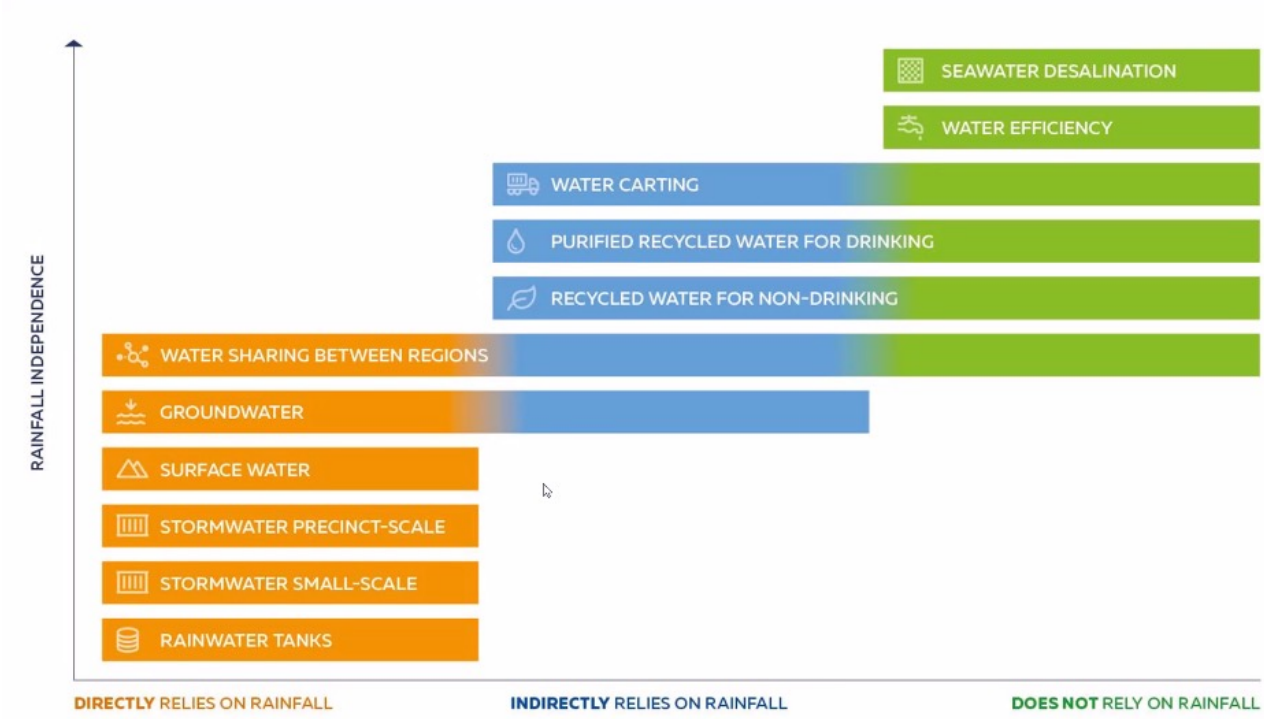
Water supply options should be designed to optimise both operational energy use and embodied energy, and usually results in lower costs and reduced emissions.

Producing drinking water from surface water supplies is generally much less energy intensive than producing it from seawater, wastewater or brackish water. The energy intensity of the reverse osmosis process increases with increasing salt levels in the water, making seawater desalination a more energy intensive method than producing drinking water from brackish surface water, recycled water or groundwater (WSAA, 2020b).

Water utilities are faced with a difficult choice – reduce emissions by choosing the least energy intensive supply source (generally surface water sources), or increase their emissions, adapt to climate change and increase water security by adopting rainfall independent supply sources.

Where alternative supplies can be powered by renewable energy or offset, this can increase the benefits of diversifying supply sources from an emissions reduction perspective.

FIGURE 21 Rainfall independence of various water supply sources



SOURCE All options on the table: Urban water supply options (WSAA, 2020b)

FIGURE 22

WATER SUPPLY SOURCE	TYPICAL ENERGY USE (KWH/KL)	REFERENCE
Groundwater including water treatment	0.2 – 2.5	Beca Consultants (2015)
		Plappally and Lienhard (2012)
Rainwater tanks	0.59 – 4.9	ISF (2013)
		Tjandraatmadja et al (2012)
		Retamal et al (2009)
Purified recycled water for drinking	1.3 – 3.8	Lam et al (2017)
		ISF (2013)
Recycled water for non-drinking	0.5 – 8.0	ISF (2013)
Seawater desalination	3.3 – 8.5	Lam et al (2017)
		ISF (2013)
		Cook et al (2012)
		Plappally and Lienhard (2012)
Stormwater harvesting and reuse	Limited data available[1]	
Surface water including water treatment	0.1 – 1.0	Lam et al (2017)
		Biswas and Yek (2016)
		ISF (2013)
		Plappally and Lienhard (2012)
		WSAA data
Water carting	Limited data available[2]	
Water sharing between regions	0.01 – 3.3	Lam et al (2017)
		Plappally and Lienhard (2012)

SOURCE All options on the table: Urban water supply options (WSAA, 2020b)

Recent climatic changes in some areas of Australia have driven water utilities to move faster towards rainfall independence than in other areas where these changes have not yet been as marked (see Case Study 9).

However, at present, in some Australian states and territories not all options for water supply are on the table for planning decisions, which could inhibit effective selection of the lowest long-term cost and most climate-resilient options.

How we are diversifying our water supplies

Each utility will consider how these options and their costs and benefits fit its local context. For example stormwater is largely unreliable as a source in most parts of Western Australia, whereas on the East Coast it could form part of the supply mix. Similarly, groundwater is important in Perth and other parts of WA but is not currently a major supply source for many areas in the eastern states. Desalination is an important part of the supply mix for several major coastal cities and will likely become more so with climate change.

This contributes to the varied emissions profiles of water utilities, making it difficult to compare them on the basis of their emissions.

If we are to move away from surface water sources of supply as part of our climate adaptation approach, we need to ensure that alternative sources are powered by renewable energy or offset, to ensure no further impact on our climate.

What's leading practice?

No water supply option on its own will be able to meet our combined challenges of population growth and climate change.

While surface water continues to supply most of our water needs at the moment, we can no longer rely on dams alone to deliver water security in major metropolitan areas because:

- There are very few suitable sites left
- Future yields are uncertain due to climate change
- Waterway health is increasingly important
- Community expectations are changing.

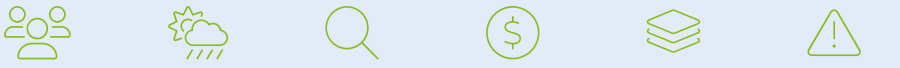
A portfolio of options makes sense as it spreads the risk, and increases our ability to balance resilience, security, cost and other network constraints, while also meeting the diverse and evolving expectations of our customers and communities.

CASE STUDY 9 WATER CORPORATION

Perth's transition to rainfall-independent supply

South West Western Australia has been hit harder by climate change in terms of rainfall declines than perhaps anywhere on Earth. While rainfall has declined by around 16% since the 1970s, runoff (and therefore inflows to dams) has declined by much more – around 80%. As a result, Water Corporation have transitioned Perth's water supply largely away from a reliance on dams, to encompass a broader, rainfall independent set of sources such as groundwater, desalinated water and purified recycled water for drinking (PRW).

CLIMATE THEMES ADDRESSED



CUSTOMERS + COMMUNITY | CLIMATE ADAPTATION PLANS | CLIMATE RISK ASSESSMENT | INVESTMENT IN CLIMATE RESILIENT WATER SUPPLIES | RESILIENCE | CLIMATE HAZARDS

Supporting healthy ecosystems with green and blue infrastructure

Water utilities have a unique advantage in supporting water-enabled liveability. Investing in green and blue infrastructure is one way that water utilities are leveraging their role in managing a significant part of the water cycle to improve urban liveability, climate adaptation and ecosystem and community resilience to climate change.

The urban water industry commits to supporting green, cool and healthy environments. The urban water industry commits to supporting healthy waterways to protect and restore ecological and community values.

Australia and New Zealand are overwhelmingly urbanised nations. Our cities are significant drivers of economic activity, as well as major population health risk sites, and therefore maintaining their liveability is critical – but the job is made more difficult with climate change.

Green and blue infrastructure is an important tool for water utilities to deploy, as it is both a climate mitigation and adaptation approach:

- Utilising green and blue infrastructure can reduce emissions from grey infrastructure (for example embodied emissions in concrete), due to trees and vegetation sequestering carbon
- Green and blue infrastructure helps reduce urban heat, reducing thermal stress on people and other species during heatwaves. For example, irrigated green space on a hot day can be up to 12°C cooler than surrounding roads and buildings

How we are supporting healthy ecosystems with green and blue infrastructure

There are a range of ways that water utilities can work towards supporting healthy ecosystems, and broader liveability outcomes while delivering their core business objectives:

- Providing fit for purpose water for green infrastructure including green parks and open space
- Supporting blue infrastructure including clean, healthy beaches and waterways through catchment management and source water protection, with community and ecosystem benefits
- Providing grants programs to support community, local government and other organisations to use water in smarter and better ways to support healthy ecosystems
- Recovering and reusing nutrients and other usable products from wastewater
- Considering biodiversity outcomes in carbon offsetting.

Several water utilities maintain investment or grant programs to assist local governments and communities to develop green and blue infrastructure projects, and examples include:

- Water Corporation's Local Government Urban Canopy Grant Program ($750,000 fund 2020-21)
- Melbourne Water's Liveable Communities, Liveable Waterways Program ($8.1m per year 2021-24)
- City West Water's (now Greater Western Water) Stormwater Harvesting Partnering Fund (invested $6.6m over two funding rounds).

Despite the large scale of benefits, water utilities are still coming up against barriers, as noted by Infrastructure Australia (IA, 2019), the Productivity Commission (PC, 2020) and WSAA (WSAA, 2019a):

- Lack of clear objectives and policy for water-related aspects of enhanced urban amenity
- Roles and responsibilities for providing enhanced urban amenity not clear
- Statutory land planning and water planning not well linked
- Stormwater planning and management are not integrated into general water planning
- Restrictions and mandates prevent putting all options on the table
- Benefits often accrue beyond water utility customers to the broader community.

What's leading practice?

Mitigating and adapting to climate change through the provision of green and blue infrastructure, and thereby unlocking the full potential of liveability benefits requires addressing several key challenges (WSAA, 2019a):

- Harnessing the full water cycle with all water supply options on the table and by coordinating the incorporation of stormwater
- Integrating our approach to planning
- Implementing an effective framework for measuring health and liveability benefits
- Creating new funding and financing models for green and blue infrastructure as social infrastructure.

Similarly to grey infrastructure, green and blue infrastructure should be designed to withstand the climate of 20-50 years' time.

Key enablers for the future

1 Developing our strategic approach

Whole of business climate strategy (mitigation and adaptation)

Climate change is just one of several major challenges that water utilities are faced with managing. Associated challenges include:

- Meeting the needs of a growing population
- Maintaining, renewing and replacing ageing infrastructure
- Reflecting changing community expectations
- Keeping services affordable for customers and minimising costs to taxpayers.

A strategic, integrated and whole of business approach is needed to help meet these challenges.

Our work in this space is driven by a combination of cost pressures, legislative, regulatory and policy factors, and customer preferences.

A whole of business approach to both climate mitigation and adaptation can help meet these challenges by embedding the necessary changes in every area of the business, and working with customers and communities to help them use water differently to do the same.

Importantly, work towards climate adaptation should not reduce efforts to mitigate emissions – they can and should work in partnership to build overall resilience.

Water utilities have a multitude of plans, and many of them will have an impact on the path a utility takes in climate mitigation, adaptation and resilience. These strategies are generally developed separately, often due to existing review cycles of each document.

A typical whole of business strategy could include the areas as indicated in Figure 23.

Incorporating climate projections into strategies is a critical part of this. While climate science is continually being reassessed as new information arises, climate projections (temperature, rainfall, sea level rise) reflect modelling uncertainty arising from uncertainty around global emission reductions.

There is a price to pay for getting this wrong – too conservative and we risk over-investing and increasing customer bills, whereas maintaining the status quo may mean we are underprepared for future droughts and population growth.

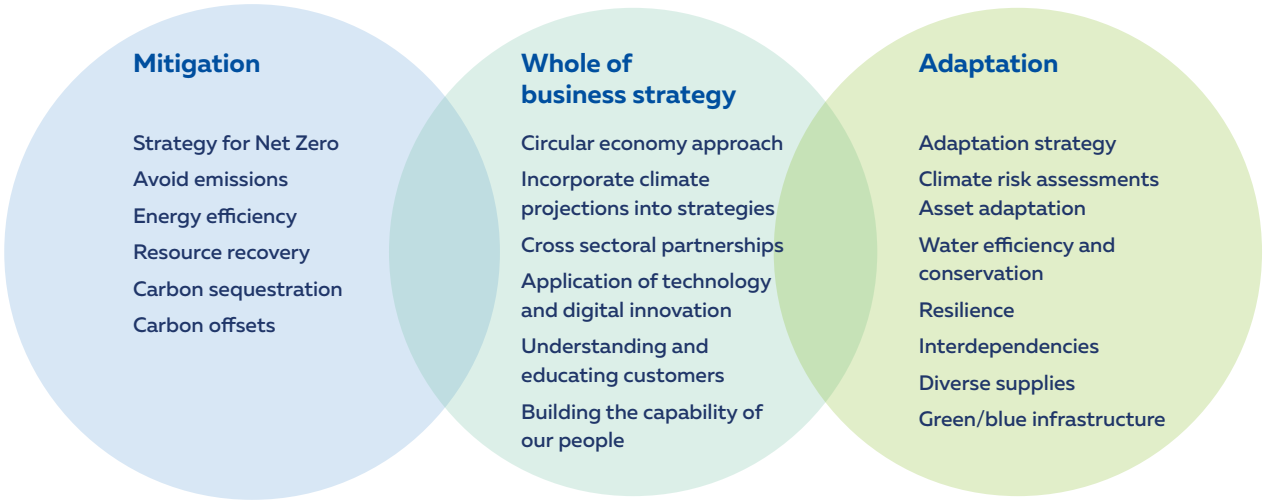
To reduce this risk, the industry uses climate scenarios to help understand the range of possible futures that may arise for demand and supply as a result of climate change.

Climate scenarios are used to estimate:

- Changes in water supply availability (eg. system yield, reliability, runoff changes due to snow cover in alpine catchments)
- Changes in groundwater recharge
- Changes in demand.

DELWP, 2020

FIGURE 23 Conceptual whole of business climate strategy for water utilities



The best tools for developing scenarios to project climate change on water availability begin with Global Climate Models, however applying the science can be complex and challenging especially for smaller regional water utilities. Guidelines from water utility shareholders, for example the Guidelines for Assessing the Impact of Climate Change on Water Availability in Victoria (DELWP 2020), assist water utilities to undertake this process as efficiently and accurately as possible.

Generally speaking at least three scenarios are used – simply using the median level of climate change increases the risk of over and under-investing, should other futures arise.

In some areas, a scenario assessing a step change (for example, post 1974 in Perth, the Millennium Drought period in Victoria) can determine the likely future conditions assuming that current conditions are a result of a step change in climate from a certain date (rather than a wet/dry rainfall period of indeterminate length).

Demand can also change as a result of climate change, though there is lower sensitivity of demand to climate change impacts relative to long term water availability. Climate change can impact both average and peak demand, primarily by changed demand for outdoor water use.

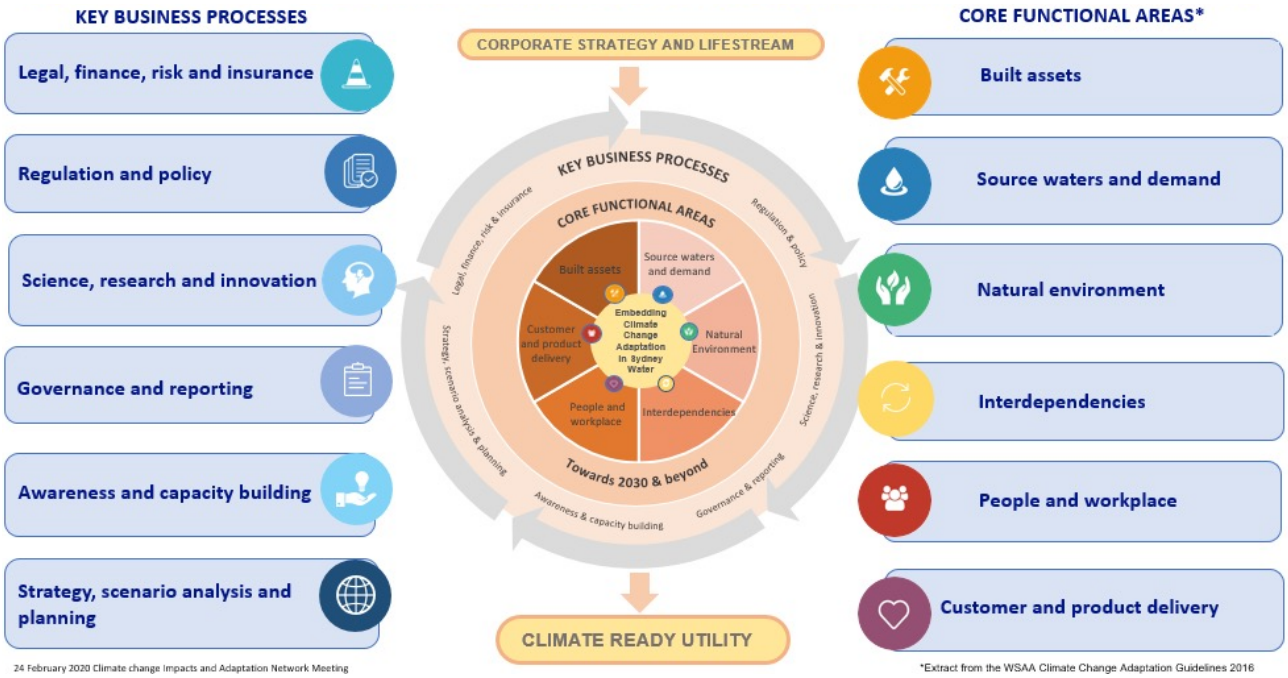
How we are developing whole of business climate strategy

Each state and territory has a slightly different approach to climate modelling based on IPCC projections:

- The Adapt NSW program which uses Narclim and is used across NSW and ACT water utilities
- SA Climate Ready program
- Victorian Climate Projections developed by DELWP

This is an emerging area for water utilities and the industry is in a phase of applying the concepts to existing planning frameworks and reporting. As an example, Sydney Water's Climate Adaptation Implementation Plan was developed in response to both NSW and Federal government strategies, as well as increasing understanding of financial regulators and legal commentary on exposure to climate risk. The new plan is a whole of business strategy to provide a consistent, robust and systematic approach to climate change adaptation governance and support embedding adaptation efforts across all business areas (Sydney Water, 2014).

FIGURE 24 Overview of Sydney Water's Climate Adaptation Implementation Plan



SOURCE Sydney Water

Barwon Water's 'Strategy 2030' recognises that as a result of generational challenges such as climate change, population growth, rapid technological advancement and economic transition, water utilities have an opportunity to shift their mindset from being simply a service provider to being an enabler of regional prosperity.

This sort of thinking builds climate action into a whole of business approach, and includes:

- Developing strategic partnerships
- Achieving Net Zero emissions
- Having a zero-waste goal
- Entrepreneurial mindset
- Building a high-performance culture.

CASE STUDY 10 SOUTH EAST WATER

Whole-of-business climate change preparedness

South East Water's climate mitigation and adaptation programs are an example of a holistic approach to addressing climate change, that aims to ensure the business minimises greenhouse gas emissions while preparing for the inevitable impacts of a warming climate today and into the future. By having a greater understanding of the potential physical and financial risks of climate change in the future, the business and its staff are empowered to strive further to reduce greenhouse gas emissions and support partners and stakeholders to do the same.

CLIMATE THEMES ADDRESSED

- NET ZERO EMISSIONS
- CUSTOMERS + COMMUNITY
- ADAPTIVE PLANNING
- CLIMATE ADAPTATION PLANS
- CLIMATE RISK ASSESSMENT
- REGULATORY OBLIGATIONS
- WHOLE OF BUSINESS CLIMATE CHANGE STRATEGY
- SOLAR PV ON ASSETS
- RENEWABLE ENERGY
- CARBON OFFSETS
- INCORPORATE CLIMATE CHANGE PROJECTIONS INTO DECISION MAKING
- DIRECTOR LIABILITY/TCFD
- CLIMATE HAZARDS
- WILLINGNESS TO PAY
- EDUCATION

Fostering an enabling regulatory environment

There are a wide range of health, environmental and pricing regulatory obligations placed on water utilities across Australia and New Zealand, however there are relatively few in relation to climate change mitigation and adaptation. Some of these are legislated, for example in Victoria, while others have basis in state government policies and strategies. As a result it is still not clear for many water utilities, particularly in states without legislated emissions targets, what the trigger is to reduce emissions, or how fast they should do so.

Regulation is a water policy tool used to protect public health, the environment, and customers as a result of the provision of water and sewerage services. They include:

Environmental regulation	To ensure the protection of the environment, particularly in relation to discharges of wastewater to the environment, but also in the way that water is abstracted and used.
Public health regulation	To ensure that water and wastewater services are supplied in a way that protects the health of users and the broader public.
Economic regulation	Designed to ensure all investment is prudent and efficient, and meeting customers' needs and their willingness to pay.

The core objective of regulation should be to promote the long-term interest of customers (in the case of environmental regulation, the environment can be seen as the customer). The onus is on water utilities to understand their customers' needs, and demonstrate to the regulator in a rigorous way that they are being followed through.

The National Water Commission in 2012 found that generally, water policy settings at the time would not impede cost-effective implementation of climate change policy. However, they also noted that the inability of water and related environmental regulations to keep pace with alternative and emerging energy sources may inhibit the development of less emissions-intensive energy sources (NWC 2012).

Customer preferences in terms of climate change actions, and willingness to pay for those actions is therefore a key area of work for many water utilities, particularly where the regulatory direction from the state is unclear or being worked through at utility Board level.

Legislated targets in the ACT, Victoria and SA have been a significant driver of water utility emissions reductions. State policy or strategy-based emissions targets may not be enough of a driver to embed emissions reductions, as it is difficult for government-owned water utilities in those jurisdictions to invest in non-cost-effective projects. This has led some water utilities to approach climate mitigation (emissions reduction) initially from a cost neutrality and reputational perspective that seeks to maintain community service levels.

Applying technology and digital innovation

The extraordinary rate of technological advancement and digital innovation holds many opportunities for water utilities to advance their responses to climate change. The disruption from the COVID-19 pandemic, in particular the move to working from home, has accelerated the identification and uptake of new technologies that are supporting water utilities' responses to the impacts of climate change across a range of business areas.

More consistent application of current technologies, trialling new technologies and continuing our digital innovation can accelerate our responses to the impacts of climate change. Delivered as part of a strategic approach to climate change, technology and digital innovation can help water utilities be better equipped, resilient and responsive to the impacts of climate change and extreme events on our business.

However, the move towards digitalisation comes with risks, particularly through increasing interdependencies such as with the telecommunications sector.

How we are using technology and digital innovation

Efforts to foster climate-smart innovation, and benefit from emerging technologies and digital innovation in their approach to managing climate risk and mitigating emissions are being applied across a range of water utility business areas:

Asset management

- Utilising intelligent systems to build climate resilience into asset networks, for example through:
  - Using big data to revise risk and asset management frameworks
  - Using forecasting and predictive models to reduce risk of asset failure
  - Utilising new types of sensor technology, and integrating sensor data to allow real time monitoring, process optimisation, decision making and staff health and safety
- Reducing Scope 3 emissions (embodied carbon emissions) through:
  - Trenchless technologies and innovative pipe linings (for example WSAA's Smart Linings for Pipe and Infrastructure CRC) project;
  - Supply chain integration;
  - Smart assets linked to automated procurement when maintenance or replacement is needed; and
  - Onsite pipe manufacture
- Developing smarter ways of detecting problems, such as reducing risk of mains breaks with improved sensing techniques to fix leaks before they become catastrophic.

Digital innovation

Collaborating within and across sectors to understand digital needs, leverage resources and improve economies of scale to trial new technologies (WSAA, 2020c).

Circular economy

Developing technology that can assist the transition to the circular economy, for example zero-cement concrete that uses industrial by-products and avoids carbon emissions associated with cement (Roychand et. al., 2021).

Customer

- Empowering customers with technology such as smart meters that can inform their decisions around water use and the circular economy. This can potentially reduce their own emissions and help households adapt to climate change and extreme events such as heatwaves and bushfires.
- Developing opportunities to better validate assumptions in green and blue infrastructure interventions, such as through heat and soil moisture sensors, real time social movement monitoring and Digital Twins.

However, the industry faces challenges in building their digital capability, including:

- High setup costs
- Financial and reputational risk in proceeding to trials that may not deliver the desired outcomes
- Bureaucratic red tape
- Overly cumbersome and time-consuming procurement procedures
- Lack of effective mechanisms to work with private industry on new technologies and building capability (eg. manufacturers, suppliers, SMEs and start-ups).

SA Water's Smart Irrigation program

SA Water is collaborating with 19 Adelaide councils to help maintain cool, green open spaces that build healthy communities. Leading this initiative is the in house-developed smart irrigation system, which takes and transmits real time data from soil moisture probes, daily weather forecasts and SA Water smart meter data.

SA Water puts this data through a sophisticated algorithm and the participants are able to determine the right amount of water to use, at the right time.

Councils involved are already starting to see cost and water saving benefits, and based on this success to date, SA Water is looking to expand the technology to more areas of South Australia.

To demonstrate the cooling benefits of a well-irrigated public open space, the utility has also installed more than 200 air temperature sensors in public parks and playgrounds around Adelaide. Readings are updated every 15 minutes and displayed live in an interactive map at sawater.com.au.

This shows the positive impact creating cool public spaces, which people can safely enjoy during warmer weather.

The principles being used to cool and green public open spaces can be applied in your own backyard too. A quick 30 second spray, or 'flash-watering', of your lawn or a leafy canopy can reduce air temperatures in your garden for about half an hour.

Misting systems – whether in a backyard or a public space – can also provide demonstrated cooling benefits, and during warmer months of the year, SA Water installs temporary misting stations at events like the Fringe Festival and Tour Down Under.

Additionally, in recent years, SA Water worked with the Adelaide Airport to conduct an innovative heat mitigation trial. This found the smart use of water to maintain soil moisture and cultivate green space can reduce average ambient temperatures by more than 3°C on warm days, and potentially lower heat-influenced costs like air conditioning and aircraft performance, as well as reduce carbon emissions associated with take-off.

While this trial has since concluded, results and learnings from the work have been incorporated into SA Water's ongoing greening and cooling initiatives.

What's leading practice?

The South Australian Government's Climate Action Plan (2021-25) uses the term 'climate-smart innovation' to describe the state's approach to managing their climate response through technology and digital innovation, and provides a framework for their main water utility SA Water to work within.

WSAA's W-Lab Roadmap is a collaborative approach to supporting technology adoption and digital innovation. W-Lab includes over 100 water utilities across Australia and New Zealand, external innovation partners Isle Water utilities and Think Place, and linkages to the global water sector.

This will deliver an industry-leading program for WSAA members (WSAA, 2020c), and assist water utilities to meet their climate challenges through technology and digital innovation.

W-Lab enables water utilities to deploy climate-smart technologies. This can assist other sectors to manage their climate risks and meet emissions targets faster, and reduce the high setup costs and risk involved in digital innovation.

CASE STUDY 11 MACKAY REGIONAL COUNCIL

Conserving water through digital transformation

Since 2018 Mackay Regional Council has rolled out more than 110,000 digital smart water meters to homes and businesses, and uses an application called 'Aqualus' to track usage and leaks. More than 16,000 Mackay residents also use the associated 'myH2O' website to track their water use. The technology can quickly identify unusually high water use and inform customers that they may have a leak, and since the project's inception has helped identify over 100,000 leaks totalling over six gigalitres of water.

CLIMATE THEMES ADDRESSED

CUSTOMERS + COMMUNITY

APPLYING TECHNOLOGY + DIGITAL INNOVATION

2 Better understanding our customers and community

Customer perceptions of climate change

Urban water utilities are customer-centric businesses. Customer surveys, and broader surveys of the Australian and New Zealand population indicate that our customers and the broader community are increasingly aware of climate change and are seeing its impacts now.

The urban water industry commits to engaging with customers and communities to achieve a balance between climate change action costs and outcomes, including respecting the needs of current and future generations.

Despite being in the midst of a global pandemic, concern for climate change is at a record high. This aligns with the 2019 WSAA Customer Perceptions Survey (WSAA, 2019c) of almost 10,000 respondents across Australia and NZ, and demonstrated that 84% believe the climate is changing. It also confirmed that 70% of customers believe water is scarce and many are translating that into water efficient behaviours in their home, garden and workplaces.

The number of people that believe they are already experiencing the impacts of climate change has increased by 15% in a year to nearly 50% of those surveyed (The Australia Institute, 2020).

Emerging customer trends

Communication, demonstrating transparency and caring for our customers is important to their perceptions of trust, value for money, reputation and overall satisfaction. Perceptions about bill stability also have a strong influence on customer trust. Customer trust is critical to water utilities' communication efforts and preparing customers for the impacts of climate change on services and bills (WSAA, 2019d).

However, beyond water efficient behaviours, many customers do not a make a connection with how climate change may impact service reliability, water quality, environmental outcomes and most importantly, the size of their water bill.

The challenge for the urban water industry is how to improve customer water literacy to the point where that connection is being made, and there is a greater understanding of the impact of climate change on where their water comes from, and how much it costs.

What's leading practice?

How we are better understanding our customers and community

As water utilities continue their journeys to become more customer centric, and as climate change begins to have greater implications for service standards, supply augmentations, and bills, customer engagement processes are becoming more sophisticated.

CASE STUDY 12 YARRA VALLEY WATER

Determining customer support to mitigate greenhouse gas emissions and climate change impacts

For its 2018-2023 pricing submission to the Victorian Essential Services Commission, Yarra Valley Water utilised two innovative customer engagement techniques - a Citizens' Jury and a conjoint analysis to determine its customers views on a wide range of matters.

This was informed by an extensive jury information pack which included the challenges Yarra Valley Water faces with climate change their pledge to reduce emissions. This material was followed up by some expert 'witnesses' who spoke on climate change impacts amongst other matters. The Citizens' Jury's recommendation to save water now for the future was driven by the impacts of climate change. They also endorsed Yarra Valley Water's commitment to reduce greenhouse gas emissions.

While customer sentiment was clear in not wanting a bill increase, customers endorsed seven outcomes to be delivered over the 5-year period, including strengthening Yarra Valley Water's targets for per capita water consumption and greenhouse gas emissions. This resulted in a $1m per year increase in expenditure for the utility's work to protect the environment over the price period.

CLIMATE THEMES ADDRESSED

CUSTOMERS + COMMUNITY | REGULATORY OBLIGATIONS | WILLINGNESS TO PAY | EDUCATION

Customer and community climate and water literacy

Community climate and water literacy is essential if we want customers to understand costs and trade-offs, and participate in investment decisions regarding climate change.

During Victorian PREMO pricing submissions many water utilities reported that their customers wanted to know more about their water utility. While engaging with customers about how their water utility plans to tackle climate change is important, having meaningful conversations with customers about where their water may come from in the future is arguably even more critical.

Customer acceptance can have major implications for water utility supply sources, with associated cost implications. Education is critical to acceptance, particularly around purified recycled water for drinking.

Consistent messages, demonstration of success and sufficient time for public engagement is imperative for the introduction of alternative water sources and our adaptation to climate change.

How we are improving climate and water literacy

Education may be as simple as changing the language when we communicate with customers.

For example, in their 'Our Water Future' community engagement program, Barwon Water uses the phrase 'a hotter, drier climate' instead of 'climate change' to be clear about the impacts for the region.

Barwon Water's Our Water Future engagement program

This is a comprehensive, 18-month engagement program ahead of their 2022-2027 Urban Water Strategy (a regulatory obligation) to work with the community, stakeholders and regional leaders to design a new water future for their region. It uses a partnership approach and includes the following steps:

Working with the community, stakeholders and regional leaders to gather ideas, develop a community vision and determine criteria to assess ideas and options

With the community, work through options to consider for their new Urban Water Strategy

Draft the 2022 Urban Water Strategy, which will take into account recommendations from the community panel and include another round of community consultation

These steps are designed to ensure that Barwon Water's customers and community have a deep understanding of the implications of climate change for their region, the trade-offs that need to be considered, and how that may affect both their bills and where their water comes from in the future.

Future service standards and willingness to pay

Water utility customers and the community generally expect water utilities to do the right thing when it comes to the environment. However, working towards Net Zero and adapting to the impacts of climate change are not always least cost options.

Water utilities have made a significant shift towards placing their customers at the heart of their operations. At its core, it means engaging with our customers to understand their preferences and incorporating this into our strategic decisions and service standards.

A key consideration is to what extent current service standards can be maintained in a cost-effective way in the context of climate change. In general, customer surveys indicate that the broader customer base is satisfied with the current levels of service, do not want these decreased and yet are not willing to pay for an increase in service standards.

While many new assets are being driven by population growth and renewals, maintaining existing service standards in the face of climate change will come at increased maintenance, operating and asset renewal costs. This is in addition to the investment required to bring online new water sources, cater for growth and increased customer expectations around areas such as liveability, stormwater management and waterway health.

Economic regulators have also sometimes had concerns where investing in mitigating and adapting to climate change could result in higher prices to customers – in 2020 the economic regulator in South Australia, ESCOSA, determined that SA Water's Zero Cost Energy Future plan should be funded commercially rather than through customer charges.

This means that a key activity for water utilities is helping regulators understand that customers are willing to pay for emissions reduction efforts and other climate change programs that go beyond cost effectiveness.

Willingness to Pay studies are one of a number of techniques water utilities are using to decide on what investments to make and to demonstrate the customer's input to this decision. These studies are particularly relevant for monopoly organisations where customers cannot choose their provider. While willingness to pay studies cannot answer all questions, the use of the technique has matured in recent years and water utilities should be considering them when determining their investments and pricing submissions.

The aim is to educate customers on how climate change influences the provision of water and sewerage services, and the costs and trade-offs associated with it, while gaining an understanding of their appetite to contribute financially through increased bills.

> The goal for water utilities is to have complex conversations with our customers: climate change will impact levels of service, there will be costs associated with this, what are you prepared to pay for this and how should we manage investment to ensure equity and fairness for future generations.

How we are determining future service standards and our customers' willingness to pay

Understanding the future risks, costs and benefits of a range of service standards is a challenging area that needs further work to enable timely investments. Trade-offs between service standards and costs need to be subject to rigorous cost–benefit analysis, public consultation and review, taking into account the effects of climate change mitigation and adaptation. Revised management objectives and service standards may be required in light of both mitigation efforts and adaptation to the impacts of climate change.

The urban water industry will need to engage with both customers and regulators in this space, and apply an evidence and risk-based approach to determining future service standards.

The risk for the sector is that if it's not done well, it could set up a tension between the expectations of customers when it comes to service standards and the cost of future services.

An area of future work for the industry is in understanding customer preferences and willingness to pay for different emissions reduction measures, including carbon offsets, as each capture a different set of benefits. Gaining an appreciation of customer preference here can assist water utilities to target investment in carbon offsets including carbon sequestration projects that may have associated liveability, biodiversity and other benefits.

What's leading practice?

Scottish Water's 2020 Pricing Determination

One of the best examples of the role of customers in determining climate adaptation investment for a water utility is Scottish Water and their 2021 pricing determination. It demonstrated how customers can be brought into a strategic engagement about the need for investment to meet future climate adaptation needs.

The innovative aspects of this approach included:

- Co-design of the pricing determination between the customer forum and the organisation (as opposed to a more adversarial negotiated outcome)
- Taking a long term approach beyond the regulatory period
- Moving beyond the lowest cost approach and included non-financial costs and benefits when considering options
- A transparent process with a commitment by Scottish Water to adopt the principle that 'every decision should be the one it would take if the customer were in the room'.

The outcomes of this customer engagement process included customers agreeing to a 28% increase in capital spending, resulting in a 2.5% + CPI bill increase annually for six years, to deliver on the vision of:

- Net Zero carbon emission by 2040
- Maintaining and replacing Scottish Water's aging asset base in an optimal way (carbon and circular economy considerations)
- Delivering liveability and wider social benefits (job creation, access to green space for leisure and well-being).

The price increase was the lowest that still enabled Scottish Water to deliver the vision above.

CASE STUDY 13 HUNTER WATER

Customer perceptions of climate change and willingness to pay for climate change programs

As a result of its largest ever residential customer survey in 2018, Hunter Water has robust evidence of the role customers want it to play in a low carbon future. More than 90% of customers support taking action now to address climate change, and around 75% are willing to pay $1 or more annually on their water and wastewater bills to reduce Hunter Water's greenhouse gas emissions.

CLIMATE THEMES ADDRESSED

NET ZERO EMISSIONS | ENERGY MANAGEMENT | CUSTOMERS + COMMUNITY | REGULATORY OBLIGATIONS | RENEWABLE ENERGY | CARBON OFFSETS | WILLINGNESS TO PAY | EDUCATION

Equity in climate adaptation

Climate change is generally expected to make regions that are already hot and dry, hotter and drier in the future. At the same time many of these areas are expecting major population increases. Water utilities have an opportunity to use water to help deliver an equitable climate adaptation response.

As housing prices tend to be lower in growth areas than established areas of Australian and New Zealand cities, they tend to attract people from a lower socio-economic demographic, including newly arrived migrants and people from non-English speaking backgrounds. The combination of a lower socio-economic demographic, non-English speaking cultures and the need to adapt to climate change in already hot and dry areas presents a major challenge.

The NSW government has projected the impact of climate change in terms of temperature rise, drought frequency and heatwave intensity and duration on the state's Aboriginal population. The research has found that 20% of the state's Aboriginal population live in areas that already have the most days per year over 35°C, and are more than twice as likely to live in drought affected areas.

Water utilities servicing these areas will need to consider how they can support vulnerable populations during droughts and times of water restrictions.

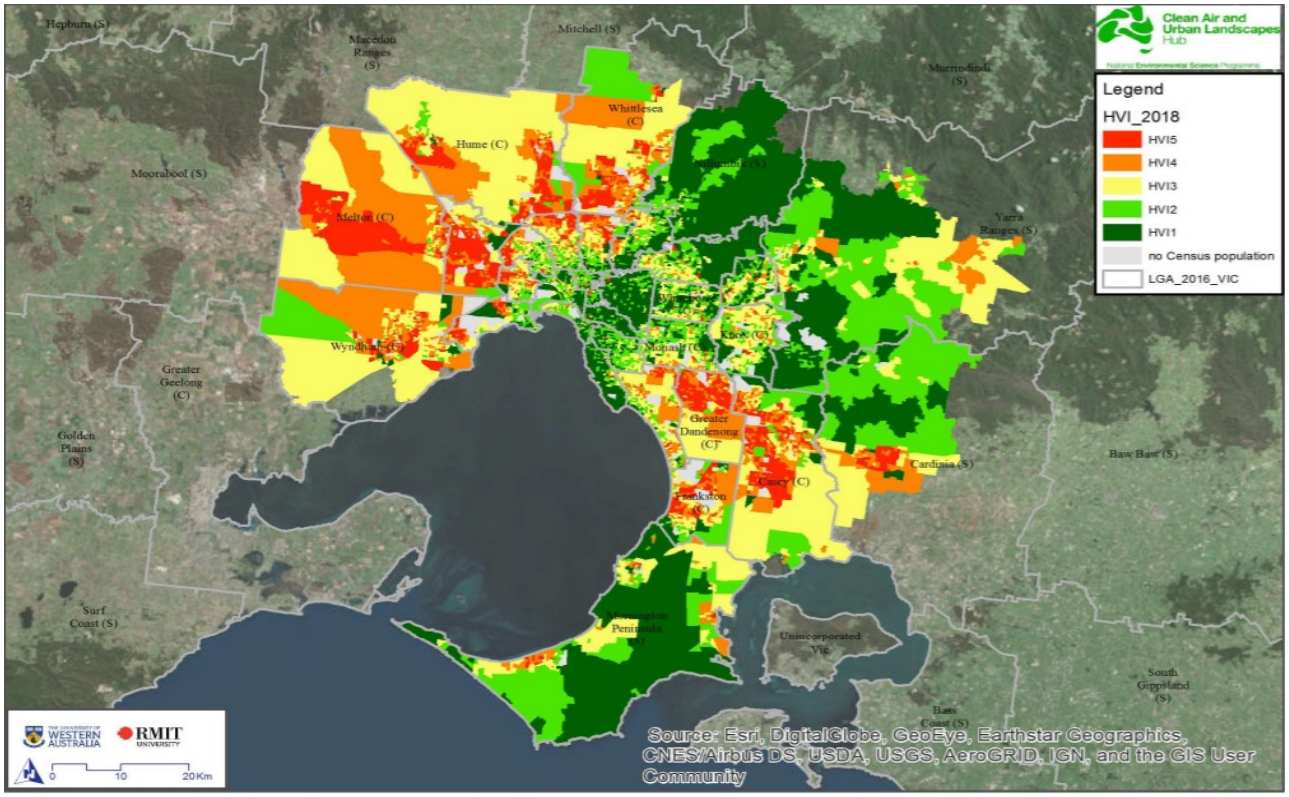
How we are delivering equitable climate adaptation

The water industry is working through how best to support equitable responses to climate change, and current activities include work supporting urban greening efforts through water in some of our hottest, driest and most disadvantaged suburbs, such as in western Sydney and western Melbourne (see Case Study 14).

What's leading practice?

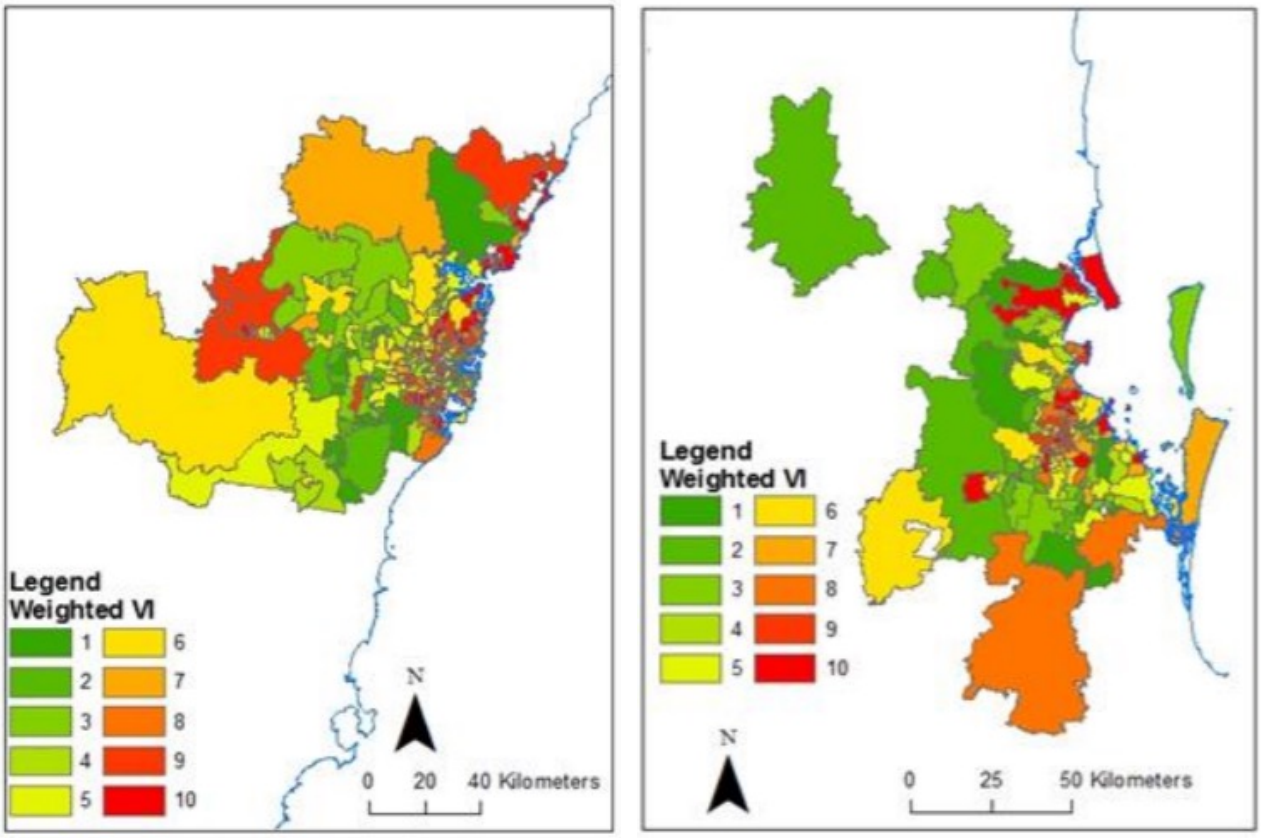
One of the biggest considerations in terms of equity, is intergenerational equity when it comes to investing in climate change adaptation. Investment (along with the necessary price rises) should be spread across long time horizons. Investing earlier will be less expensive than postponing investment, even though the benefits may not be seen for many years. There is evidence of support for this which resulted in smoother price rises in the 2020 Scottish Water pricing determination (see Future Service Standards and Willingness to Pay).

FIGURE 25 Map of the Heat Vulnerability Index at SA1 level in Melbourne



SOURCE Sun et. al. (2019)

FIGURE 26 Greater Sydney and Brisbane heat vulnerability index



SOURCE Loughnan et al. (2013)

CASE STUDY 14 GREATER WESTERN WATER

Greening the West

Greening the West is an example of a successful regional scale urban greening and cooling collaboration, demonstrating equity in adapting to climate change in Melbourne's booming western suburbs. Greater Western Water's role has been more than their core business of water and sewerage provision - but to lead and galvanise a broad coalition of stakeholders with similar drivers, provide water expertise and alternative water sources for the greening effort, as well as assist in delivering significant community benefits.

CLIMATE THEMES ADDRESSED

CUSTOMERS + COMMUNITY

CUSTOMERS + COMMUNITY

CLIMATE HAZARDS

EQUITABLE RESPONSES TO CLIMATE ADAPTATION

3 Building the capability of our people

Climate literacy and climate-ready skills

Climate change is arguably the most significant transformational force impacting on our sector. However, there is still significant uncertainty on the speed and extent of impact that key drivers for change will have on water and wastewater workforces.

To be successful in this uncertain future, water utilities will need to ensure the concepts and implications for the business of climate change mitigation, adaptation and resilience are widely understood within the workforce, and be able to attract the right sorts of talent to maintain a climate-literate workforce with climate-ready skills.

WSAA's Workforce Skills of the Future Report (WSAA 2017) considered the key drivers of change in the future, and explored eight different scenarios which describe what the future water sector could plausibly look like.

Key scenarios were based on the following:

- Climate change (stable versus unstable and strained)
- Customer engagement (engaged and active versus passive)
- Regulation (highly versus self-regulated)
- Technology adoption (stable versus rapid and disruptive)

Water utilities will need to carefully consider how these scenarios will impact on the skills needed in the future to manage their strategic approach to climate change, including across workforce health and safety and education.

Resiliwiki *Climate change adaptation for staff*

To address the challenges of adapting to climate change and improving water utility decision-making, Water Research Australia and several utility members funded a project involving more than 30 industry experts to develop a new online resource for climate change adaptation information. Located at **https://climateadaptation.atlassian.net**, it is intended to be the 'first stop for climate change adaptation guidance'.

The site builds on WSAA's Climate Change Adaptation Guidelines by:

- Suggesting best-practice assessment approaches suitable at the local scale
- Identifying available climate data
- Determining how to select adaptation options that best mitigate local effects
- Reviewing mechanisms which are most effective for developing an organisational response to achieve climate resilience.

There are four key resources that are available through the site:

- A review of global good practice in climate change adaptation
- The 'pathfinder'; a tool that helps identify appropriate assessment approaches and data identified using a series of flow charts
- A climate change syllabus that outlines fundamental competencies needed by practitioners
- The 'future directions' guide, which identifies key areas for improvement by water utilities for better data-driven decision-making

The site is now ready for user adoption and is available to all members of Water Research Australia.

What's leading practice?

Climate literacy in our workforce will be a foundational step for water utilities developing strong whole of business strategies to deal with emissions reduction, climate change adaptation and resilience.

Whole of business training programs for staff on climate change can help to ensure that all staff are climate literate. As part of its Climate Adaptation Plan, Icon Water includes staff health and safety campaigns in its list of existing business resilience to climate change controls.

Peer to peer learning, of the sort offered by WSAA and other organisations, also play a significant role in developing workforce climate skills and knowledge base, adding much value to utility climate mitigation actions and adaptation measures.

Maintain a healthy and safe workforce

Water utilities deliver an essential service that must continue despite the prevailing weather conditions. This includes maintaining service continuity on days of extreme heat, bushfire risk, storms and flood events. Climate change is exacerbating the issues that staff may deal with on a day to day basis.

> The health, safety, and wellbeing of our people, communities, and workplaces is critical. We strive to be free from harm and injury, both physical and psychological. The industry is committed to taking a focused and strategic approach to achieving impactful and sustained changes (WSAA and EY, 2019).

Climate change presents both physical and mental health and safety issues for staff, both from higher average temperatures as well as extreme heat, including:

- Direct and acute safety threat to staff accessing assets and worksites due to the impacts of extreme climate-related events (eg. bushfires, extreme heat, floods, storms)
- Indirect risk to staff, for example through extreme heat exposure causing heat stress (dehydration, heat stroke, sunburn), reducing productivity, and increasing risks of heat-related morbidity and mortality
- Mental health impacts on staff from extreme climate-related events in the local community (eg. stress, anxiety, depression, PTSD, alcohol and substance abuse, aggression and violence, suicide, and exacerbation of other underlying mental health problems), including from loss of personal assets and those of people known to staff, and local environmental impacts.

How we are maintaining a healthy and safe workforce

This is an emerging area of risk that the urban water industry is looking to build the evidence base for, to better understand the quantum of current and future impact on staff as a result of climate change.

Some of the ways in which specific climate risks are being managed by the urban water industry include:

- Incorporating climate risk management into corporate incident and emergency management plans
- Prepare, practice and review emergency response plans
- Developing and promoting partnerships and collaboration with a range of stakeholders, landowners, the community and other industries to more comprehensively plan and manage extreme event response
- Adopting new technology (e.g fatigue management monitoring)
- Developing collaborative culture internally and training staff on workplace arrangements, operational requirements and site inductions during extreme events
- Rotating rosters for operational staff and limiting time in the field to ensure staff have adequate recuperation time
- Flexible working arrangements
- Including physical/mental health and safety in the entire project lifecycle (eg. planning, design, construction, operations and maintenance)
- Ensuring staff:
  - Are aware of declared risks and are briefed on OHandS standards, equipment and procedures including emergency response procedures
  - Are medically and physically capable of doing the requested work
  - Have adequate skills base to safely and successfully undertake the work
  - Have access to and take with them to worksites the correct PPE
  - Are given adequate breaks and access to physical and mental health and wellbeing services.

What's leading practice?

WSAA has developed several sets of guidelines which are progressing the industry towards best practice in managing and mitigating the impacts of climate-related events on our workforce:

- Bushfire management: National Good Practice Operational Guidelines for the Australian Water Industry (WSAA, 2020a)
- Water Industry Health and Safety Maturity Model and Water Industry Mental Health Framework (WSAA and EY, 2019) – this includes a commitment to Zero Harm, which can also be viewed in the context of the impacts of climate change on staff health, safety and wellbeing
- Water Industry Fatal Risk Guidelines (2018).

Climate and resource stress will have an impact on the future of the work environment, and is included as a major consideration in WSAA's Water Industry Health and Safety Maturity Model.

4 Managing our financial risk

Climate change and water industry financial trends

Climate change is a financial mega-trend. In 2020, Deloitte put the cost of inaction on climate for Australia at $3.4 trillion, and 880,000 fewer jobs by 2070, and estimated that the economic impact of the COVID-19 pandemic is similar to the economic impact that climate change is likely to have every year out to 2050 if we do not adapt quickly enough.

At a time of strongly increasing investment in the industry, financial resilience is emerging as a concern. Financial resilience across the urban water sector is fundamental to meeting industry challenges while maintaining the affordability of services. The recession associated with COVID-19 has placed pressure on both utility revenue and customers' ability to pay and underlines the need for the industry to be able to withstand financial shocks.

Climate change will compound the financial trends already occurring in the industry:

- High demand for capital from renewal of assets, new investment in water security assets to manage population growth and lower inflows to surface water storages, as well as digital innovation in the industry
- Policy and regulatory expectations for downward pressure on prices at the same time as having high investment levels is increasing debt
- Likelihood of increasing interest rates after a benign period with record low rates will increase debt servicing costs.

The climate risks described earlier in this paper (see Climate risk assessments) carry financial implications that are material for the water industry:

Physical risk

Financial implications of impacts on natural and built environment.

Economic transition risk

Market impacts driven by policy, technology, social responses to those physical risks.

Liability

Financial implications of litigation from failure to mitigate or adapt.

These are no longer just long term risks, but are emerging over mainstream investment horizons including the short term, and have increased in materiality and magnitude as a result of three key drivers:

Net Zero Emissions policy

Approximately 110 jurisdictions around the world have policy or legislated targets for Net Zero Emissions by 2050, and target-setting escalated significantly in number and sectoral distribution during 2020.

Changes in expectations from equity and debt investors

Climate change has overshadowed the impact from the pandemic in this area, and is evidenced in continuing analysis and divestment from high carbon intensity industries and companies exposed to climate risk.

Legal liability

Climate change remains the most significant legal threat globally, and is no longer limited to large emitters, but includes public sector entities that fail to adequately have regard to or manage climate risks

The recent bushfires in Australia have heightened the legal risks for directors in relation to climate change.

The financial sector is therefore exposed to climate-related financial risks when they finance companies that have a major impact on the climate and the environment, or that aren't managing their own climate risks appropriately.

Water Utilities are in turn exposed to climate risk in the financial market in a number of ways. For example:

1. Some utilities seek capital directly from the market and may face availability constraints or increased costs of finance.
2. For utilities that primarily borrow from their State Government Treasury Corporations there is greater risk that they will be subject to Statewide financing constraints as state debt increases.
3. More generally, if climate risk increases capital costs a higher Weighted Average Cost of Capital (WACC) will increase water prices. Affordability concerns may limit the capacity of water utilities to invest in longer term assets.
4. Banking divestment of high carbon emitting industries, for example of coal fired power plants that supply water utility assets
5. Possibility of insurance premium rises or unavailability of insurance for assets exposed to climate risk, or have high carbon intensity.

These risks may accrue earlier to regional water utilities with smaller revenue bases.

How we are managing our financial risk

Evidence from Sydney Water's participation in the NSW Green Bonds program has indicated that investors are increasingly focused on water stress and nature-based solutions, with the bonds program being heavily oversubscribed since launching in 2018. This is one way water utilities and governments can de-risk their asset portfolios (see section on Sustainability Bonds and Valuing our Natural Capital).

What's leading practice?

Though several water utilities are considering it, at the time of writing only one utility, Coliban Water in regional Victoria has taken the step to include a shadow price for carbon in its capital investment decision making process, which it expects will reduce the risk of their capital investment program locking in a high carbon future (see Case Study 15).

The implications of a national carbon price on the water industry are similar to a utility's shadow carbon price, but would go further, and there are likely a number of direct and indirect impacts (NWC, 2012):

- Some water utilities may become liable for fugitive emissions, if they were to exceed the threshold set
- Higher input costs for energy and energy-intensive inputs
- Impacts on demand, reflecting higher energy costs faced by users.

A carbon price would increase the cost of operating facilities that produce emissions, however this has been estimated to be relatively low compared to overall operating costs.

Estimated impact of a national carbon price on Sydney Water

Required spend of $900,000 year on carbon permits for its scope 1 emissions (less than 1% of its total operating expenditure). Increased energy costs of $8.6m per year, versus an extra $12m per year to meet the cost of water security and diversified supplies. Increases in costs of carbon-intensive inputs to its supply chain (Scope 3) to increase opex by $5.9m per year. Capex to increase by up to $3m per year, in a $636m capital works program for 2010-11 financial year (ie. Less than half a percent)

SOURCE Sydney Water, 2011

CASE STUDY 15 COLIBAN WATER

Application of a shadow carbon price in capital decision making

The use of a shadow carbon price by Coliban Water is an example of explicitly considering future costs of carbon in decision-making. It is expected that the approach will drive behavioural change in the business through the consideration of carbon and climate change at the beginning of the project lifecycle. In addition, the business will likely avoid 'lock-in' of high emitting technologies.

CLIMATE THEMES ADDRESSED

NET ZERO EMISSION

CLIMATE CHANGE PROJECTIONS IN DECISION MAKING

DIRECTOR LIABILITY/TCFD

Director liability in relation to climate change

Water utilities are generally well prepared to meet the risks of litigation as a result of climate change. Water is a resource that is inherently subject to climate variation and climate change, and water utilities build this risk into their long-term planning to ensure continuity of supply and the other services they provide.

Water utilities, where they operate under a corporatised model, have Boards which are subject to the same fiduciary duties required of all corporations under the Corporations Act (Cwlth 2001). Various states and territories also have their own legislation that sets out additional requirements of Boards and senior directors.

An update of The Centre for Policy Development's (CPD) Hutley-Harford Davis legal opinion for the public sector in 2019, found that public sector directors have duties of care and diligence to consider climate risk that are at least as stringent as private company directors.

The Hutley-Harford Davis opinion emphasised that directors who do not properly consider and disclose foreseeable climate-related risks could be held liable for breaching their legal duties (Hutley and Hartford-Davis 2016).

Though there are some likely impediments to enforcement for public sector directors, CPD cautioned that with increasing climate risk and impacts on public infrastructure, service provision, customers and the environment, there is likely to be increased scrutiny on the public sector's role in accounting for climate risk (Dibley, Hurley and Sheppard 2019). The discussion paper included five recommendations, aimed at state governments that could help public sector Boards and directors better manage climate risk:

- Create a whole of government toolkit and implementation strategy for considering and managing financial risks arising from climate change
- Use existing public authority accountability mechanisms to strengthen management of climate-related financial risks
- Issue formal ministerial statements of expectations to clarify how public authorities and their directors should manage climate-related risks and policy priorities
- Consider legislative or regulatory changes to ensure consistent consideration, management and disclosure of climate risk by public sector decision makers.

Litigation is a material risk for public sector Boards. The UN Environment Program published its Global Climate Litigation Report: 2020 Status Review, which notes that globally, climate change-related litigation doubled form 2017-2020, with over 1500 cases filed in 38 countries (UNEP 2020). At the time of writing no damages have been awarded to a plaintiff in any of these cases, however at least one US utility (Pacific Gas and Electric) has filed for bankruptcy over their failure to adapt to climate change.

Common climate litigation charges include:

- Violations of "climate rights" that impact fundamental human rights including the right to life, health, food, and water
- Government failure to enforce climate change mitigation and adaptation commitments
- Corporate messaging that contains false or misleading information about climate change impacts or carbon reductions.

In 2021 the NSW Environment Protection Authority became a local example of climate litigation, after a successful class action lawsuit by the Bushfire Survivors for Climate Action (BSCA) resulted in the NSW Land and Environment Court ordering the EPA to take steps to safeguard against climate change.

Australia is the second most active jurisdiction for climate change-related litigation globally, after the United States (Mallett et. al., 2020).

How we are managing director liability

As part of its Pilot Water Sector Climate Change Adaptation Action Plan (DELWP 2018), the Victorian Department of Environment, Land, Water and Planning (DELWP) has put together guidance for the Boards and senior executives of Victorian water utilities and catchment management authorities, outlining both the physical and transition fiduciary risks as water utilities move towards a Net Zero future.

The Managing Climate Change Risk: Guidance for Board Members and Executives of Water Corporations and Catchment Management Authorities report (DELWP 2019) provides a clear articulation of existing director obligations and includes steps for effective decision making to assist in discharging those obligations. Guidance includes:

- Where the obligation to manage climate risks comes from
- The extent of a Board member's duty in relation to climate change
- How Board members can discharge their duties with due diligence
- How entities can plan and act when there is uncertainty.

What's leading practice?

Melbourne Water's 2020-21 Annual Report includes description of how they are managing climate risks, which includes (Melbourne Water, 2021):

- Scenario planning
- Risk governance and management, including KPIs and indicators that help to track adaptation, and manage risks to water supply, sewerage, flood and drainage, and waterways
- Climate planning and response.

Three key pieces of guidance in this area, TCFD, Australian Securities and Investment Commission (ASIC) climate governance, and the Australian Institute of Company Directors (AICD) Climate Governance Initiative can be mapped against each other to provide a useful guide for water utilities looking to navigate and assist decision makers in this area (Table 10). The AICD Climate Governance Initiative in particular provides a list of questions for company directors and Boards to ask their organisations in order to ascertain and reduce climate risk (TCFD, 2017; ASIC, 2021; AICD, 2021).

TABLE 10 Mapping director liability guidance for water utilities

TCFD RECOMMENDATIONS	ASIC CLIMATE GOVERNANCE	AICD CLIMATE INITIATIVE
Governance	Consider climate risk	How are issues associated with climate change integrated into our Board Governance (strategic and oversight) responsibilities? Is this issue receiving adequate focus?
		Should this be a matter for the full Board, included in the remit of an existing subcommittee, or does it require a specific sustainability subcommittee?
		Do we have the right leadership for the strategic direction we want the organisation to take?
		Do we need to recruit management with differing skills and experience?
Strategy		Are there emerging regulatory or policy developments that may signal market directions?
		What are our competitors doing – or planning to do?
		Should we introduce GHG targets? Should we have a pathway to Net Zero? How are our augmentation lead times changing?
		Have we considered how the changing climate may impact on our operations and supply chain?
Risk management	Develop and maintain strong and effective corporate governance	What is the organisational policy on climate change? Do we need a specific document?
		How do we as a Board and senior management ensure we are staying up to date in this dynamic area?
		Are our remuneration structures aligned with our strategic approach to climate change or do they create perverse incentives, for example that may favour investment in assets at risk of being stranded in a transition economy?
	Comply with the law	No related initiative
Metrics and targets	Disclose useful information to investors	Where have we assessed climate change as a material issue?
		How have we assessed its potential impact on our financial position and prospects?
		Have we put specific questions to our CFO about the impact of material climate assumptions on asset useful lives, valuation and impairment, liability provisions, revenues, expenditure and cashflows?

Insuring against climate risk

Climate change equals insurance risk. These risks are increasing as our climate warms, our seas rise and our soil dries out. The risks are amplified for coastal assets in particular. Working closely with the insurance sector on clearly defined climate adaptation methods and data may lead to stable or declining insurance premiums.

As the cost of insurance reflects risk, we will likely see premiums rise as climate change impacts increase. Accordingly, when risk is reduced, for example through climate adaptation measures, the cost of premiums should reduce.

Globally, extreme weather events including hurricanes, winter storms and bushfires are pushing insurance premiums higher globally, though it is difficult to disentangle these from other factors that raise premiums.

An extreme weather event doesn't have to happen in Australia/New Zealand for insurers to price in the risk, or retreat from it. Experience overseas may convince local insurers of a change in risk profiles.

Anecdotally, the impact water utilities are seeing on insurance from climate risk depends on location and recent extreme weather events. In Far North Queensland several retail insurers have exited the market, and some council water utilities are seeing even mutual insurance schemes increasing premiums by 10–15% annually. In some jurisdictions, water utilities are not seeing any change yet to their premiums.

Water utilities in many locations have assets located at or near sea level, or in bushfire-prone areas, leaving them exposed to climate risk. While good asset design has reduced some of that risk, many of our assets are long lived and we need to ensure they are able to be covered by insurance over their full lifecycle.

TCFD is likely to have the largest impact on insurance premium rises in the short-medium term by the same market-driven changes occurring in the financial sector more broadly (see Climate change and water industry financial trends).

Importantly, major global central banks are being asked to report on their climate risks. State and Federal governments sell their Treasury bonds to these banks in order to raise finance. In turn, State and Federal Treasuries are likely to be asking water utilities for a clearer picture of their climate-related risks.

Water utilities insured in the commercial market may be more exposed to these changes than water utilities insured through state or local government captive insurers. Smaller regional utilities may also be more exposed to these changes as a result of the cost of the climate adaptation measures necessary to reduce their risk.

How we are insuring against climate risk

There are a wide range of ways that water utilities insure themselves against climate risk for their assets. Options that are utilised include:

- Retail insurance for individual assets or asset portfolios
- Self-insurance through mutual insurance schemes
- Captive insurers, owned by individual local or state governments, covering certain proportions of risk, or all risk
- Negotiating directly with insurance underwriters (anecdotally quite common)
- Asset retreat (the extent to which this option is utilised is unclear).

The Brisbane floods class action, and the Insurance Council of Australia withdrawing support for the Warragamba Dam wall raising in 2021 shows that insurers are starting to look more closely at the water industry.

There are therefore opportunities for water utilities to better understand their climate risks and maintain or increase insurability – often the major risks are in just a few assets rather than across the entire asset base – and adapt those assets where possible.

What's leading practice?

Adapting to climate change should reduce risk, and hopefully liability. Generally speaking, water utilities have government shareholders that have a role in ensuring water utilities will have access to finance to cover potentially rising insurance premiums. Some jurisdictions and some insurance managers also provide guidance to their water utilities on best practice in reducing their liability.

There may be a gap in jurisdictions where this guidance is not provided, a point highlighted by the Royal Commission into Natural Disaster Arrangements (Commonwealth of Australia, 2020), which noted that insurance companies should provide better guidance on acceptable methods to reduce liability for individuals, and a claim can be made that this should be extended to sectoral guidance for broader risk reduction.

The Cross Dependency Initiative (XDI) advocates for risk-based insurance pricing as one of a suite of recommendations aimed at government and regulators, to reduce climate risk to the built environment. Under this recommendation, financial regulators would require that insurance industry products fairly reflect both site specific hazard probabilities and asset specific vulnerability, thus providing lower premiums for more resilient designs and materials, and a clear market signal that investment in resilience will be fairly rewarded by lower premiums (Mallon et. al., 2019).

Importantly, XDI also recommends that State and Federal governments implement support schemes to finance adaptation in areas at high risk. This could finance resilient construction, municipal works or relocation of assets (Mallon et. al., 2019).

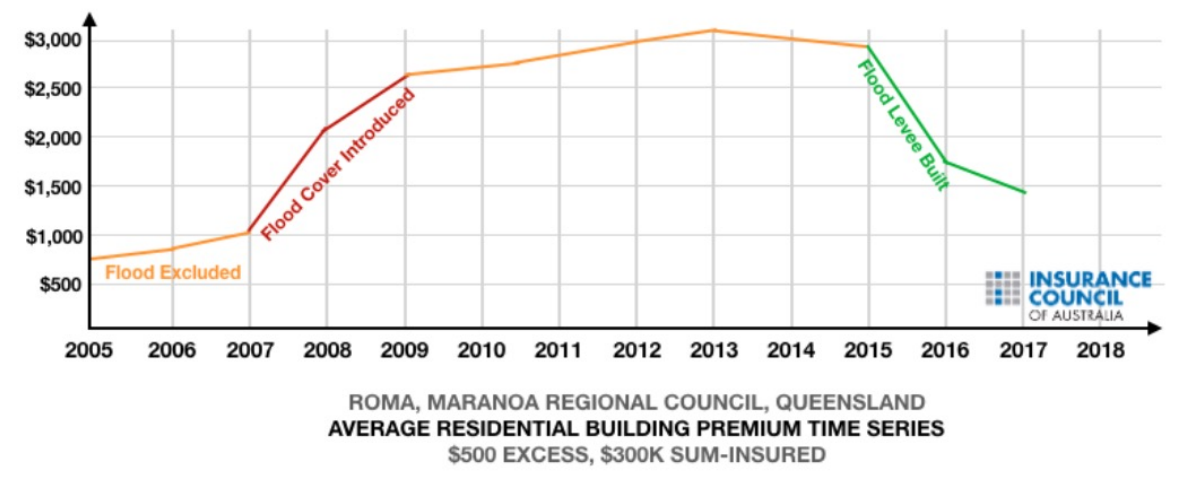
The Royal Commission into Natural Disaster Arrangements noted that the insurance industry can encourage risk mitigation by providing clear guidance on the measures that will materially reduce risk, and therefore lower premiums (Commonwealth of Australia, 2020).

A gap in industry knowledge is how much climate change adaptation measures can influence insurance premiums. Closer and more effective collaboration between the insurance and water sector is clearly in the best interests of businesses, shareholders, customers and insurers. Equally, water utilities should work with insurers to provide data that demonstrates material risk reduction, in order to see premiums reduced.

Climate adaptation reducing insurance risk

One of the few water-related examples of insurers reducing premiums in response to risk mitigation is not a water industry case. In 2007 retail property insurance premiums rose sharply in Roma, south-west Queensland, as flood damage was included for the first time in policies. In 2012 Suncorp wrote to Maranoa Regional Council and stated that insurance policies for Roma residents would not be renewed. Many residents struggled to insure their properties until the state government stepped in and helped fund risk mitigation measures in the town, including a flood levee, which by 2015 had resulted in insurance premium reductions (Figure 27).

FIGURE 27



SOURCE Insurance Council of Australia https://disasters.org.au/news/2018/6/29/the-dollar-value-of-mitigation-roma-flood-mitigation-insurance

Sustainability bonds

Sustainability or 'green bonds' are a financial instrument geared towards investment in sustainability projects, and represents a shift of investor sentiment towards projects with 'green' credentials and nature-based solutions. Globally there is huge appetite from investors for green bonds and demand currently exceeds supply in this $1.2 trillion market.

There are two main types of 'Green bonds':

- Proceeds bonds, as the name suggests, fund projects with dedicated environmental and/or social benefits
- Sustainability-linked bonds do not finance particular projects but rather finance the general functioning of an issuer that has explicit sustainability targets that are linked to the financing conditions of the bond.

The use of sustainability bonds can promote the development of green and blue infrastructure instead of hard or 'grey' infrastructure solutions to water industry and liveability problems, through its focus on nature-based solutions.

In 2018, the NSW Government launched the first Sustainability Bonds Program in Australia to promote investment in infrastructure that provides broader sustainability benefits, including building future climate resilience. The program was heavily oversubscribed, giving an indication of the support for these sorts of financial instruments in the investor community.

This is an emerging area for the urban water industry and few water utilities apart from Sydney Water have publicly announced their involvement or interest in these types of financial instruments.

CASE STUDY 16 SYDNEY WATER

NSW Sustainability Bonds

Sydney Water is playing its part to mitigate the impacts of climate change, protect and enhance our environment while shaping a low carbon, circular and sustainable water utility for future generations. To support this approach, Sydney Water has been a major participant in the multi-award winning NSW Sustainability Bond Programme (SBP) since its launch by the NSW Treasury Corporation (TCorp) in 2018. Eligible 'green' projects that Sydney Water has showcased through this programme include those that focus on renewable energy; energy efficiency; pollution prevention and control; sustainable stormwater management; climate change mitigation; and eco-efficient and circular economy adapted production technologies.

FIGURE 28 Cooks River Naturalisation Project funded by TCorp NSW 2019 Sustainability Bonds

SOURCE Sydney Water

CLIMATE THEMES ADDRESSED

NET ZERO EMISSIONS
ENERGY MANAGEMENT
CUSTOMERS + COMMUNITY
ADAPTIVE PLANNING
GREEN AND BLUE INFRASTRUCTURE
SUSTAINABILITY BONDS

Anglian Water's Sustainability Finance Framework

Anglian Water in the UK have developed a Sustainability Finance Framework to guide the issuance of Green, Social and Sustainability Bonds, private placements, bank facilities and leases, to fund their Asset Management Plan for the period 2020-2025.

The framework aligns with the ICMA Green Bond Principles 2018, the Social Bond Principles 2020 and the Sustainability Bond Guidelines 2018, as published by the International Capital Market Association (ICMA). The framework also aligns with the Loan Market Association's (LMA) Green Loan Principles 2020.

Figure 29 describes Anglian Water's business model under this framework, which commits Anglian Water's Board to using 'six capitals' in decision making, including natural capital (see next section Valuing our natural capital).

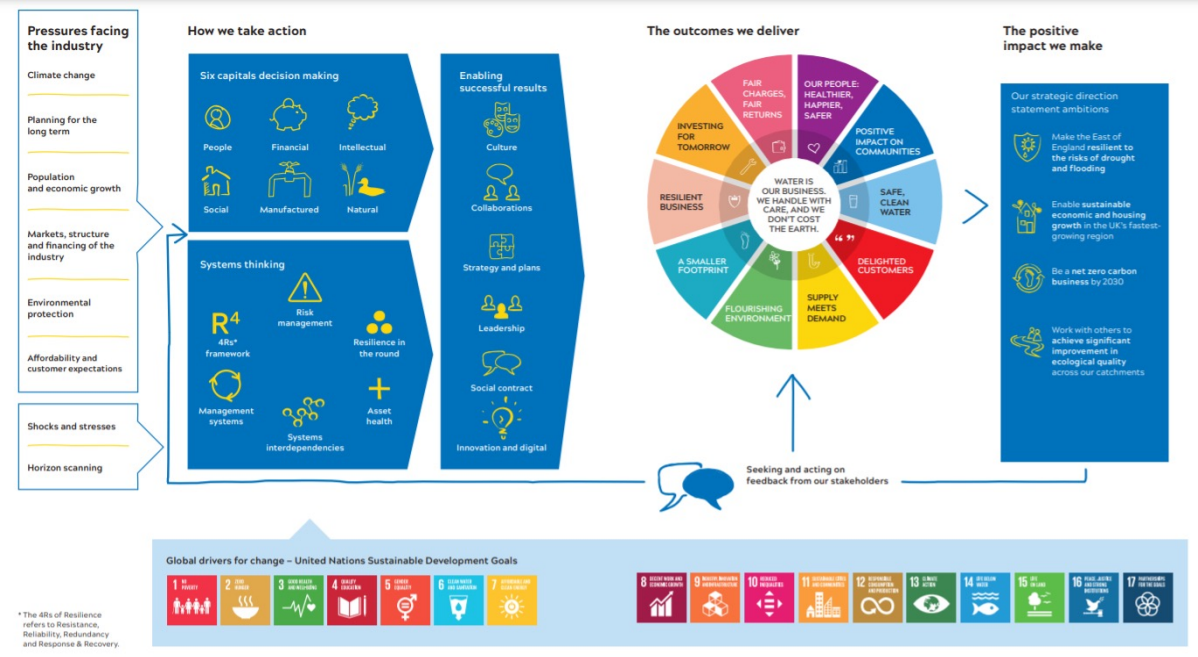
The Green Bond Principles

The Social Bond Principles

The framework supports the financing of water and water recycling projects that demonstrate environmentally sustainable management of natural resources and land use, as well as adapting to climate change.

This work has earned them Anglian Water two Queen's Awards for Enterprise: in 2015 and 2020.

FIGURE 29 Anglian Water Sustainability Framework business model



SOURCE Anglian Water 2020

Valuing our natural capital

There is a growing international consensus that recognising natural capital assets alongside other economic assets can steer investment away from negative outcomes and towards nature-positive outcomes. Natural capital assets for the urban water industry include green and blue infrastructure, which has the dual benefit of reducing our emissions and adapting to climate change at the same time. Valuing this 'natural capital' can assist in getting more consistent outcomes.

Traditional economics has had difficulty pricing in environmental externalities, meaning we largely do not account for the negative impact our economic activity has on our environment. As climate change impacts countries and companies' bottom lines, economists are starting to take seriously the need to put the planet on balance sheets. The UK Treasury Dasgupta Review, with a foreword by Sir David Attenborough, is a sobering assessment of humanity's failure to manage our global portfolio of natural assets (Dasgupta 2021).

Natural capital is directly relevant to at least eight United Nations Sustainable Development Goals (SDGs), including those targeting hunger, healthy lives, water and sanitation, resilient cities, sustainable consumption and production, climate change, marine ecosystems and terrestrial ecosystems.

For water utilities, valuing 'natural capital' and ecosystem services, such as green and blue infrastructure, can help to secure funding sources to deliver better outcomes for community and environmental health, and improve resilience to climate change at the same time.

> The urban water industry has a unique advantage over other sectors, to deliver green and blue infrastructure by virtue of the resource we manage. As part of valuing the natural capital we deliver, the industry has done the work to understand the health benefits directly attributable to water-enabled liveability, and they stack up – benefits attributable to water can be up to $94 per person per year (WSAA, 2019a).

Realising these benefits may be difficult, as there are no clear pathways to fund and deliver them. From a water utility perspective, this may result in missed opportunities to maximise water-enabled liveability.

A major opportunity to maximise the liveability benefits of water-related investments, and accelerate climate adaptation efforts at the same time, is to consider green and blue infrastructure as social infrastructure and fund it in the same way. This could include through public-private partnerships, contributions from beneficiary stakeholders, and direct government funding for identified public health benefits (WSAA, 2019a).

How we are valuing our natural capital

WSAA's 2019 report Blue + Green = Liveability highlighted two key challenges that need to be overcome in order to better achieve this (WSAA, 2019a):

1. Implementing an accepted framework for measuring liveability benefits
2. Funding blue and green infrastructure as social infrastructure

The urban water industry has put much effort over the past decade into this important area, and is continuing to progress in ways that include:

- Developing our economic evaluation capability, and including the financial, social and environmental value of water-enabled liveability outcomes in business cases (see Skinner and Satur 2020)
- Investing in improvements in modelling capabilities and data at a local scale
- Continuing to engage with customers to ensure we understand their preference and willingness to pay (see Future service standards and willingness to pay)
- Collaborating and sharing best practice information and data with partners in other sectors
- Working with shareholders and stakeholders to understand how benefits and costs can be equitably shared amongst project partners.

There are now lots of examples of water utilities investing in green and blue infrastructure (see Case Study 14), and the scale of potential benefits is large: one example from Sydney Water's work in the Western Sydney growth corridor estimates benefits to the environment and new communities of approximately $AUD6.5 billion as a result of green and blue infrastructure provision (WSAA, 2019a).

Sydney Water is participating in the NSW DPIE Recognising Natural Capital Program (ReNCAP), working with industry partners to improve the visibility of natural assets in financial decisions.

ReNCAP proposes to value some of these natural capital assets in a more comprehensive manner through a pilot study. The first stage of the pilot involves engaging with key individuals at Sydney Water through a series of workshops to identify the elements of a potential solution, before applying those to an accounting exercise in stage two. The program also aims to understand how government can facilitate the breakdown of barriers to achieving this, and support the NSW 2040 Economic Blueprint which guides state investment strategy towards sustainable projects.

What's leading practice?

There has been important progress in the development of accounting frameworks to assist in valuing natural capital. The System of Environmental-Economic Accounting—Ecosystem Accounting (SEEA-EA framework adopted by the UN in March 2021) enables the integration of the environment into standard economic reporting. It provides robust and internationally accepted concepts and methods to organise information on nature, so it can be linked to economic information and national accounting practices.

Several water utilities such as Urban Utilities are investigating aligning their accounting to this framework.

2 https://tnfd.global/about/

While the TCFD has generated a major shift in how water utilities approach climate risk, a similar taskforce has been set up for nature-related risks and opportunities – the Taskforce on Nature-related Financial Disclosures (TNFD)[2]. It is expected that this initiative will develop and deliver a risk management and disclosure framework for organisations to report and act on evolving nature-related risks, which aims to support a shift in global financial flows away from nature-negative outcomes and toward nature-positive outcomes.

For water utilities looking to better value their natural capital, aligning financial management and reporting to this framework may assist that endeavour.

Case studies

CASE STUDY 1 CAIRNS REGIONAL COUNCIL

Impact of cyclones on customer and service standards

Several cyclones will form in northern Australia each year, however they may not all make landfall (cross the coast) or impact the Cairns area. Active cyclones in the broader region may also bring periods of strong winds, heavy rain and flash flooding to Cairns. The most challenging impact of cyclones for water and wastewater infrastructure is the loss of telecommunications resulting in the inability to remotely control treatment processes. With the impact of climate change, Cairns is predicted to have less frequent but more intense cyclones, and so preparing for cyclones is a core business continuity requirement for the Council.

CLIMATE THEMES ADDRESSED

SERVICE STANDARDS

BUSINESS CONTINUITY

Background

The last Category 5 cyclone to impact Cairns was in January 2011 (Cyclone Yasi) with an estimated damage bill of $35 million. These costs were predominantly for damage to roads, vegetation and above-ground Council assets.

Council is experienced in both planning for and managing cyclones to reduce continuity of service risks. Key risks for the council water business during cyclone (or high intensity storm) events include:

- Damage to infrastructure from falling trees (both tree roots damaging pipes and trees hitting critical infrastructure)
- Loss of power
- Loss of SCADA communications
- Flooding risk, blockage of raw water intake infrastructure
- Flooding impact on raw water quality
- Safety of Copperlode Falls Dam.

During an emergency event, the delivery of water services is integrated with the Local Disaster Management Group. Regular exercises test the readiness of Council and other service providers for major cyclones. Council's Utility Services Branch (responsible for delivery of water and wastewater services) activates its operational Business Continuity Plan to ensure key staff are 'stood up' for the event, roles and responsibilities made clear, and fatigue management considered.

Other key risk mitigation measures include:

- Ensuring critical assets have generators, and a rigorous preventative maintenance program exists for Programmable Logic Controller (PLC) batteries
- Ensuring three days of drinking water storage before events hit
- Construction occurs in accordance with design guidelines that take account of cyclone ratings
- Dedicated operations control centre with additional cyclone safeguards, including cyclone shutters
- Stand-alone radio network
- Good relationship with the power provider to prioritise sites for reconnecting power

Benefits to the utility, and to climate-related outcomes

Like other water utilities, Council has Customer Service Standards relating to the provision of safe and reliable drinking water and effective treatment of wastewater. Considering cyclones and intense storms are a key risk for Cairns, it is appropriate for the Council to invest significantly in managing this risk. Building cyclone resilient infrastructure adds approximately 5% to project costs, which is a significant financial burden.

As part of its preparedness, Council develops Business Continuity Plans for cyclone events, and tests them annually against various scenarios.

According to the Australian Climate Council, an increase is likely in the proportion of the most intense tropical cyclones, those with stronger winds and heavier rainfall such as Yasi, while the total number of tropical cyclones will likely decrease.

Importantly for utilities south of northern Australia, a greater proportion of Tropical Cyclones may reach further south along Australia's east and west coastlines. It is important that other utilities can learn from the experiences of those that have been subject to these risks on an annual basis.

CASE STUDY 2 COLIBAN WATER, EAST GIPPSLAND WATER, LOWER MURRAY WATER, SOUTH EAST WATER, SOUTH GIPPSLAND WATER, SOUTHERN RURAL WATER, WANNON WATER, WESTERNPORT WATER, YARRA VALLEY WATER

Zero Emissions Water

Zero Emissions Water (ZEW) Ltd started as a joint project between 13 water utilities in Victoria (now consolidated to 12), to purchase renewable energy from the Kiamal Solar Farm, Victoria's largest solar farm located in Ouyen in the north west of the state.

This novel partnership between so many water utilities results in cheaper renewable power than if purchased individually. Participating water utilities benefit through lower emissions, while the contract also provides a hedge against rising grid-sourced energy costs. The outcome benefits the environment and creates savings for customers, helping to maintain steady water bills.

CLIMATE THEMES ADDRESSED

NET ZERO EMISSIONS

ENERGY MANAGEMENT

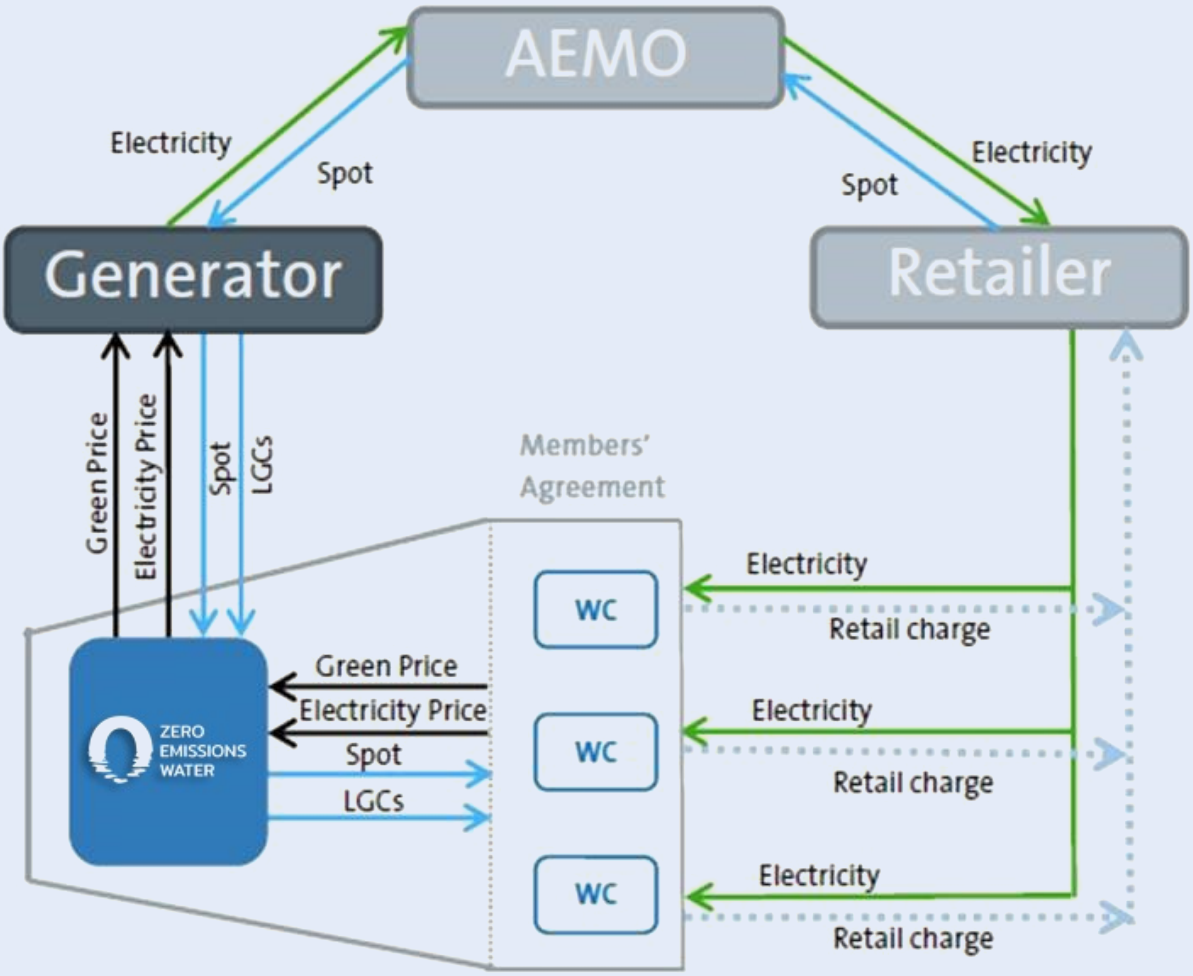
REGULATORY OBLIGATIONS

RENEWABLE ENERGY

This unique arrangement is the first of its kind in Australia, and a major step forward for the participating utilities reaching Net Zero Emissions.

Background

Since 2018, Victorian water utilities are required to reduce emissions by varying degrees under their Statement of Obligations (Emissions Reduction) issued by the Victorian Minister for Water.



ZEW arose through the Intelligent Water Networks (IWN) program, which is a partnership between:

- VicWater
- 18 Victorian water corporations
- Victorian Department of Environment, Land, Water and Planning.

The IWN program investigates new technologies and innovations to meet common challenges in a more efficient manner. Working together made sense because of the more attractive commercial arrangements to be gained.

ZEW was created as a limited liability umbrella company that enables participants to aggregate their renewable energy requirements to access the wholesale generation market.

Purchasing renewable power assists each utility to meet their Net Zero Emissions targets by reducing each utility's Scope 2 emissions via imported energy from the grid.

Benefits to the utility, and to climate-related outcomes

FIGURE 30 Kiamal Solar Farm, Ouyen

SOURCE Total Eren

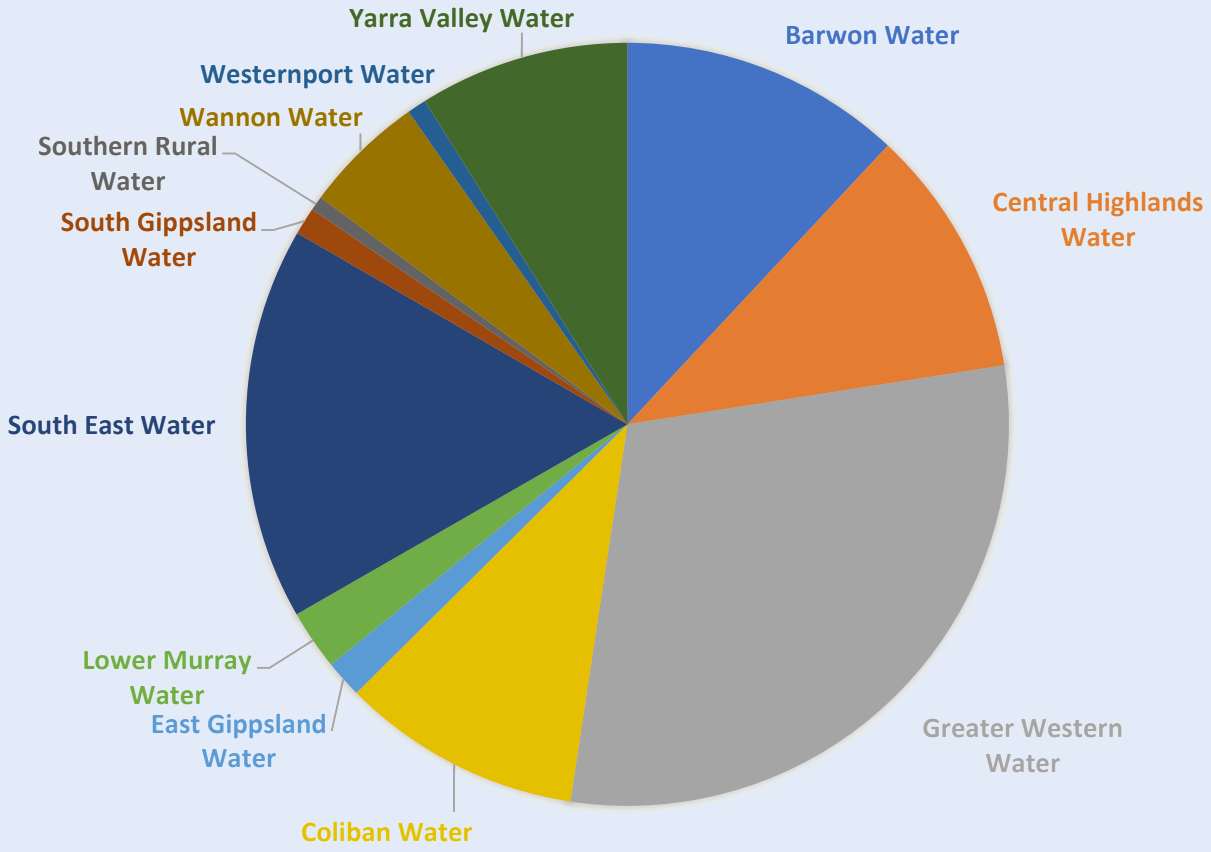
ZEW provides each utility with access to cheaper rates and allows smaller utilities with limited energy demands direct access to the corporate power purchase agreement (PPA) market. ZEW negotiates a fixed price contract for renewable power (not including delivery costs which are covered individually with retailers).

Each participant is allocated the portion of power they have subscribed for, and these allocations are settled individually within the ZEW umbrella agreement.

ZEW will purchase 65 GWh of renewable energy per year dependent on how much energy the solar farm can supply to the grid. The power purchase agreement will run to 31 December 2030 and will supply each participating utility between 20% to 50% of their total energy needs, representing a combined emissions reduction of up to 64,000 tonnes (CO_2e) per year based on the current Victorian grid emission factor.

The ZEW contract commenced on 1 October 2019, and the supply agreement is delivering renewable power for members at below market rates, and this is expected to continue for the foreseeable future.

FIGURE 31 Zero Emissions Water members share



SOURCE Yarra Valley Water

CASE STUDY 3 LOGAN CITY COUNCIL

Carbon neutral Logan

In 2017, Logan City Council committed to a Carbon Reduction Strategy and action plan with an objective to be carbon neutral by 2022. Projects that Logan Water have implemented to align with the strategy to reduce carbon emissions include the Cedar Grove Environmental Centre and the Loganholme WWTP Biosolids Gasification Facility.

CLIMATE THEMES ADDRESSED

NET ZERO EMISSIONS | FUGITIVE EMISSIONS | REGULATORY OBLIGATIONS | ENERGY EFFICIENCY | EMERGING TECHNOLOGY | RENEWABLE ENERGY | RESOURCE RECOVERY/ REUSE

Background

Cedar Grove Environmental Centre

Cedar Grove Environmental Centre (CGEC) is a 204ha site located on the Logan River comprising a state-of-the-art wastewater treatment plant, 7 hectares of constructed wetlands, vegetation corridors, community facilities including 2.5 km walking track along the Logan River, picnic tables and amenities, as well as a Landcare nursery, a solar farm and 37 hectares of biodiversity offset planting.

Loganholme WWTP Biosolids Gasification Facility

The environmental license for the first stage of the wastewater treatment plant (WWTP) is the strictest in Queensland and perhaps Australia. Under this license, Council must achieve a net environmental benefit for the surrounding catchment. This means that Council must find ways to reduce nutrients entering the Logan River (from all sources) by 1.5 times the amount discharged in the high-quality reclaimed water from the WWTP. This has not been done previously in Queensland.

FIGURE 32 Loganholme WWTP

Logan City's largest wastewater treatment plant (WWTP) at Loganholme provides services to 300,000 people. It produces 34,000 tonnes of biosolids (treated and partially dewatered sewage sludge) each year.

Every day, six trucks of biosolids are transported 300km to the Darling Downs agricultural area for use as a soil improver.

This is a major operating cost for Logan City Council; about $1.8 million per year or 30% of the total operating costs at Loganholme WWTP. Transporting biosolids by truck can also adversely affect communities and the environment through increased traffic, fumes, odours and high greenhouse gas emissions.

FIGURE 33 Cedar Grove Environmental Centre

Benefits to the utility, and to climate-related outcomes

Council extended the environmental features of the CGEC by:

- Planting native trees on 37ha of the site to offset approved vegetation removal by developers across Logan.
- Installing a 150kW on-site solar farm to contribute energy for WWTP operations.
- Integrating the reclaimed water outfall pipeline in a fish ladder on Seqwater's weir on the Logan River to replace water released to maintain environmental flows. This saves 3ML of water per day in the weir pool which is a future drinking water resource.
- Reducing the environmental impacts of trunk pipeline construction by using horizontal directional drilling on long sections (up to 1.3km) to reduce vegetation cleaning around waterways and koala habitat.
- Initiating environmental research projects on-site with Griffith University.

The benefits included:

- A net environmental benefit for the catchment
- New recreational facilities for the community
- Reforestation of previously cleared farmland, increasing biodiversity and wildlife habitat, and capturing CO_2 from the atmosphere
- Rehabilitation of parts of the Logan River banks
- Environmental research and education opportunities.

Loganholme WWTP Biosolids Gasification Facility

Council has a target of achieving carbon neutrality for its operations by 2022. The biosolids gasification facility will help achieve this by:

- recovering energy from waste
- reducing energy consumption
- sequestering carbon and binding heavy metals which reduces carbon emissions (initially by about 4,800 tonnes per year)
- destroying persistent organic pollutants and micro and nano-plastics to comply with environmental regulations.

The facility will significantly reduce the disposal of biosolids, saving about $500,000 in operating costs each year for Council and the community.

The biosolids gasification facility produces a safe, environmentally friendly biochar. This product can be marketed as a soil conditioner and added to potting mix; providing a sustainable solution for an existing waste product.

FIGURE 34 Loganholme WWTP gasification demonstration plant

Further information

WWTP at Cedar Grove video
https://www.youtube.com/watch?v=cBRJzGNz62I

Loganholme Gasification Facility video
https://www.youtube.com/watch?v=ahetsXyFU6M

CASE STUDY 4 WATERCARE, NZ

1MW floating solar array, Rosedale Wastewater Treatment Plant

The 1MW floating solar array at the Rosedale WWTP will help Watercare achieve its operational emissions reduction targets and realise operational cost savings. The floating array creates value from an otherwise marginal land asset (the pond), and provides a testbed for future deployments on other reservoirs and dams. The array is a real, visible example of an exciting green energy solution in the heart of Auckland. The Rosedale Wastewater Treatment Plant (WWTP) is Watercare's second largest wastewater treatment facility and among the largest in New Zealand. The plant serves a population of approximately 220,000.

CLIMATE THEMES ADDRESSED

NET ZERO EMISSIONS

SOLAR PV ON ASSETS

RENEWABLE ENERGY

WHOLE OF BUSINESS CLIMATE CHANGE STRATEGY

LAND USE

RESILIENCE

FIGURE 35 Drone picture of floating solar array

SOURCE Vector Powersmart

The 1,040kW floating solar array project is the result of a partnership between Watercare and the local lines company and solar installer Vector PowerSmart.

The project delivered several firsts in New Zealand – it was the first time floating solar had been used and it is the first megawatt-size solar project in New Zealand. The array comprises 2,700 JA Solar panels and 4,000 floating pontoons and occupies about 9,500m2 on the treatment pond, making excellent use of a marginal land asset in a dense urban environment. 16 x 50kW SMA inverters convert the electricity into AC where it then joins an 11kV ring main and helps power the WWTP along with biogas cogeneration. The array can produce 1.486GWh per year.

The array utilises an interlocking pontoon system called 'Hydrelio' from French company Ciel et Terre, who have been involved in numerous floating solar installations worldwide.

The array was assembled row by row and constructed in four large sections and each section was then towed across the pond by boat.

To ensure a stable and fixed location on the pond, each section was attached to the 65 x 2.4 tonne geo-located anchor points that had earlier been placed into the pond by a crane-barge. Once assembled, the array is very stable and it is possible to walk on it for panel cleaning and maintenance purposes.

FIGURE 36 First floating quadrant is towed into position June 2020

SOURCE Vector Powersmart

FIGURE 37 Operational array prior to opening ceremony with Mayor October 2020

SOURCE Watercare

FIGURE 38 Still from drone footage of completed array, October 2020

SOURCE Vector Powersmart

FIGURE 39 On-shore SMA inverters installed June 2020

SOURCE Watercare

FIGURE 40 Array almost completed July 2020

SOURCE Vector Powersmart

Benefits to the utility, and to climate-related outcomes

- Help achieve Watercare's 45% operational emissions reduction target by 2030
- Reduce carbon emissions from energy by 145 tonnes of CO_2e each year
- Deliver operational cost savings (around $150k pa)
- Improve energy self-sufficiency/resilience of the WWTP
- Support Watercare's objective to achieve Net Zero carbon emissions by 2050
- Raise the public profile of Watercare and Vector Powersmart and enhance the profile of solar energy as a viable solution for other water utilities and businesses
- Create excitement around green energy as a solution to climate risks
- Contribute to New Zealand's carbon emission reduction targets under the Paris Agreement and the government's 100% renewable electricity target by 2035.

CASE STUDY 5 BARWON WATER

Renewable Organics Network

Barwon Water's Australian-first Renewable Organics Network (RON) is a cogeneration facility supplying renewable electricity to Barwon Water's Colac Water Reclamation Plant, and renewable hot water to several industrial customers in Colac. The RON initiatives provide renewable energy, reduced waste and carbon emissions. It demonstrates how strong and dynamic strategic partnerships with businesses, councils and agencies can play a critical role in the success of circular economy projects, by leveraging the strengths and value of all partners to contribute to regional prosperity.

CLIMATE THEMES ADDRESSED

NET ZERO EMISSIONS | RENEWABLE ENERGY | RESOURCE RECOVERY/ REUSE | CROSS-SECTORAL PARTNERSHIPS

Background

Barwon Water is moving from a utility service provider to an enabler of regional prosperity. It has set challenging sustainability targets that will support the region's transition to a circular economy. Barwon Water is aiming to achieve zero waste, zero emissions and 100% renewable electricity use as a part of its Strategy 2030 goals.

The first stage of cogeneration installation, taking the entire Colac Water Reclamation Plant off the grid, is due to be completed by early 2021. Total cost for the project is $39.79 million (Colac Water Reclamation plant upgrade $30m, RON $9.79m) funded by Barwon Water's capital works improvement program, outlined in its 2018 Price Submission.

Key to the success of the RON is Barwon Water's strategic partnership with two Colac-based major global export manufacturing businesses, Australian Lamb Company (ALC) and Bulla Dairy Foods. Strong and trusted relationships with industry and councils are a significant enabler of the RON initiatives.

The partnerships that underpin the RON require commitment and clarity to ensure everyone understands their role, responsibility and investment from the start. It was important to involve prospective partners throughout the business case development and provide clear, tailored updates for each party involved.

As both projects have evolved, it has been important to allow the partnership to adapt accordingly. The more partners involved, the more flexibility is required to ensure mutual benefits continue to be created and maintained throughout the process.

Benefits to the utility, and to climate-related outcomes

The project leverages existing water and sewerage infrastructure to convert high-strength commercial and trade waste organics into dispatchable renewable energy, hot water for commercial operations and value add by-products, such as soil enhancers for agricultural purposes.

In doing so it is diverting waste from lower order disposal routes, creating clean renewable energy, reducing costs, generating jobs and driving economic growth in the region. Measurable benefits include:

- The net production of 5.5 gigawatt hours of renewable electricity each year. Approximately 50% of this renewable electricity will be used "behind-the-meter" to take the Colac Water Reclamation Plant completely off grid electricity, while the remaining renewable electricity generated will be exported into the grid
- Renewable hot water will be generated and supplied to ALC via an innovative hot water pipeline, which offsets ALC's natural gas consumption from the grid by 21.4 terajoules each year – equivalent to the gas usage of 350 households
- The generation of this dispatchable renewable energy in the form of hot water and electricity results in carbon emissions being reduced by 6,300 tonnes each year.

Broader benefits include

- For business, the Colac RON creates a circular economy, where waste production generates savings on electricity and heating bills and reduces their carbon emissions
- For Barwon Water customers, the energy created can be used to power (and reduce intensive energy costs for) the Colac Water Reclamation Plant, keeping bills affordable
- Addressing climate change by reducing greenhouse gas emissions
- Enabling sustainable waste management, and reduced waste / energy costs for customers
- Helping Barwon Water achieve its commitment to zero waste/ zero emissions by 2030.

A second strategic partnership between Barwon Water and six municipal councils is exploring options for a broader 'Regional RON'. This partnership is considering the viability of a dedicated processing facility to convert organic matter from regional municipal kerbside collection and biosolids generated through the wastewater treatment process into renewable energy, heat, biogas and soil enhancers. The total area potentially serviced by this RON covers a population of approximately 600,000 people.

CASE STUDY 6 YARRA VALLEY WATER WATER CORPORATION

Hydrogen opportunities for water utilities

Globally, hydrogen is undergoing a renaissance as the world seeks to decarbonise. Water utilities can play a potentially large role in decarbonising the economy through both biogas, which is produced in wastewater treatment, and hydrogen, which can be both an energy source and a fuel. Water utilities are in a unique position of competitive advantage with regard to the requirements of production, including having access to water, land away from population centres but close to markets, and renewable energy. Two Australian examples of water utility hydrogen projects are Yarra Valley Water in Melbourne, and Water Corporation in Western Australia, which have used their particular circumstances to participate in the hydrogen value chain in different ways.

CLIMATE THEMES ADDRESSED

NET ZERO EMISSIONS | ENERGY MANAGEMENT | FUGITIVE EMISSIONS | ENERGY EFFICIENCY | EMERGING TECHNOLOGY | RENEWABLE ENERGY | RESOURCE RECOVERY/ REUSE

Background

The urban water industry is actively exploring the opportunities, challenges and benefits that could arise from participating in the hydrogen economy. Key drivers for this include:

- Water is a key input for all forms of hydrogen production
- Water utilities often have land available with appropriate attributes to support safe and cost-effective hydrogen production
- Water utilities are large energy users, and many have made Net Zero-carbon emissions commitments
- Increasing commitment by the urban water industry to transition to and actively participate in the circular economy.

There are two main ways that water utilities can participate in the hydrogen economy:

1 Supplying water to hydrogen production facilities

2 Participating in the hydrogen value chain in various ways (ie. producing hydrogen)

The availability of water and land are the two key attributes that give water utilities a competitive advantage in the production of hydrogen at cost-effective scales. This gives rise to several considerations for water utilities in participating in the hydrogen economy:

1 Managing the competing demands for water and deciding which water resource is the most cost-effective and yet also meets other business and customer considerations

2 Wastewater treatment assets are often strategically located in outer-suburban fringes with good connectivity to transportation, gas, industrial and manufacturing infrastructure.

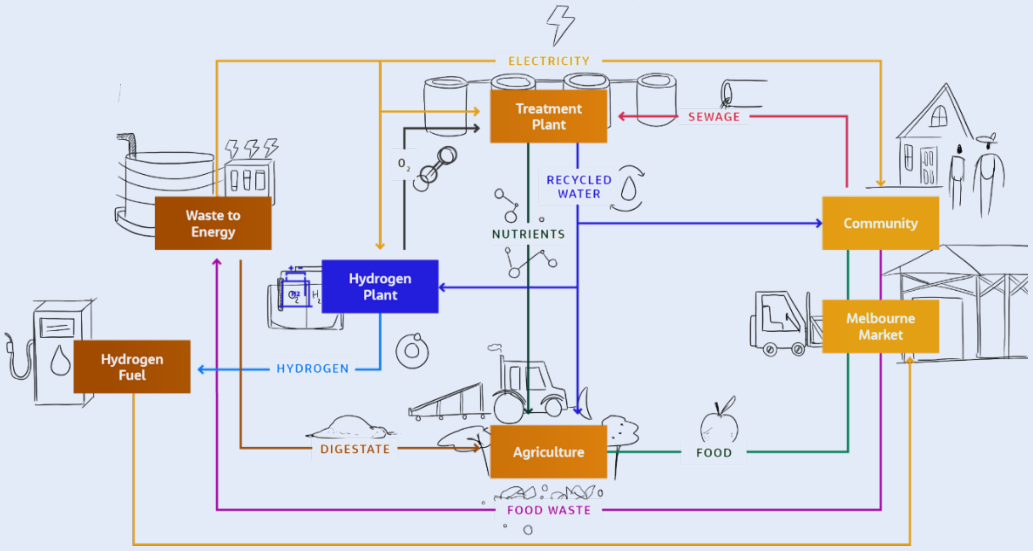
Supplying raw water to hydrogen production facilities is a legitimate business pathway for water utilities. However, the attributes described above can support a significant value add, and source of unregulated revenue, if utilities produce hydrogen themselves and make use of the by-products within their own operations, or on-sell them to the market.

'Green Hydrogen' – referring to hydrogen produced with renewable energy - will have the most marketability and consumer preference of all types of hydrogen production.

Yarra Valley Water and Water Corporation have approached the hydrogen economy in different ways.

Water Corporation has partnered with the Hazer Corporation, at their Woodman Point Wastewater Treatment Plant, which is the location of Hazer's Commercial Demonstration Plant (CDP) that is currently being built. The CDP aims to demonstrate a proprietary technology that utilises the methane component of the biogas (ie. CH_4) generated from sewage treatment to produce hydrogen and captures the carbon as graphite, which has commercial and industrial value.

FIGURE 41 Conceptual circular economy diagram for hydrogen production



SOURCE Yarra Valley Water

FIGURE 42 Hazer demonstration plant site at Water Corporation's Woodman Point Treatment Plant

Yarra Valley Water is working towards an electrolysis hydrogen production facility co-located at their Aurora Wastewater Treatment Plant in Melbourne's northern suburbs, which also already houses a Waste to Energy plant. This will use renewable energy generated from the waste to energy plant, to split recycled water into hydrogen and oxygen, with the oxygen forming a critical part of the business case, as it is able to be reused in the wastewater treatment plant process, or on-sold to commercial and industrial users.

The green hydrogen will supply local demands for renewable fuel to be used in stationary power and heat generation; industrial applications; blending into the natural gas distribution network; and fuel for supporting mobility applications such as forklifts, buses and back-to-base trucks.

Benefits to the utility, and to climate-related outcomes

Both these projects provide multiple benefits:

- Reducing/offsetting carbon emissions
- Support a circular economy approach by reusing what are typically termed 'waste' products – treated recycled water and biogas from wastewater treatment
- Providing new revenue sources to the utility.

For Water Corporation, the initial target of the commercial demonstration plant will have a hydrogen production capacity of 100 tonnes and 38 tonnes of graphite per year. Although modest in scale at present, this project has commercial potential with the hydrogen as low emission fuel and the graphite for sale into the advanced materials market for carbon fibre and related products.

The major benefits to Water Corporation include an offtake agreement for its biogas, productive use of excess biogas that may have otherwise been flared, collaboration with industry to assist development of new technologies and demonstration of the potential of a circular economy approach. A full-scale plant following the commercial demonstration plant would significantly increase these benefits.

For Yarra Valley Water, the major benefit is to demonstrate how a water corporation can leverage the following positive attributes:

1 Owned and available special purpose land

2 Surplus recycled water

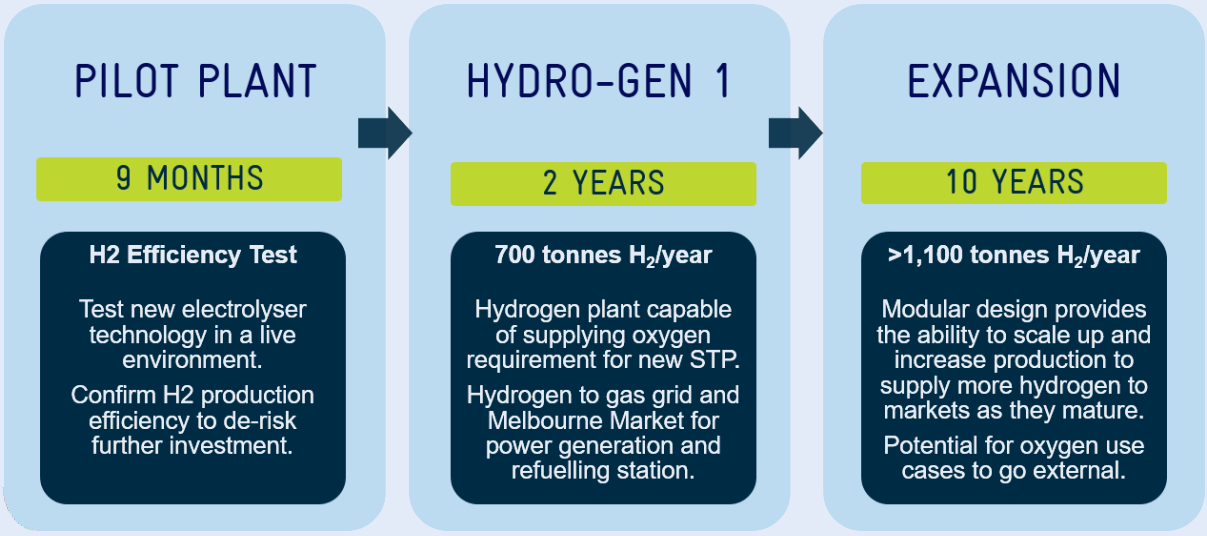
3 Direct access to renewable energy

4 Local demand for hydrogen

5 Partial subsidy from internal demand for oxygen

6 Access to new technologies, to produce a renewable fuel that can decarbonise hard to reach areas of the economy, at prices that compete with the displaced fossil fuels.

Yarra Valley Water has applied for grant funding to deliver a pilot plant, and then subsequently for a lager permanent facility that will produce and distribute 700 tonnes of green hydrogen per annum to local demands, leaving the oxygen to be consumed onsite by a new recycled water treatment facility.



CASE STUDY 7 ICON WATER NORTH EAST WATER HUNTER WATER

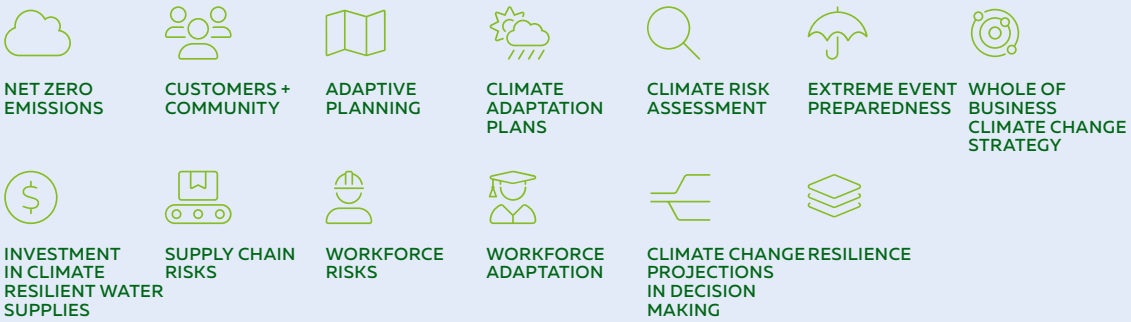
Water sector climate adaptation planning

Given water utilities are so heavily reliant on weather and the water cycle, resilience to climate change and variability is critical to ensure essential services to communities can continue to be met under these increasingly changing conditions.

Many utilities are developing climate adaptation plans, in response to business risk as a result of climate change, as well as regulatory drivers. Importantly, some also recognise that a whole of organisational approach is needed to achieve the actions.

This case study showcases three utilities' approaches in this space, and demonstrates both climate adaptation planning as well as adaptive planning approaches.

CLIMATE THEMES ADDRESSED



Background

Icon Water

Icon Water identified climate change as a significant business risk and strategic imperative through its Business Strategy 2020. On World Environment Day in June 2020, Icon Water launched its Climate Change Adaptation Plan with a summary brochure produced for the community. Fifty-six actions identified will help mitigate 31 short term climate change-related risks over the next three year horizon.

These actions are framed around five key themes: emissions reduction; water security; adapting in line with the community; climate resilient infrastructure design; and monitoring, evaluation and capacity building.

Critically, the plan supports Icon Water's goal of Net Zero emissions by 2045 (consistent with the ACT Climate Change Strategy). The plan also outlines the impacts of climate change on water security, service levels and the environment, recognising the particular impacts climate change has on operations.

The plan takes a practical risk-based approach to climate change adaptation (figure 3), based on the WSAA Climate Change Adaptation Guidelines with modifications consistent with Icon Water's business context.

North East Water

Climate has a significant influence on the sustainability of North East Water's service delivery. North East Victoria has experienced a significant number of climatic events over that past decade, including extensive catchment bushfire (2003, 2006, 2007, 2009, 2013, 2020), extended drought, floods and storms, as well as heatwaves. Such events have demonstrated adaptive management through response (lessons), planning and risk management processes.

Although adapting to a more variable climate is and will be a significant challenge and therefore adaptation strategies and plans are essential, recent years of exposure to climate related events make this more tangible.

North East Water's 'Adapting to a Changing Climate' Strategic Initiative aims to maximise its capacity to respond to a changing climate, through understanding the proposed impacts on infrastructure and services as a result of a changing climate.

This Strategic Initiative will assist the business to adapt to a changing climate through developing appropriate business, infrastructure and people solutions that ensure sustained and improved resilience in services to meet the needs of customers and communities across North East Victoria.

Key objectives include:

- Understand the policy and business landscape to maximise capacity to respond to a changing climate
- Project the impact of proposed climate change scenarios on infrastructure and service obligations
- Investigate the practicality and sustainability of innovative options (e.g. stormwater, groundwater, small scale collection)
- Risk assess the potential impact from climate change to infrastructure from key hazards
- Categorise where the highest risks exist so implementations can be incorporated into planning and management of water and wastewater services for these systems
- Embed climate adaptation thinking within connected business activities including relevant strategies, plans and processes.

Hunter Water

Hunter Water is impacted by climate and weather and have developed experience in managing extreme events associated with these variables. Example events include, the 2007 'Pasha Bulker' storm, 2015 East Coast Low super-storm, Lake Macquarie tidal inundations, as well as the 2019/20 NSW drought.

Long term planning that incorporates climate change risk into decision making is essential to ensure ongoing business resilience to an uncertain climatic future.

In Hunter Water's 2017+3 Strategy, climate change is a strategic driver that represents key challenges, but also opportunities. Hunter Water has revised its Climate Change Adaptation Strategy which utilises adaptive pathway thinking to guide its approach to climate change adaptation.

Though Hunter Water is well positioned to deal with climate change, the Climate Change Adaptation Strategy builds on existing business capability and systems to quantify the risks and improve staff understanding of climate change impacts.

Key objectives of the revised strategy include:

- Understand and keep climate risks within appetite
- Embed climate change risks into decision making
- Build resilience for the unexpected
- Timely action to achieve efficient adaptation
- Consider regional resilience and transition.

Benefits to the utility, and to climate-related outcomes

Icon Water

The plan recognises that a whole of organisation approach is required to achieve its broad range of actions. Many of the actions achieve multiple benefits such as resource recovery, social resilience, workforce health and safety, energy efficiency, business continuity and biodiversity conservation outcomes.

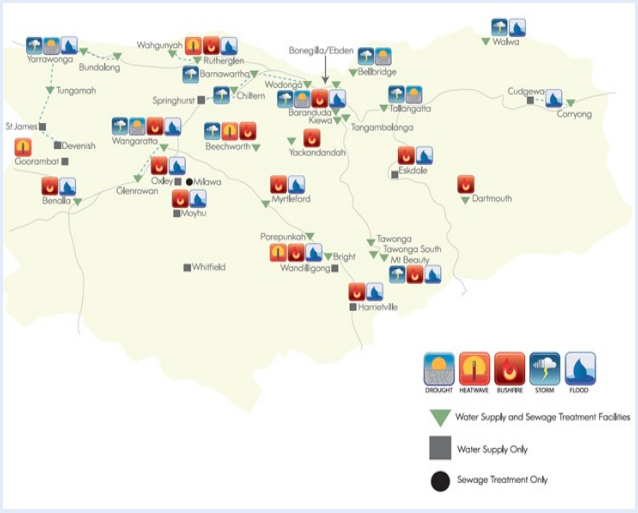
By following the plan, Icon Water can remain current with community, government and business expectations of sound climate risk management. Collaboration across industry bodies, researchers and other organisations enables information and experience to be shared. The plan also positions the business to take advantage of opportunities that build resilience to climate change.

Examples of specific outcomes include:

- Water conservation messaging through Icon Water's 'Care for Water' campaign launched in December 2019, was successful at raising awareness around Permanent Water Conservation Measures and promoting water saving activities throughout the community. Visits to related water conservation pages increased by 900% compared to prior to the campaign's commencement.
- Developing Catchment Actions for Clean Water Plans and implementing Icon Water's Bushfire Operational Plan for 2020-21 assisted in preparedness before and recovery after the 2020 bushfires.

As at 1 January 2020, 16 percent of actions in the Climate Change Adaptation Plan were complete. While actions continue to progress, it is too early to see a significant reduction to the risk profile. The profile will be reviewed after two years and every three years thereafter.

North East Water



Benefits of North East Water's climate adaptation approach include:

- Better understanding climate science specific to the region
- Identifying key climate hazards relevant to service delivery
- Establishing cross-functional teams to ensure necessary business functions are represented
- Assessing impacts by location and asset to quantify risk and inform business decisions
- Establishing guiding principles to adapt with appropriate caution
- Integrating climate adaptation with all key planning processes
- Identifying and embedding climate considerations within business systems and processes, across infrastructure, operational, maintenance and service delivery.

Hunter Water

Benefits of Hunter Water's revised approach to climate adaptation include:

- Strengthened business leadership understanding and commitment, as well as demonstrating regional leadership
- Business-wide adaptation framework and better internal coordination
- Integrating climate change into decision making
- Better understanding of interdependencies
- Identifying gaps in knowledge
- Making better information accessible to the community
- Better coordination of financing needed for adaptation
- Improved monitoring and reporting.

CASE STUDY 8 SYDNEY WATER

Conserving water through advances in leak prevention

Leaks and breaks pose an issue for all water utilities, and may increase with climate change's influence on soil moisture and tree root ingress. Advances in leak prevention to minimise unaccounted for water by Sydney Water and the University Technology of Sydney is a leading example of using acoustic sensing to detect leaks and breaks. This has resulted in a total of 70 likely leaks detected, with a total of 44 leaks confirmed and repaired since deployment.

CLIMATE THEMES ADDRESSED

CUSTOMERS + COMMUNITY

ADAPTIVE PLANNING

TECHNOLOGY + DIGITAL INNOVATION

FIGURE 43 A Von Roll acoustic sensor and logger in the Sydney CBD

SOURCE Sydney Water

Background

Leaks and breaks cause disruptions to the network and customers, resulting in costly pipe maintenance as well as water loss. With ever-advancing smart technology and the rise of the Internet of Things (IoT), acoustic sensors, as a method of leak detection can effectively identify potential leaks for proactive and targeted repairs.

To improve leak detection, Sydney Water in collaboration with the University of Technology Sydney (UTS), have deployed 229 acoustic sensors across five Central Business District (CBD) areas since December 2019. The Sydney CBD, Bankstown, Penrith, Chatswood and Liverpool CBDs have been prioritised for sensor deployment using a pipe failure prediction tool model.

Since December 2019, acoustic data from the sensors has been analysed, with signal processing algorithms being developed to automate the analysis and increase the reliability of leak alarms. A web portal has also been developed, which will host the data from the range of acoustic sensor models in one location for ease and efficiency of integration within Sydney Water's wider IT systems.

Benefits to utility and to climate-related outcomes

Following the deployment of acoustic sensors, Sydney Water aims to reduce reactive leak detection work by 50% and reduce 50% of unaccounted water loss within three years in the five CBD areas.

So far, a total of 700ML/year has been saved in the Sydney CBD with an approximate water product cost of >$3 million saved.

These findings will also consolidate the current learnings of UTS and Sydney Water in its predictive MNF and predictive modelling of pipes for leaks to by reducing 25% of unaccounted water loss in 50% of the pressure zones over three years.

Furthermore, the lack of disruption to Sydney Water's network will benefit all customers, motorists, residents, and the public with reducing their need to call Sydney Water to report leaks or breaks and ensures water is reserved for customer consumption to support ongoing drought and climate change resilience efforts within NSW.

It will also reduce the need for manual surveying and increase safety standards for Sydney Water employees as they can better plan and schedule work.

FIGURE 44 Online leak sensing map of acoustic sensors deployed across five CBD areas in Greater Sydney

SOURCE Sydney Water

CASE STUDY 9 WATER CORPORATION

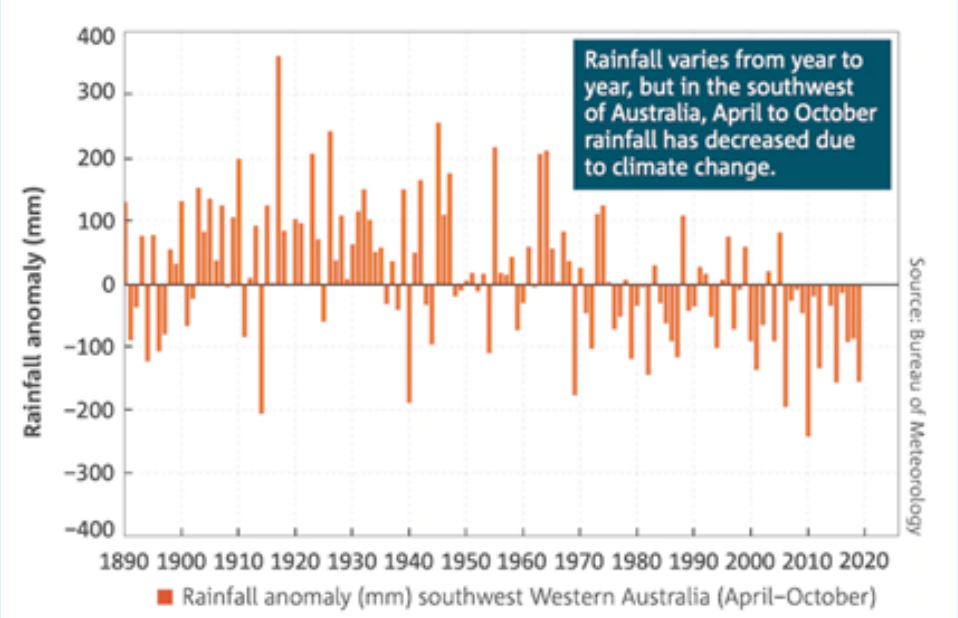
Perth's transition to rainfall-independent supply

South West Western Australia has been hit harder by climate change in terms of rainfall declines than perhaps anywhere on Earth. While rainfall has declined by around 16% since the 1970s, runoff (and therefore inflows to dams) has declined by much more – around 80%. As a result, Water Corporation have transitioned Perth's water supply largely away from a reliance on dams, to encompass a broader, rainfall independent set of sources such as groundwater, desalinated water and purified recycled water for drinking (PRW).

CLIMATE THEMES ADDRESSED

CUSTOMERS + COMMUNITY | CLIMATE ADAPTATION PLANS | CLIMATE RISK ASSESSMENT | INVESTMENT IN CLIMATE RESILIENT WATER SUPPLIES | RESILIENCE | CLIMATE HAZARDS

FIGURE 45 Cool season rainfall declines in South West Western Australia



SOURCE BOM

Background

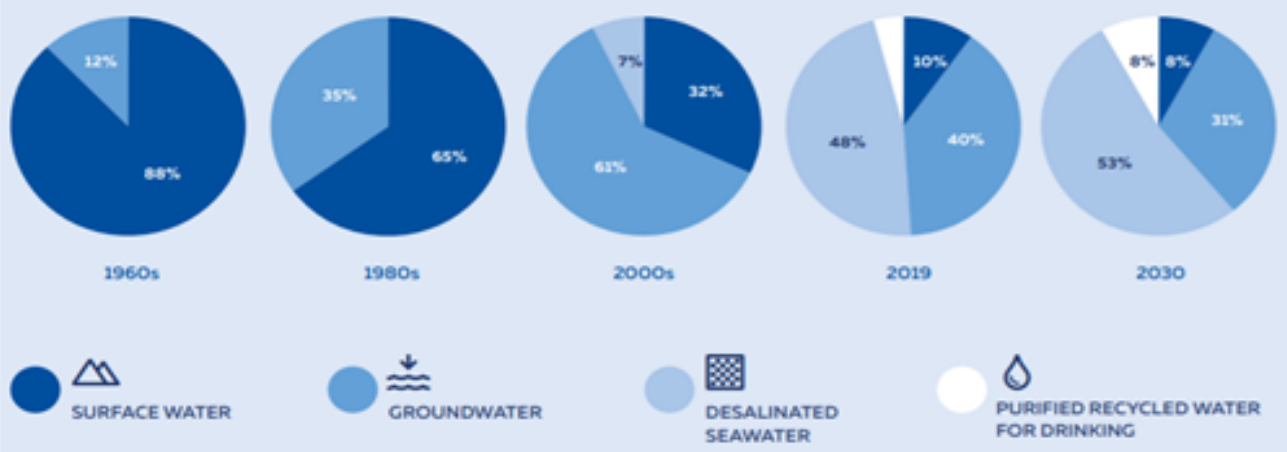
Overall there has been around a 16% decline in rainfall in South West Western Australia, but over the cool season rainfall has declined by 20-30% (Figure 45).

Prior to 1975, Perth's dams received an average of 420 billion litres of streamflow each year, which would still be enough to supply the city today. In comparison, during 2019 Perth's dams received just 44 billion litres of streamflow.

To add to this, Perth now also experiences higher average temperatures and an increase in the annual number of days over 35°C, which can lead to a spike in water demand.

Perth's dams now supply an ever-diminishing fraction of total water supply (Figure 46), forcing a drastically rethink and reshape where new water supplies can come from.

FIGURE 46 Water supply sources in Perth 1960s – 2030s



SOURCE WSAA 2020b

In response, Water Corporation has developed a climate adaptation program "Water Forever", which adopted a three-pronged approach to improving Perth's resilience:

- Working with the community to reduce water use to help defer the need for investment in further new climate independent sources
- Developing new water sources where necessary
- Increasing the amount of water recycled

Perth's water supply portfolio has now shifted to rainfall independent sources and includes a combination of diverse sources, including seawater desalination, purified recycled water for drinking (groundwater augmentation, Figure 47), groundwater and dams.

FIGURE 47 Schematic of groundwater augmentation process

SOURCE WSAA 2020b

Benefits to the utility, and to climate-related outcomes

Water Corporation's implementation of PRW is a result of over a decade of work in securing the trust of regulators, bipartisan Government support and community acceptance.

Perth's groundwater augmentation scheme supplies 38ML/day after being commissioned in 2017 (WSAA 2020b), improving the city's resilience to further impacts of climate change on its dams by increasing rainfall independence.

Key to the success of this approach was a decade of community engagement, begun at grassroots level that has led Perth to have some of the most well-educated water customers in Australia.

WSAA's 2021 customer sentiment monitor survey of nearly 9,000 people found that across Australia, 74% of people are open to purified recycled water being considered as part of the future drinking water supply.

CASE STUDY 10 SOUTH EAST WATER

Whole-of-business climate change preparedness

South East Water's climate mitigation and adaptation programs are an example of a holistic approach to addressing climate change, that aims to ensure the business minimises greenhouse gas emissions while preparing for the inevitable impacts of a warming climate today and into the future. By having a greater understanding of the potential physical and financial risks of climate change in the future, the business and its staff are empowered to strive further to reduce greenhouse gas emissions and support partners and stakeholders to do the same.

CLIMATE THEMES ADDRESSED

Background

The water sector is in an excellent position to act on the global threat of climate change. Initially, South East Water has been driven by Government requirements to reduce GHG emissions by 45% from the baseline by 2024/25, and to establish a pathway to Net Zero emissions by 2030. However in working to meet these requirements the business realised that further action was not only possible, but urgent. As a result, South East Water have developed four strategic pillars to act decisively to protect the future of the business, customers and local region:

- Faster and deeper emissions cuts
- Organisation-wide climate risk assessment
- Alignment with the Taskforce on Climate-related Financial Disclosures (TCFD)
- Educating staff and ensuring transparency.

Faster and deeper emissions cuts

South East Water hope to reduce emissions faster than the regulatory requirement. For the upcoming Victorian Price Submission 5 process the business will engage with customers to gauge their willingness to reduce emissions faster and deeper than statutory obligations. The business has also done the work to understand the costs and risks of this approach.

Organisation-wide climate risk assessment – Climate Adapt

South East Water conducted an organisation-wide, bottom-up analysis of it climate adaptation risk profile and are developing adaptation and risk control plans to address multiple climate futures.

Alignment with the TCFD

South East Water reviewed its compliance with the recommendations of the TCFD and have designed a governance system that will help meet those recommendations.

Education campaign

South East Water will ensure transparency by educating our staff and sharing key risks and commitments with customers and the community in line with the TCFD.

Benefits to the utility, and to climate-related outcomes

Faster and deeper emissions cuts

South East Water has pledged to be Net Zero by 2030. To reduce direct emissions, they have commissioned solar arrays at several sites and joined Zero Emissions Water (see Case Study 2) to jointly procure more solar energy as part of a bulk purchase arrangement.

Their largest Water Recycling Plant upgrade at Boneo will be Net Zero, and they have created an Energy Master Plan to help identify energy efficiency and optimisation opportunities at all treatment plants and pump stations.

To offset hard to abate emissions, and to guarantee meeting their emissions reduction target on time, they are tendering to procure Large-Scale Generation Certificates (LGCs). Their research has shown that commercial third-party LGCs can help them reach emissions targets quickly and at minimal cost to customers.

Organisation-wide climate risk assessment – Climate Adapt

Adaptation to climate change is necessary and the future is uncertain. As a result, South East Water is conducting a thorough, bottom-up climate risk assessment.

The business has put together a team of 'Risk and Resilience Managers' (RRMs) – experts from across the organisation – who are reviewing climate data under high, medium and low climate change scenarios in 2030, 2050 and 2090. Through multiple workshops and team analytics, the RRMs review the latest data, including storm tide inundation and flooding layers down to a few-meter resolution, and are undertaking detailed risk assessments of assets and services. Any near term risks will be planned for and included in the upcoming Victorian Price Submission 5 process.

Climate Adapt recognises that South East Water has the potential to protect itself, its customers and the environment– but only if they know what to plan for, start early and can adapt the plan as needed. Climate Adapt will provide the information and the tools to best plan for the future.

Alignment with the TCFD

In line with the recommendations of the TCFD, South East Water are assessing the risks and opportunities associated with three IPCC scenarios representing different levels of future emissions intensity. Transitional risks (reputational, technological, market, policy and legal risks) and physical risks (eg. bushfire and flooding) are being assessed and the scenarios are supported by the latest available data.

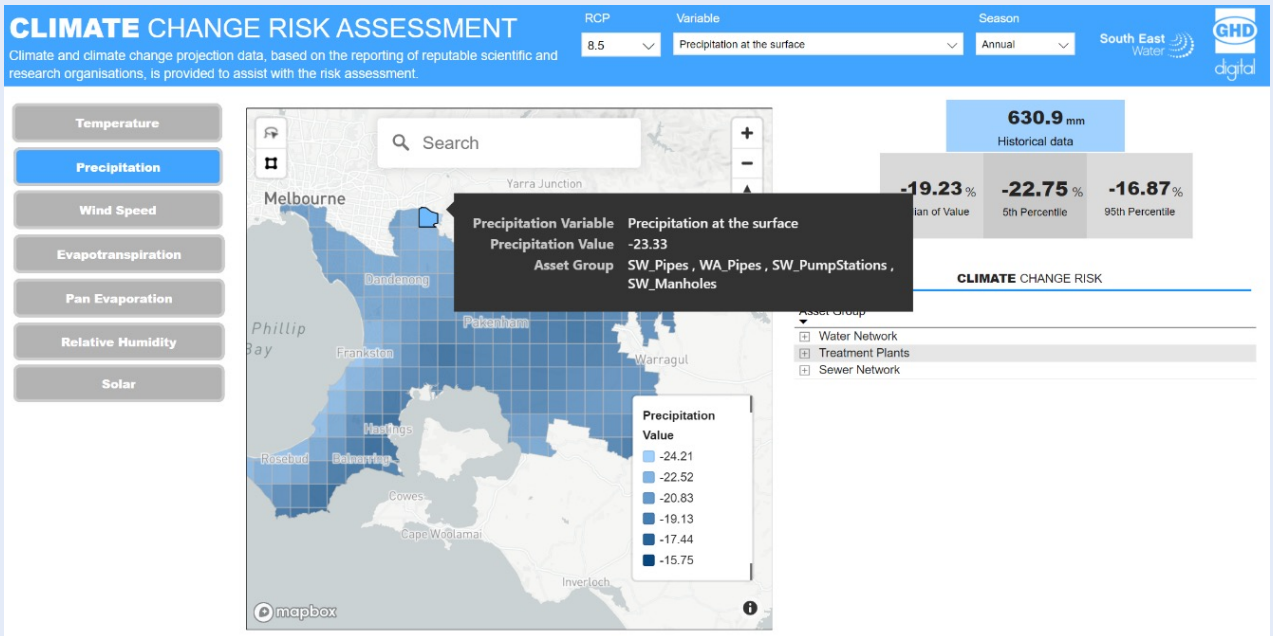
South East Water are also developing a roadmap for meeting the 11 disclosure recommendations identified in the TCFD. In their upcoming 2020/21 Annual Report, they have prepared a preliminary gap analysis assessing current climate risk management practices and disclosures and identifying areas for improvement.

There is oversight into this process from quarterly updates to Board, as well as the Climate Adapt Steering Committee which is chaired by Lara Olsen, Managing Director and made up of members from the Executive Team. This ensures senior executive leadership and buy-in for this whole of organisational approach.

Following the Climate Adapt program in 2021, South East Water will review the findings and compare their performance against other relevant organisations using Ernst and Young's Climate Risk Barometer to support their journey to more complete TCFD disclosures.

Education Campaign

To educate staff and community, Climate Adapt includes a segment focused on increasing understanding of the urgency of climate change, the key risks to the local environment and the key elements of the business's climate adaptation and mitigation work programs. To educate staff South East Water have developed a campaign that includes a whole-of-organisation 'Town Hall' with an expert panel, lunch and learn sessions with the environment and energy teams, articles on their intranet, and a dedicated MS Teams Channel. For the community, South East Water are developing a dedicated section of their website where members of the public can view public climate information and see not only the impact climate change could have on their water utility, but also what their utility is doing to reduce emissions and adapt to climate change.



CASE STUDY 11 MACKAY REGIONAL COUNCIL

Conserving water through digital transformation

Since 2018 Mackay Regional Council has rolled out more than 110,000 digital smart water meters to homes and businesses, and uses an application called 'Aqualus' to track usage and leaks. More than 16,000 Mackay residents also use the associated 'myH2O' website to track their water use.
The technology can quickly identify unusually high water use and inform customers that they may have a leak, and since the project's inception has helped identify over 100,000 leaks totalling over six gigalitres of water.

CLIMATE THEMES ADDRESSED

CUSTOMERS + COMMUNITY

APPLYING TECHNOLOGY + DIGITAL INNOVATION

Background

Mackay Regional Council's (MRC) water and waste business was facing the challenges of a rapid increase in population, requiring significant investments in capacity expansion, which in turn was resulting in unsustainable increases in water tariffs.

In 2011 it was estimated that based on then consumption patterns and population growth estimates, the current treatment plant would reach capacity by 2020. Due to space constraints at the location of the current treatment plant, the only viable option identified was to build a new second treatment plant in a greenfield location. The capital cost of a new treatment plant including raw water pipelines was estimated at around $100 million.

A revised strategy was developed to focus on non-capital solutions to address the growing demand and resulting impacts on capacity. One aspect was a demand management program with a target of reducing daily per capita consumption by 10 per cent.

A key element of the program was to develop a better understanding of the consumption behaviours of Mackay residents. It could then be determined how this impacted the output of the treatment plants and therefore capacity.

As with most water utilities, while Mackay has suitable SCADA systems in place within its treatment facilities, there was very little information captured once the water left the treatment plant. The only information on consumption patterns came through twice-yearly meter reads, which did not provide the granularity needed to analyse and understand customer behaviour patterns.

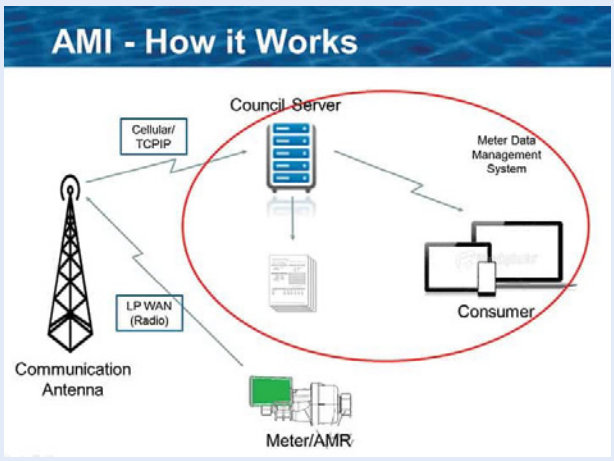
MRC was also aware that it had around 15 per cent network losses, which while within national averages, was still a significant figure.

Accessing detailed information in a cost-effective manner was identified as an important prerequisite to achieving the identified demand management goals.

MRC adopted a two-pronged strategy which involved installing an automated metering infrastructure (AMI) network to capture and analyse detailed demand data, and launching a comprehensive social marketing program.

The other prong of the strategy was the deployment of a five-year social marketing campaign, which was developed based on the information gathered through a fairly extensive customer survey process.

FIGURE 48 Schematic of automatic meter reading in Mackay



SOURCE Utility Magazine

Benefits to the utility, and to climate-related outcomes

Since the program began Mackay has rolled out over 110,000 automatic meter readers (AMR) across its water network, generating hourly meter reads from each meter, which enable a range of analytics to be performed on the data (see Figure 49).

The average duration of a leak has reduced from over 150 days to around 60 days. With around 2.5 per cent of the properties having a leak at any given time, the reduction in the average duration is expected to contribute towards lower consumption.

The demand management program has seen Mackay exceed the targeted 10 per cent reduction in its water consumption. Average per capita residential consumption is down from around 240 litres per person per day (L/d) to around 200L/d, a reduction of just over 17 per cent. This will have an associated carbon emissions reduction impact on a per ML supplied basis.

Since the project's inception, it has helped identify over 100,000 leaks totalling over six gigalitres of water. These water savings have deferred an augmentation of the new treatment plant until 2036, yielding savings of around $20 million.

In comparison to 2010/11 prices, the average Mackay residential customer will pay approximately $400 per annum less for water by 2025. Both water and sewerage prices were held steady (zero percent increase) for the three years following the project beginning, as a result of the savings gained.

FIGURE 49 Digital meter in Mackay

SOURCE Utility Magazine

CASE STUDY 12 YARRA VALLEY WATER

Determining customer support to mitigate greenhouse gas emissions and climate change impacts

For its 2018-2023 pricing submission to the Victorian Essential Services Commission, Yarra Valley Water utilised two innovative customer engagement techniques - a Citizens' Jury and a conjoint analysis to determine its customers views on a wide range of matters.

CLIMATE THEMES ADDRESSED

CUSTOMERS + COMMUNITY | REGULATORY OBLIGATIONS | WILLINGNESS TO PAY | EDUCATION

This was informed by an extensive jury information pack which included the challenges Yarra Valley Water faces with climate change their pledge to reduce emissions. This material was followed up by some expert 'witnesses' who spoke on climate change impacts amongst other matters. The Citizens' Jury's recommendation to save water now for the future was driven by the impacts of climate change. They also endorsed Yarra Valley Water's commitment to reduce greenhouse gas emissions.

While customer sentiment was clear in not wanting a bill increase, customers endorsed seven outcomes to be delivered over the 5-year period, including strengthening Yarra Valley Water's targets for per capita water consumption and greenhouse gas emissions. This resulted in a $1m per year increase in expenditure for the utility's work to protect the environment over the price period.

Background

To understand what customers expect and value, there were three main elements to Yarra Valley Water's customer-led engagement that underpinned its price submission:

- Several foundational pieces of research to understand what was important to customers in a broader sense
- Conjoint choice modelling across packages of services
- Citizens' Jury

The main driver was to get a deeper level of understanding of what customers value. Rather than asking customers quick survey questions, customers were armed with the business information and access to experts of their choosing to weigh the available evidence find common ground, and explore necessary trade-offs.

The Jury made ten recommendations. All were accepted and incorporated into the pricing submission. This included a specific recommendation - to keep pace with climate change impacts and population growth to ensure efficient and uninterrupted water, the Citizens' Jury expects the business to continue to undertake research and development initiatives with a focus on:

- Ensuring sufficient water supplies for the future
- Reducing short- and long-term costs
- Delivering services with minimal interruptions.

Several other recommendations contained elements of saving water for the future. And whilst no specific recommendation was made by the jury associated with greenhouse gas emissions, the jury information pack asked a number of questions which the jury responded to over the course of their deliberations. This included endorsing greenhouse gas emission reductions consistent with Yarra Valley Water's pledge to government.

In parallel with the Citizens Jury, Yarra Valley Water undertook conjoint choice modelling with a representative sample of 1100 customers. The trade-off technique replicates a purchase situation, comparing packages of services and their associated price. Consistent with the citizens jury, this process identified additional value from water savings and reductions in greenhouse gas emissions. However, customers did not see additional value if there was an increase in their bill overall.

Benefits to the utility, and to climate-related outcomes

Customers demonstrated that, equipped with all the information and time they needed, they were able to provide recommendations on the important questions facing Yarra Valley Water.

Customer sentiment was clear: they did not want a bill increase, and they valued increased services over a bill decrease. At a minimum, customers wanted a continuous supply of safe clean drinking water and safe removal of waste. Customers also expected the utility to maintain the service and manage future challenges such as population growth, ageing infrastructure, affordability, and climate change.

In the short to medium term, the challenge is how to maintain existing customer service levels in the face of more extreme climate events and predicted temperature variations, without significant customer and community inconvenience, cost and bill impacts.

Overall, when Yarra Valley Water's customers think about looking after the environment, their main concern is climate change and its impact – reflected in their recommendations to save water and reduce greenhouse gases. Further, when thinking about what they valued, customers identified caring for and protecting the environment alongside assisting vulnerable customers and water saving as most important.

As a result of all research and engagement activities, Yarra Valley Water proposed seven outcomes, two of which were: 'Care for and protect the environment', and 'Water availability and conservation'. Taking a long-term planning view of climate change and environmental sustainability, the climate change-relevant elements in these outcomes included:

- Targeted water conservation resources, education and programs for customers and the community
- Proactive leak detection programs
- Providing recycled water to over 100,000 customers in mandated recycled water areas to the north of Melbourne
- Targeted research and development and new asset innovations, to keep pace with the impacts of climate change and population growth, to reduce maintenance costs and optimise infrastructure investment to ensure a sustainable water source in the future
- Minimising impacts on the environment, including inflow and infiltration and sewerage spills and proposing to reduce emissions by 53.4% by the end of the pricing period (2022-23) from the 2016-17 baseline, consistent with the pledge to government.

The Essential Services Commissions price review framework (PREMO) incentivised Yarra Valley Water to ensure that their proposals sought to understand customers' priorities and maximise community value. The outcomes from this process provided the business with a clear understanding of customers' needs and expectations including their support and preferences for both mitigating and reduce climate change impacts.

The final pricing determination included a $1m per year increase in investment to deliver the 'Care for and protect the environment' outcome' over the pricing period.

CASE STUDY 13 HUNTER WATER

Customer perceptions of climate change and willingness to pay for climate change programs

As a result of its largest ever residential customer survey in 2018, Hunter Water has robust evidence of the role customers want it to play in a low carbon future. More than 90% of customers support taking action now to address climate change, and around 75% are willing to pay $1 or more annually on their water and wastewater bills to reduce Hunter Water's greenhouse gas emissions.

CLIMATE THEMES ADDRESSED

NET ZERO EMISSIONS | ENERGY MANAGEMENT | CUSTOMERS + COMMUNITY | REGULATORY OBLIGATIONS | RENEWABLE ENERGY | CARBON OFFSETS | WILLINGNESS TO PAY | EDUCATION

Background

Hunter Water is making a concerted effort to engage broadly and deeply with its customers to develop a strong understanding of their values, preferences and priorities so that the findings can be reflected in its activities and services. In parallel, Hunter Water has recognised the need to build more sustainable and resilient water and wastewater systems. Among other benefits, resilient systems would have the flexibility to help address climate change risk exposures, contributing to emissions neutrality targets in the NSW Government Climate Change Policy Framework and achieving consistency with global aspirations supported by Australia.

In support of these objectives, Hunter Water undertook its largest ever willingness to pay survey in which it sought customer views on its role in delivering non-mandated environmental outcomes, such as climate change action, and obtained evidence in support of delivering those outcomes through regulated expenditure allowed for in regulated prices.

The online customer survey primarily involved a modified contingent valuation method approach to measure customer capacity and willingness to pay, with supplementary questions aimed to gauge sentiment and cross-check results.

The carbon footprint question described the current situation whereby Hunter Water makes carbon savings through energy efficiency projects that are implemented if they reduce electricity costs and therefore help keep water bills low. Continuing this approach would see Hunter Water's carbon footprint increase, due to servicing a growing population and more energy-intensive treatment plant technology, but would not change customers' bills. Customers could choose to continue the current approach or select from three 'do more' options in which Hunter Water's carbon footprint is reduced. The carbon footprint reduction options ranged from a little to a lot and each option showed the additional amount the respondent would need to pay in their bills, in dollar terms, to fund the environmental outcome.

Examples were given of the types of projects that Hunter Water could deliver to achieve the carbon reductions.

The reduction amounts and associated costs were based on forward looking maximum and minimum estimates of what could realistically be delivered within the five years. Both were listed as ranges, which meant that survey respondents understood that there was some uncertainty in the final level of service that would be provided in the period, and the final cost to the household.

At the end of the survey, respondents were shown a detailed estimate of the impact of their choices on their future water bill and corresponding environmental outcomes that would be provided. An example is shown in Figure 50. A feedback loop allowed survey respondents to change the level of each environmental service they wanted until the respondent was comfortable with the bill impacts.

Several design features were included to make the survey more user friendly and robust. The carbon footprint question included a combination of text and images to

account for different customer preferences for digesting information. The emissions impact that each option would have on the environment was described by reference to how many equivalent cars could be considered to have been "taken off the road" during the period.

This approach was taken to address feedback during focus group testing which indicated that it was difficult for respondents to gauge the magnitude of the more technically accurate measure (CO_2 equivalents).

FIGURE 50 Example of bill impact including estimates of 2025 water and sewerage charge.

Summary of your choices

Based on the options you have chosen, an estimate of your annual water bill for 2020-25 is shown below. Your annual water bill estimate is based on your most recent year of water use, so it's our best estimate of what your bill will look like in the future.

Your water and sewer service charge, Environmental Improvement Charge, stormwater drainage charge and water usage charge are shown so you can see what your bill might look like in the future. You cannot change these charges in this survey.

Hunter Water customers pay 3 water bills each year. To show you what a water bill will look like we show you an average bill. We also show you how much you might pay a year in total from 2020 to 2025.

If you want to change any of your options for how much stormwater, carbon, wastewater recycling, and water conservation Hunter Water provides during 2020-25, you can go back to the question and change your answers. Click here to see how you can go back and change your answer.

If you are willing to pay the amounts shown as "Total payable by you" in the bill estimate below please click NEXT to finish off the survey.

Residential water charges	How much you will pay each year	Additional service that Hunter Water will provide during 2020-25	Your estimated Maximum annual bill 2020-25	Your estimated trimester bill 2020-25
Water service charge	$95.0		$95.0	$31.67
Sewer service charge	$620.0		$620.0	$206.67
Environmental Improvement Charge	$39.0		$39.0	$13.0
Stormwater drainage charge	$0.0		$0.0	$0.0
Water usage charge	$976.0	kL consumed by household	$976.0	$325.33
Subtotal before additional charges	**$1730.0**		**$1730.0**	**$576.67**
Bankwork and landscaping of Hunter Water's open stormwater drains	$0.0-50.0 per year for 2020-25	0.0-6.0 kilometers naturalised	$50.0	$16.67
Increasing Hunter Water's carbon footprint	$0.2-3.0 per year for 2020-25	0.0-2000.0 cars off roads	$3.0	$1.0
Increasing Hunter Water's stormwater harvesting	$1.0-4.0 per year for 2020-25	40.0-150.0 ML harvested	$4.0	$1.33
Increasing Hunter Water's wastewater recycling for business and industry	$0.0-30.0 per year for 2020-25	1000.0-1800.0 ML recycled	$30.0	$10.0
Increasing Hunter Water's wastewater recycling for irrigation	$0.5-5.0 per year for 2020-25	248.0-400.0 ML recycled	$5.0	$1.67
Increasing Hunter Water's water conservation programs	$1.0-1.5 per year for 2020-25	30000.0-50000.0 household supported	$1.5	$0.5
Wallsend Flood Levy	$10.0-15.0 per year for 2020-25		$15.0	$5.0
Subtotal after additional charges			**$1838.5**	**$612.83**
Pensioner rebate - water			$0.0	$0.0
Pensioner rebate - wastewater			$0.0	$0.0
Total payable by you			**$1838.5**	**$612.83**

Benefits to the utility, and to climate-related outcomes

Customers were very engaged with Hunter Water's survey, as shown by the number of responses (680 households) and high completion ratio (93%). Customers also indicated that they appreciated the opportunity to provide input into shaping future activities, particularly environmental services.

Around 75% of respondents were willing to pay $1 or more towards reducing carbon emissions and approximately half said they were willing to pay an extra $6 on bills each year (see Figure 51). This amount would be a very small percentage increase to a typical household's water bill. The findings are compelling because they require customers to prioritise carbon reduction against other environmental outcomes and personal budget constraints.

The responses to the sentiment questions aligned with the willingness to pay findings. For example, 89% of respondents supported taking action now to address climate change and 94% supported using renewable energy (see Figure 52). This alignment provides additional confidence in the reliability of the results.

By conducting the survey Hunter Water has piqued customer curiosity and gained robust insights. It can confidently continue to investigate and implement carbon reduction initiatives knowing it has a mandate from customers and robust evidence to support recovery of the costs through regulated prices.

FIGURE 51 Willingness to pay results – carbon footprint

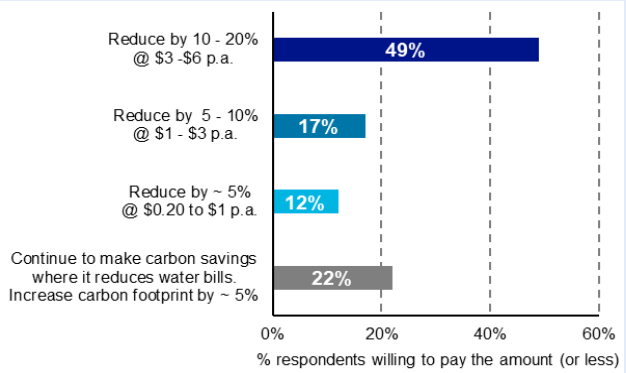
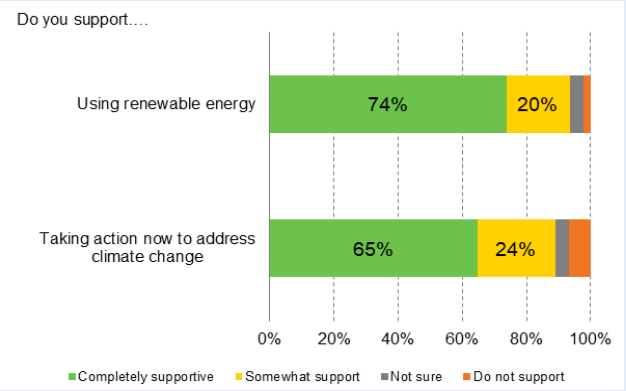


FIGURE 52 Results from sentiment questions



CASE STUDY 14 GREATER WESTERN WATER

Greening the West

Greening the West is an example of a successful regional scale urban greening and cooling collaboration, demonstrating equity in adapting to climate change in Melbourne's booming western suburbs. Greater Western Water's role has been more than their core business of water and sewerage provision - but to lead and galvanise a broad coalition of stakeholders with similar drivers, provide water expertise and alternative water sources for the greening effort, as well as assist in delivering significant community benefits.

CLIMATE THEMES ADDRESSED

CUSTOMERS + COMMUNITY | CUSTOMERS + COMMUNITY | CLIMATE HAZARDS | EQUITABLE RESPONSES TO CLIMATE ADAPTATION

Background

Melbourne's western suburbs are some of the fastest growing in Australia. They receive around half the rainfall of Melbourne's eastern suburbs, and can experience warmer daytime temperatures. Climate change is expected to exacerbate this further. Given their location on Victoria's volcanic plain, the natural vegetation originally supported grasslands rather than dense canopy cover – this means that the overall canopy cover is one of the lowest in the country. Community health is also a significant driver, with issues such as diabetes and obesity compounding the challenges of population growth, climate change and heat stress.

Green and blue infrastructure is a low-cost strategy to improve access to high quality, irrigated green space that can bring high impact results – environmentally, economically and for the health and wellbeing of the residents who live there.

Greening the West is an initiative established in 2011 by City West Water (now Greater Western Water) to deliver positive health, social and liveability outcomes in Melbourne's western suburbs. It was created as an alliance of 23 organisations, including local governments, water utilities and community groups with a desire to use green and blue infrastructure to drive these outcomes.

The program is underpinned by Greater Western Water's Stormwater Partnership Fund, established in 2018, which helps the local governments involved in the program not only to plant trees and use alternative water to irrigate them, but to leverage funding from other sources including government, the health sector and the philanthropic sector.

The Greening the West collaboration aims to achieve the following medium to long term goals:

- 25% increase in alternative water for green space by 2030
- Double tree canopy cover in the west by 2050
- Green space to be increased by 25% by 2030.

Benefits to the utility, and to climate-related outcomes

This regional collaborative model helps communities have a say in planning decisions around water, is replicable in other regions, and has the added benefit of generating public and importantly, political interest, which increases the chances of future funding.

There is significant inequity in access to high quality greenspace and canopy cover in Melbourne's western suburbs. Greening the West is already having an impact on improving equity, and particularly the concept of intergenerational equity – respecting the needs of current as well as future generations.

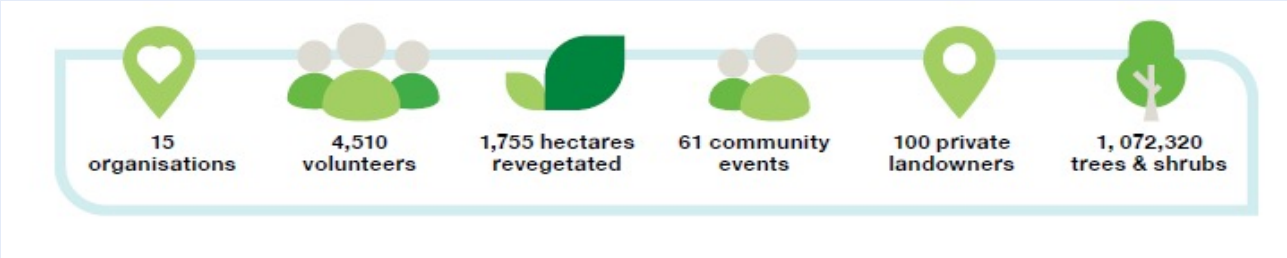
Over five years Greening the West has leveraged over $30m in state and federal funding to deliver better liveability and urban heat reduction outcomes in Melbourne's west. This includes over $6.6m funding from City West Water/Greater Western Water through the Stormwater Harvesting Partnership, which has led to the creation of nine new stormwater harvesting projects across six local government areas including at Woodlands Park (Essendon), Edinburgh Gardens (Fitzroy), Melbourne Ballpark (Altona), and Dempster Park (Sunshine). These projects have increased resilience to climate change in Melbourne's west, and saved around 110 megalitres of potable water annually.

Overall Greening the West has achieved the following outcomes so far for the community in Melbourne's west:

The Greening the West regional partnership has received two Premier's Sustainability Awards: in 2019 for the One Million Trees project, a sub-project falling under the GTW banner, and in 2020 City West Water won for their Stormwater Harvesting Partnership Fund, which has assisted in achieving Greening the West's desired outcomes through provision for alternative water for urban greening and cooling. In 2020 GTW was also recognised by the United Nations Sustainable Development Goals for the One Million Trees project in delivering Goal 13- Taking Climate Action.

Greening the West has significantly raised the profile of the water utility and its current and potential roles in supporting community health through urban greening and cooling. It provides a model that can be replicated in other regions, regardless of jurisdictional circumstances.

This program has demonstrated how collaboration benefits the water utility, and has led to commitments to other partnerships, such as Living Melbourne, Moonee Ponds Creek Chain of Ponds, Hobsons Bay Wetland Centre and recently an MOU with Victoria University.



CASE STUDY 15 COLIBAN WATER

Application of a shadow carbon price in capital decision making

The use of a shadow carbon price by Coliban Water is an example of explicitly considering future costs of carbon in decision-making. It is expected that the approach will drive behavioural change in the business through the consideration of carbon and climate change at the beginning of the project lifecycle. In addition, the business will likely avoid 'lock-in' of high emitting technologies.

CLIMATE THEMES ADDRESSED

NET ZERO EMISSION

CLIMATE CHANGE PROJECTIONS IN DECISION MAKING

DIRECTOR LIABILITY/TCFD

Background

Carbon has been considered in the Multi-Criteria Analysis for over seven years at Coliban Water, however, the future costs of mitigating, or offsetting the additional carbon were excluded from the assessment.

A shadow price on carbon assists to ensure investment decisions reflect all costs to achieve Carbon Zero cost-effectively. Shadow carbon pricing is a method of investment decision analysis that adds a proxy carbon surcharge to the price of projects that involve the creation of carbon emissions.

The shadow carbon price gives an edge to options that are more emissions efficient, other things being equal, when analysing investments and other strategic opportunities. It is an explicit way to anticipate future policies relating to carbon reduction and avoid stranded or inefficiently allocated capital.

The shadow carbon price adopted by Coliban Water is derived from work completed by the IPCC during the development of the Fifth Assessment Report and the World Bank's Carbon Pricing DashBoard. It follows a pathway through three different trajectories (Central, Low and High) out to 2050. The different trajectories allow for robust sensitivity analysis using the carbon price.

Benefits to the utility, and to climate-related outcomes

The application of a shadow carbon price highlights the impact of climate change and the potential costs of inaction. It allows for decisions to be made with visibility of future carbon costs.

The shadow carbon price is one of a number of tools that Coliban Water uses to consider carbon in decision-making processes, other tools include:

- Technical specifications and tender evaluation criteria in capital delivery
- Performance management, asset replacement and energy audits in Operations
- The use of a Marginal Abatement Cost Curve in carbon reduction projects.

CASE STUDY 16 SYDNEY WATER

NSW Sustainability Bonds

Sydney Water is playing its part to mitigate the impacts of climate change, protect and enhance our environment while shaping a low carbon, circular and sustainable water utility for future generations. To support this approach, Sydney Water has been a major participant in the multi-award winning NSW Sustainability Bond Programme (SBP) since its launch by the NSW Treasury Corporation (TCorp) in 2018. Eligible 'green' projects that Sydney Water has showcased through this programme include those that focus on renewable energy; energy efficiency; pollution prevention and control; sustainable stormwater management; climate change mitigation; and eco-efficient and circular economy adapted production technologies.

CLIMATE THEMES ADDRESSED

NET ZERO EMISSIONS | ENERGY MANAGEMENT | CUSTOMERS + COMMUNITY | ADAPTIVE PLANNING | GREEN AND BLUE INFRASTRUCTURE | SUSTAINABILITY BONDS

FIGURE 53 Cooks River Naturalisation Project funded by TCorp NSW 2019 Sustainability Bonds

SOURCE Sydney Water

FIGURE 54 Cup and Saucer Creek wetland delivered as part of the TCorp Sustainabilty Bond issuance

SOURCE Sydney Water

Background

The first of its kind in Australia, the NSW SBP is underpinned by global standards including the Climate Bonds Initiative (CBI), the Green Bond Principles (GBP) and the International Capital Market Association (ICMA), and provides a mechanism for capital to flow more directly to projects which deliver positive environmental and social outcomes.

Assisting in the transition to an SDG-aligned and Net Zero carbon economy, Sydney Water has provided infrastructure to support the issuance of three bonds under the programme. The first $1.8 billion record breaking Green Bond in 2018 was used in part to finance the Lower South Creek Treatment Program upgrades for sustainable water and wastewater management.

In 2019, the first Sustainability Bond (also $1.8 billion) was issued, which included not only 'green' projects, but also a variety of clean transportation and social programs. Sydney Water were able to finance a suite of stormwater naturalisation and improvement projects through the Sustainability Bond.

Benefits to the utility, and to climate-related outcomes

Reimagining stormwater asset renewal through a naturalisation lens provided the opportunity for Sydney Water and investment partners to rethink the role water infrastructure can play through innovative, integrated design solutions. These natural capital or green assets also increase the lifespan of built infrastructure, improve resilience to climate change and produce a variety of co-benefits like reduced carbon emissions, recreational opportunities and habitat protection.

The key benefit for Sydney Water from participating in this type of financial instrument is to create more value for customers through new sustainable finance mechanisms and potential access to cheaper capital.

Other benefits of participating in the NSW Sustainability Bond Program for Sydney Water include:

1 **Unlocking future opportunities in financing a net zero carbon economy as well as promoting an orderly transition from a linear to a circular economy.**

   This will be sought through partnerships and initiatives in the new Sydney Water Carbon Zero Plan and the Circular Economy and Resource Recovery Strategic Blueprint which set an ambitious direction to decarbonise operations and seek bold opportunities for value creation in many parts of our value stream.

2 **Inspiring innovative cross-government solutions to NSW's most pressing environmental problems through the piloting of a new program to develop methodology that quantifies the value of natural capital and its benefits**

   The success of TCorp's Sustainability/Green Bond program led to the NSW Dept. Of Planning, Industry and Environment (DPIE) initiating the Recognising Natural Capital Program (ReNCaP).

   ReNCaP is a new national initiative aiming to develop fit-for-purpose methodology to recognise natural capital in financial decision making and accounting. Linked to our transition with the circular economy, this will assist Sydney Water to assess the real value of the benefits of nature and the ecosystem services that nature provides that are not reflected in the current economic and monetary measures developed for the linear economy.

3 **Improved integration of sustainability practices**

   This assists Sydney Water in the transition to an SDG-aligned and Net Zero carbon economy by contributing to global best practice in impact and outcomes measurement, reporting and transparent disclosure of sustainability outcomes.

4 **Advancing sustainability and promoting investment in and development of infrastructure fit for the future whilst simultaneously achieving climate goals**

   This is being achieved by attracting new local and global investors which will assist in funding resilient water infrastructure in future and catalyse the market change towards a circular zero economy.

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Acronyms

ANCOLD	Australian National Committee on Large Dams
CSIRO	Commonwealth Scientific and Industrial Research Organisation
DELWP	Victorian Department of Environment, Land, Water and Planning
DPIE	NSW Department of Planning, Industry and Environment
ENSO	El Nino Southern Oscillation
ESCOSA	Essential Services Commission of South Australia
IPCC	International Panel on Climate Change
NGERS	National Greenhouse and Energy Reporting Scheme
PV	Photovoltaic
TCFD	Taskforce on Climate-related Financial Disclosures
WSAA	Water Services Association of Australia

Glossary

Climate change adaptation	The process of adjustment to actual or expected climate and its effects.
Climate change mitigation	Reducing the emissions generation by an organisation's activities in order to mitigate the impact of those activities on climate change.
Carbon neutral	An activity, product or organisation is carbon neutral when its greenhouse gas emissions are equal to zero. To become carbon neutral, companies must rigorously calculate their emissions, reduce them as much as possible, then purchase and retire carbon offsets to the equivalent of the remaining emissions (Source Tasman Environmental Markets)
Carbon negative (also known as carbon positive)	The reduction of an entity's carbon footprint to less than neutral, so that the entity has a net effect of removing carbon dioxide from the atmosphere rather than adding it. Becoming carbon negative requires a company, sector or country to remove more CO_2 from the atmosphere than it emits.
Carbon offsets	A reduction of GHG emissions that compensates equally for emissions released elsewhere. Carbon offsets credits are typically specified as the equivalent of one tonne of carbon dioxide equivalent (CO_2-e). There are a range of carbon offset products available:
	Australian Carbon Credit Units (ACCUs)
	Certified Emission Reduction Units (CERs)
	Removal Units (RMUs)
	Voluntary Emission Reduction (VERs)
	Verified Carbon Units (VCUs)
Green and blue infrastructure	the vegetated landscape in urban areas such as trees, parks, and open space, as well as the water environments within a city, such as rivers, lakes, ponds and bays/ocean
Fugitive emissions	Emissions of gases such as nitrous oxide (N20) and methane (CH_4) primarily from wastewater transport and treatment, but also from decaying vegetation in dams.
Net zero emissions	Reducing an entity's carbon footprint to neutral, through a combination of emissions reduction and offsetting.
Resilience	the capacity of individuals, communities, institutions, businesses, and systems within a city to survive, adapt, and grow no matter what kinds of chronic stresses and acute shocks they experience (Definition from the Rockefeller Foundation's 100 Resilient Cities program)
Shandy	Mixing several sources of water of differing qualities together to increase overall quality, for example stormwater and treated wastewater
Zero cost energy	Energy costs from the grid are balanced out by energy from renewable sources that have already met their payback periods, generating essentially free of charge or being exported back to the grid.

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