
GAS GOES
GREEN
TOMORROW'S HEAT,
TODAY'S OPPORTUNITY:
NET ZERO INNOVATION IMPACTS
ena
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association

CONTENTS

INTRODUCTION

Reducing our household carbon emissions by 95% over the next 30 years is a huge challenge – and one that is already requiring us to rethink the way we will use our energy.

For Britain's gas and electricity networks, this means delivering investment to build the infrastructure needed for new green technologies - creating benefits that go way beyond our front doors.

The economic footprint of our gas and electricity grid infrastructure is substantial, with wires and pipes crisscrossing every part of the country that are worth an estimated £60bn. Currently, 40,000 people are employed by energy network companies in the UK and Ireland.

When we invest in our grid infrastructure, we invest in Britain's local communities and supply chains.

Existing Energy Networks Association research shows that transitioning the UK to a hydrogen economy will require investments of approximately £159bn over the next 30 years. From 2045, this investment will be paid back through benefits to customers, totalling over £116bn by 2050.

By using a combination of hydrogen and biomethane, working in partnership with electrification, to replace natural gas could save us all as much as £13bn a year by 2050.

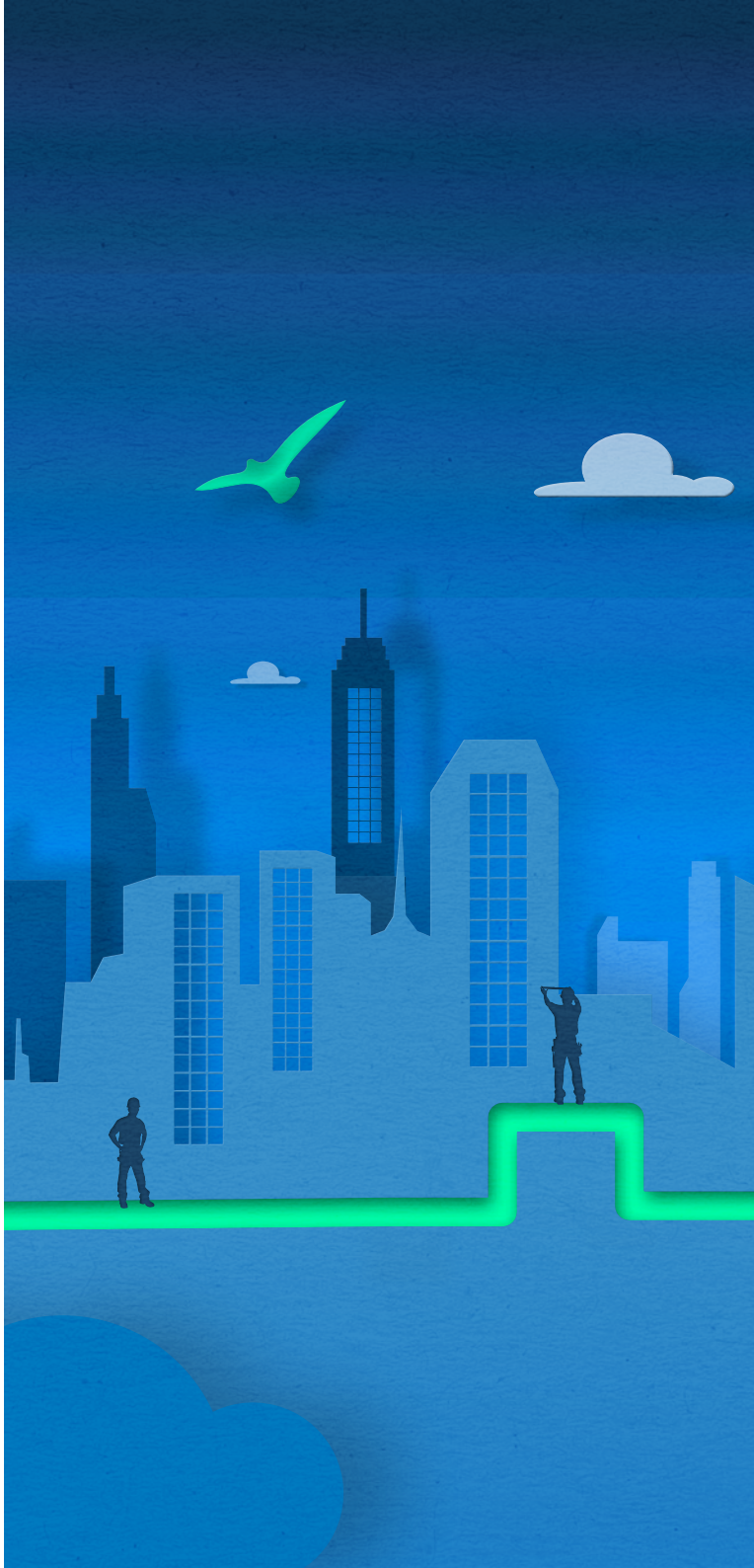
In January 2021, Energy Network Association published Britain's Hydrogen Network Plan, a roadmap for converting our gas network infrastructure to run on hydrogen instead of natural gas.

For Britain's local gas networks, a lot of progress has already been made, with hydrogen-ready piping installed in nearly two-thirds of their networks. By 2032, the networks plan to have invested a total of £28bn to progress even further.

But more work is yet to come.

Cutting-edge, world-leading energy network innovation is vital to ensuring that our economy can continue to access the energy it needs to safeguard jobs and to maintain our international competitiveness as the world goes through decarbonisation.

In this report, we build on the 2020 Gas Goes Green Zero Carbon Commitment to set out the scale of investment that Britain's gas networks wish to deliver to hydrogen innovation projects and preparing the gas networks. This work will be focused over the next ten years, creating highly-skilled, high-tech green jobs through investment and ensuring that the impact of that innovation is felt in communities across the UK.



EXECUTIVE SUMMARY

Net Zero Innovation Impacts sets out how Britain's five gas networks propose a total of £6.8bn of investment in gas network innovation projects between 2021/22 and 2031/32 - all of which are related to the roll-out of hydrogen.

Our proposals for the investment needed to create the world's first zero-carbon gas grid fall into five groups:

- **Decarbonising Britain's Industrial Clusters**
- **Ensuring our networks are ready for net zero**
- **Accelerating Britain's hydrogen economy**
- **Delivering a whole systems approach**
- **Creating options for decarbonising transport**

These groups demonstrate the wide impact that gas network innovation will have on decarbonising the UK's road to Net Zero.

Our solutions consider the impact of a hydrogen economy on the national and local levels. They will provide a unique opportunity to invest in both green infrastructure and communities across the country, through the creation of highly skilled, good quality, sustainable, green jobs that will deliver truly world-leading solutions to the challenge of decarbonisation.

Based on the Office of National Statistics formula for calculating the expected jobs impact, this investment is expected to deliver 13,300 high-tech green innovation jobs across the gas network companies over the next ten years. Another 11,400 jobs could be created in wider supporting supply chains, clearly demonstrating the wider economic impact of our plans. This is a major increase on the 40,000 people currently employed by both gas and electricity networks in the U.K. and Ireland.

Because network companies are regulated monopolies, the investment will be delivered through the price control system that governs their expenditure. It is therefore subject to approval, from the energy regulator Ofgem, who will make those decisions based on their analysis of customer value for money and the requirement for investment, which is determined by wider Government policy, such as the Prime Minister's Ten Point Plan for a Green Industrial Revolution, the Hydrogen Strategy or the 2021 Energy White Paper.

If approved, investments will be delivered through the RIIO-2 price control (2021-2026) and further price controls between now and 2032.

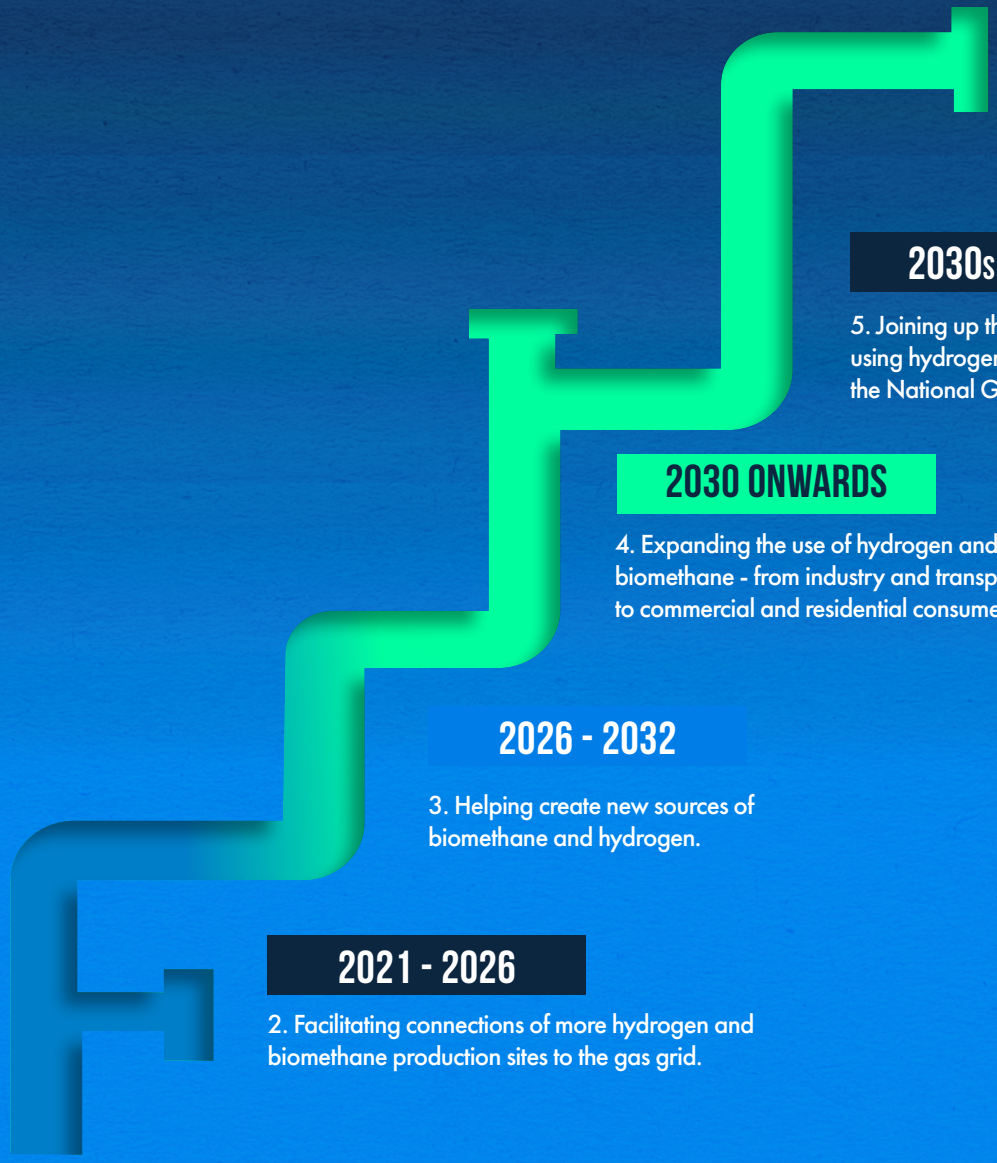
OUR PATHWAY TO NET ZERO

To progress our commitments to zero carbon, our Pathway to Net Zero sets out six key steps to achieve net zero emissions by replacing the use of natural gas with hydrogen and biomethane by 2050.

The six steps consider how our plans for decarbonisation need interconnected solutions. The Pathway sets out how combining electrification with the use of hydrogen and biomethane could save £13bn a year compared to other solutions that rely solely on electricity.

The planned steps demonstrate how transforming the existing infrastructure of our gas grid will enable decarbonisation in industry, transport and domestic sectors and how we plan to incorporate a wider use of renewable energy sources.

The Pathway sets out a vision for an interconnected system whereby the gas networks work together to deliver the key six steps to a fully functioning zero carbon gas grid by 2050.



2020 - 2024

1. Planning and research – to prepare for a transition away from natural gas.

2021 - 2026

2. Facilitating connections of more hydrogen and biomethane production sites to the gas grid.

2026 - 2032

3. Helping create new sources of biomethane and hydrogen.

2030 ONWARDS

4. Expanding the use of hydrogen and biomethane - from industry and transportation to commercial and residential consumers.

2030s - 2040s

5. Joining up those parts of the country using hydrogen and biomethane, through the National Grid.

BY 2050

6. The world's first fully functioning zero carbon gas grid, using 100% low carbon gases.

BRITAIN'S HYDROGEN NETWORK PLAN

Britain's Hydrogen Network Plan sets out the detail of the activities that Britain's gas network companies will undertake to turn Britain's hydrogen ambitions into reality.

The Plan shows how the companies, responsible for owning and operating £24bn of energy infrastructure, will:

1

Ensure the safe delivery of hydrogen through innovation projects. This includes work undertaken by the Hy4Heat programme (led by BEIS) to test different household appliances such as boilers, heaters and cookers in various settings, and the world-leading H21, H100 Fife and HyNTS Future Grid projects which are testing different parts of the gas network.

2

Maintain security of energy supply to ensure gas networks have enough capacity to meet Britain's energy demands using hydrogen. This includes modelling how gas networks will behave to ensure that capacity is put in place in the right places and to calculate how much hydrogen will be needed. Projects such as Project Cavendish on the Isle of Grain will pioneer the connection of hydrogen production facilities to Britain's gas networks.

3

Work with people's needs to help reduce carbon emissions whilst ensuring that people and businesses have a choice of different low carbon technologies – in our homes, our offices and factories, as well as on our roads. This includes delivering hydrogen neighbourhood domestic trials of different appliances through the world-leading H100 Fife project and hydrogen village trials through the HyNet Homes, Future Billing Methodology and Real Time Networks projects which will help ensure consumers continue to receive accurate gas bills, as more hydrogen is introduced to the gas grid.

4

Deliver jobs and investment, including through the replacement of old iron mains gas pipes around the country with new, hydrogen-ready pipes instead. By 2032, the companies are planning to have invested £28bn in doing so in projects around the country. The Plan shows that gas network companies are playing a role in delivering £1.5bn of funding in industrial decarbonisation projects around the country.

HOW WE WILL DELIVER OUR INVESTMENT

The investment set out in this report will deliver our plans for the world's first zero-carbon gas grid, following the six steps of the Gas Goes Green Pathway and delivering the detail of Britain's Hydrogen Network Plan.

Gas network companies deliver investment through the RIIO price control system, administered by the energy regulator Ofgem. Proposals for innovation investment are submitted by network companies and then either approved or rejected by the regulator, in accordance with value for money criteria and the requirements of wider Government energy policy.

Under the current RIIO-2 price control period (2021-2026), there are five different funding mechanisms that network companies can use to invest:

FUNDING MECHANISM	PURPOSE
Net Zero and re-opener development, use-it-or-lose-it (UIOLI) allowance	To enable network companies to fund early design and preconstruction work. It also allows Gas Distribution and Gas Transmission network companies to undertake small Net Zero facilitation projects.
Net Zero pre-construction and small projects re-opener	To allow Gas Distribution and Gas Transmission network companies to undertake design and preconstruction work that is too material for the UIOLI and also to progress Net Zero facilitation projects that aren't material enough for the Net Zero Re-opener.
Net Zero re-opener	To introduce an increased level of adaptability into the RIIO-2 price control by providing a means to amend the price control in response to changes connected to the meeting of the Net Zero targets, which affect the costs and outputs of network licensees.
Strategic Innovation Fund	To support network innovation that contributes to the achievement of Net Zero while delivering real net benefits to network companies and consumers; to work with other public funders of innovation so that activities appropriately funded by network consumers are coordinated with activities funded by the government.
Network Innovation Allowance	To fund innovation relating to support for consumers in vulnerable situations and/or the energy system transition. Research, Development and Demonstration trials between Technology Readiness Levels (TRLs) 2-8.

OVERVIEW OF ALL PROJECTS

From testing the blending of up to 20% hydrogen into the existing infrastructure to finding new ways to transport 100% renewable hydrogen from offshore wind turbines to your living room, each project is undertaking the vital work to make the zero-carbon gas grid a reality.

Following the goals outlined in Britain's Hydrogen Network Plan, our projects look to find innovative solutions to the nations rising carbon emissions while helping to rejuvenate industrial hubs across the UK, increasing investment in local economies through the creation of highly skilled jobs.

With developments occurring in each of these projects, it is essential that we carefully track and monitor the progress at every stage to ensure that we meet each step of the wider Gas Goes Green Pathway to Net Zero.

To successfully monitor the progress and activity of each of these projects, we have assigned each to one of the **following five key categories**:

1. Decarbonising Britain's Industrial Clusters

Helping decarbonise Britain's six Industrial Clusters, which contain a mixture of heavy industries that are currently dependent on natural gas for manufacturing.

2. Ensuring our networks are ready for net zero

Using innovation to repurpose our existing infrastructure so it is hydrogen-ready.

3. Accelerating Britain's hydrogen economy

Infrastructure innovation investment that will help unlock the development of the hydrogen economy in the UK.

4. Delivering a whole systems approach

Finding new ways to work more closely with other parts of the energy system across traditional boundaries.

5. Creating options for decarbonising transport

Using innovation to ensure that the right network infrastructure is in the right places to support people's decarbonised transport choice.

OVERVIEW OF ALL PROJECTS

Our proposals are for new investment. In some cases, this will be for additional investment to expand or develop existing projects that have been running for some time, such as the pioneering HyDeploy hydrogen blending project, and in others this will be for new projects.

Across these five categories, we plan to invest a total of £6.8bn in cutting edge, world-leading decarbonisation innovation projects between 2021/22 and 2031/32.

The largest proportion of investment we propose is for decarbonising Britain's six Industrial Clusters, which over time will serve as anchor points for the wider decarbonisation of homes and transport. This investment is planned to be consistent over the next decade or so. Investment in network preparation for Net Zero is the second largest category, with investment being relatively small in the first part of this decade before accelerating quickly in the latter part of the 2020s.

	INVESTMENT	ESTIMATED DIRECT JOBS CREATED	ESTIMATED SUPPLY CHAIN JOBS CREATED
Decarbonising Britain's Industrial Clusters	£4,368,683,000	9,191	8,047
Ensuring our networks are ready for Net Zero	£2,236,616,308	3,646	3,123
Accelerating Britain's hydrogen economy	£150,647,000	436	289
Delivering a whole system approach	£12,300,000	33	14
Creating options for decarbonising transport	£7,150,000	31	13
	£6,775,396,308	**13,337**	**11,486**

PROFILE OF PROPOSED GAS NETWORK INNOVATION INVESTMENT 2021/22 TO 2031/32

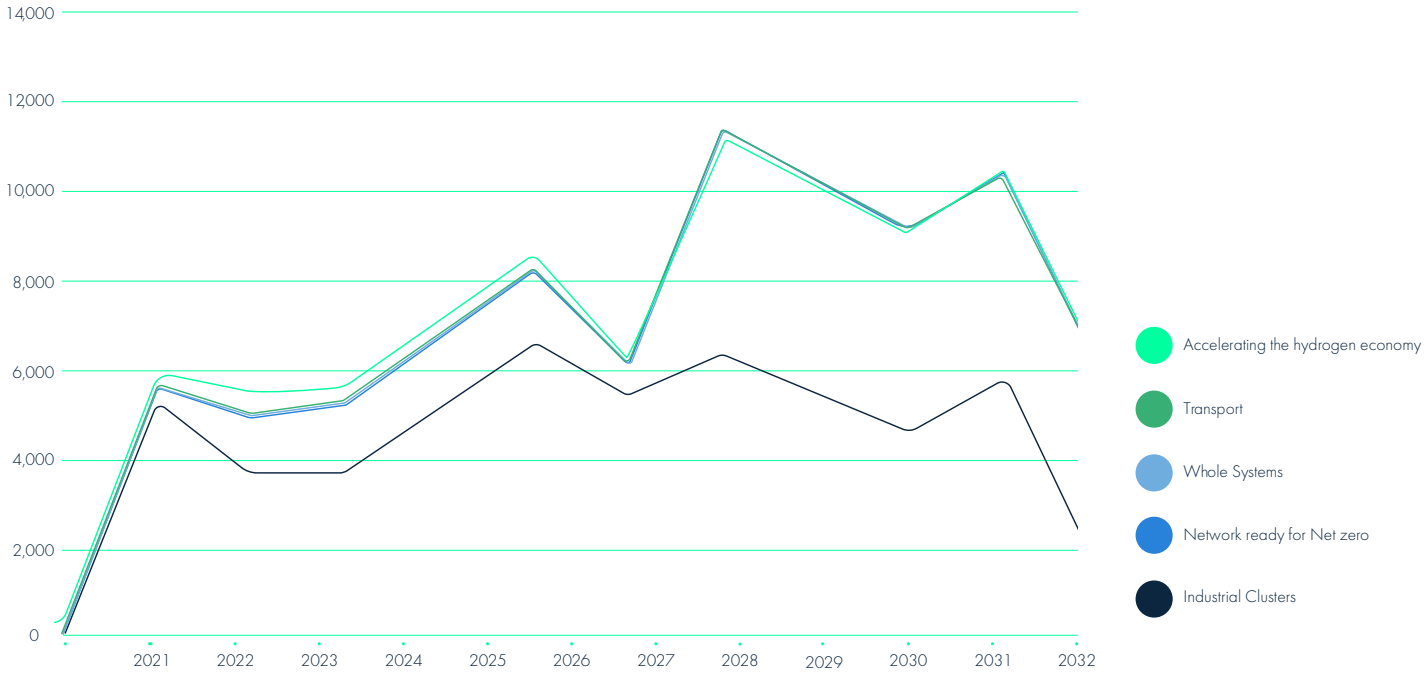
OVERVIEW OF ALL PROJECTS

In total, using the recommended formula by the Office of National Statistics, we expect this investment to deliver 13,337 direct jobs and 11,486 related supply chain jobs between 2021/22 and 2031/32, with the number of jobs peaking in 2028.

By 'direct jobs' we mean people employed by gas network companies themselves and 'supply chain jobs' we mean people employed by those project partners, contractors and sub-contractors working to deliver the projects. To put this in context, gas and electricity network companies in the United Kingdom and Ireland currently employ around 40,000 people.

With approval of projects by the regulator, we expect additional jobs to be created from 2022 onwards. Once again, decarbonising Industrial Clusters and gas network preparedness for hydrogen will deliver the largest numbers of jobs, however the profile of their creation is more uniform than the profile of investment levels.

EXPECTED PROFILE OF JOBS CREATED BY PROPOSED INNOVATION PROJECTS 2021/22 - 2031/32



OVERVIEW OF ALL PROJECTS

Britain's gas network companies are, first and foremost, local companies also playing a national role. These companies, and the infrastructure they are responsible for, are rooted in the communities they serve. So, any innovation investment delivered by them has the potential to create jobs in those communities.

The impact of the innovation projects will be felt in communities across the country. Investment and jobs will be delivered in all regions of Great Britain, reflecting the different licence areas of different gas network companies. For those gas distribution networks with two licence areas, this investment will be distributed evenly between the two.

Whilst SGN's Southampton Water project represents the biggest investment by one network company, others, such as Cadent, plan major investments of over £100m in the decarbonisation of the Humberside and Merseyside Industrial Clusters.

GAS DISTRIBUTION NETWORKS

- SGN
- NORTHERN GAS NETWORKS
- CADENT GAS
- WALES & WEST UTILITIES

Northern Gas Networks

£16,828,900
INVESTED

77 estimated direct jobs created
41 estimated supply chain jobs created

SGN

Your gas. Our network.

£3,341,653,000
INVESTED

7044 estimated direct jobs created
6019 estimated supply chain jobs created

WALES&WEST UTILITIES

£52,594,000
INVESTED

214 estimated direct jobs created
100 estimated supply chain jobs created

Cadent

Your Gas Network

£1,295,530,000
INVESTED

2940 estimated direct jobs created
2569 estimated supply chain jobs created

nationalgrid

£2,000,397,809
INVESTED

3034 estimated direct jobs created
2706 estimated supply chain jobs created

Note: Total figures provided for 'investment', 'numbers of jobs by network company' and 'investment or jobs by category' may not perfectly align due to rounding and division of projects between different networks where projects are being collaborated on. Full information for each project is provided in the Appendix.

1 DECARBONISING BRITAIN'S INDUSTRIAL CLUSTERS

Total network investment planned for this category:	£4,368,683,000
Total number of direct jobs we expect to create:	9,191
Total number of supply chain jobs we expect to create:	8,047

Industrial Clusters can be found across the country and are a crucial part of the UK's economy. Clusters are groups of diverse industries in the same location across the country, producing resources and materials, such as iron and steel. The clusters are key hubs of local economic activity, invaluable to local supply chains and economies for providing high-quality jobs, paying higher than the UK average wage.

Clusters are heavy users of fossil fuels, accounting for some of the hardest-to-abate greenhouse gas emissions in our economy. Approximately a quarter of all UK emissions comes from industry. And more than two-thirds of these emissions originate from a small number of energy-intensive industries within these clusters.

Decarbonising industry, therefore, offers an opportunity to develop our existing infrastructure for a greener future.

As part of our Pathway to Net Zero, we aim to create the world's first net zero Industrial Cluster by 2040. We hope to make the UK leaders in this growing sector and create a low-carbon exemplar to be used internationally.

On our Pathway to achieving this goal by 2040, we aim to establish at least one low-carbon cluster by 2030. These developments in our existing infrastructure will support industrial decarbonisation and attract greater investments and innovations in low-carbon infrastructure.

TOMORROW'S HEAT, TODAY'S OPPORTUNITY:
REDUCING OUR EMISSIONS FROM INDUSTRIAL CLUSTERS

GOVERNMENT AMBITIONS

Reaching the target of net zero carbon emissions by 2050 will require huge change across all sectors, including industry. Industry accounts for 16% of UK greenhouse emissions. Industry plays an essential role in society, contributing **£170 billion** to the overall economy.

INNOVATION PROJECTS DECARBONISING INDUSTRIAL CLUSTERS

PROJECT UNION

As low-carbon clusters develop, National Grid will be ready to link them using repurposed pipes carrying hydrogen. By connecting these clusters, we can increase the security of supply and the resilience of the gas network.

Net Zero Teesside

Aims to deliver the UK's first zero-carbon Industrial Cluster through deploying CCUS technology. The project plans to capture up to 10 MtCO2e.

During construction, the project could enable an annual gross benefit of up to £450 million and support up to 5,500 direct jobs.

HyNet North West

Includes the development of a new hydrogen pipeline to supply hydrogen to industry and the creation of the UK's first carbon capture usage and storage (CCUS) infrastructure.

These changes can save over 1 MtCO2e every year.

H21

Led by Northern Gas Networks, the H21 programme is delivering evidence in support of a transition to a 100% hydrogen future.

H21 is testing existing gas network infrastructure's suitability for delivering hydrogen.

SWIC

A partnership between industry, infrastructure companies, the public sector and academia, SWIC will help decarbonise heavy industry in South Wales, preserving 113,000 manufacturing jobs and creating thousands of new green jobs by 2050.

MAP KEY

- SGN
- NORTHERN GAS NETWORKS
- CADENT GAS
- WALES & WEST UTILITIES
- EXISTING LIQUID NATURAL GAS TERMINALS
- BRITAIN'S SIX INDUSTRIAL CLUSTERS
- POTENTIAL NATIONAL HYDROGEN GAS NETWORK
- OTHER GAS NETWORKS

Cadent Your Gas Network · nationalgrid · Northern Gas Networks · SGN Your gas. Our network. · WALES&WEST UTILITIES

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CASE STUDIES

Southampton Water

Planned network investment:	£1,074,000,000
Estimated direct jobs created:	2,321
Estimated supply chain jobs created:	2,206

On the south coast of England, the Southampton Water project looks to support the decarbonisation of local industry and transport. Currently, the area, which is home to one of the UK's largest and busiest ports, sees around 2.6 million tonnes of CO2 emitted each year. Through their work, the project will investigate the feasibility of developing a hydrogen super-hub at the Port of Southampton to help deliver hydrogen production and distribution across the entire south coast.

As well as this super-hub, the project aims to scrutinise the role of carbon capture, utilisation and storage (CCUS) could play in the decarbonisation of the region. Eventually, the project aims to further develop this by laying the foundations for further decarbonisation in high emission sectors like shipping and industry.

HyNet North West

Planned network investment:	£810,500,000
Estimated direct jobs created:	1,781
Estimated supply chain jobs created:	1,626

The HyNet North West project is leading innovation in low carbon and hydrogen energy in the northwest and North Wales. From 2025, the project will produce, store, and distribute hydrogen while capturing and storing carbon from industry across the region. As well as upgrading and reusing existing infrastructure, the project will oversee the building of new infrastructure which is affordable and safe. With these developments, the project has the potential to see benefits to both the UK's drive to net zero and local communities. The updates to infrastructure will not only have the potential to reduce CO2 emissions by 10 million tonnes every year by 2030 but they also will create, and maintain, thousands of local jobs.

CASE STUDIES

North East Network and Industrial Cluster Development

Planned network investment:	£2,098,053,000
Estimated direct jobs created:	4,261
Estimated supply chain jobs created:	3,499

Scotland's north-east and central belt are home to some of its largest industrial carbon emitters. The sector's reliance on natural gas means that it emits 11.9Mt of CO2 emissions per year: the equivalent of 2.6 million cars, or roughly all the cars in Scotland.

SGN's North-East Network and Industrial Cluster project is laying the foundations for the rapid decarbonisation of this high-emitting sector, proposing to demonstrate the feasibility of a 100% renewable hydrogen energy system that will repurpose the existing gas network to reduce those emissions.

East Coast Hydrogen

Planned network investment:	£262,000,000
Estimated direct jobs created:	545
Estimated supply chain jobs created:	492

East Coast Hydrogen is a collaboration between Cadent, Northern Gas Networks and National Grid covering a footprint that includes the North East and East Midlands regions. It's a project that is seeking to create a hydrogen network with as little cost as possible by re-purposing existing pipeline assets and building new pipelines only if needed. It is anticipated that this network will build out from the planned hydrogen production clusters in the Humber region, Teesside and the East Midlands - complementing and building on the existing plans of the hydrogen cluster consortia.

The aim is to be ready to transport hydrogen to where it is needed for decarbonising heavy industry, heating, power generation and transport. Connection of the Humber and Teesside clusters, and hydrogen storage, would then be followed by connection to HyNet North West and other hydrogen production clusters in Cumbria and East Anglia.

2 ENSURING OUR NETWORKS ARE READY FOR NET ZERO

Total network investment planned for this category:	£2,236,616,308
Total number of direct jobs we expect to create:	3,646
Total number of supply chain jobs we expect to create:	3,123

To ensure that the entire network can deliver hydrogen to our homes and businesses, we need to invest in the existing infrastructure of our energy networks. These projects will help accelerate our work on readying our networks, firstly, for natural gas blended with hydrogen and eventually 100% hydrogen.

Our existing Iron Mains Replacement Programme has already installed hydrogen-ready pipelines in almost two-thirds (62%) of our local networks. Our projects also look to develop and improve our existing infrastructure to reduce gas shrinkage by 23% in the RIIO-2 period, thus ensuring the reliability of our services for the consumer. The Iron Mains Risk Reduction Programme, for instance, looks to upgrade the existing infrastructure of our networks by replacing cast iron pipes and repairing poorly sealed joints on aged assets. With investments in our innovation projects, we can accelerate this progress even further – upgrading and building upon our existing gas infrastructure.

Our projects ensure that the network is ready for net zero at both a national and local scale, already delivering in-depth Hydrogen trials, working towards the aims of Britain's Hydrogen Network Plan, the Prime Minister's Ten Point Plan and the Government's Hydrogen Strategy.

CASE STUDIES

SGN Your gas. Our network. H100

Planned network investment:	£115,000,000
Estimated direct jobs created:	170
Estimated supply chain jobs created:	165

H100 Fife will demonstrate just how we can distribute green hydrogen to homes and replace the use of natural gas. The hydrogen will be produced by an electrolyser, powered by electricity from a wind turbine, and delivered through a new pipeline. The project will operate over two phases and will work on an opt-in basis for customers. The first phase, which will begin work in 2022, will provide 300 customers in the area with 100% hydrogen. A further 300 customers will be invited to opt-in to the trial in the second phase. The project will provide an opportunity to review the impact hydrogen has on the existing network while ensuring that progress is made on Scotland's 2045 net zero targets.

nationalgrid FutureGrid

Planned network investment:	£45,000,000
Estimated direct jobs created:	197
Estimated supply chain jobs created:	103

On a national scale, FutureGrid will provide an entire network demonstration to test the distribution of hydrogen across the national system. The project will include the building of an offline hydrogen testing facility in Spadeadam to test the ability of the National Transmission System (NTS) to transport hydrogen. The facility will be built from decommissioned transmission assets and will replicate the entire network while remaining separate from the main NTS. This will ensure that testing is undertaken in a controlled environment without risking the safety or reliability of the existing network. The facility will be used to test varying percentage blends of hydrogen to assess how the network performs at distributing hydrogen and will provide valuable insights into how this work can be translated to the NTS.

CASE STUDIES

LTS Futures

Planned network investment:	**£20,000,000**
Estimated direct jobs created:	**74**
Estimated supply chain jobs created:	**31**

Projects focused on testing both the Local Transmission System (LTS) and the National Transmission System (NTS) will help ensure efficient transportation of hydrogen around the country, to homes and businesses across the UK.

The LTS forms the backbone of the wider energy network, ensuring the reliability and accessibility of more local gas distribution to towns and cities around the country. The LTS Futures project, therefore, is essential in ensuring the updates to existing infrastructure to make the switch from natural gas to hydrogen. Initial research into the existing infrastructure highlighted that 91% of the existing SGN pipeline network will most likely be suitable for the switch to hydrogen. As the project develops, greater investigations, including a live trial, will be made to ensure the suitability of the entire existing infrastructure in delivering hydrogen safely and securely.

3 ACCELERATING BRITAIN'S HYDROGEN ECONOMY

Total network investment planned for this category:	£150,647,000
Total number of direct jobs we expect to create:	436
Total number of supply chain jobs we expect to create:	289

With 85% of homes in Great Britain connected to the gas grid, we must look to reform the existing gas network structure to tackle the carbon emissions. By creating the world's first zero-carbon gas grid, our gas network infrastructure will act as the platform for building the UK's hydrogen economy.

Our innovation projects will develop and help roll out the technical and enginerring expertise needed to run gas networks on a mixture of different gases from different sources, progressing towards 100% over time, to replace the current use of natural gas and so reduce carbon emissions.

By creating the ability to run Britain's gas networks in a smarter way that capitalises on this learning, we will make our infrastructure more capable of being configured in different ways in different places, to deal with differing needs and requirements of those connecting green gas production to the gas grid, and those using it to reduce their emissions.

CASE STUDIES

Cadent Your Gas Network HyDeploy

Planned network investment:	**£32,100,000**
Estimated direct jobs created:	**13**
Estimated supply chain jobs created:	**13**

The HyDeploy project has pioneered the blending of up to 20% hydrogen into the UK gas grid. Foundational work at Keele University has already demonstrated the safe delivery of a 20% hydrogen blend to 100 homes and 30 university buildings using the existing infrastructure, allowing homes to reduce their carbon emissions without having to change their gas boilers, heaters or cookers.

By building on this success, HyDeploy 2 will demonstrate the safety of a hydrogen blend on a public network at Winlaton, in Gateshead. This next phase in the project involves a trial area of 670 homes as well as the local church, primary school and several businesses.

Following this, HyDeploy 3 will look to further these investigations into hydrogen blends on both industrial and commercial gas customers. With each stage of the project, HyDeploy looks to test and demonstrate the suitability of blended hydrogen using the existing network infrastructure, providing the evidence base for the use of up to 20% hydrogen in 284,000 km of gas pipelines that supply heat to 85% of homes across Great Britain.

CASE STUDIES

Cadent Your Gas Network

Future Billing Methodology

Planned network investment:	**£4,800,000**

The Future Billing Methodology project explores options for a fair and equitable billing methodology that will be suitable for a lower-carbon future. The current system, Flow Weighted Average Calorific Value (CV) billing regime, has the potential to restrict entry to unconventional gases that comply with Gas Safety (Management) Regulations GS(M)R. As well as this, the current system would require expensive processing to match the CV of the primary inputs. The project looks to understand how diverse gas sources can be integrated into the current system by exploring options for assigning CV at more specific levels and, with the findings, will inform the industry on billing options for the future hydrogen economy.

These innovation projects will attract investments in green technology and will be used across the supply chain. Investments will be used for key developments such as blending into the gas networks to creating green electricity using curtailed power to providing fuel sources for heavy-goods vehicles.

4 DELIVERING A WHOLE SYSTEMS APPROACH

Total network investment planned for this category:	£12,300,000
Total number of direct jobs we expect to create:	33
Total number of supply chain jobs we expect to create:	14

As Britain builds a zero carbon energy system, the traditional boundaries between different parts of the existing, fossil-fuel based system will start to change, requiring a more interconnected approach between those parts.

The challenges of reducing carbon emissions across the country combined with the need to find innovative solutions to bring hydrogen to homes and businesses requires a whole systems approach.

By working collaboratively, variable renewable energy can be stored and used as hydrogen by gas networks across the country. Mixing hydrogen and biomethane into the gas grid to reduce household carbon emissions, for instance, will also help stimulate the production of gases that can be utilised across other areas of the economy.

This integrated way of working is key to reducing our carbon emissions and reaching our net zero goal.

5 CREATING OPTIONS FOR DECARBONISING TRANSPORT

Total network investment planned for this category:	£7,150,000
Total number of direct jobs we expect to create:	31
Total number of supply chain jobs we expect to create:	13

As well as industry, our research shows that there is no realistic scenario whereby the UK can achieve net zero emissions by 2050 without addressing the other large carbon-emitting sectors, such as power, heat, and transport.

Reducing carbon emissions in the transport sector is complex. We must ensure that these new technologies are not only tested in our wider energy system but that the consumer still has access to the same reliability of their transport services.

These innovation projects will establish how advancements in our gas networks delivering hydrogen can open new opportunities to develop 'Green Mobility Hubs' across the UK. These hubs will help reduce carbon emissions across public, private and freight transportation. Using a combination of hydrogen, biomethane, and electricity, these hubs will offer consumers' variety in their transportation technologies without impeding everyday life.

CASE STUDIES

Cadent Your Gas Network — Hy4Transport

Planned network investment:	**£6,000,000**
Estimated direct jobs created:	**18**
Estimated supply chain jobs created:	**8**

Hy4Transport investigates the challenges that need to be addressed to ensure that hydrogen can play a key role in decarbonising the UK's transport industry. The project will include demonstrations of how purified grid-supplied hydrogen can be utilised for fuel cells across the transport sector as well as how the requirements of such a system can be achieved on forecourts. By investigating the potential of hydrogen use in transport, Hy4Transport will help unlock cost-competitive, green solutions for the sector using alternative technologies.

CONCLUSION

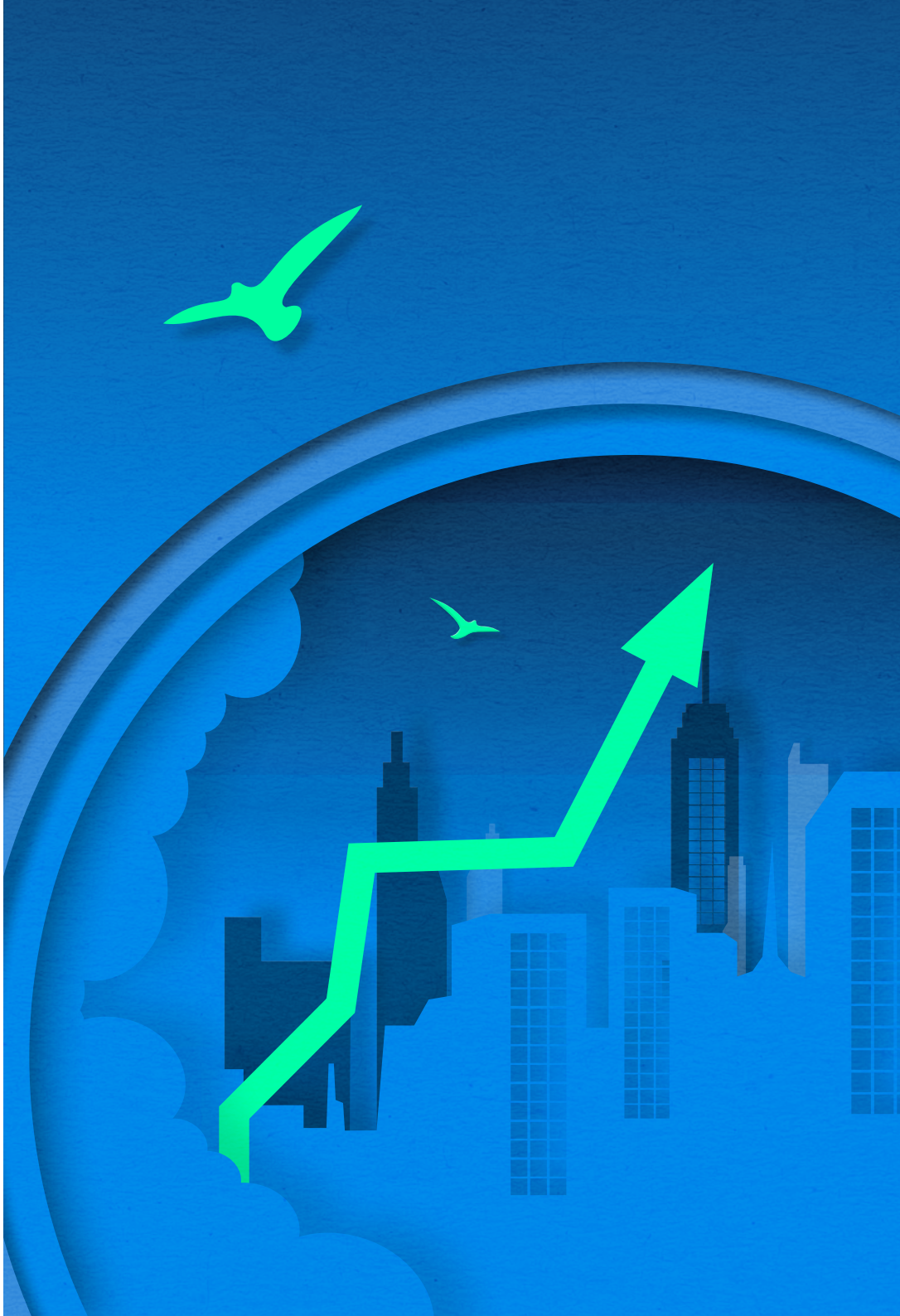
The severity of the climate emergency means that we must work now to ensure a greener future. The innovation projects set out in this report, however, demonstrate how investing in innovation will not only provide solutions to the climate emergency but will also create green investment and jobs in communities across the UK. They highlight how using hydrogen in Britain's homes, businesses and industry will mean that our energy networks will invest in our communities as we decarbonise by building the infrastructure for new green technologies we all need.

Through these projects, we hope to make the UK a leader in the green revolution on power and create an exemplary model that will be replicated across the world. Revolutionary work in projects like HyNet, H21 and HyDeploy are already looking at ways to upgrade and build upon the existing network infrastructure to distribute and deliver hydrogen safely and securely through the National Transmission System (NTS) and significantly reduce carbon emissions by 2050.

From the progress made by our projects across the five key categories, we can see that as well as helping to reduce carbon emissions across the UK our projects are directly benefitting local communities through increased investment and the creation of highly skilled jobs. As well as working towards the goal of decarbonising industry, Industrial Clusters across the UK, for example, offer an opportunity to invest in communities through the preservation, and creation, of jobs. The South Wales Industrial Cluster, for instance, will not only preserve the existing 113,000 manufacturing roles but could create thousands of further roles by 2050.

Crucially, these projects will help provide the infrastructure we need to provide consumers with the widest possible range of green technologies to reduce their emissions, all whilst helping keep the costs of decarbonisation as low as possible.

Learn more about how we plan to meet our steps on our Pathway to Net Zero to create the world's first fully functioning zero carbon gas grid here.



APPENDIX A: JOB METHODOLOGY

Investing in green technologies to deliver hydrogen to Britain's homes will create long-term, sustainable jobs across the country. The developments made to the existing infrastructure of our gas networks, as well as new green technologies, will generate a boost in the UK's economy through the creation of jobs and investment in communities.

The metric we can use to measure this return on investment is through the number of jobs created across the country. By calculating the number of jobs created across the five networks each year, we can compare the current workforce statistics with how many jobs the industry is estimated to support and track the increase over time.

We can use the following model to quantify this:

Using the multipliers set out in the Office for National Statistics datasheet[1] , we can calculate the effects a net zero grid would have on direct, indirect and induced employment. The datasheet allocates for this sector, i.e., the "manufacture of gas; distribution of gaseous fuels through mains; steam and aircon supply", with a Full Time Equivalent (FTE) standard multiplier of 2.9 and an effect multiplier of 4.96.

- A standard multiplier measures the ratio between the initial impact and the total impact. For jobs, this means that for every 1 person employed directly as a direct result of capital investment, 2.9 are created overall for this sector.

- An effect multiplier correlates with the total impact of a £1m increase in final demand. When this comes to jobs, this means that for every £1m increase of final output, 4.96 jobs are supported directly and indirectly by the economy.

By using these multipliers, we can assess the effect of hydrogen in Britain's homes has on three types of employment:

- Direct employment refers to the employment created as a direct result of the capital investment in a given project, for instance, the lead network, the project partners, etc.

- Indirect employment is the employment created across the supply chain supporting the projects, i.e., manufacturing.

- Induced employment, which requires a type 2 multiplier, a measure of employment and benefit to the wider economy due to the increased spending by those employed directly and indirectly due to investment in a project.

1: https://www.ons.gov.uk/economy/nationalaccounts/supplyandusetables/articles/inputoutputanalyticaltables/methodsandapplicationtouknationalaccounts

APPENDIX A: JOB METHODOLOGY

In order to calculate the direct and indirect employment rates, we must divide the effect multiplier by the standard multiplier. Therefore, in this case, 1.71 direct FTE jobs and 3.25 FTE indirect jobs are supported.

Example:

Take a £1bn investment over 10 years. CAPEX is the final demand in this calculation so is therefore valid.

We have to assume also that this is after tax, and that the factor is applicable every year and unchanged by deflation (an investment now would have been less 5 years ago for example).

Assuming £100m is spent each year for 10 years. This level of investment in the economy is estimated to support:

100 x 4.96 = 496 jobs overall for 10 years, with 171 of these being direct and 325 being indirect.

For each project, based on the above example, we would need the following information:

- Total CAPEX and timeline
- Or, if available, a more accurate spend profile

With the production of the grid's infrastructure being focused initially across Britain's Industrial Clusters, hydrogen in homes across the nation will be directly supporting long-term jobs and investment in five key categories.

APPENDIX B: INVESTMENT & JOBS DATA BY PROPOSED PROJECT

Project	Phase	Summary	Lead Network	Category	Start FY	End FY	Lifespan (Years)	Total Network Investment (£)	Estimated direct jobs created	Estimated supply chain jobs created	Emissions benefit (tCO2e)
HyNet	Feasibility	North-West hydrogen and Industrial Cluster	Cadent	Industrial Clusters	2018/2019	2021/2022	4	500,000	2	1	0
	Phase 1 & 2 FEED				2021/2022	2027/2028	7	20,000,000	42	18	0
	Phase 1 & 2 Construction				2024/2025	2026/2027	3	250,000,000	636	618	4,500,000
	Phase 3 FEED				2024/2025	2027/2028	4	40,000,000	148	64	0
	Phase 3 Construction				2027/2028	2030/2031	4	500,000,000	954	926	7,500,000
Cumbria Humber	Feasibility	Hydrogen production & storage in Cumbria	Cadent	Industrial Clusters	2021/2022	2021/2022	1	30,000	0	0	0
	Pre-FEED				2022/2023	2022/2023	1	1,000,000	15	6	0
	FEED				2022/2023	2025/2026	4	5,000,000	18	8	0
	Construction				2027/2028	2030/2031	4	100,000,000	191	185	0
East Coast Humber	Feasibility	Humber hydrogen and Industrial Cluster	Cadent	Industrial Clusters	2021/2022	2021/2022	1	100,000	1	1	0
	Pre-FEED				2022/2023	2022/2023	1	2,000,000	30	13	0
	FEED				2022/2023	2025/2026	4	10,000,000	37	16	0
	Construction				2025/2026	2028/2029	4	250,000,000	477	463	0
HyNet Homes	FEED	2000 home hydrogen village demonstration, 100% hydrogen demonstration	Cadent	Network ready for net zero	2022/2023	2022/2023	1	3,000,000	44	19	0
	Construction				2022/2023	2025/2026	4	40,000,000	76	74	0
HyDeploy	HyDeploy 2	20% blend in Winlaton, Delivers technical evidence to allow blending	Cadent	Accelerating the hydrogen economy	2018/2019	2022/2023	5	13,300,000	20	20	0
	HyDeploy 3	First scale deployment of blending, Delivers technical evidence to allow blending			2022/2023	2024/2025	3	12,000,000	31	30	0

South Wales Industrial Cluster		FEED	Wales & West Utilities	Industrial Clusters	2021/2022	2022/2023	2	2,000,000	15	6	0
		Pre-construction			2021/2022	2026/2027	6	16,000,000	39	17	0
Industrial Cluster - Hydrogen for Homes		Network Development	Wales & West Utilities	Industrial Clusters	2022/2023	2023/2024	2	600,000	4	2	0
Southampton Water	Pre-FEED	Development of a hydrogen economy in the Southampton Water Industrial Cluster and the wider area	SGN	Industrial Clusters	2021/2022	2021/2022	1	1,000,000	15	6	0
	FEED				2022/2023	2025/2026	4	20,000,000	74	32	0
	Phase 1				2025/2026	2027/2028	3	107,900,000	274	267	791,200
	Phase 2				2030/2031	2032/2033	3	242,800,000	618	600	3,385,600
	Phase 3				2033/2034	2036/2037	4	702,300,000	1,340	1,301	5,501,600
	Phase 4				2037/2038	2040/2041	4	0	0	0	6,936,800
North East Network and Industrial Cluster development	FEED	Decarbonisation of Scottish Industry and the creation of a hydrogen economy on the east coast and central belt of Scotland	SGN	Industrial Clusters	2021/2022	2021/2022	1	80,000,000	1,182	508	0
	Construction - RIIO-2				2021/2022	2025/2026	5	1,130,617,309.78	1,725	1,676	2,038,896.899
	Construction - RIIO-3				2026/2027	2030/2031	5	789,970,029.64	1,205	1,171	10,921,146.69
	Construction - RIIO-4				2031/2032	2035/2036	5	97,465,660.84	149	144	16,053,676.30
	Construction - RIIO-5				2036/2037	2040/2041	5	0	0	0	17,502,804.43
	Construction - RIIO-6				2041/2042	2045/2046	5	0	0	0	19,121,913.15
	Construction - RIIO-7				2046/2047	2051/2052	5	0	0	0	19,153,637.73
H100 Fife	Phase 3	Expansion of H100 network to commercial and industrial customers	SGN	Network ready for net zero	2022/2023	2025/2026	4	75,000,000	143	139	18,000
	Phase 4	Expansion of H100 network to develop transport refuelling infrastructure			2024/2025	2030/2031	7	25,000,000	27	26	4,000
Multiple Occupancy Buildings	Physical Testing	R&D and field trial of hydrogen in MOBs	SGN	Network ready for net zero	2023/2024	2025/2026	3	34,000,000	167	72	0
LTS Futures	Field Trial and Material Testing	Field testing/trial to enable the repurposing of the LTS to hydrogen and/or CO2	SGN	Network ready for net zero	2022/2023	2025/2026	4	20,000,000	74	32	0

Hydrogen Deblending	Feasibility Phase 2		NGGT	Accelerating the hydrogen economy	2021/2022	2022/2023	2	620,000	5	2	0
Future Grid	Compression Development & Demonstration	Compression on the NTS will need to migrate to manage hydrogen/methane blends and also use this to power the compression. This project will understand the capability of the compression system at varying blends and look at the effect of variability on the system. It is understood that at higher concentrations of hydrogen we will require increased power from the compressors, this project will determine the cheapest options for this on the NTS.	NGGT	Networks ready for net zero	2021/2022	2024/2025	4	10,000,000	37	16	0
	Deblending Development & Demonstration	Blending into the NTS may lead to varying compositions of hydrogen and methane that would not be acceptable to consumers, deblending allows us to ensure our customers see the required consistent gas blend through the transition. This technology may also play a part in ensuring the safe running of key NTS equipment without costly overhauls being required at once.			2022/2023	2025/2026	4	5,000,000	18	8	0
	Operational and Maintenance Development & Demonstration	Operational and maintenance procedures when transporting hydrogen will need to change. Common operations such as hot tapping will no longer be acceptable and alternatives will be required. This project determines and demonstrates those procedural updates and informs standards/policy updates.			2022/2023	2025/2026	4	5,000,000	18	8	0
	Online	FutureGrid Online and enduring facility for third party collaboration			2023/2024	2026/2027	4	25,000,000	92	40	TBC

Project Union	Phase 1 - Pre-FEED	Project Union will review the potential phased repurposing of NTS pipelines to carry hydrogen and provide a hydrogen transmission 'backbone' for the UK -First FEEDer	NGGT	Networks ready for net zero	2021/2022	2022/2023	2	2,000,000	15	6	0
	Phase 1 - FEED				2023/2024	2024/2025	2	20,000,000	148	64	0
	Phase 1 - Construction				2025/2026	2027/2028	3	100,000,000	254	247	2,000,000
	Phase 2 - 4				2027/2028	2032/2033	6	1,800,000,000	2,289	2,223	32,000,000
Project Centrum	Pre-FEED	Review of infrastructure and progress through FEED. Theddlethorpe and Bacton to facilitate hydrogen production.	NGGT	Accelerating the hydrogen economy	2022/2023	2022/2023	1	2,000,000	30	13	0
	FEED				2023/2024	2027/2028	5	15,000,000	44	19	0
H21	Analysis/Validation of Components on Existing Equipment			Networks ready for net zero	2020/2021	2021/2022	2	399,488	3	1	0
	Initial Hydrogen Strategy				2020/2021	2021/2022	2	90,000	0	0	0
	Services				2021/2022	2021/2022	1	117,289	1	1	0
	I&C customers				2020/2021	2021/2022	2	64,250	0	0	0
	Phase 3 Understanding requirements				2020/2021	2021/2022	2	40,500	0	0	0
	Wider Impact of Hydrogen - Safety and risk.	Reviewing the impact of remaining equipment in the network. i.e. filters, slam-shuts, wafer check valves. Looking at capacity, operations etc. Scope to include velocity, buoyancy, noise and if pre-heating required.			2021/2022	2022/2023	2	500,000	4	2	0
	Phase 3/Occupied Trials - Part 2 Preparation - Safety and risk	The prerequisites include such requirements as: - Legal consents and exemptions, - Confirmation of hydrogen production and supply, - Surveying of the existing system and homes, - Co-ordinating supply of the required appliances, - Duty holders responsibilities, - Starting the safety case exemption.			2021/2022	2022/2023	2	500,000	4	2	0
InTEGRel	IoT Pressure Sensor Pilot - Network development	Scope currently being developed	NGN	Networks ready for net zero	2021/2022	2024/2025	4	750,000	3	1	0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