

Environmental Action Plan

Contents

| | |
|--|-----------|
| Overview | 3 |
| Our Action Plan Part 1: Decarbonising our business operations | 20 |
| Shrinkage (including theft of gas)..... | 20 |
| Direct (scope 1 & 2) emissions..... | 27 |
| Indirect (scope 3) emissions | 33 |
| Managing uncertainty and deliverability of net zero emissions..... | 35 |
| Our Action Plan Part 2: Reducing our environmental impact | 37 |
| Stakeholder engagement on reducing our environmental impact | 38 |
| Spoil and other waste associated with excavations | 39 |
| Direct waste generated and accumulated on sites | 40 |
| Helping our employees reduce their environmental impact..... | 42 |
| Community, biodiversity and natural capital..... | 43 |
| Water consumption | 44 |
| Our Action Plan Part 3: Facilitating the low carbon / emission energy system transition | 45 |
| The story so far | 45 |
| Supporting our customers of tomorrow | 51 |
| End State: Green Gases | 52 |
| End State: 100% Hydrogen..... | 56 |
| End State: Peak and Emergency Energy Store | 63 |
| End State: Decommissioning | 64 |
| Enduring Environmental Engagement | 65 |
| Supporting Material | 66 |

Overview

Our Environmental Action Plan

This document is our Environmental Action Plan (EAP), which explains how we will take responsibility for the environmental impacts of our network and business operations during the RIIO-2 period and how we will drive improvements in our environmental performance throughout this period. This plan has been written to comply with Ofgem's RIIO-2 business plan guidance and contains the features that Ofgem require of an EAP¹.

Why is focusing on the environment important?

Environmental issues have risen in prominence in recent months and years, with high profile environmental protests; greater visibility of the human consequences of the climate crisis around the world; and a renewed national focus on the environment from the Government and political parties. In May of this year, the Committee on Climate Change (CCC) recommended a target of "net zero" greenhouse gases by 2050², a target that has been adopted by the Government. Protecting the environment has therefore become a higher priority across society, including amongst our customers and stakeholders.

The importance of the environment is reflected in our engagement with customers and stakeholders. The environment is typically described as a high priority and an important area for Cadent to focus on across engagement with all groups. Our understanding of other gas distribution network's engagement with customers is that their customers and stakeholders say the same.

Why Cadent should lead the way on the environment

The gas network is at the centre of the energy system in the UK, delivering critical energy to homes, businesses and industry reliably, efficiently and safely. It delivers more than twice as much energy in a year as the electricity network, with a typical home receiving over five times as much energy from the gas network as the electricity network on a cold winter day.

As the largest gas distribution company in the UK, we provide an essential service that keeps the energy flowing to over 11 million homes, offices and businesses. However, natural gas (methane) is a fossil fuel and greenhouse gas. Both the leakage of methane from our network, and the burning of the methane that we deliver to our end customers, release greenhouse gases and therefore contribute to climate change. In order to achieve "net zero" greenhouse gases by 2050, it will be necessary to decarbonise the provision of heat in the UK and Cadent will need to adapt to facilitate this. We recognise that we have a significant part to play in providing a green, responsible and sustainable future. As a key player in the current and future environmental landscape of the UK, we believe that Cadent has a responsibility to set an example in the way it operates as a business and seek to minimise the environmental footprint it creates in functioning day to day.

How the environment is part of our wider business planning processes and decisions

As a business under new ownership, it is important to both the Board, and the company, that we embrace future challenges and embed environmental considerations into our wider business planning processes and decisions.

Earlier this year, we published our first Safety and Sustainability Report³ which, as well as meeting our current regulatory reporting requirements, considers the relationship between our environmental, societal and resilience goals.

We have established a Board-level Safety and Sustainability Committee (the Committee), supported by an Executive level Safety and Engineering Committee and a Customer Operations and

¹ https://www.ofgem.gov.uk/system/files/docs/2019/09/riio-2_business_plans_guidance_september_2019_-_published_0.pdf

² <https://www.theccc.org.uk/publication/net-zero-the-uks-contribution-to-stopping-global-warming/>

³ <https://cadentgas.com/about-us/responsibility/safety-and-sustainability-report>

Performance Committee (COPC), to further integrate sustainability and the delivery of short, medium and long term environmental goals into our business strategy and decision-making activities. The Committee is responsible for providing independent assurance to the Board on the scope, adequacy and effectiveness of the company’s safety and sustainability policies and management systems and has been active in setting out our strategic direction and ambition for sustainability.

The membership of the Safety and Sustainability Committee provides a wealth of expertise from a wide range of sectors and international perspectives, including the utilities sector, global business and Government. The Committee is seeking to better understand where we are today and will use the results of our first international sustainability benchmarking, (with ‘GRESB’) in 2019, to provide a basis to build and learn. The initial benchmarking in 2019 showed we outperformed our peers and significantly outperformed the average.

“We are very conscious of our leadership role in making a positive contribution to the climate change agenda.”

Howard Higgins, Chair of the Safety and Sustainability Committee

Our environmental management system has been certified to ISO14001 standards for over 20 years, including recent accreditation to the updated ISO14001:2015 standard. This management system combines many elements of good practice:

- It identifies those elements of an organisation’s activities that have the potential to impact on the environment. These are collated within a business-wide ‘Environmental Aspects’ register and set out the risk and control framework to ensure compliance with legislative and other obligations.
- The aspects are ranked and prioritised on the basis of the potential severity of their impacts on the environment to ensure that the appropriate controls are enacted.
- It identifies metrics that can be used to measure the scale of impacts on the environment and targets to drive continual improvement. This helps us to prioritise areas of focus.
- It monitors emerging or changing requirements, external trends and best practice.
- It identifies opportunities to embed more sustainable practices and drive environmental benefits.
- We have established a cross-business Environmental Best Practice Forum and Network Safety Health and Environment (SHE) forum.
- We carry out an annual management review process, presenting a comprehensive statement of performance risk and opportunities to our Executive Team and our Board, ensuring visibility at the highest levels of the organisation.
- Our investment sanctioning process requires examination, evaluation and sign-off of environmental risks and opportunities for all projects. This integrates elements of changing environmental legislation, such as the Medium Plant Combustion Directive (now in Environmental Permitting Regulation, 2018) into forward business plans.
- We monitor standards of environmental management on all our sites through an annual baseline exercise and periodic focused audits.

These practises enable us to identify risks and potential impacts, and specify the controls required to minimise environmental harm. Our last audit report in July 2019 showed a clean bill of health with no weaknesses or nonconformities identified and no corrective actions required.

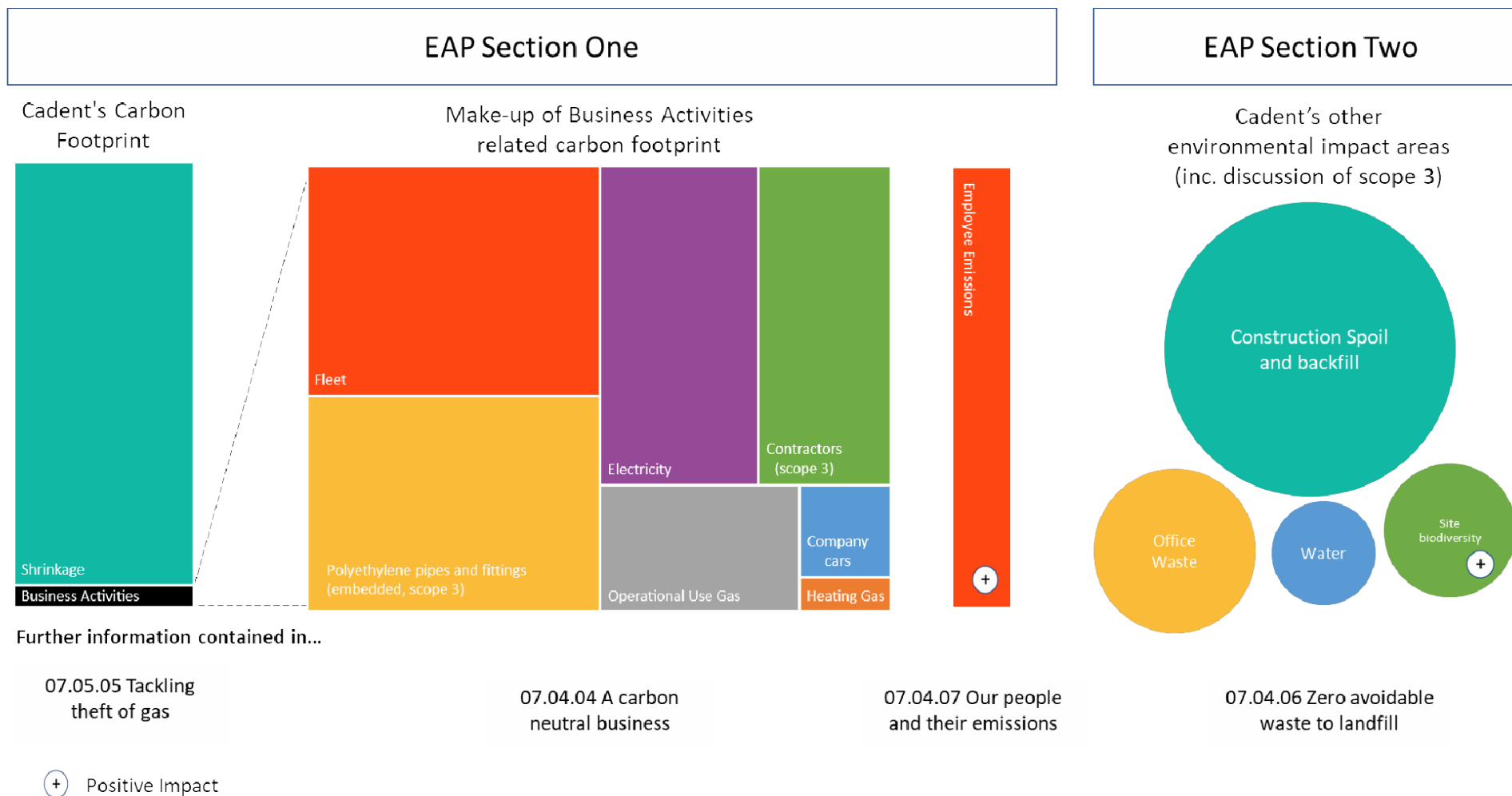
How do Cadent’s activities currently impact on the environment?

Cadent’s activities currently impact on the environment through:

- The release of greenhouse gases, either directly or indirectly, as a result of the operation of the business transporting a primarily fossil derived natural gas i.e. the “carbon footprint” of the business; and
- A range of potentially negative impacts on our physical environment, for example, by sending recyclable waste to landfill as a result of a lack of the correct controls.

The breakdown of these impacts is shown to scale in Figure 1:

Figure 1 Our impacts on the environment and where they are covered in our plan



The release of greenhouse gases

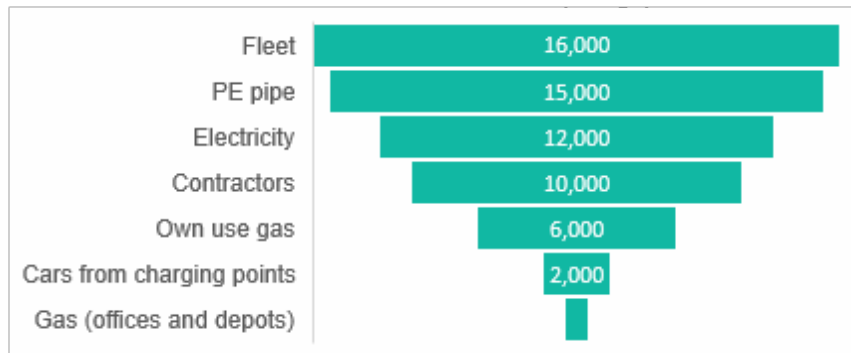
The majority (96%) of carbon dioxide equivalent greenhouse gases emitted by Cadent in 2018/19 were the result of shrinkage emissions, namely the leakage of methane from our gas distribution networks. However, like many other businesses, we are also responsible for greenhouse gas emissions as a result of the day-to-day running of our business, including:

- the operation of our commercial vehicle fleet
- carbon emissions “embedded” in the services we procure (e.g. our contractors’ fuel usage) or the materials we procure (e.g. our polyethylene (PE) pipes)
- our energy consumption emissions
- our business mileage emissions
- our use of gas as a fuel in our network processes: ‘own use gas (OUG)’.

For the purposes of this EAP, given the scale of our shrinkage emissions, and the unique issues associated with their mitigation, we have discussed shrinkage under a separate heading. As an indicator of scale, our shrinkage emissions equate to over 1mTCO₂ pa, with the remaining components illustrated below, making up less than 5% of our overall business carbon footprint.

As such, we have defined our “business carbon footprint” (BCF) to cover emissions from our day-to-day operations, excluding shrinkage. Whilst these day-to-day emissions are smaller in scale than our shrinkage emissions, the issues that we face in reducing them are important to us and businesses and customers across the country. We are therefore committed to taking the lead in addressing such issues.

Figure 2 Comparison of baseline annual BCF emissions at the start of RIIO-2 (tCO₂e)



Throughout this document, we refer to emissions consistent with their categorisation by the Greenhouse Gas Protocol, which we define here for clarity.

- Scope 1: direct emissions from owned or controlled sources;
- Scope 2: indirect emissions from generation of purchased energy; and
- Scope 3: indirect emissions (not in scope 2) that occur in the value chain of the company (either upstream or downstream). Can also be referred to as “embedded carbon”.

Impacting our physical environment

In addition to the emission of greenhouse gases, Cadent can impact our physical environment in a number of ways, with key examples including:

- how we manage spoil that is generated from our mains replacement programme - our most material source of waste: in 2018/19, we generated over 415,000 tonnes of this waste;
- responsible management of our direct waste, which is generated through our day-to-day operations, for example office waste;
- improving site biodiversity can be affected by essential works that may require the removal of trees and vegetation; and
- our use of natural resources such as water and other key engineering materials.

Hierarchy of impacts

We have established an impacts hierarchy across our activities, informed by the relative scale of impacts on CO₂e emissions where appropriate. We set this hierarchy using the risk based approach described below in our progress to date on the environment.

Our hierarchy is:

Figure 3 Hierarchy of impacts



In formulating this hierarchy we have recognised that since separation from National Grid our opportunities to enhance natural capital and biodiversity have diminished as ownership of the largest areas of our estate – that occupied ex-gas holder sites – no longer rests with Cadent.

Our progress to date on the environment

Our environmental management system conforms to the ISO14001 standard which imposes a rigorous approach to the identification of environmental risks across our activities. These are described within our Aspects Register and ranked according to severity of risk and likelihood of occurrence. Controls are then developed and embedded according to this risk hierarchy. Our environmental management system includes a number of key performance measures and targets that help us to understand and monitor our most material potential impacts and the effect of our initiatives to mitigate them. These key performance indicators include some which were determined by Ofgem for RIIO-1. The table below represents a selection of key measures and metrics that reflect the direct impact of our operations on our customers, communities and the environment. We are using these to drive our ambition, define priorities and measure our performance during the remaining years of RIIO-1.

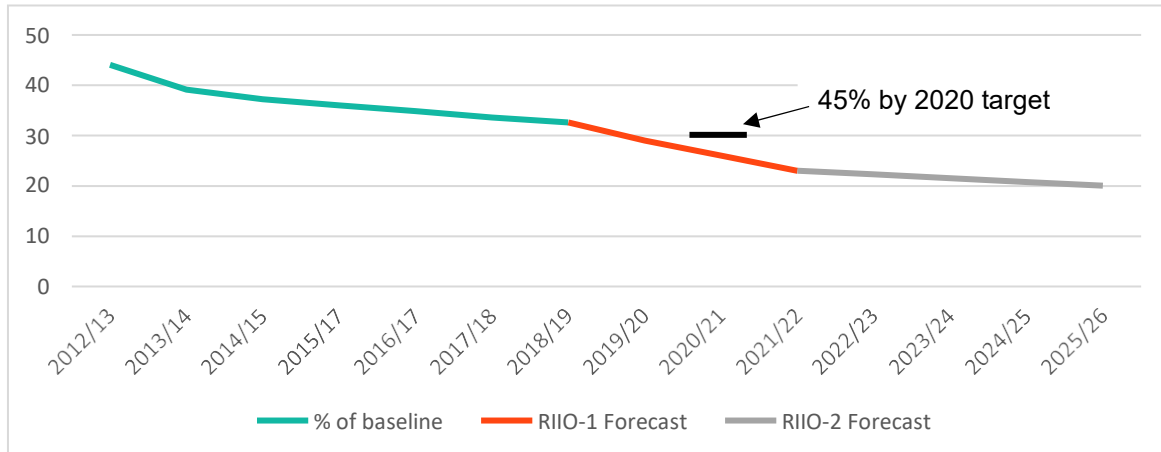
Table 1 Environmental Performance

| Environmental impact | Target/baseline level | 2018/19 performance | Progress against target |
|---|---------------------------------|---|-------------------------|
| Shrinkage emissions | 1,348 GWh | 1,214 GWh | |
| Waste from excavations | No absolute target set | 415,514 tonnes | n/a |
| Percentage waste diverted from landfill | >90% | 97% | |
| Percentage of first use backfill | <70% | 89% | |
| Waste from Cadent operations | No absolute target set | 2,700 tonnes | n/a |
| Percentage diverted from landfill | Zero avoidable by 2021/22 | 15% | |
| Non-shrinkage BCF | 42,185 tonnes CO ₂ e | Scope 1: 26,210 tonnes CO ₂ e Scope 2: 8,668 tonnes CO ₂ e Total: 34,878 tonnes CO ₂ e | |
| Commercial fleet use emissions (scope 1) | Part of BCF | 18,159 tonnes CO ₂ e | |
| Gas consumption – operational (scope 1) | Part of BCF | 811 tonnes CO ₂ e | |
| Own use gas emissions | Part of BCF | 5,321 tonnes CO ₂ e | |
| Business mileage emissions | Part of BCF | 1,918 tonnes CO ₂ e | |
| Electricity consumption – operational (scope 2) | Part of BCF | 8,668 tonnes CO ₂ e | |
| Embedded carbon – contractor fuel usage | No absolute target set | 15,492 tonnes CO ₂ e | n/a |
| Embedded carbon – Polyethylene (PE) pipe and fittings) | No absolute target set | 12,898 tonnes CO ₂ e | n/a |
| Water consumption | No internal targets set | 139,000 m ³ | n/a |
| Serious environmental incidents | 0 | 0 | |

As the green shading in the table above indicates, we are making strong progress against the majority of our environmental targets. The amber shading for commercial fleet fuel use emissions reflects the fact that we have moved to more efficient vehicles that consume more fuel but cause fewer emissions per mile, and that the level of workload activity across our networks has risen giving rise to additional miles driven.

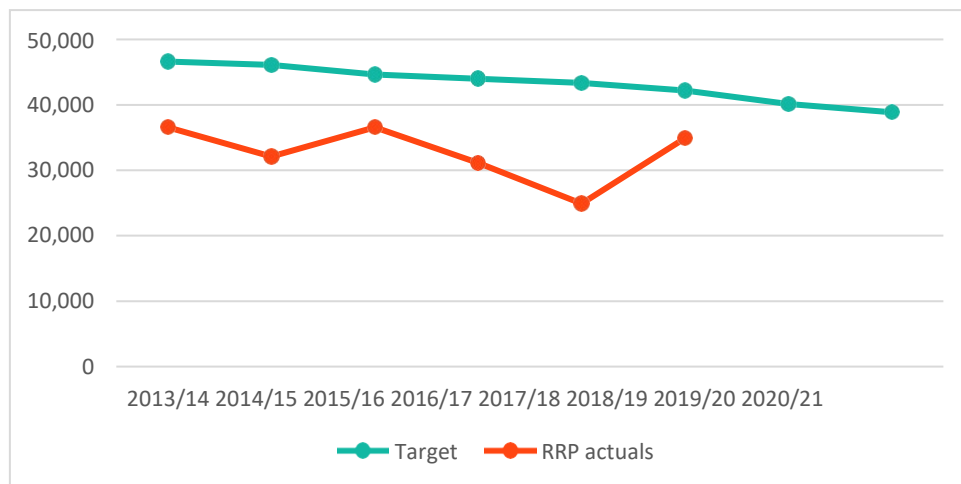
We are publicly committed to reducing our greenhouse gas emissions by 80% by 2050⁴. In 2018/19 we delivered a 68% reduction in greenhouse gas emissions (including shrinkage) against the 1990 baseline, achieved by replacing and repairing leaks on our distribution pipelines. This has delivered a reduction of over 250,000 tonnes CO₂e per year – the equivalent of taking more than 100,000 vehicles off the road. Our target reduction for 2020 was a 45% reduction, and, as such, we are significantly ahead of, and remain on target to achieve, our goal for 2050, as shown in the graph below.

Figure 4 Greenhouse gas emissions reductions against 1990 baseline (% of baseline)



Our goal for 2018/19 was to reduce our non-shrinkage business carbon footprint (BCF), as defined by Ofgem⁵, by 4%, including a reduction relating to electricity consumption by 5%. In 2018/19, we reduced our BCF by 3%. This follows relatively strong performance in prior years: overall, we have reduced our business carbon footprint by over 23% since 2013 and, as a result, we remain ahead of our long-term target trajectory as shown in the graph below. Our 2021/22 target is to reduce our business carbon footprint by 17% from 2013/14 levels.

Figure 5 Business carbon footprint vs target (tCO₂e)



In 2018/19, we reduced energy consumption in our offices and depots by 9% and over 90% of the electricity we use to light and power our offices and depots is from certified renewable sources.

We have reduced our average emissions from our company car fleet from 106g/km to 94g/km over the course of 2018/19 through initiatives such as capping company car emissions, procuring efficient vehicles, and offering green incentives.

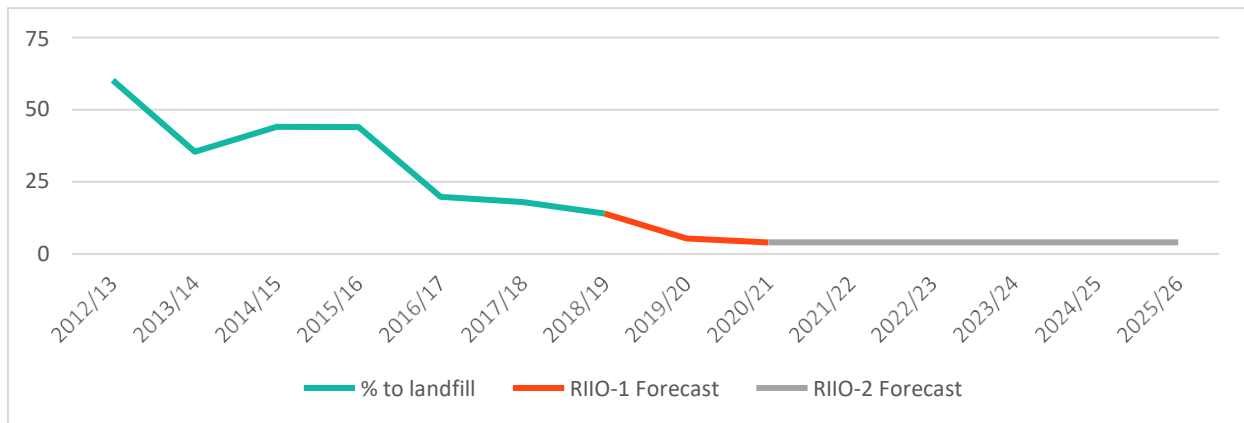
⁴ This target includes scopes 1, 2 and 3 emissions

⁵ Set out in the Regulatory Instructions and Guidance for table 7.6 https://www.ofgem.gov.uk/system/files/docs/2019/03/riio-gd1_gas_distribution_rigs_version_draft_6.0_0.pdf

In 2016, we introduced our goal of zero avoidable waste to landfill by 2021/22, acknowledging that a small proportion of waste will not be able to be diverted or recycled. In 2018/19, we sent 14% of our waste from our direct operations to landfill⁶, down from 60% in 2012/13, continuing our progress towards our 2021/22 goal, as shown in the graph below. Embedding good practices has resulted in only 4% of our waste going to landfill in some months. We have successfully phased out all plastic water cups and hot food containers and introduced the sale of reusable travel mugs. In April 2019, we removed all non reusable cups across our sites.

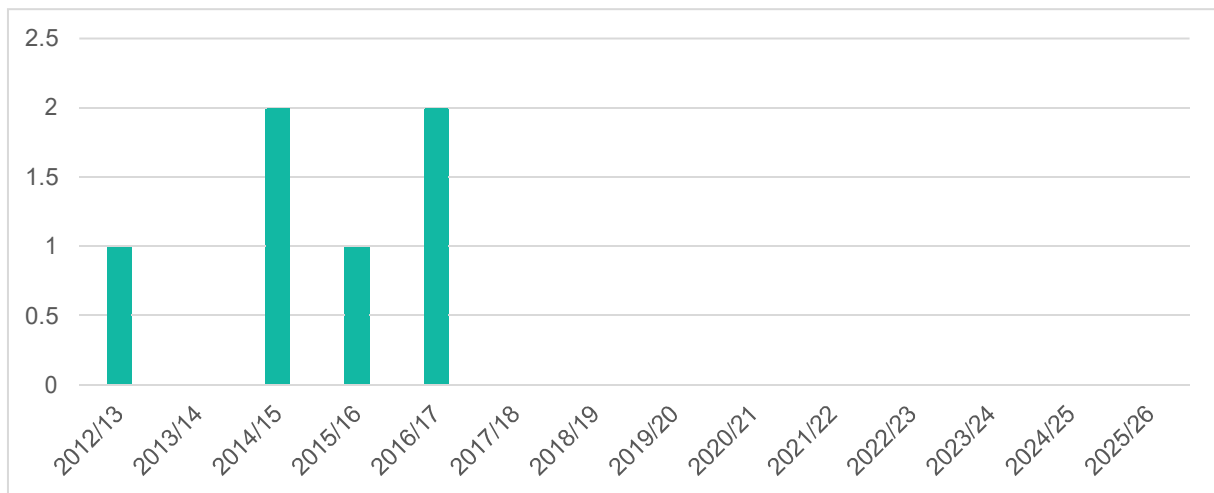
We have regulatory targets to ensure that we send no more than 10% of excavated spoil wastes to landfill, and import no more than 30% virgin aggregate for backfill. We routinely divert more than 95% of our waste from landfill. This is achieved by initiatives such as using low dig and no-dig techniques, inserting new plastic pipe into old metallic services, and using vacuum excavation.

Figure 6 Percentage of waste sent to landfill



We are committed to ensuring that there are no serious environmental incidents as a result of our operations. In 2018/19, for the second year in succession, there were no category 1⁷ incidents associated with our activities, as shown in the graph below.

Figure 7 Category 1 environmental incidents



Opportunities and challenges for addressing material impact areas

Shrinkage

As stated above, 96% of carbon dioxide equivalent greenhouse gases emitted by Cadent in 2018/19 were the result of shrinkage emissions, namely the leakage of methane from our gas distribution

⁶ Direct operations excludes spoil

⁷ As defined in the Common Incident Classification Scheme

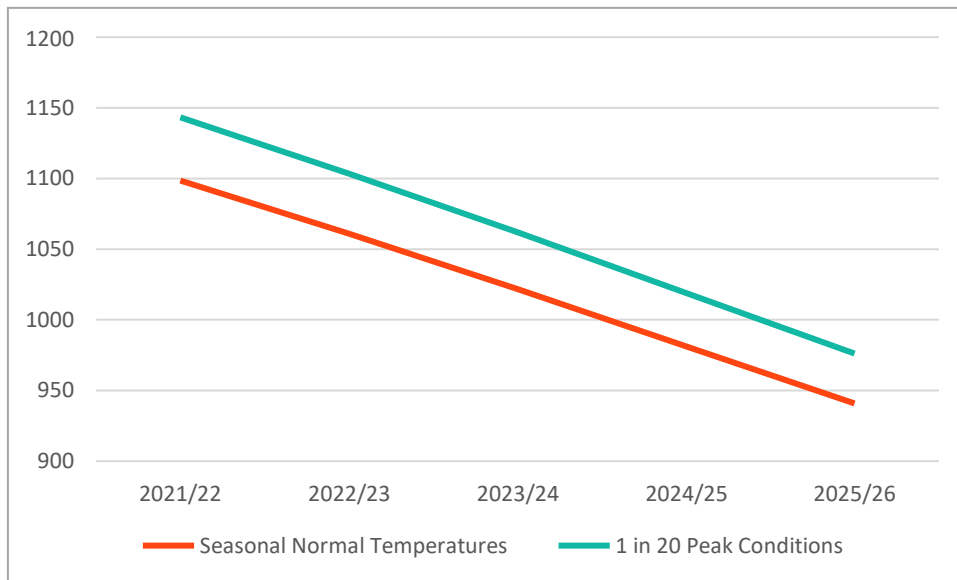
networks. Leakage from our pipes is less than 0.5% of overall throughput, however, methane is a potent greenhouse gas.

Key drivers of network leakage include old iron pipes and higher network pressure. Our investment into optimising pressure management and gas conditioning (applying mono-ethylene glycol (MEG) to joints within the iron pipes) has helped us to reduce leakage to date: we expect to have reduced leakage by 28% by the end of the RIIO-1 period (compared to the start of RIIO-1). However, there are diminishing marginal returns to proactively seeking to reduce leakage: there are no longer any pressure optimisation opportunities, and opportunities for MEG gas conditioning are also more limited going forward.

The most effective action that we can take to reduce leakage from our network is to upgrade our pipeline network. Customers are generally supportive of efforts to reduce leaks from our network. However, based on willingness to pay engagement, customers do not support such upgrades. Mains replacement is costly and needs to be consistent with long-term network planning. Further information on customer views on shrinkage is included below in part 2.

However, our forecasts, illustrated below, show a 14% to 17% reduction in shrinkage at a Cadent level over the RIIO-2 period given our proposed mains replacement programme and housing growth forecasts.

Figure 8 Cadent RIIO-2 Forecast Shrinkage Reduction Range (GWh)



Business carbon footprint

We have defined our “business carbon footprint” (BCF) to cover emissions from our day-to-day operations, excluding shrinkage. Whilst these day-to-day emissions are smaller in scale than our shrinkage emissions, the issues that we face in reducing them are faced by businesses and customers across the country and the emissions themselves are often more directly within our control.

The table below shows the categories of carbon emissions (both direct and indirect) that make up our business carbon footprint and potential initiatives that could reduce these emissions.

Table 2 Potential initiatives to reduce our business carbon footprint

| Category of carbon emissions | Scope / direct / indirect | Potential initiatives to reduce emissions |
|------------------------------|---------------------------|---|
| Energy consumption | Scope 2, indirect | <ul style="list-style-type: none"> • Improve energy efficiency; • Purchase renewable energy |
| Fleet emissions | Scope 1, direct | <ul style="list-style-type: none"> • Procure more emissions-efficient vehicles • Procure zero emissions electric vehicles (EVs) • Install EV charging points |
| Business car mileage | Scope 3, indirect | <ul style="list-style-type: none"> • Reduce the emissions cap on permitted vehicles in the scheme • Facilitate EVs by installing EV charging points |
| Own use gas | Scope 1, direct | <ul style="list-style-type: none"> • Purchase renewable energy |
| Embedded carbon | Scope 3, indirect | <ul style="list-style-type: none"> • Work with suppliers to reduce indirect emissions |

Of the areas above, those over which we have most direct control are energy consumption, fleet emissions and own use gas. We believe that by ambitiously and proactively targeting reductions in these areas, we can have the greatest environmental impact. Furthermore, action in these areas, can facilitate the reduction of scope 3, indirect, emissions, where we are reliant on the cooperation of our suppliers, contractors and/or employees.

Our environmental impact

As stated above, one of the main ways that we impact our physical and wider environment is through the generation of waste, either spoil as a result of our mains replacement programme, or direct waste such as office waste.

Whilst we aim to divert all excavated waste from landfill, we cannot control what we find during excavation and there are some problematic categories of waste, such as asbestos containing materials, for which landfill remains the most appropriate solution. Furthermore, we aim not to import any first use aggregate to backfill our excavations, however, the economic and environmental costs of transportation mean that this is not always appropriate.

The reduction of direct waste requires both a behavioural change amongst our employees and changes in facilities and/or procurement. We believe that by setting ambitious targets with respect to our own carbon footprint and waste processes, we can lead by example and support our employees to do the same. In Part 2, we consider how we can support our employees to reduce their environmental impact, both in terms of emissions and waste.

With respect to biodiversity, we may need, as part of essential works, to remove trees or vegetation. Although we have limited landholdings, there is scope for us to deliver improved spaces for nature by working in partnership with local communities and conservation organisations.

Consideration of customers, stakeholders and industry research

In formulating our environmental plan, we have been informed by the views, and willingness to pay, of our customers and stakeholders. We have also benefited from research into best practice adopted by other organisations and thought leadership on the future of the industry.

Customer and stakeholder engagement

We have undertaken significant work to ensure we understand how our customers and stakeholders view our environmental responsibilities. We can draw upon 27 engagement activities, including workshops, surveys and consultations, with over 14,000 participants and respondents.

Environmental issues were usually important to customers and stakeholders, although they were often not deemed as important as topics like safety and reliability. Examples of the importance placed

on the environment include the following:

- 83% of the 2,332 respondents to our domestic survey in October 2018 thought green company policies were very important (47%) or quite important (36%), with only 2% seeing this topic as not very important or not at all important.
- When the Energy Networks Association (ENA) engaged 78 stakeholders in September 2018 via interviews and questionnaires on the environment, innovation in environmentally friendly solutions was one reason given for positive views of gas networks.
- In September 2018, we asked 206 customers about their priorities during deliberative workshops, and 48 individuals considered 'hard to reach' in focus groups about their priorities. 'Protecting the environment and creating a sustainable energy future' was a medium priority compared to others. When we asked the same questions during interviews with 21 stakeholders, it was a high priority.
- The 65 customers at our vulnerability engagement events in August 2019 prioritised protecting the environment, and it was seen as a current issue, particularly in the context of future generations.
- At our fifth customer forum in August 2019, the most ambitious option we presented for reducing our carbon footprint was the most popular with the 130 participants.

However, it is important to recognise that views on the environment were mixed:

- In our public survey of 165 individuals in October 2018, respondents were either supportive of replacing gas with renewable sources or sceptical of climate change and therefore uninterested in green solutions. Respondents commented that there need to be global green solutions in order to make a greater impact, rather than the UK making changes on its own. Some respondents expressed support for reducing the carbon footprint of the business but felt this should be combined with minimising disruption for customers.
- When we tested different options for business carbon footprint reductions with 2,547 customers during business options testing in August 2019, results were split. The results of quantitative surveys of domestic customers favoured the least ambitious option in two of our regions, but a medium level of ambition in the other two. Non-domestic customers surveyed were more evenly split across each possible level of ambition. Lastly, participants in more detailed qualitative workshops mostly favoured the most ambitious option.

In addition to formal engagement activities, we actively participate in industry forums, working groups and one-to-one meetings with stakeholders. These include:

- Meetings with Local Authorities and regional Mayors to understand their plans and priorities, and share our plans for RIIO-2; this includes meeting relevant officials and politicians and attending larger forums and groups arranged by them.
- Meetings with Government and parliamentary groups to understand their emerging policies for the future energy system and the future role of gas.
- Ofgem's working groups to inform preparation for RIIO-2.
- Meetings with wider industry, charities and campaigners to understand their views on the environment and test our plans, and roundtable events to discuss environmental matters with them.

We have also reached out some of the largest charities and campaigning groups concerned with the environment to ask their opinions on our plan. However, at this time none have been able to provide any formal comments or feedback.

Organisations have presented varied views on the most appropriate route to decarbonising heat and the future role of gas, with no clear consensus emerging.

Further details of our engagement on specific initiatives are included throughout this document.

Research

The development of our environmental strategy has also been informed by research that we have commissioned to enable us to understand best practice adopted by other organisations and potential future scenarios for the decarbonisation of heat. We commissioned:

- Enzen, a leading consultancy, to synthesise research relating to our environmental commitments, asking them to consider best practice adopted by other UK utilities, global utilities and other organisations, including contractors and retailers.
- Ernst & Young (EY) to prepare a report on options to stimulate investment in BioSNG.
- Research from Newcastle University, in partnership with other companies, on perceptions of hydrogen.
- Progressive Energy Ltd research on the potential for network-supplied hydrogen to be used for transport.

We have also been able to draw upon a range of research by third parties, including:

- Frontier Economics' research for the Institute of Power Systems and Power Economics (IAEW) on the value of gas infrastructure in a climate-neutral Europe.
- The UK Energy Research Centre's (UKERC's) research on public perspectives on paying for the energy transition.

The insights taken from this research and our actions in response are covered in each specific area of our EAP.

Formulation of our strategy

The development of our EAP has been informed by:

- An assessment of which initiatives are cost-effective and can have the greatest environmental impact, further informed the views of our customers and stakeholders.
- The research that we have commissioned on best practice and the future of the industry.
- The strategic direction received from policy makers.

We have focused on areas where cost benefit analysis suggests expenditure can have the biggest impact and where there is the greatest scope for setting an example with transferable initiatives that can be adopted by employees, customers and other organisations.

The three business carbon footprint options, set out in our Action Plan Part 1 below, received support in roughly equal measure when they were presented to customers. However, recent trends suggest that concern for the environment is growing amongst customers. Furthermore, there has been clear direction from Ofgem that we should demonstrate ambition in our RIIO-2 planning, and the Government's 2050 target for net zero carbon emissions has shown leadership and direction in this area.

As a result, we have chosen to be ambitious in our plans to protect the environment. We have chosen the option with the highest delivery targets with respect to reducing our business carbon footprint. Furthermore, we are targeting zero avoidable waste to landfill by 2021/22.

It is our aspiration that by ambitiously addressing issues that are also being faced by other organisations, our stakeholders, customers and communities, we can lead the way to a low carbon, more environmentally aware, future. We will back this up by proactively supporting our contractors and employees in their efforts to minimise their carbon footprints and reduce waste.

In finalising the implementation of our plan, we have sought to minimise costs and prioritise early achievement where benefits are greatest. For example, we will ensure that the EV rollout is introduced in the most amenable urban locations first, and that a phased approach makes use of forecast EV price reductions in the coming years. We have built in additional protection in case delivery risks outside of our control, such as the EV supply chain not being in place; which prevent delivery of our programme.

In formulating our environmental plan, we have ensured that the actions that we have proposed to mitigate our emissions and our impact on our physical environment are consistent with the potential (and currently uncertain) longer term scenarios for the industry given the Government's net zero objective.

However, our plan also considers the actions that we need to take now to facilitate the path to decarbonisation, in which we believe the gas networks will play a key role.

Longer term scenarios for the gas industry

The Government had committed to reduce greenhouse gas emissions by 80% by 2050 from 1990 levels, and have now legislated to deliver a net-zero target by 2050. The scale of this climate change challenge is immense and urgent action is needed in the next few years to ensure pathways are available to deliver a low cost, secure and sustainable energy transition for future customers.

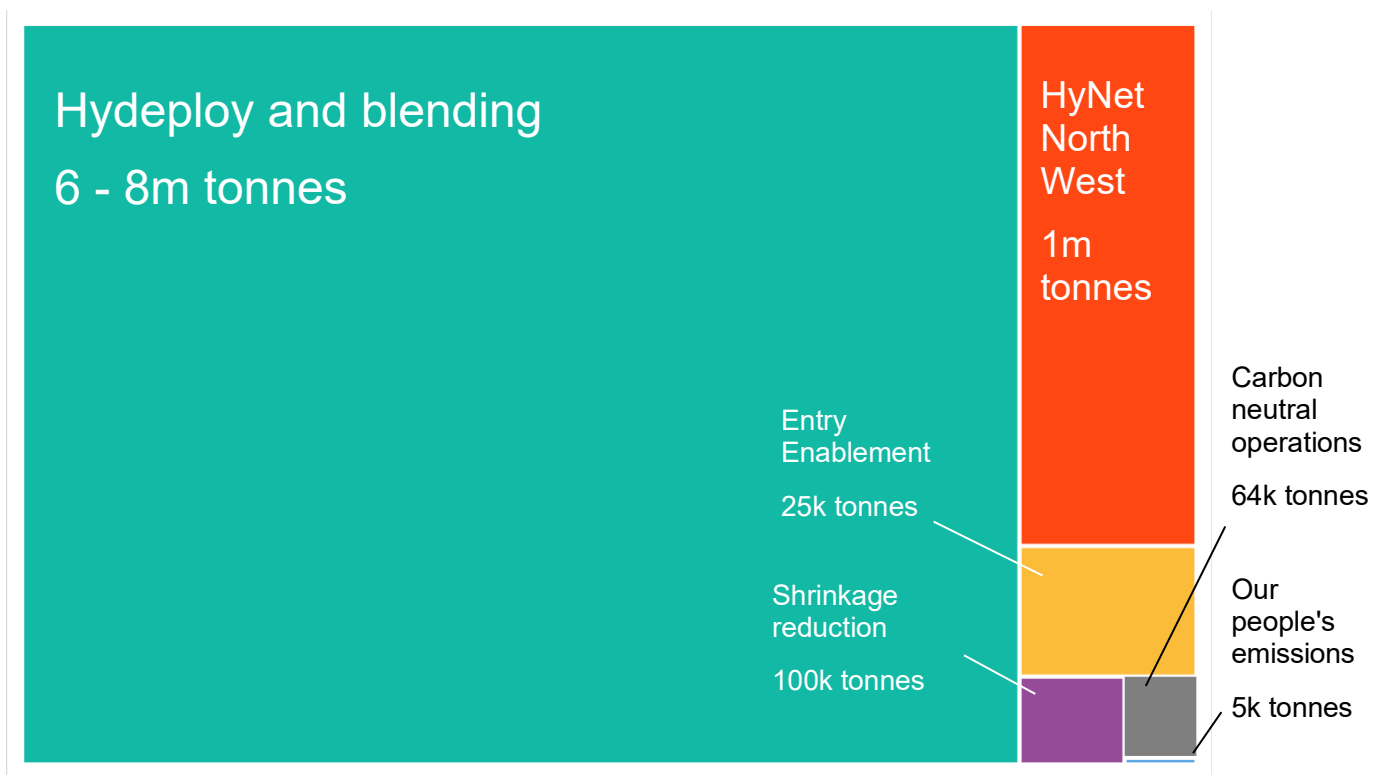
The core areas where we are taking steps to create such pathways are heat and transport. In their recent report, the CCC recognised the key role lower carbon gas and hydrogen could play in delivering the most cost-efficient and secure pathway to decarbonise heat.

We have developed and launched the HyDeploy project, designed to demonstrate how much hydrogen can be added to methane without requiring any changes to consumer appliances. This would deliver a step change in carbon emission reductions and would also enable the hydrogen supply chain to develop, prove itself, innovate, identify whole system interactions, and reduce costs.

We have also listened to our stakeholders and identified the HyNet North West project, as a strong candidate for the first hydrogen/Carbon Capture and Storage ('CCS') cluster in the UK. This project is primarily aimed at establishing a credible decarbonisation option for heavy industry, but would also provide a low carbon fuel for transport, power generation and for heating.

These initiatives have the potential to deliver significant additional reductions in CO₂ emissions. While the development of these projects is currently uncertain, and illustration of the reductions they could achieve is shown below in Figure 9.

Figure 9 Potential annual reduction in carbon emissions from longer term initiatives and our business carbon footprint



We have long been a leading voice ensuring the gas network is playing a full role in the journey to decarbonise the whole energy system. Supported by increasing research and studies, we have always believed that there are no credible future low carbon energy scenarios in which the gas network is not playing a vital role in keeping the lights on and keeping people safe and warm.

Overview of our strategy

In summary, our EAP sets four specific and challenging goals:

- We will become a net zero emissions organisation.
- We will become a zero avoidable waste to landfill organisation.
- We will support our employees in reducing their, and their communities', environmental footprint.
- We will facilitate and determine the role clean gas can play to deliver a cost-effective transition to a low carbon energy future.

Each of these goals goes beyond the legislative requirements either in scale or timetable, whilst recognising that delivery must be cost-effective, and reflect stakeholder feedback.

The actions proposed by this plan are summarised below.

Summary of EAP actions

Table 3 Summary of environmental business plan actions

| Category / number | Action |
|---|---|
| Part 1: Decarbonising our business operations | |
| Action 1: accreditation of environmental goals | We will regularly review our longer term targets beyond RIIO-2 and pursue accreditation of our goals and programmes from the Science Based Targets Initiative. |
| Action 2: shrinkage reduction | We will achieve and strive to outperform our reputational shrinkage incentive target for RIIO-2. We will report progress and the specific actions we have taken to achieve this in our Annual Environmental Report. |
| Action 3: theft of gas | As one of the components of shrinkage, we will maximise the benefits to customers and stakeholders from a theft of gas incentive, and our ambition is to recover at least £8m over the RIIO-2 period. |
| Action 4: Energy Efficiency | We will reduce all utility energy consumption by at least 10% by 2024. |
| Action 5: renewable energy | We will procure 100% certified renewable energy to meet our energy needs by 2026. |
| Action 6: business mileage | We will deliver a 15% reduction in our business mileage emissions intensity through RIIO-2. |
| Action 7: vehicle fleet | We will target a zero emissions first responder vehicle fleet across all our networks by the end of RIIO-2. |
| Action 8: embedded carbon in pipes and fittings | We are targeting a reduction in carbon intensity of our pipes and fittings throughout RIIO-2 by delivering the recommendations of a report to be published by 31 March 2021, setting out the opportunities and barriers to reducing the carbon intensity of PE pipe and fittings. |
| Action 9: work with suppliers to reduce emissions | We will work with our suppliers to extend the measurement of, and continually reduce, Scope 3 indirect emissions. |
| Action 10: measuring the carbon intensity of major projects | We will develop our methodology to measure and report on the carbon intensity of major construction projects. |
| Action 11: carbon offsetting | We will offset all residual unavoidable emissions to become a certified net-zero company using UN certified UK based schemes. |

| Category / number | Action |
|--|--|
| Part 2: Reducing our environmental impact | |
| Action 12: waste from excavations | During RIIO-2, less than 5% of our waste from excavations will be sent to landfill. |
| Action 13: minimising use of first use aggregate | During RIIO-2, less than 10% of our backfill will be first use aggregate in the North West and East of England, and 5% in the West Midlands and North London. |
| Action 14: sustainable procurement | In our annual environmental reporting, we will include a summary of the environmental and sustainability criteria we have used in all significant procurement events. |
| Action 15: reducing our employees' carbon footprint | We will work with our employees to help them and their communities deliver a reduction of 5,000 tonnes CO ₂ e a year by the end of RIIO-2. |
| Action 16: key site environmental enhancement plan | <p>We will publish our key site environmental enhancement plan as part of our environmental and sustainability annual reporting before the start of RIIO-2. We will then update these plans, and report on performance and delivery annually through the RIIO-2 period.</p> <p>We will undertake the Wildlife Trusts biodiversity benchmarking process to ensure that our actions plans are robust and conform to these externally assessed standards.</p> |
| Part 3: Facilitating the low emissions energy system transition | |
| Action 17: review of distributed gas entry arrangements | We will lead an industry review of distributed entry gas commercial arrangements to establish methodologies that are robust, sustainable and scalable, with the ambition of presenting initial change proposals to Ofgem prior to the commencement of RIIO-2. |
| Action 18: funding for entry gas reinforcement | We will establish and utilise a flexible funding regime for entry gas reinforcements, supported by an appropriate uncertainty mechanism. |
| Action 19: entry gas customer and stakeholder forum | We will establish an Entry Gas Customer and Stakeholder Forum to allow customers and stakeholders to raise issues, for the gas network to test issues we have identified, to identify and action knowledge sharing, and to establish and maintain an activity schedule of framework changes. |
| Action 20: entry gas connections methodology | We will establish a Entry Gas Connection Standards Methodology statement and a supporting voluntary governance arrangement to enable customers and stakeholders to propose value adding improvements. |
| Action 21: off gas grid communities | We will conduct a trial to identify small communities where the gas network can be extended at a low cost. |
| Action 22: off grid gas communities | We will establish a community connection support service to identify and advise communities that could economically connect to the gas grid. |
| Action 23: HyNet | Given a direction from Government and/or Ofgem, we will submit proposals to create a HyNet system operator function and to design and construct the hydrogen transportation network with a supporting commercial and operational framework, to meet customer and stakeholder requirements for hydrogen in the North West of England. |
| Action 24: hydrogen blending | We will ensure an efficient and effective hydrogen blending regime can operate at the earliest opportunity, with the end consumers protected financially by paying for the energy they receive, and from unsafe gas blends. |
| Action 25: hydrogen conversion | We will support Government plans for large scale trials of hydrogen conversion. |
| Action 26: emergency / back-up network role | We will ensure the network can support increasing use in emergency, back-up and peak conditions, serving and protecting the whole energy system. |

| Category / number | Action |
|---|--|
| Action 27: decarbonisation of heating | We will promote and build up the evidence case that supports least cost, least disruptive options for our customers to decarbonise their heating. |
| Action 28: evidence for electrification | We will ensure all the evidence for alternative options, including the wide scale electrification of heat are challenged and based on robust analysis and information. |
| Action 29: decommissioning plans | We will develop robust decommissioning plans and protocols to protect consumers during the transition, following the publication of the detailed strategy and programme to install alternative systems. This may not occur during RIIO2. |
| Action 30: Annual Environmental Reporting | We will report annually on our environmental performance, including progress against the actions in our RIIO-2 EAP, and any additional regulatory requirements. We will seek stakeholder feedback to continually improve our reporting through RIIO-2. |

The graphs below illustrate the forecast reductions in carbon emissions by initiative over the RIIO-2 period. The table shows the emission reductions by year, relative to the baseline at the start of the RIIO-2 period, and the associated incremental totex costs incurred.

Figure 10 Carbon emissions before offsetting (tCO2e)

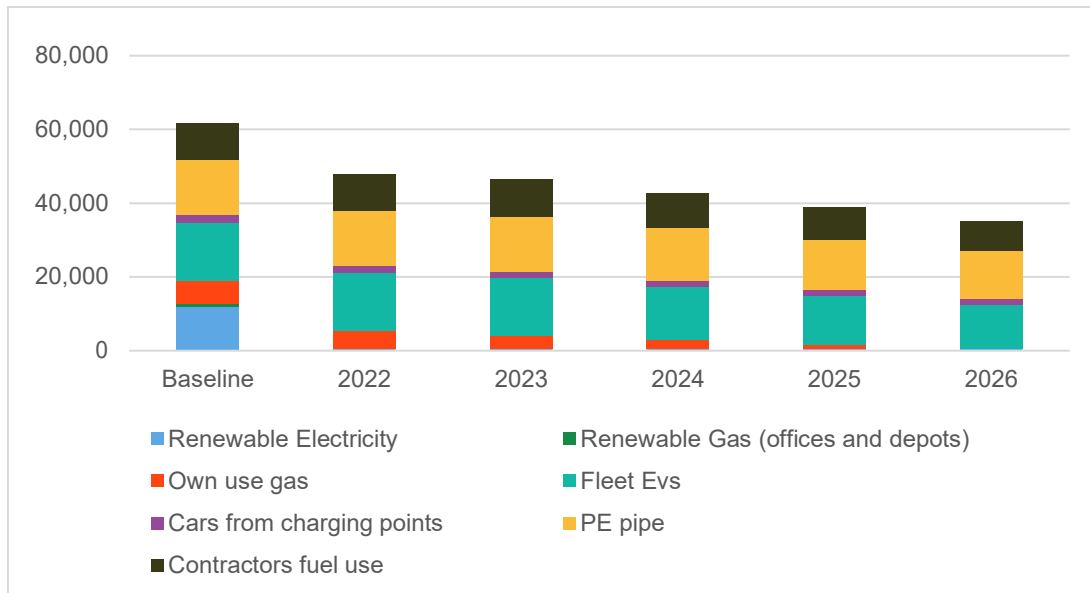


Table 4 Non-shrinkage emissions reductions per year relative to baseline at the start of RIIO-2 (tCO2e)

| | Base line | 2022 | 2023 | 2024 | 2025 | 2026 | Cost to deliver in RIIO-2 |
|---|-----------|---------------|---------------|---------------|---------------|---------------|---------------------------|
| Renewable electricity | 12,000 | 11,500 | 11,500 | 11,500 | 11,500 | 11,500 | |
| Renewable gas | 750 | 750 | 750 | 750 | 750 | 750 | £0.39m |
| Own use gas | 6,000 | 1,200 | 2,400 | 3,600 | 4,800 | 6,000 | |
| Fleet electric vehicles | 16,000 | 160 | 320 | 1,540 | 2,772 | 4,000 | £49.6m |
| Business mileage (including charging points at sites) | 2,000 | 164 | 254 | 343 | 425 | 500 | £4.8m |
| PE pipe | 15,000 | 0 | 0 | 667 | 1,333 | 2,000 | - |
| Contractors' fuel use | 10,000 | 0 | 0 | 667 | 1,333 | 2,000 | - |
| Total emissions savings | - | 13,774 | 15,224 | 19,067 | 22,914 | 26,750 | |
| Offsets | - | 5,000 | 5,000 | 15,000 | 20,000 | 35,000 | £0.76m |

Structure for the rest of the document

The remainder of our EAP is structured into three parts:

- **Part 1: Decarbonising our business operations**

This part of our EAP considers the greenhouse gas emissions that our business is responsible for, either directly or indirectly, and initiatives that we propose to reduce such emissions under the following headings:

- Shrinkage (including gas theft)
- Direct (scope 1 & 2) emissions (including stakeholder engagement)
- Indirect (scope 3) emissions (including embedded carbon)
- Managing uncertainty and deliverability of net zero emissions

- **Part 2: Reducing our environmental impact**

This part of our EAP considers the impact of our business operations on our physical environment under the following headings:

- Spoil and other waste associated with excavations
- Direct waste generated and accumulated on sites
- Helping our employees reduce their environmental impact
- Community, biodiversity and natural capital
- Water consumption

- **Part 3: Facilitating the low emissions energy system transition**

This part of our EAP explains how we propose to support the transition to an environmentally friendly, and flexible, low carbon and low emissions energy system under the following headings:

- The story so far (the emergence of biomethane and the road to zero emissions); and
- Supporting our customers of tomorrow (the potential end states for the UK energy system - green gases, 100% hydrogen, peak and emergency energy store and decommissioning).

Our Action Plan Part 1: Decarbonising our business operations

We are committed to driving down the emissions from our operations, prioritising activities to reduce leakage with a further commitment to reach a net zero non-leakage business carbon footprint ('BCF') by the end of the RIIO-2 period. This target net zero ambition excludes most shrinkage related emissions but we have included our own use gas within this key climate change commitment. This commitment reflects the urgency with which we view the need to address emissions directly under our control, and align closely with the Government's net zero pathway by 2050. Due to the importance we attach to this commitment and the range of actions we will take to deliver it, it is underpinned by Appendix 07.04.04 A carbon neutral business.

The first stage in that journey will drive real reductions which are efficient and cost-effective. This will always be at the core of this commitment, but to achieve carbon neutrality, we will need to use certified emissions offsetting schemes, as promoted by the Government to address what are currently unavoidable emissions. Action through later regulatory periods will permit further real emissions reductions and consequently a reduction in the reliance on offsetting, as reductions in currently unavoidable emissions become more practicable.

As a key enabler, and to provide greater clarity and robustness to this commitment, we will review and challenge our longer term targets for 2050 and pursue accreditation of our goals and programmes from the Science Based Targets (SBT) Initiative. The commitments in our Business Plan, including in this EAP, will put us in a strong position to deliver on restated targets according to SBT principles, and secure SBT accreditation.

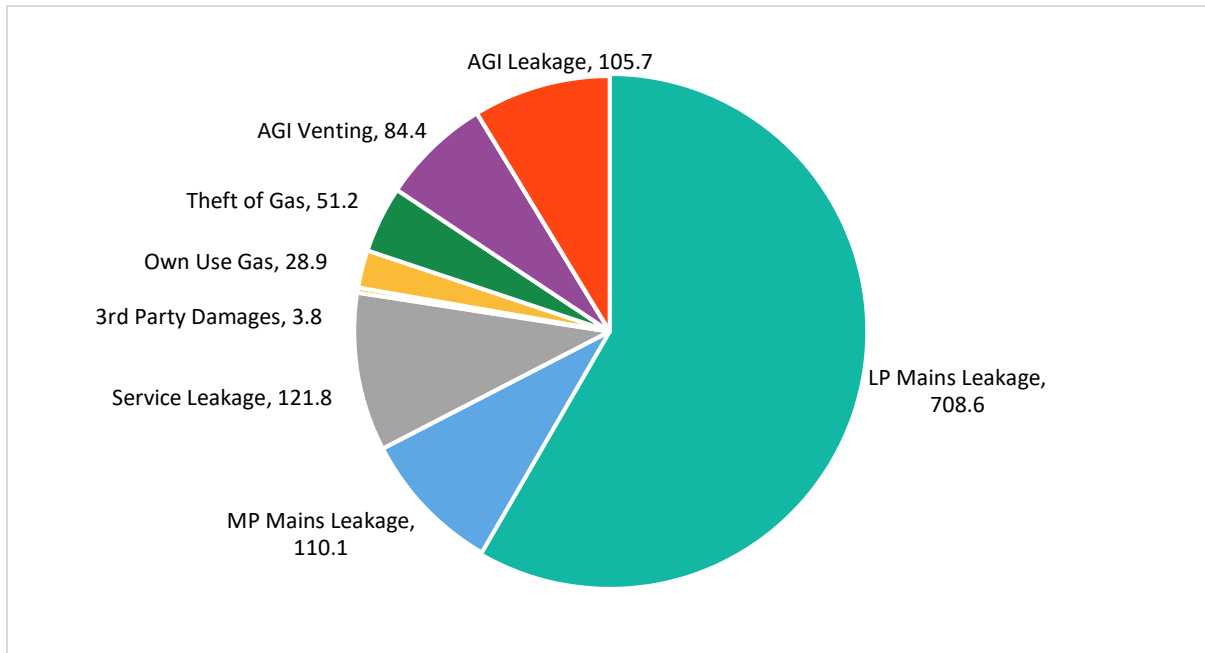
| Action | 01 |
|---|----|
| We will regularly review our longer term targets beyond RIIO-2 and pursue accreditation of our goals and programmes from the Science Based Targets Initiative. | |

Shrinkage (including theft of gas)

Methane is a strong greenhouse gas, with over 100 times the global warming potential of CO₂. A small part of the gas we transport in our network is lost, which is known as shrinkage. Leakage from our pipes is less than 0.5% of overall throughput, and is hence relatively small compared to electricity losses for example.

Different components are shown in Figure 11 below:

Figure 11 Shrinkage Breakdown 2018/19 (GWh)



The largest component of shrinkage, and our impact on greenhouse gas emissions, is leakage from low pressure old metallic pipes in our network.

The most effective action we can take to reduce leakage remains the replacement of these assets; upgrading our pipeline network with modern low emissions materials. In addition, the level of leakage is a function of the system pressures that we operate the network to. If pressures are reduced then leakage reduces, although the extent to which we can do this is capped by the need to maintain a safe operating pressure to deliver supplies to end customers. We are also able to reduce leakage by applying gas conditioning via MEG to joints within the iron pipes.

Customer and stakeholder views

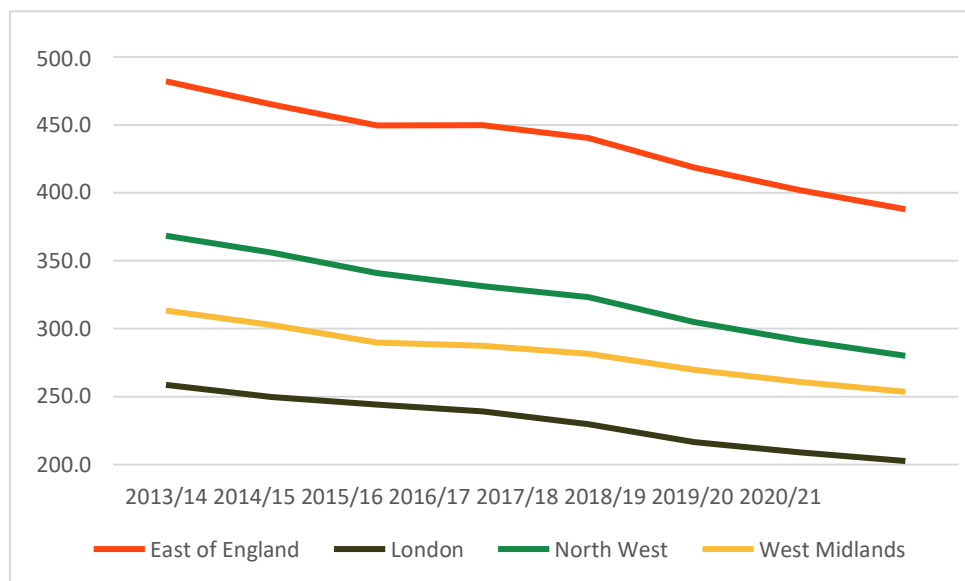
Our customers indicated that they broadly support activities addressing shrinkage loss. 206 participants in our discovery phase deliberative workshops highlighted the importance of minimising leaks, for both environmental and safety reasons. 91% of the 2,332 participants in our domestic survey said that reducing gas leakage was ‘very important’ or ‘quite important’ to them. Older respondents, those with gas mains, social renters, homeowners, those without children and those without a relationship with Cadent were most likely to view this as important.

Our survey of 783 employees also supported the importance of shrinkage, as ‘minimising gas leaks’ was scored as the third highest priority.

However, we tested the willingness to pay for reduced leakage and our stated preference survey found zero willingness to pay for a decrease in the proportion of gas lost through leakage (we tested reductions to 0.45%, 0.35% and 0.25% compared to a baseline of 0.6%).

RIIO-1 performance

Figure 12 Overall RIIO-1 Shrinkage Performance



Note: 2020/21 numbers are indicative.

We expect to have driven down leakage of gas to under 28% of its 1990 baseline by the end of the RIIO-1 period (compared to the start of the price control). On top of the delivery of the mains replacement programme, our investment into optimising pressure management and improving the effectiveness of gas conditioning has driven leakage down further. The latter two elements have now reached their maximum as pressures cannot be lowered any further without risking reliability issues and breaching our network safety case.

Gas conditioning via MEG saturation has reached a high, given that we are progressively replacing the old metallic pipes year on year, hence conditioning will be less useful.

Optimising mains replacement

We have considered the optimal mains replacement programme for RIIO-2 by assessing our statutory requirements to satisfy the Pipeline Safety Regulations and through engagement with our stakeholders on the optimal discretionary level of replacement. We outline the options we considered and the engagement process we have carried out in detail in the customer outcome area ‘Delivering a resilient network to keep the energy flowing safely and reliably’, in Chapter 7 of our Business Plan.

We explicitly tested the level of cost benefit replacement customers were willing to pay for, and the relative priority that they placed on replacement being targeted across safety risk, interruption avoidance and leakage reduction. Our conclusion from this insight is that customers are willing to pay for cost benefit work and have a preference for a balanced targeting across the criteria, rather than any one of the specific areas (such as leakage reduction). In determining the level of replacement, we also assessed the need to manage the uncertainty of potential different pathways to decarbonisation more generally, and the need to ensure that our decisions do not hinder, and indeed help facilitate, these pathways.

The commitments we are making in our Plan therefore see us delivering our base level of statutory requirements under the iron mains replacement programme, a targeted programme of replacement of the highest risk steel pipes, with the addition of our mid-option level of cost benefit analysis justified work. We have modelled this level of replacement into our forecast of leakage.

Pressure management

Our investment in pressure management profiling systems, automatic control measures and further innovations in use of gas conditioning in RIIO-1 has greatly enhanced our ability to manage leakage across the large parts of our networks. This has enabled us to drive the average system pressure in particular to its lowest optimal point, given the need to maintain a safe and reliable operating pressure to our customers. The RIIO-1 incentive has resulted in us seeking the lowest possible operating pressures. We cannot deploy lower pressure settings without risking minimum pressure breaches at our customer's point of use, which would breach our safety case.

These investments and techniques will continue to help us manage leakage in RIIO-2 but there are several factors that are likely to increase pressure from the levels we are currently operating at.

Firstly, average system pressure is dependent on the weather and largely the number and pattern of cold days that are experienced, which stretch the network to deliver reliable supplies to customers. Hence forecasts need to take account of peak day requirements.

Secondly, there is an interaction between the system pressure and the replacement programme in terms of the level of insertion that is being targeted (i.e. where a pipe is replaced by inserting a new, narrower pipe within the existing pipe). This method is much lower cost than the alternative of 'open cutting', which involves much greater excavation and roadwork impact. We have assessed the optimal trade-off between pressure management, capacity and replacement costs in determining our overall plan and extent of insertion.

Thirdly, new customer demand from gas power stations, compressed natural gas fillings stations and gas entry customer requirements may require an increased pressure profile to optimise the network and make capacity available for these resources to connect. The impact will vary, however, depending which pressure tier they are connecting to.

We have therefore taken account of these factors in our shrinkage forecasts.

Gas conditioning

The effectiveness of gas conditioning will reduce as mains replacement progressively removes the older sections of pipeline that can benefit from the treatment. Our expectation is that gas conditioning saturation levels will not increase from levels we are aiming to achieve by the end of RIIO-2, and most likely will fall over RIIO-2 back to levels similar to our current outturn levels.

By innovating, we will continue to investigate practical techniques to reduce leakage during RIIO-2 including the use of robots and other internal treatments. This is one of our Innovation Strategy themes.

Own use gas

Own use gas is the remaining controllable area of shrinkage, excluding theft of gas which is discussed below. This is a very small component of shrinkage, but we confirmed elsewhere in this EAP our commitment to procure renewable low carbon gas to cover this energy use. We have also committed to improve energy efficiency including own use gas. Compliance with the requirements of the Medium Combustion Plant Directive (now translated into the Environmental Permitting Regulations) will also act as a lever for more efficient, lower emissions plant and help reduce own use gas.

Forecast shrinkage for RIIO-2

The graph below shows our projected shrinkage forecast volumes over the RIIO-2 period, using as a starting point our latest published forecast for our end of RIIO-1 position (2020/21). We have set out two scenarios:

Table 5 Shrinkage Targets and Ambitions

| Assumption | Shrinkage target level | Shrinkage ambition level |
|--------------------|---|--------------------------------------|
| Weather conditions | Peak demand conditions | Seasonal normal demand |
| Demand | Housing growth based on published local authority plans | |
| Gas conditioning | Current saturation levels | Higher end of RIIO-1 ambition levels |
| Mains replacement | Plan km targets and insertion rate assumptions | |

Shrinkage target levels – peak conditions

Using the assumptions above, the shrinkage forecast for RIIO-2 is shown in Figure 13 below:

Figure 13 Cadent RIIO-2 Peak Winter Shrinkage Forecast (GWh)

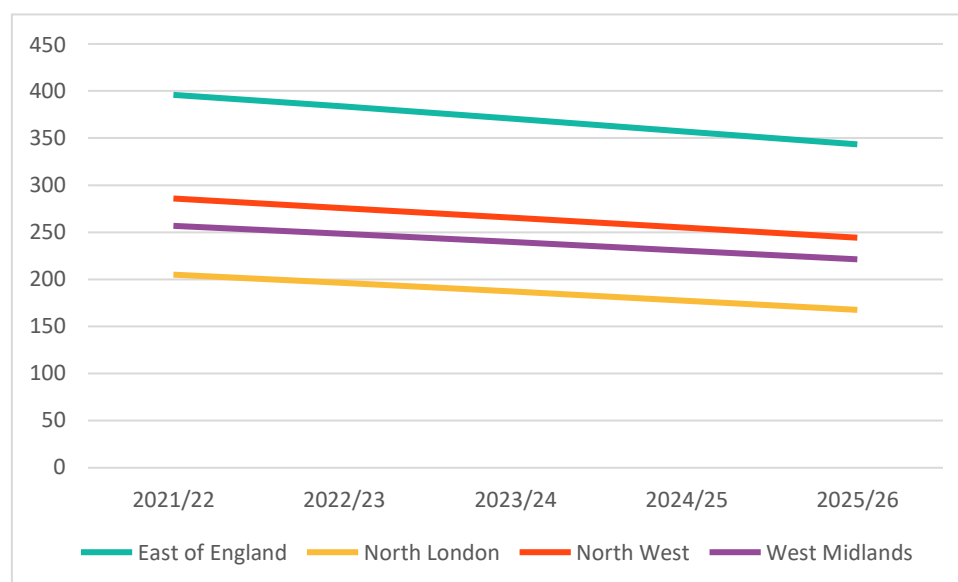


Table 6 Peak Winter Shrinkage Forecast (GWh)

| | 2020/21 | 2021/22 | 2022/23 | 2023/24 | 2024/25 | 2025/26 | Reduction |
|-----------------|-------------|-------------|-------------|-------------|-------------|------------|------------|
| East of England | 393 | 396 | 383 | 370 | 357 | 343 | 13% |
| North London | 203 | 205 | 196 | 187 | 177 | 168 | 17% |
| North West | 281 | 286 | 276 | 265 | 255 | 244 | 13% |
| West Midlands | 252 | 257 | 248 | 239 | 230 | 221 | 12% |
| Cadent | 1129 | 1143 | 1103 | 1062 | 1019 | 976 | 14% |

The forecast shows a target 14% reduction in leakage at a Cadent level, with a range from 12% reduction in the West Midlands to 17% reduction in North London.

Shrinkage forecast – seasonal normal weather

We have modelled the outcome under a seasonal normal weather condition, which would drive a lower average system pressure, and assuming a better gas conditioning outcome.

Table 7 Seasonal Normal Shrinkage Forecast (GWh)

| | 2020/21 | 2021/22 | 2022/23 | 2023/24 | 2024/25 | 2025/26 | Reduction |
|-----------------|-------------|-------------|-------------|-------------|------------|------------|------------|
| East of England | 393 | 384 | 372 | 359 | 347 | 334 | 15% |
| North London | 203 | 196 | 188 | 179 | 170 | 161 | 21% |
| North West | 281 | 273 | 264 | 254 | 244 | 234 | 17% |
| West Midlands | 252 | 245 | 237 | 229 | 220 | 212 | 16% |
| Cadent | 1129 | 1099 | 1061 | 1022 | 981 | 941 | 17% |

This shows an increased forecast reduction to 17% over RIIO-2 at the Cadent level, with a range from 15% to 21% across our networks.

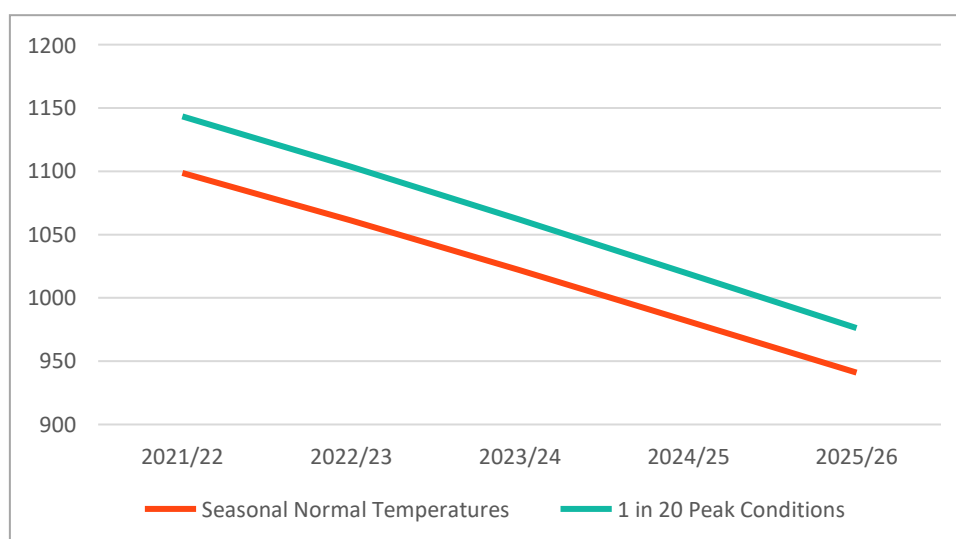
Regulatory considerations

Ofgem have prescribed a reputational incentive for the overall shrinkage forecast target level, and a bespoke financial incentive for gas conditioning and average system pressure based on the end of RIIO-1 performance levels. We have some significant concerns with the operation of the financial incentive in terms of its consistency with the rest of the RIIO-2 framework, its practicality and its value, which we will continue discussing with Ofgem.

We will report on our performance against our shrinkage target forecast, and take appropriate actions to optimise these measures, balancing the various competing incentives.

As the overall shrinkage incentive is reputational, we believe our performance should be assessed within the range defined by the worst case “Peak” scenario and the more typical Seasonal average view set out above. Broadly therefore, we would expect shrinkage to outturn in the range 14-17% for Cadent across RIIO-2, against our current expectation of the end of RIIO-1 position. This would deliver emissions reductions between 0.4m and 0.6m TCO₂.

Figure 14 Cadent RIIO-2 Forecast Shrinkage Reduction Range



| Action | 02 |
|---|----|
| We will achieve and strive to outperform our reputational shrinkage incentive target for RIIO-2. We will report progress and the specific actions we have taken to achieve this in our Annual Environmental Report. | |

Theft of gas

Theft of gas is an industry-wide problem that has been estimated to cost between £220m and £400m each year – theft contributes to the volume of shrinkage gas, and therefore the cost is ultimately paid for by customers.

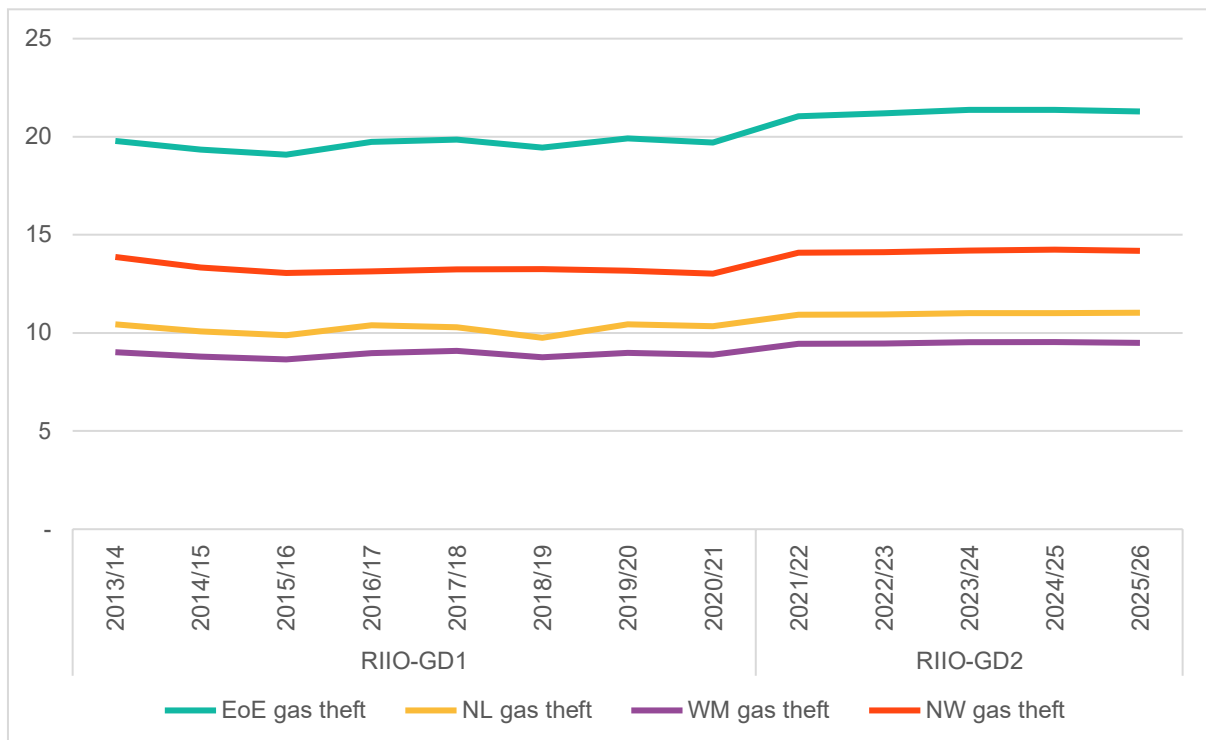
In addition to increasing shrinkage, those who take gas from our network without paying have no incentive to reduce their consumption, so this has a further negative impact on the environment.

During RIIO-1, our activity has been driven by our licence obligation to investigate and seek to recover costs where we are made aware of such occurrences, i.e. a reactive obligation. We are funded by retaining any monies recovered to cover our costs, however this does create a shortfall as not all investigations result in recovery of costs, and does not provide an incentive for the networks to innovate to identify theft. Between 2014 and 2019, this resulted in a shortfall of £840k.

In RIIO-2 we are proposing a new incentive mechanism, as we believe this will drive greater levels of theft investigation and cost recovery, increasing monies returned to customers, with the added benefit of reducing the risk presented by unsafe and potentially dangerous behaviours. The incentive mechanism we have set out is also designed to be simple and straightforward, proportionate to the value involved, and we believe is in the best interests of customers.

Figure 15 outlines our historic gas theft records and forecast gas theft to the end of RIIO-2. It is important to note that the table relates to shrinkage definitively identified as gas theft i.e. gas we can confirm as having been stolen, not total gas theft. Our **Output Case 07.04.05, Tackling the Theft of Gas** outlines our ambition to identify more gas theft in RIIO-2. It is for this, positive reason, that we present an upward trajectory across all networks.

Figure 15 Gas theft identification RIIO-1 and RIIO-2



| Action | 03 |
|--|----|
| <p>As a component of shrinkage, we will maximise the benefits to customers and stakeholders from a theft of gas incentive, and our ambition to recover at least £8m over the RIIO-2 period.</p> <p>Further detail on our approach to theft of gas can be found in Appendix 07.04.05 of our Business Plan.</p> | |

Direct (scope 1 & 2) emissions

We have made good progress in reducing our business carbon footprint, as defined and reported throughout our RIIO-1 regulatory reporting. We are already outperforming Ofgem’s targets set for 2021, and will continue to drive further reductions in areas within our direct control.

Overall, the target is to reduce our aggregate Scope 1⁸ and 2⁹ emissions by 20% during RIIO-1 from a 2012/13 level of 48,691 tonnes CO₂e.

- For Scope 1 emissions, we have targeted a 5% reduction over the RIIO-1 period
- For Scope 2 emissions, we have targeted a 27% reduction.

We are on a pathway to outperform our emissions targets throughout the RIIO-1 period. For emissions defined in BCF as Scope 1 and 2, we are ahead of our 2020/21 targets, having achieved an overall reduction of 32.5% compared to our 1990 baseline(at the end of 2018/19).

For each area of our business carbon footprint, we have identified an ambitious set of actions, which we have then extended and challenged further to make them as stretching as possible.

⁸ Scope 1 emissions are direct emissions from owned or controlled sources

⁹ Scope 2 emissions are indirect emissions from generation of purchased energy

Table 8 Business Carbon Footprint Ambitions

| Area | Target | Cost to deliver in RIIO-2 | Stretch from RIIO-1 |
|---|---|---------------------------|--|
| Renewable electricity | Incremental energy efficiency improvements supported by higher quality metering data. | | 90% certified renewable at the end of RIIO-1 |
| Renewable gas | Purchase 100% renewable energy for all energy we directly consume in our offices and depots by end of RIIO-2. | £0.39m | 100% above RIIO-1 |
| Own use gas | Procure 100% renewable energy for the gas consumed at operational sites for gas pre-heating and other process-related needs. | | 100% above RIIO-1 |
| Fleet electric vehicles | Targeted procurement of most emissions-efficient vehicles for our commercial fleet and prioritising lowest emissions vehicles for use in urban areas. Zero emissions emergency first responder vehicles across all our networks. | £49.6m | A step change from RIIO-1 diesel dominated fleet |
| Business mileage (including charging points at sites) | Deliver enduring reductions in business mileage carbon intensity over RIIO-2. 15% reduction in emissions intensity. EV charging points at every office and operational depot site. Extended depot and home charging to support emergency response. | £4.8m | TBC |

In each of these areas, Cadent has developed targets and action plans designed to outperform incremental change as delivered through RIIO-1 and strive for step change actions in RIIO-2. The plans aim to deliver real emissions reductions in overall shrinkage and drive for net-zero in all other non-shrinkage emissions (scopes 1,2 and 3).

Continued incremental reductions through RIIO-2 would have been the lowest cost option, but would deliver the least change. We have set a more ambitious target following engagement.

We sought the views of customers and other stakeholder on three options.

Option 1

Energy consumption

The least ambitious and lowest cost option is to continue with incremental reduction targets, supported by ongoing Energy Savings Opportunities Scheme (ESOS) audits. Consumption reduction, greater energy efficiency and subsequent emissions reductions are core to the journey and we will

have completed an extensive automatic meter reading programme to support greater visibility of consumption. However, we believe we should take bolder steps and are proposing to procure 100% renewable energy to account for all consumption under our direct control by the end of the period. This will include:

- All metered electricity consumption at offices, depots and operational sites, including telemetry and cathodic protection
- All metered gas consumption at offices and depots
- All own use gas consumed at operational sites for gas pre-heating and other process related needs
- Targeted procurement of the most emissions-efficient vehicles for our commercial fleet and prioritisation of the lowest emissions vehicles for use in urban areas.

These proposals are relatively low cost, and universally supported by our engagement with customers and stakeholders.

We will contract for the provision of 100% certified renewable electricity and gas. Should a supplier not be able to guarantee 100% renewables, we will offset any residual related emissions. For all metered supplies, this will be achieved within the first two years of the RIIO-2 period. We are also committed to procuring renewable gas to meet our own use gas needs.

Whilst our energy supplier has not indicated we will have a challenge in securing sufficient green gas certificates, we are well aware that there is uncertainty in the capacity of the renewable gas markets to meet this increase in demand immediately without impacting on demands for transport or other needs. A major component of this uncertainty arises from the future of the Renewable Heat Incentive, which has supported the bulk of existing biomethane investments. The current scheme runs out in 2021, with no replacements yet in place. A Government policy consultation signposted for 2019 on a replacement scheme is yet to be published. The main political parties have stated their support for green gas, so we would expect a replacement scheme to be in place in time to support our green gas certificate purchase plans in RIIO-2. We have recognised this uncertainty by proposing a phased approach to reach our green gas target by the end of the five year period.

Fleet emissions

We operate over 3,000 vehicles in our commercial fleet, mainly 3.5 tonne vans which are required to meet the size and payload requirements of our operational teams.

Currently, diesel-fuelled vehicles are the only viable and cost-effective choice. We are trialling other technologies including compressed natural gas ('CNG'), and all our core and vac vehicles can use both CNG and diesel. However, throughout the next RIIO periods our procurement strategy will at a minimum match Government targets and exceed them as opportunities arise. This is a conservative, lowest cost approach, but one that is achievable and parallels activity at a national level.

Option 1 is well supported as the lowest cost, most achievable option but will nevertheless deliver a step change in the way we manage and account for our energy consumption and related emissions.

Option 2

This option includes each of the steps from Option 1 but adds a further, challenging step – reducing the impacts of our commercial fleet and supporting employees using cars for business travel.

The vehicle requirements of our First Call Operatives ('FCO') are lighter than most of our operational teams, and in today's markets their needs may be met by fully EV's. Option 2 proposes zero emissions first responder vehicles by investing in EVs for every FCO operating in our North London network. Vehicle use in London is a significant consideration, with increasing concerns around vehicle emissions, local air quality and noise, as well as congestion, and other, charging. The required vehicles will be procured and deployed throughout the RIIO-2 period, reducing exhaust emissions of these vehicles to zero, including NOx and particulates.

The primary reason for proposing to deliver this zero emissions fleet in North London first relates to the complexities and uncertainties involved. Delivery across one network will be a challenge, but will be a lower risk approach than pursuing the same aim across all our networks. We propose to start in

London rather than our other networks due to the greater population density, meaning higher numbers of customers would benefit from the change. We do note, however, that the air quality and other non-carbon environmental requirements are common to other metropolitan areas and there is a strong case for deployment across all our networks or a balanced approach, introducing EVs across the high workload areas of a number of cities. This is addressed in Option 3 below.

The charging infrastructure to support these EVs will need to be enhanced, and Option 2 includes the provision of EV charging points at every office and operational depot site. This will have the additional benefit of supporting business drivers to make more sustainable vehicle choices, and will reinforce our programme of supporting low emissions vehicle choices for business travel through caps and incentives.

Option 3

This option includes all the elements of Options 1 and 2 above but drives a more widespread deployment of EVs, providing these to all FCOs in each network through the RIIO-2 period. This increases the Capex requirements, but will deliver wider Opex reductions by avoiding increased exposure to charges for driving within congested urban areas or air quality action areas. Phasing the deployment through the RIIO-2 period also reduces operational risk by ensuring that a compliant vehicle will be able to attend emergencies as required.

Use of EVs for FCOs will also require change in practice and behaviours due to the limited range on a single charge. Where FCOs are based in their service area and are dispatched from home, we propose to install, where practicable, home charging facilities for FCOs. Greater deployment of EVs for FCOs will also require further investment in depot-based charging facilities to ensure accessibility of charging points and fully charged backup vehicles are available.

Greater rollout of charging points will also support greater employee uptake of EVs for wider business purposes.

Stakeholder feedback on options to decarbonise our business operations

Engagement activities

We have engaged with over 15,000 stakeholders and customers on this topic, using a range of engagement methods including activities specific to RIIO-2. We have also assessed best practice, taking lessons from companies such as Marks and Spencer and Unilever, who have announced all their energy use comes from 100% renewable sources. In addition, they ensure staff are trained in conserving energy, even down to delivery drivers' driving habits.

During our engagement, customers discussed the specific issue of reducing Cadent's environmental footprint by using EVs, as did staff during our employee workshops in August 2019. In all instances, the future use of EVs received a mixed reaction.

Therefore, in order to test stakeholders' views on the specific options we were proposing, we undertook a business options testing process with over 2,500 customers in August.

Through this engagement, we found that Option 1 was marginally more popular in the results of our domestic business options testing survey, receiving 38% of the vote, compared to 34% and 28% for the more ambitious Options 2 and 3.

In follow-up qualitative workshops, which allowed further time to explain our proposals, the majority of customers supported our most ambitious, stretching option: a net zero business carbon footprint by the end of RIIO-2.

Stakeholder feedback was split fairly evenly across the three options with no overriding preference for any of the options.

There was a difference in preference by region, and in North London, where it may be expected that a customer would be more concerned about the clean air impact of EVs, there was actually a clear

preference for Option 1, while at the qualitative workshops in Manchester and Birmingham, Option 3 was the preferred option.

For the businesses surveyed, the message was slightly different, with Option 2 being the most favoured with 36% of the vote, while Options 1 and 3 received 33% and 30% respectively.

Triangulating feedback on options to decarbonise our business operations

As customer feedback was mixed regarding the specific options, we undertook a more formal decision-making process, witnessed by members of our Customer Engagement Group, to make the final decision on the option we would present in our Business Plan.

Through a formal assessment of the options (triangulation review) Cadent took the decision to follow the most ambitious route: Option 3. This option is the most aligned to the UK's commitments under the Climate Change Act and international targets in the form of the Paris Agreement. It is also strongly supported by Cadent's Board and senior leadership, aiming to demonstrate further effective leadership in the decarbonisation agenda.

In doing so, we chose to balance customer feedback with the clear direction outlined by Ofgem, that we demonstrate ambition in our RIIO-2 planning, and the leadership demonstrated by the Government's 2050 target for net zero carbon emissions.

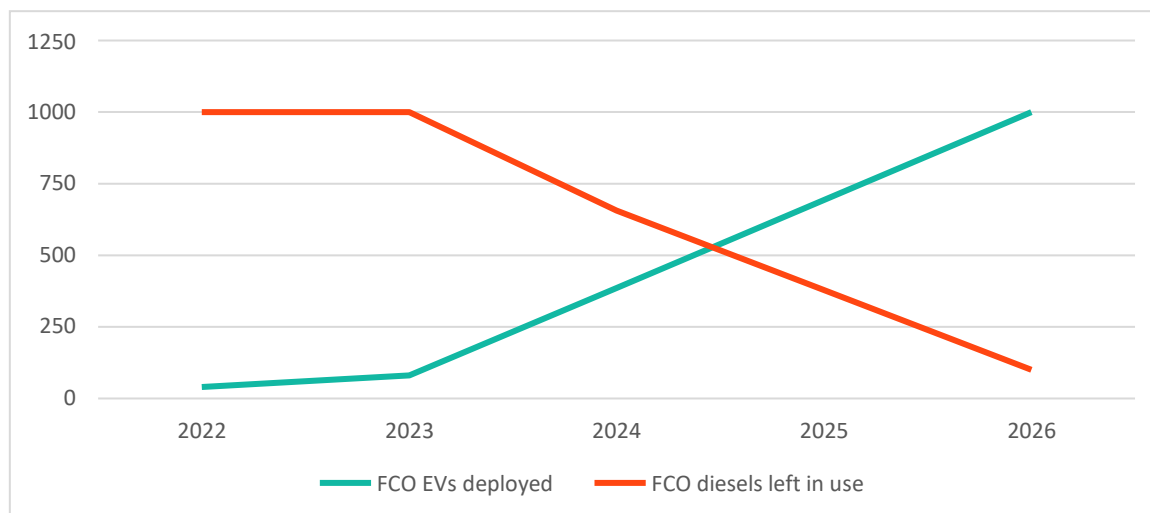
This direction from policy makers was crucial to our decision to choose the most ambitious of the three options, which received customer support in roughly equal measure.

In making this decision, we acknowledge that aspects of the plan – notably the introduction of EV vehicles into our first responder fleet – will result in costs to customers.

Therefore, in implementing this option we have undertaken deliverability planning to ensure the EV rollout is introduced in the most amenable urban locations first, and that a phased approach makes use of forecast EV price reductions in the coming years. The deployment of First Call Responders EVs following a trial in 2022 is described in more detail in Output Case 07.04.04 and is illustrated in Figure 16 below. We have built in additional protection in case delivery risks arise outside of our control, such as the EV supply chain not being in place; which prevent delivery of our programme. In such an event we would anticipate the funding being carried over into the RIIO-3 period. The objective is to reduce emissions, therefore alternative options that will emerge would be explored, such as the use of hydrogen or compressed biomethane.

When we tested these proposals alongside our other commitments, over 80% of domestic and non-domestic customers found the environmental elements of our business plan acceptable.

Figure 16 deployment of first call responders' electric vehicles



In adopting the more ambitious proposals, our key environmental actions for RIIO-2 are summarised below:

| Action | 04 |
|---|----|
| <p>We will reduce all utility energy consumption by at least 10% by 2024.</p> <p>Detailed targets to be set following the 2019 ESOS exercise, permitting an informed, all-encompassing energy efficiency strategy to be embedded before the start of RIIO-2. We will pursue reduction targets in excess of 10%, over and above the reduction of 27% we have already delivered to date. Our planned move to a single central location within a modern, efficient building will also be a key enabler that will be included within these efficiency targets.</p> <p>Measures: Total energy consumption, energy intensity of top 10 energy consumption sites, on-site generation of renewable energy.</p> | |

| Action | 05 |
|--|----|
| <p>We will procure 100% certified renewable energy to meet our energy needs by 2026.</p> <ul style="list-style-type: none"> We will change our procurement approach to embed a commitment to purchase 100% renewable energy to meet the electricity needs of our offices and depots within the first two years of the RIIO-2 period, reducing this element of our BCF emissions to zero. Throughout the RIIO-2 period, we will work with our energy suppliers to procure 100% renewable gas equivalent to our own use gas consumption. This will effectively reduce this component of our BCF to zero. We have an asset replacement programme aimed at improving the thermal efficiency of all pre-heat provision across our networks, to reduce consumption and further reduce the carbon intensity of our own use gas needs. Measures: total own use gas, total certified renewable gas and energy intensity per GWh throughput. | |

| Action | 06 |
|--|----|
| <p>We will deliver a 15% reduction in our business mileage emissions intensity through RIIO-2.</p> <ul style="list-style-type: none"> We will drive behaviour change and accompanying alternatives to travel for the business to reduce its total mileage annually. We will continue to reduce the cap on permitted vehicles in the company car and salary sacrifice fleet, and use individual vehicle emissions factors to calculate and reduce the emissions intensity of our business mileage. This will provide a more realistic estimate of our business mileage emissions and demonstrate that they are at least comparable with the high-level estimates based on DEFRA conversion factors which we currently report, which show a 23% reduction. To support our people in making the right vehicle choices, we will accelerate our plans for EV charging infrastructure at our sites, targeting installation of 175 points by the end of RIIO-2. <p>Measures: total business mileage, average (business user) vehicle emissions, emissions intensity e.g. emissions per 1,000 miles travelled.</p> | |

| Action | 07 |
|--|----|
| <p>We will deliver a zero emissions first responder vehicle fleet across all our networks by the end of RIIO-2.</p> <ul style="list-style-type: none"> We are committed to replacing all vehicles used by FCOs with zero tail pipe emissions vehicles by the end of the RIIO-2 period. These vehicles comprise around 30% of our fleet. As the fleet vehicle market changes, we will reassess the strategy for our remaining fleet and, where possible, accelerate the procurement of further ultra-low emissions vehicles. Replacing our FCO vehicles with electric vehicles will reduce our commercial fleet emissions by more than 30% over the RIIO-2 period. <p>Measures: Fleet fuel consumption, EV charging energy use, emissions intensity e.g. emissions per 1,000 miles, number of FCO vehicles, number of zero emissions FCO vehicles.</p> | |

Indirect (scope 3) emissions

Alongside the direct Scope 1 and 2 emissions described above that comprise our business carbon footprint we are also committed to act on our Scope 3 emissions¹⁰. As a result of our activities, we procure or use a range of goods and services which give rise to indirect emissions or emissions embedded in the products such as PE pipe and fittings. This element of our commitment will require us to engage, motivate and work with our supply chain to deliver reductions in these emissions.

There are several benefits associated with measuring indirect (Scope 3) emissions. For many companies, the majority of greenhouse gas (GHG) emissions and cost reduction opportunities sit outside their own operations. The most effective routes to reduce these emissions are by considering them alongside steps taken to improve resource efficiency and selection of materials. By measuring indirect emissions, companies can:

- assess emission hotspots in their supply chain;
- identify resource and energy risks in their supply chain;
- identify which suppliers are leaders in their sustainability performance;
- identify energy efficiency and cost reduction opportunities in their supply chain;
- engage suppliers and assist them to implement sustainability initiatives;
- improve the energy efficiency of their products; and
- positively engage with employees to reduce emissions from business travel and commuting.

We have an established Global Supplier Code of Conduct which requires all suppliers to meet the standards we set in environmental and social performance. As part of this, we require specific disclosure of data relating to emissions impact.

During RIIO-1, we recorded and reported on indirect, Scope 3, emissions embedded in pipe and fittings used in mains replacement (see below) and contractor vehicle usage.

Through the RIIO-2 period we will extend our accounting and reporting of Scope 3 emissions to include other principal indirect emissions and engagement more widely in our supply chain.

We will account for the indirect emissions associated with the management of waste, initially using DEFRA conversion factors to establish baseline values. We will work with our waste management contractors to establish emissions from the transport and other related activities arising from the management of our wastes. This would include any potential emissions gain through the use of our waste as feedstocks in waste to energy facilities.

We will work with our in-house Estates Team and third party providers to develop the data to account for the indirect emissions due to our use of cloud based computing solutions in parallel with the reduction in our own energy use. This would help prevent masking of direct emissions reductions by exporting the emissions to a third party.

We will also implement a common standard for sustainability options appraisal and carbon accounting in construction and other capital projects. This has been piloted within the Integrated Security Solutions project and has led to new best practice. This includes using hydrogen fuel cell lighting on our construction sites and major redesign of key aspects of the civil engineering design.

Accounting for carbon will be used as a decision support tool in design and project delivery, optimising material usage and transport which are frequently the most carbon intensive elements of a project.

Contractor vehicle emissions will be measured and subject to the same goals as for our own direct operations.

¹⁰ Scope 3 emissions are indirect emissions (not in scope 2) that occur in the value chain of the company (either upstream or downstream).

Embedded Carbon in our supply chain

Pipe and fittings

We already measure and monitor embedded carbon in the PE pipe and fittings we procure to support our mains replacement and repair activities. Whilst a regulatory driven replacement programme is in place it is challenging to set specific reduction targets without compromising delivery.

We do, however, see multiple opportunities to increase the efficiency with which we use procured pipe and fittings and reduce wastage within our processes. Through the RIIO-2 period we will target reductions in the embedded carbon, per km replaced, and we will work with our pipe and fittings suppliers to reduce embedded carbon at source. The production of these items is relatively energy intensive and has related issues of transport emissions and packaging which are seen as opportunity areas over the RIIO-2 period.

Current gas industry standards set out stringent specifications for the materials used in construction of PE pipe for gas infrastructure, including the permissible recycled content. We will work with our colleagues in the other gas networks to investigate the opportunities for changing these specifications to permit wider use of recycled materials, if strength, safety and other requirements can be met.

As a key enabler for target setting we will carry out the necessary research to determine routes to reduce the environmental and carbon intensity of pipe and fittings and use this to propose effective targets from the start of RIIO-2.

| | |
|--|-----------|
| Action | 08 |
| We are targeting a reduction in carbon intensity of our pipes and fittings throughout RIIO-2 by delivering the recommendations of a report to be published by 31 March 2021, setting out the opportunities and barriers to reducing the carbon intensity of PE pipe and fittings. | |

Our current recorded scope 3 footprint, comprised of the embedded carbon in procured pipe and fittings combined with the emissions due to our contractor fuel use is currently about 30,000 tonnes.

Our current reporting is not comprehensive. Our action plan will be built on engaging more widely with our supply chain to establish a revised scope 3 emissions baseline which accounts for at least 80% of our supply chain by value. We will work with our suppliers and the Supply Chain Sustainability School programme to raise awareness of the issues of embedded and indirect emissions and establish targets that will drive reductions before the end of RIIO-2.

This approach is already being piloted through the remaining period of RIIO-1 working with the entire contractor cohort involved in the Critical National Infrastructure Security upgrades at our Above Ground Installations. All contractors and Cadent project supervisors are being trained in the use of a consistent carbon accounting methodology (Name of the MACE tool). We have already demonstrated across this project that this approach drives real resource efficiency and hence indirect emissions reductions and form a model to deploy more widely across our supply chain.

New Projects

For major capital delivery projects, we will establish a methodology for carbon calculation and sustainability appraisal to be deployed for all new projects developed and sanctioned during RIIO-2. The methodology would include the tracking of change in carbon intensity between the designed stage and delivered stage.

| | |
|--|-----------|
| Action | 09 |
| We will work with our suppliers to extend the measurement of, and continually reduce, Scope 3 indirect emissions. | |
| Measures: Total embedded carbon tCO ₂ e in laid pipe; Total embedded carbon per km laid | |

| | |
|--|-----------|
| Action | 10 |
| We will develop our methodology to measure and report on the carbon intensity of major construction projects. | |
| Measures: Carbon intensity per £million expenditure | |

Managing uncertainty and deliverability of net zero emissions

At the core of our Action Plan are real emissions reductions through consumption efficiencies. This will be accompanied by a range of offsetting measures, the first of which will be the procurement of renewable energy to meet our needs. This will be subject to market availability and competitive pricing. The optimal approach to offsetting will be reviewed throughout the period.

The greatest uncertainties lie with zero tail pipe emissions vehicles. The two key variables in this Action Plan are the cost of the vehicles and available range of alternatively fuelled (battery EV) vehicles.

The capital cost of vehicles is falling so the cost-effectiveness of this proposal may improve over the period.

The vehicles will need to be fit for purpose, providing usable range for our FCOs on a single charge per shift. The technology is improving rapidly but, based on current capabilities, phased rollout will be required over the final 3 years of RIIO-2, following smaller scale trials in 2021 and 2022. We propose early deployment in city centre areas where range will be less of an issue, and as capabilities improve, we will extend this to all areas of all networks. However, should there be a significant shortfall in the capability of zero emissions vehicles, and we can demonstrate we have considered all credible options, we will roll this commitment into RIIO-3 when improved technologies are likely to be available.

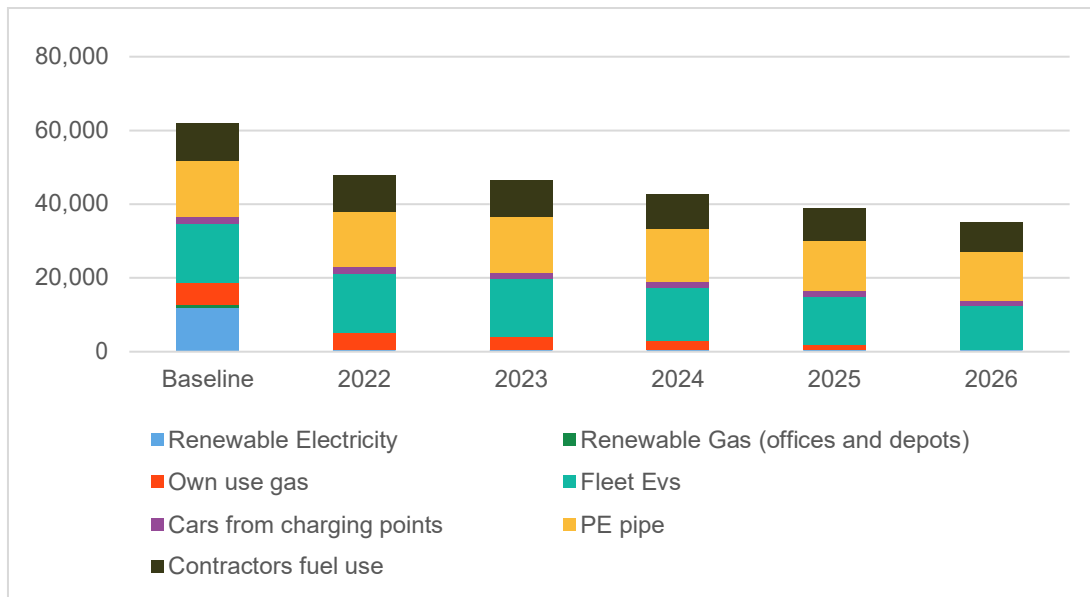
Effective emissions reductions will not deliver a net zero outcome. Measurement of our business carbon footprint shows that indirect emissions due to the procurement of plastic pipe and fittings for mains replacement are a key component of our emissions inventory. Along with the associated activities to replace our pipes, there will be a core element of emissions that are unavoidable until large scale mains replacement ceases. To reach a net zero position, these unavoidable indirect emissions, along with the remainder of our direct emissions, require an effective offsetting programme.

Offsetting will be achieved through partnership with third parties and will exploit UK based certified or UN Gold Standard offset mechanisms. There are very effective, and socially valuable, overseas offsetting schemes available. However, our offsetting programme costs are estimated on the basis of UK tree planting, supported by Climate Change, the Government's appointed offsetting partner.

Offsetting through tree planting in the UK is one of the most expensive routes to offset emissions. It is however visible and tangible to our customers and stakeholders. It also has a range of contingent benefits in creating new habitat, improving biodiversity, stabilising soils and helping reduce flood impacts. New tree plantings are also a social gain, providing access to new natural areas with proven benefits to health and wellbeing.

| | |
|--|-----------|
| Action | 11 |
| We will offset all residual unavoidable emissions to become a certified net-zero company. | |

Figure 17 Business Carbon Footprint Emissions Reductions (tonnes CO2e)



Our Action Plan Part 2: Reducing our environmental impact

As a responsible business, it is incumbent on us to become more resource-productive, to manage our consumption of finite natural resources and reduce the amount of waste material that we dispose of. We have embedded a highly effective environmental management system and supporting control measures to avoid or mitigate environmental impacts, and have used the system to show how we can drive even greater performance through the RIIO-2 period.

We have already made significant progress in managing our waste. Our contract partners are routinely exceeding Ofgem's target of sending less than 10% of waste spoil and excavation to landfill. In parallel, we have driven significant reductions in our waste management performance.

We have applied a parallel focus on managing waste from Cadent's direct operations. In 2015/16, over 25% of our waste was sent to landfill. This was reduced to 20% by 2018 and is currently below 14%. Through mapping the fate of our wastes through the waste management chain, we have demonstrated that there are key opportunities for us to improve further. In particular, we will address behavioural, organisational and technical factors that are resulting in some recyclable materials and natural resources being either landfilled or incinerated as fuel rather than being recovered. This results in loss of the financial and intrinsic value for reuse of valuable non-renewable natural resources.

Impact areas

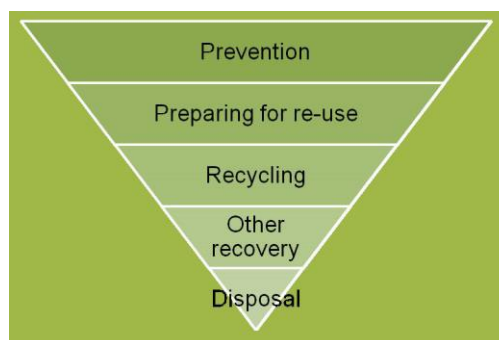
Our environmental management system shows us that greenhouse gas emissions are our most significant environmental impact, followed by management of waste arising from our activities. This section of our EAP covers the use of resources and the other areas of our activities that impact the environment, including biodiversity and natural capital.

Effective and more resource-efficient management of processes giving rise to waste involves many factors. Our impact hierarchy shows that we generate two principal waste streams:

- **Spoil and other waste associated with excavations** to replace ageing underground metallic gas pipes
- **'Direct' waste generated and accumulated on sites** as a result of our own operational and office-based activities

Each waste stream is managed according to the waste hierarchy¹¹, an established ranking of management options according to what is best for the environment. It promotes reduction, reuse and recycling, with landfill (disposal) being the least favourable and most expensive option.

Figure 18 the waste hierarchy



¹¹ https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/69403/pb13530-waste-hierarchy-guidance.pdf

Stakeholder engagement on reducing our environmental impact

Sources of insight

At our future generations workshops, the 45 participants were asked to rank the following environmental priorities: 'Removing avoidable plastics from our operations', 'Use more recycled materials' and 'Set a target of 95% of spoil to be diverted from landfill'. These scored second, third and fourth highest respectively (out of a total of 14 options).

Many of the 200 participants at our fourth customer forum thought the initiatives in this commitment were generally low cost and easy to deliver, albeit limited in their impact.

80 of our employees participated in an August 2019 workshop, the majority of whom understood the need to improve our environmental footprint. Many participants felt that Cadent was already doing a lot to achieve this, but that these initiatives were not being communicated enough internally. Examples given included removing single-use plastics and not handing out stationery unnecessarily.

At one of the workshops for non-English speakers or those who speak English as a second language, different environmental measures were discussed. There were differences in the importance that different groups attached to each measure. All groups ranked 'Use more recycled materials and recycle more' somewhere within their top priorities, with some viewing it as the most important because it is a simple and achievable measure.

During focus groups with 48 hard-to-reach people, participants were concerned that we should use recycled or recyclable plastics in our pipes. This concern was echoed by some of the 206 customers in the deliberative workshops.

'Use less paper, water, energy and fuel' was also ranked highly, with many participants saying that achieving zero waste is an effective way to proactively become carbon neutral. 'More efficient use of pipes to reduce the amount of plastic we need' was also ranked as high priority due to the large scale of our pipe network.

When customers and experts were asked about their views on Cadent's plans to reduce its business carbon footprint by our partners Verve for their August 2019 report, Cadent's previous (current at the time) plan was not enthusiastically received by either customers or experts. Many experts felt that nothing should be going to landfill and one expert said that 5% should be the maximum. Some also expected to see more emphasis on reuse.

While the removal of single-use plastics from offices and depots in 2019 was universally liked by customers, the target of zero avoidable plastic in the supply chain by 2025 wasn't considered ambitious enough. Our use of the term 'avoidable' waste (defined as waste that is not TEEP: not technically, economically or environmentally practicable to be recycled) in the target was felt by some as a loophole which could give us too much leeway.

There were also some concerns that landfill wasn't being further reduced. Waste management plans were considered ambitious by some experts and only acceptable by others. The single use plastic reductions were viewed positively, but there was again some uncertainty over the use of the term 'avoidable' plastic. Experts from the construction industry wanted greater emphasis on recycling and reuse.

Acknowledging feedback on options to reduce our environmental impact

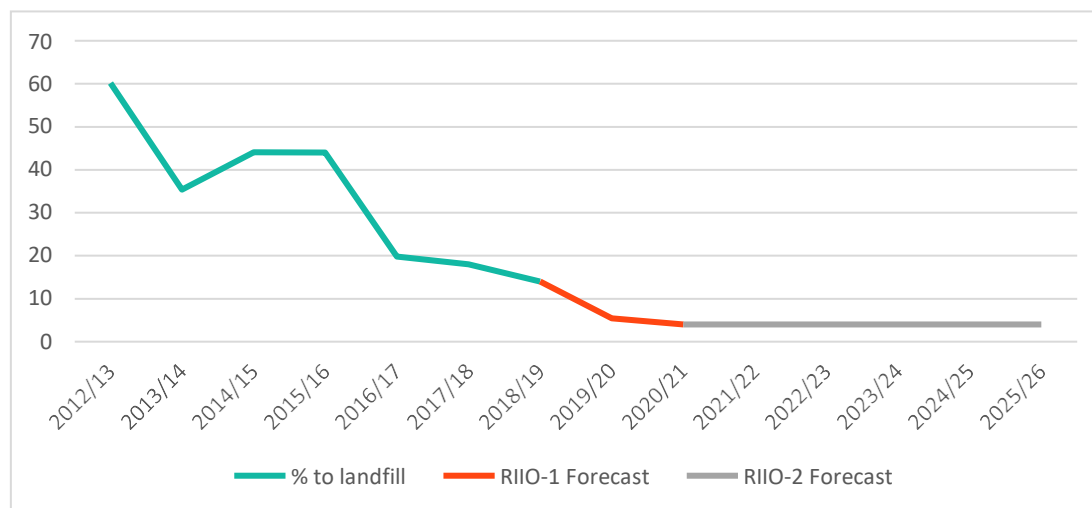
We are pleased that customers support our ambition to minimise our environmental impact.

We acknowledge that in some instances, such as business waste to landfill, customers called for us to be even more ambitious. Therefore, we have decided to accelerate our activities in this area and have set a target of zero avoidable waste to landfill by 2021.

We also acknowledge customers' concern that our targets relate to 'avoidable waste'. Unfortunately, this caveat must remain within our planning given that certain substances cannot currently be practically recycled due to TEEP reasons.

We use a TEEP test to applying the waste hierarchy to each component of our waste streams. We have already commenced on a programme to map every component of our waste that is currently not routinely recycled. Working with our waste management provider this triggers a detailed consideration of the options that could be deployed and whether it conforms to TEEP. This approach, founded on the waste hierarchy, will help us deliver both reductions in waste to landfill but also innovative approaches to reduce waste at source.

Figure 19 percentage of waste sent to landfill



While our ambition is to send zero avoidable waste to landfill, a small proportion of waste will not be possible to avoid. Therefore, our target is to send less than 5% to landfill overall. However, our ability to achieve landfill use as low as 4% in some months demonstrates our commitment to tackling this challenge, and we will seek to reduce below 5% wherever possible. We will regularly publish our ongoing strategy for continuous improvement.

Spoil and other waste associated with excavations

Spoil generated from our mains replacement programme is our most material source of waste. In 2018/19, we generated over 415,000 tonnes of this waste.

We and our mains replacement contractors are currently outperforming the RIIO-1 target of 90% diversion from landfill. In 2018/19, over 97% of this waste was diverted from landfill through reuse or recycling.

We are also outperforming the RIIO-1 target of importing no more than 30% first use aggregate. Currently, this is 11% across our operations.

Our aim is to target 100% diversion of excavated waste from landfill and to import 0% first use aggregate.

However, we cannot control what we find during excavation. We have to deal with what we uncover, and some problematic wastes are encountered which are not technically, economically or

environmentally feasible to divert from landfill. Hazardous asbestos containing materials, glass reinforced plastics, sealant foams and some types of glass are all examples of wastes for which landfill is currently the most viable option. Although diversion of 100% from landfill remains our ambition we are committing to maintain the challenging target for our action plan of diverting from landfill at least 95% of excavated spoil from our mains replacement programme, with an aim of 100%. In our annual environmental performance report, we will include information on the composition of the material we send to landfill, alongside possible further steps we can take to reduce or remove this type of waste stream.

Similarly, for the material used to backfill our excavations, some geographic areas have extensive quarrying operations and little spoil recycling infrastructure. The economic and environmental impacts of excessive transport to meet targets mean that our proposed targets will be regional, and all will be less than 10%, with the aim of 0%.

| | |
|---|-----------|
| Action | 12 |
| <p>During RIIO-2, less than 5% of our waste from excavations will be sent to landfill. We will report on the waste that is sent to landfill and the actions underway to reduce this further.</p> | |

| | |
|---|-----------|
| Action | 13 |
| <p>During RIIO-2, less than 10% of our backfill will be first use aggregate in the North West and East of England, and 5% in the West Midlands and North London.</p> | |

Achieving these targets will support a more circular approach to the management of a high volume waste stream. It will also help to promote effective management of spoil arisings especially segregation of wastes minimise amounts deemed as hazardous (which reduces costs to manage). Similarly setting challenging targets for waste management supports further innovation to reduce spoil arisings from no- or low- dig approaches to mains replacement and repair.

Changes in Environment Agency requirements to assess and classify wastes from utility excavations may, however, drive more waste to landfill and incur greater costs to Cadent in the short term due to uncertainty in implementation.

Direct waste generated and accumulated on sites

We have made significant strides in the management of waste as a result of our direct activities. We have reduced the amount of waste sent to landfill from 20% in 2016 to 10% today (rolling 12 month averages), with current in-month performance reaching as low as 4%. This waste reduction realises financial benefits in addition to environmental improvements.

We have already set a **target of zero avoidable waste to landfill by 2021**. Achieving and maintaining this goal requires behavioural change amongst our employees as well as changes in facilities. Subsequently, we are implementing wide-ranging improvements at our sites to promote segregation of waste. This will enable increasing recovery and recycling of a wider range of materials. Small examples of this include the removal of all paper towels from occupied sites.

There are strong pressures to reduce plastic waste, reflecting legislative drivers in Europe and the UK, changes in practice in Asia regarding the acceptance of plastic wastes for recycling, and significant media coverage illustrating the impact of plastics on our environment. This has also been an issue which attracted attention in our customer forums.

Plastic is a hugely important commodity in view of its resilience, strength and flexibility and for many uses it remains an ideal material, including the use of PE pipe and fittings as replacement gas distribution materials. Current gas industry standards set out stringent specifications for the materials used in construction of PE pipe for gas infrastructure, including the permissible recycled content. We will investigate the opportunities for changing these specifications to permit wider use of recycled

materials, if strength, safety and other requirements can be met. This will be one of the key deliverables set out above (Action 8) as part of our commitments to reduce our scope 3 emissions.

We have made significant commitments to remove **all single use plastics from our offices and depots by the end of 2019** and **all avoidable plastics from our supply chain by 2025**. We will use the TEEP test as the tool to determine what is, and is not, avoidable. We have already made considerable steps in this direction, we have already removed all plastic cups and disposable plastic hot drink and food containers from our offices and depots.

We are trialling alternatives to plastics for packaging and transport of fittings and we are working with our suppliers to address the use of plastics in our supply chain, particularly delivery of the large volumes of PPE that we use, demonstrating that they drive positive economical and environmental solutions.

We will introduce greater weighting for environmental and sustainability criteria in procurement exercises – for instance, requiring the development of closed-loop supply of plastic barriers, cones and other street furniture and will report on how we have included environmental and sustainability factors in our procurement processes.

| Action | 14 |
|---|----|
| In our annual environmental reporting, we will include a summary of the environmental and sustainability criteria we have used in all significant procurement events. | |

Overall environmental performance on our sites

We recognise that compliance with legal and regulatory requirements is the minimum standard that stakeholders would expect. However, we believe that good standards of environmental management at our sites drive efficiency and ultimately safety of our people and our communities. We want to go beyond the level set out in law and in regulations, so we have set our standards for environmental management of our sites to reflect this. Our site baseline performance is based on the scores from a check list of 54 environmental aspects grouped into 7 themes carried out at every one of our occupied sites. Our performance against our internally generated ‘compliance-plus’ standard has improved from an average baseline score of 63% to 78% in 2018/19, and we have set 100% targets for 2021/22. Our improvement plans address management and performance against the key themes, shown below. We will re-evaluate our baseline and targets and set more challenging targets including proactive measures, and links to local biodiversity and habitat (discussed further below) and we will continue to drive improvements over and above the baseline standard throughout the RIIO-2 period..

Table 9 baseline scores

| Compliance theme | 2017 score | 2018 score |
|------------------------|------------|------------|
| Site appearance | 77% | 79% |
| SHES notice board | 52% | 67% |
| Spill response | 64% | 71% |
| Hazardous substances | 69% | 80% |
| Oil storage | 51% | 59% |
| Waste water management | 46% | 54% |
| Waste management | 76% | 78% |

Helping our employees reduce their environmental impact

We will implement our goals in a way that engages our employees, raises awareness of the issues faced by everyone in the environment we share, and promotes Cadent as a role model. We will empower our people to deliver smaller scale change that collectively makes a positive contribution.

We have evidence that small pilot programmes (which tap into the will and enthusiasm of our people) can reduce their carbon or wider environmental footprint. Small changes by individuals, when delivered at scale, encouraged through incentives and robustly measured, have the potential to result in real reduction in our collective footprint. This can be measured and delivered alongside the actions taken at a corporate level and supports a clear line of sight between individual and company objectives.

| Action | 15 |
|--|----|
| We will work with our employees to help them and their communities deliver a reduction of 5,000 tonnes CO₂e a year by the end of RIIO-2. | |

Key areas in which our employees impact the environment through greenhouse gas emissions and waste include:

- Commuting to work and business travel;
- Use of non-renewable resources at work and home, including plastics;
- Energy consumption at home;
- Minimisation and segregation of waste;
- Acting as low carbon ambassadors at home and in the community;
- Positive action through volunteering with environmentally-centred charities or other groups.

A voluntary small scale, four week employee challenge delivered in Cadent during February 2019 demonstrated clearly the progress that a group of committed people can make in a short period of time.

The average household carbon footprint is generally estimated at around 5 to 8 tonnes per year¹². If we could reduce each household's carbon footprint by 1 tonne per year through the measures above (which we estimate is realistic by the end of the price control) then, given we have more than 4,000 direct employees and there would be further knock-on impact on their communities, we would save around 5,000 tonnes CO₂ per year.

However, we are aware that most employee engagement and initiatives like the sustainability challenge are rarely adopted holistically. A 100% uptake across our employees is very unlikely to be achieved, but effective communication and tailored support to our people and the communities they serve have provided the basis for an ambitious aspiration to target people-scale change.

The steps we have already taken lead us to believe that we can mobilise our workforce to support our ambition and deliver real and measurable savings in emissions and overall environmental impact. The actions align with our wider proposals to be a carbon neutral business, including supporting our employees to make more sustainable transport choices such as low emissions vehicles.

The rationale and cost of these proposals is covered in more detail in our **Output Case 07.04.07 Our people and their emissions**.

Our progress will then be demonstrated through calculating cumulative reductions through the actions taken and verified e.g. the annual average reduction in emissions from a household switching from an oil to a gas fired central heating boiler, or air source heat pump.

¹² Estimates vary – for example: <https://www.theccc.org.uk/wp-content/uploads/2016/07/5CB-Infographic-FINAL-.pdf>

Community, biodiversity and natural capital

When it was part of National Grid, the gas distribution business was part of the ‘natural grid’ programme for enhancing natural capital and ecosystem services. However, since the change in ownership, we do not have extensive landholdings and opportunities to continue this programme. In particular, our landholdings have reduced during RIIO-1 with the disposal of the larger areas of land around gas holder sites.

However, we comply with all statutory requirements and good practice guidelines for managing the natural environment at our sites and during construction activities. A particular example of this is site reinstatement following security upgrades at a number of our critical national infrastructure sites. Our contractors engage with local communities to develop bespoke site remediation plans, which include commitments like 4-1 replanting of trees, hedgerow, grass and wildflower replanting.

We are committed to improving the environment by planting four trees/hedgerow plants for every one removed. Planting schemes are agreed as part of project planning and often achieved in partnership with our neighbours, using native species in keeping with the local environment.

We prepare site environmental baselines at each of our sites. This involves a set of 50 questions to understand environmental features and characteristics of each site and inform plans for environmental improvements. We maintain bespoke baselines and plans for each site (as opposed to, for example, a generic set of actions for a given type of site). We are in the process of adding biodiversity questions to these baselines and through 2020 we will establish a formal set of biodiversity data for each site and prepare improvement actions accordingly.

At a site in East London we worked with a neighbouring school to establish planting that provided them with a new natural resource accessible to all students. At some sites, such as Tur Langton we removed 35 trees and replaced with 140 new plants, providing greater visual screening and providing new natural capital and potential habitat. During essential works at Drointon, replanting on site was not possible. However, in this case, 350 new trees will be planted at a nearby woodland site supported by The Conservation Volunteers (TCV) in place of the 80 trees removed.

Although we have limited landholdings, we will implement programmes through the remainder of RIIO-1 and into RIIO-2 to deliver improved spaces for nature and communities through working in partnership. We are committed to putting in place detailed plans for environmental enhancements at our key sites, prior to the start of RIIO-2. This will involve working closely with local communities and partner organisations that can bring their own specialist and unique resources.

| Action | 16 |
|---|----|
| <p>We will publish our key site environmental enhancement plan as part of our environmental and sustainability annual reporting before the start of RIIO-2. We will then update these plans, and report on performance and delivery annually through the RIIO-2 period.</p> <p>The Key Sites Environmental Enhancement Plan will consider themes including:</p> <ul style="list-style-type: none"> Habitat and ecosystem enhancement working in partnership to improve woodland and other habitats in areas associated with our activities and accounting for the gain in natural capital and ecosystem services. Local collaborations to tailor the management of our site and boundary hedges etc. to complement the neighbouring environment. We will undertake the Wildlife Trusts biodiversity benchmarking process to ensure that our actions plans are robust and conform to these externally assessed standards. | |

Our Community Fund may provide support for further community environmental initiatives. The Community Fund will look at a range of options with specific activities such as increasing biodiversity and people’s access to green space, with positive impacts on mental health and other social issues. For example:

- Biodiversity and habitat creation.** The amount of space and quality of habitats is decreasing, but small changes can have significant benefits. This can be as simple as providing bat boxes/bird boxes/ bird feeders, to more active approaches to promoting the variety of flora at sites to supplement and complement the local environment.

- **Tree planting.** The CCC reported that the UK needs to plant ~30,000 hectares of woodland per year to help offset societal greenhouse gas emissions and reach net-zero. We can commit to support this aim, over and above its own net-zero programme, through woodland creation schemes. We do not have sufficient landholdings to create our own woodlands so partnerships with the Woodland Trusts or National Forest, tree planting at Wildlife Trust sites for example, can facilitate this.
- **Urban areas.** Trees are good for improving air quality, provision of shade and water management. Such areas could be an excellent opportunity to develop partnerships in the community with Wildlife Trusts in rural areas and Groundworks (for example) in urban areas. Working with community groups we can establish specific wooded areas or improve, manage and increase the population of street trees.
- **Green Gyms and Community green spaces.** *Green gyms* are fun and free outdoor sessions with guided practical activities led by trained group leaders such as planting trees, sowing meadows and establishing wildlife ponds. They contribute to greening the local community, provide access to green space and opportunities to volunteer and work in green spaces with positive impacts on mental health and wellbeing. They will tend to be tailored to local community needs, resources and supported through Wildlife Trusts, Groundwork or TCV.
- **Community:** There will be a number of ways in which we can change the way we manage our land to support our community or environmental needs. Trees, hedges, wildflowers will all make our sites look more attractive and valuable to our neighbours, potentially at lower cost than highly managed grassed areas. Our people live and work in communities so a commitment to support community environmental projects, especially with an employee representative, will be a powerful enabler. A specific example of what can be achieved is the King's Cross skip garden and café, led by Global Generation, growing cooking and serving produce on a post-industrial corner of London.

Water consumption

The management of water consumption is important to us, and we need to continue to demonstrate a responsible approach to the use of this natural resource. This is a well controlled risk and not prioritised as a key output through our EAP.

Our consumption of water is dominated by typically domestic use in offices and depots and we have already embedded much good practice here including low flush toilets and urinals. We use significant volumes of water in water bath heaters across our networks, but these are sealed systems. When removed the water is correctly disposed of. Any new water bath heaters are more efficient and use lower volumes of water through vacuum phase or modular boiler approaches and low impact corrosion additives. Where water is used in projects any abstraction or discharge is controlled through appropriate permits and returned to source or by discharge consents. We will continue to monitor and measure water consumption and drive more efficient and responsible consumption, but the scale of this does not warrant a separate output measure.

Our Action Plan Part 3: Facilitating the low carbon / emission energy system transition

This section of our EAP sets out how we are responding to the urgent need to decarbonise the energy system. It describes how we are applying whole energy system thinking to support decarbonisation and the energy system transition, as well as, wider stakeholder driven environmental and economic considerations, including clean air and economic growth.

We show a pathway where energy efficiency and low carbon gases and hydrogen combine to deliver the climate change targets. This also sets out how we are determined to drive this transformation to secure a “net-zero” future.

The story so far....

The Government had committed to reduce greenhouse gas emissions by 80% by 2050 from 1990 levels, and have now legislated to deliver a net-zero target by 2050. The scale of this climate change challenge is immense and urgent action is needed in the next few years to ensure pathways are available to deliver a low cost, secure and sustainable energy transition for future customers.

The core areas where we are taking steps to create such pathways are heat and transport. In their recent report, the CCC recognised the key role lower carbon gas and hydrogen could play in delivering the most cost-efficient and secure pathway to decarbonise heat.

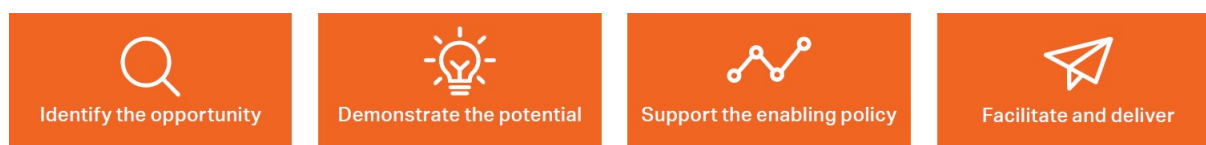
We have long been a leading voice ensuring the gas network is playing a full role in the journey to decarbonise the whole energy system. Supported by increasing research and studies, we have always believed that there are no credible future low carbon energy scenarios in which the gas network is not playing a vital role in keeping the lights on and keeping people safe and warm.

The needs of our customers and stakeholders have always been clear; that decarbonisation must be achieved at the lowest cost and with least disruption, both at home and in communities.

The decarbonisation question we have sought to address has therefore been to **identify how the gas network can help to unlock the lowest cost and least disruptive pathway to the decarbonisation of heat and transport.**

Within a collaborative framework with the other energy networks and involving a wide range of stakeholders, our engagement approach has been to:

Figure 20 Our Engagement Approach

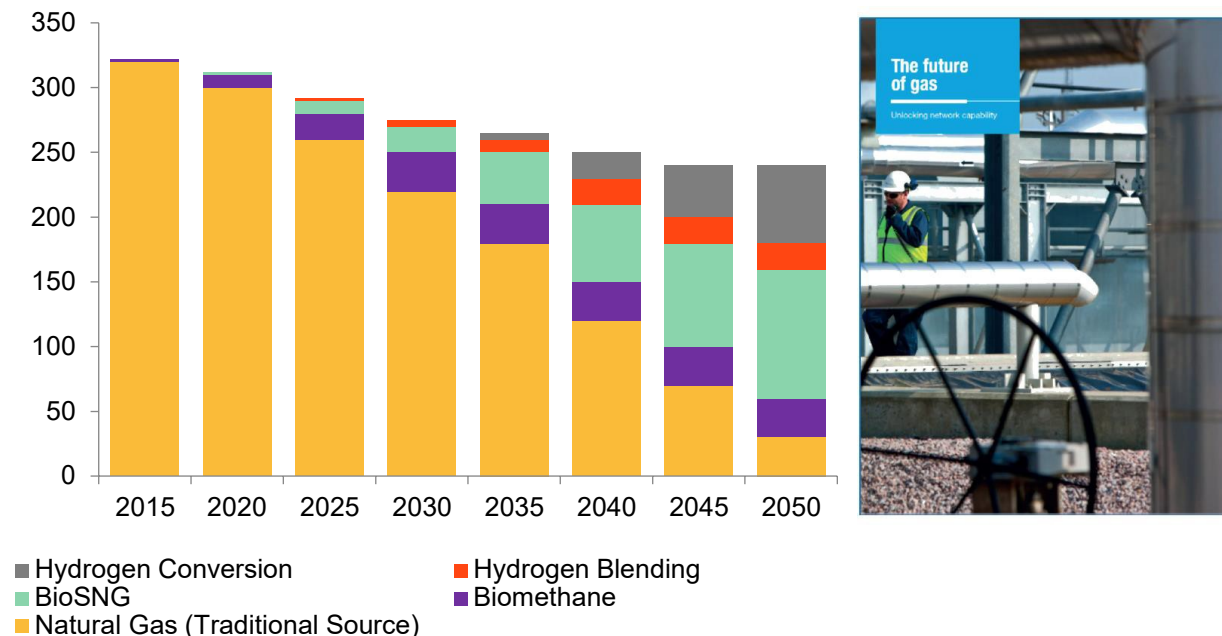


As the challenges of decarbonising the gas network were not well understood, starting in 2015 we published a series of discussion documents, to help engage stakeholders and raise awareness to encourage a wider industry debate. The final chapter in this series is included in the references and

summarises the research findings around the topics of customer demand, transport, renewable gas and heat.

The summary sets out a pathway of how the gas network could evolve to deliver the decarbonisation target for heat and transport as illustrated below:

Figure 21 The Pathway to 2050 (TWh / year)



The emergence of biomethane

We took the first steps almost 10 years ago with our influential role, working with Government to establish the Renewable Heat Incentive ('RHI'), to support green gas injection into the gas grid.

Biomethane from anaerobic digestion was a proven technology that could be rolled out in the UK. We worked to remove technical barriers and to establish an effective financial support mechanism through the RHI. We have also lobbied to encourage wider energy policy to direct feedstocks from less efficient combustion, to the production of lower emission and more flexible green gas.

This has been a great success, with an impressive step change in the amounts of low carbon biomethane coming on to the gas grid across the UK. There is still much more work to be done to build on this strong start and enable and facilitate the full potential from biomethane.

Bio-synthetic natural gas – turning black bag waste into energy

Whilst biomethane is a green, low cost, and reduces emissions with no consumer disruption, we knew that the scope for biomethane was limited by feedstock availability. We could however see the potential from a new technology: BioSNG. This could create flexible Syngas, producing either hydrogen or methane, from the more abundant drier waste and non-waste feedstocks, including black-bag waste.

We supported an initial pilot project at Swindon which successfully demonstrated each component. We then invested in a larger commercial demonstrator project. This demonstrator has experienced financial challenges, exacerbated by the varied funding streams, investors and other backers. This highlights the difficulties in taking new technologies from small scale testing, to larger scale and then full scale commercial roll out. We remain confident in the principle supporting the benefits case for this technology, and we are reassured by the emerging support for the Swindon projects continuation, and other similar projects that are being taken forward such as in the North West. The requirement remains strong for an efficient and straightforward route to market to enable the waste sector to convert their residual waste stream into clean low emission energy.

To understand the potential for green gas, we commissioned a **report from Anthesis and E4Tech** to identify the potential for biomethane and BioSNG from indigenous feedstock. This showed the UK could produce up to 180TWh of green gas in 2050, which is sufficient gas to supply 50% of homes in the UK.

Exploring the commercial regime

To help develop policy, in parallel with the technical demonstration, we commissioned EY to produce a report which assessed the best options for a financial support mechanism for BioSNG to enable large scale roll out. This was published in 2018.

Figure 22 EY BioSNG Report



We have also considered the role of the gas network to reduce emissions from other sectors. The transport sector, whilst focussing on electricity for smaller vehicles, did not have a credible alternative to diesel for larger vehicles. We could see the potential for the existing gas network to support a large reduction in emissions from Heavy Goods Vehicles via the use of Compressed Natural Gas ('CNG'). We partnered with CNG Fuels and John Lewis to commission the first high pressure filling station near Preston and ensured a quality evidence base was built up so that the benefits were unequivocal. With the help of EU Skills and the Energy Utilities Alliance (EUA), we established the Natural Gas Vehicles Network which brought together representatives across the supply chain to coordinate work and insights into potential for this technology. Through these partnerships, we successfully lobbied the Treasury to establish and maintain a fuel duty differential to support fleets switching over to CNG. There is now a healthy pipeline of new CNG refuelling stations being developed across our network, with manufacturers confident to develop the vehicles.

The road to zero emissions – a hydrogen pathway

Biomethane and BioSNG can deliver a huge reduction in carbon emissions, but they cannot take us to or beyond our current carbon reduction targets. This requires the replacement of fossil natural gas, with a zero or negative carbon alternative. The only candidate to fill this role at the required scale is hydrogen.

There are many engineering and other challenges associated with replacing natural gas with hydrogen in our network, which have a degree of disruption. Therefore, we have been working alongside Government and the other gas networks to understand the work required to re-purpose the gas network for hydrogen. We have also led the work to show the merits of hydrogen blending.

We developed and launched the HyDeploy project, designed to demonstrate how much hydrogen can be added to methane without requiring any changes to consumer appliances. This would deliver a further step change in carbon emission reductions beyond those from biomethane and bioSNG, and would also enable the hydrogen supply chain to develop, prove itself, innovate, identify whole system interactions, and reduce costs.

As well as the HyDeploy project, and to enable faster implementation, we are making a commitment relating to the implementation of an operational Hydrogen Blending regime, which is discussed further in the Hydrogen section below.

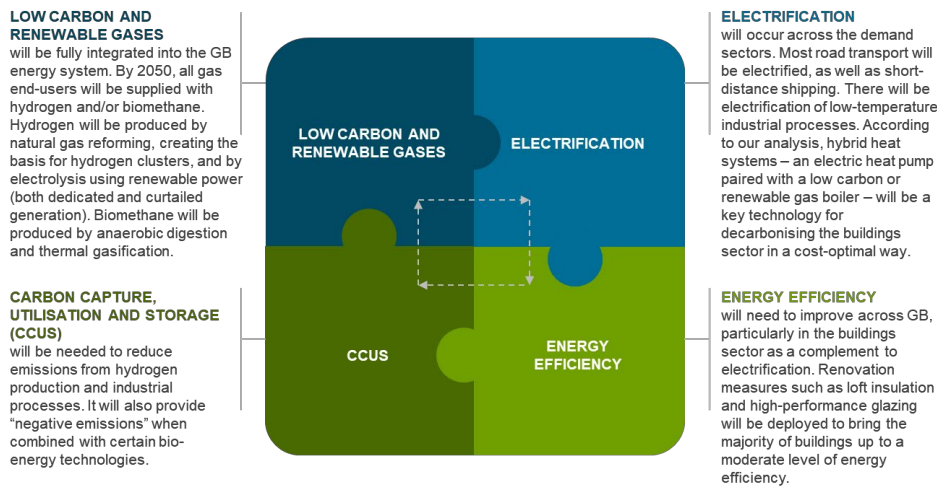
We have also listened to our stakeholders and identified the HyNet North West project, as a strong candidate for the first hydrogen/Carbon Capture and Storage ('CCS') cluster in the UK. This project is primarily aimed at establishing a credible decarbonisation option for heavy industry, but would also provide a low carbon fuel for transport, power generation and for heating. This is also discussed further in the Hydrogen section below.

We are constantly engaging and responding to our stakeholders, and in 2018, Government and the Department for Business, Energy and Industrial Strategy (BEIS) challenged the gas networks to produce a coherent pathway to decarbonise gas, bringing together all the activities across different companies into a single credible strategy.

To determine a clear pathway to net-zero, the ENA on behalf of the gas networks commissioned a report by Navigant, which was published in October 2019¹³

The Navigant work has been supported throughout by extensive stakeholder engagement, and was based around four core elements:

Figure 23 Gas Pathways Core Elements



The Navigant work found the Balanced Scenario represented the least cost pathway for the energy networks to achieve net zero by 2050.

¹³ <http://www.energynetworks.org/gas/futures/gas-decarbonisation-pathways/pathways-to-net-zero-report.html>

The Balanced Scenario shows how the first steps to net zero involving biomethane, BioSNG and hydrogen blending can be expanded, and with hybrid heating systems, and hydrogen production, progressively move the UK on to a clean gas economy.

This approach moves ultimately to 100% hydrogen in large areas, grown from the initial hydrogen/CCS clusters, and with blends of green gas in areas more remote from the more viable areas for the production of hydrogen.

Figure 24 The Navigant Balanced Scenario

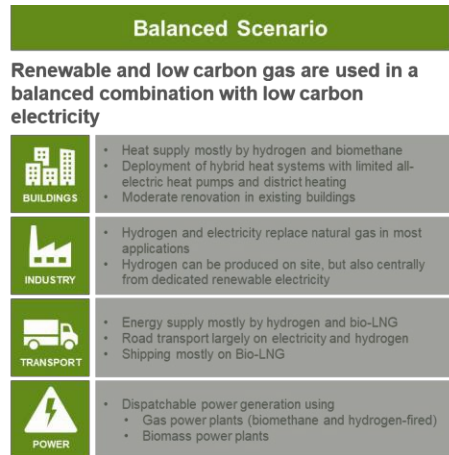
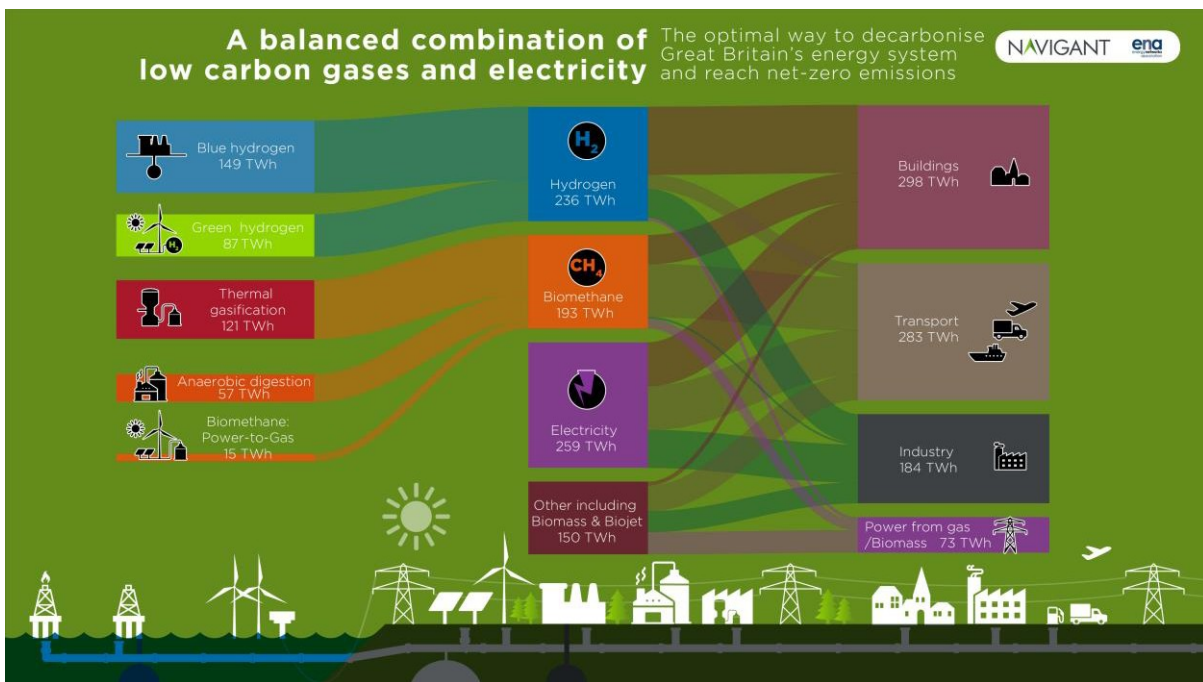


Figure 25 The role for gases in the Navigant Balanced Scenario



Navigant then set out the actions required (Figure 26 and Figure 27 below), to support the delivery of the net-zero clean gas pathway, highlighting the actions that needed addressing within the RIIO-2 period.

Figure 26 Low regrets actions to support the Net Zero pathway

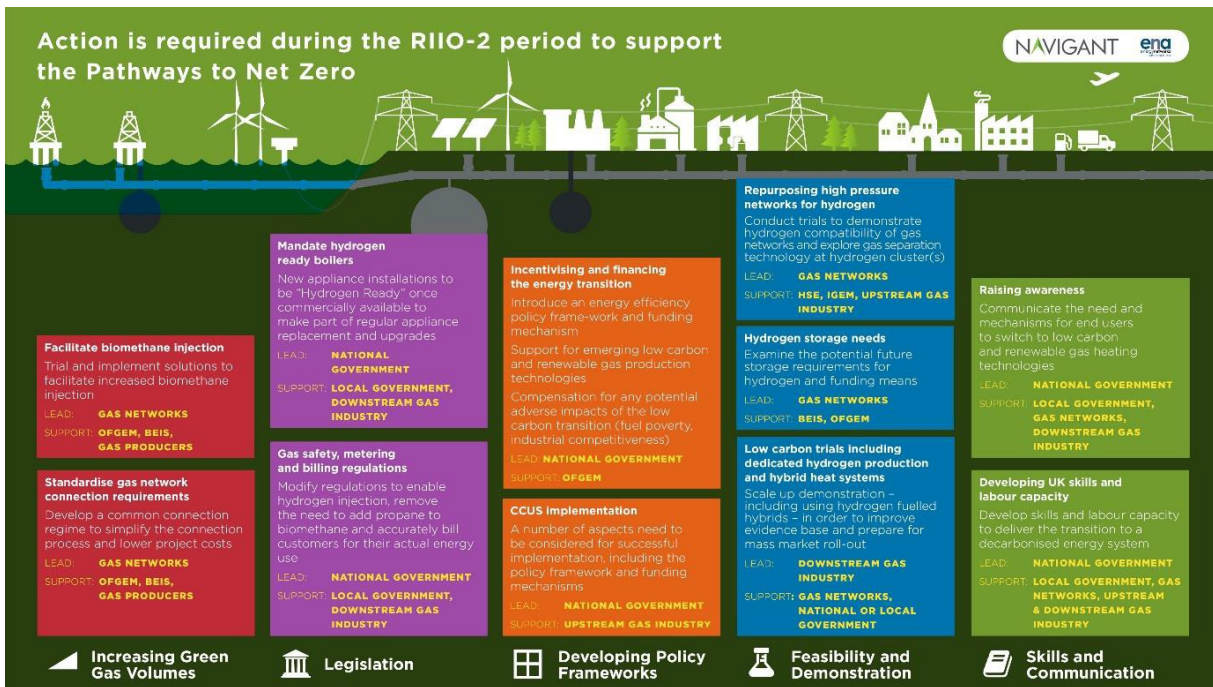
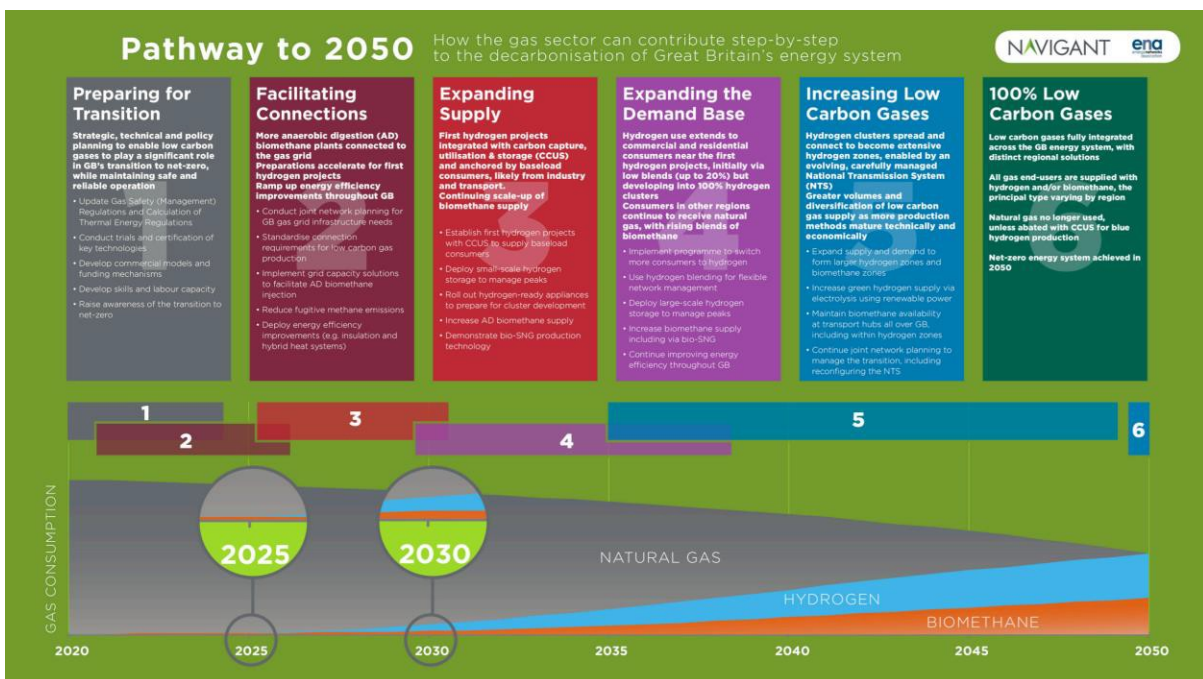


Figure 27 Navigant Final Report, Pathway to Net Zero



Following the publication of the Navigant report, the gas networks are now assessing the coordinated programme of work to deliver the required next steps. Some areas will be led by the gas networks, and in others, we will work with the ENA to influence Government, Ofgem and other key stakeholders.

There are many areas however where we have already recognised the need to take action, including filling evidence gaps. How we are supporting these actions, either with work already in progress, or within our RIIO-2 Business Plan, are set out in the following section, and are also summarised in Chapter 6 Net Zero and a Whole System Approach.

Supporting our customers of tomorrow

It is critical to maintain momentum in delivering pathways which will meet the UK’s climate change targets and we recognise the critical role the gas network plays given that it currently transports a predominantly fossil fuel product.

Whilst we do not know what the future role will be for the gas system and the wider energy networks, in preparing our business plans, our role is to ensure we keep all the options open, and do not create unnecessary obstacles. The Gas Pathways work sets out a clear route to reach net-zero using the gas networks, our plans must be robust against a range of different scenarios.

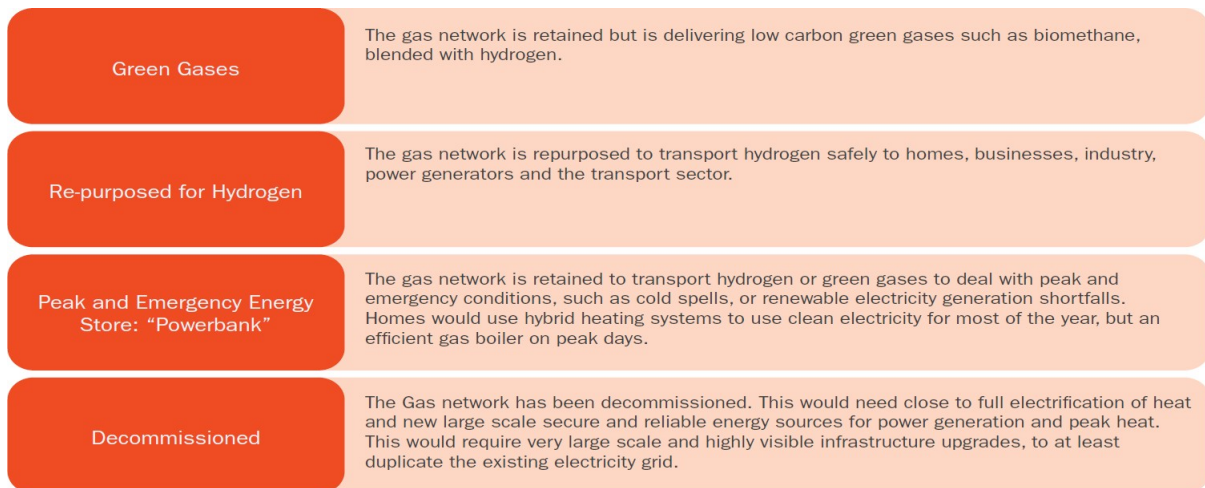
In RIIO-2, we will ensure all decarbonisation options remain available, and by working closely with Government and our other key stakeholders, take appropriate and significant steps towards our net-zero goal. We will work to ensure the interests of our customers are properly represented as the Government policy is shaped, and that the political decision making is completed based on sound robust evidence.

Whilst decarbonisation is currently the most prominent driver for the energy system transition, there is an increasingly strong regional ambition in urban areas to improve air quality. Cleaner air is a further benefit that is delivered from the transition to green gases and hydrogen.

To try to help understand future scenarios for the gas network, we have used the four possible stable 2050 “End States” for the gas network. These are conditions where decarbonisation has been achieved and there is therefore no longer any decarbonisation driver of future change for the gas networks. The full electrification of heat and the decommissioning of the gas network is one such stable End State. The other three involve retaining an operational gas transportation network, but changing either the fuel it transports, or how the gas conveyed is used, to meet the decarbonisation target.

These End States are summarised below and all require a substantial change to the way the gas network is employed.

Figure 28 Possible 2050 End States



Whilst we may consider some of these End States to be more likely than others, ultimately, the long term outcome will be driven by political decision making, and is therefore unknown at this time. The final outcome may also be a UK wide patchwork containing elements of each End State. Furthermore, the route to an End State may involve utilising components from other pathways, for example, hydrogen blending.

The following sections set out our approach to each of these End States, and the actions we are proposing to support the transition. Table 1 below summarises the way that the network can support the pathway in RIIO-2.

Table 10 Supporting the Pathway in RIIO-2

| End States | Is current network a barrier? | Supporting the pathway in RIIO-2 |
|---------------------------------|-------------------------------|---|
| Green Gases | No | Support for entry reinforcement Entry regime review Connections standardisation Customer and stakeholder forum Enduring framework development |
| Re-purpose for hydrogen | No | Supporting Government policy development and building the evidence case for hydrogen HyNet Hydrogen Blending Occupied premises trials |
| Peak and Emergency Energy store | No | Flexible funding for reinforcement uncertainty Stakeholder underwriting to enable timely critical and efficient infrastructure |
| Decommissioning | No | Detailed planning dependent on delivery plan for replacement heating systems and associated infrastructure |

End State: Green Gases

Entry Enablement

From our day-to-day interactions with green gas and other entry gas project developers, we have heard that the primary issues for the networks to address are:

- the availability of network entry capacity
- standardisation of connections processes and the sharing of best practise across networks.

This was reinforced by the results of our joint stakeholder engagement exercise with the other gas networks, and the feedback into Ofgem’s RIIO-2 Decarbonisation stakeholder groups. More recently these issues were reiterated at the Distributed Entry Gas Review event we held in August 2019.

As well as enabling the connection of new distributed gas flows, the provision of entry capacity is also a factor for existing entry customers that may have variable flow agreements. This can occur where there is limited network capacity at certain times of the year, which can lead to flaring of gas that is unable to be stored.

In considering how we respond to this challenge, we recognise that both the investments and charging arrangements must be addressed in parallel. Simply proposing capital expenditure projects (such as strategically located in-grid compressors) would not resolve the issue, as the current pricing rules would result in the triggering party still picking up the cost. The barrier to entry gas would only be effectively removed if the new investments are supported by an element of cost socialisation.

We are also mindful that other energy network methodologies have a long track record of evolving pricing regimes that consider both entry and exit. Gas distribution in contrast has only recently had to accommodate entry gas. We do not consider the current pricing regime will be fit for purpose as entry gas connections grow in the future (for example, for biomethane and other forms such as bioSNG, blended hydrogen, or shale).

The electricity distribution networks faced a similar challenge in the past. They used to treat embedded generation as negative demand. This worked at small scales, but not as levels became significant and resulted in system constraints and large network costs. The electricity networks have told us that they did not start to address this issue early enough, making change much harder as they were required to implement change with large numbers of customer having already been positively or negatively affected, resulting in sunk investments. In gas distribution, we have the opportunity to design a commercial regime at a much earlier stage. This enables us to introduce a solution that is scalable and sustainable, as levels of entry gas grow.

We are therefore committing to support both network investment and a pricing consultation to unlock the full potential for new sources of gas connecting to our network. We have already initiated a review of the pricing and related commercial arrangements governing the connection of gas entry facilities to our network, which we are designing to be capable of completion in time for RIIO-2. The final timetable will be governed by the industry framework and associated processes.

Whilst the new arrangements would be dependent on the formal industry framework change mechanism, we would anticipate that when a new gas entry facility applies to connect to our network, we would be required to deliver the full requested export capacity upon completion of all necessary works, including any wider system reinforcements. Our expenditure plans include the costs net of customer contributions, and we propose they are released via a flexible revenue driver that will become active once the underpinning commercial arrangements are switched on.

The regulatory framework should also be flexible to support any emerging incentives that may become necessary. For example, where an entry customer is able to connect and export all, or part of, their full capacity at an earlier date before the wider reinforcements are complete, an incentive scheme may be desirable. This would provide a reward where we accommodate incremental flows, and a penalty should we be forced to constrain flows below the contracted minimum level. The reward/penalty could be based on the lost incremental/decremental costs associated with the higher/lower exports.

This approach to Entry Enablement is discussed in detail in the **Output Case 07.04.08: Entry Capacity Enablement and flexible reinforcement.**

| | |
|--|-----------|
| Action | 17 |
| We will lead an industry review of distributed entry gas commercial arrangements to establish methodologies that are robust, sustainable and scalable, with the ambition of presenting initial change proposals to Ofgem prior to the commencement of RIIO-2. | |

| | |
|---|-----------|
| Action | 18 |
| We will establish and utilise a flexible funding regime for entry gas reinforcements, supported by an appropriate uncertainty mechanism. | |

Connections Standardisation

Our customers and stakeholders have told us of their frustrations with inconsistencies and perceived lack of coordination and sharing of best practise across the gas networks. They have also highlighted a lack of transparency and a clear escalation route regarding processes and standards.

In addition to the evolution of the technical standards, as the energy system becomes more decentralised, the regulatory and contractual framework must also adapt. In the past, most “market” change in the gas sector has been driven top down from the transmission level. In electricity, this change from transmission to distribution is already well under way, with the current focus developing the framework to support efficiencies at the distribution level e.g. the establishment of DSOs.

The commercial framework for gas transportation, including the Uniform Network Code (UNC), charging arrangements and bilateral contracts, is complex and hard for business and industrial customers and stakeholders to understand and to navigate. In some cases, customers do not have a

direct route to change the framework as they are not parties to the UNC. This is a marked difference in electricity where connected customers are parties to the Connection and Use of System Code.

As independent custodians of the commercial framework (we are independent from gas supply and production), we are able to play a central role in identifying and developing changes to address issues and challenges facing our customers and stakeholders. Elsewhere in our business plan we are committing to focus on three classes of customer that are relatively new, and as multi-site national portfolio operators, are most likely to encounter friction with the framework. Distributed entry gas customers are one of these key customer segments.

For each of these areas, including entry gas, we will establish a customer/ stakeholder forum, which will meet regularly to:

- Allow customer/stakeholders to raise issues.
- Allow Cadent to test issues we have identified.
- Identify and action knowledge sharing.
- Establish and maintain an activity schedule of framework changes.

As well as the creation of these new forums and change driver, we are also committing to address the issue of connections standardisation. We will establish a voluntary Distributed Entry Gas Connection Standards which can then be revised through an agreed industry change process, led by our entry gas customers, through the Entry Gas Forum. Whilst we can make this commitment for our own networks, it is a single coordinated approach across all networks that our customers need. We are therefore working with the other gas distribution networks to build support for a single methodology statement common to all networks, in place by the start of RIIO-2.

This approach to support Connections Standardisation and continuous improvement for Entry Gas customers is discussed in detail in Appendix 07.04.08: Entry capacity enablement and flexible reinforcement.

| | |
|---|-----------|
| Action | 19 |
| We will establish an Entry Gas Customer and Stakeholder Forum to allow customers and stakeholders to raise issues, for the gas network to test issues we have identified, to identify and action knowledge sharing, and to establish and maintain an activity schedule of framework changes. | |

| | |
|--|-----------|
| Action | 20 |
| We will establish a Entry Gas Connection Standards Methodology statement and a supporting voluntary governance arrangement to enable customers and stakeholders to propose value adding improvements. | |

Off Gas Grid Decarbonisation

Ahead of wider UK heat decarbonisation, the Government have already started considering how to decarbonise off gas grid communities currently relying on high carbon fossil fuels such as oil and coal.

We believe that in some circumstances, for example where off gas grid communities are relatively near to the gas network, conversion to mains gas will be a very attractive proposition. This mains gas supply could then subsequently be decarbonised, with green gases or potentially hydrogen.

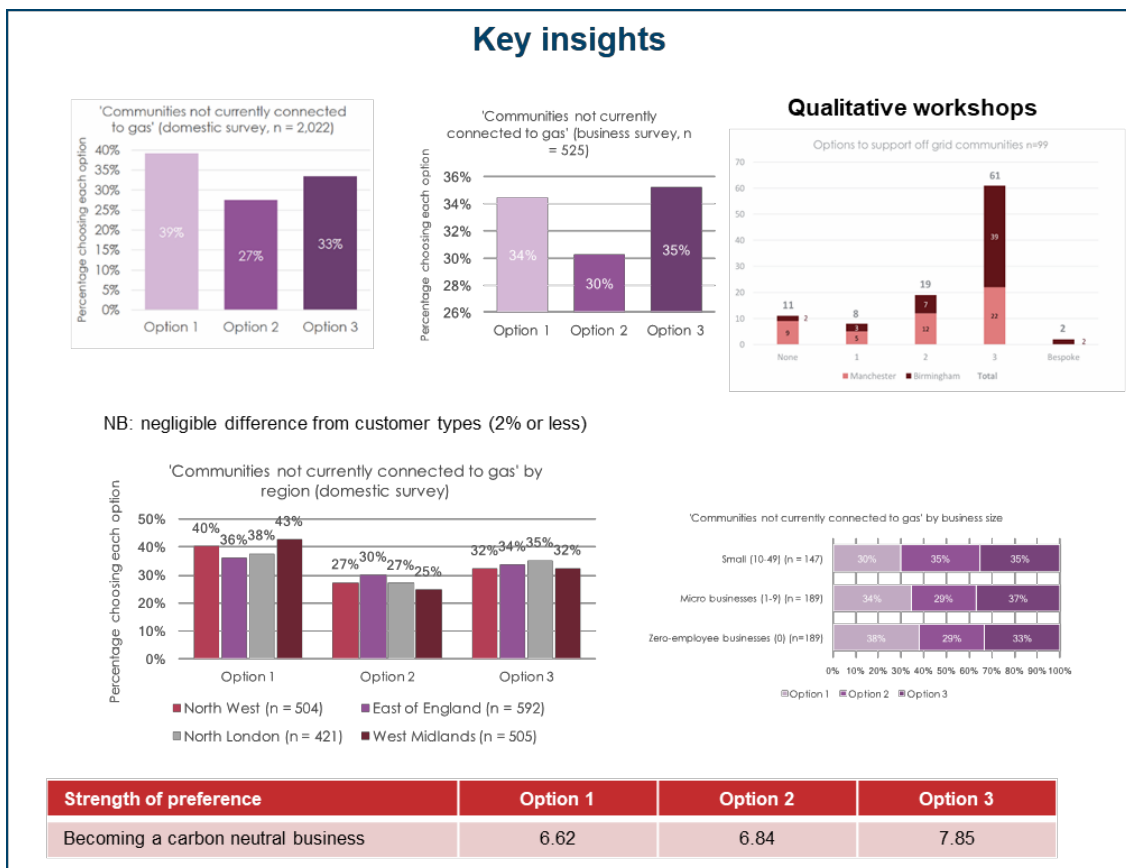
We have commissioned a study by NERA (See supporting material) to assess the socio-economic benefits of converting oil or coal heated homes to mains gas. This identified a significant benefit from conversion, which was of a sufficient value to support the incremental cost of extending the gas network. Further benefits will be realised if households in those communities are in fuel poverty.

Furthermore, we tested different options to support off-gas grid customers as part of our engagement programme:

Figure 29 Business Options Testing

| Options – BOT | | |
|---------------|--|-----------------------------|
| Option | July plan & BOT | Cost & bill impact |
| Option 1 | Support communities that want to connect to the gas grid | £0 |
| Option 2 | Option 1, but with <u>2</u> pilot projects to examine potential benefits of connecting | £2.8m £0.02 bill impact |
| Option 3 | Option 1, but with <u>6</u> pilot projects to examine potential benefits of connecting | £10.3m £0.04 bill impact |

Figure 30 Business Options Testing – Key Insights



Whilst the views were balanced across the three options, taking account of the strength of preference, and the feedback from the Qualitative discussion, we have concluded there is robust justification for us to run a trial and explore this further.

Therefore, during RIIO-2, we are committed to undertake trials, to identify small communities where the gas network may be the best option for the community, and where extending, the typical cost is no more than £5,000 per consumer. Before, during and after the trials we would work closely with the communities to understand their thinking, motivation, reaction, and overall experience. We will discuss options including energy efficiency measures, with careful presentation of comparative whole life costs. We would explore approaches to accelerate or improve take up, and if the trials do prove successful, we will then investigate enduring changes to the regulatory framework to enable such gas network extensions to be available as a standard service across the networks.

Separately, but in support of the small scale trials, we will establish a robust community connection support service within the business. Both to identify, and advise, off gas grid communities that could economically connect to the gas grid under the current rules. This service would also then support

communities as they process their applications and projects proceed to construction and commissioning. This would be a similar service to the highly successful approach employed by our fuel poverty partners Affordable Warmth Solutions, when connecting communities in fuel poverty.

This service could be critical for communities wishing to reduce their carbon emissions, and communities that decide to seek a connection in response to a potential future ban on gas network extensions, should future Government policy dictate.

| | |
|---|-----------|
| Action | 21 |
| We will conduct a trial to identify small communities where the gas network can be extended at a low cost. | |
| Action | 22 |
| We will establish a community connection support service to identify and advice communities that could economically connect to the gas grid. | |

We are including the costs to provide the community connection service in our baseline totex, but the detailed proposals and funding for specific gas network extension trials would be taken forward through the strategic innovation funding mechanism to support the energy system transition and whole system thinking. When the proposals are developed for these innovation projects, we will engage with specific communities to ensure there is sufficient support on the ground, before any physical works commence.

Further detail on our approach for off gas grid communities can be found in Appendix **07.04.09**.

End State: 100% Hydrogen

The use of renewable forms of methane to replace fossil natural gas represents the least cost and least disruptive option to decarbonise the gas system. Whilst we have supported an impressive step-change in biomethane during RIIO-1, there are insufficient feedstocks to replace gas demand. An alternative low carbon gas is required to achieve the UK's carbon reduction targets, and the only option at the scale required is hydrogen.

We are working closely with the other gas networks and the Government to understand the implication on our gas network of repurposing to carry 100% hydrogen, but any subsequent decision to progress this option is unlikely to be taken ahead of the submission of RIIO-2 Business Plans, and possibly not until the middle of the next decade.

We do not believe we need to wait until the strategic decision on hydrogen is taken in the future, to take forward initiatives that demonstrate hydrogen at scale. We have developed the HyNet and Hydrogen Blending proposals that if triggered, would represent a massive step forward in the use of hydrogen to reduce carbon emissions and improve air quality. Both projects have been developed with extensive stakeholder engagement which clearly demonstrates strong support, and has also helped shape the proposals themselves.

The energy networks will play a vital role in supporting the Government as they gather the evidence base to enable the strategic decisions to be taken. A lot of the technical work to show the capability of the gas network to support the transition is already in train, and we believe the most significant evidence gap lies in the understanding of the customer experience. We believe filling this evidence gap will be a priority area over the RIIO-2 period and will be built around large at scale trials of different low emission energy technologies. Pilot and trial projects that raise awareness of hydrogen, will be a vital part of this evidence base.

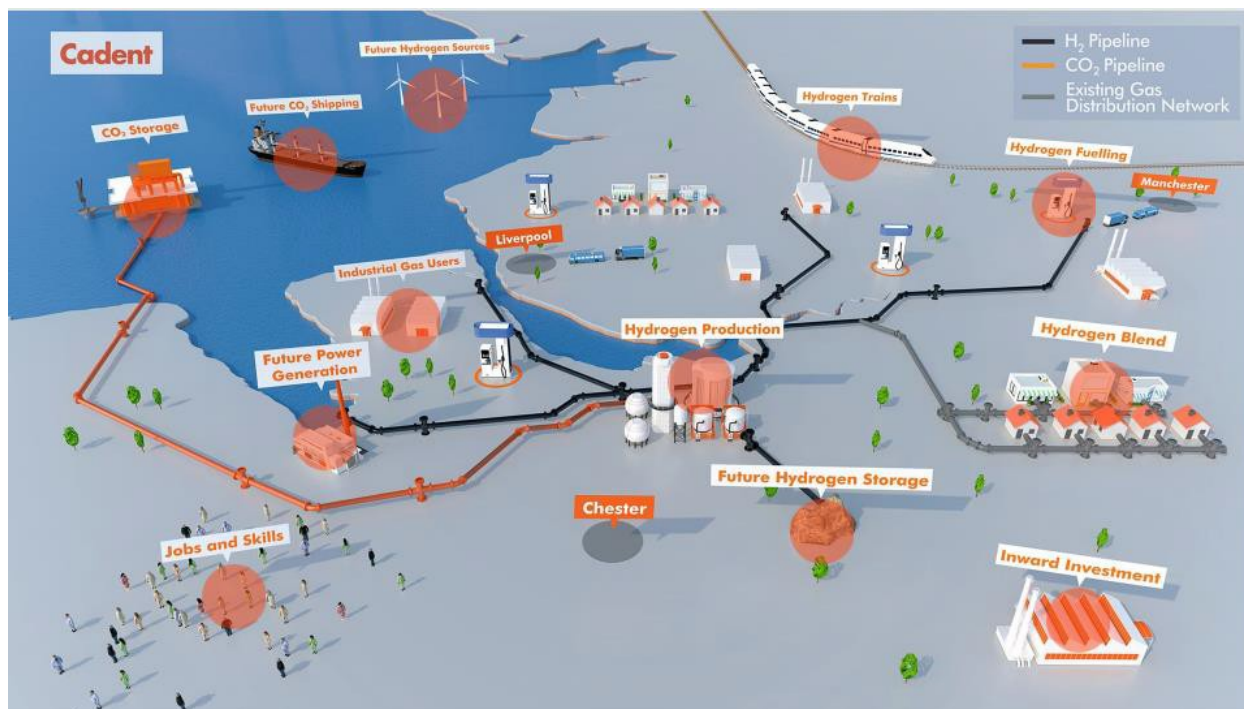
Our RIIO-2 proposals to support hydrogen comprise three large scale initiatives:

- HyNet: A large scale hydrogen cluster in the North West
- Hydrogen blending: The implementation of a UK wide blending regime
- Hydrogen heating retrofit.

Each of these are described in more detail below.

HyNet: Large scale hydrogen cluster in the North West of England

Figure 31 Diagram of North West Hydrogen Cluster



Through our relationships and engagement with a number of organisations, we identified that there is a critical evidence gap in terms of a credible option to decarbonise heavy industry.

In response to this, we have worked with partners to develop the HyNet project; capable of providing hydrogen at scale for heavy industry in the North West of England.

The project, illustrated in the graphic above, comprises four key components.

- Carbon capture and storage: Initially taking CO₂ produced by existing plants, but capable of also storing CO₂ from the production of hydrogen
- Hydrogen production: Initially supplied locally, but expanding to supply a wider customer base in the region
- Hydrogen Transportation: Delivering efficiently produced hydrogen for industry, transport, power generation and heating via a dedicated hydrogen network
- Hydrogen Storage: To ensure hydrogen can be supplied reliably and economically as the demand base grows.

Whilst the concept was driven by heavy industry, our stakeholder engagement has highlighted the additional value that could be obtained by incorporating hydrogen for transport. Clean air is a top priority for many of our regional stakeholders including the regional Metro Mayors in the North West. Providing clean low carbon energy sources for low emission vehicles, including trains and shipping, are integral to these ambitions, which hydrogen can meet. The benefits of network supplied hydrogen were confirmed in a report commissioned by Cadent, and published in June 2019¹⁴.

In addition to hydrogen for industry and transport, HyNet can support economic growth and can also provide hydrogen for power generation, and for heating either as 100% hydrogen, or as a blend with natural gas ahead of full decarbonisation. A report by Amion (see Supporting Material) estimate the

¹⁴ https://hynet.co.uk/app/uploads/2019/06/15480_CADENT_HYMOTION_PROJECT_REP.pdf

total Gross Value Added (GVA) impact in the North West to be £17bn to 2050, with 191,000 total employment years created for the period.

The extensive stakeholder support for the project is summarised in the attached supporting material, including a letter of support from the Mayor of Greater Manchester.

The HyNet project is expected to have reached the pre-FEED stage **by the start of the RIIO-2 period**, and any further development would require a clear regulatory framework and supporting policy in place, for each of the primary programme components: CO₂ transportation and storage, Hydrogen production, Hydrogen transportation and Hydrogen storage.

Whilst we have led the development of the initial HyNet concept, we believe other parties are best placed to take forward the hydrogen production, CO₂ infrastructure and hydrogen storage elements. As the current gas distribution network operator, we would be well placed to take the role of hydrogen system operator (SO) for HyNet, to coordinate gas flows, including blending into the existing gas network. We'd expect the system operator to play a role in confirming the extent and size of the hydrogen network, including the hydrogen production and storage required to provide the required level of security. The system operator can contract with, but does not need to own or operate the production or storage facilities.

If directed and with a supportive regulatory framework, the HyNet SO could also undertake the role of hydrogen network asset owner. They would construct and own the hydrogen transportation network to meet customer and stakeholder's requirements. The hydrogen pipeline component of the project is currently estimated to cost £200m.

We believe large scale expenditure for pilots and trials to fill the evidence gap to support decarbonisation policy, should be borne at least by all gas consumers, potentially supported by other consumers, and Government. We do not think it is appropriate for a small subset of consumers, such as North West consumers to fund trials that are necessary for UK decarbonisation policy. This is a principle already enshrined in the current Network Innovation Competition funding mechanism in RIIO-1 which recovers the costs from all gas consumers.

The need to minimise the impact on bills was further reinforced in a report completed by Newcastle University for Cadent and Northern Gas Networks (NGN), looking at Hydrogen Perceptions in the areas where hydrogen blending may be trialled. The report concluded that: *"In sum, the majority were clear and unambiguous that any increase to their energy bills as a result of using hydrogen would be unacceptable."* The report did indicate that in the trial areas, there should be no insurmountable barriers from the general public for hydrogen trials, given sensitive and considered engagement.

The Thames Tideway project represents a recent example of a new large scale innovation requiring a different approach to funding. A very long asset life, and the government underwriting of cost overruns ensure the impact on customer bills can be minimised. Competition could also play a part in the delivery, either in a competition similar to offshore transmission owners in the electricity sector, or by

Figure 32 Letter of Support from the Mayor of Greater Manchester



robust procurement for the construction. The pros and cons of all options would need to be carefully assessed and consulted upon by Ofgem and Government, prior to implementation. This is a critical milestone to the project and early certainty regarding the framework will reduce the overall project timetable risk.

Where trials are installing long life assets, as in the case for a high pressure hydrogen transportation network, the assets could be funded through a Regulatory Asset Base (RAB) approach, with the costs recovered over the asset life. This would minimise the overall impact on consumer bills, with the 'willingness to pay' research we have undertaken indicating a general willingness across the population to accept higher bills to support green gas.

The RAB approach for the hydrogen network is consistent with other utility networks, and is also a key option in the recent Government consultation considering business models for new Nuclear power generation, Carbon Capture and Storage, and Hydrogen Production.

The overall impact on gas bills depends on a number of factors, including the treatment in the regulatory asset base, and any funding from taxation. As an indicator, based on the need to recover £10m pa to fund the Hynet hydrogen network, this would equate to 16p on a 15,000kWh annual gas bill, based on 900TWh UK gas demand. The ability to fund the project over a much longer period, e.g. Thames Tideway >100 years, is another mechanism to reduce the overall impact on consumer bills.

In addition to construction and commissioning costs, there will be ongoing costs of operating the network. In addition, the HyNet operating model is likely to result in a net cost if consumers are to be protected from unreasonable costs arising from transitioning from one energy source to another. Based on feedback from stakeholders, we do not think the project is likely to be achievable if converting industries are required to fund their conventional gas system costs as well as the costs of the new hydrogen system at the same time. A protection mechanism is likely to be required for a period.

Due to its size and unpredictability, we believe the net cost arising from a protection mechanism could be funded by the Government rather than gas consumers, at least during the trial period. We think there is a weaker case for any non-converting customers, such as the transport or power generation sectors, to receive a non-cost reflective price for access to hydrogen. These new loads could however help minimise the net cost from protecting converting industry. Use of the hydrogen network should be maximised as far as possible from all types of customers as the greater the take up, the lower the average unit cost.

If Cadent were given a delivery or operational role with HyNet, we would expect this activity to be supported through the new RIIO-2 strategic innovation mechanism that is being established to support the energy system transition. An implementation funding mechanism for these styles of projects would unlock quicker timescales for benefit realisation. If this route is not fit for purpose, e.g. if it is on insufficient scale and flexibility, a bespoke reopener triggered by a direction from Government would be required and we have included this as an uncertainty mechanism as a contingency measure.

In accepting proposals to undertake this work, we would expect clear success criteria that meets all our stakeholders needs, with mechanisms to support efficient delivery, and a funding approach that provided an appropriate balance of risk and reward. From our engagement with stakeholders, the success criteria would include meeting the agreed timetable and flexible operational measures to ensure sufficient hydrogen is available as each party goes through their own conversion processes, which will have their own levels of uncertainty.

If other parties are selected to undertake the role of HyNet system operator or asset owner, a new contractual and physical interface between the hydrogen asset owner and the existing and new system operators will be required. This will be a gas system first, and add complexity, cost, and risk, which would need to be justified for what is a trial project, which should focus primarily on the operational and economic delivery. We would expect to be able to recover any costs we incur in establishing and operating the framework required for us to coordinate our operations safely and efficiently with any new third party network operators or owners.

| Action | 23 |
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| <p>Given a direction from Government and/or Ofgem, we will submit proposals to act as the HyNet system operator and to design, construct and own the hydrogen transportation network with a supporting commercial and operational framework, to meet customer and stakeholder requirements for hydrogen in the North West of England.</p> | |

HyDeploy



The HyDeploy project is providing the evidence base to show substantial percentages of hydrogen can be blended with methane, reducing the carbon intensity without having to change any end user equipment. The project is in two phases, with the first already underway on a private network at Keele University. The final phase would complete in 2023 and involves testing across a number of test areas in the North of England. The project is expected to conclude during the RIIO-2 period.

Once the safety case is proven for blending, it becomes technically feasible to inject hydrogen across the UK gas distribution system. This would reduce carbon emissions, enable a significant gearing up of the hydrogen supply chain, and the exploration of new whole energy system solutions e.g. for hydrogen power generation/hydrogen vehicles. It would also raise awareness of hydrogen with the general public.

As with biomethane and bioSNG, hydrogen blending represents a decarbonisation option that can be implemented with no disruption in homes or communities and can therefore be implemented at a faster pace. As set out by the CCC the need to reduce carbon emissions is urgent, but just proving that blends can be accommodated technically will not result in large scale hydrogen blending. A regulatory and commercial framework will be required both to support the construction of hydrogen plant and its connection, but also to enable a UK wide blending regime to operate. This must have the capability to accommodate a high number of interacting hydrogen plant with the system operator ensuring safe and efficient operation and coordination with other gas flows.

Hydrogen production and blending will need Government enablement, as well as an operational, regulatory and commercial framework.

RIIO-2 Proposals

Supported initially with innovation funding during RIIO-1, and subsequently via RIIO-2 Innovation mechanisms, we will design an efficient and effective hydrogen blending regime that supports and facilitates the growth of hydrogen production, whilst protecting end consumers. We will develop these proposals transparently, with full industry and wider stakeholder engagement throughout. This will result in a delivery plan that can be deployed when required by Government/Ofgem regulations. The development of the regime will include a consultation on the appropriateness and design of an incentive scheme for the network operator controlling the access to hydrogen on to the gas grid. The building blocks of a blending regime are set out below:

Figure 33 Blending Regime Building Blocks

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| Protecting the end consumer from excess hydrogen | Dispatching hydrogen injections to match changing gas demands | Responding to events and emergencies | Impact on shrinkage gas |
| Network pricing | Customer bills and cost recovery | System operator incentive | New connections |

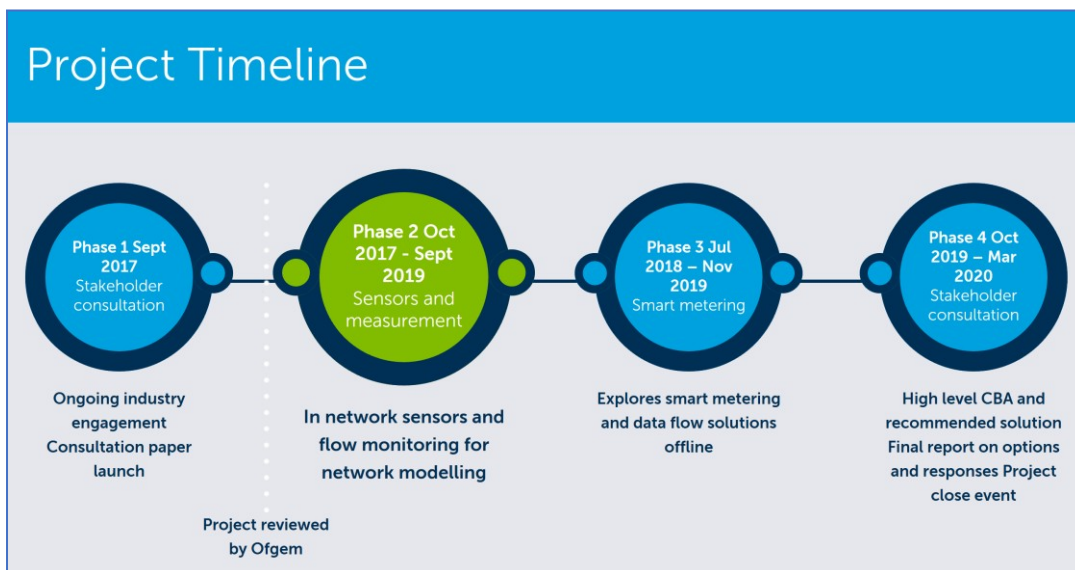
We would implement the final agreed hydrogen blending framework with efficient operating costs passed through to gas shippers. This will be triggered by a direction from Government, and supporting regulatory obligations. Our proposals would include the costs for the implementation and operation of the blending regime across our networks. We suggest a flexible uncertainty mechanism is employed so that this funding is not released until the trigger to deliver the works has occurred, or is imminent.

Future billing methodology

A key enabler for hydrogen blending is the ability to change the gas bill calculation methodology so that consumers pay for the energy they receive. Hydrogen has a lower energy content, so customers receiving blended hydrogen will be receiving less energy than a consumer using the same volume of natural gas. Our innovation project, the Future Billing Methodology(FBM) initiative, is designed to identify the best approach to enable the customer billing arrangements to accommodate hydrogen blends or other injections of distributed gas, including biomethane. Blending cannot take place unless the billing arrangements have been addressed.

To implement the conclusions from the FBM project may require the gas networks to undertake activities, including the installation of equipment, to deliver the new billing arrangements.

Figure 34 Future Billing Methodology Project Timeline



Once the FBM project has concluded and the results socialised, we will bring forward innovation proposals to implement the findings. This is not expected until after the submission of network Business Plans. If the innovation mechanism cannot support this work then the proposed bespoke price control reopener required to support hydrogen blending uncertainty will be deployed for the gas networks to enable the FBM work to be completed and blending at scale enabled.

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| Action | 24 |
| We will ensure an efficient and effective hydrogen blending regime can operate at the earliest opportunity, with the end consumers protected financially by paying for the energy they receive, and from unsafe gas blends. | |

Heating retrofit trials

We have seen from survey work undertaken with the ENA by YouGov, supported by the BEIS Public Attitude Tracker, the challenges of understanding and anticipating consumer opinion on the complex issue of heat decarbonisation. A report by Madano¹⁵ for the CCC also highlighted the difficulties in supporting consumers and encouraging change.

Public opinion cannot be guessed or assumed but must be observed from real life trials. We must also recognise that a view expressed before a change is made, can be modified significantly, having lived with the change for a period. A household may not believe they could possibly live with a new type of heating system, but having had the opportunity to experience the change, may be very happy to continue.

However, whilst public attitude may be an important factor, a Government may still decide to impose an option that is unpopular, due to its confidence in the overall benefit realisation.

From our many observations, we believe the only robust approach to properly gauge the customer experience is by trialling at scale, and over a sensible period, which for heating must ideally include a sustained cold spell. A strong measure of the acceptability would be whether the customer opts to revert, or wishes they could revert, at the end of the test period.

Trials at scale are also vital to provide technical evidence, as well as consumer feedback.

We know from our work in the Hy4Heat project that the Government are considering undertaking large scale in-premises trials of hydrogen domestic heating during the RIIO-2 period. The gas networks will need to deliver these trials.

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| Action | 25 |
| We will support Government plans for large scale trials of hydrogen conversion. | |
| To illustrate the potential scale of these trials, we suggest a range of £30-50m per trial. | |

We expect any projects will be taken forward under the RIIO-2 innovation mechanism to support the Energy System Transition. The scale, scope, location and timing of the trials, and the associated cost, will be determined in consultation with the Government, their agents, and the other gas networks, after the submission of our Business Plan.

¹⁵ <https://www.theccc.org.uk/publication/public-acceptability-of-hydrogen-in-the-home-madano-and-element-energy/>

End State: Peak and Emergency Energy Store

Any start of a transition of the gas network to a peak/emergency End State during RIIO-2 would require the installation of new hybrid heating systems, with large numbers of heat pumps installed alongside gas boilers. It could also see large scale back-up power generation connected to the gas network to secure the electricity grid. This would in large part be decentralised to enable the generation to support local electricity grid constraints, as well as balancing national supply and demand.

This End State sees the use of the gas network becoming more 'peaky', with bigger within day swings with the gas usage, whether methane or hydrogen, becoming more binary for heating and power generation, with either all on or all off. The main driver for network capacity and therefore investment is the provision of infrastructure to meet the peak demand, with the potential for higher peaks than today, even though overall gas transported is very low over the course of a year.

This use of the network as an energy back-up/top-up service does make the opportunity to avoid investment by demand side action more limited, as the network is providing a service of last resort, to be used when nothing else is available, and the need is urgent. Customers would have little scope to switch to alternative energy sources and lower their gas demand, which could reduce the gas network investment requirements.

For a peak day, demand from existing domestic customers will not be much different than the evolution of current heating demand; the differences would be seen away from peak conditions. The connection of additional individual new homes to the network is unlikely to drive a need for reinforcement, however this may not be the case for larger scale housing, business and industrial developments. This could drive network reinforcements, as could the continued growth in decentralised gas fuelled power generation. Depending on where real connection requests materialise and the characteristics of the local network, if all the future growth forecasts do become reality, then significant network reinforcements may be required.

Shorter term policy on gas network extensions, which may be published for consultation by the Government ahead of RIIO-2, could result in a full or partial ban on gas network extensions where fossil gas is involved. Whilst this may stop longer term growth, in the shorter term we could also see the opposite affect if there is a dash from developers and communities to secure network extensions before a ban is implemented. In addition, such a ban on gas heating in homes could see a rise in gas heated district heating schemes, which could also drive a higher gas demand than individual systems, especially if the scheme also generates electricity with Combined Heat and Power (CHP) or fuel cell installations.

There is therefore considerable uncertainty in future peak demand growth, which is why our Business Plan proposals include a revenue driver uncertainty mechanism so that we are funded effectively and in a timely manner for when investment is required on the ground.

Our whole system initiatives set out in Chapter 6, include working closely with regional bodies to ensure the network infrastructure is in place to meet their long term needs. In support of this, we are bringing forward proposals for regional authorities to have the option of underwriting network reinforcements, so that the most efficient infrastructure can be installed in a timely manner, and does not represent a barrier to regional ambitions. We are also committing to establish a forum for regional stakeholders which can monitor progress, identify issues and propose new changes that may be required during RIIO-2.

Note: The use of flexible funding mechanisms for network reinforcements, and the creation of new options to regional authorities, will ensure the network is not a barrier to the evolution of the network towards a peak/emergency End State.

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| Action | 26 |
| We will ensure the network can support increasing use in emergency, back-up and peak conditions, serving and protecting the whole energy system. | |

End State: Decommissioning

Whilst there is an increasingly large body of evidence reinforcing the criticality of a gas network at the heart of the least cost, secure, reliable, low emission energy system of 2050 and beyond, the wide scale electrification of heat and the decommissioning of the gas network remains a scenario to consider, however unlikely.

Decommissioning of any substantial parts of our network will only be possible, once the alternatives, primarily for space heating in buildings, are in place. There may also be a period where multiple systems are run in parallel as consumer confidence is built up. Decommissioning can also not occur before any necessary actions are taken to end the use of gas as a back-up energy source e.g. gas boilers as back-ups to geothermal, waste heat or heat pump based district heating schemes.

Until all gas users are removed from a section of network, decommissioning can place our customers in very vulnerable situations. We can therefore only start developing our decommissioning plans once the alternative net-zero heating technologies are installed, their secure fuels and feedstocks in place, and the significant levels of new power generation, and its back-up and associated grid infrastructure have been successfully commissioned.

A detailed plan to decommission the gas network can therefore only realistically be started once the implementation plan has been finalised. Timing will not be an issue, as the time required to install all the equipment and infrastructure to replace all the current gas heating in the UK, will take far longer to complete than decommissioning the gas grid. Decommissioning may be able to be undertaken with a lower degree of urgency than the installation of the new systems.

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| Action | 27 |
| We will promote and build up the evidence case that supports least cost, least disruptive options for our customers to decarbonise their heating. | |

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| Action | 28 |
| We will ensure all the evidence for alternative options, including the wide scale electrification of heat are challenged and based on robust analysis and information. | |

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| Action | 29 |
| We will develop robust decommissioning plans and protocols to protect consumers during the transition, following the publication of the detailed strategy and programme to install alternative systems. This may not occur during RIIO2. | |

Enduring Environmental Engagement

This EAP as well as being part of our RIIO-2 Business Plan submission, will be the basis for our ongoing environmental engagement through the RIIO-2 period.

We will produce an annual environmental performance report which will show how we are performing against our RIIO-2 EAP, and will also include the supplementary information we have committed to provide. This report will also include any additional regulatory requirements Ofgem establish in our updated RIIO-2 environmental reporting licence obligations.

We will continue to engage on our environmental performance with our stakeholders including our online communities, regional groups, the Customer Engagement Group, and specialist environmental organisations. This ongoing engagement will provide vital feedback on our performance, on the form and content of our annual report, and to challenge what and how we are delivering on our plan. This is likely to continue to be a fast changing area and we will need the guidance of our customers and stakeholders to support continuous improvement and identify new options and opportunities. This will be critical to ensure we can achieve ours and our stakeholders ambitions and be seen and recognised as leading environmental performers and critical enablers of a net-zero future.

Our enduring stakeholder engagement strategy, including our environmental engagement is set out in detail in **Appendix 05.01**.

| Action | 30 |
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| <p>We will report annually on our environmental performance, including progress against the actions in our RIIO-2 EAP, and any additional regulatory requirements. We will seek stakeholder feedback to continually improve our reporting through RIIO-2.</p> | |

Supporting Material

Business plan appendices

07.04.01 Annual report and accounts

07.04.02 Sustainability report

07.04.03 Sustainability first initiative

Output cases supporting this plan

07.04.04 A carbon neutral business

07.04.05 Tackling theft of gas

07.04.06 Zero avoidable waste to landfill

07.04.07 Our people and their emissions

07.04.08 Entry capacity enablement flexible reinforcement

07.04.09 Supporting off grid communities

Reports and supporting evidence

06.00 Future of gas series: unlocking network capability

06.01 Review of bioenergy potential

06.02 Options for stimulating investment in BioSNG

06.03 Pathways to Net-Zero: decarbonising the Gas Networks in Great Britain