D

Delivering an environmentally sustainable network

This section of our business plan includes our Environmental Action Plan. The Plan encompasses our targets in relation to heat decarbonisation (in line with Ofgem's requirements).

This first chapter of the section explains our net zero ready vision. The vision enables decarbonisation of heat, as part of a wider, whole system pathway to mitigate the threat of climate change.

In this section:

Chapter 13. Our net zero ready vision for 2035 CVP

1. Highlights of our plan

- Our ambitious whole system plan will decarbonise heat, power and transport in our regions, delivering a net zero ready network by 2035.
- Based on a broadly defined whole system approach, our plan will facilitate low cost, reliable and sustainable energy for generations today and in the future.
- We are responding to the clear steer from consumers, organisations such as local authorities, and public opinion in general that society must act now to mitigate the threat of climate change.
- This steer, combined with our own ambitions, provides the basis for our net zero ready vision and for the timeline to achieve this by 2035 – a pathway that while ambitious, is both credible and achievable.
- Our plan is founded on extensive research and live trials, and reflects the view from wider research and opinion formers that a variety of solutions, applied on a regional basis, will be required.
- Our approach will support the development of Local Area Energy Plans (LAEPs). These plans will provide substantial value to consumers by ensuring that energy system solutions offer the lowest cost pathway and least disruption. Pathfinder and Pathfinder Plus, our ground-breaking energy system simulator, will enable this best value to be extracted.
- The proposals in this chapter support decarbonisation of heat and as such form part of our Environmental Action Plan (Click **Chapter 14** for further information).

We will use our ground-breaking and unique Pathfinder model to fully support Local Area Energy planning.

2. Introduction

This is a critical time for the UK energy sector, with legally binding obligations to eradicate the UK's net contribution to climate change by 2050. At the same time the energy system (gas, electricity, transmission and distribution) is fast becoming one of complex, dynamic interactions, driven by changes in the supply and use of energy. We therefore must consider the whole system.

The UK Government's June 2019 decision[1] provided greater certainty about the timeframes for our sector to deliver a zero carbon energy system. Our plan to be net zero ready by 2035 represents our contribution to this goal, meaning that our network will be able to support the required quantities of green gas, eliminating the need for fossil methane. We will be able to support flexible generation and transport, which in turn supports decarbonisation of the electricity and transport sectors. We decided to choose the date of 2035 to reflect the ambition of our stakeholders and in response to their climate emergency declarations, including by the Welsh Government and local authorities. It is also the earliest date that allows a sensible balance between the speed and cost of delivery.

Click **Appendix 13A** for information about our strategic approach to the future of energy challenge.

1 The Government amended the Climate Change Act in June 2019. This was in response to the Committee on **Climate Change's report 'Net Zero – The UK's contribution to stopping global warming', 2 May 2019**.

As part of our extensive programme of research we have listened carefully to those with alternative views.

Click **Appendix 13B** for further information on the wider decarbonisation debate with stakeholders.

This plan defines our net zero ready vision for 2035 – our objective being to anticipate how customers' use of the network might change as they move to using lower carbon technologies and as they move towards lower carbon gases and avoid the use of fossil fuels. It also describes the investments necessary to allow our network to support these new requirements and a separate net zero CVP has been created.

Click **Appendix 13C** which sets out the net zero Consumer Value Proposition.

CVP net zero

Our net zero CVP delivers £4.3bn of value; our vision delivers over £30 of net value for every £1 invested.

3. Aspects that are certain

The sector is going through significant change, and clear trends are emerging that have informed our investment proposals for GD2 and beyond.

- Energy networks are becoming more closely integrated, interacting in more complex and dynamic ways. Our demand data clearly shows the increase in the use of flexible gas generation at times when renewable generation decreases due to weather conditions. It also reflects new generation requirements as older coal-fired stations are decommissioned.
- Customers with different requirements and behaviours are having a significant impact on our network. For example, we are having to increase the frequency with which we reconfigure our medium and intermediate pressure systems to enable green gas producers to inject during hot weather (when demand is low). We also expect to implement smarter systems to manage changes in network flows to support gas and electric vehicle charging.
- Peak demand is set to increase by 11% over the next 10 years due to the new requirements detailed above. Investment will be required so that we can continue to provide a reliable and safe supply of gas. This will be necessary in spite of an expected reduction in annual gas demand because customers will be using gas in different ways.
- Flexible generation tends to be gas powered. These generators are making use of the cheap form of storage provided by our network, offering flexibility and a quick response at a lower cost than many other forms of electricity storage. By making use of our network, flexible gas generators can compete in the services they provide for electricity balancing, benefitting electricity customers.
- The Future Homes Standard that is being consulted on would prevent gas supplies to new housing. In isolation this would limit further peak demand growth; however, alternative technologies may still have an impact on gas networks via hybrid heat networks and CHP.

Click **Appendix 17B** for further information.

Chapter 13. Our net zero ready vision for 2035 (continued)

– To minimise whole system costs there is now a growing consensus that, instead, we must consider all technologies, and on a regional basis. This view was recently confirmed by, among others, the Committee on Climate Change[2]. It was also supported by our own Green City Vision project[3], in collaboration with SSEN and UKPN.

4. Our net zero ready vision

How we developed our vision

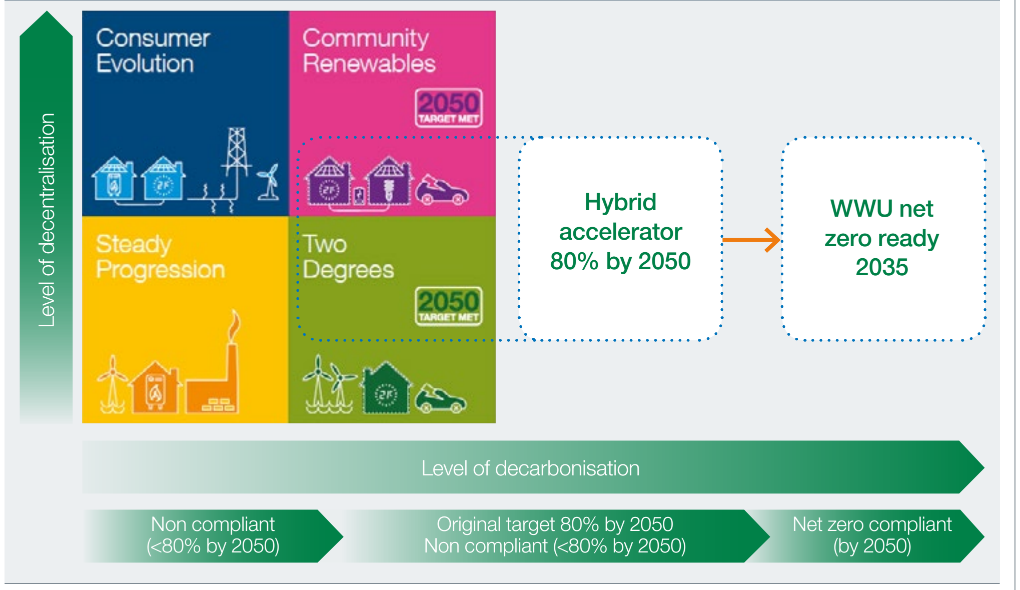
It is with the above certainties and trends in mind that we have developed our ambitious, evidence-based net zero ready vision for decarbonisation in our regions. Founded on a broadly defined whole systems approach, our vision will facilitate the low cost, reliable and sustainable energy that our customers want for their heat, power, light and transport – both today and tomorrow.

A key input to our vision are the results from our Regional Future Energy Scenario (FES) innovation project. For this project we commissioned Regen to develop forecasts of our customers' requirements through to 2035 for a range of scenarios including four that were aligned to the National Grid FES framework and the 'hybrid accelerator', which increased the use of hybrids and biomethane. Regen's forecasts[4] were based on significant stakeholder engagement and input from four workshops carried out across our regions, which included a session looking at specific challenges around the decarbonisation of industry.

We have ensured that these forecasts can be used in our whole system modelling using our innovative and unique whole system energy model, Pathfinder[5].

2 'UK Housing; Fit for the Future?', 21 February 2019.
3 Click **Appendix 13D** for information on Green City Vision.
4 Click **Appendix 13D** for information on Regional FES.
5 Click **Appendix 13D** for information on Pathfinder.

Figure 1: Progression of our vision



Pathfinder models the whole system energy flows (on an hourly basis) to meet heat, light, power and transport demands for a given scenario using a mix of energy supplies that is also specific to the energy scenario.

Click **Appendix 13D** for information about our future of energy research.

Click **Appendix 13E** for information on how Pathfinder will support the development of LAEPs.

Click **Appendix 13F** for information on our whole system approach.

Learning from the recent all-GDN Pathways project which was led by the Energy Networks Association (ENA) showed that the north of the UK is most likely to make significant use of hydrogen while the south is more likely to move to biomethane. This is due to carbon capture, usage and storage opportunities in the north.

Following the recent net zero announcement we have used the outputs from regional FES, learning from Pathways, and stakeholder support as the basis of our new net zero scenario; this scenario assumes an even greater penetration of green gas in our local distribution zones and also accounts for hydrogen post 2035 to meet the 2050 net zero requirement.

The position of the scenarios in Figure 1 reflects their relative level of decentralisation and decarbonisation by 2050. The first block of scenarios in the figure shows the National Grid FESs, which are well established within the sector.

The two scenarios to the right (hybrid accelerator and net zero ready) are scenarios developed by and for WWU, reflecting the specific regional factors for our networks. In the case of the last scenario – WWU net zero ready – we have increased the ambition to meet the new 100% net zero requirement.

Our commitment

Deliver a net zero ready network by 2035.

Chapter 13. Our net zero ready vision for 2035 (continued)

Our vision

Our vision is to meet the levels of decarbonisation supported by the WWU net zero ready scenario above. Decarbonisation will be achieved in the following ways.

Reduced demand:

- Customers' annual demand for gas for heating will be reduced as they adopt more efficient and flexible systems and continue to make improvements to insulation in their homes and businesses. These savings have most impact away from peak when insulation is most effective and when hybrid systems will operate on electricity. The SSEN/WWU/UKPN Green City Vision project found that up to 20% CO_2 savings were delivered by insulation improvements.

Click **Appendix 13G** for further information on smart hybrid heating systems.

Hydrogen for industry and cities:

- The UK's largest cities and big industry will be converted to run on hydrogen. In our region the cities are expected to be Swansea, Cardiff, Newport and Bristol. Hybrid heating systems (as trialled in our Freedom project)[6] will help make the best use of hydrogen and renewable electricity.

Biomethane and blended hydrogen for other cities, towns, suburbs, and smaller industry:

- Remaining cities, towns and suburbs will be fuelled by green gas and have hybrid heating.
- The FreeNonDom project (a project investigating the use of hybrid heating systems for non-domestic customers) has demonstrated the use of hybrids for non-domestic loads.

Transport:

- Many heavy goods vehicles, buses and trains will be fuelled by hydrogen or green gas, significantly reducing carbon emissions.
- The vast majority of private cars will be electric vehicles, with more than 30m on the road across the UK, partly fuelled by electricity generated from green gas.
- Gas and electric vehicles are cleaner than petrol and diesel and will significantly improve air quality.

Power:

- The primary sources of electricity will be renewable.
- Wind, solar, marine and a small fleet of nuclear power stations supported by back up green gas generation plants will keep the lights on.
- A small amount of electricity storage across the UK will help balance the grid (including from vehicle to grid), while smart hybrid systems installed in homes and businesses will enable flexibility through the use of smart controls that can move demand between gas and electricity to optimise whole system operation.

The vision we have set out here is the most plausible and suitable for our regions; it also remains flexible and allows for alternative future pathways. In this way, customers' interests will be protected.

The research we have undertaken as part of this work – including our analysis of the rate at which new heating technologies are being adopted in our region – supports the investment that is already planned in GD2 as part of our base allowance. As such it represents no regrets investment.

The vision has been determined using local-level information from our Regional FES and Pathways projects to understand where transport and green gas investment are most likely to be needed. In order to determine the potential specific reinforcement required for flexible gas generation connections we have also used information from our connections register and from the capacity market register for future loads.

6 Freedom was a live trial where we installed air source heat pumps alongside gas boilers in 75 homes alongside smart functionality to optimise both appliances. Click **Appendix 13G** for further information.

5. Enabling whole systems

As this chapter has already outlined, in recent years the need to consider interactions across different sectors – transmission and distribution, power and gas – has become increasingly important. This applies locally and nationally, particularly given that many local authorities are declaring climate emergencies and are looking for decentralised solutions. For example:

- the increase in EVs is likely to impact on demand from flexible gas generators at peak times;
- high costs associated with electricity connection and opportunities to avoid high time of use tariffs or provide demand-side response services are leading to increased gas flows to support CHP for on-site generation;
- the uptake of air source heat pump technology has the potential to reduce annual gas throughput, although where these are implemented as part of a gas hybrid solution we anticipate that peak gas demands will be less affected.

We are the only network to have developed a high-resolution, whole system model in recognition of these increased interactions, Pathfinder Plus. The model supports the planning processes across the gas and electricity networks and can be used by third parties to support development of local decarbonisation plans.

We have shared Pathfinder with other networks, with SGN having adopted it to simulate Brighton and Edinburgh. Other networks are considering its use.

Plans and processes for joint planning with other network companies

Working with others and sharing best practice allows us to constantly improve for the best.

We have a long history of working closely with other gas network companies. In GD2 we will continue to drive joint planning and collaboration and will formalise our work in this area through our new whole systems charter (described below). This is supported by formal requirements such as those in our licences and Uniform Network Codes; and workgroups such as the Gas Futures Group, which is coordinated by the ENA.

CVP For every £1 invested in sharing our whole systems data and Pathfinder model, there is £40 of value to consumers.

Our culture of sharing learning and best practice is demonstrated by our collaboration around both innovation projects and improvement activities.

Specific areas of focus will include:

- continuing to work closely with the National Grid ESO, providing input from our research and data from our control systems to support the production of their FESs;
- continuing to support the industry review of NTS capacity access arrangements.

During GD2 we will build on our relationships with DNOs, having already completed energy innovation projects with SSEN, WPD and UKPN.

We will also continue to collaborate through industry groups such as the single scenario workgroup and the Open Networks project.

A recent collaboration is Zero2050, an initiative led by National Grid to speed up progress of the decarbonisation of South Wales. The partnership, which encompasses business, community, academia and others, is using Pathfinder Plus to develop a whole system solution.

Click **Appendix 1D** for letters from SPEN and WPD about our successful collaboration in GD1.

Identification and adoption of potential whole system solutions

We recognise opportunities to benefit from standardised processes across networks so that processes and equipment can be designed for use across the whole of the UK. There are opportunities too for networks to benefit from streamlined processes such as increased data sharing and consideration of whole system solutions to avoid investment. This would benefit customers by reducing costs.

As far back as 2010, we led an industry review of the Offtake Arrangement Documents to relax some of the notification periods required for rate changes, so we could increase the flexibility we offer our power generation customers to allow them to participate more fully in electricity markets. During GD2 we will:

- continue to actively support the Open Networks project through the advisory group. We are currently leading Workstream 4, Product 2: Whole networks real-time operation, and supporting Product 4: Investment;
- continue to explore whole system solutions for managing the demands of peak heat while maximising use of available renewable energy and green gas.

In collaboration with other partners and Western Power Distribution, Project Freedom investigated how smart control systems could control hybrid heating systems. The objective was to minimise the investment that would be required on DNO networks to support peak heating requirements by using the flexibility available in the gas networks

- This would be done by heating homes via gas boilers when this is a better solution for whole system operation. This work is now being expanded for non-domestic customers through our FreeNonDom project.

Long-term whole system thinking

Investigating regional decarbonisation plans to enable whole systems thinking can assist in the development of future networks and reduce carbon emissions.

We have undertaken extensive research and stakeholder engagement to help us and others understand the impact of future scenarios on stakeholders and networks.

In addition to using our Pathfinder model for our own analysis we have shared it with external groups that are keen to develop regional decarbonisation plans. We engage with wide-ranging steering groups and advisory panels including Flexis, LEPs and the Welsh Government. We also commissioned and sponsored the national Carbon Connect series.

Chapter 13. Our net zero ready vision for 2035 (continued)

Whole system investment in GD2

Our Green City Vision project is a specific example of the way in which we have used Pathfinder and worked with DNOs to consider how a range of long-term future decarbonisation approaches would impact whole systems usage in a real location (in this case Swindon). This project used a bespoke analytical approach to provide a consumer driven solution that delivers desired outcomes for future consumers, namely decarbonisation of heat, power and transport at the lowest cost and least disruption.

Our Regional FES project is a ground-breaking approach to mapping every locality in our region as a basis for working with DNOs to find optimal long-term solutions for heat, power and transport. This provides net benefit for each sector's consumers – minimising bills, maintaining reliability and enabling decarbonisation.

The above are examples of local area energy planning, whereby we work with DNOs and the local community to devise optimal approaches for specific regions.

We recognise the value and support we can offer local authorities in developing their decarbonisation plans by providing data, modelling capability and whole systems understanding. We are currently working with a partner to scope out and develop guidance documentation in this area.

In GD2, we propose the development of our future of energy team under an uncertainty mechanism so that we are resourced to provide this service. In this way we will make sure that consumers receive the best value from both GD2 and ED2 in a whole systems way.

By including transport in our whole systems approach, we generate benefits for broader sections of society, such as determining the optimal transport policy for each locality, for example whether public service vehicles should be fuelled by batteries, biogas or hydrogen. The alternative options can be evaluated and benefits quantified. This whole system approach, which we have led locally, links the energy generation opportunities in a region with the low carbon demand requirements.

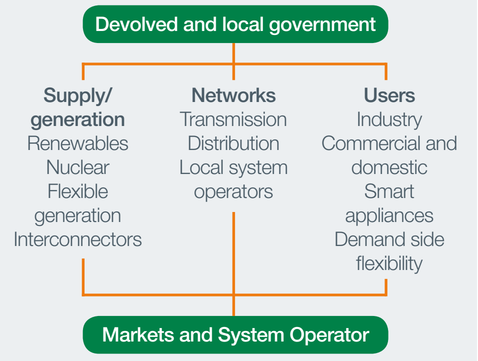
Pathfinder Plus

This tool is a derivative of Pathfinder but includes detailed whole system costing algorithms. It will be used with partners in the whole energy system, is valued as part of our CVP and provides the following benefits:

- Develops proposals that can be valued and compared with alternative scenarios, providing annual dual fuel bill predictions.
- Identifies and quantifies benefits to the broader area of society, such as the consumer and system benefits of energy efficiency.
- Enables market based solutions to be compared and utilised by defining the whole system as being wider than networks.
- Allows comparisons of proposals with business as usual.

Pathfinder Plus

PathfinderPlus will be utilised with organisations across the whole system:



The Zero2050 project will identify potential opportunities for the south Wales region, utilising Pathfinder Plus to seek agreement between wider stakeholders on optimised proposals and to understand the trade-offs between the whole systems partners. This would include, for example, the optimised use of say battery storage and flexible generation capacity.

Implementing whole system solutions in GD2

Justified by analysis to date, we have created costed proposals in the key areas where we can contribute as a whole system partner. These include enabling renewable generation, the connection of green gas and the facilitation of transport. The proposals described exceed historical 'business as usual' activity and are principally designed to enable the decarbonisation of energy.

We describe the investment in the following sections. We will continue to work with prospective whole system partners and towards the end of 2019 we will also have visibility of the recommendations proposed by the Open Networks – Whole System workstream.

We will review the investment on our network or other opportunities that will support a more coordinated and efficient whole system. In the meantime, we include the investment within a proposed uncertainty mechanism to ensure that consumers are always protected.

To further demonstrate our commitment and formalise our work in this area, we propose a whole systems charter to underpin our approach. The charter will commit us to work with stakeholders to create customer focused, least cost and joined up solutions to deliver net zero:

1. Stakeholder engagement
2. Data and information sharing and innovative solution proposals
3. Whole system Local Area Energy Plans development
4. Understand the customer value or 'business case'
5. Open the proposals to competition, including market solutions.

We propose to ask the Customer Engagement Group to review our progress against the charter on an annual basis.

6. Our contribution

Figure 2 shows the key elements that will be necessary to deliver our ambitious net zero ready vision. It is set out in five-year blocks, taking us from GD1 to 2036, recognising the GD2 timeframes.

These numbers are derived from internal sources such as our enquiries database and external sources such as National Grid FES, as well as reports from BEIS and from the Association for Decentralised Energy. In some cases we have increased the level of ambition where these reports were based on 80% decarbonisation targets.

Our commitment

Ensure that the investments we make today will support future energy scenarios and therefore represent a 'no regrets' energy solution.

£700

The potential savings for customers using hybrid heating systems, as demonstrated by Project Freedom.

Our net zero ready network pathway, whilst ambitious, is both credible and achievable.

Figure 2: Our net zero timeline

			Cumulative			
		2019 Baseline	**2021**	**2026**	**2031**	**2036**
A: Enabling renewable electricity generation						
Enabling renewable generation	Flexible generation connected (MWe)	628	644	2,002	3,197	4,253
B: Green gas capacity – to enable a biogas grid in non-hydrogen areas						
BioGases (inc H2 blending)	Annual BioGas capacity (TWh)	1.7	2.7	11.3	18	24
	Compressors (Nos)		1	12	23	33
	Smart control systems (Nos)		1	12	23	33
C: HGV/PSV transport						
HGV/PSV transport	Biogas filling stations (Nos)	3	12	49	61	58
	Hydrogen filling stations (Nos)	0	0	2	10	13
D: A hydrogen ready network for industry and cities						
Hydrogen (100%)	National trials		✓			
	1st National Cluster			✓		
	NW England Extension to N Wales			✓		
	South Wales Cluster				✓	
	M4 extension to Bristol					✓
E: Enabling low carbon heat networks						
Heat Networks – Gas CHP/gas hybrid	BEIS HNDU supported schemes (Nos)	0	0	9	17	24
	General roll-out – FES19 derived (Nos)	440	600	1,900	2,600	3,300
F: Low cost; low carbon distribution system						
Low Cost; Low Carbon Network	PE in Distribution System (%) – LP/MP		75	83	92	100
	Distribution pipeling leakage (GWh)	256	241	216	110	24
	AGI Venting and leakage (GWh)	73	70	60	13	3
G: System operability						
System operability	New forecasting tools			✓		
	Smart system and compressor control		✓	✓	✓	✓
	DNO/GDN process and planning alignment	✓	✓	✓	✓	✓

Chapter 13. Our net zero ready vision for 2035 (continued)

7. Investment and justification

In 2018 Ofgem and the RIIO-2 Challenge Group asked networks across transmission, distribution, gas and electricity to agree a set of common factors and assumptions in developing a single view of the future. The work that was completed in 2019 forms a baseline for Ofgem, and for us, and we have used the lowest of the range as a comparator for each of our own scenarios below.

Click **Appendix 13H** for more information on the single scenario.

Our investment planning demonstrates that a small amount of investment of £1.7m will be required in GD2 to upgrade some of our pressure reduction installations as part of our base allowance. In addition we will need to continue with our mains replacement programme (the costs of which are set out in Chapter 16). This investment has a high level of certainty, as in most cases it:

- is based on known customer enquiries or capacity market information which are consistent for all scenarios; or
- is based on evidence from the Pathways project that every street will still need a gas pipeline, albeit that it may be being used to carry low carbon gases (this applies particularly to the mains replacement project);
- has been included in our BAU totex plan because it supports any current licence obligation delivered through our current connections policy.

The uncertainty mechanisms by which we propose that additional investment is funded to support our net zero vision will take account of the lower levels of certainty we have about growth related to decarbonisation in our region.

Where proposals are above the levels described in the single scenario, and are outside our current licence obligations, and may mean us taking on additional risk we are proposing appropriate uncertainty mechanisms.

Click **Chapter 12: Dealing with uncertainty** for further detail on the elements that will be necessary to deliver our ambitious net zero ready vision. 104

Of the seven elements (as set out in Figure 2) that make up our contribution, four will require investment in GD2. The remaining elements will require investment in GD3 and beyond. It should be noted that any investment will be iterative and will only be made once customers' requirements are fully confirmed. Until we have that specific customer information it is not possible for our proposals to be fully justified and costed.

We summarise each element below and provide more detailed information in a series of appendices, 13I to13N.

A: Enabling renewable electricity generation

Using our existing infrastructure for energy storage keeps costs low and enables more renewable electricity generation.

As outlined above, in recent years there has been a rapid increase in electricity generation connecting to the local power distribution networks.

As renewable generation cannot provide the resilience of controllable generation and there has been a decline in the use of coal, we have seen a dramatic shift to gas flexible generation.

In our region we have connected 31 flexible generation sites to date in GD1. These generators make use of our network's flexibility in providing significant storage to offer more competitive flexible generation services that enable electricity network balancing.

By using the existing pipeline system to store gas, the UK gas network is providing a cheap form of storage. The level of value was recognised in Imperial and Poyry's 2017 report[7] for the Committee for Climate Change, which confirmed that using increased flexible gas generation would deliver annual reductions in whole systems operating costs of £612m.

We anticipate that a large number of flexible generation sites are likely to connect in the next few years.

To make sure that we would not be investing unnecessarily we have explored the potential for constraining developers' flexibility and, in some cases, have added new terms to network exit agreements.

£612m

Using the flexibility provided by our network avoids £612m a year whole systems operating costs.

7 https://www.theccc.org.uk/publication/roadmap-for-flexibility-services-to-2030-poyry-and-imperial-college-london/

We held interruption auctions both this year and last, and to encourage participation we contacted sites directly where interruption would help us offset the pipeline investments above. No contracts were forthcoming at any price.

Click **Appendix 13I** for more detailed evidence, both on the general trends in generation sources and the impacts on our network.

Through our engagement with large industrial users we understand the reliance they place on a reliable supply, particularly for high heat processes where disruption could have significant cost impacts on equipment and production. We also know that many businesses are increasing their use of CHP, and the role gas plays in providing a reliable source of electricity even where the electricity network is constrained.

An example of the impacts of additional flexible generation on network capacity is the situation in the Swansea area, where accommodating additional demand for flexible gas generation would materially impact flows in our network and result in supply issues in Pembrokeshire. This is because a pipeline in this area has reached capacity and so would constrain flows. Reinforcement on the lower pressure tiers would also be required here. This, and other examples, are detailed in the table overleaf.

Gas flexible generation will support decarbonisation of the whole system by providing the flexibility needed to enable the continued increase in the use of renewable generation.

Chapter 13. Our net zero ready vision for 2035 (continued)

This is valued as part of our net zero CVP. It supports whole system operation by acting as a primary interface between the gas and electricity networks. Flexibility in the gas network supports the requirement in the electricity network, and facilitates increases in electricity demand for electric vehicles and other new technologies.

Investment required in GD2

Figure 3 shows our projection compared with the lowest range of the single scenario allocation for our region. It can be noted that we are already above single scenario levels.

Click **Appendix 13I** for further information on our projection.

Significant investment for new pipelines would not be funded by us under current arrangements, which would stifle growth required to support renewable generation. We believe arrangements may need to change to address the impediments so that the UK's net zero ambition can be realised. To recognise this, and because forecasts are above the single scenario, project funding is proposed to be a net zero uncertainty mechanism. This means that funds would only be released to us for the work once evidenced by customer requirements or policy change. It should be noted that the developer would still be responsible for the connections costs associated with their project.

Click **Chapter 12: Dealing with uncertainty** for further information. 104

We have identified that the following investment will be required in GD2.

Flexible generation funding mechanisms

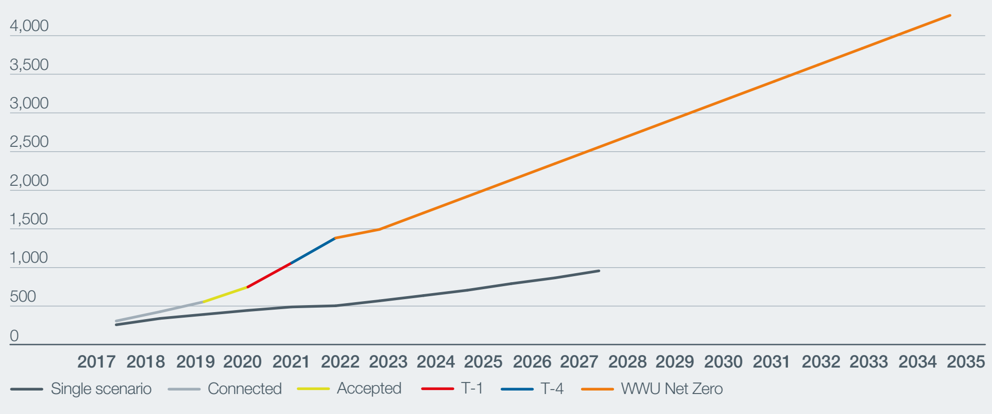
	Work required	GD2 costs £m	Proposed funding mechanism (note as ex-ante totex, or net zero review mechanism)
Pressure Reduction Installation upgrades		1.7	Baseline totex
Pipelines for capacity and/or storage	**Northern System** 7.7km x 450mm diameter from Wickwar, north towards Berkeley Road	7.7	Net zero mechanism
	Central System 2.2km x 500mm diameter from Corston Field, west towards Brislington tee (Queen Charlton)	2.2	
	13.8km x 300mm diameter from Corston Field, south east towards Trowbridge	13.8	
	East Dundry rebuilt to operate with a minimum inlet pressure of 10 bar (it is currently designed to operate down to 12 bar)	–	
	Southern System 8.9km x 500mm diameter from Choakford, east towards Tigley	8.9	
	20km of at least 200mm ST pipeline from Bancyfelin Pig Trap to Lampeter Velfrey	20.0	
	+ another 30km post t-4 but projected for GD2	30.0	
Below 7 bar reinforcement (MP and IP)	75kms	29.7	Net zero mechanism
Total		**114.0**	

Figure 3 shows the amount of electricity that could be generated by gas generators connected to our network and the status of those connections. This forecast is based on intelligence acquired from the sector, including the accepted enquiries and the T-1 and T-4 capacity auction data that has been published. This data was extrapolated to 2035. We recognise this level is a high proportion of the FES projection for this year but the proposed net zero uncertainty mechanism would protect consumers.

CVP net zero

Our net zero CVP for renewable generation delivers an NPV benefit of £40.5m; for every £1 invested this delivers a net benefit of £0.40.

Figure 3: Flexible generation output MWe[1]



1 These figures are for flexible generation that are in addition to a small number of larger connected sites which were originally connected as base load.

Chapter 13. Our net zero ready vision for 2035 (continued)

The overall investment required to support flexible generation in GD2 is £1.7m ex-ante totex and £112.3m via the net zero uncertainty mechanism. This represents a contribution for customers of 20 pence per bill per year. This would allow us to support the ongoing and increased use of renewable intermittent generation in our region and replace decommissioned coal generation.

Note: this is based on the 2018 single scenario work, current progress using the outputs of our regional FES innovation project, and our latest intelligence of sites being developed in our region via our own enquiries database and the t-4 capacity mechanism.

B: Green gas capacity

Enabling the use of greener gases will reduce carbon emissions.

We have connected 19 biomethane sites during GD1 and have a further seven accepted enquiries. In total, the 26 sites would provide heat to 175,000 homes if fed into a traditional heating system, or around a million hybrids. Our current projections to achieve net zero are for a further 25–35 sites to connect during GD2.

Click **Appendix 13J** for further information on biogases.

Our OptiNet project is looking at low-cost ways to increase entry capacity by using compression and other new technologies.

In his 2019 Spring Statement the Chancellor announced a consultation for later this year on increasing the proportion of green gas in the grid in a bid to reduce the UK's use of natural gas. Research[8] suggests that significant feedstock is available to support further growth in this area and with a high proportion of the country converting to hydrogen the potential for our region is substantial.

We are already experiencing entry capacity issues in parts of our network and have had issues with sites being backed out at periods of low demand, usually overnight in the summer. We proactively reconfigure local pressure settings so that existing natural gas sites do not take priority over biomethane sites, with some success. However, as the number of connections to our network continues to grow, we will need to look at longer term, more sizeable solutions such as compression and storage.

It will be necessary for us to adopt this technology in GD2 so that we can accept the required volumes of green gas to support decarbonisation.

8 http://www.energynetworks.org/assets/files/gas/Navigant%20Pathways%20to%20Net-Zero.pdf

Green gas will support decarbonisation by providing low carbon gas to thousands of customers in all sectors, who will be able to continue to use their existing plant and equipment as they do now. It supports whole system operation in the same way that natural gas does now.

Investment required in GD2

The investment required to roll out our OptiNet technology to business as usual in other parts of the network would cost £18.2m. This represents a contribution for customers of 43 pence per bill per year, and is valued as part of our net zero CVP. There may also be a requirement for investment in interday storage to support green gas injection in GD3, unless incentive and market mechanisms encourage producers to match local and regional demands on a day to day basis. This would also improve network resilience.

Finally, we recognise opportunities to further exploit opportunities for decarbonisation by undertaking research to deal with fugitive CO_2 emissions that occur during anaerobic digestion processes prior to gas injection. We are currently scoping innovation projects in this area.

The figure below shows our projection when compared with the single scenario allocation for our region.

Figure 4: Green gas injection (excl hydrogen) Annual TWh

Chapter 13. Our net zero ready vision for 2035 (continued)

We have identified that the following investment will be required in GD2. Further information about the various funding mechanisms is provided in Chapter 12: Dealing with uncertainty.

Green gas injection funding mechanisms

	Work required	GD2 costs £m	Proposed funding mechanism
Compressors	12	16.6	Net zero mechanism
Smart systems	12	1.6	Net zero mechanism
Total		**18.2**	

The overall investment required in GD2 is £18.2m. This represents a contribution for customers of 43 pence per bill per year. This would allow us to accept increased volumes of green gas onto our network including at times of low demand.

Note: this is based on us receiving an eighth of the 193 TWh biomethane available (2050) in the Pathways report (balanced scenario), by 2035. This is supported by the fact that this project concluded that biomethane would be used in the south of the UK, with the north of the UK moving to hydrogen.

We note that this is an ambitious target and that current progress does not reflect this level of ambition because of uncertainty around the Renewable Heat Incentive.

CVP net zero

Our net zero CVP for green gas and decarbonisation of heat delivers an NPV benefit of £4.2bn; for every £1 invested this delivers a net £246 benefit.

C: Heavy goods and public service vehicles HGV/PSV

Moving to cleaner transport fuels improves air quality and reduces carbon emissions.

We have connected three fuelling stations to support CMG buses in large cities during the past few years and predict a significant increase in this area.

Fuelling stations are often most active during a relatively short number of hours in the day, at least in the case of 'return to depot' fleets when buses or HGVs come back for refuelling at the end of the day. The impact of increased demand in these cases is experienced over teatime, which is already our peak. The result is that reinforcement to support these sites is also required, often on the lower pressure tiers. The sites use compressors because the gas in the vehicle storage tanks needs to be at around 250 bar. As applications come in, we undertake bespoke analysis for each. We anticipate that in some cases a level of reinforcement will be required to support these flows. If the number of sites is large enough this could also have an impact on our diurnal storage requirement.

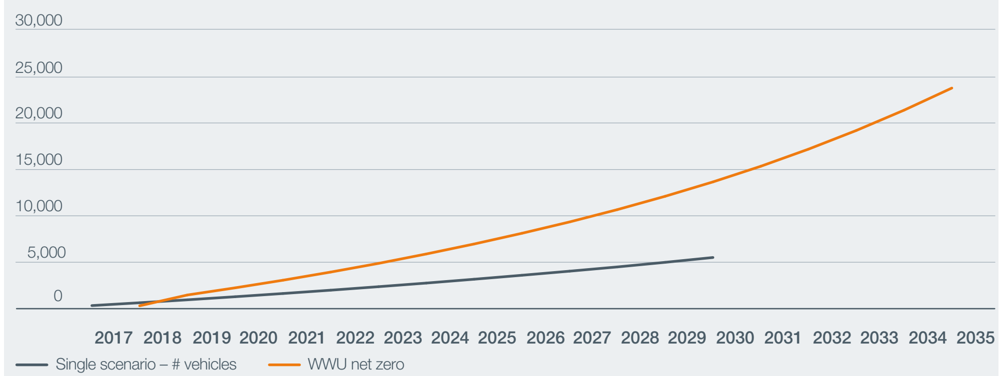
Figure 5 shows our projection of gas vehicles when compared with the single scenario allocation for our region.

Click **Appendix 13K** for further information on transport.

CVP net zero

Our net zero CVP for Transport delivers a NPV benefit of 92m; for every £1 invested this delivers a net benefit of £14.60.

Figure 5: Numbers of gas vehicles



The use of gas for transport as CMG will support decarbonisation and improvements to air quality by reducing the use of petrol and diesel for transport. Where the gas is green gas the reduction in CO_2 will be even more significant. Where gas is piped through the UK networks there will be a contribution to whole systems efficiency in reducing the amount of transport needed to move fuel around the country. This in itself will further contribute to reduced energy usage and CO_2 emissions.
We have identified that the following investment will be required in GD2

Gas vehicles funding mechanism

	Work required	GD2 costs £m	Proposed funding mechanism
Reinforcement	16km	6.3	Net zero mechanism
Total	**16km**	**6.3**	

The overall investment required in GD2 is £6.3m. This represents a contribution for customers of 1 pence per bill per year. This is valued as part of our net zero CVP. This would allow us to support the increase in use of gas vehicles, which will have a positive impact on decarbonisation and air quality.

Chapter 13. Our net zero ready vision for 2035 (continued)

D: Heat networks

There are around 14,000 heat networks across the UK, which supply around 2% of all heat demand from UK homes, businesses and industry. Currently 91% of heat networks are powered by gas.[9] The BEIS Clean Growth Strategy suggested that heat networks could, by 2050, meet 17% of heat demand in homes and up to 24% of demand in business and public sector buildings. The UKCCC[10] proposes that 18% of homes will be connected to a low carbon hybrid heat network in its core scenario, but with the use of gas to meet peak demand.

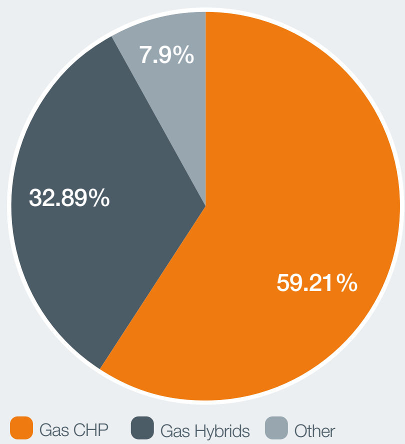
As discussed in Appendix 13L, heat networks can increase local gas demand, and in the case of Combined Heat and Power energy centres, double it. Research from BEIS[11] indicates that 92% of future heat networks listed for delivery in the 2020s will be sourced from gas CHP or gas hybrids (see Figure 6).

However, delivery has been slow, with only nine of the BEIS promoted schemes being forecast to become operational in the area by 2026. The scale of investment requirements in these circumstances is uncertain and we are not proposing investment in GD2 base allowances, but suggest it forms part of a net zero uncertainty mechanism.

Click **Appendix 13L** for further information on heat networks and CHP.

9 BEIS Clean Growth: Transforming Heating – Overview of Current Evidence (December 2018).
10 UKCCC Net Zero Technical report (May 2019).
11 BEIS: Heat Networks: 2019 Q2 Pipeline, (August 2019).

Figure 6: Proposed heat networks – Energy source – BEIS (August 2019)



Other:
Biomass/Mine Water – 3.95%
EfW (Energy from Waste) – 3.95%

Gas Hybrids:
EfW (Energy from Waste) – 10.53%
Water source heat pump – 7.89%
Biomass – 7.89%
Ground source heat pump – 2.63%
Waste heat (w/o heat pump) – 2.63%
Biogas – 1.32%

E: A hydrogen-ready network for industry and cities

Changes to infrastructure will enable us to transport hydrogen in the network and reduce carbon emissions.

We anticipate that hydrogen uptake will be accelerated in response to the Government's net zero announcement.

18%

The UKCCC proposes that 18% of homes will be connected to a low carbon hybrid heat network by 2050.

The mains replacement programme means that our networks are largely hydrogen ready in our low pressure distribution networks. As a result, minimal investment would be required to make them properly hydrogen ready in order to support the transformation across to hydrogen.

A number of projects are underway to develop evidence and safety cases to support the transport in existing pipelines of hydrogen blended in natural gas at proportions of up to 20% volume. These projects include Hydeploy, a trial at Keele University that is looking at the use of blended hydrogen in existing gas networks.

Data from the Regional FES indicates that blended hydrogen will be injected by 2030 in the south west of England, and by 2027 in Wales. We have been supporting the Navigant Pathways project, coordinated by ENA, which is looking at a roadmap to decarbonise the gases in our network.

The project included the development of case studies demonstrating the impacts of difference pathways on consumers and networks. This has shown that the north of the country would be dominated by pure hydrogen and the south of the country – which includes our region – would be dominated by biomethane, with hydrogen clusters and blending in specific areas.

The hydrogen pathway comprises the following: North Wales is expected to be able to receive a proportion of hydrogen from the industrial North West Hydrogen Cluster; and in South Wales work is already underway to determine the feasibility of using hydrogen to support a regional industry cluster. We anticipate developments in hydrogen for industry that will support hydrogen for all loads in Swansea, Cardiff, Newport and Bristol.

While the single scenario (2018 FES) did not include any hydrogen for us before 2035, we believe that uptake will accelerate as outlined above to meet net zero. In our region this would impact North Wales in GD2, South Wales in GD3 and the M4 extension to Bristol during GD4.

Chapter 13. Our net zero ready vision for 2035 (continued)

The use of hydrogen will support decarbonisation by providing low carbon gas to customers who use it. Where hydrogen is blended with methane gas no action will be needed by customers to update their equipment and appliances. However, in the case of pure hydrogen, external enablers will be required.

The use of hydrogen supports whole system operation in the same way that natural gas does now, and its contribution to decarbonisation will support initiatives in other areas such as renewable generation and the use of hybrid heating systems to help the UK achieve its net zero ambition.

In addition, the use of power to gas means that hydrogen can support whole system balancing and reduce the impact of constraints to renewable generation that would otherwise be in place.

Click **Appendix 13M** for further details of the hydrogen proposals.

Investment required in GD2

The rate of repex will not be increased in GD2 above the planned mains replacement programme (Click **Chapter 16**). However, we believe that specific investment in this area will be required during GD3 to support hydrogen roll-out.

F: Low cost, low carbon distribution system

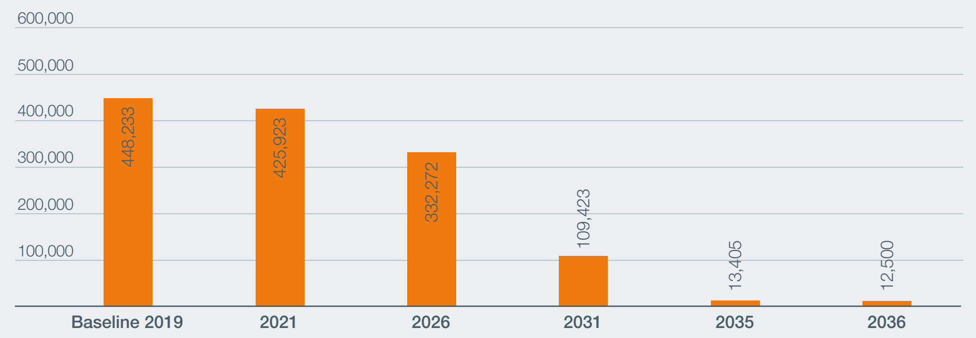
Renewing infrastructure will reduce carbon emissions and improve infrastructure long into the future.

As we outlined above, we will continue our mains replacement programme in GD2. This will support our net zero ambition in two ways. Firstly, by reducing leakage and the associated greenhouse gas emissions, and secondly by providing a network that is largely hydrogen ready to transport pure hydrogen.

By 2035 our network will be ready to transport pure hydrogen.

Figure 7 shows the forecast reduction in CO_2 equivalent greenhouse gas emissions as leakage from our network as we move towards full decarbonisation towards our net zero vision.

Figure 7: Greenhouse gas emissions (CO_2 equivalent)



The delivery of a low cost, low carbon system will help decarbonisation by reducing the amount of leakage in our system. At the same time the carbon content of the gas will be reducing because of increases in the proportion of green gas being injected into the network. The ability to transport a range of gases in the system will support whole system balancing, allowing decisions to be made about how different sources of energy in different regions can be used in the most efficient way. As mentioned above, our ability to accept hydrogen injection into our network will also help make the best use of renewable generation via power to gas technology when it would otherwise be constrained.

Note: These projections are based on: assumed completion of the mains replacement programme by 2032; increased work to reduce emissions from our above ground installations; and an increase in the proportion of green gas (including hydrogen) that is transported by our network based on an early view of our Regional FES project and supported by the findings of the Pathways project.

Investment required in GD2

We intend to increase the rate of repex in GD3 and we will have additional costs associated with recruitment and training to support this during GD2. As we approach transformation in GD3 we will also need to undertake specific work associated with rolling out pure hydrogen (over and above the work we have undertaken for mains replacement).

In GD2 we will participate in research and development to understand the impact of hydrogen and to seek ways to reduce emissions from our above ground installations.

GD3 repex preparation mechanism

	Work required	GD2 costs £m	Proposed funding mechanism
Repex preparation	Recruitment and training to support increased repex workload starting GD3	10	Net zero mechanism
Total		**10**	

G: System operability

Our network must be flexible to deliver our vision, with smarter controls, more dynamic operation and consideration of the whole systems impacts, especially with local electricity DNOs. We have plans to deliver new system requirements in relation to day to day monitoring, control and optimisation of our assets. These processes will become increasingly complex as we develop new gas injection strategies and more flexible gas usage. We have plans in place to address the increasing cyber risk and these are discussed in Chapter 20. We are currently working with the other GDNs and NTS to review how daily processes for calculating LDZ calorific values will be passed from NTS to the GDNs.

Investment required in GD2

The below investment is expected in GD2 and is valued as part of our net zero CVP. We have had increased requests for support in GD1 from third parties such as community energy projects and local authorities (in relation to their climate emergency declarations). We expect this to grow in GD2 and will increase our manpower to facilitate third party research projects, aligning with our support of LAEPs.

Click **Appendix 13E** for further information on our work with LAEPs.

System operability improvements will help decarbonisation, enabling us to support new technologies, new gases and changing customer requirements. These improvements will help the UK meet its net zero ambitions, supporting whole system optimisation.

Click **Appendix 13N** for further information about system operability.

CVP net zero

This is valued as part of our net zero CVP in our renewable generation, decarbonisation of heat and transport models.

System operability funding mechanisms

	Work required	GD2 costs £m	Proposed funding
New IT systems/ functionality including:	Improve short, medium and long-term forecasting systems and increase visibility of our network and customer behaviour by linking data into control systems	1.6	Net zero mechanism
Increased manpower	This team will include a Director of FOE; Green Gas Development Manager; System Optimisation Manager; FOE Project Manager; FOE Project Officer; FOE Network Analyst; FOE Community Engagement	0.8	Net zero mechanism
Total		**2.4**	

8. Customer and stakeholder feedback

We have been a leading partner in debates around the future of energy – influencing and informing and listening at national, regional and local levels. This engagement has informed the 2035 vision and our investment proposals.

While customers want bills to remain affordable, they have identified the environment and decarbonisation as important priorities on which we should focus future investment planning.

There is also a wider sense from the public and organisations that represent them on the urgent need to address climate change – expressed for example through the declarations of climate emergencies by local authorities, universities and NHS trusts.

Government, policy makers and regulators

We work closely with high-level decision makers within government, regulatory bodies and other decision makers, including BEIS and the UKCCC, engaging around aspects such as smart hybrid systems and the use of hydrogen, and sharing the findings of the Freedom project.

We are pleased that our views are now being shared by decision makers, such as within the UKCCC's February 2019 Housing policy report, which endorsed smart hybrid heating systems and hydrogen cities as a low regrets pathway to the full decarbonisation of heat. As another example the Welsh Government's Head of Housing Decarbonisation has expressed a keen interest in considering a large-scale demonstrator of smart hybrid heating systems within social housing in Wales.

Other examples of our commitment to an informed debate include being the first network to present to the All Party Parliamentary Group for Energy Studies; we have also contributed to all phases of the Carbon Connect work. We are on the Advisory Board of Flexis and chair or participate in many other groups including the Institute of Welsh Affairs' project Re-energising Wales.

Other stakeholder engagement

We held two conferences (on green gas and distributed power generation) to share learning and best practice between networks, developers and other industry parties with a view to improving and aligning processes and gaining insight into future requirements for green gas and power generation customers. The key feedback was that stakeholders were pleased to have an opportunity to engage and share best practice and keen that gas networks should continue to work together and develop standard approaches where possible.

We regularly discuss future of energy developments with our Critical Friends Panel, including at surgery sessions for those who are keen to engage with us further.

We work closely with university academics to share practical industry knowledge and to learn from their theoretical research, modelling and expertise. We are currently sponsoring PHD students at the University of South Wales who are examining production of biomethane, making processes greener and more controllable. This engagement provides insights into the way technology may be heading and future opportunities.

We have routine discussions with our larger users and specifically contacted 14 of these customers around the interruptions auction. At the Regional FES workshops, attended by 20 key users, key topics discussed were their use of gas for power generation, their decarbonisation options, and implications of changes to gas quality specifications as we look to admit a wider range of gases into our network.

During early 2019 we conducted specific focus group sessions with stakeholders to test our decarbonisation strategies and to help us understand how customers feel about short-term disruption for long-term gain.

In addition, the CEG challenged our early strategy, commenting that it was too narrow and that it focused solely on heat and did not adequately consider scenarios from other sources. We have worked extensively with the CEG to explain our whole systems data and modelling. We have also significantly widened our GD2 focus to incorporate heat, power and transport and have increased our ambition to deliver a net zero ready network by 2035.

The RIIO-2 Challenge Group acknowledged the vision and challenged the fact that no action is being taken during GD2. They requested further analysis on the options considered and this is now contained in our net zero uncertainty mechanism.

Click **Appendix 5F** for further information on our engagement.

Engagement informing our commitments

Delivering a net zero ready network by 2035

Based on 22 engagements with more than 22,000 stakeholders, it is clear that our commitment is viewed as the right thing to do to help reduce emissions across the UK and for us to evolve as a responsible business. Our breadth of engagement includes our vulnerable customers, 43% of whom said that a sustainable future is the most important objective after reliability. Our domestic customers indicated that investment in innovative and greener technology is the second most important priority.

Our customer acceptability research from summer 2019 showed an overall acceptability of 64% for this commitment. Its relative importance in our willingness to pay research showed this as only 17th out of the 25 commitments; however, interestingly it came out as the 9th commitment customers were willing to pay more for.

There is clear stakeholder interest and approval for our projects (such as Freedom) supporting this commitment. Therefore, we are now recommending steps that would roll out this work, striving towards industry-wide decarbonisation. Based on this feedback and Government support, we are committing to delivering a net zero ready network by 2035.

> We've enjoyed working with Wales & West Utilities on Biomethane connections – these projects have the lowest cost, least complexity, and most capacity innovation within the GB market.

Green gas stakeholder

Invest in innovation to support the national strategic energy challenges, working collaboratively with Ofgem, BEIS and the wider industry

Based on 20 engagement events involving over 22,000 stakeholders; it was clear that we should do more to inform our stakeholders on future energy and decarbonisation initiatives while ensuring that we are aligning with key players in the industry.

In addition it was clear that we should share information, such as the Energy Pathfinder tool, more widely to support the development of future energy scenarios. In our willingness to pay research SMEs scored this commitment higher than domestic customers both in terms of importance and perceived value.

Our collated feedback recognises that investing in innovation and working collaboratively with the wider industry to support national strategic energy challenges is an important priority to stakeholders, and we should develop our plans with this in mind.

Ensure that the investments we make today will support future energy scenarios and therefore represent a no regrets energy solution

Based on 15 engagement events, including over 22,000 stakeholders, we are seen as playing a central role in creating a sustainable energy future. Stakeholders are encouraging us to incorporate measures to achieve this in our planning. In particular the view of the Critical Friends Panel was that investment for a green future was a priority although there were concerns particularly in Llandudno and Swansea about whether the assets would be fit for purpose for emerging technologies in the future.

Our national collaborative engagement with experts highlighted that there is a delicate balance between low regrets and the need to act now. We are therefore committing to ensuring that the investments we make today will support future energy scenarios and therefore represent a 'no regrets' energy solution.

Chapter 13. Our net zero ready vision for 2035 (continued)

Future engagement

In GD2 we will continue our quarterly meetings with powergen developers, engagement with industry through our annual forecasting process, and our discussions with other developers wishing to connect to the grid.

We will undertake further research and innovation along with collaborative whole system projects such as Zero2050, a project looking at decarbonisation pathways for South Wales.

We will also continue to work with local authorities, as well as with SPEN, WPD and SSEN, to develop agreed scenarios for the areas where our geography is coincident.

Finally we will set up a Wales Green Gas Panel in Wales where we only have one connection to date, allowing us to promote best practice. We will also use our national collaborative engagement to widen our coverage and further promote biomethane across the UK. While we are not proposing a bespoke Stakeholder Engagement Incentive, our commitment to engagement in GD2 is explained in detail in Chapter 5 where this Wales Green Gas Panel is also explained further.

CVP net zero

Our £10m investment in heat innovation will deliver a consumer value of £82m in GD2, part of our net zero CVP.

Click **Appendix 13O** for more information about the future requirements of industry in our region.

9. Enablers to our vision

Innovation CVP

We anticipate that there will be a requirement for innovation projects to support this area of work during GD2 because of the significant change in this area. Projects are likely to be needed to:

- deliver low-cost modern energy services to allow customers to use energy in the ways they want to use it;
- maximise the adoption of technology that can demonstrate flexible, cross vector or low carbon technologies;
- deliver whole system solutions that enable no build options, both within and outside of our geographical region;
- implement the technology, methods and policies to deliver a net zero ready network by 2035.

Our commitment

Invest in innovation to support the national strategic energy challenges, working collaboratively with Ofgem, BEIS and the wider industry.

Financing options

As outlined previously, we believe that there should be an uncertainty mechanism that will support our net zero ambition while protecting customer bills and network financeability.

Any current licence obligations delivered through our current connections policy have been included in our BAU totex plan.

Third party enablers

While this chapter has focused on the investment that will be necessary for us to deliver our net zero ready vision by 2035, there are a number of areas where the actions of third parties will have an impact and where market forces will come into play. We have provided our forecasts of the key enablers below.

Our net zero timeline

Enablers		2019 Baseline	2021	2026	2031	2036*
Hybrid Heating Systems	BioGas Areas (Consumers)	70	500	120,000	300,000	625,000
	Hydrogen Areas (Consumers)	–	–	–	200,000	375,000
Off Gas Grid heating	Heat Pumps (Consumers)	2,100	3,200	25,000	75,000	130,000
DNO Investment Drivers	Peak Demand increase (%)	0%	5%	12%	27%	39%
	System Inertia %	70%	67%	64%	59%	55%
	Storage (MWh)	11,000	12,000	13,000	13,900	15,000
Renewable generation capacity needed (GW)	Wind	2.3	4.8	6	7.2	8.5
	Nuclear	1	1	1	1.1	1.2
	Marine	0.003	0.005	0.08	0.18	0.3
	Solar	0.14	0.23	0.32	0.41	0.5
Transport (thousands vehicles)	EV Cars	29	80	1,000	3,300	3,600
	EV EV Vans/LGV	1	2	18	200	400
	Electric Buses	0.03	0.05	0.4	3.5	9
	CMG Buses	0.04	0.25	0.5	2.5	5
	CMG HGVTrucks	0.17	2	7.6	12	18.8
Energy Efficiency	Demand reduction % on 2018 level	0%	3%	5%	10%	15%

* Data in this table is shown in the 5 year increments that reflect likely RIIO periods.

Chapter 13. Our net zero ready vision for 2035 (continued)

As part of this wider picture we recognise that our customers and other stakeholders have a role to play in delivering decarbonisation strategies by changing the ways in which they use energy and the quantities they consume. Support will be necessary for vulnerable customers and those in fuel poverty to assist them to make changes in their current arrangements.

The table below provides details of the ways in which enablers may be delivered during and beyond GD2. Significant discussion with industry and regulators would be required to determine the preferred approach and to confirm how it would be funded.

Enablers to consumer uptake of low carbon technology (eg hybrid heating)

Enabler	Description	Who pays	Pros	Cons
Energy supplier obligation	Energy suppliers deliver on their obligation by installing innovative measures to eligible households.	Immediate pass-through to all consumers via energy bills.	Proven methodology.	Sporadic Ad-hoc
Delivery provider auctions	Installers bid into a central process to win installation work.	Immediate pass-through via taxation.	An element of means testing through taxation processes.	Would compete against other departmental priorities eg education and health. Delivery risks around a centrally managed process and government funding.
Gas and electricity network obligation	Networks deliver on their obligation by installing innovative measures to eligible households.	Immediate pass-through to consumers via suppliers (included in the opex element of network charges).	Networks are experienced in delivering major projects and are delivering exceptional standards of service.	Sporadic Ad-hoc
ECO bank funding	An obligation to provide low-cost finance to customers.	Customer pays.	Eases the burden of initial upfront costs on consumers.	Little incentive exists for consumers to act. High delivery risk.
Network led roll-out	Networks lead installation of innovative measures to eligible households.	Funding through RAV and paid back over a lifetime of eg 45 years (included in capex element of network charges).	Networks are experienced in delivering major projects and are delivering exceptional standards of service.	New approach.

Conclusion

This chapter has set out our ambitious plan to decarbonise heat, power and transport in our regions, delivering a net zero ready network by 2035. We have a clear vision of the role our network will play, what needs to happen to facilitate this, and how much investment is required in GD2. We are confident that decisions taken now will avoid more costly solutions in future, and very much welcome the sense of urgency that has come from the Government's June 2019 announcement.

We propose a total investment of £150.9m, of which £140.9m form the basis of our net zero uncertainty mechanism and are valued as part of our net zero CVP at £4.3bn.

Finally, we are excited to be a part of a broadly defined whole systems approach that will provide the flexible and regional solutions that our customers are seeking for today and in future.

A summary is included below of the investment to be delivered through our uncertainty mechanism proposal.

Net zero forecast costs

	Work required	Cost £m RIIO–2	Cost per annum
Flexible generation			
PRI upgrades[1]	23	1.7	0.3
Pipelines for capacity and/or storage	85km	82.6	16.5
Below 7 bar reinforcement (MP and IP)	75 km	29.7	6.0
Total		**114.0**	**22.8**
Green gas			
Compressors	12	16.6	3.3
Smart systems	12	1.6	0.3
Total		**18.2**	**3.6**
Gas vehicles			
Reinforcement	16km	6.3	1.3
Total	**16km**	**6.3**	**1.3**
System operability			
New IT systems and functionality including: forecasting system upgrades and data controls		1.6	0.3
Increased manpower	Support net zero activities	0.8	0.2
Total		**2.4**	**0.5**
GD3 repex preparation			
Recruitment and training		10	2
Total estimate spend		**150.9**	**30.18**

1 This is included in our base totex proposals.