THE PATH TO DECARBONISATION

Seizing the value of digitalisation and the new energy paradigm

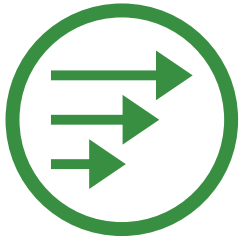
November 2023

GWI GLOBAL WATER INTELLIGENCE | Schneider Electric

Executive summary

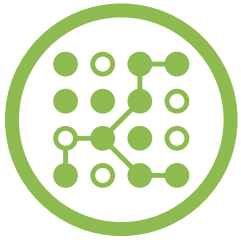
According to GWI:

52% of **water infrastructure's carbon emissions** are generated by **fossil fuel energy sources**, meaning that optimising energy efficiency is the major low-hanging fruit for the industry.



Exploring the key drivers for water sector decarbonisation

Surging water demand and volatile energy prices are driving innovative solutions to do more with less, and institutional pressures for net zero, transparency and water stewardship are escalating the decarbonisation agenda.



Navigating global decarbonisation trends

Europe, East Asia, Australia, and North America are pioneers in utility decarbonisation but opportunities are emerging in Latin America and Southeast Asia, especially in well-performing utilities with private sector involvement and ESG targets.

Crafting a digital decarbonisation strategy

IoT sensors can be deployed to understand baselines and monitor KPIs in real time. Then with asset management software the results of decarbonisation strategies can be easily shared.

Mastering the energy toolkit

Firstly, digital platforms and software are low-capex solutions to **reduce** the energy consumption of existing assets, either by providing actionable insights or automating processes.

Secondly, renewable energy can **replace** fossil fuel energy sources, with multiple pathways to green the energy mix without a capex-heavy burden.

Finally, by embracing the circular economy, energy can be **recovered** throughout the entire sludge treatment train, creating new revenue streams while mitigating greenhouse gas emissions.

Contents

Net zero and decarbonisation are rapidly moving up the agenda for the global water sector as it simultaneously grapples with the challenges of increased water demand, current and future climate concerns and volatile energy prices. To meet these competing demands, digital technologies and the new energy paradigm are being implemented to optimise water sector energy efficiency.

The function of this white paper is twofold:

- To map out the context of water sector decarbonisation, examining the drivers and global opportunities.
- To share the key steps in creating a decarbonisation strategy: from understanding the baselines, to the technologies used to reduce, replace and recover energy, and sharing results.

Throughout the process digital tools are the enabler; facilitating real-time, data-driven decision-making, allowing utilities and industrial users to decarbonise in the most efficient and low-capex way.

Decarbonisation drivers


Creating a digital strategy


Global market overview


Tools for energy efficiency


Regional decarbonisation opportunities


Tools for energy transition

Glossary

Greenhouse gas (GHG) — Gases in the Earth's atmosphere that trap heat, such as carbon dioxide, methane and nitrous oxide.

Net zero — Reaching a balance between GHGs emitted and captured, by reducing all GHGs so that the remainder can be balanced by off-setting or sequestration.

Emission scopes

Scope 1 — Direct GHG emissions, originating from facilities and/or assets owned/controlled by the organisation.

Scope 2 — Indirect GHG emissions through the organisation's consumption of purchased energy.

Scope 3 — Other indirect GHG emissions from the organisation's value chain that are not attributable to purchased energy; including emissions from purchased goods and services (e.g. transport or construction).

Accessing renewable energy

In-house project — The utility or end-user owns and funds the renewable energy infrastructure, typically hiring a contractor to build and operate it.

Power purchase agreement (PPA) — The utility or end-user purchases electricity via a long-term, fixed price contract from the energy provider that is responsible for the renewable energy infrastructure.

Off-site PPA — The energy provider's infrastructure is off the utility or end-user's land, for example a wind or solar farm.

On-site PPA — The energy provider's infrastructure is on the utility or end-user's land, for example a floating solar farm on a reservoir.

Energy efficiency and decarbonisation

Carmen de Miguel
Schneider Electric

Energy is commonplace in all conversations with customers, partners, and peers in the water industry. Whether either directly from price volatility and the green transition, or indirectly from increasing complexity in treatment processes and regulation, the impact of energy on the bottom line of water and wastewater utilities is on the rise. Within the journey to net zero or even negative greenhouse gas (GHG) emissions targets, energy is the low-hanging fruit within the short-term range of actions to take.

As such, we should see mature plans around the energy conversation across the water sector today. But as seen from the first outcomes from a quick survey among SWAN (Smart Water Networks Forum) members, there is much to do and many questions in the air regarding energy efficiency challenges. For example, "What to prioritise; How to optimise resources and funding; How to leverage data, start small and scale; Is it that complex all the way through; How to trigger innovation and change?" An urgency to act now and drive results in few years or months' time, is confronted with lack of resources and experience in combined power and process management.

Now that digital technologies are all over the place, "energising" the water industry with a digital mindset looks like the right thing to do and sharing what has worked well paves the way too. This whitepaper wants to serve as an overview of how to structure successful roadmaps to achieve energy efficiency and carbon targets making use of digital transformation and experts' support.

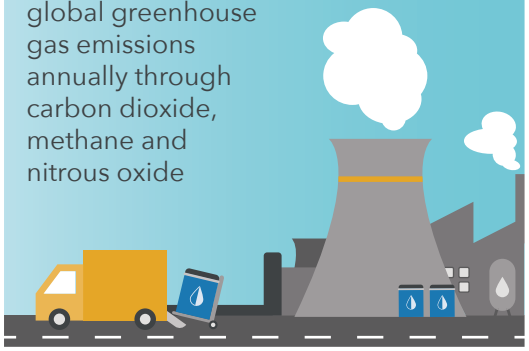
Drivers for decarbonising the water sector

Why is decarbonisation becoming a priority now?

The last few years have seen a shift towards decarbonisation on a global scale, with investment and implementation emerging throughout many industries. In the water sector, a range of factors are driving both industrial water users and utilities towards decarbonising their activities.

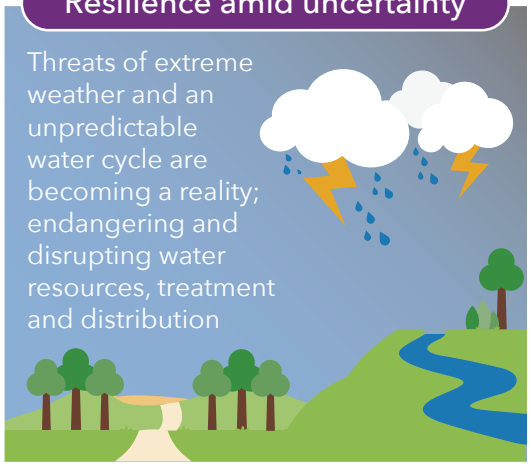
Sector-wide carbon emissions

Utility water infrastructure contributes 1.8%* of global greenhouse gas emissions annually through carbon dioxide, methane and nitrous oxide



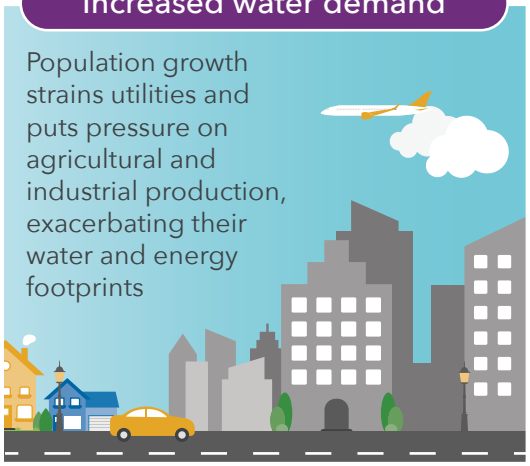
Resilience amid uncertainty

Threats of extreme weather and an unpredictable water cycle are becoming a reality; endangering and disrupting water resources, treatment and distribution



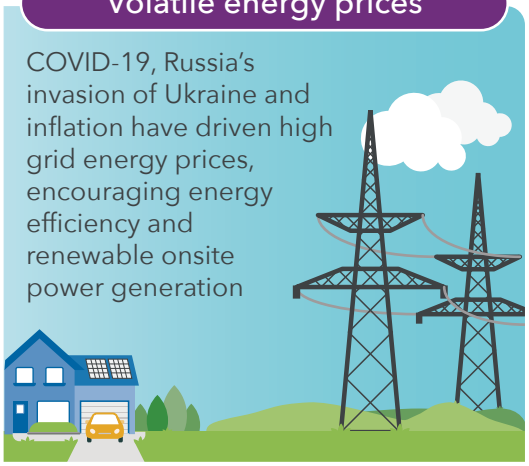
Increased water demand

Population growth strains utilities and puts pressure on agricultural and industrial production, exacerbating their water and energy footprints



Volatile energy prices

COVID-19, Russia's invasion of Ukraine and inflation have driven high grid energy prices, encouraging energy efficiency and renewable onsite power generation



Pressure for transparency

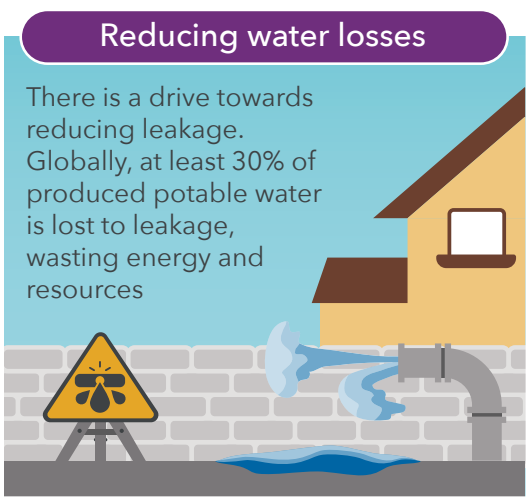
Global pressure intensifies for decarbonisation goal setting and progress reporting, holding nations, companies, and utilities accountable to their targets

Global decarbonisation initiatives

The Paris Agreement and Sustainable Development Goals lead global decarbonisation efforts – recently bolstered by the Global Methane Pledge, the Race to Zero and the Wastewater Zero Commitment

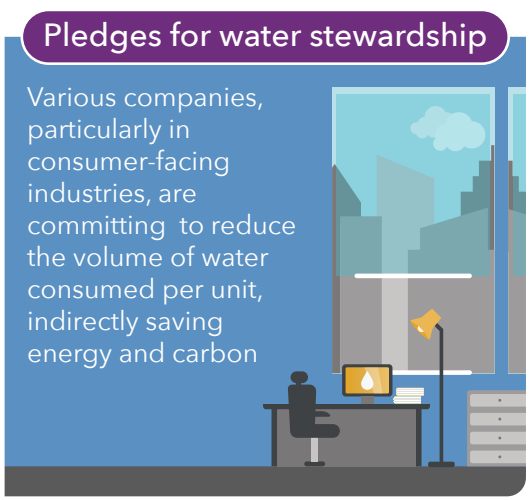
Reducing water losses

There is a drive towards reducing leakage. Globally, at least 30% of produced potable water is lost to leakage, wasting energy and resources



Pledges for water stewardship

Various companies, particularly in consumer-facing industries, are committing to reduce the volume of water consumed per unit, indirectly saving energy and carbon



*GWI estimates from Water Without Carbon (2022) research. Refers to scope 1 and 2 emissions only.

The global market for water sector decarbonisation

Which geographical regions are hotting up for water sector decarbonisation?

Water sector decarbonisation initiatives are growing, with GWI research showing that at least 87 water utilities are committed to net zero as of 2023. Several other utilities have set intermediate commitments, contributing to decarbonisation without committing to net zero. Conversely, industrial water users prioritise cost reduction, water efficiency and pollution permit compliance over decarbonising their water use, although it is expected to become an increasing focus in the future.

Europe

One of the strongest utility decarbonisation markets globally, with the largest proportion of GWI's recorded utility net zero commitments being from the region. However, most activity is in Western rather than Eastern Europe.

North America

Few utilities have made their own commitments to net zero. Instead, utilities typically contribute to the municipality's decarbonisation goals, rather than setting their own.

Asia Pacific

A divided region, with Australia having one of the globe's strongest decarbonisation drives and South Asia one of the weakest. In the region, meeting strict permits and SDG 6 are the priority, however Mumbai recently became the first city in South Asia to set a city-wide net zero pledge.

Latin America

Few utilities focus on decarbonisation, with reaching SDG 6 and climate adaptation being stronger priorities. However, GWI research has identified three high-performing utilities that have committed to net zero.

Middle East

There are very few decarbonisation commitments from water utilities, but in some cases the utility's strategy comes from a national net zero pledge, for example, with the UAE and its national water utility TAQA. The Middle East is focusing on reducing water losses and decarbonising desalination.

Africa

For African utilities, climate adaptation is the greatest concern. A few well-performing utilities and bulk water providers are improving energy efficiency and reducing dependence on the grid, but this is driven by cost reduction and climate adaptation rather than decarbonisation.

Utility focus: Europe

Do technologically advanced utilities dominate the European decarbonisation market?

In Europe, decarbonisation is propelled regionally by the European Union (EU), with policy drivers such as the Europe Climate Law legally enshrining the goal of EU climate neutrality by 2050. More technologically advanced markets are predominantly located in Northern and Western Europe.

Imminent opportunities

The UK and Denmark have extremely high-performing utilities, and notably the entire water sector in both nations has commmited to net zero or climate neutrality by 2030.

Denmark has advanced in nitrous oxide (N_2O) management. From 2018-2020 nine plants monitored direct N_2O emissions from wastewater with €670,000 EPA funding. Also, a tax on N_2O emissions from waste water treatment plants over 25,000 p.e could be introduced after 2025.

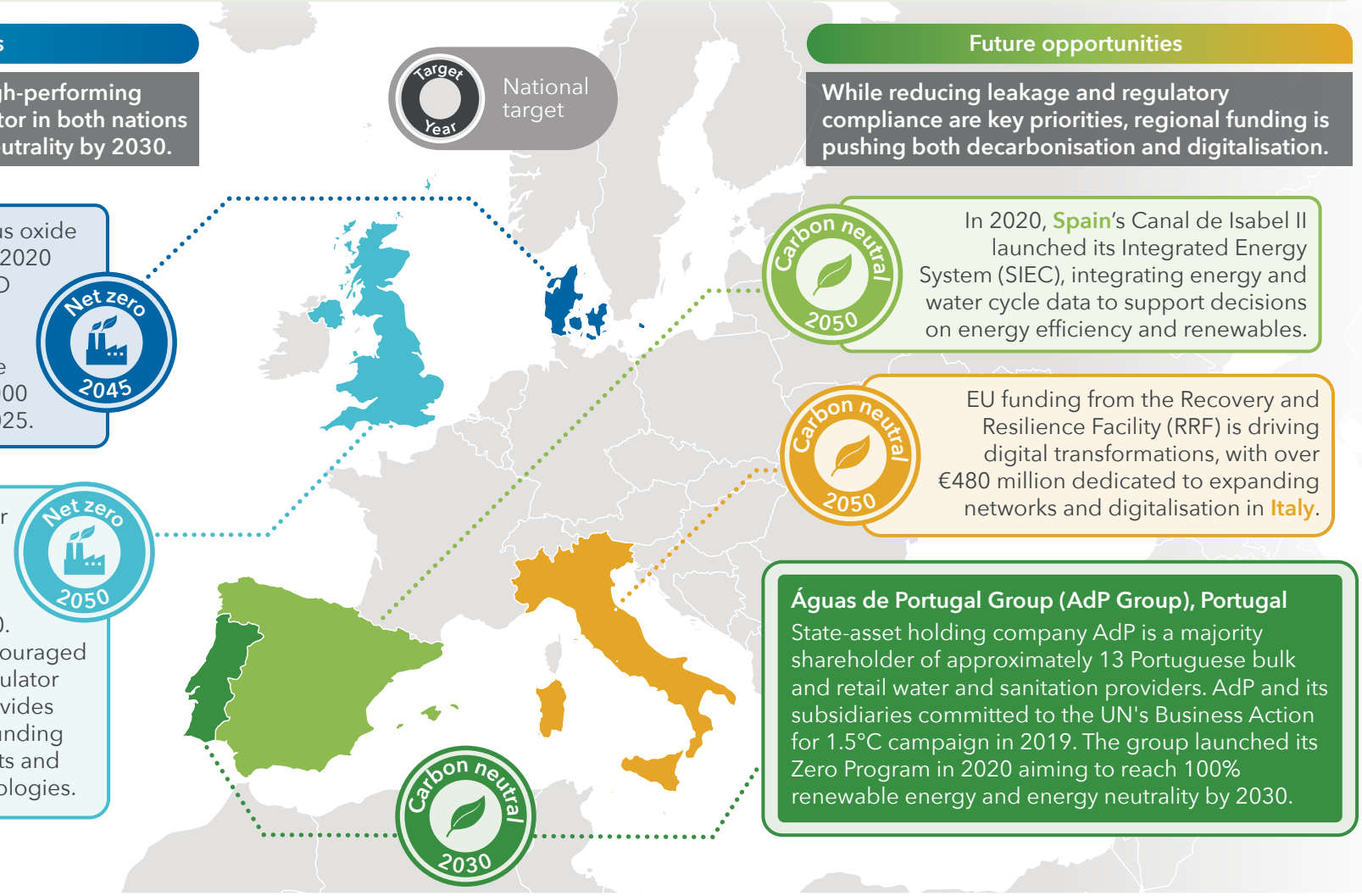
Net zero 2045

Severn Trent, UK

In May 2023, the utility announced the world's first retrofit carbon neutral site, which will use digital twin and virtual technology for optimisation.

In 2020, **UK** water companies came together under Water UK's roadmap to 2030. Innovation is encouraged by economic regulator Ofwat, which provides £200 million in funding to various projects and innovative technologies.

Net zero 2050



Future opportunities

While reducing leakage and regulatory compliance are key priorities, regional funding is pushing both decarbonisation and digitalisation.

Carbon neutral 2050

In 2020, **Spain**'s Canal de Isabel II launched its Integrated Energy System (SIEC), integrating energy and water cycle data to support decisions on energy efficiency and renewables.

Carbon neutral 2050

EU funding from the Recovery and Resilience Facility (RRF) is driving digital transformations, with over €480 million dedicated to expanding networks and digitalisation in **Italy**.

Águas de Portugal Group (AdP Group), Portugal

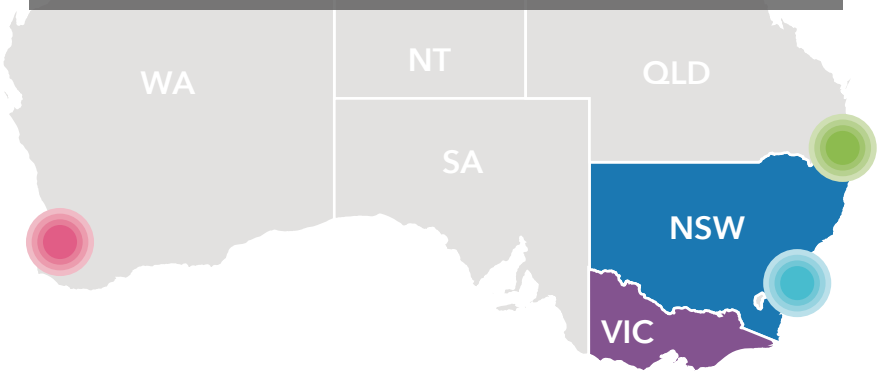
State-asset holding company AdP is a majority shareholder of approximately 13 Portuguese bulk and retail water and sanitation providers. AdP and its subsidiaries committed to the UN's Business Action for 1.5°C campaign in 2019. The group launched its Zero Program in 2020 aiming to reach 100% renewable energy and energy neutrality by 2030.

Utility focus: Australia

With the nation only committing to net-zero in 2022, why does Australia have such a mature and diverse utility decarbonisation market?

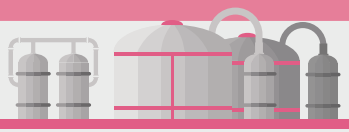
Almost all Australian utilities are owned by the state or local council, meaning their strategies are closely tied to their respective governments'. Each state or territory has their own net zero strategy, most aspirational rather than legislated. Net zero by 2030 became legislation in 2022 at the national level, following the election of Anthony Albanese as prime minister, which is likely to propel new decarbonisation market opportunities.

The Federal government encourages technological innovation for the energy transition (especially the water-waste-energy nexus) with funding from the Australian Renewable Energy Agency (ARENA). With the legislation for net zero targets at the federal level passed in September 2022, the budget for ARENA is likely to increase, creating more opportunities for innovation.



Munster, Western Australia

Up to **AUD$9.4 million** from ARENA



Biogas/biomethane to hydrogen & graphite

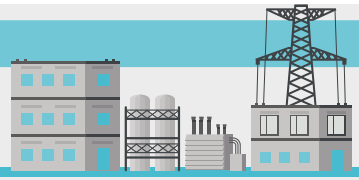
Logan City, Queensland

Up to **AUD$6.2 million** from ARENA

Biosolids to energy using gasification

Sydney, New South Wales

Up to **AUD$5.9 million** from ARENA



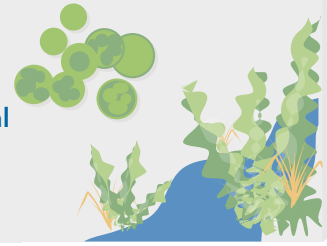
Biogas/biomethane grid injection

Victorian Water Sector, Victoria

Victoria stands out among Australian states and territories with its legislated net zero targets, and is the only state where all **18 water utilities have committed to net zero by 2035**, including some as small as 12,000 p.e. Collaboration within the state's utility sector has been instrumental, with a **pioneering joint power purchase agreement** facilitating affordable prices to access a large off-site solar farm.

Sydney Water, New South Wales

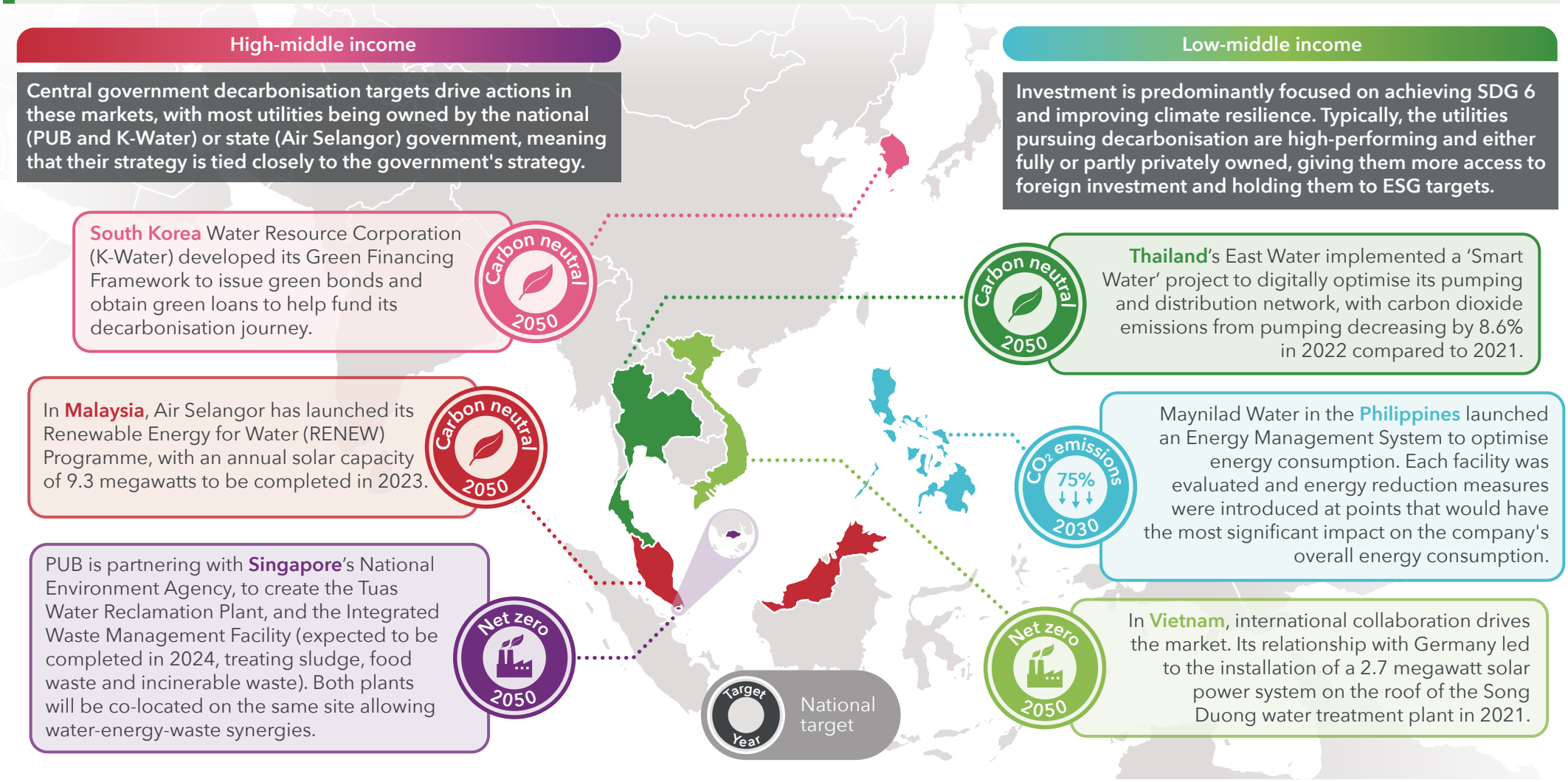
Focuses on low-cost solutions using the Cost of Carbon Abatement Tool (CCA), a software that the utility developed in 2010 with Sydney Water Energy Partners. **A recent decarbonisation project of note includes a trial of an algal wastewater treatment method from Pacific Bio, a low-cost alternative to conventional tertiary treatment that simultaneously sequesters carbon.**



Utility focus: East Asia

Is decarbonisation out of reach for low-middle income countries?

The highly developed nations of Singapore and South Korea are renowned technology and innovation hubs. However, actions towards decarbonisation in Asia are not limited to regions with high incomes but are also developing in some low-middle income countries.



Utility focus: Americas

North America has few utility net zero targets, but does that make Latin America the stronger market?

Latin America exceeds North America in utility net zero commitments, despite being perceived as less technologically advanced. However, North American utilities prioritise decarbonisation through municipal net zero pledges rather than their own initiatives.

North America

Very few utilities in the region have their own net zero targets. Most utilities contribute towards the decarbonisation strategies of the municipality or state that they are part of, with most states having some form of net zero strategy. Biden's Bipartisan Infrastructure Law is pushing investment into water at a federal level, but the focus is more on climate adaptation and water scarcity, rather than decarbonisation.

City of Calgary, Albert, Canada

USD $725 million was invested by the City of Calgary to upgrade its largest WWTP (Bonnybrook WWTP), including installing a biogas CHP, which will reduce Bonnybrook's GHG emissions by about 17,500 tCO_2e/year, and could be injected into the grid.

Metropolitan Water District of Southern California, USA

Carbon neutral 2045

The transition to renewable energy is mandated by State Bill 100, and the Water District is aiming for 88% of its electricity to be 'carbon-free' by 2025.

Target Year — Utility specific target

Latin America

In Latin America, the largest and highest-performing utilities are leading the region's decarbonisation efforts, enabled by their high service delivery, bankability, and need to meet their ESG targets to satisfy their private investors. Three major utilities have set targets for carbon neutrality rather than net zero, whereas others have intermediary commitments in their company sustainability policy.

SANEPAR, Brazil

Its 2021 sustainability policy commits to mitigating greenhouse gases, promoting the circular economy and improving the energy efficiency of equipment. It has received finance from the German development bank KFW and the state government for sewage sludge energy efficiency projects.

Aguas Andinas, Chile

Carbon neutral 2050

The utility has set its own targets for carbon neutrality by 2050. By 2024 it aims to have 80% of electricity consumption incorporated into monitoring and energy optimisation schemes. Wells for groundwater extraction have been a key focus with continuous monitoring systems installed to maximise energy efficiency.

Where to start: Strategise

How do water utilities or industrial water users start on the decarbonisation pathway?

When beginning a decarbonisation journey, digital tools are essential to streamline the strategisation process – from using digital sensors to understand baseline operations or software to monitor and report on KPIs.

Understand the baseline

Determine current energy consumption and carbon footprint.

For example

Locating pressure points using IoT sensors or energy management systems.

Set a goal

Determine a broad and overarching goal.

For example

Using more renewable energy.

Map out the direction

Create a long-term plan, including expected reporting frequency and defining the roles of those involved in the project.

For example

Building a roadmap to 2050.

Set KPIs

Set specific, attainable, and time-bound objectives to reach a goal and incrementally increase the KPIs as performance increases.

For example

% share of renewable energy in the mix by 2025.

Communicate commitment

Encourage internal employee engagement and communicate commitment externally.

For example

Using digital software to streamline KPI monitoring and reporting.

Getting the most out of digital data

How can real-time data be taken to the next level?

Once real-time data is generated, digital tools can enhance its value – enabling a birds-eye view of the entire system, unprecedented cross-departmental communication, or automating processes entirely.

Centralising data and control

Giving 24/7 insight into the whole facility and network, using digital tools such as SCADA (Supervisory Control and Data Acquisition) at a central location or command control centre. This integrates various data sources and enables real-time monitoring and analysis.

Water Control Centre of Acciona (CECOA), Spain

Collecting, monitoring and analysing the operational data of all Acciona plants globally using data management platforms. This has been taken even further with the integration of machine learning (ML) and artificial intelligence (AI).

Integration of OT-IT

Integrates IT (information technology), which analyses the data from sensors, with OT (operational technology) which allows the physical control of the asset, enabling better control and communication, and improved efficiency.

Maynilad, Philippines

OT and IT departments were bought together, facilitated by the Field Monitoring User System (FieldMOUS), enabling plant-wide sensor data to be viewed in real time from a central control room.

Digital twin

A virtual representation of the physical asset, mirroring its processes in real time and allowing the operator to simulate different conditions and responses. To identify energy saving opportunities, advanced analytics and optimisation algorithms could be used.

Padania Acque, Province of Cremona, Italy

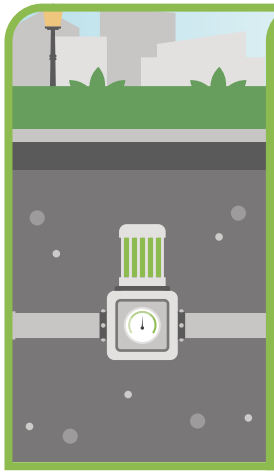
A digital twin was used alongside asset management software to bring a predictive approach to management, reducing energy consumption by at least 5% and increasing earnings before interest, taxes, depreciation, and amortisation by 22% over three years.

Least sophisticated → Most sophisticated

Tools to reach goals: Reduce

How can maximum value be achieved from existing assets?

Existing assets can be optimised using software to reduce carbon emissions, and slash energy and chemical costs. Utilising digital software has a short return on investment, with some companies offering their platform via a subscription service to further reduce the capex burden on the end-user.



Pump network optimisation

Advanced control systems and machine learning can optimise pumping by dynamically adjusting pressure and speed to match demand.

Metropolitana Milanese, Italy
By automatically controlling the operation of well fields and pumping stations, energy consumption was reduced by 8% in the first year, equating to €410,000/year (at 2021 rates).

Plant optimisation

Advanced process control (APC) technology can optimise various processes including aeration and chemical dosing, reducing energy consumption and operational costs.

Aigües De Barcelona, Spain
Process optimisation software was used to monitor and control the operations of the sewage treatment plant, reducing aeration energy costs by 41%.

Edge control

Edge control enables data collection and analytics at the network edge rather than a centralised server, processing high volumes of real-time data with reduced latency.

Royal HaskoningDHV, Nereda installations
Schneider Electric is the preferred supplier for Nereda wastewater treatment, providing automation and edge control to optimise the proprietary process.

Leakage and water efficiency tools

Smart technology can be used for leakage management, to boost utility and industrial water efficiency, each indirectly reducing energy and carbon footprints.

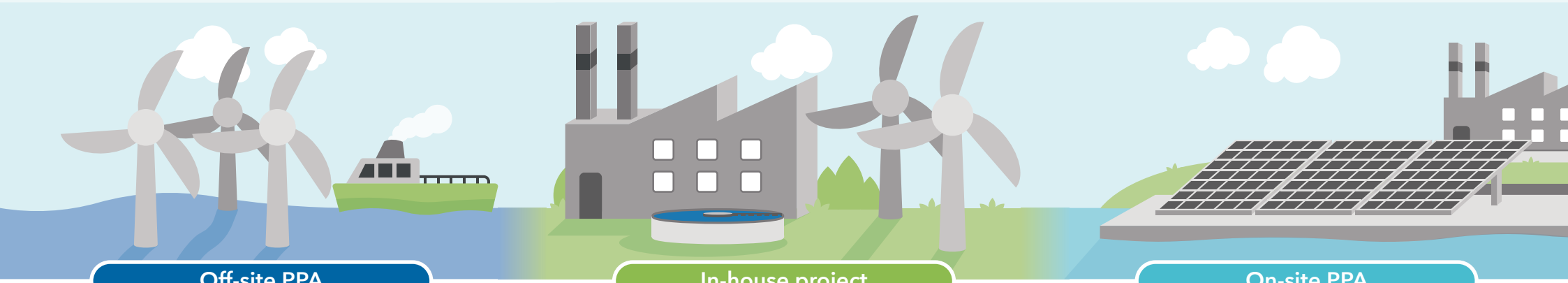
Anglian Water, UK
(Water Advisor + Geo SCADA Expert)
Leakage was cut by 10% and operational efficiency increased by 10% by using SCADA, edge control and water management software.

Tools to reach goals: Replace

Does not having access to capital to spend mean that renewable energy is out of reach?

Replacing conventional energy sources with renewable alternatives is a key focus for the water sector to reduce scope 2 emissions, with many utilities having deadlines to achieve a 100% renewable energy mix. While greening the energy mix with renewable energy may seem capex-intensive, power purchase agreements (PPAs) can be utilised to shift the capex to the energy provider.

Different pathways to access renewable energy



Off-site PPA

Northumbrian Water, UK

Northumbrian Water signed a 10-year PPA with Danish energy company Ørsted to access 100 GWh/year of energy from the Race Bank off-shore wind farm in the North Sea.

In-house project

Hamburg Wasser, Germany

In April 2023, Hamburg Wasser commissioned its fourth wind turbine at Dradenau WWTP to power the plant, with surpluses injected into the grid.

On-site PPA

PUB, Singapore

In 2020 PUB signed a 25-year PPA for 122,000 floating solar panels at the Tengeh Reservoir, capable of powering five local water treatment plants and offsetting 7% of PUB's overall energy needs.

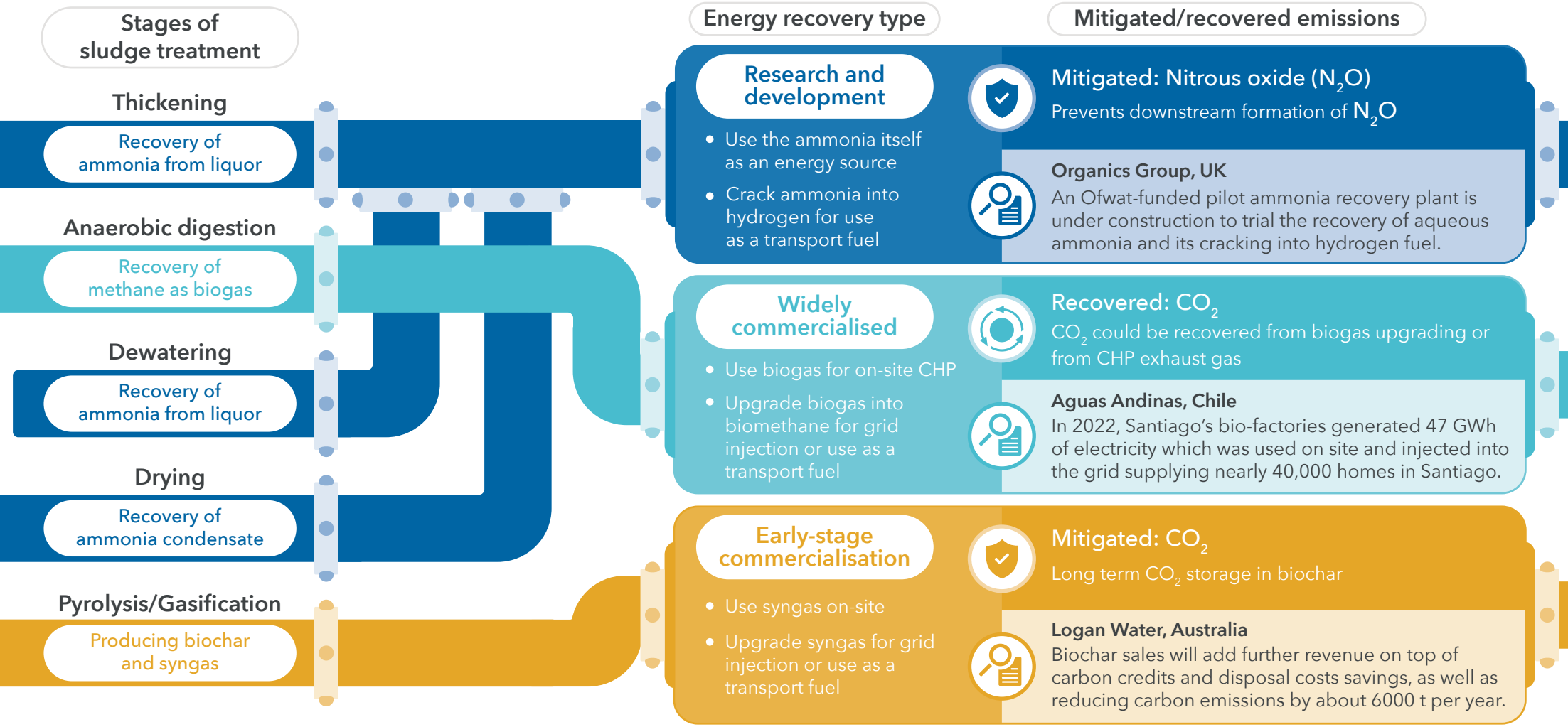
Combining renewable energy with microgrids

Microgrids integrate renewable and conventional energy sources. They address challenges like intermittent renewable energy production, high grid energy prices and power disruption – as Fairfield's Public Works (USA) utilised after Superstorm Sandy.

Tools to reach goals: Recover

What untapped energy sources are being lost in waste streams?

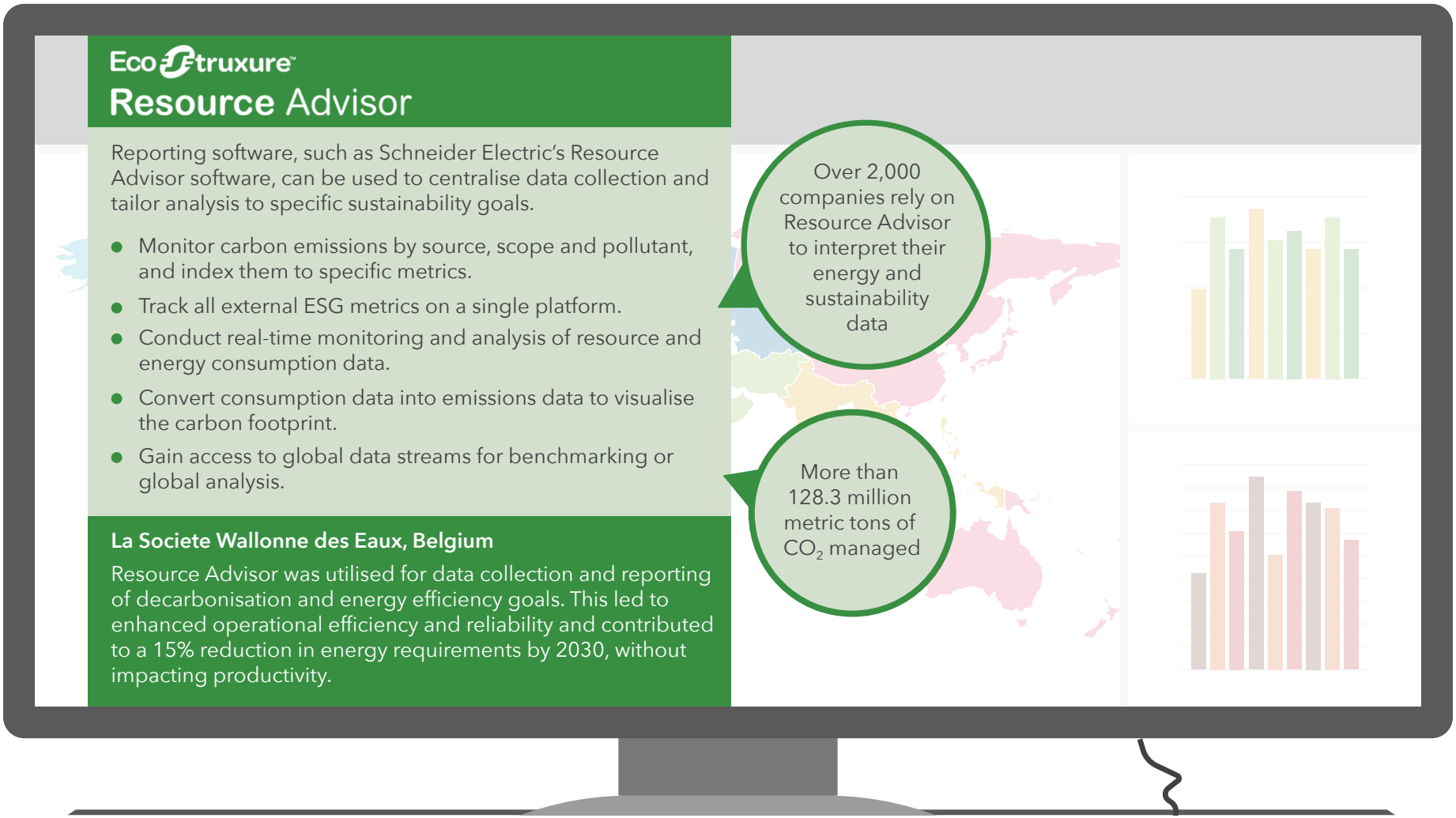
The intersection of the circular economy and the water-energy nexus drives opportunities, especially in sludge treatment, to reduce waste, cut greenhouse gas emissions and in some cases open new revenue streams – enabling utilities to transition from being an energy consumer to an energy producer.



Sharing results

How can raw data be centralised to track and share progress?

Not only is the water sector under pressure to decarbonise, but it is also increasingly encouraged to disclose its progress for transparency and accountability. Various software or data systems can be used to streamline the reporting process and create visual dashboards.



The steps to decarbonisation

What are the key six steps to digital decarbonisation?

Strategise

Determine energy and carbon baselines using IoT sensors or energy management software, and use this information to create goals, KPIs and a long-term roadmap to decarbonise.

Digitise

Use real-time insights, and then maximise the value of the data by centralising and integrating data from various locations and forms, utilising it to automate processes or incrementally optimise them.

Reduce

Use digital tools, such as edge control, advanced control systems and smart leakage detection, to reduce energy consumption in networks and treatment sites.

Replace

Incorporate renewable energy into the energy mix, whether through a PPA or in-house projects.

Recover

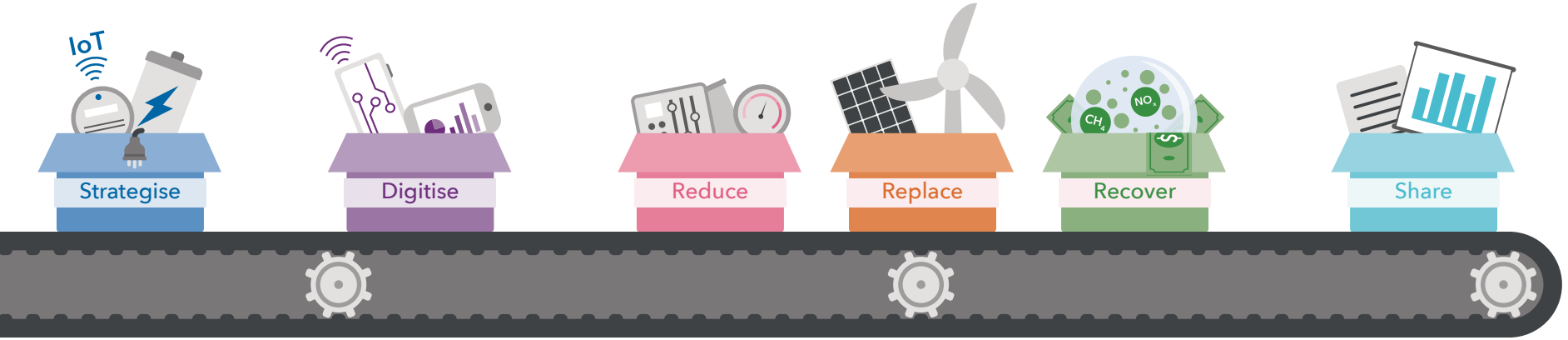
Harness energy from on-site processes and capture process emissions, such as methane and nitrous oxide. Capturing biogas and injecting biomethane is becoming a major trend for opening new revenue streams.

Share

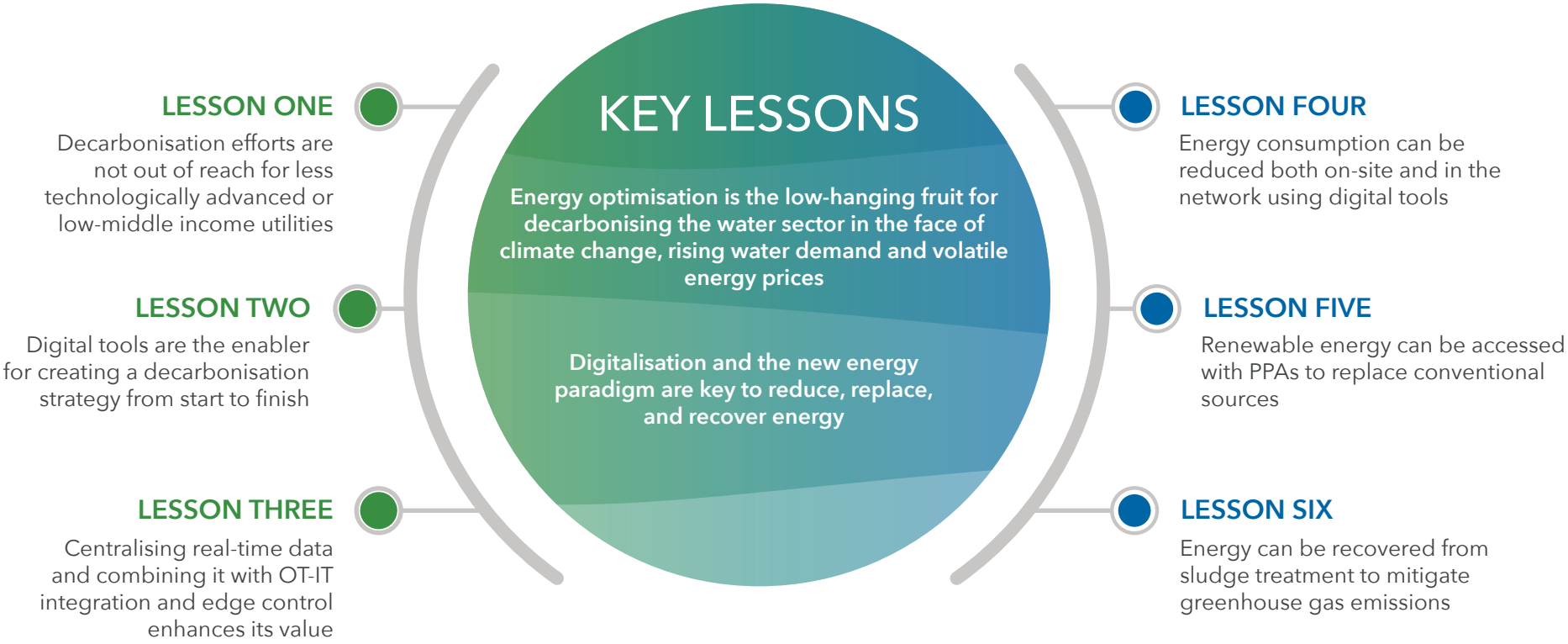
Use software and digital platforms to aggregate data in line with KPIs and create dashboards or digestible reports to share internally and with investors. KPIs can then be modified or strategies can be improved to further decarbonise.

Then what? – Climate adaptation

Adaptation is the next part of the puzzle and digital technologies offer a wide array of tools to improve climate resilience, such as microgrids for power outages, or smart sewers for managing combined sewer overflows (CSOs). Decision making can also be streamlined, using digital twins to simulate climate scenarios.



Conclusion



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Written by: Sandie Garland
Comment piece by: Carmen de Miguel
Edited by: Kelly Thompson & Charlie Walker
Proofread by: Charlotte Oakes & Georgia Bottomley
Designed by: Shaun Hazell & Amelie Robert

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Media Analytics Ltd.,
Suite C, Kingsmead House,
Oxpens Road,
Oxford OX1 1XX,
United Kingdom

Tel: +44 1865 204 208
Fax: +44 1865 204 209

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