Our net zero strategy to 2030

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Foreword

When we first began our journey towards carbon neutrality at Anglian Water at the start of the last decade, we were navigating new and unfamiliar territory. We had come early to the realisation that we had a clear duty to tackle our emissions - not just because the water sector is generally one of the most power hungry, but because the rural nature and flat landscape of our region means we need even more energy than most to pump water to where it is needed.

Our determination to do the right thing by our communities and the environment - since codified in our purpose - meant doing nothing was not an option.

"Our purpose is to bring environmental and social prosperity to the region we serve through our commitment to Love Every Drop"

We have made enormous progress since we set our first carbon reduction targets in 2010, but as early adopters, it was a steep learning curve for us and our supply chain.

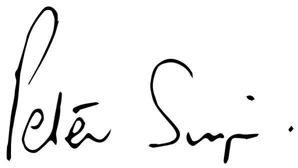
I am genuinely heartened that the conversation, and the action being taken, have both moved on so dramatically since those early days, and that we are now able to muster the might and minds of our whole sector behind reaching net zero by 2030. And five years after the Paris Agreement, and with COP26 on the horizon, we are seeing a palpable positive shift in attitudes right around the world.

We all know it is more urgent than ever to try to undo - or at least put a stop to - the damage we are doing to our planet, and to adapt our assets to be fit for the future. It has almost become a cliché to talk about the temperature records that are being broken on what feels like a daily basis around the world. And the extremes of weather we are seeing, not just around the world, but here in our own back yard in the East of England, make it impossible to ignore the need to tackle our remaining emissions right now, in parallel with our efforts to be resilient to the changing climate which is already underway.

So we are accelerating our progress to net zero and setting out here the pathway that will get us there by 2030, based on our three-step hierarchy of reducing emissions, decarbonising our electricity supply and removing or offsetting our residual emissions.

It won't be easy - in fact it will be incredibly challenging - and as I write, we don't have all the answers. Finding and delivering them is going to take sustained and genuinely collaborative efforts throughout the coming years, not just from us but from our supply chain, our peers, from government and from regulators. As co-sponsor of the Water UK Net Zero Routemap, I and my colleagues across Anglian Water have a special responsibility to lead and shape that action.

But based on our track record, which has seen us reach and surpass successive targets on both operational and capital carbon, drive the development of the global standard for carbon management in infrastructure (PAS 2080), and, most recently, launch the world's first sustainability linked bond tied to net zero targets, I am completely confident we'll get there. The stakes for our environment and our communities are too high for us to fail.



Peter Simpson

CEO, Anglian Water

Executive summary

Our region is the driest and lowest lying in the UK, more vulnerable than most to the effects of climate change, giving us hotter, drier summers and warmer, wetter winters, and causing sea level rise. The more the world warms, the worse those effects will be. That is why we are playing our part in the global effort to limit further climate change: by moving to net zero operational emissions by 2030.

Our decarbonisation journey

For many years we have been at the forefront of carbon reduction in the water industry. With a committed leadership and a determined supply chain, by 2020 we had reduced capital carbon by 61 per cent in our capital programmes from our original 2010 baseline and reduced operational emissions by 34 per cent from a new baseline set in 2014/2015. We are also supporting system-wide decarbonisation in the region, for example by exporting waste heat to warm tomato greenhouses in our region year-round - something we are looking to repeat at other sites.

Our 2030 decarbonisation targets

Our goal is to achieve net zero operational emissions by 2030 and to maintain this thereafter. Net zero covers our operational activities (Scope 1, 2 and outsourced Scope 3 operations). We have also set a 70 per cent capital carbon reduction target by 2030 from a 2010 baseline.

Our 2030 net zero strategy

Achieving net zero means we will reduce the greenhouse gas emissions from our operations as far as possible and ensure overall we have no impact on greenhouse gases in the atmosphere. Any residual emissions that we cannot avoid or reduce will be counterbalanced from 2030 by an equivalent sequestration of gases.

Our net zero strategy impacts all of our business operations and those of our supply chain. It requires a flexible approach and the exact steps we will take in our journey will require extensive collaboration with our supply chain, our peers, government and regulators.

Our strategy is centred on:

- **Maximising energy efficiency and renewable energy generation and storage**
- **Procuring green electricity**
- **Decarbonising our vehicle fleet**
- **Maximising the value of our biogas**
- **Managing our process emissions**
- **Opting for alternative fuels**
- **Developing our offsetting strategy**

We will encourage the right behaviours in our organisation and in our supply chain to maintain a constant focus on carbon reductions.

Our pathway to net zero

In our strategy, we have set emissions reductions goals for both 2025 and 2030, as well as describing the associated risks and uncertainties. We have developed two possible pathways:

- Our 'target pathway' to 2030 - this is the central projection that we will use to monitor our progress over time;
- A 'stretch pathway' to 2030 - this is a more ambitious pathway which we would like to achieve if supported by additional funding and favourable government policy. It will provide a benchmark that will constantly drive ambition and stimulate further action with our partners in the water industry and other sectors, unlocking additional opportunities.

Our challenging pathway to net zero (shown in Figure 1) involves reducing emissions by 34 per cent by 2025 and 74 per cent by 2030. This will leave us with 26 per cent of the 2018/19 baseline to offset to achieve net zero in 2030.

Figure 1: Our target pathway to net zero by 2030

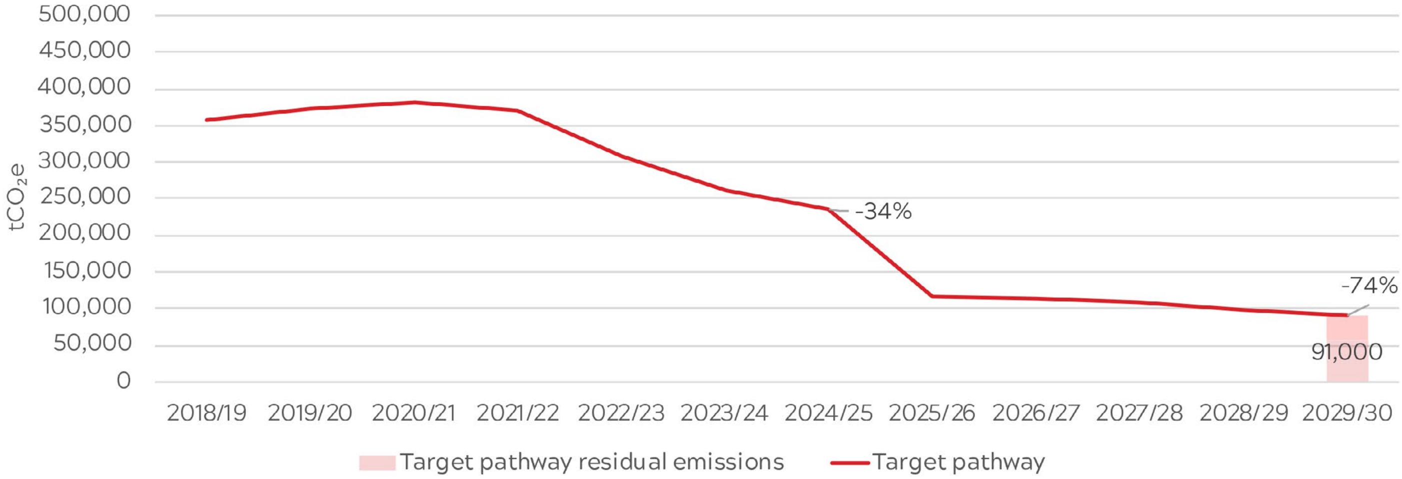
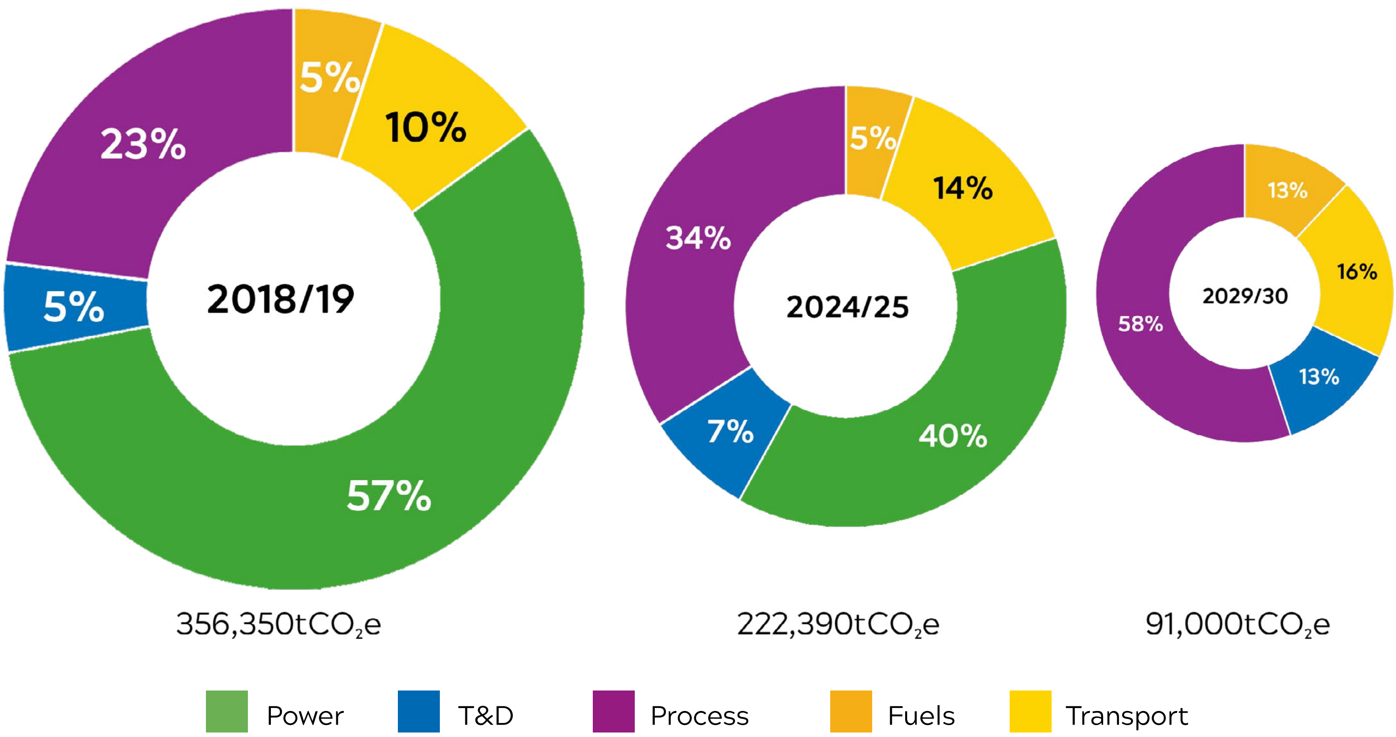


Figure 2 below shows our total emissions split by emission cluster at our 2018/19 baseline, in 2024/25 and in 2029/30.

Figure 2: Market-based target pathway - emission clusters



Our 2029/30 residual emissions will consist of:

83,000tCO_2e of direct process and fugitive emissions from wastewater, sludge and water treatment services

23,500tCO_2e of transport-related emissions from HGVs and vans

18,300tCO_2e of emissions arising from electricity transmission and distribution loss, associated with green power purchased from the grid

18,600tCO_2e of emissions associated with fossil fuels used for process heat and emergency standby generation

Here is how we will achieve those reductions:

Maximising energy efficiency and renewable energy generation and storage:

By 2025, we will:

- Implement energy efficiency measures to reduce our power demand by 26GWh/y in 2025, saving a total of 9,700tCO_2e of emissions;
- Install up to 238MWp of solar generation capacity on and around our sites, through power purchase agreements (PPAs) including the 17.6MWp of capacity already delivered. This will yield up to 230GWh/y. We will consume 80GWh/y and export the balance to the grid;
- Continue to generate over 115GWh/y of renewable power through our biogas CHP engines, of which we will export 34GWh/y. This will avoid 45,000tCO_2e/y of emissions by 2024/25;
- Continue to generate over 12.1GWh/y from our existing wind turbines. We are consuming 2GWh/y and exporting the rest to the grid. This will avoid 4,560 tCO_2e/y of emissions by 2024/25;
- Continue to explore energy storage opportunities in our sites to give us further flexibility.

Between 2025-2030, we will:

- Procure a further 10GWh of renewable energy through private wire power purchase agreements and 90GWh more renewable electricity from renewable energy installations in our region;
- Implement energy efficiency measures to reduce our power demand by a further 58GWh/y;
- Continue to implement energy storage opportunities across our sites.

Procuring green electricity:

By 2025, we will:

- Meet up to half of our remaining grid electricity requirements (after reducing demand through energy efficiency measures and renewable energy PPAs) through REGO-backed green tariffs or by sleeving renewable energy (see glossary) to our sites through corporate power purchase agreements.

Between 2025-30, we will:

- Aim to procure all of our remaining grid electricity through green tariffs or by sleeving renewable power to our sites.

Decarbonising our vehicle fleet:

By 2025, we will:

- Replace small vehicles at the end of their service life with electric equivalents (25 per cent of our small vehicle fleet);
- Switch 10 per cent of our diesel HGVs to run on liquified natural gas (LNG).

Between 2025-30 we will:

- Replace 90 per cent of all small vehicles with electric equivalents;
- Switch 55 per cent of our HGVs to LNG;
- Gradually switch medium-sized vehicles and HGVs to alternative fuels such as hydrogen or biomethane - a programme extending beyond 2030.

Maximising the value of our biogas:

By 2025, we will:

- Have a plan to upgrade the biogas we produce to biomethane that can be exported to the grid, used as transport fuel or supplied to industry, helping to reduce emissions in more challenging sectors of the economy;
- Develop a hydrogen strategy that will see us playing a greater role in the UK energy economy post 2030.

Between 2025-30, we will:

- Switch 54 per cent of our CHP generation capacity to operate as biomethane upgrade plants, producing 200GWh/y of biomethane which, by displacing fossil fuels, will deliver a more than 36,000tCO_2e emissions reduction. Although this reduction will arise elsewhere in the economy, it will count towards our own net zero goal.

Managing our process emissions:

By 2025, we will:

- Install monitoring equipment at four of our large sites to improve our understanding of the scale and location of process emissions. This will be shared and reviewed alongside evidence from comparable studies in the UK and elsewhere when possible;
- Review the three-tier methodology suggested by the Intergovernmental Panel on Climate Change (IPCC) in establishing an accurate baseline position;
- Target conversations, together with other water companies, with the Department for Business, Energy and Industrial Strategy (BEIS), Defra (the Department for the Environment, Farming and Rural Affairs) and Ofwat, to secure a wider scale of investment for monitoring and measurement;
- Continue to work with the rest of the industry, through UKWIR, Water UK and the wider scientific community, to better understand the scale of the N_2O emissions factor and CH_4 emissions from water recycling and sludge treatment;
- Seek to reduce CH_4 process emissions and minimise fugitive losses where possible;
- Continue to investigate alternative processes such as Membrane Aerated Biofilm Reactor (MABR) for implementation post 2025, to help avoid N_2O emissions.

Between 2025 and 2030, we will:

- Develop our strategy for reducing process emissions, having developed a better understanding of such emissions by 2025.

Opting for alternative fuels:

By 2025, we will:

- Replace 30 per cent of our gas oil for non-transport uses with hydrotreated vegetable oil (HVO) while reducing consumption through efficiency gains to save 7,000tCO_2e;
- Continue our assessment of hydrogen production and use.

Between 2025-2030, we will:

- Have switched 100 per cent of our gas oil demand to HVOs;
- Have a hydrogen strategy in place to maximise the benefit in our operations and the wider region

Developing our offsetting strategy:

By 2030 and then beyond, we will still have some residual emissions which we will need to manage in order to achieve net zero. We currently expect our residual emissions to be around 26 per cent of our 2018/19 baseline, with the majority stemming from process emissions.

Our ambition is to maximise opportunities to remove carbon in our own land (insets) and adopt a leading position in offsetting by supporting new markets across our region that bring maximum co-benefits (offsets).

We commit to:

- Implement forestry schemes on 50 hectares of our own land (insets), following best practice on biodiversity and the Woodland Carbon Code;
- Improve our scientific knowledge on potential removal opportunities such as in soils, wetlands, marshes and grasslands, and seagrass restoration, by engaging with key stakeholders and assessing their removal potential;
- Set up a framework on offsets to engage the best suppliers in the market to help us make the right investment decisions for both insets and offsets;
- Strengthen relationships in our region with key landowners and farm entrepreneurs to support the development of land management schemes that avoid and remove carbon emissions.

Planning for post-2030

To prepare our business for a post-2030 net zero operating environment, we therefore commit to:

- Align all our current innovation activities, in particular those innovations that will allow us to reduce further our residual emissions going forward;
- Identify gaps and collaborate with the rest of the industry to understand other innovations that are required to address key knowledge gaps;
- Assess our asset replacement cycles in AMP8 (2025-2030) and beyond and identify opportunities to implement our current innovations;
- Prepare a hydrogen roadmap for our business and engage with key stakeholders;
- Test our net zero interventions against future climate projections in our region;
- Continue to collaborate with asset owners in our region to maximise the potential of connected digital twins;
- Build on our current efforts to maximise system-wide decarbonisation in our region, such as exporting waste heat and other low carbon resources;
- Maintain an active role in supporting the creation of robust, local offset markets;
- Continue to engage with our supply chain and our peers to drive the agenda on capital carbon post 2030 and set targets that are aligned with emerging science. By 2022 we commit to have a capital carbon roadmap and targets that stretch from 2030 through to 2050;
- Maintain an active and leading role with water industry groups and continue working closely with our regulators, government and other stakeholders to influence policy relevant to net zero.

Innovation and collaboration - such as through our Innovate East series of events with Essex and Suffolk Water and Yorkshire Water - will be key to delivering on our net zero ambitions

Chapter 1: Playing our part in combatting climate change

Playing our part

We are in a climate emergency. It could evolve into a climate disaster without rapid global action to reduce carbon emissions. To spur others on, it is essential that organisations like ours show the way: we have examined the science, analysed the risk and developed the knowledge.

We are in the vanguard but in good company. The 2015 Paris Agreement set the ambition to halt the rise in global temperatures to well short of 2°C above pre-industrial temperatures. Since then, internationally, policies have been put in place to enable decarbonisation and the public have become increasingly supportive.

In 2019 the UK committed to reduce national greenhouse gas emissions (CO_2e) to net zero by 2050. It requires every organisation in every sector to accelerate decarbonisation.

> **"We must transform the way we operate, while maintaining a resilient and affordable service for our customers, and protecting and enhancing the environment."**

Our region - low lying, with a long coastline and low rainfall - is particularly susceptible to climate change. One of our strategic priorities is to provide a climate-proof service to our current and future customers through our climate resilience activities (as set out in our latest Climate Change Adaptation Report).

To play our part in national and international efforts to limit global temperature rise to less than 2°C (and ideally less than 1.5°C) by the end of the century, in 2019 we committed, alongside all water companies in England, to reach net zero carbon by 2030. This commitment relates to our operational emissions - those over which we have greatest control. Our CEO Peter Simpson is one of the co-sponsors of this ambitious target, described by the UK's High Level Climate Champion for COP26 Nigel Topping as "one of the most significant steps taken by the industry anywhere in the world".

The 2030 sector target and the associated Routemap, launched in 2020, have really helped to focus our minds on taking action early. We want to avoid locking unnecessary carbon in our assets now so that we can continue to operate in a net zero operating environment in 2030 and by 2050 - benefiting future customers as well as the customers of today. Achieving and maintaining net zero in a changing climate will be a key challenge for everyone and we need to recognise the importance of joined-up investment planning for climate change mitigation and adaptation.

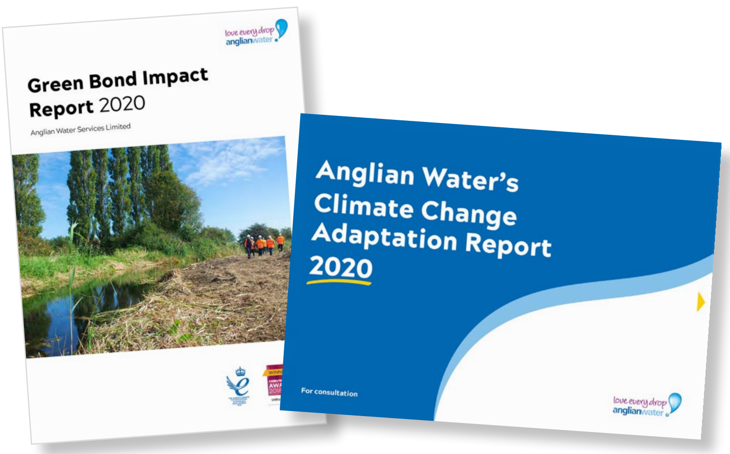
Our decarbonisation journey

For many years Anglian Water has been at the forefront of carbon reduction in the water industry. Our decarbonisation journey began in 2010, when we first set ambitious goals to reduce our operational and capital carbon emissions, at a time when measuring and managing capital carbon - the carbon in our assets and what we build - was unheard of.

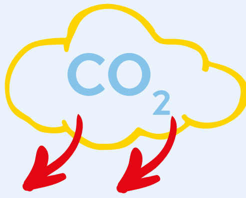
With a committed leadership and a determined supply chain, by 2020 we had reduced capital carbon by 61 per cent in our capital programmes from our original 2010 baseline and reduced operational emissions by 34 per cent from a baseline set in 2014/2015. These whole life carbon reductions have already benefited our customers through driving additional capital expenditure (capex) and operational (opex) efficiencies.

Working with Government and leading businesses through our role in the Green Construction Board, we developed the world's first standard for managing carbon in infrastructure (PAS 2080), which is now being used nationally and internationally.

We have also achieved platinum status on ISO 14064, the international standard for the quantification and reporting of greenhouse gases.



Case study: Capital carbon reduction and resilience



Marston Water Recycling Centre (WRC), near Grantham in Lincolnshire, currently recycles water for a population of approximately 63,500. This is expected to rise to 76,000 by 2031, and there are plans for significant new housing developments in the area. The capacity at the WRC would be insufficient to cater for this growth, and the works was also at the limit of its ability to remove ammonia to required discharge water quality standards.

The tertiary treatment process at Marston WRC consists of four large grass plots covering 64 acres. Initially, the plan was to stop using these existing grass plots and build a new pumping station and nitrifying sand filter, which would involve erecting new concrete structures, phasing out the natural cleaning process and increasing operational energy consumption (and therefore carbon emissions).

However, the area is a designated Local Wildlife Site, and home to an abundance of wildlife, so the Anglian Water team came up with a revised plan to remodel the grass plots to provide greater treatment capacity and climate resilience instead.

Completed in December 2019 after 12 months on site, the project delivered an efficiency saving of £1,957,000 (39 per cent) and a 90 per cent capital carbon saving (534tCO_2e), while newly planted trees help offset the site's carbon footprint further.

Our decarbonisation ambition by 2030

Our 2030 decarbonisation ambition covers the majority of the emissions we can control and influence:

Capital carbon (Scope 3):

We have set a 70 per cent capital carbon reduction target by 2030 from a 2010 baseline.

Operational carbon (Scope 1, 2 and some Scope 3)

We have set a target to reach net zero operational emissions by 2030 and to maintain this status beyond 2030.

Our current focus is to achieve deep decarbonisations in the emissions over which we have greatest control. These are our operational emissions (Scope 1, 2 and some Scope 3 relevant to our outsourced activities).

For the emissions over which we have a degree of influence, such as capital carbon, we will build on our success to date in achieving over 60 per cent reductions since 2010, and we commit to developing a separate capital carbon reduction routemap to cover our emissions between 2030 and 2050. In doing so, we will consider the Committee for Climate Change's UK net zero pathways and the need for some sectors to achieve absolute zero carbon emissions by 2050, as well as the new net zero standard that will be published later in 2021.

Our future role

> **We will continue to play our part in combatting climate change post-2030; indeed, our aspiration is to lead the agenda in our region.**

To achieve this goal, we want not only to achieve deep decarbonisations in our own business and our supply chain, but also to support stakeholders in our wider region with their own decarbonisation ambitions. We also have a key role to play in influencing customer behaviour in a net zero operating environment.

We have already implemented ground-breaking innovations to support emissions reduction outside our operational boundary, such as exporting waste heat from the water recycling process to warm two vast tomato greenhouses in our region. We have also begun to engage with local farmers to see how we can support their plans to develop local soil management schemes that achieve carbon removals. We anticipate many future opportunities that will support our ambition to adopt a systemic approach to net zero in our region.

Case study: Greenhouses in Norfolk

Cross-sector collaboration will unlock further opportunities for our 2030 strategy and beyond.

In a world first, we have partnered with Oasthouse Ventures to use warm water, the natural by-product of the water recycling process, to heat two of the UK's largest greenhouses, one in Norfolk, the other in Suffolk. Through extracting heat from final effluent discharged from our water recycling centres, the glasshouses emit 75 per cent less carbon in heating and cooling in comparison to using traditional fossil fuels. Closed-loop heat pumps are used to transfer waste heat from Anglian Water water recycling centres to the greenhouses to accelerate the growth of the plants. The heat pumps are powered by a new CHP plant, the carbon emissions of which will be channelled back into the greenhouses to help the plants grow.

There are additional environmental benefits, too, since the water that is recycled to the chalk stream is cooled - better for aquatic organisms and less likely to promote bacterial growth.

Together the two greenhouses are capable of producing 10 per cent of the UK's tomatoes. This remarkable engineering feat provides a blueprint for sustainable, low carbon food production to meet the challenge of delivering net zero.

We are currently exploring the use of similar heating systems powered by waste water in other settings, both domestic and commercial, including new housing developments, community centres and swimming pools.

The £120 million project was awarded Net Zero Carbon Initiative of the Year at the 2020 Utility Week Awards.

WINNER
Utility Week AWARDS 2020
Net Zero Award

Chapter 2: 2030 net zero strategy - our approach

Getting to net zero will require transformation across every part of our business and involve our whole supply chain. It requires our whole organisation, and everyone who works with us, to be innovative, flexible and adaptable.

We have to drive carbon from every part of our operations without compromising the care, service and value we provide for our customers and communities.

> **“Getting to net zero is going to be a journey. We know the direction but not every twist and turn on the way. We need everyone to come on that journey with us.”**

Many of our decarbonisation interventions are influenced by evolving policy and regulatory practices (for example the direction of future UK energy policy, the UK approach to offset markets, or future environmental quality standards that may drive increases in energy demand), or by uncertainties in science (for example process emissions and/or removal potential of some natural sequestration options).

Our strategy is centred around:

- encouraging the right behaviours in Anglian Water, our supply chain and our customers to help maximise demand-side reductions;
- embedding technological innovations to reduce our reliance on fossil fuel energy consumption through accelerating our renewable energy generation and storage, as well as reductions in our process emissions and transport; and
- deploying nature-based solutions in our land to remove part of our residual emissions and, where necessary, avoiding additional emissions from additional grey infrastructure.

We know that we cannot achieve net zero alone. We will play our part in influencing external stakeholders that can influence the rate of our progress (for example Government, regulators and energy sector operators, and sector-focused groups such as Water UK) to manage the risks outside our control. We will continue to incentivise our supply chain to help find innovative solutions for the difficult-to-decarbonise emissions.

How do we define our 2030 net zero commitment?

Our net zero commitment by 2030 reflects an operating environment where we have no overall impact on the atmosphere from the greenhouse gas (GHG) emissions that are in our operational boundary. This means that any residual emissions that we cannot avoid or reduce are counterbalanced by an equivalent sequestration of gases from the atmosphere.

Our scope of emissions

Our 2030 net zero commitment covers our operational emissions as reported in the water sector Carbon Accounting Workbook. These emissions include:

- **Scope 1:** Emissions from burning of fossil fuels, process and fugitive emissions
- **Scope 2:** Purchased electricity from the grid and exports of any electricity we generate
- **Scope 3:** emissions associated with business travel, outsourced activities, and transmission and distribution losses from the electricity grid;

The scope of our emissions in our 2030 net zero commitment includes carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O). These are the greenhouse gases associated with all of our operational activities.

Our emissions boundary

Our emissions boundary considers our business activities in our appointed business, as defined in our business plan for 2015-2020 (asset management period 6, or AMP6).

Our decarbonisation principles

We will apply good practice in our approach to decarbonisation by following the decarbonisation hierarchy of:

- Reducing/avoiding greenhouse gas (GHG) emissions;
- Using green electricity and investing in renewable energy systems;
- Removing any residual and difficult to avoid/ remove emissions through natural sequestration measures within our boundary and through credible offset credits outside our boundary. Our approach to offsetting will prioritise supporting offsetting schemes in our region, in the UK territory and finally, only where not economically or technically possible within the UK, in the international offset credit markets.

Figure 3: Our decarbonisation hierarchy and examples of interventions we are considering

1. Emissions Reduction

- Energy efficiency measures
- Water efficiency
- Leakage Reduction

2. Renewables & Green Electricity

- Solar & Wind PPAs
- CHP
- Green electricity

3. Removals / Offsets

- Carbon insets / offsets

Over time, we will prioritise the interventions that have the most significant carbon reduction potential and the greatest co-benefits in our region, aligned with our six capitals approach to investment decision-making, and that strike the right balance between carbon reduction potential, cost, customer bill impacts and the long-term resilience of our operations. The details of all the decarbonisation interventions we are considering are included in Section 4.

Our six capitals approach

Using six capitals thinking helps us to keep our responsibility to customers, communities and the environment at the front of our minds when making business decisions. We have developed definitions and a set of metrics for each of the capitals to help us understand, track and report on our impact on them.

Natural

The health of the natural systems and resources that we rely on and impact in our region and beyond; the availability and quality of water in our rivers and aquifers; the protection of our soil and biodiversity; and our impact on carbon emissions.

Social

The value of our relationships with stakeholders, including customers, communities and other organisations; the impacts we have on people and society (both positive and negative) and the trust they place in us as a result.

Financial

The financial health and resilience of the organisation and our access to and use of sustainable finance.

Manufactured

The ability of our infrastructure to provide resilient services to meet the current and future expectations of our customers.

People

The knowledge, skills and wellbeing of our people; the health, happiness and safety of our working environment; and our organisational culture and ways of working.

Intellectual

The knowledge, systems, processes, data and information we hold, create and share within our business and with our alliance partners.

How we will report our progress

To date, we have reported our emissions in our Business Plan and annual integrated reports using the Carbon Accounting Workbook (CAW) and a location-based approach, which is in line with Department for Environment, Food and Rural Affairs (Defra) reporting guidelines. We will report our emissions through our annual greenhouse gas report.

Our 2030 net zero commitment is to be measured and reported using market-based reporting, which is in line with the water sector Net Zero Routemap. This means that we will report our net emissions by taking into account export of any surplus renewable energy we generate and purchase of green electricity, both backed by Renewable Energy Guarantees of Origin (REGO) that must be retained by Anglian Water. For further information on market and location-based reporting for Scope 2 emissions, see Appendix 1.

> **We commit to report our emissions on an annual basis using both location and market-based reporting.**

We will align with the latest version of ISO14064 and we will continue to be verified by Achilles Carbon Reduce (or equivalent) to ensure our progress to net zero is credible and externally validated. We will continue to work with UKWIR and Water UK to ensure the credibility of the CAW and the suitability of reporting against net zero.

Achilles
Carbon Reduce Certified
Powered by Toitū Envirocare

Chapter 3: Baseline and historic operational emissions

More people to serve and tighter environmental controls have pushed up our operational emissions slightly since 2014/15.

Population growth is one of our most significant challenges: our customer base has grown by 475,000 people over that time. That is a lot more water to abstract, treat, supply, and recycle. Our region is famously flat. With few hills we can't take much advantage of gravity, so we use more energy than other water companies to pump clean water and water for recycling from place to place.

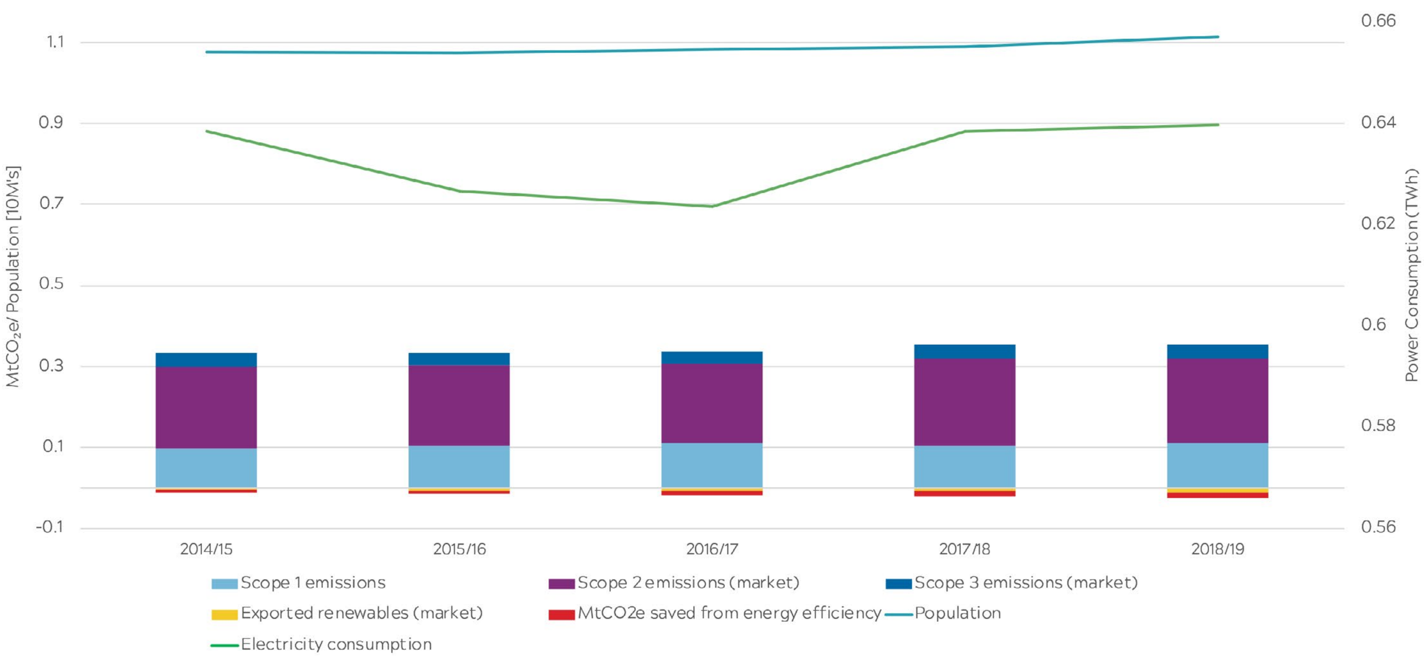
Meanwhile, our region's size and low population density (growth notwithstanding) mean we run more water and water recycling treatment works than any other company - 1,257 - around a quarter of all the works in England and Wales. The size of our region also means we must transport a large volume of sludge (the output of the water recycling process) to our regional sludge treatment centres, which increases our transport emissions.

Increasingly tight environmental consents have also pushed up the energy intensity of water and water recycling treatment processes.

What has this meant for our carbon footprint?

Net emissions increased by five per cent between 2014/15 and 2018/19 - approximately 17,000tCO_2e, as shown by Figure 4.

Figure 4: Our historic emissions (market-based reporting)



We have historically reported our emissions using the location-based method for Scope 2 (electricity). This means that we have been reporting our purchased electricity emissions using a grid average emissions factor (refer to Appendix 1). Our historical net emissions have been reducing year on year and this has been largely driven from energy efficiencies we have achieved, from the gradual decarbonisation of the electricity grid, and from the production and export of renewable energy from our biogas facilities.

Since our net zero commitment is set under market-based reporting, we have re-stated our historic emissions using the market-based reporting method. The market-based reporting method shows the emissions from grid electricity by using an emissions factor specific to our supplier (rather than the grid average that we have historically used as our basis for reporting, in common with the rest of the water sector, which uses a location-based method).

The market-based reporting shows an increase in our historical emissions, since the emissions from "brown electricity" we have been purchasing from our supplier have been increasing. This has been one of the dominant factors for the gradual increases in emissions shown in Figure 4. Market-based reporting has highlighted the importance of shifting our future electricity procurement choices to greener electricity. For further details on how our emissions compare using the market and location-based approach, refer to Appendix 1.

> **We have driven significant improvements in energy efficiency, saving on average 10GWh since 2014/15.**

At the same time, to combat upward pressures, particularly those associated with greater electricity use due to population growth, tightening environmental standards and climatic effects such as floods and droughts, we have also driven significant improvements in our energy efficiency, saving on average 10GWh/y since 2014/15, which has cumulatively reduced our power consumption by 60GWh/y compared to what it would have been without our interventions. Without the success of our energy efficiency measures, the increase in our emissions would have doubled to 10 per cent, or ~33,000tCO_2e.

We have also increased our renewable power generation through biogas combined heat and power (CHP) by 24 per cent between 2014/15 and our baseline year. This provides an additional 21GWh of power to consume on our sites or export to the grid to support regional and national decarbonisation. This renewable energy generation has further reduced our net emissions by more than 35,000tCO_2e.

Decarbonising our power demand

Our services are inherently power intensive. To meet our net zero objectives we will need to actively drive the identification, development and delivery of renewable energy generation to decarbonise the power we need to use.

Benefits to our customers - historic GHG performance

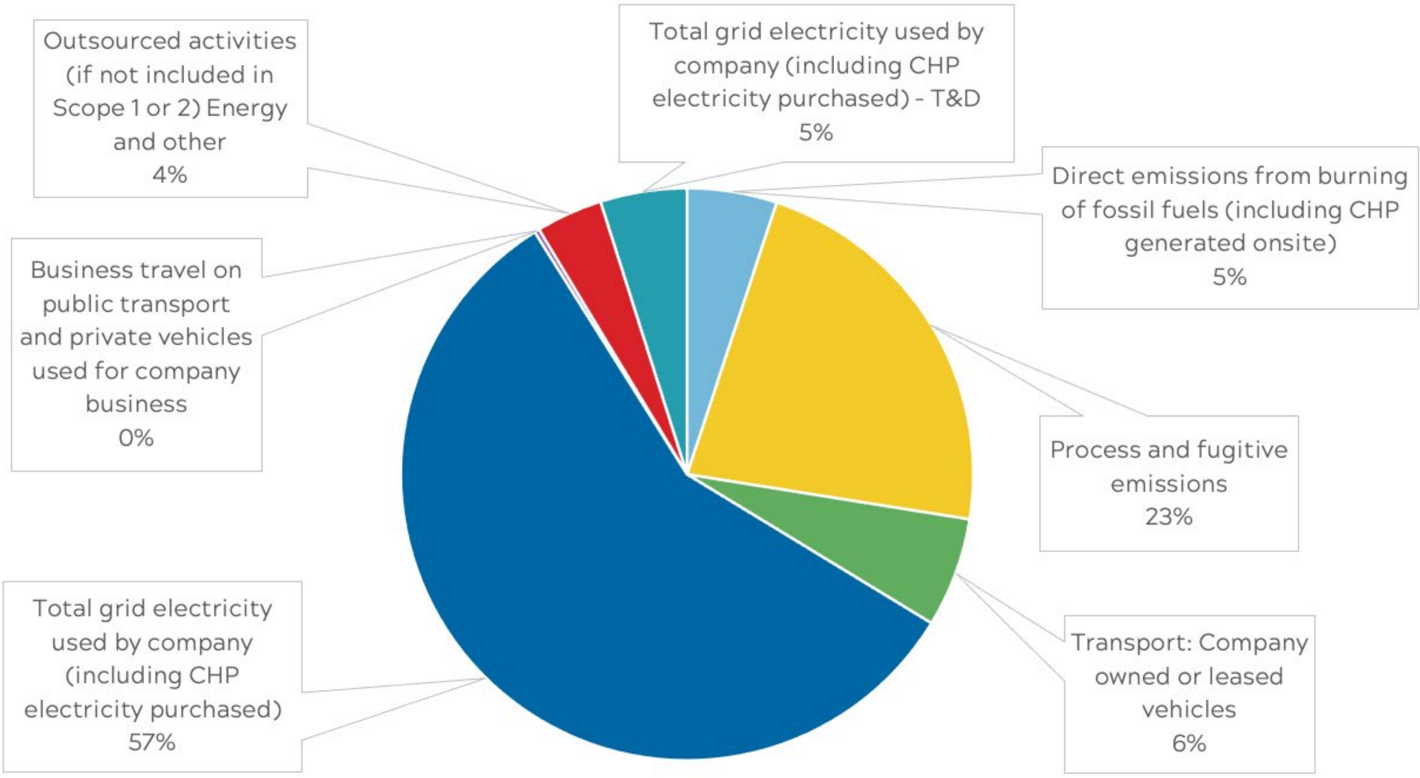
Our customers have benefited from our carbon reduction actions to date. The generation of our own renewable energy through driving bioresources innovations such as HPH, together with the implementation of energy efficiency measures, has had a significant positive impact on our grid electricity costs, which helps keep bills low.

Our net zero baseline - 2018/19

Our baseline year for reporting progress against our net zero commitment is 2018/19, in line with the sector routemap. While our final target is net zero, progress will be reported as a percentage reduction from our 2018/19 baseline. To date, alongside our peers in the industry, we have been reporting our annual emissions using a location-based approach to reporting (from the Carbon Accounting Workbook). However, the net zero sector commitment is based on market-based reporting. We have therefore adjusted our annual emissions from 2018/19 to reflect the market-based approach. For further detail around market and location-based reporting, refer to Appendix 1.

Our baseline emissions are shown in Figure 5 and illustrate total baseline emissions of 356,350tCO_2e. This baseline takes into account recent corrections in our sector's Carbon Accounting Workbook, which we use to report our emissions. This correction increased our process emissions by 19,700tCO_2e and has been added to our original reported 2018/19 emissions.

Figure 5: Our baseline emissions in 2018/19 (under our net zero boundary)



The majority of our emissions (57 per cent) come from our grid electricity consumption (netted off from any renewable electricity we generate from our CHPs to supplement our current electricity demand and any REGO-backed renewable exports).

These are followed by process and fugitive emissions (the direct emissions from our water recycling and sludge treatment facilities), accounting for just under 25 per cent, as these are currently being reported in our sector.

Transport emissions associated with operating our own fleet and those of our subcontractors to move sludge and water around our sites, together with emissions from our vans and cars used to travel to our sites to operate and maintain them, account for over 10 per cent.

Since our originally reported baseline emissions, we have been working closely with our peers, Water UK and UK Water Industry Research (UKWIR, our industry's research body) to better understand the emissions factors from water recycling treatment. This review, as well as independently reviewing scientific evidence, has resulted in additional alternative factors to better reflect the true scale of such emissions. Research is still ongoing and we are working closely with our industry to better understand those emissions through targeted monitoring. Once we have that more detailed understanding, we will need to re-baseline our emissions for 2018/19 to ensure consistent reporting and a true decarbonisation trajectory to 2030.

Our understanding of the upward change in the N_2O emissions factor, following a report by UKWIR in 2020, will impact our baseline and residual emissions in 2030. In reviewing the UKWIR data and IPCC information from 2019, the increase could be the range of 41,000 to 118000 t/CO_2e

Nevertheless, in the interest of being consistent with the rest of our industry, we will report our baseline and net zero trajectory using the current industry-wide emissions factor for process emission until a revised industry N_2O emissions factor is available, at which point we will revise our baseline. This is expected in the next three years following the results of N_2O monitoring.

Chapter 4: Pathways to net zero operational carbon

Our challenge is to reach net zero in less than two AMPs - that's under 10 years. We have looked at what is possible in the current AMP and the 2025-30 period, and set out options and priorities in two possible pathways.

Those pathways assess the maximum achievable with current funding, policies and appetite for risk versus what could be achieved with additional funding, strong policy support and willingness to take action despite market uncertainty.

- **Our target pathway to 2030:** The total reduction in residual emissions to 91,000tCO_2e/year is realistic, but is not easy to achieve. It relies on us transforming both our own operations and those of our supply chain, as well as requiring a great degree of agility on our part and significant engagement with our sector's stakeholders. The target pathway will be what we use to monitor our progress over time.
- **A stretch pathway to 2030:** If we wish to go further and faster, our stretch pathway would leave us 57,500tCO_2e to offset. It reflects the art of the possible, if additional funding and policy levers can be put in place. It is intended to fuel ambition and stimulate further action, particularly relating to regulation, the market, policy, science and technology, and investment. We have already started to analyse the opportunities to see what actions are required by us and others in our industry to get there.

Throughout this strategy we have presented our net zero trajectories to 2030 in both target and stretch pathways.

To develop the pathways, we have assessed a number of decarbonisation interventions which we have grouped into clusters. These are shown in Figure 6 below.

Figure 6: The decarbonisation interventions we have analysed grouped into clusters

Purchased electricity and renewables
- UK electricity grid decarbonisation
- Energy efficiency measures (incremental and systemic)
- Leakage reduction
- Water efficiency
- Alternative treatment processes
- Catchment management
- Nature-based solutions
- Solar, Wind PPAs
- Energy storage
- CHP
- Green electricity, sleeving (for offsetting residual emissions from power consumption)

Transport
- EV small vans
- Electrifying components of large vehicles
- HGVs to LNG
- HGVs to hydrogen
- Behavioural travel changes

Process emissions
- Targeted monitoring for N_2O emissions
- Alternative treatment processes
- Operational optimisation for fugitive emissions

Biogas
- CHP efficiencies
- Biomethane to grid
- Biomethane to transport (HGVs)

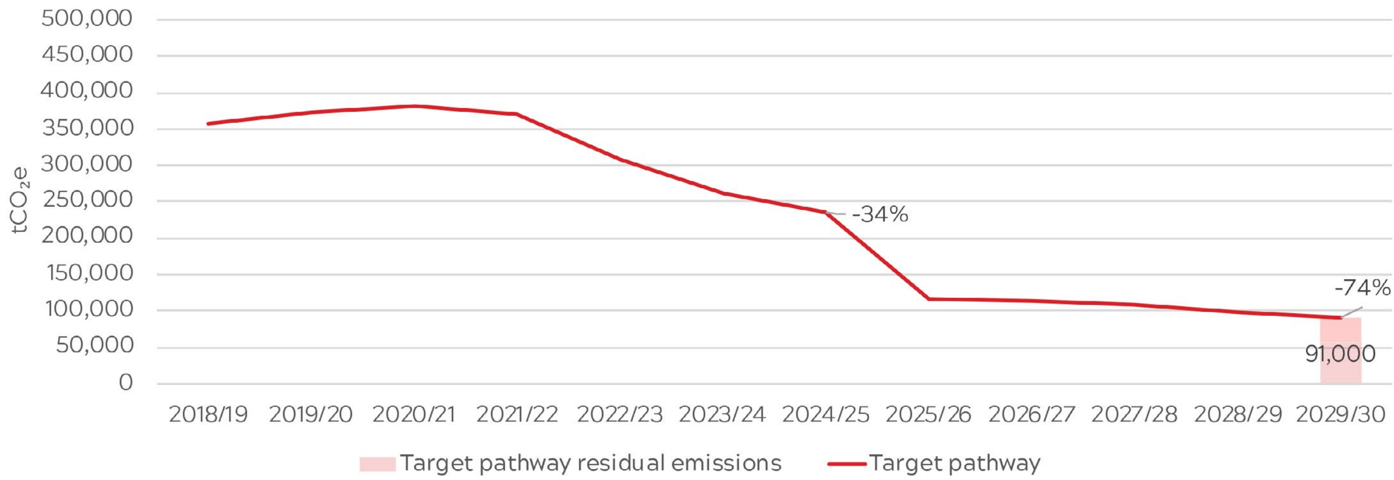
Alternative fuels
- HVO
- Hydrogen (green, grey)
- Biomethane to transport (HGVs)

Removals and offsets
- Insets (trees, grassland, seagrass)
- Regional offsets (soil sequestration)
- National, international offsetts (carbon offset credits)

Our 2030 target pathway to net zero

Our target pathway to 2030 net zero is shown in Figure 7. It delivers a total of 74 per cent reduction in emissions from our 2018/19 baseline.

Figure 7: Our target pathway to net zero by 2030



This pathway reflects the market-based reporting methodology and uses the current industry reported N_2O emissions factor. The red line shows the reductions in our emissions, including our future procurement choices, to gradually switch our grid electricity supply to green electricity. The red line also includes any reductions in emissions generated from using renewable electricity from the solar private wire sites that we have been developing. Although it is a power purchase agreement (PPA) model, the reason for including these sites in the red line is that we have invested considerable effort to identify and develop the solar sites and have opted for an off-balance sheet model where our developer pays for capex/opex and we agree an electricity charge for the electricity we consume on our sites.

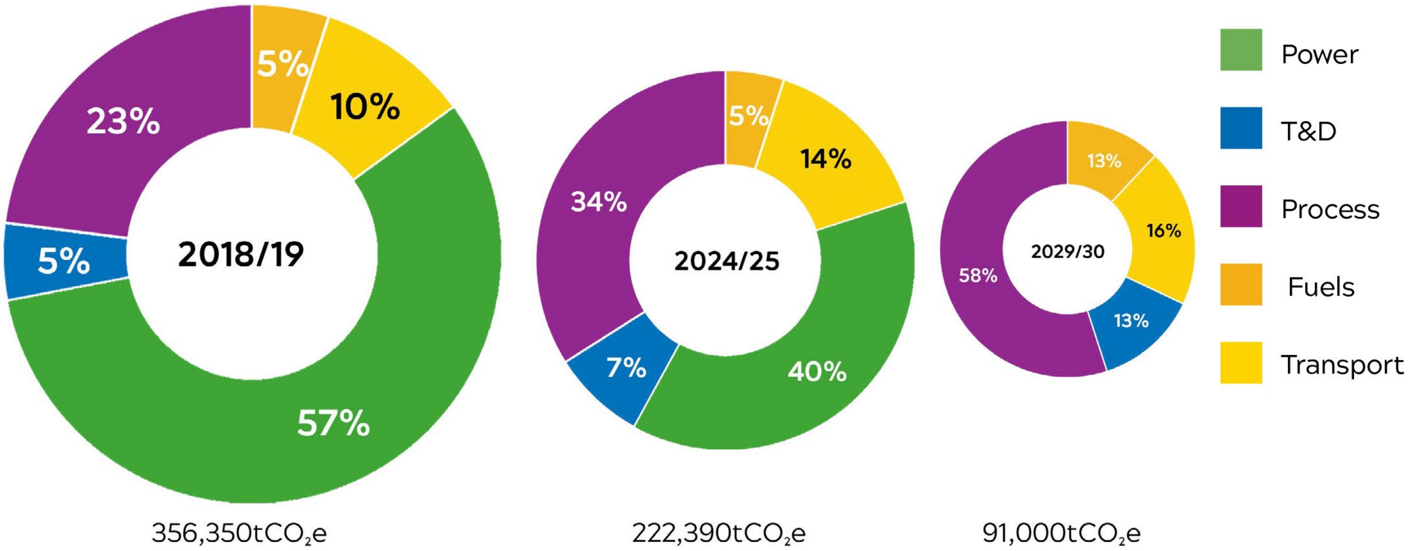
"We can see that by 2030 we will have reduced/avoided our emissions by 74 per cent from our current baseline."

This means that our residual emissions in 2030 will be around 26 per cent. These emissions will have to be removed and/or offset. Our removals and offsetting strategy is presented at the end of Section 4.

We believe that our target pathway is the most balanced pathway for our business and our customers.

A breakdown of how the emissions in the individual clusters change over time in our target pathway (as being reported in our baseline) is shown in Figure 8.

Figure 8: Change of our emissions contribution to our total emissions by 2025 and 2030 in our target pathway to 2030



We can see that as we decarbonise our electricity supply over time, by 2030 our residual emissions will be dominated by process, transport and alternative fuels.

Our target pathway headline actions are summarised below. For further information, refer to the 2030 trajectories in the individual decarbonisation clusters.

By 2025 we will:

- Have installed up to 238MWp of solar generation, including 17.6MWp of capacity already delivered since 2020. This will generate more than 230GWh/y, of which 80GWh will be used to power our own demand. This will reduce our emissions by more than 30,000tCO_2e;
- Continue to generate over 115GWh of renewable power through our biogas CHP engines, which reduces our emissions by 45,000tCO_2e;
- Have reduced our power demand by over 26GWh/y in 2025 through energy efficiency measures and reduced our emissions by a further 10,000tCO_2e;
- Gradually transition to procuring REGO-backed green electricity and pursue renewable energy sleeving opportunities (up to 50 per cent);
- Gradually replace 30 per cent of our gas oil demand with hydrotreated vegetable oil (HVO), while simultaneously reducing our consumption. This reduces our emissions associated with non-transport fuels by over 7,000tCO_2e compared to our 2018/19 baseline;
- Implement monitoring equipment at three of our large sites to improve our understanding of the scale and location of N_2O emissions;
- Replace 25 per cent of small fleet that are at the end of their service life with electric equivalents and switch 10 per cent of our own diesel HGVs to be liquified natural gas (LNG) fuelled.

By 2030 we will:

- Procure a further 10GWh of renewable energy through 'behind the meter' opportunities and 90GWh more renewable electricity from sleeving in our region;
- Implement energy efficiency measures to reduce our power demand by a further 58GWh/y;
- Pursue REGO-backed green electricity and sleeving to cover our residual emissions associated with grid electricity (up to 100 per cent by 2030);
- Switch 54 per cent of our CHP generation capacity to biomethane production. By 2030, we plan to inject over 200GWh/y of biomethane to the national gas grid;
- Power 90 per cent of all our small fleet with electric power and switch 55 per cent of diesel HGV vehicles to LNG;
- Switch 100 per cent of our gas oil demand to HVOs.

For further details please refer to our individual decarbonisation interventions and more detailed trajectories that are presented in subsequent sections of this chapter.

This pathway is challenging to achieve. This is largely due to having to rely on many external factors such as:

- Uncertainty in the science behind process emissions. This is something we are actively trying to understand to manage and reduce our residual emissions over time. Appendix 2 summarises our past and current work in this area and highlights the uncertainties around those emissions;
- Future regulatory standards, such as the future direction of the Water Industry National Environment Programme (WINEP), possible biosolids restrictions into farmland;
- Incentives around supporting the deployment of biomethane to grid in existing installations;
- The viability of technologies for electrifying larger vehicles in our fleet and availability of publicly accessible charging infrastructure;
- Future energy policy direction affecting future electricity markets, including grid pricing mechanisms, premiums for green electricity purchased, etc;
- Population growth,
- The pace of decarbonisation of the electricity grid;
- Changes in some technologies for alternative fuels and process emissions possibly not being commercially viable pre-2030 (especially hydrogen);
- Uncertainties around the science behind natural sequestration solutions (insets/offsets) and evolving offsets markets in the UK.

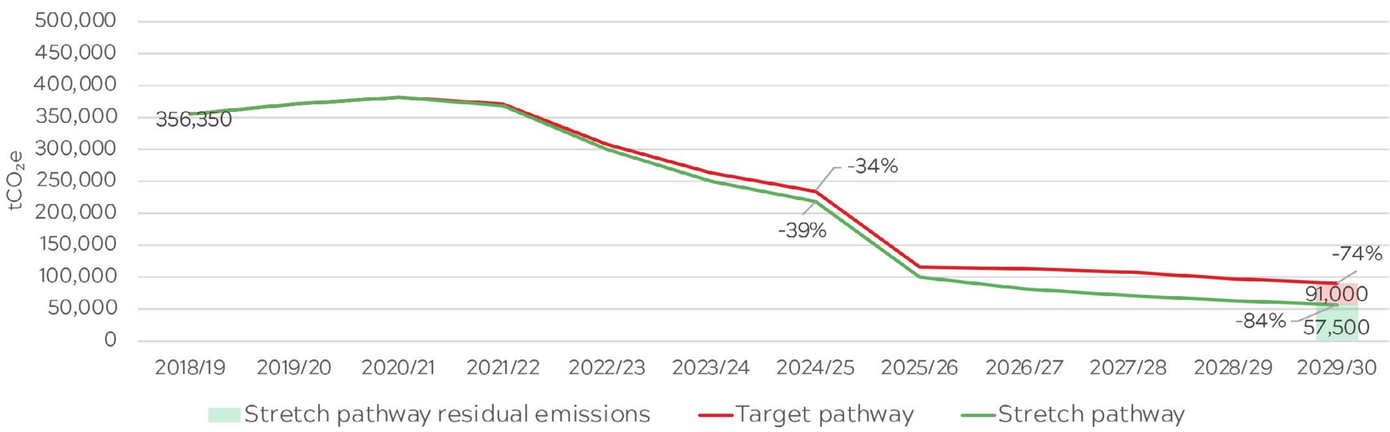
Out of all the uncertainties in each decarbonisation cluster, we have also assessed the impact of uncertainties around our process emissions and how a change in the N_2O emissions factor would affect our target pathway to 2030. This is shown in Appendix 2.

Implementing our different interventions will require significant behavioural change. It will also rely on our continued agility in identifying and adopting technological and other innovations.

What would get us to a stretch pathway?

We have analysed an alternative stretch pathway as shown in Figure 9 below. The stretch pathway reflects the art of the possible, if additional funding and policy levers were in place. We have analysed such a pathway to stimulate further action in the industry and other sectors to help unlock some additional opportunities.

Figure 9: Stretch to net zero by 2030



We can see that by 2030 we will have reduced or avoided our emissions by up to 74 per cent from our current baseline. This means that our residual emissions in 2030, excluding purchased electricity but including the grid transmission and distribution losses, could be less than 20 per cent by 2030. These emissions largely reflect our process emissions which will have to be removed and/or offset, as well as other fuels and transport.

In a 2030 stretch pathway scenario we would have to:

- Increase our energy efficiency target to reduce power demand by a further 37GWh/y, compared to our target pathway;
- Increase our generation capacity from our Solar Portfolio #2 compared to our target pathway, from additional sites that we could identify;
- Develop additional 25GWh/y from other renewable energy opportunities (including wind where possible);
- Cover remaining grid electricity emissions through procurement of green electricity and sleeving;
- Export a total of 383GWHth of biomethane (183GWhth more than our target pathway) to the national gas grid from nine of our sludge treatment facilities;
- Electrify 90 per cent of our small and medium fleet and replace 100 per cent of our own HGV vehicles and many of our suppliers' HGVs to run on LNG;
- Accelerate our transition from diesel to HVOs by 100 per cent by 2025.

For further details on the external funding, market and policy levers that would be required to achieve the stretch scenario, as well as the risks that would need to be managed, see the different decarbonisation intervention strategies presented in this section.

Future policy and regulatory impacts that we will need to engage on and seek to influence

As mentioned above, we have identified a number of policy and regulatory impacts and levers that we will need to monitor closely and engage on with our industry and government. Influencing those will help unlock some decarbonisation opportunities as well as managing our risks of increasing our emissions in the future. They are presented in Figure 10.

Figure 10: Policy and regulatory impacts

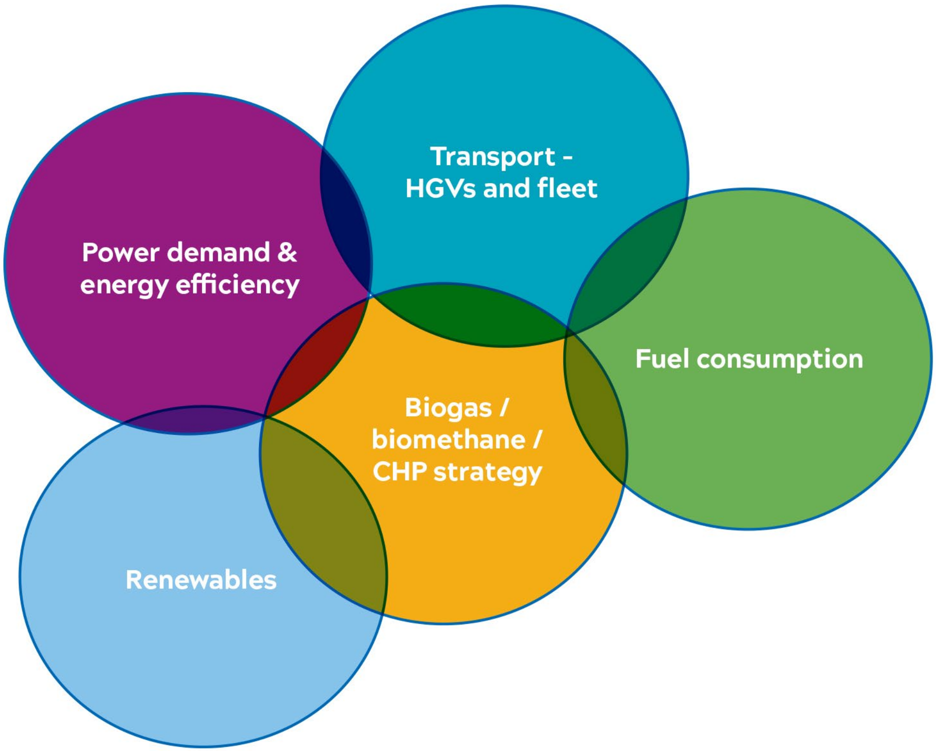
	Policy / regulatory impacts	We need to engage with
1	Future direction WINEP and other quality drivers	EA, Ofwat and Defra
2	Evolving science on process emissions and removals options	Supply chain, Defra
3	Energy policy evolution	ENA through Water UK, Ofgem, DNOs and BEIS
4	Biosolids winter land restrictions	EA
5	Mandatory water efficiency labelling scheme	Water UK
6	Future biomethane incentives	BEIS and Water UK
7	Future goal to "eliminate harm" from CSOs	EA
8	EA abstraction licence caps	EA
9	SUDs retrofits	EA
10	Evolution of UK offsets market	Defra, CCC, project developers, UK Forestry Commission, Standards organisations, AW auditors
11	Government subsidies for key interventions	Defra and BEIS

We have outlined specific policy levers and stakeholders in each of our decarbonisation cluster strategies that are presented later in this section.

What if?

As part of our analysis, we have identified a number of interdependencies that would require integrated thinking in the way we plan for our decarbonisation interventions. Some of the key interdependencies and scenarios we have analysed and incorporated in our thinking are included in Figure 11 below.

Figure 11: Key interdependencies



- What if future regulatory reforms meant that our emissions would have to significantly increase as a result of tighter regulatory standards?
- What if nature-based solutions were vulnerable in the long term due to climatic changes? How would this affect our current planning approaches?
- What if policy incentives were not in place to facilitate faster deployment of key technologies such as electric vehicles, biomethane to grid schemes and renewable energy?
- What if technologies for reducing our process emissions are not available until beyond 2030?
- What if biomethane injection to grid were not possible - what are the alternatives?
- What if government subsidies for electric vehicles were removed or increased/broadened?
- What if planning constraints, pricing mechanisms or land availability constraints impacted the scale of solar/wind PPA renewables possible?
- What if WINEP reforms set targets for process emissions and/or other metrics?
- What if hydrogen HGVs and infrastructure were established faster than expected?

Reducing the carbon intensity of our electricity use

Why?

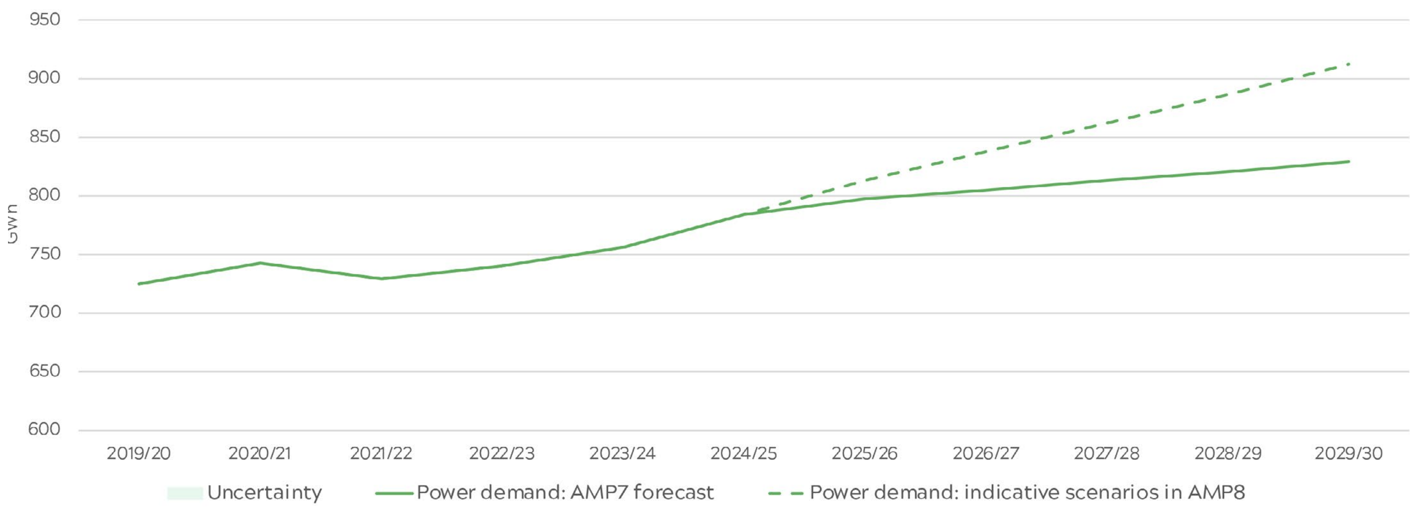
Grid electricity use (and the associated losses through the grid transmission and distribution network) accounted for over 60 per cent of our emissions in our 2018/19 baseline. This figure is based on our market-based reporting in which we take into account the actual grid electricity emissions factor from our current electricity supplier (rather than the UK grid average), and also includes any benefit we get from generating our own green electricity from our biogas and CHPs.

We have made significant progress on developing renewable energy to power our operational sites, generating 134GWh in 2020/21 through solar, wind and combined heat and power engines (CHP) - enough to power around 27,000 homes.

Although the UK electricity grid has made great progress to gradually decarbonise, full decarbonisation is set to happen by 2050 and energy policy is still being reformed. We use grid electricity primarily to power our water and water recycling assets and our use of energy has been increasing over time - this is mainly due to population growth, increases in regulatory quality standards and extreme weather events (e.g. droughts that make us produce and move more water around our region, or flooding). Our need to build resilience in our future operations, through planning for flexibility in our water resources planning, as well as other pressures such as population growth and the introduction of other potential regulatory standards (such as the WINEP reform, among others) mean that our power consumption will increase over time. Furthermore, as we plan to move more towards biomethane-to-grid (see our biogas strategy), we will lose our current renewable electricity generated and used in our sites from CHPs.

Figure 12 illustrates our current best estimate of increases in our annual power consumption by 2025 and potential scenarios that may impact the rate of increase in the future due to the factors mentioned above.

Figure 12: Our best estimate[1] for power demand increases during AMP7 and potential scenarios in AMP8



We have historically purchased grid electricity using a generation mix that is specific to our supplier. This mix is mainly from fossil fuels, and under market-based reporting our emissions associated with grid electricity are higher than the UK grid average, where there is a greater proportion of renewables in the mix. Assuming that our supplier will continue with a similar emissions factor (which has been increasing in the last three years), our emissions will significantly increase, even if we implement ambitious energy efficiency measures.

Our strategic intent

Our strategy for reducing the carbon intensity of our electricity use focuses on:

- maximising energy efficiency in our existing assets, and new assets we design and build;
- accelerating the deployment of solar and wind generation to supplement our electricity demand and reduce our reliance on grid electricity.

[1] *Dotted lines represent a conceptual uncertainty factor of +-10 per cent of the current projected power demand*

For any remaining electricity we consume through the grid, after we have maximised our energy efficiency opportunities and renewable energy, we aim to procure green electricity and sleeved power.

Energy efficiency

By 2030, we will:

- Maximise energy efficiency opportunities in our asset base, building on our 10+ year track record in optimising our electricity demand, by moving from current asset-specific opportunities to implementing system-wide, near real-time operational efficiencies. In doing that we will re-assess our current pay-back period thresholds that have driven energy efficiency on opex grounds;
- Work closely with our delivery partners to align our current and future capital programmes to promote operational carbon efficiencies in all new assets we build by setting clear targets.

Renewable energy (solar and wind)

By 2030, we will:

- Maximise the deployment of solar and wind electricity through private wire schemes (prioritising off-balance-sheet projects through PPAs) and accelerate energy storage opportunities;
- Maximise the opportunities from electricity market evolution to assess the commercial implications of solar and wind PPAs at specific trigger points in time.

Green electricity procurement and sleeving

By 2030, we will:

- Pursue renewable energy guarantees of origin (REGO)-backed green electricity and sleeving opportunities to cover 100 per cent of our remaining emissions associated with grid electricity;
- Become an active purchaser of electricity and identify suppliers that can accommodate sleeving where this will provide best value for customers.

Benefits to our customers

Decarbonising our grid electricity emissions early will bring our business and our future customers greater resilience from volatile grid electricity prices. For the highest capex/opex activities normally associated with renewable energy generation, we are opting for off-balance-sheet schemes in our own land and land adjacent to our sites through PPAs where the whole life cost of any development is born by the developer and we agree an offtake electricity price.

Our target pathway

Energy efficiency

By 2025, we commit to:

- Implement 26GWh/y energy efficiency reductions by re-thinking the way we assess pay-back periods and moving towards system-wide energy efficiency measures. We will design a near-live operational model to be able to optimise controls and energy in our clean water networks (from production to demand) to be implemented post-2025 in selective clean water operational areas.

Renewable energy

By 2025, we commit to:

- Have developed up to 238MWp of solar generation (which includes the 17.6MWp we have already installed at 14 of our sites, which will generate 16,000MWh every year). This generation capacity consists of three portfolios (Portfolio #1 of 29.2MWp to be delivered by 2023 and generate 27,500MWh; Portfolio #2 estimated to be 30MWp and generating 28,500MWh/y by 2025 and Portfolio #3 and other standalone opportunities of 161MWp generating 154GWh/y by 2024/5). All these portfolios are developed on or adjacent to our own land using a PPA private wire model. From the electricity generated across all three portfolios by 2025, we will be using over 80GWh/y to power our own sites, which are adjacent to the solar plants;
- Maximise our energy storage opportunities, building on our experience from installing battery storage at Cambridge Milton water recycling centre and at Little Melton Water Treatment Works. We will continue to assess the performance of energy storage and appraise the business case alongside our framework of solar investors. We anticipate that energy storage will play an important part in maximising the use of solar electricity generated through our PPAs in periods where we do not need the power, enabling us to dispatch it during periods of low performance of the solar plants.

Green electricity procurement and sleeving

By 2025, we commit to:

- Gradually switch our current grid electricity supply into REGO-backed green electricity and pursue sleeving opportunities (up to 50 per cent). We will do so, after we have maximised renewable energy and energy efficiency opportunities, in line with our decarbonisation hierarchy;

- Better understand the electricity market dynamics and pricing and identify additional opportunities for sleeving (for example from purchasing part of the excess green electricity generated in our solar plants to be used in other facilities we have, or other sleeving contracts, backed by REGOs).

Energy efficiency

By 2030, we commit to:

- Implement an additional 32GWh/y energy efficiency reduction during AMP8 (2025-2030) by implementing more difficult to decarbonise efficiency measures and by having the right net zero emphasis. This means that our power consumption trajectory would not increase significantly, over and above the rate we have forecast, from future regulatory requirements. The assumption is that those (e.g. WINEP reform) would be assessed on a whole life carbon basis before being implemented. We will aim to implement our near-live operational model in most of our operational areas in our clean water network (which would require additional funding).

Renewable energy

By 2030, we commit to:

- Procure a further 10GWh of renewable energy through behind the meter opportunities and 90GWh more renewable electricity from sleeving in our region. We have done an initial screening of such sites at third-party land in our region;

- Identify and implement more cost-effective energy storage opportunities, building on the lessons we will have learned during AMP7 (2020-2025).

Green electricity procurement and sleeving

By 2030, we commit to:

- pursue REGO-backed green electricity and sleeving opportunities to cover up to 100 per cent of our remaining emissions associated with grid electricity. In addition, we will explore additional opportunities to sleeve/purchase some of the power generated through our solar PPAs that we would not otherwise use.

Our target pathway to 2030 is shown in Figure 13.

Anglian Water's 894KWp solar installation at Jaywick Water Recycling Centre meets up to 36 per cent of the site's energy requirement

Case study: Solar programme

As part of our ambitions around solar energy, in 2019 we created the UK's largest subsidy-free renewables and energy storage framework. Our track record on renewables has since gone from strength to strength and in September 2020 the largest solar array on our sites - and one of the largest in the water sector - was energised. Formed of more than 42,000 solar panels, the Grafham array supplies over a quarter of the energy needs of one of our largest water treatment works.

The past year (2020/21) has been a record-breaking one for solar at Anglian Water, with 7.2GWh generated from the growing portfolio of 14 solar photovoltaic (PV) installations at our sites - an increase from 3GWh in 2020. By 2022 we expect to generate more than 16GWh from solar.

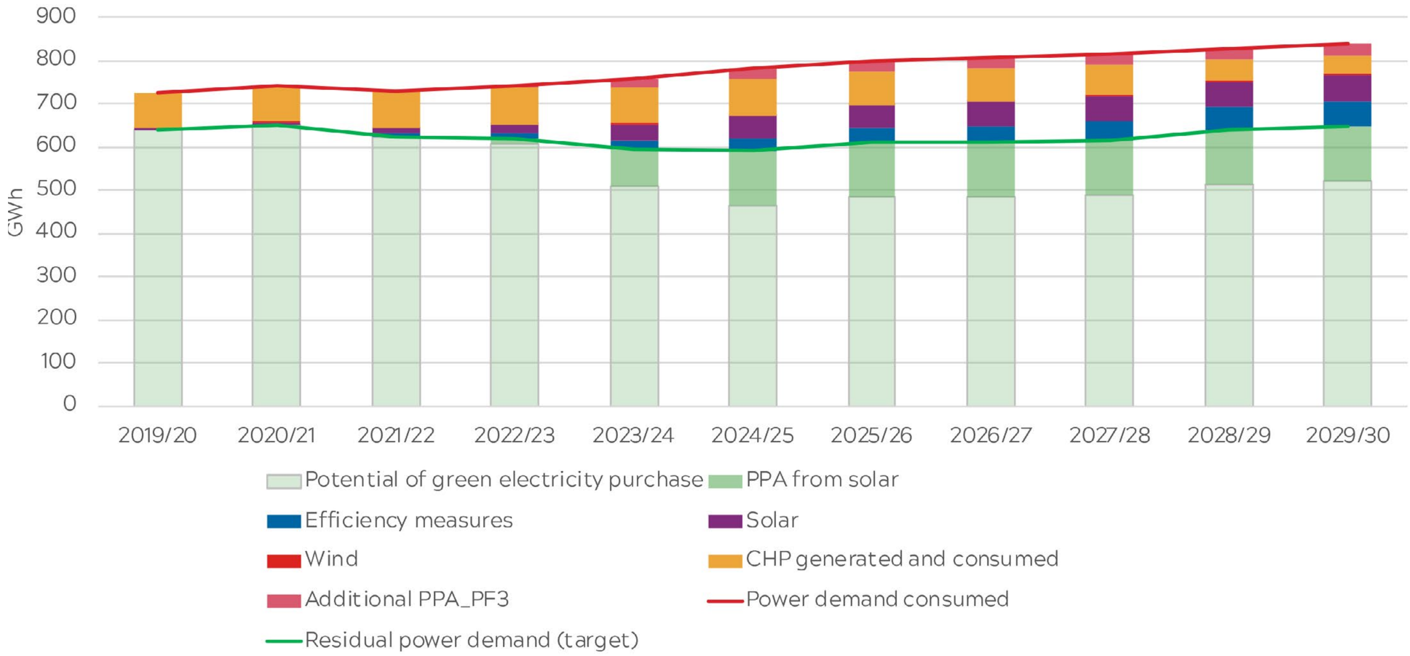
We have partnered with experts in delivering renewable energy solutions throughout our renewables programme. Our AMP6 (2015-2020) renewables programme was carried out and is managed under a 25-year PPA contract with Innova, HBS New Energies and Macquarie GIG which saw us build 15MWp of solar, reducing carbon emissions by 4,000 tonnes of CO2e and increasing renewables generation by approximately 10 per cent, delivering annual savings in excess of £0.6 million.

We subsequently entered a partnership with Next Energy Capital (NEC) which, as referenced above, forms part of the UK's largest unsubsidised solar and renewables framework. NEC will design, build, own and operate 30MW of solar assets as part of a 25-year PPA contract.

We are also investing in energy storage with redT and energy tech company Open Energi at our Little Melton WTW, which can store excess solar power generated during the day and be used at other times, reducing our reliance on the grid.

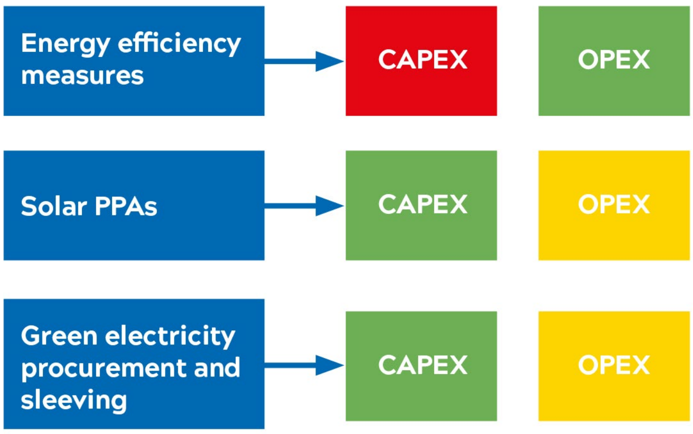
Our award-winning holistic approach to renewables, utilising CHP, solar and wind power, provides a blueprint for how to reduce the carbon emissions arising from powering large infrastructure as well as reducing energy costs, helping to manage price volatility and improving resilience.

Figure 13: Our target pathway to 2030 for decarbonising the intensity of our purchased electricity



The wind generation shown in Figure 13 is the generation from our existing wind turbines which generate over 12GWh/y and we consume approx. 2GWh/y, the rest being exported (REGO-backed electricity).

Capex/opex impact of our target pathway



Unlocking additional opportunities to get us to a stretch pathway by 2030

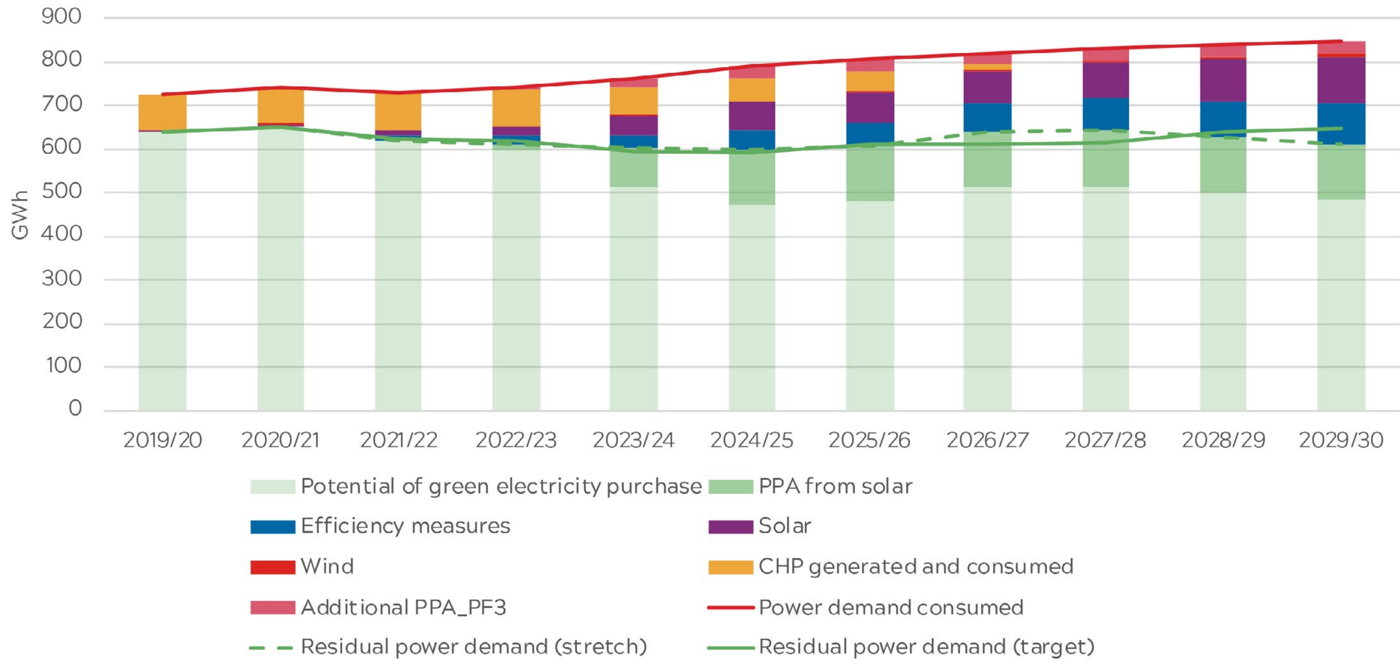
A number of additional opportunities could be unlocked with the right policy levers and other external factors, such as unlocked planning constraints, additional funding and technology maturity/viability, among others. These would get us to a stretch pathway by 2030 as below.

In a stretch pathway, by 2030 we would have to:

- Increase our energy efficiency target to reduce power demand by a further 37GWh/y, compared to our target pathway. This will be very challenging and would require significant additional funding. We have already achieved quite significant efficiencies in our asset base (the low hanging fruit) and we would need to really assess technology swaps in our treatment operations, investing additional funds to accelerate leakage reduction (which could be higher than the current sustainable economic level, target sewer infiltration, etc), accelerating nature-base solutions and catchment approaches as well as our approach to near-live operational response at catchment level;
- Increase our generation capacity by 2025 from our Solar Portfolio #2 from additional sites that we could identify and develop as part of Portfolio #2. These additional sites are locations where viability is not yet confirmed, and we where we do not yet know whether we will have any additional delays due to planning constraints;
- Maximise energy storage across our sites;
- Develop an additional 25GWh/y from other renewable energy opportunities (including wind power where possible) and using the generated electricity on our sites. For wind generation, we would need to overcome the current planning constraints and uncertainties associated with new onshore wind generation;
- Cover remaining grid electricity emissions through procurement of green electricity and sleeving (including through corporate PPAs or from our solar portfolios for power we do not currently need to import).

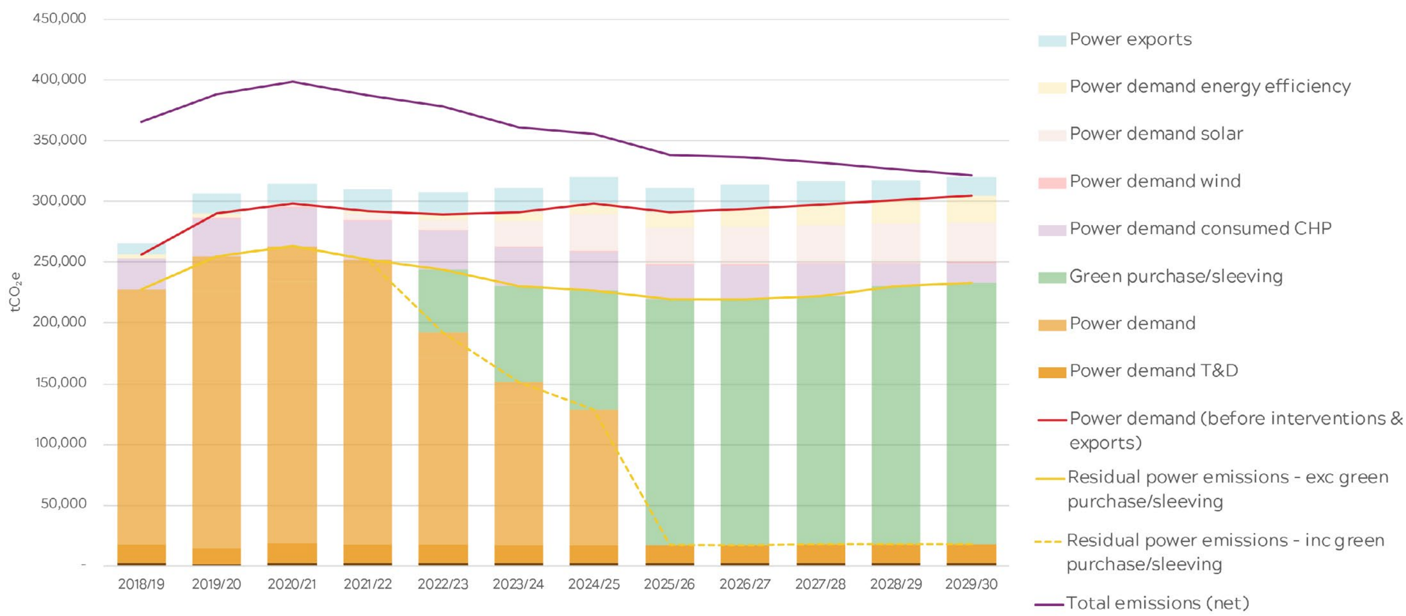
The 2030 stretch pathway is shown in Figure 14 below.

Figure 14: A stretch pathway to 2030 for decarbonising the intensity of our purchased electricity as compared to our target pathway



It should be noted that our stretch pathway also factors in an 8GWh/y increase in power demand from the additional biomethane upgrade plants that we will be running in this scenario. This does reduce the overall emissions reduction the stretch pathway achieves in comparison to the target pathway. Figure 15 below shows how the combination of all decarbonisation interventions relevant to purchased electricity affects our emissions profile over time.

Figure 15: Our target pathway for green electricity purchase



As seen from Figure 15, our strategy going forward involves us managing our energy demand, accelerating renewable energy PPAs (behind the meter), exporting our own renewable energy and maximising storage opportunities and finally switching from our current purchased brown electricity supply to a greener supply.

Risks and uncertainties we need to manage

The main risks and uncertainties associated with this cluster include:

- Extreme weather events, which will become more frequent, such as in 2021 where we had to divert most of our resources away from energy efficiency into addressing pressing operational issues. The impacts of climate change are becoming more evident and future increased drought frequencies mean that we may have to pump more water around our region to build resilience and maintain service standards;
- Funding availability to implement longer payback period solutions that are more likely to result in more transformational energy efficiency measures;
- Grid decarbonisation is one of the key factors affecting our rate of decarbonisation towards net zero. Changes in the pace of the grid decarbonisation will impact the magnitude of our residual emissions as well as the cost effectiveness of future energy efficiency measures. A faster grid decarbonisation rate will make significant investments in energy efficiency less attractive from a net zero perspective;
- Uncertainty in the future financial balance between the cost of investing in energy efficiency and the cost of sourcing low carbon energy;
- Future regulatory changes, such as Water Industry National Environment Programme (WINEP) reform or other standards and future Water Resources Management Plan (WRMP) requirements that may increase our power consumption from 2025;
- We have experienced some challenges in the pace of development in our solar PPAs due to EPC contractors not being used to working according to water industry specifications and close to operational sites. Although we are taking various mitigation measures to address this, it is still a risk;
- Grid connection risks for our solar portfolios. While these are managed by the developer (in the PPA model we are following), significant delays or cost of grid connections may delay some of our projects coming online on time;
- Planning challenges around solar. As we have experienced at the proposed solar installation close to our site at Wing, in Rutland, these may pose delays in the deployment rates of our PPAs;
- Planning risks for onshore wind. These have been an ongoing issue.

Our actions to ensure a flexible strategy

Energy efficiency

We will:

- Continue to align our current and future capital programmes and the long-term planning of our strategic water resource options to our net zero strategy to ensure the operational power demand of new schemes is minimised. We have already set a target to our supply chain to reduce operational carbon in each scheme by 27 per cent (from a 2015 baseline). We will build on our track record for creating a collaborative culture with our alliance partners focusing on behaviours to deliver our programme against carbon targets;
- Continue to engage with and influence our regulators, the rest of the industry and our customers to better understand the whole life carbon impact of future regulatory decisions, especially the WINEP reform, inland bathing waters and abstraction licence caps;
- Continue to assess the co-benefits and alignment to net zero of our approach to nature-based solutions (including sustainable drainage systems -SuDS - and catchment management);
- Seek to better understand carbon reductions resulting from our water efficiency campaigns and how user behaviour can influence our energy demand going forward;
- Re-assess the way we plan our energy efficiency programmes of work to ensure carbon benefits are at the heart of any decisions. We will do this by extending our paypack period thresholds to see what further near-live operational measures we can implement in our region. We will build on our current work on near-live modelling in our clean water operational areas;
- Ensure we have sufficient resources in Anglian Water and our supply chain to focus on implementing larger energy efficiency programmes to help us minimise operational risks due to external pressures, such as extreme weather events;
- Continue to monitor our progress on an annual basis to ensure that the right balance is stuck between investing in energy efficiency and investing in other decarbonisation opportunities, especially as we gradually decarbonise our electricity supply.

Renewable energy (solar and wind)

We will:

- Ensure we retain and retire any renewable energy guarantees of origin (REGOs) we get from our solar, wind and CHP renewable energy generation. This will enable us, under a market-based reporting methodology, to be able to claim zero carbon electricity generation. More specifically, in our solar portfolios we commit to buy 100 per cent of the REGOs for any energy we use. We will then identify whether we could purchase any excess solar energy generated through sleeving and retain the REGOs;

- Continue engaging with our solar PPA investors, their EPC contractors and district network operators (DNOs) to ensure our solar portfolios are delivered on time and bring us the benefit as per our target pathway;

- Continue to monitor planned solar developments in our region (outside our own land) to identify and benefit from additional solar generation by 2030 and beyond;

- Continue to invest in energy storage opportunities (or through a PPA model) on our sites to better understand performance and costs and establish whether we will be able to have greater energy flexibility and use some of these opportunities for our back up power demands and reduce our reliance on fossil fuels (see our alternative fuels strategy);

- Continue to engage with local authorities to monitor planning risks for onshore wind in our region.

Green electricity procurement

We will:

- Undertake wider market engagement to better understand future grid electricity tariff scenarios, especially any premiums for green electricity and sleeving, to have a more informed electricity procurement strategy at specific trigger points in time.

Behaviours to drive carbon reduction

Alongside the adoption of new technologies, we also need to ensure that our own workforce, our supply chain and our customers are encouraged to adopt low carbon behaviours. For energy efficiency, these include:

- Ensuring our staff are informed on how to be as energy efficient as possible in our offices and sites;

- Encouraging our staff to challenge and report areas where energy efficiency can be improved;

- Encouraging collaborative behaviours across our energy efficiency, innovation and catchment management teams to identify how we can maximise co-benefits of nature-based solutions and digital enablers to drive down our carbon emissions, improve resilience and provide other environmental benefits;

- Helping our customers become more water efficient helps save significant energy demand in their homes associated with domestic hot water heating. (The carbon benefits to households through water efficiency can be 3.5 times more than the benefit for water companies).

Our biogas strategy

Our strategic intent

By 2030 we will:

- Maximise the value of our biogas from our Advanced Anaerobic Digestion (AAD) facilities by considering alternatives that have the greatest carbon reduction benefit and lowest bill impact to our customers. This involves switching from biogas/CHP into biomethane production and injection into the gas grid or use in transport, depending on the attractiveness of different policy incentives;

- Actively consider opportunities associated with hydrogen production from our bioresources assets for potential implementation post 2030. This is to ensure we are prepared for the potential switch of the gas grid to hydrogen by 2040 and beyond.

Why?

> **"Our bioresources have been an excellent renewable energy resource to date."**

Over the years we have benefited from policy incentives for renewable energy to invest and maximise the value of our biogas. We have been fuelling CHP engines with our biogas to generate renewable electricity and heat. We have used such electricity to offset our imports from grid electricity in some of our sites but also to export any surplus to the electricity grid.

More recently the UK Government has introduced different incentives relevant to renewable heat (the renewable heat incentive, known as RHI, and its replacement, the Green Gas Support Scheme, known as GGSS) and renewable transport (the renewable transport fuel obligation or RTFO). This is a move to gradually decarbonise heat and transport in the UK through the use of biomethane - a fuel based on biogas which is mixed with a small amount of propane (a fossil fuel) to have the right consistency to be injected into the national gas grid. Biomethane production has a greater carbon benefit than using biogas through CHP; however, injection into the gas grid is location specific and the cost is best justified through benefiting from the right policy incentives.

Furthermore, the UK's recent 10-point green industrial revolution plan has ambitious goals for the deployment of hydrogen, part of which is to be used for heating and transport. Biogas can be one of the routes to hydrogen production and injection into a future hydrogen grid.

Benefits to our customers

Maximising the value of the biogas from our sludge treatment centres will benefit our customers through the provision of low carbon electricity and heat, as well as resulting in a positive environmental impact in the communities we serve.

Our target pathway

By 2025:

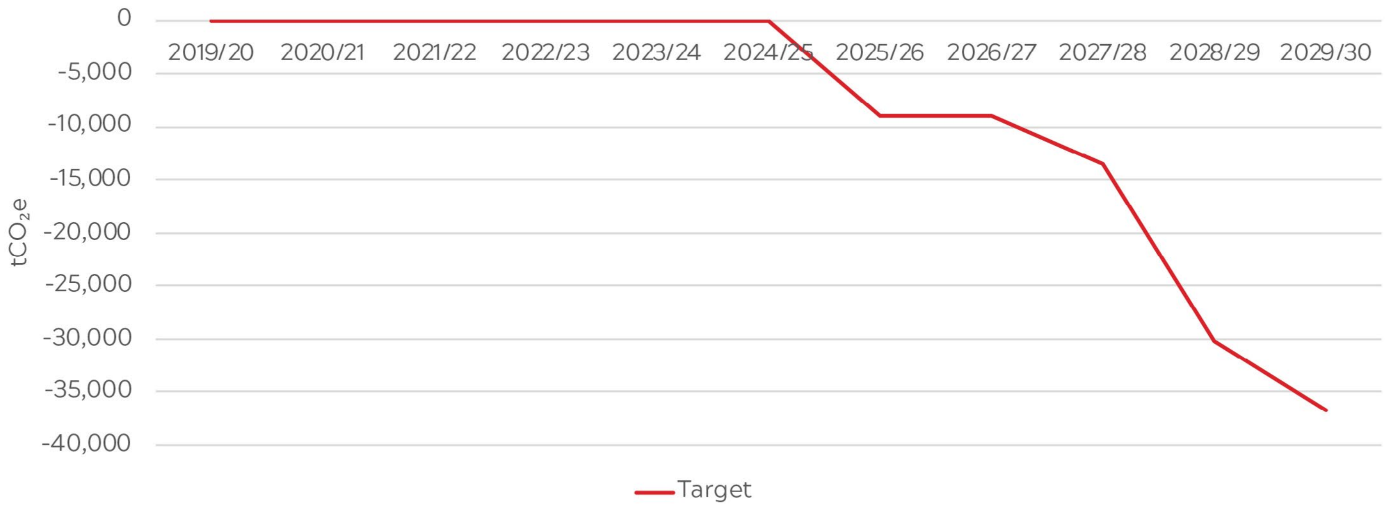
- Our target is to continue using our biogas through our existing CHP facilities.

By 2030:

- Our target is to gradually switch 54 per cent of our existing CHP generation capacity to biomethane production. The total biomethane we plan to inject to the gas grid by 2030 is 200GWh/y. We have assessed that the sites with the greatest potential to meet this target are our new Cambridge sludge facility and our existing facilities in Cotton Valley, Great Billing and Whittingham.

Figure 16 shows the estimated carbon reductions by 2030 from our target biogas pathway.

Figure 16: Carbon reductions by 2030 from our biogas target pathway



In meeting our biomethane target by 2030 we will be losing 55,000 MWh/yr of renewable electricity that we currently generate from our CHPs. We currently use this electricity on site or export it into the electricity grid. This means that we will need to supplement the heat currently generated from our existing CHPs and the biogas used in boilers and used to heat our digesters, with an additional 25,000 MWhth of imported natural gas to use in our boilers.

To be able to export our biomethane to the national gas grid, we will need to mix it with an additional 24,000 MWhth/y of propane by 2030. There will also be an additional power demand associated with biogas to biomethane upgrading of 9,000 MWh.

Overall, the net carbon reduction benefit from switching to biomethane is greater than that derived from CHP alone. Figure 16 shows our carbon reduction net benefit by 2030 for our target pathway.

Our target pathway is quite challenging since it requires additional capex. To make the options commercially viable, sufficient levels of incentives will have to be in place. Our understanding is that the new GGSS incentive will be applicable to new facilities, such as in our Cambridge sludge treatment facility. Our assumption is that the RTFO or its future replacement will continue to provide support for existing facilities.

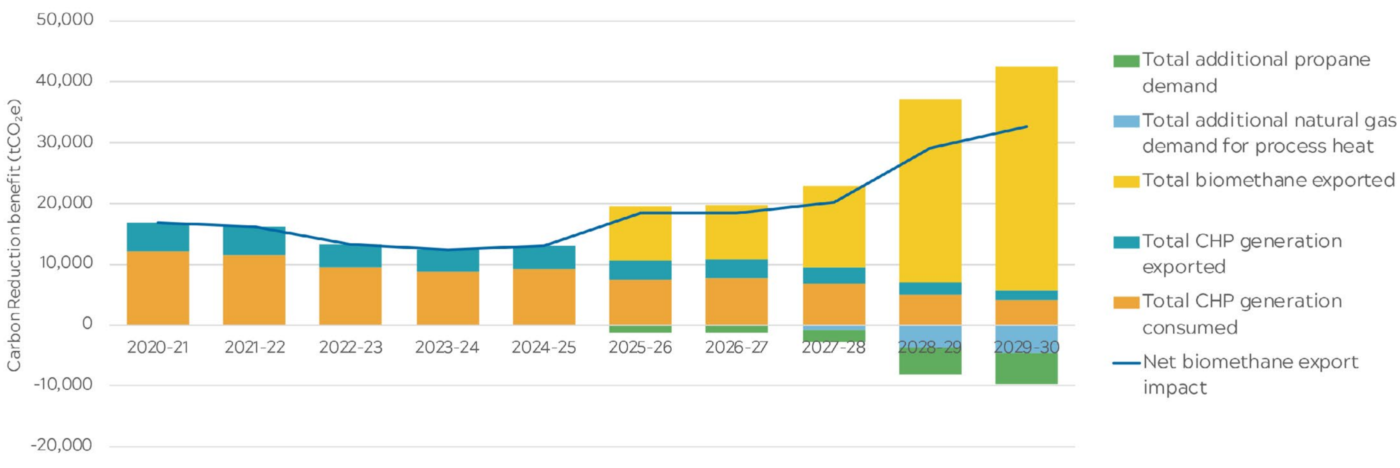
Case study: Anglian Water's HpH (heating, pasteurisation and hydrolysis) technology

HpH Technology is the new biological hydrolysis technology developed by Anglian Water experts.

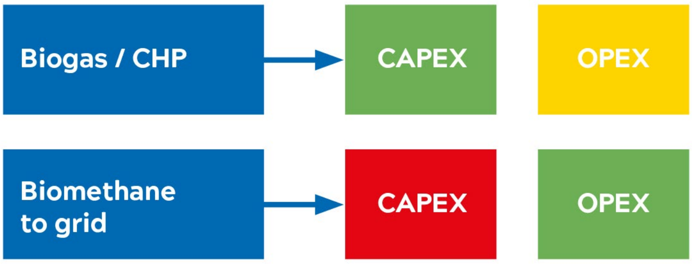
Responsible for processing around 150,000 tonnes of dry solid sewage sludge per annum, we identified an opportunity to develop a new hydrolysis technology that could maximise a plant's biogas production even further than existing anaerobic digestion technology - to reduce not only operating costs but also the plant's carbon footprint.

The result, HpH Technology, is now installed across four Anglian Water sludge treatment centres. Results to date have produced an average of over 1 MWh/TDS of renewable electricity from the biogas produced via our fleet of CHP engines - while producing a high-quality enhanced treated biosolids product for use in agriculture as a soil conditioner.

Figure 17: Carbon reduction net benefit by 2030 for our target biogas pathway



Capex/opex impact



Unlocking additional opportunities to get us to a stretch pathway by 2030

In order to achieve a stretch pathway by 2030, we would need to transition to biomethane-to-grid installations by the time the first CHP engine on each of our sites reaches its 100,000-hour asset life. By 2030, this would cover more than 99 per cent of existing generation capacity through CHPs.

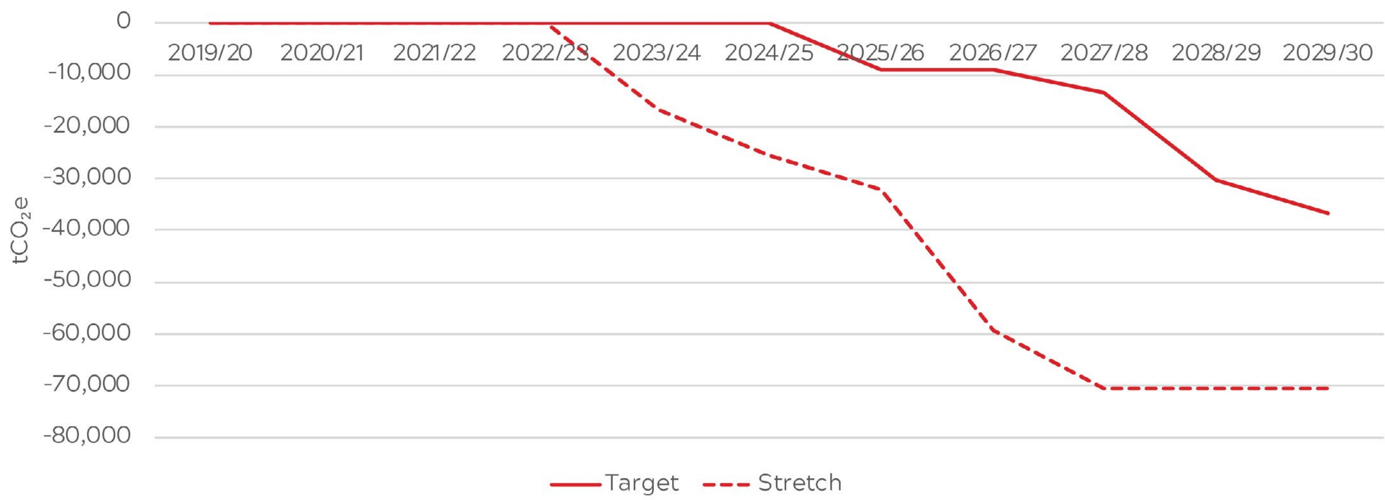
In a stretch pathway, by 2025 we will need to switch 37 per cent of our total existing CHP generation capacity to produce biomethane. This includes developing our CHP capacity at Cotton Valley and Great Billing to biomethane-to-grid installations. The total amount of biomethane we could export to the grid would be 140GWh/y.

This would mean that we would lose over 44GWh/y of renewable electricity from CHPs (the majority of which we currently use and 30 per cent of which we export). We would need to import 16GWhth/y of natural gas by 2024/25, and 16.7GWhth of propane. We would also incur an additional power demand for the biomethane upgrade plant of 6GWh/y.

In a stretch pathway, by 2030 we would need to export a total of 383GWhth of biomethane to the national gas grid from nine of our sludge treatment facilities. Our total of 116GWh/y of renewable electricity currently generated from CHP would be lost and we would need an additional 63GWh/y of additional natural gas, 46GWh/y of propane and an additional power demand of 17.5GWh/y.

Figure 18 shows the estimated carbon reductions from the additional biomethane produced in the stretch pathway to 2030.

Figure 18: Carbon reductions by 2030 in a stretch pathway



Risks and uncertainties we need to manage

The risks and uncertainties we will need to monitor over time include:

- the impact from GGSS applying to new sites only and whether other incentives (including RTFO) are applicable to facilitate biomethane-to-grid installations in existing sites;
- the level of biomethane government subsidies fluctuating over time;
- the proximity and cost of sludge sites to the national gas grid;
- the risk of potential land bank loss affecting biogas strategy which could lead us to consider alternative sludge treatment and disposal routes (such as incineration);
- uncertainty around future hydrogen policy direction which may pose a long-term risk to any biomethane and biogas investments we make pre 2030;
- the impact on carbon reduction potential in bioresources from installing alternative water recycling processes (such as Membrane Aerated Biofilm Reactors - MABR) that could affect sludge volumes and biogas potential.

Our actions to ensure a flexible strategy

Our actions to manage the risks identified and maintain flexibility in our strategy include:

- Engaging through industry groups and relevant Government bodies to monitor closely the direction of travel for the different policy incentives supporting biomethane-to-grid schemes. If there is no support for existing sites, or if the level of incentives is lower over time, we will run different scenarios for potentially diverting biogas back into our boilers, exporting biogas into neighbouring industries that may require it for their own decarbonisation efforts, using biomethane in our transport fleet or potentially exporting our sludge for co-digestion in other new facilities in our region that may benefit from future biomethane incentives. We will need to make some tactical decisions as the policy is changing;
- Assessing our overall cost impact over time by running additional scenarios for biomethane to grid by 2030 based on expiry of Renewables Obligation certificates (ROCs) from our CHP engines and how the different levels of incentives for biomethane may vary;
- Engaging early with National Grid to better understand the costs of grid connection in the identified sites;
- Optimising the amount of additional natural gas we would need to import to heat our digesters by assessing the cost of better insulation, exploring alternative sources of heat (such as viability of waste heat from our water recycling facilities, ground source heat pumps, electrified heat blankets, among others);
- Continuing our engagement with Defra, the Environment Agency (EA), ADAS, the Country Land and Business Association (CLA), the National Farmers' Union (NFU) and Water UK networks to better understand the EA's position on the Farming rules for Water (Rule 1) that may prevent biosolids to land and/or extended storage on Anglian Water sites, that may increase our Scope 1 emissions;
- Continuing to improve our understanding on whether the production of hydrogen from biogas can be competitive post 2030 when compared with alternative biogas uses;
- Engaging with Energy UK and National Grid to better understand the future direction of hydrogen policy in the UK and when the gas grid is expected to be fully hydrogen operated. This may impact our investment strategies for biomethane schemes;
- Continuing our assessment of how biomethane could be used in our HGVs post 2025;
- Engaging with our supply chain to understand potential benefits from alternative sludge treatment processes (such as pyrolysis, gasification and incineration) to mitigate the risk of losing our landbank;
- Understanding the impact on our biogas strategy from deploying alternative water recycling process to reduce other emissions (post 2030) on our future sludge volumes and biogas strategy.

Behaviours to drive carbon reduction

Alongside the adoption of new technologies, we also need to ensure our own workforce, our supply chain and our customers are encouraged to drive innovation and adopt low carbon behaviours. For biogas, these include:

- Encouraging our innovation teams to continue to push the boundaries for how much biogas we can produce and improve our overall energy balance;
- Encouraging our operations and maintenance and innovation teams to collaborate to understand how we can use technology to identify where fugitive methane emissions are likely to occur and proactively identify interventions to minimise these.

Managing our process emissions

Our strategic intent

By 2030, we will:

- Lead the way in improving our understanding of process and fugitive emissions - and how they may be managed and reduced, through operational optimisation, asset modification and replacement where possible;
- Work closely with our supply chain and the rest of the industry to test pilot solutions to reduce our process emissions and to determine those that will be cost effective to implement at scale.

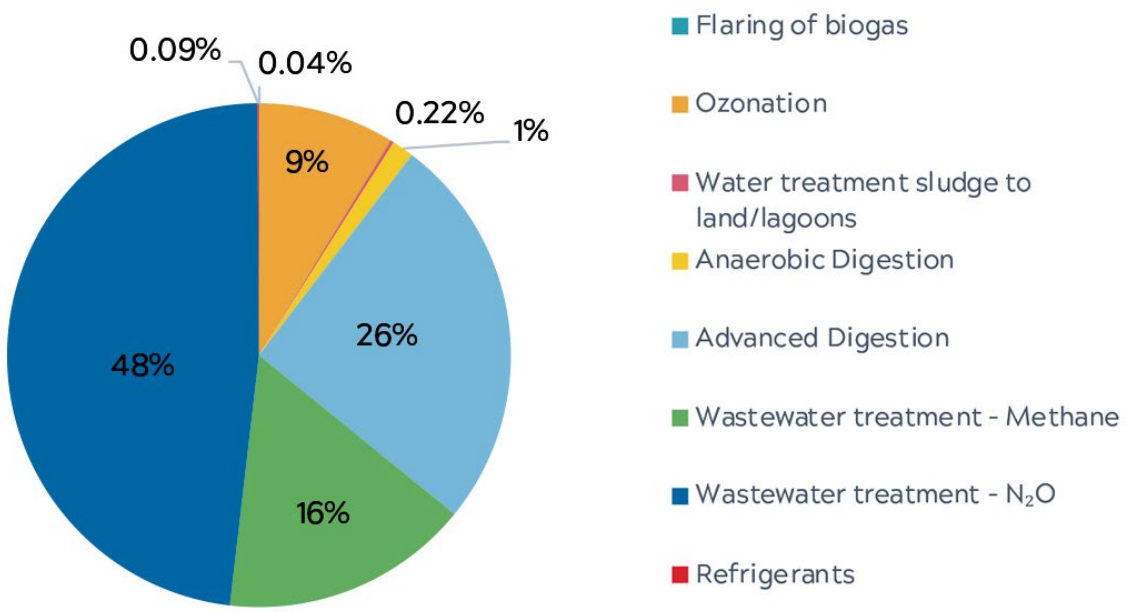
Why?

Process emissions, primarily nitrous oxide (N_2O) from secondary water recycling treatment, and methane (CH_4) from water recycling and sludge treatment and storage, account for 23 per cent of our baseline 2018/19 emissions and will become the largest component of our residual emissions by 2030 as other sources are reduced. These emissions are particularly difficult to tackle and are a big challenge for our sector.

Process emissions are a by-product of collection and treatment in our water recycling facilities and fugitive emissions defined as unintended losses or leaks from the system. These are illustrated in a schematic in Appendix 2.

The proportion of process emissions in our operations, as reported in the Carbon Accounting Workbook (CAW) in 2020/21, are shown in Figure 19 below. This highlights that the majority of our process emissions arise from our water recycling and sludge treatment activities. Water-related process emissions account for just under 10 per cent of our overall process emissions and are largely driven by ozonation.

Figure 19: Proportion of process and fugitive emissions from our operations in 2020/21 (industry reported N_2O EF)

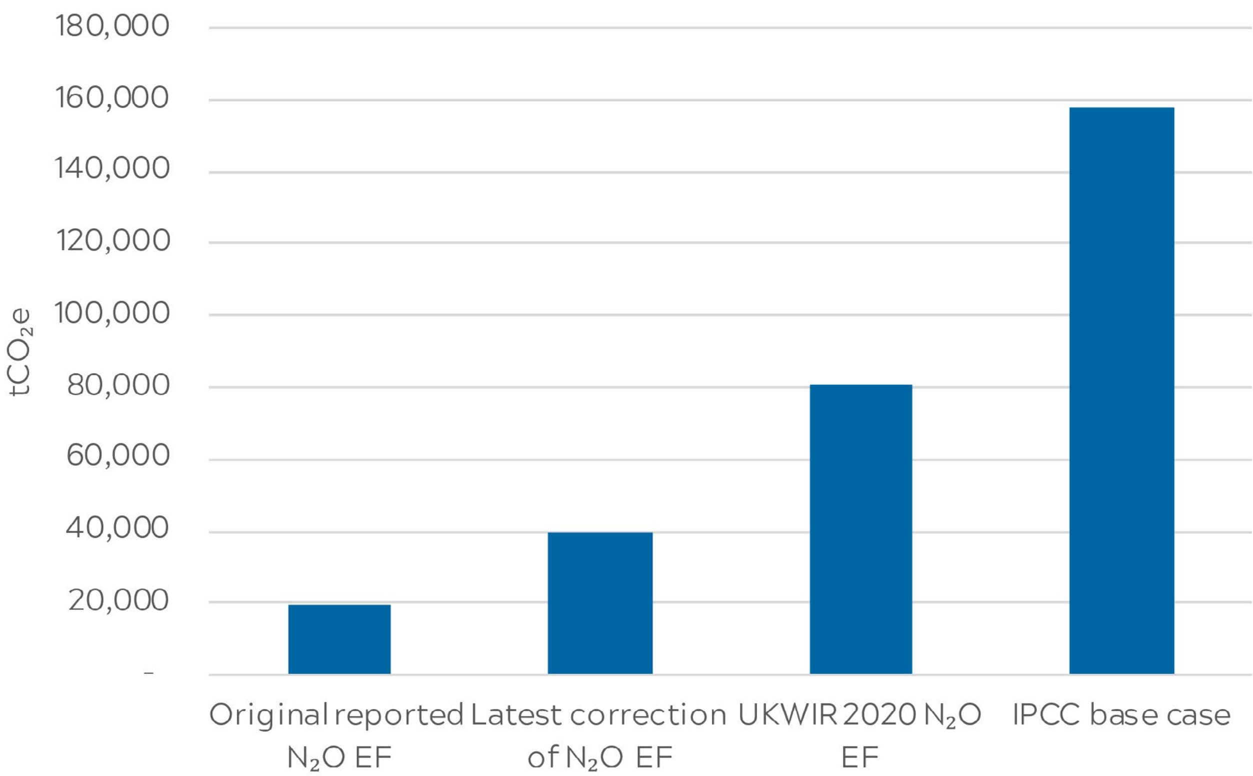


There is great uncertainty in the magnitude of those emissions in our operations and the science has been evolving over time. Currently we do not know the exact magnitude or the emissions factor of N_2O emissions and we have been working with our peers to improve our understanding. Our sector undertook a research project by UKWIR (UK Water Industry Research) in 2020[2] where various emissions factors for N_2O have been assessed. This work has shown great variability in the location and magnitude of these emissions and the main recommendation for our industry has been to install monitoring equipment to help us improve how we understand and manage them. Appendix 2 provides further detail.

Our industry current understanding, from the UKWIR work in 2020, shows that the N_2O emissions factor is likely to be significantly higher than the current industry reported value. This means that our baseline emissions, our target net zero trajectory to 2030 and our residual emissions in 2030 will all be higher. This is a key risk for us and our peers and hence once we have the right evidence we will have to re-assess our baseline and net zero trajectory.

Figure 20 illustrates how different emissions factors could impact the level of our residual emissions in 2030, adding between 41,000 and 118,000 tCO_2e/year.

Figure 20: Our water recycling process emissions from N_2O based on different emission scenarios



Our target pathway

Due to the complexity of the process emissions and likelihood of further increase in reported emissions as our understanding and evidence base improves, we have assumed that there will not be overall reductions in our process emissions by 2030 from our current baseline.

Our strategy for process emissions is as follows.

By 2025, we will:

- Install monitoring equipment at four of our large sites to improve our understanding of the scale and location of process emissions. This will be shared and reviewed alongside evidence from comparable studies in the UK and elsewhere when possible;
- Review the three-tier methodology suggested by the Intergovernmental Panel on Climate Change (IPCC) in establishing an accurate baseline position;
- Engage, together with other water companies, with the Department for Business, Energy and Industrial Strategy (BEIS), Defra and Ofwat, to seek to secure wider scale of investment for monitoring and measurement;

[2] *UKWIR 2020 Quantifying and reducing direct greenhouse gas emissions from waste and water treatment processes - https://ukwir.org/quantifying-and-reducing-direct-greenhouse-gas-emissions-from-waste-and-water-treatment-processes-1*

- Continue to work with the rest of the industry, through UKWIR, Water UK and the wider scientific community, to better understand the scale of the N_2O emissions factor and CH_4 emissions from water recycling and sludge treatment;
- Seek to reduce CH_4 process emissions and minimise fugitive losses where possible;
- Continue to investigate alternative processes such as MABR for implementation post 2025, to help avoid N_2O emissions.

By 2030, we will:

- Have sufficient data to develop a robust strategy for reducing process emissions by considering different decarbonisation interventions. Appendix 2 gives an overview of the different decarbonisation interventions we have already been considering for managing process emissions.

Benefits to our customers

The cost of covering our water recycling treatment tanks and treating the captured gases (i.e. off-gas), would be considerable and likely to have a significant impact on customer bills. Our strategy on process emissions is therefore to better understand the scale and location of our N_2O and CH_4 emissions and, once we have done that, to work with our supply chain and the international scientific community to find the most cost-effective ways to reduce these emissions as much as possible. We will prioritise operational responses and optimisation, then consider alternative treatment technologies. Covering tanks and treating the off-gas will be treated as the last resort.

Risks and uncertainties that we need to manage

The risks and uncertainties we will need to monitor over time include the following potential outcomes:

- N_2O and CH_4 emissions are significantly higher than our current baseline;
- N_2O emissions factor and scale is higher than we previously estimated, as our understanding improves;
- CH_4 process and fugitive emissions are higher than anticipated following close investigation and monitoring;
- Funding becomes available to allow us to move from monitoring four sites to mass monitoring by 2025;
- Funding becomes available to allow us to implement active control and optimisation of our water recycling processes to reduce process emissions as much as possible;
- Technologies for reducing/avoiding process emissions over and above operational interventions are not available or have a significant customer bill impact.

Our actions to ensure a flexible strategy

Our actions to manage the risks identified and maintain flexibility in our strategy, include:

- Implementing N_2O monitoring at four water recycling sites by 2022;
- Reviewing, trialling and implementing the most promising tools and methodologies to monitor CH_4;
- Continuing to work with other water companies to unlock funding opportunities for targeted monitoring in additional sites through the Ofwat Innovation Fund;
- Engaging with Defra and BEIS to explore additional sources of funding;
- Continuing to investigate the benefits of novel approaches to CH_4 monitoring used in the oil and gas sector for leak detection and assess how they could help us improve the data we have on fugitive emissions from our anaerobic digestion facilities;
- Understand balance between energy optimisation and N_2O optimisation.

Behaviours to drive carbon reduction

Alongside the adoption of new technologies we also need to ensure our own workforce, our supply chain and our customers are encouraged to drive innovation and adopt low carbon behaviours. For process emissions these include:

- Our operational, capital delivery and innovation teams collaborating to drive the most efficient roll out of monitoring to help continue to develop our understanding of how best to manage process emissions;
- Utilising digital enablers, real time monitoring and predictive analysis to help operational staff utilise the data from monitoring to drive process emissions reductions.

Decarbonising our transport operations

Our strategic intent

By 2030 we want to be:

1. Changing our behaviours to minimise business travel and encourage smarter maintenance and operations to reduce unnecessary travel between our sites;
2. Gradually electrifying our small fleet and electrifying components of our medium fleet;
3. Gradually switching our own and our suppliers' HGVs to liquified natural gas (LNG) in the short term and into biomethane and hydrogen in the future.

Why?

Our transport emissions account for over 6 per cent of our baseline and can be up to 12 per cent in our target pathway in 2030.

We rely on a large fleet of cars and diesel vans that are currently running on fossil fuels. We have assessed the potential for decarbonising our small fleet and diesel vans as they reach the end of their operational life.

We also own a large number of HGVs and rely on contractor-owned HGVs for business operations such as cake haulage. We have been engaging with the supply chain to understand the potential for switching our HGVs into LNG (liquified natural gas) in the short term, and biomethane and potentially hydrogen as longer term lower carbon fuel sources.

Reducing our transport emissions will allow us to reduce our reliance on offsets by 2030 and beyond.

Benefits to customers

Decarbonising our fleet will result in less air pollution, benefiting the air quality in the communities we serve. Optimising and reducing our travel activities across our region will also result in a lower number of vehicles and reduced traffic disruption across our region.

Our target pathway

Small fleet and medium

By 2025, we will:

- Replace 25 per cent of small fleet that are at the end of their service life with electric equivalents. This is a total of 460 vans. Switching to electric vehicles (EVs) will involve charging them in existing public EV infrastructure and installing selective EV charging points in some of our own sites.

By 2030, we will:

- We will continue to replace our small fleet and around 90 per cent of all our small fleet will be electric (1,742 vans);
- Explore the opportunities for electrifying components of our larger vans (currently not available) and run electrical equipment from our diesel vans.

HGVs

By 2025, we will:

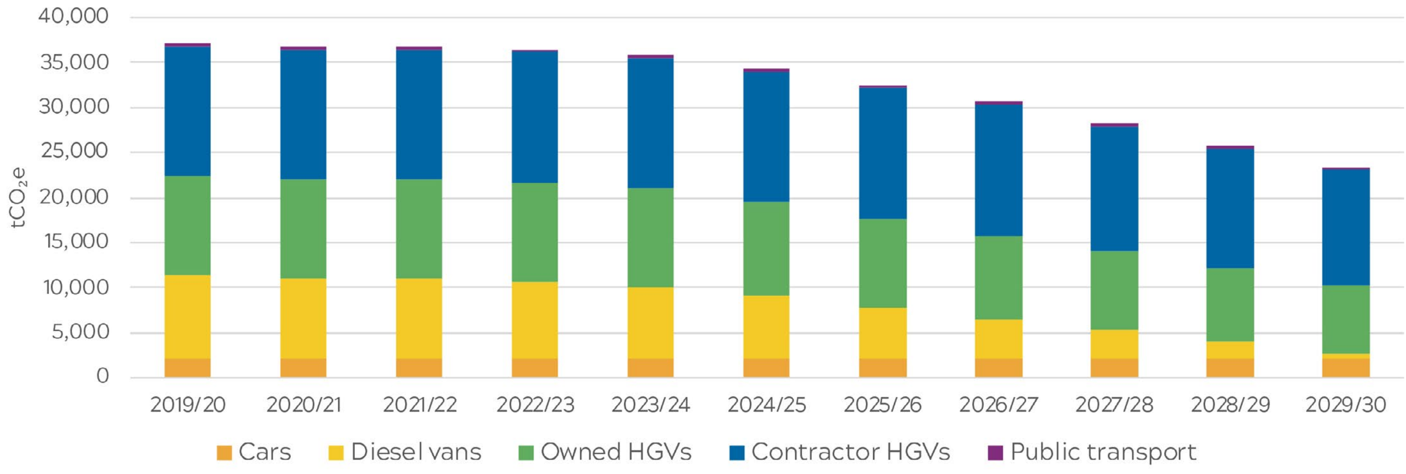
- Gradually switch 10 per cent of our own diesel HGVs to be fuelled by LNG - this is by replacing eight of our own HGVs as they reach the end of their life;
- Have invested in a pilot scheme of an LNG refuelling station in one of our sites. We aim to have three LNG refuelling stations on our sites by the end of 2025;
- Have assessed the potential of using biomethane as a proportion of LNG in our fuelling stations for our HGVs and assess the viability of using hydrogen by and post 2030.

By 2030, we will:

- Replace 55 per cent of our diesel HGV vehicles (a total of 48 vehicles) when they reach the end of their life with LNG-fuelled alternatives;
- Work with our supply chain to gradually switch a total of 24 vehicles in their own HGV fleets to LNG. This represents a three-year lag compared to our own target transition. This transition will be supported by allowing access to Anglian Water LNG refuelling stations;
- Implement biomethane mixing with LNG in our fuelling stations.

Our target pathway is shown in Figure 21.

Figure 21: Our 2030 target decarbonisation trajectory for transport



This target is challenging to achieve, as it will require additional funding to switch to electric vehicles and to LNG-fuelled HGVs. We have based our business case on government grants which may change over time. There is also the risk of insufficient electric charging points available at colleagues' homes, where the vans are parked overnight. Technologies to electrify components of large vans are not in place yet, and the incentives for fuelling our HGVs with biomethane and/or hydrogen over time may change and/or not exist.

Changing our behaviours to reduce our commuting and business mileage

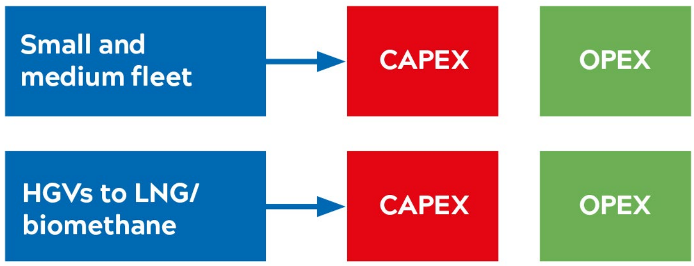
> **For our business travel and commuting, we have been looking at opportunities to reduce vehicle mileage, through behavioural and technology changes.**

While commuting mileage is not within our net zero boundary, we commit to develop a travel management plan and to better understand how to reduce our commuting distances. We have learned a lot about remote working during the Covid-19 pandemic and have invested in our IT infrastructure to enable and encourage more virtual meetings. We have already converted a floor at our Thorpe Wood House office in Peterborough into a collaborative space, as our colleagues are no longer expected to come to the office every day. We have very recently introduced electric vehicles (EV) as an option for colleagues who have company cars and who could pay to upgrade to an EV if above their job role. Use of EVs by our colleagues will also help to reduce our emissions associated with business travel between sites.

To support a reduction in business miles we have invested in proof of concept technologies to allow for the remote operation of our sites. Through this we are aiming to reduce our business mileage for maintenance and operational activities.

We commit to roll out a travel plan across our organisation by 2023 to help reduce commuting and business travel.

Capex/opex impact



Unlocking additional opportunities to get us to a stretch pathway by 2030

We have assessed the additional opportunities that are needed to get us to a stretch pathway by 2030.

Small fleet

In a stretch pathway, by 2025, we would have to:

- Replace 30 per cent of our small and medium fleet with electric equivalents as they reach the end of their service life.

By 2030 we would have to:

- Electrify 94 per cent of our small and medium fleet. This represents electrifying our entire small and medium fleet (a total of 1,742 vans).

HGVs

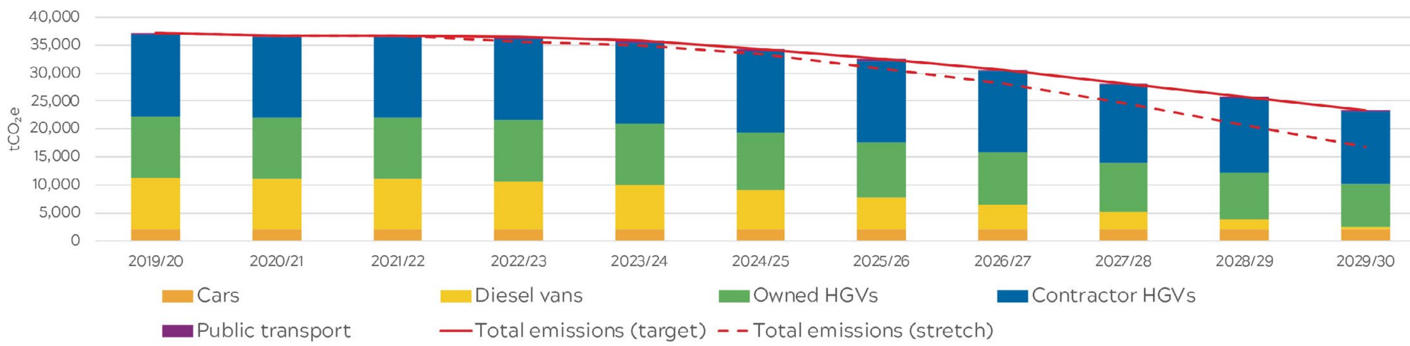
In a stretch pathway, by 2030, we would have to:

- Replace all of our own HGV vehicles (currently 86 vehicles) to run on LNG with a proportion of biomethane.
- Work with our supply chain partners to switch 40 of their diesel HGVs into LNG (with a proportion of hydrogen) fuelled at our own LNG stations.

To achieve the stretch pathway would require additional funding (to cover the additional costs of EVs, LNG HGVs and LNG fuelling stations), more LNG/biomethane fuelling stations and more electrification charging points for our small and medium fleet EVs.

Figure 22 shows how our target pathway compares with a stretch trajectory.

Figure 22: Our 2030 target and stretch decarbonisation trajectory for transport



Risks and uncertainties

The main risks and uncertainties we will need to monitor and manage include:

- Suppliers may not switch their HGV fleet to LNG as fast as our target trajectory;
- The business case for meeting our strategy relies on Government grants which may change over time;
- Most small and medium fleet EV charge points are assumed to be on public/home charging points and some on our sites. There is a risk that insufficient EV charging points will be available in public infrastructure for our target trajectory, and/or that the additional cost impact of installing EV charge points at our sites may be high;
- Supplies of LNG and hydrogen may not be available when we need them;
- There may not be enough suitably close service stations for replaced fleet.

Our actions to ensure a flexible strategy

We will:

- Continue to engage with our EV small fleet supplier; we currently own 43 EV small vans and have more than 40 EVs on order;
- Continue to engage with our supply chain to closely monitor and encourage changes in EV technologies and ranges in larger vans;
- Prioritise small vehicles that spend most of their time at our larger sites with EV charging infrastructure;
- Continue to assess the opportunities for installing EV charge points in our large sites powered from renewable energy. Energy storage will play a key part in this and will give us the flexibility of storing some of the renewable energy we generate and use into energy storage (batteries) and electric vehicles;

- Continue to monitor the availability of government grants and other sources of funding to ensure we minimise the impact on our customers' bills;
- Continue to monitor the availability of LNG and hydrogen with our supply chain. We have also been investigating how much of the LNG is using biomethane and need to explore how to maximise biomethane use. LNG HGV technologies are the same as for liquified biomethane, which gives us further flexibility to switch in the future;
- Continue to engage with our supply chain to ask for lower carbon HGVs. We will need to provide the right incentives to our suppliers to meet our target;
- Continue to monitor the different policy incentives and run scenarios on the type of fuel use for our HGVs, especially movements in hydrogen markets and the cost of biomethane;
- Begin a fleet rationalisation strategy to see how much we could reduce demand for transport (small fleet and HGVs) in our region. We have the largest geographic region of any water company in England and Wales, with over 1,000 small water recycling facilities, and we currently treat sludge at 10 sites. As part of this strategy, we will assess the impact of having additional dewatering and thickening hubs to reduce the volume of sludge that is being transported.

Behaviours to drive carbon reduction

Alongside the adoption of new technologies, we also need to ensure our own workforce, our supply chain and our customers are encouraged to adopt low carbon behaviours. For our transport operations, these include:

- Providing financial incentives for our HGV drivers to achieve fuel efficiency targets;
- Providing driver training to improve fuel efficiency and safety of drivers for HGVs and our van fleet, this includes use of two-way cameras to train our apprentice drivers;
- Building on the success of flexible and remote working to continue to significantly reduce our business miles travelled;
- Utilising scheduling software to inform drivers of best routes and travel times to avoid time idling in traffic;
- Encouraging drivers and utilising technology to stop idling when delivering sludge loads to treatment centres;
- Providing access and incentives to choose electric vehicles as part of our company car programme.

Our alternative fuels strategy

Our strategic intent

By 2030, we want to:

- Reduce our reliance on fossil fuels and opt for lower carbon alternatives;
- Understand how we can best play our part in a future UK hydrogen economy (which is set to grow post 2030).

Why?

In addition to grid electricity and transport emissions, we are using other fossil fuels, such as gas oil, diesel, petrol, natural gas and others, to support our operations. Fossil fuels (outside grid electricity and transport) account for less than five per cent in our baseline emission; however, their share is set to increase by 2030 to 20 per cent. Although this is a small proportion, we want to reduce our reliance on these fuels going forward.

As set out in our biogas strategy, our gradual switch to biomethane will require additional fossil fuels to supplement the heating of our digesters, as well as propane to upgrade our biogas to biomethane. Our use of natural gas and propane is therefore set to increase by 2030 and as described in our biogas strategy, we will need to explore other alternatives for heating our digester facilities.

Furthermore, we have already started to explore the potential for hydrogen in our business and how it may benefit our future customers as well as our wider region - as a potential future hydrogen producer and as a hydrogen consumer (see our transport strategy), but also to ensure we provide sufficient water to other green hydrogen generators in a future hydrogen economy.

Benefits of each cluster to customers

Understanding the benefits of hydrogen to Anglian Water could bring significant cost and carbon savings in our existing operations and hence our customer bills. However, such benefits are likely to materialise post 2030.

Our target pathway

By 2025, we will:

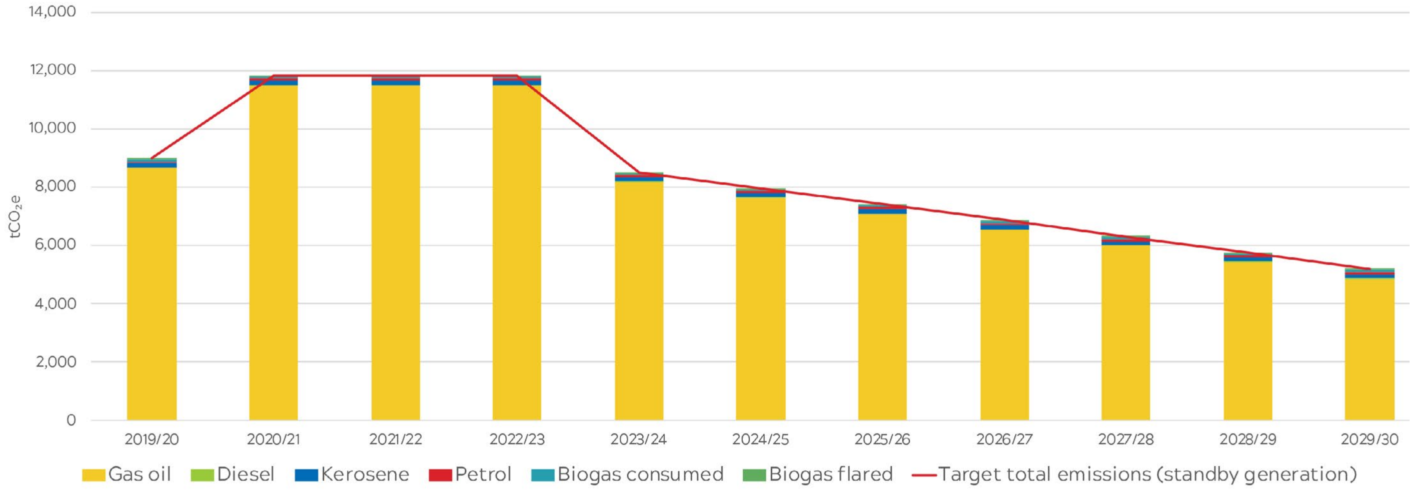
- Gradually replace 30 per cent of our gas oil demand by hydrotreated vegetable oils (HVOs). We are expecting that changes in triad management will no longer allow us to run our standby generation from 2022/23, which would incentivise us to reduce our current standby generation fuels by one million litres/year. Other carbon reductions will be achieved by switching to HVOs. HVOs can be used in our existing generators with no expected technology swaps;
- Have a better understanding of the opportunity from hydrogen production and use in Anglian Water.

By 2030 we will:

- Have switched 100 per cent of our gas oil demand to HVOs.

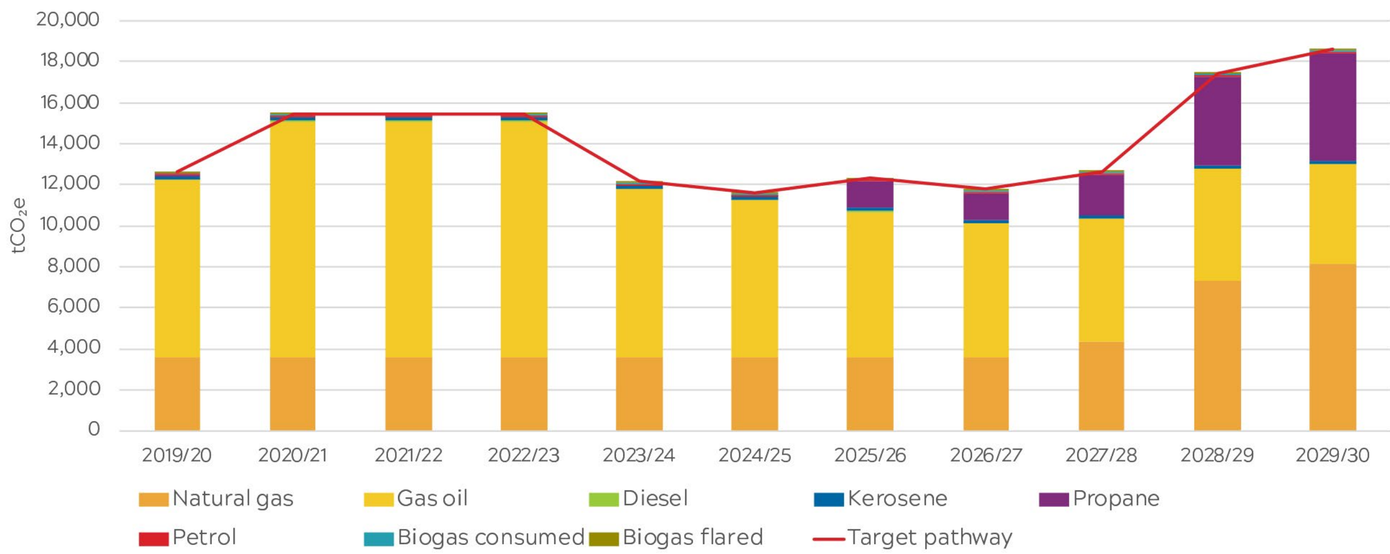
Figure 23 shows our target pathway for gradually switching to HVOs by 2030.

Figure 23: Our target pathway for alternative fuels by 2030



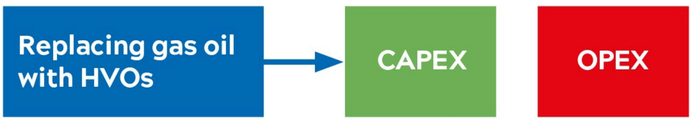
We will also see an increase in propane and natural gas use following our gradual switching from biogas/CHP to biomethane to grid by phasing out the use of CHPs on site. Such increases are covered in our biogas strategy. Overall, our reliance on fossil fuels will increase over time. See Figure 24 which illustrates the overall increase in the use of fossil fuels, dominated by the use of propane and natural gas as a result of our biogas strategy. Nevertheless, such a move to biomethane is still the most carbon-efficient choice (see our biogas strategy).

Figure 24: Our target pathway showing our combined fuel use, to include fuels from our switch to biomethane



Capex/opex impact

Switching to HVOs currently has a cost premium



Unlocking additional opportunities to get us to a stretch pathway by 2030

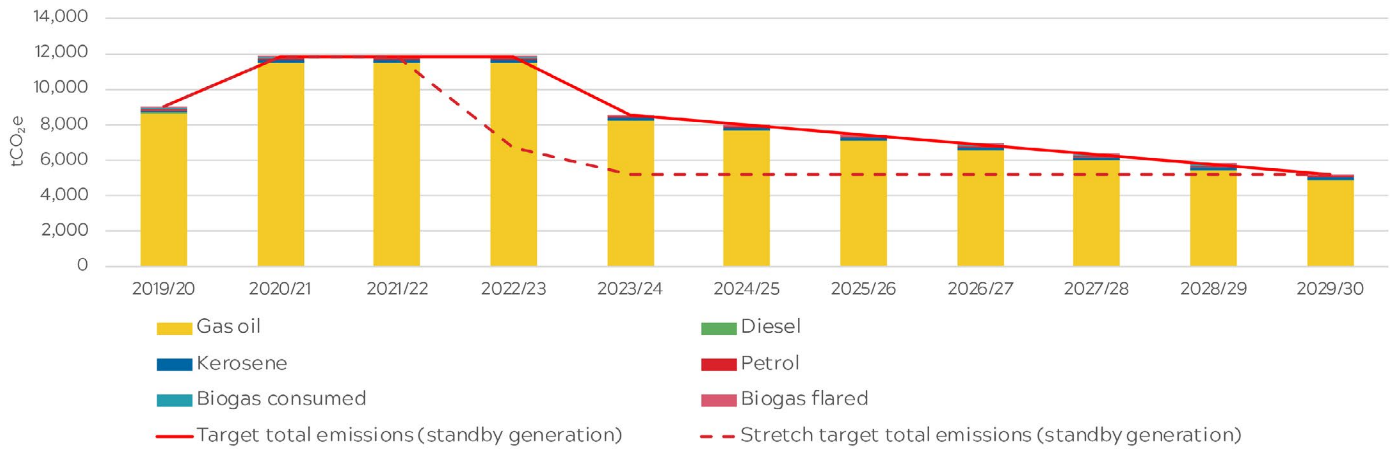
We have assessed the additional opportunities that would be needed to get us to a stretch pathway by 2030.

In a stretch pathway, we would have to:

- Switch 100 per cent of our gas oil use to HVOs by the end of 2023. The challenges to achieving this transition relate primarily to cost and supply chain availability.

Figure 25 shows a profile in a stretch pathway.

Figure 25: Our fuels trajectory in a stretch pathway



To unlock further opportunities to reduce our fossil fuel use, we would have to completely rethink how we use our standby generation. Our back-up generation cannot be completely eliminated, as it is key for our operational resilience. While we are exploring the potential for energy storage on our sites (see our energy strategy), we will have to better understand whether powering our standby generators and/or our EVs with renewable energy stored on our sites - or, in the future, with biomethane or hydrogen - would be viable to help us achieve deeper decarbonisations.

Risks and uncertainties

The risks and uncertainties we will need to monitor and manage with our fuel use include:

- Availability of supply and price points.

Our actions to ensure a flexible strategy

We will:

- Continue to challenge the need and purpose of using fossil fuels (and their alternatives) for standby generation by exploring alternatives such as renewable energy stored in our sites;
- Continue to generate further efficiencies in how we heat our digestion facilities, as stated in our biogas strategy;
- Build on our current work on hydrogen (technical and cost assessment of how we could produce green hydrogen through electrolysis and use pure oxygen in our water recycling facilities in the future, and grey hydrogen from biogas and bioresources) and see how hydrogen can fit into our energy mix and dispatchability strategy post 2030;
- Engage with the main hydrogen players in our region (from the BEIS industrial clusters such as the Humber estuary and Sizewell C in Suffolk) to better understand how we can identify synergies for using hydrogen in Anglian Water as an alternative fuel (for generation and/or transport) or any of its by-products (pure oxygen) in our water recycling facilities;
- Consider the implementation of hydrogen pilot programmes post 2025, by benefiting from government funding, to quantify the benefits of hydrogen generation and use in our asset base.

Behaviours to drive carbon reduction

Alongside the adoption of new technologies, we also need to ensure our own workforce, our supply chain and our customers are encouraged to adopt low carbon behaviours. For our fuel consumption these include:

- Encouraging internal and external collaboration to drive and accelerate the development of lower carbon alternatives to fossil fuel, such as hydrogen;
- Continuing to encourage operations and maintenance teams to drive fuel efficiency on site and supporting them to find lower carbon alternatives to existing fuel consumption drivers, e.g. hydrogen or battery storage standby generation;
- Collaborating and engaging across teams to identify co-benefits opportunities, such as the potential to use HVO on-site to refuel vans and cars.

Managing our residual emissions

Why?

By 2030 (and beyond) we will still have a proportion of residual emissions which we will need to manage in order to get to net zero. Our residual emissions will be around 26 per cent of our baseline emissions, with the majority of those stemming from process emissions. Some emissions will result from using lower carbon fuels to power our standby generators and using fossil fuels to heat our digesters and produce biomethane to export to the gas grid; we will also have some remaining transport emissions and emissions associated with losses in the electricity grid transmission and distribution.

> **“We want to see the offsetting market develop in a robust and credible way that delivers value to our region.”**

We will therefore need to remove carbon, or purchase credible offset credits, to get to net zero. The current offsets market in the UK is organised on a voluntary basis and is quite limited in relation to potential demand from organisations with net zero targets. We want to see this develop in a robust and credible way that delivers value to our region. In particular, an offset market could support sustainable farming, to which our region makes a vital contribution, and help reverse the loss of our region's biodiversity. We have already begun engaging with local farmers to help support innovative soil management schemes that avoid and reduce carbon.

At the heart of the concept of a regional carbon offsetting market is the recognition that biodiversity varies considerably at a local level, and offsetting solutions must be appropriate to local needs and work for both buyers and sellers of offsets. The key purpose of a regional offsetting market is to create the right conditions and incentivise local landowners to adopt and augment sustainable farming practices. Implementing sustainable practices will improve air and water quality and wildlife habitats, enhance the rural landscape and its heritage, mitigate flood risk, use resources more efficiently and reduce waste to combat climate change.

Our strategic intent

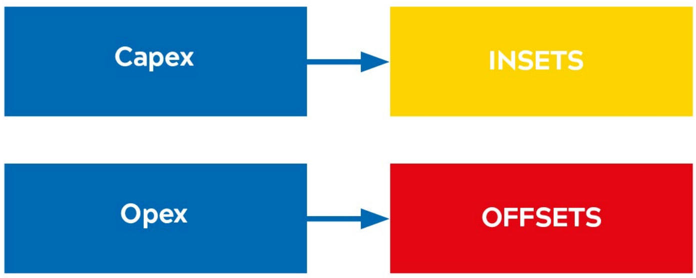
Our ambition is to maximise opportunities to remove carbon in our own land (insets) and adopt a leading position in offsetting by supporting new markets across our region that bring maximum co-benefits (offsets), such as those listed above.

Our offsetting approach is aligned with the Oxford offsetting principles, which seek to prioritise removals offsets over time (as opposed to avoided emissions from third parties). Our approach acknowledges the uncertainty which currently exists around certain types of offsets. We expect that the types, quality and market factors relating to offsets will have evolved significantly by 2030, and further still by 2050.

Our removals hierarchy prioritises the delivery of removal benefits in our own landholdings, followed by supporting credible offset schemes in our region where the offsets are verifiable to best practices and belong to a credible registry. The next step in our hierarchy is to offset elsewhere in the UK. Only as a last resort will we offset internationally.

We are also currently focusing our efforts to better understand the science behind emerging removals schemes relevant to soil management, grassland restoration, wetlands, seagrass and others. These solutions, in addition to afforestation/reforestation practices, are aligned with current industry best practices (e.g Achieving net zero. A review of the evidence behind potential carbon offsetting approaches, Environment Agency, April 2021).

Capex/opex impact



Our regional offsetting will include working with local landowners to improve soil quality

Risks and uncertainties

The main risks and uncertainties which we need to monitor closely and manage by 2030 and beyond include:

- Continuous development in the science around emerging carbon removal schemes such as grassland restoration, seagrass, blue carbon and others;
- The limited size of voluntary offset markets in the UK, aside from the Woodland and Peatland Carbon Codes;
- A lack of clear policy and guidance for certification and credible removals schemes outside our own land, beyond existing voluntary standards (such as the Golden Standard, Verra, etc, which are mainly internationally focused);
- Increasing demand for offsets, which is very likely to push prices up in the future.

Our target actions for a flexible strategy by 2025 and beyond

We will:

- Implement forestry schemes on 50 hectares of our own land (insets), following best practices on biodiversity and the Woodland Carbon Code practices. Although this will give us approximately 10,000tCO_2/y of carbon removal benefit by 2030, trees increase their removal potential over time, so we want to begin this process early. A stretch target by 2025 would involve forestry schemes on 100ha of our own land, which has the potential to remove over 20,000tCO_2/y by 2030;
- Improve our scientific knowledge on potential removal opportunities such as from grassland and seagrass restoration, by engaging with key stakeholders and assessing the removal potential over time;
- Set up a framework on offsets to engage the best suppliers in the market to help us make the right choices on our investment decisions for insets and offsets;
- Strengthen our relationships with key landowners and entrepreneurial farmers in our region to support the development of soil management schemes that avoid and remove carbon emissions. We have already identified a number of schemes that have the potential to remove 25,000tCO_2e/y by 2022 and are currently engaging with the project developer to assess the credibility of the scheme (currently audited to ISO 14064-2) and the offset credits registry. Through our support for such schemes we are keen to influence voluntary standards for offsets in the UK, such as the development of the new Soil Carbon Code;
- Engage with other project developers to better understand the details of additional due diligence required for implementing credible offsetting schemes in new markets;
- Continue to assess carbon removal co-benefits of all nature-based solutions we are planning to develop in AMP7 (2020-2025) and beyond - especially through our work on catchment management and biodiversity net gain;
- Take an active role through Water UK to continue the engagement with the Environment Agency and Defra to influence the direction of offsets markets in the UK and best practices in land management as much as possible.

Planning for post-2030

By 2030, we know that we will have residual emissions (especially process emissions, which we are still working to fully understand). We also know that we will have to reduce our reliance on offsets post 2030 and prepare to maintain our net zero status beyond that date in a changing climate, market, policy and economic landscape.

> **"It is essential that we plan early for the transformation that will be required in our business."**

We have already been exploring various innovations to see how best to implement them and promote further carbon reductions across our asset base, especially around:

- reducing our process and fugitive emissions through anaerobic water recycling treatment with nutrient recovery and recycling in our region;
- understanding the best future carbon reduction benefit if future incentives around biogas and biomethane change and/or in response to potential loss of our treated sludge land bank, through innovative sludge treatment technologies such as pyrolysis and gasification;
- building on our current work on digital twins and implementing artificial intelligence to promote further demand (water and energy) reductions and better co-optimise our water and water recycling networks, together with our renewable energy generation, our future electrified fleet, standby generation fuels, energy and water storage, as well as understanding the best ways of having more dispatchable energy;
- becoming an active hydrogen producer through the use of ammonia, through electrolysis or from our biogas assets, as well as understanding the benefit of technology swaps in our water recycling operations to use pure oxygen from hydrogen production to help reduce our reliance on electricity and costs for aeration, and exploring the use of hydrogen in our HGVs and other fleet, among others;
- building on our activity around implementing nature-based solutions by 2030, understanding the potential of more accelerated adoption in our asset base, and better quantifying co-benefits such as carbon sequestration.

To prepare our business for a post-2030 net zero operating environment, we therefore commit to the following by 2030. We will:

- Align all our current innovation activities into the different decarbonisation interventions, with a roadmap for implementation and action at specific trigger points in time. We will focus in particular on those innovations that will allow us to further reduce our residual emissions going forward;
- Identify gaps and collaborate with the rest of the water industry to understand other innovations that are required to address key knowledge gaps; both those we currently have and those we will have in the next five to ten years;
- Assess our asset replacement cycles in AMP8 (2025-2030) and beyond, and identify opportunities to implement our current innovations that will be ready for commercialisation in the future. This will give us a better understanding of when to act;
- Prepare a hydrogen roadmap for our business and engage with key hydrogen stakeholders in our region;
- Take an active role on wider hydrogen policy discussions in the UK with our regulators, government, water sector bodies, Energy UK, supply chain and key energy players in the market;
- Test our net zero decarbonisation interventions and scenario planning against future climate projections in our region with a view to integrating them with our climate resilience plans;
- Continue to collaborate with other asset owners in our region to better understand the potential of connected digital twins in our region to facilitate the inter-operability of our assets with the wider system, building on our work with the Centre for Digital Built Britain on connected digital twins;
- Maintain an active role in supporting the creation of local/regional offset markets, influencing policy and markets in this space, in particular for natural sequestration solutions that have greater readiness levels (such as soil sequestration), but also in areas including seagrass and grassland;

- Engage with our supply chain and our peers to drive the agenda on capital carbon reduction post 2030 and set targets that are aligned with science. By 2022, we commit to have a capital carbon roadmap and extend targets to 2050 that are aligned with our approach to net zero operational emissions;
- Maintain our active role with the Green Construction Board and continue to lead the decarbonisation agenda in construction and infrastructure;
- Maintain our active role with water sector bodies and our leading position on engaging with our regulators, government and other stakeholders to closely monitor and influence changes in policy levers.

30th anniversary 2017 bcia
in association with mabey enabling global infrastructure
british construction industry awards WINNER
CARBON REDUCTION PROJECT OF THE YEAR AWARD

Through innovation and engagement with our supply chain, the award-winning Grafham Resilience Reservoir was delivered with a 62 per cent reduction in capital carbon and a 53 percent reduction against the cost of a traditional solution - exactly the approach needed to achieve our 2030 ambitions

Chapter 5: Summary of our actions to 2030 and beyond

2021 to 2025

- **Renewable energy:** Continue to deliver our three portfolios of private wire PPAs
- **Energy efficiency:** Deliver our current programme to deliver 26GWh/y reduction in power demand
- **Green procurement:** Gradually procure more REGO-backed green power to cover up to 50 per cent of our power demand
- **Transport:** Switch 25 per cent of our small diesel fleet to electric and 10 per cent of our HGVs from diesel to liquified natural gas (LNG)
- **Alternative fuels:** Switch up to 30 per cent of our gas oil demand with hydrotreated vegetable oil (HVO)
- **Residual emissions:** Implement 50 hectares of forestry schemes on our own land
- **Process emissions:** Continue to work with sector stakeholders to improve understanding of N_2O emissions and trial alternative treatment processes (e.g. membrane aerated biofilm reactor (MABR))
- **Biogas:** Engage with Defra (the Department for the Environment, Food and Rural Affairs) to highlight the importance of maintaining biosolids to land disposal route and its role to net zero
- **Energy efficiency:** Engage with regulators using a quantified evidence base to influence future policies that align to net zero, including on nature-based solutions.
- **Alternative fuels:** Engage with Government and other stakeholders to inform our future biomethane strategy and our role in a future hydrogen economy

Key

- Implementing decarbonisation intervention
- Engagement activity
- Strategic planning/adaptation activity

2021 to 2023

- **Process emissions:** Install monitoring at four large sites
- **Green procurement:** Gradually procure more REGO-backed green power
- **Renewable energy:** Engage with local authorities to understand planning constraints
- **Biogas:** Engage with BEIS and other stakeholders to highlight the value of green gas incentives and other barriers to gas to grid injection
- **Residual emissions:** Engage regional stakeholders to promote and support credible reduction/removal offsetting projects
- **All:** Secure innovation funding to pilot and develop low carbon technologies/approaches, especially on widescale monitoring of process emissions
- **Renewable Energy:** Continue to identify additional opportunities for AMP8
- **Energy efficiency:** Complete evidence base of near-live operational response at catchment scale
- **Alternative fuels:** Complete our investigation studies and develop hydrogen strategy
- **Capital carbon:** Develop a capital carbon reduction routemap beyond 2030

2023 to 2025

- **Process emissions:** Establish new N_2O emissions factor following monitoring and develop business cases for mitigation options
- **Transport**: Monitor development and costs of hydrogen for large vans and HGVs
- **Residual emissions:** Evolve offsetting strategy
- **Biogas:** Test market for alternatives to biomethane to align with available incentives
- **Alternative fuels:** Engage suppliers to explore low carbon heat for sludge treatment

2021 → 2022 → 2023 → 2024 → 2025

Chapter 5: Summary of our actions to 2030 and beyond

Key

- ♦ (green) Implementing decarbonisation intervention
- ♦ (orange) Engagement activity
- ♦ (black) Strategic planning/adaptation activity

2026 to 2030

- ♦ (green) **Renewable energy:** Deliver an additional 100GWh/y of renewable energy
- ♦ (green) **Energy efficiency:** Deliver our current programme to deliver 58GWh/y reduction in power demand
- ♦ (green) **Green procurement:** Procure up to 100 per cent green electricity
- ♦ (green) **Biogas:** Shift over 50 per cent of our combined heat and power (CHP) capacity to biomethane production
- ♦ (green) **Transport:** Switch 90 per cent of our small diesel fleet to electric and 55 per cent of our HGVs to LNG
- ♦ (green) **Alternative fuels:** Switch 100 per cent of our gas oil demand with HVO
- ♦ (orange) **Process emissions:** Implement selective process technologies on sites requiring capital investment and continue to work with sector stakeholders to implement interventions
- ♦ (orange) **Biogas:** Engage with Defra (the Department for the Environment, Food and Rural Affairs) and other stakeholders to highlight the importance of maintaining the biosolids to land disposal route to deliver net zero
- ♦ (orange) **Energy efficiency:** Engage with the Environment Agency to provide an evidence base to support consents and policies that align to net zero

2026 to 2028

- ♦ (green) **Process emissions:** Continue roll out of energy storage
- ♦ (green) **Energy efficiency:** Implement rollout of near-live operational trial at catchment scale
- ♦ (green) **Biogas:** Switch first sites from CHP to biomethane production
- ♦ (orange) **Biogas:** Continue to engage with the market to identify best value outlets for biogas
- ♦ (orange) **Residual emissions:** Establish a leading offsets supplier framework
- ♦ (black) **Renewable energy:** Continue to develop private wire opportunities and maximise sleeving opportunities
- ♦ (black) **All:** Continue to develop digital capability to support the system level net zero solutions

2028 to 2030

- ♦ (black) **Biogas:** Assess hydrogen opportunities as part of biogas strategy
- ♦ (black) **Process emissions:** Develop a post-2030 implementation plan for alternative processes technologies

2026

Actions to inform our net zero position beyond 2030 to reduce our reliance on offsets:

- ♦ (black) Identify technology swaps to reduce process emissions and how they can be implemented to align with asset replacement lifecycles

2027

- ♦ (black) Prepare a hydrogen roadmap for our business and engage with key stakeholders
- ♦ (black) Continue to develop digital capabilities and implementation, working with external stakeholders to maximise the potential of digital twins

2028

- ♦ (orange) Continue to engage and support stakeholders to develop local offset markets
- ♦ (orange) Continue to collaborate with the rest of the industry to understand other innovations that are required to address key knowledge gaps
- ♦ (orange) Maintain an active role with water sector bodies to influence policy

2029

2030

- ♦ (orange) Continue to engage our supply chain to drive best practice on managing whole life carbon beyond 2030
- ♦ (orange) Continue to engage externally to develop a systems-level decarbonisation plan, including a strategy to export waste heat and other low carbon resources

Glossary

	Meaning
AMP - Asset Management Plan	A period linked to the regular price reviews used by Ofwat to manage investment in maintaining and improving performance. AMP periods are followed by numbers and refer to a five-year period. The current AMP is AMP7 and runs from 2020/21 to 2024/25
ASP	Activated Sludge Plant
Asset replacement cycles	Time period after which an asset or group of assets require replacement
Baseline emissions	Our baseline emissions are calculated based on our 2018/19 activities. A correction has been made to the original reported value to account for an update in how process emissions are estimated, this is explained in more detail in the strategy
Biogas	Gaseous fuel, especially methane, produced through our sludge treatment activities
Biomethane	Upgraded biogas where carbon dioxide and other gasses are removed to increase methane content
Capital carbon	GHG emissions associated with the creation, refurbishment and end of life treatment of an asset
CAW - Carbon Accounting Workbook	A spreadsheet tool used by the UK water sector to estimate and report their annual operational carbon emissions
CHP engines	Combined heat and power engines, powered by either biogas or natural gas
COP26	The 26th UN Climate Change Conference of the Parties (COP26), where parties will congregate to accelerate actions on climate change mitigation. COP26 is due to be held in Glasgow in November 2021
Defra	Department for Environment, Food and Rural Affairs
Digital twin	A digital replica or a representation of physical assets and/or system that can be examined, altered and tested without interacting with it in the real world and avoiding negative consequences
DO	Dissolved oxygen
EF - Emission factor	A coefficient which allows activity data to be converted into greenhouse gas emissions
GGSS - Green Gas Support Scheme	A government scheme which seeks to increase the proportion of green gas in the grid, through support for biomethane injection by the process of anaerobic digestion
GHG	Greenhouse gas emissions - Gaseous constituents of the atmosphere, both natural and anthropogenic, that absorb and emit radiation at specific wavelengths within the spectrum of infrared radiation emitted by the Earth’s surface, the atmosphere, and clouds
HGV - Heavy Goods Vehicle	A vehicle over 7.5 tonnes and requiring a heavy goods vehicle licence to operate

	Meaning
HPG - Heating, pasteurisation, hydrolysis	A unique advanced digestion process that pre-conditions indigenous and imported thickened sludge before anaerobic digestion to produce biogas and biosolids
HVO - Hydrotreated vegetable oils	A renewable alternative to diesel made from a mix of vegetable oils and waste such as used cooking oil which can be used as a direct replacement for diesel produced from fossil fuels
Insets	Units of greenhouse gas reduced/avoided or removed when an organisation invests in relevant projects and practices within its own organisational boundary and/or supply chain
Location-based reporting	Reporting of emissions utilising a location specific grid-carbon intensity, usually a national grid average carbon intensity, to report the carbon impact of grid power consumption
Market-based reporting	Reporting of emissions utilising a supplier specific carbon intensity based on their residual fuel mix to report the carbon impact of grid power consumption
MABR - Membrane Aerated Biofilm Reactor	An alternative secondary treatment process for wastewater
Natural sequestration	The process through which natural organisms, such as trees, absorb and store carbon from the atmosphere
Nature-based solutions	Interventions that utilise the inherent properties of natural systems to deliver outcomes, these can either replace or be complementary to typical engineered solutions
Net zero emissions	Achieved when anthropogenic emissions of greenhouse gases to the atmosphere are balanced by anthropogenic removals over a specified period. Where multiple greenhouse gases are involved, the quantification of net zero emissions depends on the climate metric chosen to compare emissions of different gases (such as global warming potential, global temperature change potential, and others, as well as the chosen time horizon). See strategy document for Anglian Water definition of net zero and its scope and boundary
Offsetting	Permanently removing greenhouse gas emissions from the atmosphere, usually through natural sequestration methods (reduction/avoidance/removal of emissions), or through trading carbon credit offsets from verified reduction/removal schemes to neutralise any residual emissions
Offsets	Credits (normally called carbon credit offsets) that an organisation can purchase or sell that reflect emissions being reduced/avoided or removed from a specific project outside the organisation's boundary
Ofwat	The Water Services Regulation Authority, or Ofwat, is the body responsible for economic regulation of the privatised water and sewerage industry in England and Wales
Operational carbon	The GHG emissions associated with the operation of infrastructure required to enable it to operate and deliver its service
Paris Agreement	The Paris Agreement is a legally binding international treaty on climate change. It was adopted by 196 Parties at COP 21 in Paris, on 12 December 2015 and entered into force on 4 November 2016. Its goal is to limit global warming to well below 2, preferably to 1.5 degrees Celsius, compared to pre-industrial levels

	Meaning
Performance Commitment	Commitments made to Ofwat to deliver specified levels of performance relating to different service outcomes for customers
PPA - Power Purchase Agreements	A contract between two parties, one which generates electricity (the seller) and one which is looking to purchase electricity (the buyer)
Process emissions	Emissions, either direct or fugitive, arising from our water recycling, sludge and water treatment activities
REGO - Renewable Energy Guarantees of Origin	Scheme providing transparency to consumers about the proportion of electricity that suppliers source from renewable generation
Residual emissions	The GHG emissions remaining once all reduction activities have been applied
RHI - Renewable Heat Incentive	A government scheme which incentivises homeowners and businesses to adopt renewable heat technologies
RTFO - Renewable Transport Fuel Obligation	An obligation placed on suppliers of transport fuels to demonstrate that a proportion of the fuel they supply comes from renewable sources
Sleeving	Renewable power taken directly from a renewable energy project and supplied (sleeved) to the buyer
SuDS - Sustainable drainage systems	Water management systems which aim to align modern drainage systems with natural water processes
UKWIR - UK Water Industry Research	Organisation responsible for facilitating the shaping of the water industry's research agenda, developing the research programme, procuring and managing the research and disseminating the findings
Waste heat	Heat produced as a by-product of a system which has the potential to be beneficially reused
WRMP - Water Resources Management Plan	Five-yearly plans produced by all water companies to forecast supply and demand and set out how they will provide secure supplies of water to homes and businesses

Appendix 1: Market versus location-based reporting

Difference between market and location-based reporting

Reporting on a location basis versus market-based reporting has an impact on how we report the electricity we purchase and export to the grid. Under location-based reporting, all emissions are reported based on a grid average carbon intensity factor, whereas for market-based reporting, a supplier-specific carbon intensity factor is used based on the supplier's residual fuel mix.

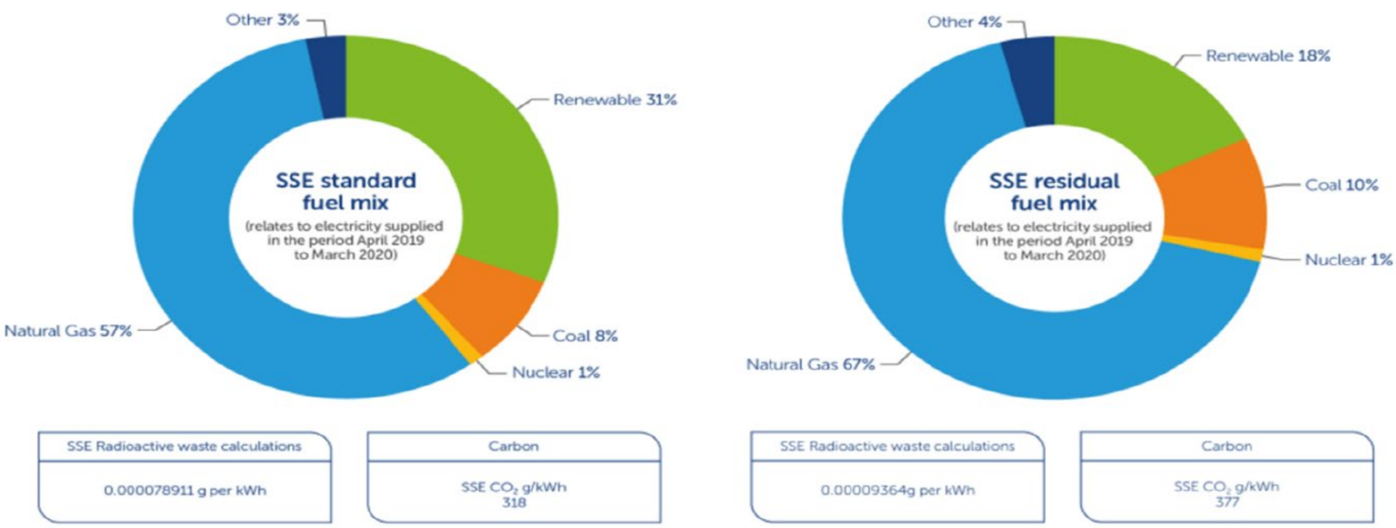
Location-based reporting also allows the claiming of carbon benefit for all generated and exported renewable power. By contrast, market-based reporting relies on Renewable Energy Guarantees Origin (REGO) certificates to validate whether the power we purchase or generate can be certified as renewable and therefore whether we can claim a carbon benefit from it. REGOs also provide a market mechanism to buy and sell these certificates and the carbon benefit associated with them. We then have the choice to purchase more REGOs to cover our power demand or sell the REGOs we gain through our renewable generation for a commercial gain. If we sell the REGOs associated with our renewable generation, we cannot then claim the carbon benefit from them under market-based reporting, as this would lead to double counting of benefits.

What is a residual fuel mix carbon intensity emissions factor?

A fuel mix is the proportion of different energy sources our specific supplier relies on to generate its overall quantity of power; this generates an average carbon intensity for that supply per kWh.

The residual fuel mix takes into account the proportion of the overall fuel mix that is supplied as a REGO-backed green tariff and removes this from the overall fuel mix. Figure A1.1 shows the difference between our supplier's standard and residual fuel mix. This indicates that as a larger proportion of renewable generation is removed to be allocated to its green tariff, the carbon intensity of our market-based grid EF is increased, therefore increasing our overall emissions.

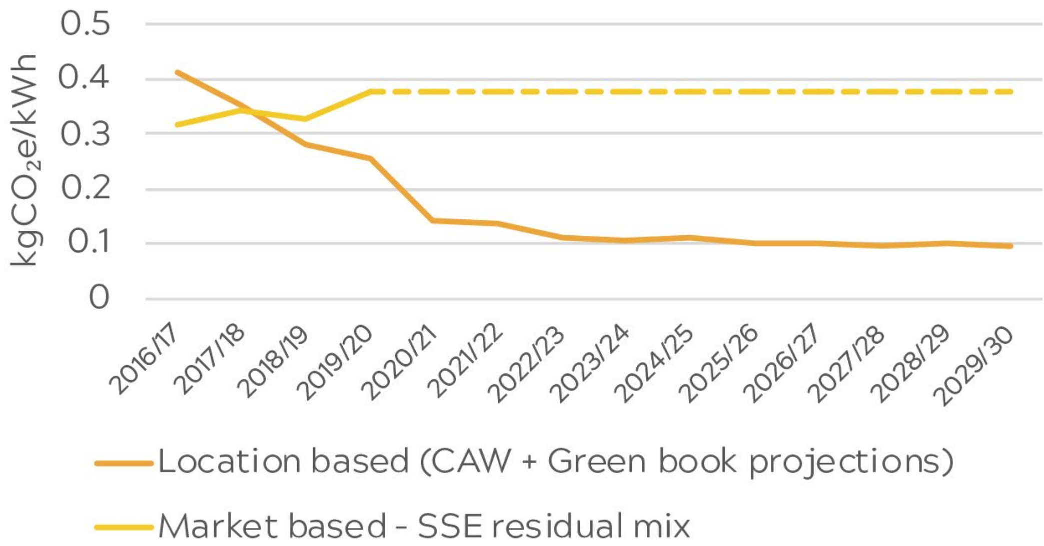
Figure A1.1: Difference between our market-based standard and residual fuel mix



The trend over the past four years for which we have data is that the residual fuel mix carbon intensity is increasing as more and more REGO-backed renewables are allocated to our supplier's green energy tariff.

Figure A1.2 shows how our supplier-specific residual fuel mix has compared to location-based grid average carbon intensity, with future supplier-specific residual emissions assumed to be constant past the latest reported year.

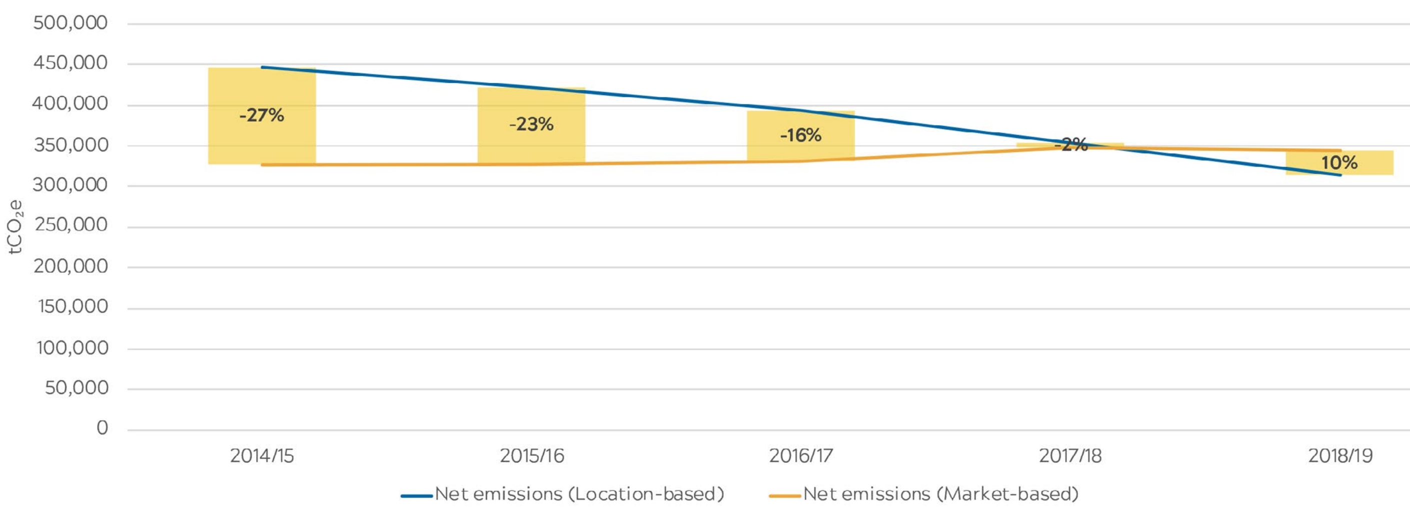
Figure A1.2: Historic comparison



How do our historic emissions compare under location and market-based reporting?

Figure A1.3 shows how our historic emissions differ under market and location-based reporting. It shows that over the past six years there has been a shift from our emissions under location-based reporting being 27 per cent higher than our market-based in 2014/15, to being 10 per cent lower in 2018/19[3]. This trend looks set to continue, with grid average carbon intensity being forecast to reduce by 30 per cent between 2020 and 2030, based on BEIS green book[4] projections.

Figure A1.3: Historic comparison of our net emissions between location and market-based reporting



How does our 2018/19 baseline compare under location and market-based reporting?

Figure A4 shows the difference between our location-based and market-based 2018/19 baseline. The total impact is an increase of just under 30,000tCO_2e (nine per cent). This is due to the difference in the location-based grid emissions factor of 283gCO_2e/kWh and our market-based grid emissions factor of 328gCO_2e/kWh. The difference in the grid emissions factors:

- increases our scope 2 emissions by 28,700tCO_2e;
- increases our scope 3 T&D emissions by 2,450tCO_2e;
- increases the carbon value of our exports by 1,300tCO_2e.

Figure A1.4: Difference between our location-based and market-based 2018/19 baseline

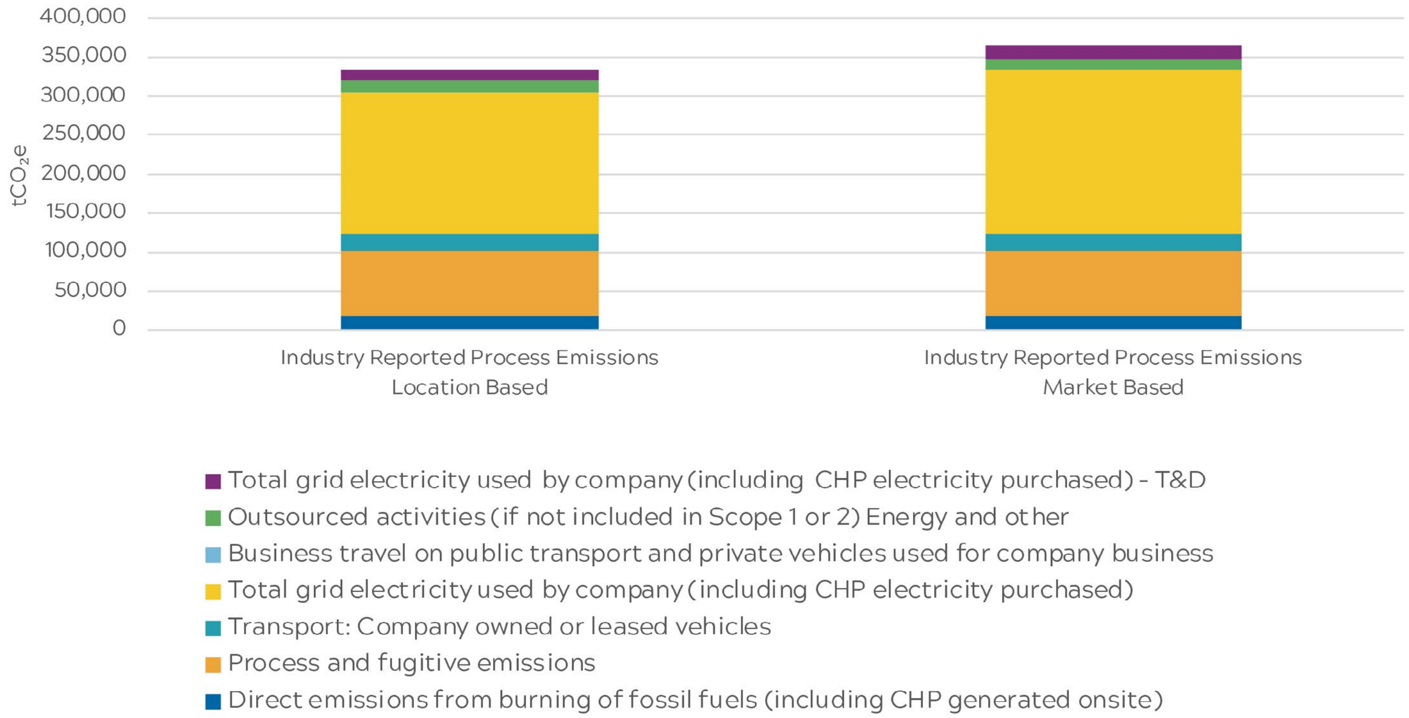


Figure A1.5: Our historic emissions under location-based reporting

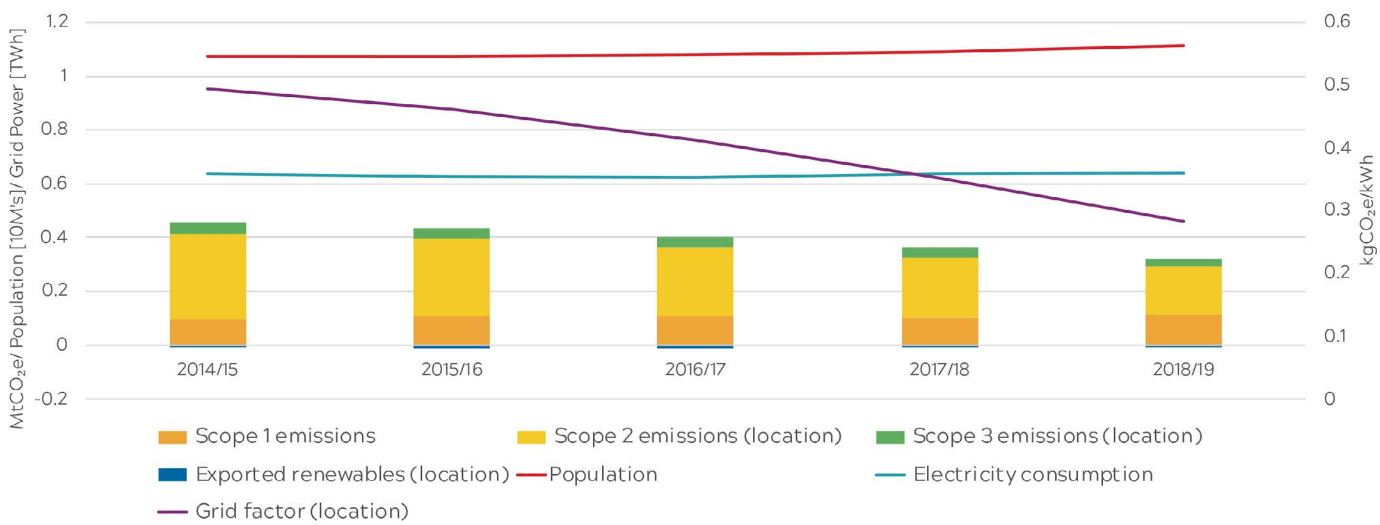
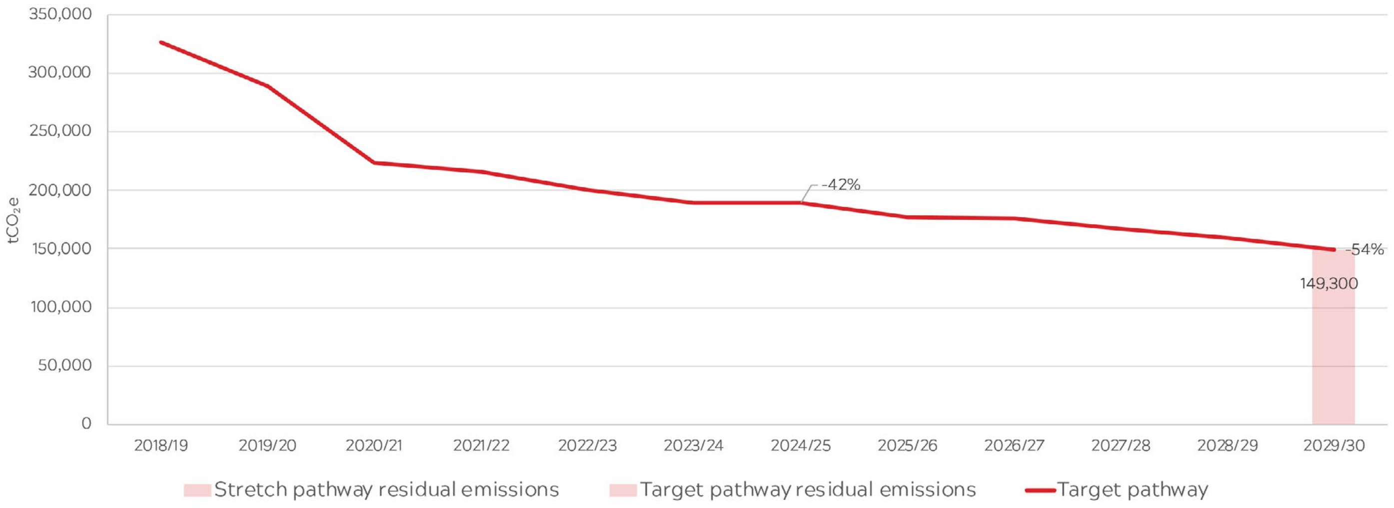


Figure A1.5 shows our historic emission under location-based reporting and highlights how our Scope 2 emissions reduce substantially compared to our market-based reporting historic emissions shown in Figure 4 in the strategy.

How does our target net zero pathway compare under location and market-based reporting?

Figure A1.6: Our target trajectory under location-based reporting



Under location-based reporting our target pathway achieves a 42 per cent reduction in emissions and a 54 per cent reduction by 2030. When compared to our market-based trajectory, it highlights that through location-based reporting our emissions initially reduce faster than under market-based reporting, achieving eight per cent more reductions by 2025. However, when we start to use our procurement mechanisms to choose lower carbon suppliers and more REGO-backed green tariffs post-2025, our market-based reported emissions achieve a greater reduction by 2030.

Figure A1.7: Our stretch target trajectory under location-based reporting

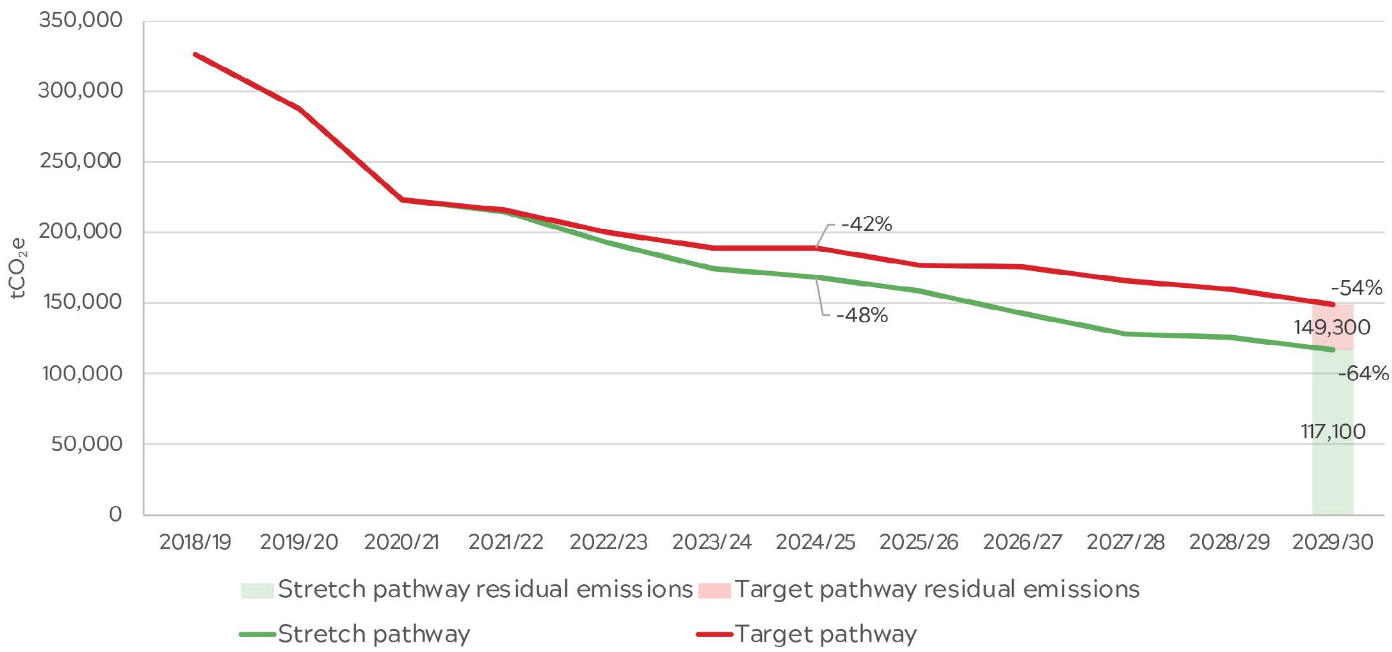


Figure A1.8: Location-based target pathway - emission clusters

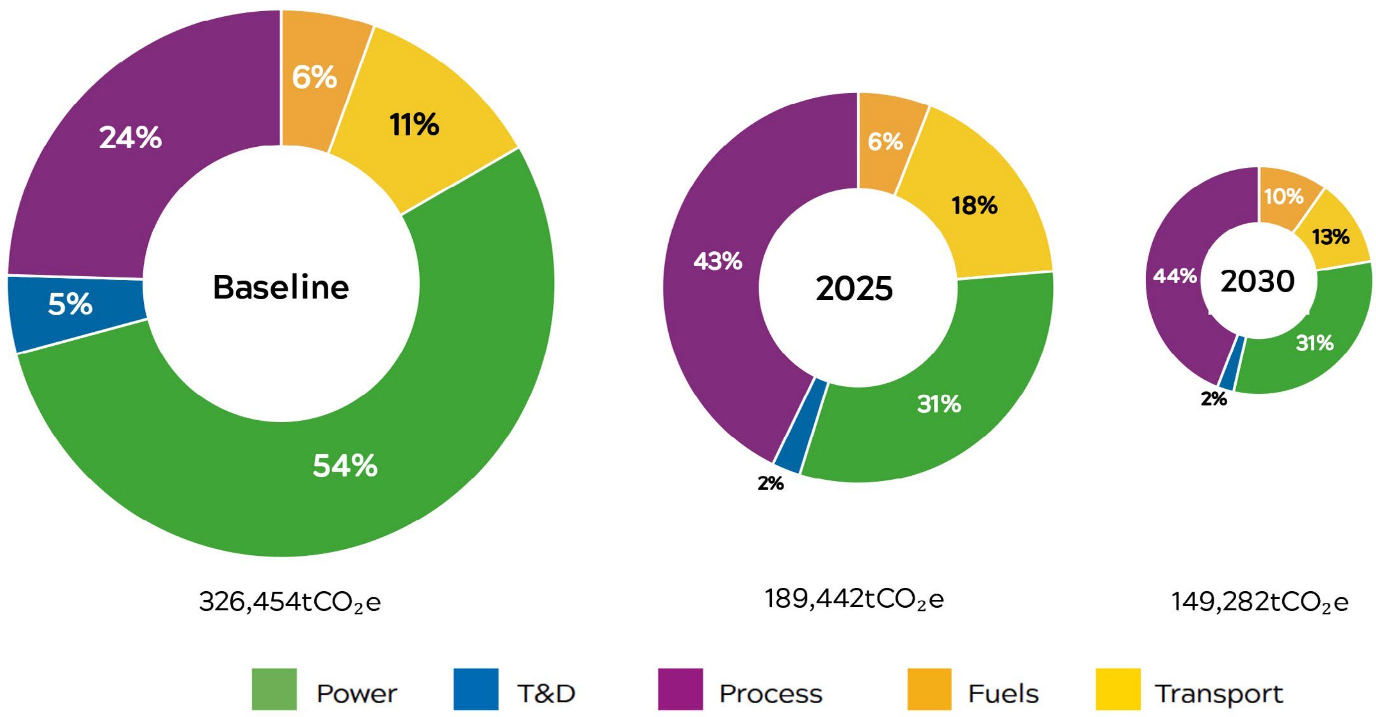


Table A1.1: Target pathway location-based vs market-based emissions

Decarbonisation Cluster	Baseline (tCO_2e)		2024/25 (tCO_2e)		2029/30 (tCO_2e)	
	Location-based	Market-based	Location-based	Market-based	Location-based	Market-based
Fuels	18,554	18,554	11,611	11,611	18,620	18,620
Transport	37,438	37,438	34,282	34,282	23,362	23,362
Power	181,077	209,818	60,456	98,126	58,995	0
T&D	15,436	17,886	4,537	6,737	4,428	18,338
Energy exports	- 8,151	- 9,444	- 4,454	- 21,376	- 39,132	- 52,422
Process emissions	82,100	82,100	83,009	83,009	83,009	83,009
Net emissions	326,454	356,351	189,442	222,389	149,282	90,908
Gross emissions	334,604	365,796	193,896	243,766	188,414	143,330

Appendix 2: Process and fugitive emissions. Our actions to better understand and reduce these emissions by 2030 and beyond

Background

As outlined in our net zero strategy, the methane (CH_4) and nitrous oxide (N_2O) emissions from our water recycling and sludge treatment processes are the most uncertain in terms of magnitude, location and cost-effective abatement methods.

Process emissions, primarily nitrous oxide (N_2O) from secondary water recycling treatment, and methane (CH_4) from water recycling and sludge treatment and storage, account for 23 per cent of our baseline 2018/19 emissions and will become the largest component of our residual emissions by 2030 as other sources are reduced. These emissions are particularly difficult to tackle and are a big challenge for our sector.

They are also highly potent greenhouse gases with a global warming potential (GWP) of 298 for nitrous oxide and 25 for methane. The GWP is a measure of how much energy the emissions of 1 tonne of a gas will absorb over a given period of time, relative to the emissions of 1 tonne of carbon dioxide (CO_2). The larger the GWP, the more that a given gas warms the Earth compared to CO_2 over that time period.

An overview of the sources and emissions factors in use is illustrated in the following two figures, process emissions being a by-product of collection and treatment and fugitive emissions defined as unintended loses or leaks from the system:

Figure A2.1: Water recycling treatment process emissions factor overview (UKWIR 2020)

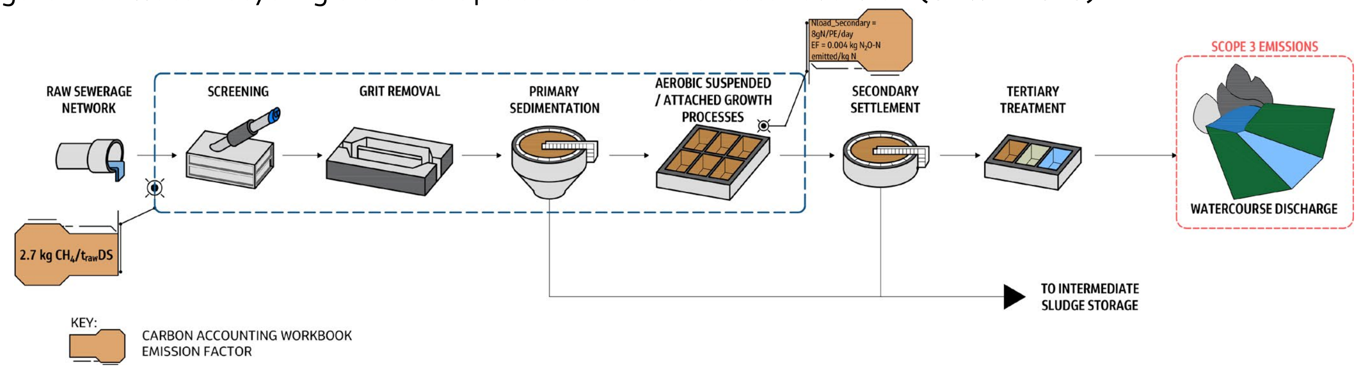
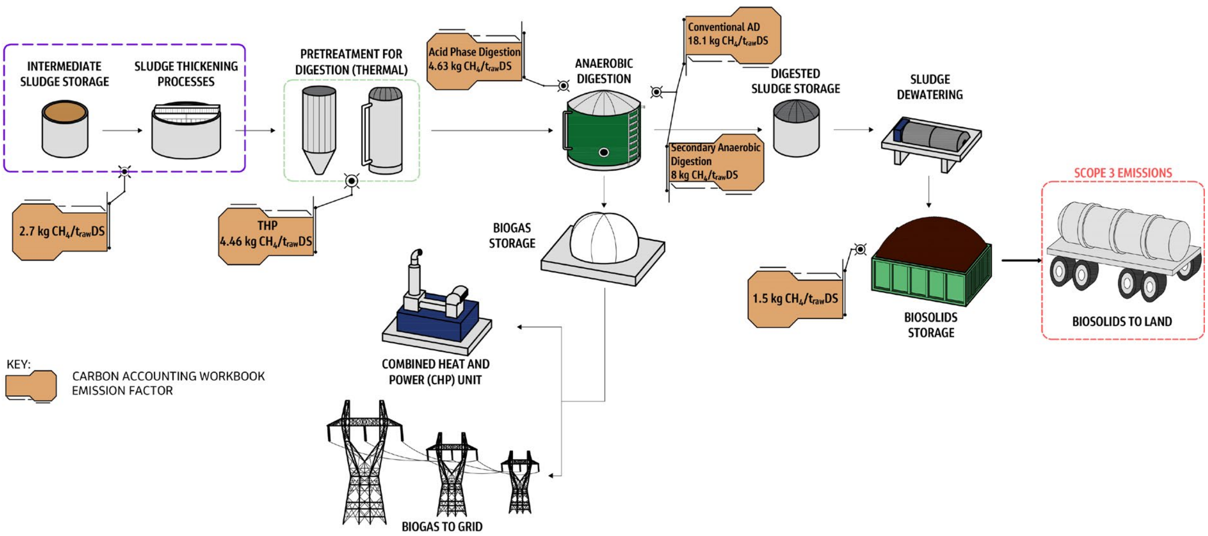


Figure A2.2: Sludge and biosolids process emissions factor overview (UKWIR 2020)



N_2O generation from water recycling treatment is highly variable and currently uncertain. In order to confirm the scale and variability in UK climate, operating conditions and asset base, further targeted monitoring needs to be completed to accurately understand their magnitude.

In 2018/2019, the Intergovernmental Panel on Climate Change (IPCC) went through a peer review of the science around N_2O production and emissions from monitoring from 29 full-scale treatment plants. The new, significantly higher, emission factor recommended by the 2019 IPCC Refinement is 0.016 kg N_2O-N/kg N, eight times higher than the original industry-wide emission factor, and four times higher than the current industry-wide emission factor, used in our baseline emissions.

The IPCC states: "Large uncertainties are associated with the IPCC default factors for N_2O", "N_2O is variable and can be significant" and "Although N_2O emissions vary by the type of nitrogen removal process used, more on-site exhaustive monitoring data are required to develop different N_2O emission factors for different treatment processes."

A study commissioned by UKWIR and delivered by Jacobs in 2020 further reviewed available data relevant to the UK and Irish water industry, including those reported in the IPCC refinement. The dataset is small in size, made up of only six studies, and would prove challenging to derive a robust emission factor from. This dataset has an average of 0.0082 kg N_2O-N/kg N and median of 0.0043 kg N_2O-N/kg N. The average is approximately twice the emission factor used in our baseline, but half that reported in the complete global IPCC dataset. This has not been adopted by the industry due to its limited nature and the wide range in the data, in favour of completing an extensive, robust monitoring programme to generate a new dataset and evidence base to produce an emission factor with less uncertainty and limitation.

An example of improving the approach in understanding and reporting emissions is the programme of work launched by the Danish Environmental Protection Agency to assist Danish utilities in collecting data on N_2O emissions from water recycling treatment[1]. In the period 2018-2020, the N_2O emission from nine different full-scale plants was monitored. The emissions data was used to calculate an overall average national emission factor of 0.0084 kg N_2O-N/kg N. This corresponds to about half of the N_2O emission factor published in the IPCC 2019 refinement.

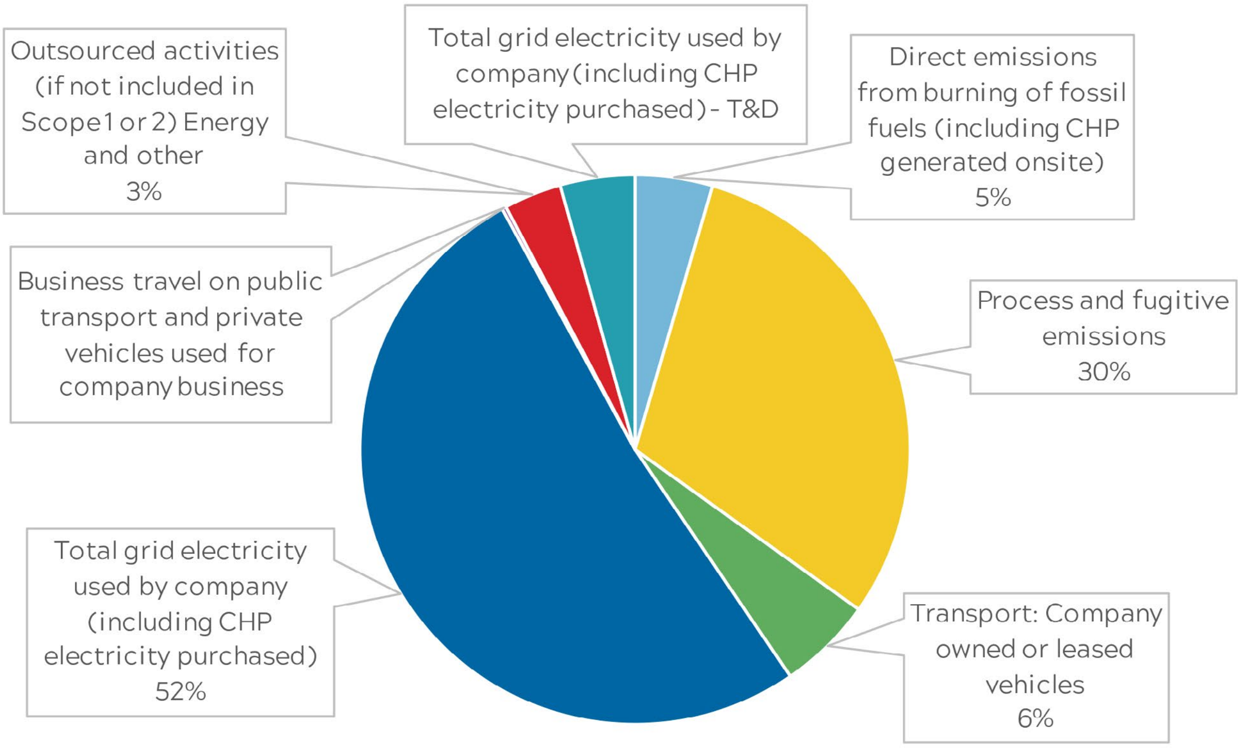
The UK industry is working with those involved with the research completed in Denmark to learn from their experience and methods and will share data to further improve our joint understanding around opportunities for mitigation of process emissions.

Figure A2.3 shows how our current understanding of the indicated scale of the N_2O emissions factor, following a review by UKWIR in 2020, affects our baseline emissions. Using the average value, it can be seen that the contribution of process emissions is greater (30 per cent) while the proportion of our purchased grid electricity emissions falls slightly to 52 per cent. Furthermore the 2019 refinement from the Intergovernmental Panel on Climate Change (IPCC) suggests the true range of these emissions may be higher still but is also highly uncertain.

Taking this evidence into account, we believe that our N_2O process emissions from water recycling treatment are likely to fall between the UKWIR 2020 average value included in Figure A2.3, and the IPCC 2019 refinement, adding between 41,000 and 118,000 tCO_2e/year to our residual emissions.

1 *Details of monitoring programme in Denmark https://www.unisense-environment.com/files/PDF/Environmental%20Protection%20Agency%20report%20on%20nitrous%20oxide%20emissions%20from%20Danish%20WWTPs.pdf*

Figure A2.3: Our baseline emissions in 2018/19 using a revised N_2O emission factor based on a recent review by UKWIR



The other main component of our process and fugitive emissions is methane (CH_4). Emissions of CH_4 from water recycling and sludge treatment, while also significant, have received less attention in studies than N_2O, with the focus being on monitoring methodologies. UK and Irish data are lacking for these emissions, so there is a need for improved understanding, baselining and mitigation of CH_4 emissions.

Currently, as shown in Figure A2.1 and A2.2, the industry utilises a number of composite emission factors. Global best practice recommends separation of emission factors for CH_4 from water recycling treatment and sludge treatment. While advanced digestion processes and new regulatory requirements such as the Industrial Emissions Directive are likely to further reduce fugitive emissions, those from sludge storage, thickening and digestate storage are likely to remain of significance for the industry. A better understanding of CH_4 process and fugitive emissions will be included alongside the N_2O measurement programme.

There are different interventions to reduce or avoid these emissions, ranging from the most expensive option of covering water recycling and sludge tanks (>£6,000/tCO_2e as per the Water UK Net Zero 2030 Routemap), to deploying alternative secondary treatment technologies that bring additional quality and resource efficiency co-benefits, as well as a number of operational interventions. Nevertheless, the exact magnitude of such emissions, especially N_2O, is currently uncertain, which makes it difficult for us, as well as the rest of the industry, to put together a sound business case to confidently justify investment options for more cost-effective intervention options to covering tanks.

We have been working hard with the rest of the industry to better understand the magnitude of nitrous oxide and methane emissions. This requires targeted mass monitoring across our water recycling and sludge treatment centres.

This Appendix outlines:

1. the main uncertainties in our understanding of process and fugitive emissions,
2. the potential impact of changes in such emissions to our net zero trajectory by 2030 and beyond, and
3. actions we have been taking and continue to take to manage those emissions by 2030 and beyond.

Current uncertainties from the magnitude of process emissions and the impact on our baseline and 2030 net zero trajectory

Together with our peers, we have seen a significant evolution in the N_2O emissions factor (EF) to the current water sector N_2O industry number.

Our understanding of the N_2O emissions factor has been improving, especially following the recent UKWIR research project[2] on conducting a literature review of process emissions and N_2O EFs from monitoring results in different facilities globally.

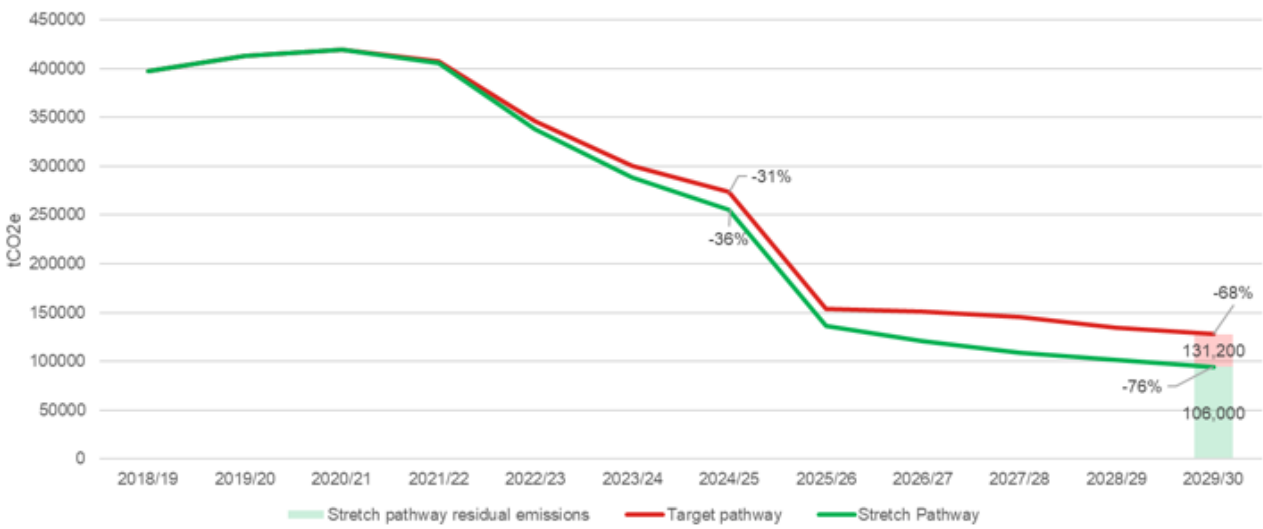
In the absence of any current mass monitoring for N_2O in our assets, the recent work by UKWIR[2] shows a current best industry estimate for the N_2O EF being 0.0082 (as compared to the current industry reported N_2O EF of 0.004 as in the CAW v15 and the Water UK sector Routemap). Nevertheless the magnitude of N_2O EF could be higher (such as the current IPCC base case of 0.016[3]).

Different values of N_2O EF affect our baseline and future 2030 trajectories. For example, our currently reported baseline emissions in 2018/19 of 356,350 tCO_2e (using a market-based reporting methodology and the industry reported N_2O EF, as shown in Chapter 3 of our strategy) would increase by over 10 per cent to 395,800 tCO_2e if we adopted an N_2O EF of 0.0082 and by more than 30 per cent to 474,500 tCO_2e if we adopted an N_2O EF to reflect the IPCC base case of 0.016.

As described in our strategy, such an increase would also mean that our residual emissions for our net zero target trajectory in 2030 could increase by up to 45 per cent (to 131,200 tCO_2e) if we used the UKWIR current estimate for an N_2O EF of 0.0082 (UKWIR - 2020).[2] This would also impact the level of our reductions in 2025, which could drop from our current 34 per cent estimate to approximately 29 per cent.

Figures A2.4 and A2.5 below illustrate how the rate of decarbonisation in our target pathway 2030 may be changing as our understanding of process emissions increases (currently illustrating the UKWIR N_2O emissions factor (Figure A2.4) and the IPCC N_2O emissions factor (Figure A2.5) - the graphs also show a different baseline position to reflect the different N_2O emissions factors). Both are using the market-based reporting methodology.

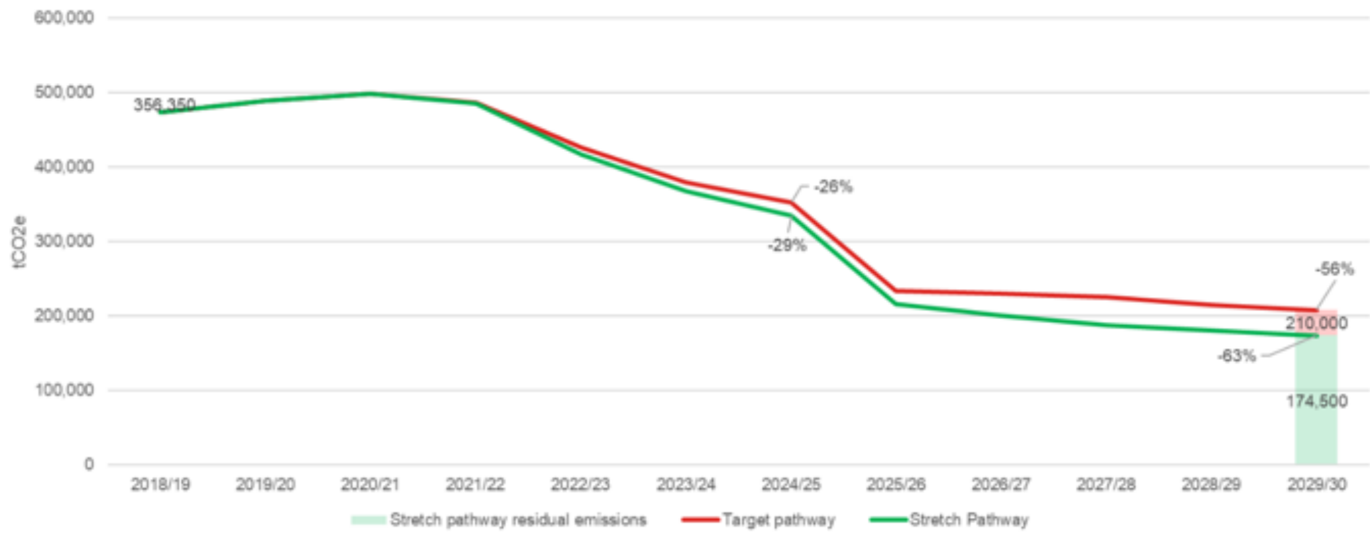
Figure A2.4: Illustration of our target 2030 pathway to net zero (market based) showing the change in residual emissions and 2025 position due to a change in the N_2O EF (N_2O EF - 0.0082)



2 UKWIR 2020 *Quantifying and reducing direct greenhouse gas emissions from waste and water treatment processes - https://ukwir.org/quantifying-and-reducing-direct-greenhouse-gas-emissions-from-waste-and-water-treatment-processes-1*

3 *IPCC 2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories refinement - https://www.ipcc-nggip.iges.or.jp/public/2019rf/pdf/5_Volume5/19R_V5_6_Ch06_Wastewater.pdf*

Figure A2.5: Illustration of our target 2030 pathway to net zero (market based) showing the change in residual emissions and 2025 position due to a change in the N_2O EF (IPCC N_2O EF - 0.016)



The above uncertainties in our understanding of the N_2O EF make it even more pressing to implement mass monitoring equipment in our largest water recycling facilities. Nevertheless if, through our earliest monitoring and from other studies, we find pragmatic ways to reduce N_2O, we should consider them. Such interventions many be quite different from our current optimisation efforts for energy and cost reduction - for example we may need to increase our dissolved oxygen levels in order to reduce N_2O emissions.

We have been working with the rest of the industry, through UKWIR and, more recently, through an application process to the Ofwat Innovation Fund, to implement such monitoring equipment.

The literature reviewed provides an updated dataset for UK and Irish specific processes (e.g. nitrifying ASPs and TFs as well as BNR processes) and could be used to derive an updated EF (0.0082), but further in-country research through extensive monitoring is preferable. We will continue to work with our peers in the sector and once a better, data-led, EF for N_2O is available for our assets in the next few years, we will re-baseline our emissions for 2018/19, aligning with new industry-wide guidance, as well as the impacts on our 2030 net zero trajectory. In the absence of better data for a UK-specific emissions factor for N_2O, as an industry we may consider adopting the IPCC EF.

Our current work for managing process and fugitive emissions by 2030 and beyond

Despite the high levels of uncertainties in the N_2O EF, as well as the location and magnitude of both N_2O direct and CH_4 process and fugitive emissions, we have not been standing still, and have already been investigating in great depth the potential interventions to help us avoid/reduce such emissions, over and above the expensive option of covering our tanks.

In assessing different interventions, we have adopted the following interventions hierarchy:

1. Targeted monitoring, operational changes and easy wins
2. Treatment technology swaps bringing additional co-benefits
3. Covering tanks and recovering gases as a last resort

- Monitoring emissions to help us characterise N_2O and fugitive emissions (CH_4) from water recycling treatment and sludge. During any monitoring regimes we are considering how to implement selective operational interventions to help us quantify the effectiveness and optimisation of any operational changes. Easy wins such as small tweaks to the operational regime of our processes, as well as targeted sealing of fugitive emissions in our sludge treatment processes, are included in this category;
- Gradual technology swaps that are aligned with the asset replacement cycles of our current water recycling and sludge treatment assets. The rates of replacement will have to be considered for both the 2030 and 2050 timescales and compare the cost versus the magnitude of reductions. Gradual treatment technology swaps have the potential to bring additional co-benefits instead of simply covering our existing tanks;
- Covering tanks and treating off-gas - which is the last resort, as it may not present the best value for money intervention for our customers.

Nitrous oxide emissions - N_2O

Targeted monitoring and operational interventions

We have been working closely with our peers and academic institutions, as well as our supply chain (in the UK as well as global suppliers) to better understand how to adopt a targeted and data-driven mass monitoring programme - for example implementing predictive tools and monitoring and using real-time data. We have over 1,100 water recycling assets in our region and will need to prioritise our monitoring efforts to reflect types of water recycling treatment processes as well as scale and operating conditions.

We have a better understanding on how to implement monitoring equipment in our Activated Sludge Plant (ASP) facilities and have already been learning lessons from our peers in Europe, especially Denmark, where N_2O monitoring and management has been taking place for some time now. The main aspects we need to be planning for are the duration of monitoring and finding the balance between cost-effective monitoring and optimisation and accuracy of reporting (especially for understanding the true scale of N_2O emissions in our assets).

In addition to our ASP and ABR facilities, we have active programmes of work with reputable research institutions, such as Cranfield University and other water companies to better understand N_2O emissions in fixed film processes, such as trickling filters. This will improve our understanding and help us plan monitor such processes more effectively. A PhD student at Cranfield University is looking at understanding how Scope 1 emissions can be reduced in the near future and ultimately eliminated by adopting flowsheets that can deliver operational carbon neutrality. The study will establish a basis to reduce emissions from existing infrastructure, using a combination approach of monitoring and adapting existing emission rate models. The research will be focused on trickling filters, which currently represent one of the biggest research gaps in emissions understanding and monitoring, due to lack of established methodology.

We have also been working with our peers to put together an application to the Ofwat Innovation Fund on implementing targeted mass monitoring. This major collaborative project will involve all water companies in England and Wales and will:

- Monitor nitrous oxide and methane emissions in the main water recycling and sludge treatment processes;
- Develop a UK-specific science base on process emission, including process-specific emissions factors and models to predict emissions from measured data;
- Mitigate and reduce emissions by changing our operational practices and developing scalable approaches.

Once we have a monitoring regime in place for N_2O we propose to implement a number of operational interventions, such as optimising dissolved oxygen (DO) levels in secondary treatment to see how N_2O generation can be minimised in aerobic and anoxic treatment zones and how the overall energy balance of the plant may change. Other operational interventions we have been considering include ammonia, nitrate and solids retentions controls.

Our current efforts for optimisation interventions have been focusing on our largest sites where almost 50 per cent of our load is treated in our top 20 sites - in particular, our major sludge treatment centres where sludge liquors that are being treated have very high ammonia loads, so are both potentially high point sources but also a priority for emissions reduction and potential for ammonia recovery.

Gradual technology swaps to reduce/avoid N_2O emissions bringing additional benefits

As part of our efforts to continuously find innovative treatment process technologies to help our energy efficiency and treatment quality efforts, we have been assessing a number of process technologies that also have the potential to reduce N_2O emissions.

For example, as part of our new flagship Cambridge Water Recycling facility, we have been assessing how we can optimise nitrification using a Membrane Aerated Biofilm Reactor (MABR) process. MABR has the potential to capture the N_2O and cost-effectively scrub it, which could result in a lower cost intervention than covering tanks.

Another process technology we have been assessing is anaerobic water recycling treatment. We have implemented a pilot of such technology, however it does not treat ammonia, and other solutions are needed for nutrient removal. There may be potential for managing CH_4 emissions if the dissolved methane is not captured.

We have also been assessing N_2O reduction potential in the sludge liquors from our Sludge Treatment facilities. We have been assessing the potential of reducing N_2O through alternative forms of treatment.

In addition to our large treatment centres, we have been reviewing the process emissions from natural treatment systems, such as wetlands, as well as tertiary treatment. Although these are smaller, we will continue to improve our understanding of these systems. Should they prove promising for reducing N_2O emissions, such systems have the potential to bring additional co-benefits in our asset base, such as CO_2 sequestration and avoidance of additional capital carbon, among others.

Finally, we have been working with our peers in the sector to complement our hydrogen strategy and bring co-benefits to our wider carbon reduction efforts, such as recovering ammonia from sludge liquors for the production of hydrogen. This is a continuously evolving area for us, and hydrogen will become more central to our net zero strategy post 2030.

For any technology swaps we have been assessing, we need to take a more strategic view of when such replacements/swaps could take place, balancing asset life, affordability, treatment co-benefits, resource recovery and whole life carbon reductions. The biggest challenge will be the capital cost for implementation and sources of funding. Nevertheless, considering asset replacement cycles to bring process emissions reductions co-benefits will be core in our strategy over time. This is one of the reasons why we have not forecast significant N_2O emissions reductions by 2030 in our target trajectory. This is a global industry challenge and an active area of research.

Process and fugitive emissions (methane) - CH_4

Fugitive methane (CH_4) emissions are gases that escape predominantly from the treatment and storage of sludge. However, CH_4 emissions in sewer networks and within treatment processes are likely to become more significant, and specific UK investigation of relevant EFs may be needed. There is significant variability in reported CH_4 emissions from water recycling treatment processes and there is no specific UK or Irish data.

Despite many current unknowns in our understanding of the magnitude of process and fugitive CH_4 emissions, we are in a better starting position than many others, due to our operating Advanced Anaerobic Digestion (AAD) processes. We have already been benefiting from avoided fugitive emissions and maximising capture and utilisation of biogas through our AAD facilities over the years.

For fugitive emissions reduction/avoidance, we are adopting the same interventions hierarchy as with N_2O.

We have been assessing fugitive emissions monitoring opportunities in our sludge storage and anaerobic digestion assets by utilising techniques such as remote sensing, currently being used in the oil and gas industry. This follows a similar approach to odour management to better understand the flux.

We are currently in the process of better understanding across our sludge sites, how changing our operational and sludge storage regimes may reduce our fugitive emissions. We have been targeting the easy wins, such as sealing leaks once identified, covering unnecessarily open sludge storage tanks and optimising our storage regimes, among others. We have been assessing additional opportunities across our sludge sites such as digester feedstock optimisation, digestate storage and gas storage practices, as well as dewatered sludge storage.

Increased biogas quantities and renewable energy generation have driven us, over the years, to optimise our sludge treatment operations. Nevertheless, there is more we can do and continue to implement by 2030 and beyond.

As part of our innovation strategy, we have also been exploring alternative sludge treatment processes, such as pyrolysis and gasification, which has been driven by the need to better understand what an alternative future may look like if we were to move away from recycling biosolids to land, and/or what a more effective energy balance may look like in a net zero UK operating environment in the future. Alternative sludge treatment processes also have the potential to reduce fugitive emissions.

We are members of a collaborative team, led by our peers in the UK water sector, for an Advanced Thermal Conversion process that has the potential to produce biochar. As part of this initiative we are trying to better understand the overall energy and carbon balance. We have also been working with others in the industry assessing hydrothermal carbonisation and are in advanced discussions with our supply chain on the costs of pyrolysis.

As with all technology swaps, we are working hard to understand the right balance of the technology effectiveness, current/future costs, carbon reduction potential and a changing regulatory environment, as well as the asset lives and replacement cycles of our existing sludge assets to help inform our technology swaps strategy by 2030 and beyond.

Conclusions

Process and fugitive emissions are the hardest emissions for us and our peers to understand and manage.

Although we have identified and have been working on a number of reduction interventions for N_2O and CH_4 emission reduction, we have not included any significant reductions in our target 2030 net zero pathway. This is mainly due to the fact that we are not currently able to fully understand our starting position, especially for N_2O emissions. Our current priority is to seek funding and install targeted monitoring equipment, understand the magnitude of such emissions, reach consensus in our sector and agree how/whether we need to re-baseline our starting position. We will do this while continuing to drive the agenda for developing sound business cases to invest in the right measures to reduce/avoid those emissions by 2030 and beyond.

We have been reviewing the process emissions from natural treatment systems, such as our flagship wetland at Ingoldisthorpe in Norfolk, as well as tertiary treatment

Appendix 3: Capital carbon reductions by 2030

Introduction

Capital carbon is a Scope 3 emission and therefore sits outside the reporting boundary for the net zero carbon strategy. However, we believe that reducing capital carbon is fundamental to delivering a low carbon future and we have therefore set targets for capital carbon reductions to 2030.

Anglian Water's use of the term capital carbon aligns with the definitions within HM Treasury's Infrastructure Carbon Review (2013), which refers to capital carbon as the emissions associated with the creation of an asset. This is measured from cradle to 'as built', in line with the UKWIR framework on whole life carbon reporting.

We first set and publicly stated capital carbon targets in 2010, with our first target being to halve capital carbon by 2015 from a 2010 baseline. Our targets have been updated every five years, in line with regulatory asset management period (AMP) cycles. The 2010 baseline has been retained, recognising the behaviours required around leadership and challenge. In 2015 we set our capital carbon reduction target at 60 per cent of our 2010 baseline by 2020, and in 2020 we achieved this target, delivering a 61 per cent reduction. In 2020 we set our 2025 capital carbon target as 65 per cent of our 2010 baseline. In 2020/21 capital carbon reductions were 61.2 per cent.

In 2016 Anglian Water became the first organisation in the world to be externally verified (though LRQA) to PAS2080 Carbon Management in Infrastructure. The carbon framework at the heart of the PAS2080 standard ensures that our approach is aligned with key stakeholders within the value chain, including product suppliers, constructors and designers, in demanding and enabling low carbon solutions.

The performance achieved in capital carbon reductions has been highlighted in our responses to CDP (formerly the Carbon Disclosure Project) and contributed to Anglian Water achieving an 'A' rating, the only UK water company to achieve such a rating and among only five per cent of companies worldwide. Our capital carbon targets and performance have also contributed to our Task Force for Climate Related Disclosures (TCFD). In addition, our capital carbon performance, targets and processes played a key role in Anglian Water launching a Sterling Green Bond in 2017, the first European utility to do so. We now have six Green Bonds in operation.

Process

For all our investments we generate an indicative design based upon the need identified. As part of this process, capital carbon figures are calculated for the design using over 1,300 carbon models - we 'build up' the asset using carbon models, each representing its constituent parts. This process generates a 2010 capital carbon baseline, using capital carbon information relevant to 2010, and a capital carbon number based on more recent information. Our most up- to- date capital carbon models are from 2016 and we will be updating the models later in 2021. The models contain a consistent data set sourced from the Inventory of Carbon and Energy, Civil Engineering Standard Method of Measurement (CESMM) workbook, Defra emission factors and direct data from a number of product and material suppliers.

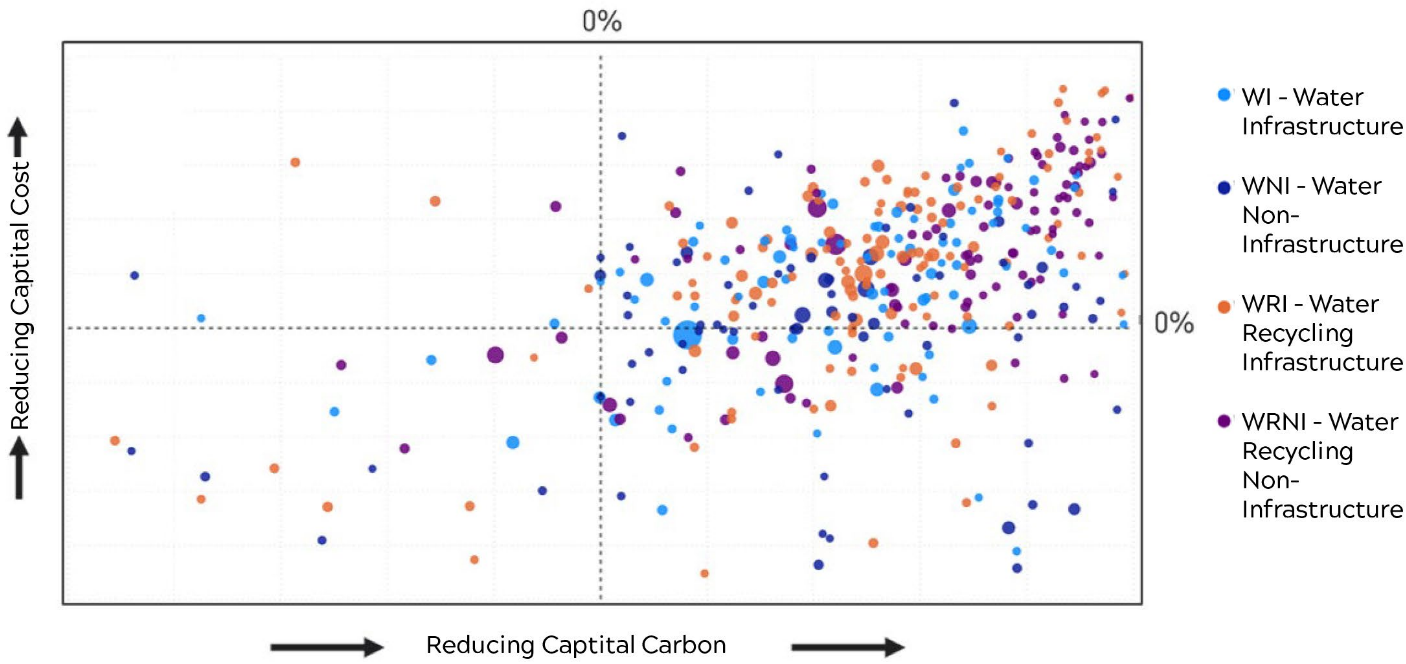
The use of carbon models allows us to be consistent with baselines, but also allows design teams to identify areas of high carbon and optioneer low carbon approaches. We use design gateways to review capital carbon performance and iterate designs such that capital carbon reduction opportunities are maximised.

Outcomes

As we have been measuring, managing and reducing capital carbon since 2010, we have access to significant levels of data to support our reporting and strategy for delivering against ambitious targets.

Evidence has now been collated over a number of years illustrating the relationship between reducing carbon and reducing cost. As can be seen from Figure A3.1 (below), most projects are concentrated in the reduced carbon and reduced cost quadrant.

Figure A3.1: Capex and capital carbon reductions in Anglian Water 2015-2020



This is an important outcome, demonstrating the direct relationship between carbon reductions and cost reductions. We have found that by concentrating on capital carbon reductions, cost reductions follow.

Using further analysis we can see that there are different levels of capital carbon reduction opportunities between above ground and below ground assets and schemes. The table below illustrates this with actual data from 2020/21.

Table A3.1: High-level performance

	Actual	Target
Percentage reduction against baseline	61%	61%

Table A3.2: Detailed Performance

	Actual	Target
Water Infra	54%	61%
Water Non-Infra	63%	61%
Water Recycling Infra	61%	61%
Water Recycling Non-Infra	76%	61%

As can be seen, non-infrastructure schemes are achieving higher capital carbon reductions than infrastructure schemes.

Using our data and our experience of delivering large-scale capital carbon reductions allows us to understand the best possible interventions in the various scheme types. These interventions include re-use and re-purposing of previously redundant assets, innovative construction techniques, the use of alternative materials, natural capital solutions and sophisticated design approaches to maximise material use efficiency.

We have excellent and long-standing relationships with our delivery partners and work in partnership with them to investigate and develop approaches to continually drive out capital carbon from our designs. In addition, contractual arrangements are structured to ensure that capital carbon reductions are fundamental to the delivery of the contract; we follow a hierarchy of 'no build/build less/build better', and contractors are not financially penalised if 'no build/build less' is the most effective solution.

2030 target

To continue to deliver large-scale capital carbon reductions and further improve performance, we have set a target of a 70 per cent capital carbon reduction against our 2010 baseline by 2030.

This is a challenging target, but given our historic performance in this area, the knowledge we have gained and a focus on the capital carbon and cost relationship, we believe that it is achievable.

However, this will involve continually improving our relationships and ways of working with our delivery partners and wider supply chain to best identify the most effective approaches; the 'easy wins' have been addressed earlier in our capital carbon reduction journey, so partnerships around shared ambitions and innovation will be required more than ever.

New low capital carbon materials afford the main opportunity to achieving very deep reductions in capital carbon, but currently are often more costly than traditional alternatives. Through detailed analysis in collaboration with our supply chain, we have identified that reductions approaching - or greater than - 72 per cent result in a carbon/cost tipping point, leading to higher cost solutions to achieve lower carbon outcomes.

This tipping point changes for different scheme types, and in order to continue to deliver these levels of capital carbon reductions we must become even more engaged with the supply chain, working in partnership to specify and demand materials with lower capital carbon.

However, additional carbon savings from the use of new materials such as low carbon concretes are currently progressing slowly. The low carbon concrete group is developing a routemap through BEIS and the Green Construction Board; however, sector demand for this type of material needs to be further enhanced among other infrastructure sectors and the wider design and construction sector to provide confidence for products suppliers to invest.

In order to deliver against our 2030 target and beyond, we intend to work with partners within the water sector, with others in the infrastructure sector more broadly, and with our construction partners to drive market transformation to deliver improved capital carbon materials while ensuring this can be achieved in a cost effective manner. We have secured Ofwat funding to develop a project to best understand carbon and cost management in the design process by developing interfaces with design software and to understand the whole life aspects of carbon in the design, operation and maintenance of our assets.

We will be building on our industry-leading performance on capital carbon by developing a capital carbon routemap beyond 2030. This strategy will plot our course to capital carbon reductions beyond 70 per cent post 2030 with an ambition to be zero carbon well before the national target of 2050.

Cover photo - The 42,000-panel solar array at Anglian Water's Grafham Water Reservoir provides more than a quarter of the energy needed to power the site's water treatment works

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