Dŵr Cymru
Welsh Water

Enhanced Investment Case: WSH66-PE11 – Improving our Frontier Performance on Net Zero Carbon

Contents

Executive Summary

We are committed to making a step change in our frontier performance in line with customer and Welsh Government expectations. This enhanced investment will enable our transition towards achieving a Net Zero position by 2040.

We have structured this document using the enhancement assessment criteria set out in Ofwat's PR24 Final Methodology, Appendix 9 (Setting Expenditure Allowances), Section A1. The enhancement assessment criteria are divided into four criteria groupings: need for enhancement investment; best option for customers; cost efficiency; and customer protection.

Need: Public awareness of, and concern about, climate change has increased rapidly over the last five years. The need to establish net zero carbon emissions has equally risen rapidly up the political agenda, and the Welsh Government has set a target of Net Zero by 2050, with interim targets for 2030 and 2040.

If we do not step up the level of investment in our Net Zero ambition in AMP8, we can expect to see:

- not reaching Net Zero in the committed timelines
- increases in OpEx expenditure in AMP9 from unmitigated energy costs due to market instability.

We have worked with independent specialists to analyse the greenhouse gases we produce. In particular, we have examined our network control systems and their impacts on fugitive emission, linking to the subsequent impact on performance. We have a well-developed understanding of the statistics and science behind the observed trends and have been able to use this insight to effectively target our response.

Options: We have assessed multiple scenarios using cost benefit analysis. In addition, we have used the Institute of Environmental Management and Assessment (IEMA) Greenhouse Gas Management Hierarchy, focusing on carbon dioxide equivalent (CO_2e) elimination and reduction to consider how best to scale and target our response.

We have identified a range of activities to achieve our Net Zero ambition and prioritised those with the most benefits for AMP8.

Our chosen option is to invest in reduction of energy consumption by using factors such as weather and demand patterns to predict optimum set points and as a result control and optimise pumping regimes. This will be delivered by the investment in the Network Control Systems for wastewater and water. Additionally, we will invest in the measurement and controlling of fugitive emissions (N_2O etc.) to achieve a reduction of over 50% by installing an advanced process control system (APC) to reduce oxide emissions during secondary treatment. The installation of the APC will require enabling works, such as equipment for data collection; upgrades to programmable logic controllers (PLCs); monitoring of N_2O to identify current positions per site, upgrading the level of confidence to a frontier standard for emission reporting; and finally, enabling works such as blower and diffuser upgrades that will increase efficiency and ensure that the reductions through the APC can be achieved.

What We Will Deliver: This enhanced investment case will deliver an APC to reduce N_2O emissions and energy consumption, as well as a network control system to further reduce energy consumption and CO_2e emissions. This will be enabled by investment in new blowers at 14 sites and new diffusers at 20 sites.

Efficient Costing: We will invest £42M (post frontier shift and real price effects, and in 2022/23 price base) to reduce climate change gas impacts through a range of interventions by 2030. This work will be in addition to that delivered in our base programme.

In developing schemes, we have modelled the costs for a basket of intervention types. The costs have been built up using historical outturn costs and quotations from suppliers for new technologies.

The costs of the carbon reduction measures we propose are efficient compared to the UK government's carbon abatement cost benchmark.

Customer Protection: Two common performance commitments linked to percentage of CO_2e removed against the 2021-2022 baseline and overall reduction in tonnes of CO_2e (tCO_2e) will be used to monitor the impacts of this work:

- Operational Greenhouse Gas Emissions (Water)
- Operational Greenhouse Gas Emissions (Wastewater)

Benefits: The investment will keep us on track with our ambitions in the Long Term Delivery Strategy. The benefits of our AMP8 Net Zero enhancement programme are summarised in Table 1.

Table 1: Summary of Benefits from this Enhanced Investment Case

	AMP8 Impact on Operational Greenhouse Gas Emissions (tCO_2e)	
	Water	Wastewater
Network Control Systems	-500	-500
Reduction of Process Emissions		-19,372
Total	**-500**	**-19,872**

Additional benefits are compliance with both UK and Welsh legislation, protecting the company and our customers from rising/unstable energy prices and mitigation/adaption to climate change.

Our approach to investment has been independently assessed by Jacobs (Engineering and Costs) and Economic Insight (CBA).

1. Introduction

We are committed to making a step change in our performance in line with customer and Welsh Government expectations. This enhancement will enable our transition towards achieving a Net Zero position by 2040.

We will track improvement via two common performance commitments:

- Operational Greenhouse Gas Emissions (Water)
- Operational Greenhouse Gas Emissions (Wastewater)

Which report the percentage of tonnes of carbon dioxide equivalent (tCO_2e) removed compared to the 2021-2022 baseline.

The investment set out in this enhanced investment case will allow the delivery of the required reduction against the 2021/22 Annual Performance Report (APR) carbon footprint of 164,644 tCO_2e.

The key schemes, costs and benefits in AMP8 are summarised in Table 2 and Table 3. The data can be found in the PR24 data tables CW21 and CWW22.

Table 2: Costs and Benefits in AMP8 from this Enhanced Investment Case (Water)

	Water		
	Enhancement CapEx*	**Enhancement OpEx***	**Impact on Operational Greenhouse Gas Emissions (tCO_2e)**
Network Control System	£1.725M	- £0.421M	-500
Total	**£1.725M**	**- £0.421M**	**-500**

** post frontier shift and real price effects, and in 2022/23 price base*

Table 3: Costs and Benefits in AMP8 from this Enhanced Investment Case (Wastewater)

	Wastewater		
	Enhancement CapEx*	**Enhancement OpEx***	**Impact on Operational Greenhouse Gas Emissions (tCO_2e)**
Network Control System	£1.725M	- £0.421M	-500
Reduction of Process Emissions	£38.555M	- £2.689M	-19,372
Total	**£40.280M**	**- £3.110M**	**-19,872**

** post frontier shift and real price effects, and in 2022/23 price base*

In AMP8 we propose to invest £3.450M in CapEx (post frontier shift and real price effects, and in 2022/23 price base) for a reduction in operational greenhouse gas (GHG) emissions of 1,000 tCO_2e through the delivery of two Network Control Systems (NOCs), one on the Water side of the business and one on the Wastewater side. NOCs aim to reduce energy consumption by using factors such as weather and demand patterns to predict optimum set points and as a result, control and optimise pumping regimes.

The Reduction of Process Emissions investment package aims to enable measuring and controlling of fugitive emissions, such as nitrous oxide (N_2O) etc., to achieve a reduction of over 50% by 2030. This package of work involves:

- Monitoring N_2O emissions to identify current position per site and upgrade the level of confidence in reporting.

- Advanced Process Control system (APC) to reduce N_2O emissions during secondary treatment processes.
- Enabling works for the APC, such as additional equipment to provide necessary data for the APC to work correctly, upgrades to PLCs, etc.
- Installing new Blowers and Diffusers.

We have structured this document using the enhancement assessment criteria set out in Ofwat's PR24 Final Methodology, Appendix 9 (Setting Expenditure Allowances), Section A1.1:

ID from Appendix 9		Abbreviated Assessment Criterion	Addressed in…
A1.1.1 Need for enhancement investment	a	Is there evidence that the proposed investment is required?	Section 2.1
	b	Is the scale and timing of the investment fully justified?	Section 2.1
	c	Does the proposed investment overlap with base activities?	Section 2.2
	d	Does the need and/or proposed investment overlap/duplicate with previously funded activities or service levels?	Section 2.3
	e	Does the need clearly align to a robust long term delivery strategy within a defined core adaptive pathway?	Section 2.4
	f	Do customers support the need for investment?	Section 2.1
	g	Have steps been taken to control costs, including potential cost savings?	Section 2.5
A1.1.2 Best option for customers	a	Have a variety of options with a range of intervention types been explored?	Section 3.1
	b	Has a robust cost-benefit appraisal been undertaken to select the proposed option?	Section 3.1
	c	Has the carbon impact, natural capital and other benefits that the options can deliver been assessed?	Section 3.2
	d	Has the impact of the proposed option on the identified need been quantified?	Section 3.2
	e	Have the uncertainties relating to costs and benefit delivery been explored and mitigated?	Section 3.3
	f	Where required, has any forecast third party funding been shown to be reliable and appropriate?	Not applicable for this case
	g	Has Direct Procurement for Customers (DPC) delivery been considered?	WSH50-IP00 Our Approach to Investment Planning
	h	Have customer views informed the selection of the proposed solution?	Stepping up to the Challenge: Business Plan 2025-30
A1.1.3 Cost efficiency	a	Is it clear how the company has arrived at its option costs?	Section 4.1
	b	Is there evidence that the cost estimates are efficient?	Section 4.2
	c	Does the company provide third party assurance for the robustness of the cost estimates?	Section 4.1
A1.1.4 Customer protection	a	Are customers protected if the investment is cancelled, delayed or reduced in scope?	Section 5
	b	Does the protection cover all the benefits proposed to be delivered and funded?	Section 5
	c	Does the company provide an explanation for how third-party funding or delivery arrangements will work for relevant investments?	Not applicable for this case

2. Need for Enhancement Investment

Public awareness of, and concern about, climate change has increased rapidly over the last five years. The need to establish net zero carbon emissions has equally risen rapidly up the political agenda, and the Welsh Government has set a target of Net Zero by 2050, with interim targets for 2030 and 2040.

In March 2021, the Board of Glas Cymru approved Welsh Water's GHG reduction targets and the roadmap to achieve them.

Our long-term target is to be Net-Zero on carbon emissions for Scopes 1, 2 and 3 by 2040 and 100% energy self-sufficient by 2050. Scopes 1 and 2 directly relate to the business's activities and Scope 3 relates to upstream and downstream emissions from supply chain activity or customer use of products and services.

This enhanced investment is the next step towards achieving Net Zero.

2.1 Evidence that Enhancement is Needed

> ***Is there evidence that the proposed enhancement investment is required?***
> ***Where appropriate, is there evidence that customers support the need for investment?***
> ***Is the scale and timing of the investment justified?***
> *– Ofwat's final methodology for PR24, Appendix 9, A1.1.1a, A1.1.1b and A1.1.1f*

2.1.1 Legislative Requirements

As well as the legal driver from UK government there is also the Environment Wales Act of 2016. This outlines the 2050 Net Zero target that companies in Wales are expected to achieve and outlines the provision of interim targets leading up to 2050 with respect to Net Zero improvement.

The Wales Act (2016) requires "*net Welsh emissions by 2050 are at least [F1100%] lower than the baseline*".

This legal driver came into force in 2021.

Additionally, the Wellbeing of Future Generations (Wales) Act 2015 outlines the current trends and is used to inform the set-up of interim targets. The current interim targets set in Section 30 – Interim Emissions targets state the following:

> *(1) For each interim target year, the Welsh Ministers must by regulations set a maximum amount for the net Welsh emissions account, expressed as a percentage below the baseline (an "interim emissions target").*
>
> *(2) The Welsh Ministers must ensure that the net Welsh emissions account for each interim target year does not exceed the interim emissions target for that year.*
>
> *(3) The interim target years are 2020, 2030 and 2040.*

2.1.2 National Environment Programme (NEP) Requirements

There are two drivers set out within the National Environment Programme (NEP) in Wales:

- Driver (1) W_ZERO_INV: Action to fully evaluate and report organisation net carbon status, including operational, embodied carbon and land-use emissions and removals.

- Driver (2) W_ZERO_IMP: Action planning and delivery of mitigation measures to deliver the decarbonisation outcomes, including ultimately net zero emissions by 2040. Supported and evidenced by consistent monitoring and reporting.

We have submitted an Options Development Report (ODR) "PR24_Enhanced Net Zero Carbon_ODR-W_ZERO_INV" to NRW aligned with this enhanced investment case to be included in the NEP.

2.1.3 Other Drivers of Needs

There is also the non-legal driver of major economic fluctuations in the volatile energy markets, which create a need for greater energy resilience.

In response to these needs Welsh Water has set out a pathway to meeting Net Zero in WSH01 Long Term Delivery Strategy.

Our approach to customer engagement is set out in Stepping up to the Challenge: Business Plan 2025-30 (Section 2.2).

2.1.4 Scale and Timing of Investment

In March 2021, the Board of Welsh Water approved the Net Zero Roadmap which aims to achieve a reduction in the total GHG emissions.

The targets set out in our business plan deliver these targets against the Ofwat performance commitments.

The diffuser and blower upgrades in our investment case for AMP8 are primarily enabling works for effectively controlling aeration on sites where we are seeking to mitigate N_2O emissions in AMP8, through the Reduction of Process Emissions work package. This work would need to be undertaken as soon as possible in AMP8 for us to hit our target of 30 sites by the end of the AMP and achieve the carbon benefits and to continue to be on track with Net Zero Roadmap.

The pace of change set out here reflects the challenges of increased carbon usages mandated by activity to meet requirements set out in the NEP in Wales, the Water Industry National Environment Programme (WINEP) in England, and other areas. These necessary investments are carbon heavy, creating a headwind which needs to be overcome as part of moving towards our target. For example, we anticipate close to 6,000 tCO_2e per year increase in embodied carbon emissions relating to the faster rate that Water Companies are expected to reduce Storm Overflow (SO) discharges, or close to 20% of our current emissions associated with the creation of new assets.

2.2 Overlap with Activities to be Delivered through Base

> ***Does the proposed enhancement investment overlap with activities to be delivered through base?***
>
> *– Ofwat's final methodology for PR24, Appendix 9, A1.1.1c*

To achieve the Net Zero ambition, there is a combination of base and enhancement investment.

The enhancement programme builds on the foundations of our AMP6 and AMP7 Net Zero investments. The assets, systems and functionality delivered in the previous and current AMPs must be maintained to enable the successful delivery of benefits from the AMP8 schemes. The costs of this maintenance activity are not included in the enhancement costs.

The Reduction of Process Emissions investment package requires, as a critical enabler, the replacement of current blowers and diffusers at our wastewater treatment works. However, these current assets need to be replaced well ahead of their otherwise useful life. That is, if it were not for

the Reduction of Process Emissions investment package, there would be no need for Welsh Water to replace these blowers or diffusers in AMP8 as it would not be a “low-regrets” base maintenance investment. As such, the cost of replacing the blowers and diffusers is not covered by base allowance and is therefore included in the enhancement CapEx figures.

2.3 Overlap with Funding from Previous Price Reviews

Does the need and/or proposed enhancement investment overlap with activities or service levels already funded at previous price reviews?
– Ofwat’s final methodology for PR24, Appendix 9, A1.1.1d

In the Reduction of Process emissions package, the upgrade of existing duty or standby blowers to new energy efficient alternatives has not been carried out in previous AMPs for these sites. It would not have been a “low-regrets” base maintenance investment to replace them well ahead of their otherwise useful life. Similarly, 20 new sites have been identified from initial desktop studies for diffuser upgrades.

In AMP7, Enhanced Net Zero Carbon Position was allocated a budget of around £30M to deliver both energy efficiency and energy self-sufficiency projects across the 5-year AMP period. This work, set out below, is on track for delivery and is clearly separate from the work being requested for AMP8.

Energy generation projects:

- Grwyne Fawr, Cantref Hydro and Pontsticill Hydro schemes
- Seven photovoltaic generation sites
- Five Fords private wire scheme

Energy efficiency projects:

- Delivering 4,000 energy efficient lights and PIRs across Welsh Water sites
- Installing ~3,000 smart heaters across Welsh Water sites
- Blower replacements at Cardiff, Cog Moors and Five Fords WwTW
- Pump replacements and refurbishments

We have delivered Process Emissions monitoring and testing works to prepare our baseline for AMP8 and understand opportunities for reduction. We have also delivered more energy efficient blower projects than was in the AMP7 plan. We are initiating work on a private wire scheme and gas-to-grid scheme which we plan to deliver in 2025.

No previous investments have been made towards the proposed sites and the overall network control system upgrades.

2.4 Alignment with the Long Term Delivery Strategy

Is the need clearly identified in the context of a robust long term delivery strategy within a defined core adaptive pathway?
– Ofwat’s final methodology for PR24, Appendix 9, A1.1.1e

Welsh Water’s Long Term Delivery Strategy looks to achieve a status of having Net Zero carbon emissions by 2040.

Welsh Water have produced a carbon route map strategy which has been agreed by the leadership team at Welsh Water. A core pathway has been developed which reflects the carbon route map and includes a range of schemes that are required to achieve the Net Zero ambition.

The projects outlined in this enhanced investment case are a key element to achieving Welsh Water's long-term goal. An assessment has been undertaken to understand the impacts of a range of scenarios on achieving the long-term ambition.

Further details can be seen in WSH01 Long Term Delivery Strategy.

2.5 Management Control of Costs

> ***Is the investment driven by factors outside of management control? Is it clear that steps been taken to control costs and have potential cost savings been accounted for?***
>
> *– Ofwat's final methodology for PR24, Appendix 9, A1.1.1g*

Work is driven by factors outside of management control as set out in Table 4:

Table 4: List of Key Drivers

#	Driver	Comments
1	Legal/Regulatory	UK Government Net Zero Targets, Environment (Wales) Act 2016, Wellbeing of Future Generations (Wales) Act 2015.
2	Changing Climate Patterns	Climate change, climate mitigation requirements
3	Major Economic Fluctuations	Volatile energy markets
4	NEP	First published 2022 for AMP8 onward. Driver references: W_ZERO_INV and W_ZERO_IMP
5	Welsh Government 'Race to Zero' challenge	Public sector bodies in Wales are required to align to this approach. Welsh Water is considered a potential key contributor to Welsh Government ambitions for the future.

Through our ongoing base maintenance activities, we seek to produce incremental improvements towards our Net Zero ambition.

The scale of the change required means that significant dedicated investment is required beyond base maintenance.

3. Best Option for Customer

In this section, we describe how we have developed options for addressing the need identified in Section 2.

We identify investment to achieve our targets using the Institute of Environmental Management and Assessment (IEMA) Greenhouse Gas Management Hierarchy, focusing on CO2e elimination and reduction - this is illustrated in Figure 1. The hierarchy places a strong emphasis on avoiding emissions as typically more effective and sustainable than relying solely on offsetting or reducing emissions that have already occurred.

The chosen option will deliver Net Present Value benefits of over £80M. There remain higher cost, higher benefit options which we have ruled out at this stage as these options fall lower in the IEMA hierarchy at 'substitute' and 'compensate'.

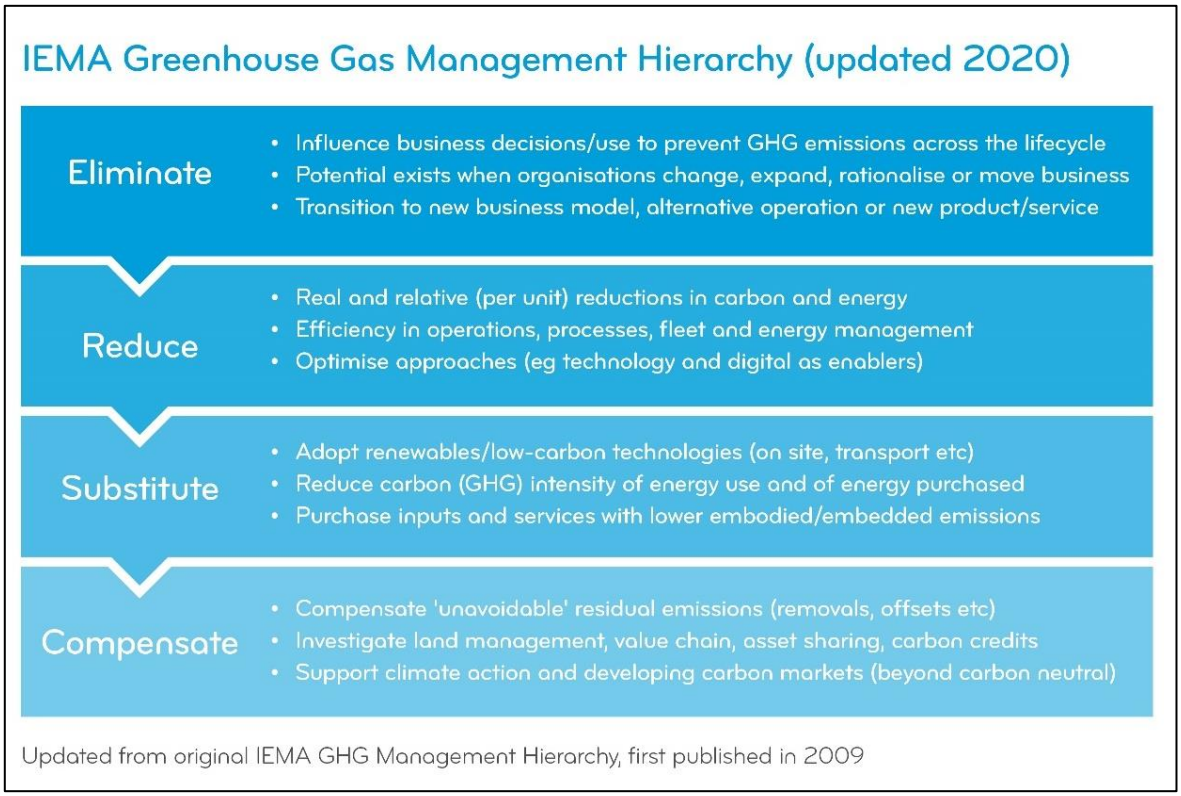

Figure 1: IEMA Green House Gas Management Hierarchy

3.1 Identification of Solution Options

Has the company considered an appropriate number of options over a range of intervention types to meet the identified need?
Is there evidence that the proposed solution represents best value for customers, communities, and the environment over the long term?
– Ofwat's final methodology for PR24, Appendix 9, A1.1.2a and A1.1.2b

3.1.1 Programme Level Optioneering

The range of potential options is large and diverse (see Table 5).

Table 5: Longlist of Options Considered

Type of Option	Brief Description of Option and Comments	Potentially Viable, i.e., progress to shortlisting?
Eliminate, reduce or delay the need for change.	**Not Viable.** We would not reach Net Zero in the committed timelines.	✗
Maintaining the effective risk controls already in place	The enhancement programme described in this document builds on the foundations of our AMP6 and AMP7 Net Zero investments. Our existing assets, systems, and controls must be maintained to enable the successful delivery of benefits from the AMP8 Net Zero schemes. The costs of this activity are included in our maintenance costs and are excluded from the scope of this enhanced investment case.	→ The costs and benefits of our base activities are included in our PR24 Plan and are outside the scope of this enhancement case.
Enhance existing resources or add new resources	**Viable.** We have identified 15 potential interventions to achieve our Net Zero strategy: • Blower Replacements • Diffuser Replacements • Pump Replacements – Wastewater and Water • Smart Wastewater pumps • Network Control Systems • Miscellaneous (Heating & Lighting) • Hydro Schemes (8 locations) • Solar PV Schemes (6 locations) • Wind • Private Wire Schemes (direct link to a renewable electricity generator) • Maintenance (as part of base) • Gas to Grid • Biohydrogen • CO_2 Production Facility (send CO_2 to market) • Reduction of Process Emissions	✓

Table 6 and Sections 3.1.1.1 to 3.1.1.4 summarise the assessment of our programme-level options.

Table 6: Assessment of Programme-Level Options

Investment	Initial CapEx* (£M)	Annual OpEx* (£M)	Annual Carbon Saving (tCO_2e)	Selected for AMP8 in Portfolio-Level Optimisation
Reduction of Process Emissions, including critical enablers of Diffusers and Blowers	39.274	-2.687	19,029	✓
Biohydrogen	32.632	-9.165	15,000	✗ (Section 3.1.1.1)
Private Wire	13.162	-2.840	13,218	✗ (Section 3.1.1.2)
CO_2 Production Facility	6.526	-0.489	5,000	✗ (Section 3.1.1.1)
Pump Replacement (Water/Wastewater)	11.096	-2.083	2,570	✗ (Section 3.1.1.3)
Diffusers (as a stand-alone option)	6.578	-1.516	1,802	✗ (Section 3.1.1.4)
Solar	13.007	-1.199	1,696	✗ (Section 3.1.1.4)
Blowers (as a stand-alone option)	5.762	-1.032	1,227	✗ (Section 3.1.1.4)
Network Control Systems (NOCs)	3.807	-0.843	1,002	✓
Smart Pumps	4.884	-0.251	299	✗ (Section 3.1.1.4)
Hydro	2.741	-0.228	275	✗ (Section 3.1.1.4)
Lighting	0.435	-0.087	103	✗ (Section 3.1.1.4)
Heating	0.109	-0.022	26	✗ (Section 3.1.1.4)

** pre frontier shift and real price effects; and in 2022/23 price base*

The schemes highlighted in green are those selected to be taken forward for the PR24 Plan. They were selected because of their high Net Present Value (as assessed via our Multi-Capital Value Framework) for the initial TotEx investment required compared to other investment options in the portfolio. No operational or other constraints have been identified that would impact the viability of these options.

3.1.1.1 Analysis of Biohydrogen and CO_2 Production Facility

The Biohydrogen and CO_2 Production Facility – while high in terms of tCO_2e reduction and providing a good return in tCO_2e reduction per £ of initial CapEx invested – present complications in funding

when separating aspects of Welsh Water's regulated and non-regulated businesses. They have been ruled out as non-viable.

3.1.1.2 Analysis of Private Wire

Using Private Wire (which also has a good tCO_2e reduction per £ of initial CapEx invested) has two drawbacks, the first is that in terms of the GHG management hierarchy, it is lower in the order of preference. The chosen option looks to eliminate and reduce emissions onsite rather than substituting or compensating as shown in Figure 1. The second drawback are the risks associated with being heavily reliant on third parties, i.e. land purchasing/ownership, grid connections etc. which is outside of Welsh Water control. An example of this is Candwr Road Solar Park which, despite original response from Distribution Network Operator (DNO) being a 2028 connection, the project would now not be eligible for a grid connection until 2037 which would put it well outside of the AMP8 timeframe.

3.1.1.3 Analysis of Pump Replacement

Whilst a good option in terms of costs and benefits, pump replacement has not been prioritised for AMP8 to reduce the overall costs of the enhancement programme. Instead, we will undertake more detailed analysis of pump performances to allow the development of a more targeted (phased) renewal programme for future periods. 424 pumps have been identified across 132 wastewater sites for testing.

3.1.1.4 Analysis of Diffusers, Blowers, Solar, Smart Pumps, Hydro, Heating and Lighting

Diffusers and Blowers (when analysed as stand-alone options, separate from Reduction of Process Emissions), Solar, Smart Pumps, Hydro, Heating and Lighting were not selected for AMP8 delivery due to the low Net Present Value (as assessed via our Multi-Capital Value Framework) for the initial TotEx investment required compared to other investment options in the portfolio.

3.1.2 Assessment and Selection of Solution Options

Our approach to cost benefit appraisal and its role in decision-making is set out in WSH50-IP00 Our Approach to Investment Planning.

Table 7 shows a sample of the cost benefit analysis undertaken for this enhanced investment case.

While the diffusers and blowers present a better Net Present Value than the Network Control Systems, they were not selected for inclusion in the PR24 Plan as stand-alone schemes. This is because the initial CapEx investment required presented too much of an opportunity cost when compared with other investment options for the Plan. That is, they were sub-optimal choices for the portfolio-level plan.

Table 7: Cost Benefit Analysis of Net Zero Enhancement Schemes

Option Name (Sample CBA)	Initial CapEx*	Present Value Whole Life Costs* (WLC)	Present Value Whole Life Benefits* (WLB)	Benefit/ Cost Ratio	Net Present Value* (=WLB - WLC)
Enhance existing resources or add new resources. Replace existing blowers with new energy-efficient alternatives that will produce the same (or more) amount of air for less power (at the same operating conditions).	£5.762M	£5.172M	£24.745M	4.784	£19.573M
Enhance existing resources or add new resources. Replace existing diffusers with new energy-efficient alternatives that will produce the same (or more) amount of air for less power (at the same operating conditions).	£6.578M	£5.905M	£36.327M	6.152	£30.422M
Enhance existing resources or add new resources. Energy self-sufficiency - Network Control Systems (wastewater and water)	£3.807M	£3.417M	£20.207M	5.913	£16.790M

** pre frontier shift and real price effects; and in 2022/23 price base*

Third-party technical assurance of cost–benefit appraisal has been completed by Economic Insight who have confirmed that our approach is robust and in line with Ofwat expectations. Full details are given in WSH50-IP00 Our Approach to Investment Planning.

3.2 Quantification of Benefits

Has the company fully considered the carbon impact, natural capital and other benefits that the options can deliver?
Has the impact of the proposed option on the identified need been quantified, including the impact on performance commitments where applicable?
– Ofwat's final methodology for PR24, Appendix 9, A1.1.2c and A1.1.2d

Table 8 shows the distribution of benefits associated with the proposed programme quantified using our Multi-Capital Value Framework.

Table 8: Split of Benefits for the Net Zero Enhancement Programme

Scenario	Distribution of benefits by value		
	Greenhouse Gas Emissions	Avoidable Costs	Total
Proposed Programme	29.5%	70.5%	100%

The benefits are split between a reduction in GHG emissions and a reduced level of avoidable costs. The avoidable costs consist primarily of reductions in electricity consumption.

3.2.1 Quantifying the Impact on Need and Performance Commitments

The impacts of changes in operation and investment are calculated using the UKWIR Carbon Accounting Workbook. This is an established process for calculating CO2e values in the water industry and has been used consistently across our business plan (including within the Multi-Capital Value Framework).

The net position of our business plan has been calculated from the multiple interventions across our programme. This work shows an increase in total CO_2.

We have separately calculated the benefits of this enhanced investment case.

From our analysis the proposed programme will make the following net impacts:

- The net reduction in operational GHG emissions from the enhancement programme is 20,372 tCO_2e.
- There is an associated increase in embodied carbon, not captured in the common performance commitments, a one-off determent of 3,408 tCO_2e.

Table 9 shows the contribution from the AMP8 Net Zero enhancement programme to the common performance commitments.

Table 9: Contribution of this Enhanced Investment Case to Common Performance Commitments

PR24 Common Performance Commitment	25-26	26-27	27-28	28-29	29-30
Contribution to Operational GHG Emissions target (tCO_2e) - Water	-10,095	-13,997	-16,738	-18,557	-19,872
Contribution to Operational GHG Emissions (tCO_2e) - Wastewater	-50	-165	-285	-400	-500

3.3 Uncertainties relating to Cost and Benefit Delivery

> ***Have the uncertainties relating to costs and benefit delivery been explored and mitigated? Have flexible, lower risk and modular solutions been assessed – including where forecast option utilisation will be low?***
>
> *– Ofwat's final methodology for PR24, Appendix 9, A1.1.2e*

Our methodology is set out in WSH50-IP00 Our Approach to Investment Planning. This includes commentary on our approach to optioneering, costing and cost benefit analysis.

For this enhanced investment case we have evaluated a wide range of options in line with our TotEx hierarchy approach.

We have highlighted areas in which the calculation of costs or benefits are unusual or uncertain and how we have mitigated for this in our evaluation. Innovation and new approaches such as biohydrogen are inherently more uncertain than tried and tested engineering approaches.

As set out in Section 2.1, there are various options which deliver cost-effective benefits, but which are either risky or dependent on third parties. The chosen options are both within management control and established technology, giving them a high probability of delivering the required benefits.

3.3.1 Increasing Confidence in Benefits

Throughout AMP7 there has been a focus on research, innovation and industry collaboration to better understand N_2O monitoring and mitigation with the aim of providing information for the development of the PR24 Plan.

We have so far invested £0.200M on the research of different monitoring technologies from Unisense, Xylem and Suez alongside the development of a N_2O risk-based model from Cobalt Water to aid in understanding the effectiveness of mitigation strategies and process risk elements for N_2O emissions.

We have also collaborated in the development of the Spring trials for process emissions monitoring and UKWIR projects including air pollutant emissions across wastewater operations.

This investment improves our ability to accurately map the benefits of interventions on GHG emissions.

3.3.2 Increasing Confidence in Costs

N_2O is a rapidly developing field within WaSCs. As such, new technology is being developed to help monitor and feed into mitigation strategies. Existing APC options have been applied successfully in several different scenarios across the world, and evidence shows a successful reduction in N_2O emissions from this.

Diffusers & Blowers (part of our Reduction in Process Emissions scheme): This type of investment is routinely undertaken at Welsh Water and is therefore high-confidence.

Network Control Systems: The initial CapEx and the OpEx savings have been estimated from the trial Network Control Project that has been delivered in AMP7, giving good confidence for the figures applied in AMP8.

4. Costing Efficiency

In this section, we give details on our approach to costing and benchmarking. Our overarching approach to developing efficient costs is set out in WSH50-IP00 Our Approach to Investment Planning.

4.1 Developing a Cost for Carbon Reduction

> ***Is it clear how the company has arrived at its option costs? Is there supporting evidence on the calculations and key assumptions used and why these are appropriate? Does the company provide third party assurance for the robustness of the cost estimates?***
>
> *– Ofwat's final methodology for PR24, Appendix 9, A1.1.3a and A1.1.3c*

In costing this investment we have applied our like-for-like (top-down) costing methodology using our Unit Cost Database's Carbon & Cost Estimating Tool (C&CET).

This was supported by bottom-up costing where prices for new assets are not incorporated in the existing cost models within the C&CET. An example of this would be the new energy efficient blowers. Another example is where we are looking to upgrade to Smart Wastewater pumps. We have worked with the supplier to produce cost estimates rather than using our existing cost models, as this would provide better cost accuracy.

To use our C&CET, we develop a scope of works which details the work items for each project. For most items of work, these have been constructed throughout previous AMPs, and therefore we have a rich source of historical cost data. Where we have common work items, we have developed cost models based on the most important cost drivers, e.g., the most influential driver to cost for a tank is volume. This costing approach forms the direct works and site-specific costs. We apply construction indirect costs and project oncosts based on the workstream, which applies modelled percentages to the cost of the direct works and site specifics.

The scope that is developed is aligned to our Work Breakdown Structure (WBS), which was developed to support our data capture process of historical project cost against delivered assets, into a scope input sheet. Within this, sizing of the assets based on the relevant yardstick, which is dictated by the WBS, is provided following calculation in the previous engineering stages. Our cost models are developed in line with our WBS and this allows us to input this information into the C&CET and generate a project estimate. The C&CET details the inclusions and exclusions of works under each cost model and the limitations of the model, so we can ensure all project costs are captured and there is also no over costing.

Some technology used in AMP7 was not available at the time in C&CET (first time usage had not yet been updated into our corporate cost system). As such we used direct project costing for AMP7 to ensure robust cost estimates for newer technologies.

Our proposed Solar PV investment option (ultimately not selected for inclusion in the PR24 Plan) is larger than we have delivered in each of the previous AMPs since AMP5. Costs are based on the market price, with uplifts applied to allow for less developed technologies, such as floating solar mounted systems. In addition, adjustment has been made to reflect economies of scale in our AMP8 programme and long-term reductions of PV panel prices in the market.

All C&CET estimates went through our internal governance process to ensure that the Unit Cost Database's models were used correctly and all costing from other sources were validated.

All assets in the C&CET have associated carbon values for embodied and operational carbon. It is therefore a relatively straightforward process to estimate the whole-life carbon benefit from different investment options; our analysis uses the SED&NZ best practice guidance and the most up-to-date carbon values per tCO_2e. We use the BEIS Greenhouse Gas reporting conversion factors 2022 for calculating GHG savings applying rates to the forecast kWh electricity savings.

We have based a lot of our costs and assumptions around what we have delivered in AMP7 and current market rates. It is expected that we will experience some changes in market conditions, and we have adjusted our costing to allow for this. For example, assumptions have been made around the rate of returns for Biomethane/Biohydrogen, where we have assumed natural gas prices reduce from current market highs to closer to 5 p/kWh for any biomethane exported.

Along with our overall costing strategy reviewed and assured by Jacobs, we have also employed third party consultants to review single enhancement cases to provide confidence that the estimates within them are robust, efficient, and deliverable.

4.2 Benchmarking Our Approach

Is there evidence that the cost estimates are efficient?
– Ofwat's final methodology for PR24, Appendix 9, A1.1.3b

We have examined the carbon benefits that our investment will generate compared to the market value for carbon reduction using published figures – namely, the finally adopted central and high values for carbon abatement costs (£/tCO_2e) for 2030 and 2050 found in Annex 1 of the UK government's policy paper "Valuation of greenhouse gas emissions: for policy appraisal and evaluation", published 2 September 2021:

- 2030 central - £280/tCO_2e (2020 price base)
- 2050 central - £378/tCO_2e (2020 price base)

The unit carbon costs of this enhanced investment case have been calculated by projecting the annual carbon reduction benefit of each scheme over the 30-year review period and measuring it against the Present Value Whole Life Costs. The figures shown in Table 10 display £/tCO_2e for our selected options – which are significantly less than the UK government's current and future abatement costs for carbon. They are also commensurate with the IMF's view of an appropriate cost for carbon, as well as the LSE's which suggests carbon prices of £50-160 for energy-intensive industries.

Table 10: Benchmarking Our Enhancement Programme

Intervention	Present Value Whole Life Costs	30-Year (tCO_2e) Saving	Benchmarked NPV £/tCO_2e
Process Control	£31.884M	581,250	£54.85
Network Control	£3.001M	30,060	£99.82

5. Providing Customer Protection

> ***Are customers protected if the investment is cancelled, delayed or reduced in scope? Does the protection cover all the benefits proposed to be delivered and funded?***
> *– Ofwat's final methodology for PR24, Appendix 9, A1.1.4a and A1.1.4b*

In this section, we set out the performance commitments from Ofwat and oversight from Natural Resources Wales (NRW) which will provide strong customer protection.

The customer is protected by the two common performance commitment covering water and wastewater. The benefits of this enhanced investment case are measurable and presented in Section 3.2. In addition, there will be regulatory oversight from NRW under the NEP. Therefore, the benefits of this enhanced investment case are fully covered through oversight from two regulators.

The proposed work will not impact on any of the other agreed performance commitments or price control deliverables (PCDs).

6. Appendix A

Table 11 shows the total cost in AMP8 for this enhanced investment case. The Ofwat drivers are:

- Greenhouse gas reduction (net zero); enhancement water CapEx (CW3b.127)
- Greenhouse gas reduction (net zero); enhancement water OpEx (CW3b.128)
- Greenhouse gas reduction (net zero); enhancement wastewater CapEx (CWW3b.177)
- Greenhouse gas reduction (net zero); enhancement wastewater OpEx (CWW3b.178)

Table 11: Contribution to AMP8 Enhancement TotEx in the Data Tables

		AMP8 Enhancement* (£M)					
	PR24 BP line	**Year 1**	**Year 2**	**Year 3**	**Year 4**	**Year 5**	**Grand Total**
Network Control System (Water)	CW3b.127	0.174	0.394	0.394	0.414	0.349	**1.725**
	CW3b.128	-0.042	-0.097	-0.097	-0.101	-0.084	**-0.421**
Network Control System (Wastewater)	CWW3b.177	0.174	0.395	0.394	0.413	0.348	**1.724**
	CWW3b.178	-0.043	-0.097	-0.097	-0.101	-0.084	**-0.422**
Reduction of Process Emissions	CWW3b.177	6.639	7.989	7.986	8.149	7.793	**38.556**
	CWW3b.178	-0.264	-0.605	-0.614	-0.649	-0.556	**-2.688**
		6.638	**7.979**	**7.966**	**8.125**	**7.766**	**38.474**

** post frontier shift and real price effects, and in 2022/23 price base*

What We Will Deliver: This enhanced investment case will deliver an advanced process control system to reduce N_2O emissions and reduce energy consumption (enabled by investment in new blowers at 14 sites and new diffusers at 20 sites), as well as network control systems for water and wastewater to further reduce energy consumption and tCO_2e emissions.