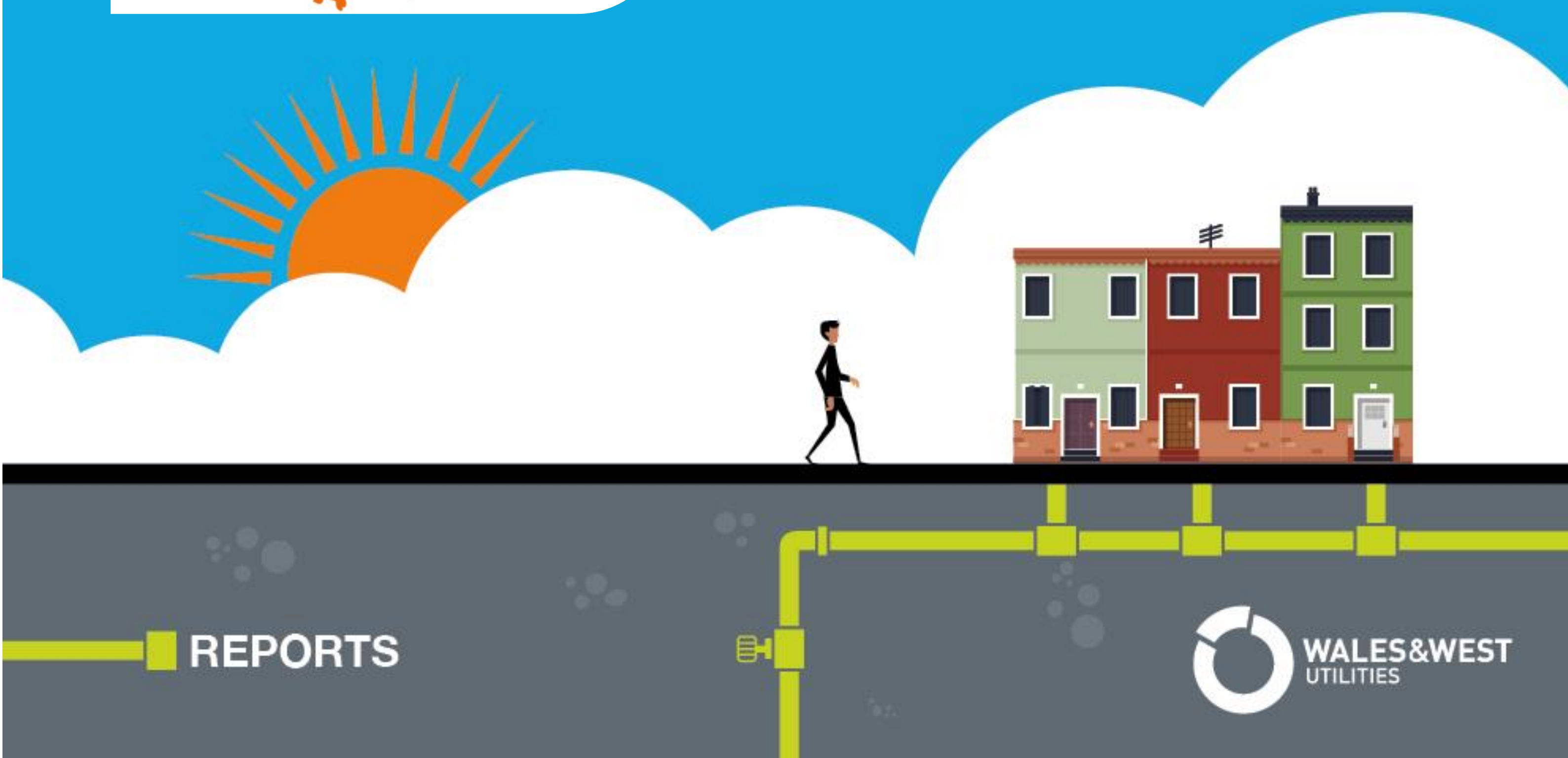
# 2019 Long Term Development Statement

Wales & West Utilities Ltd

# Foreword

Welcome to our Long Term Development Statement for 2019, which provides an indication of the usage for our pipeline system and likely developments. It is intended to help companies that are contemplating connecting to our system or entering into transportation arrangements to identify and evaluate opportunities.

**Andrew Hopkins** - WWU
Director of Asset Management, Health, Safety & Environment

The statement reflects our 2019 planning process and incorporates a reappraisal of our analysis of the market and of the demands on our network. As such it contains the latest information on volumes, the processes we use to plan the development of the system (including demand and supply forecasts), the impact of greater integration of electricity and gas networks, and system reinforcement projects and associated investment.

We are publishing the statement just five weeks before we submit our business plan to Ofgem for the period 2021-26. Our plan will set out our ambitious vision, which is for our network to be net zero ready in our regions by 2035. This is our response to the climate change challenges we face, informed by the needs and wants of our stakeholders and underpinned by extensive research (both our own, and that of others). Our vision will also support the UK Government's commitment to a zero carbon energy system[1].

Our vision takes account of the changes we are already seeing in the energy sector, with gas and electricity, transmission and distribution fast becoming a series of complex and dynamic interactions. It is based on a broadly defined whole systems approach to decarbonisation.

Turning now to look back at our performance this year, some highlights of 2018/19 include:

- We have seen the results of our innovative Green City Vision, a project demonstrating whole system thinking using our Pathfinder model. The project was a joint collaboration with UKPN and SSEN and was led by Progressive Energy. By integrating supply-based and demand-based solutions across both networks, the scenarios modelled indicated that continued operation of both the gas and the electricity networks will provide the least disruptive pathway to compliance.

- We have completed our Regional Future Energy Scenario (FES) project, a ground-breaking initiative with our partner Regen to create a set of regional scenarios for gas and heat for the south west of England and in Wales. These growth scenarios, backed by extensive analysis and stakeholder engagement, have been used to help us and other stakeholders understand the future requirements and usage of the gas network.

[1] The Government amended the Climate Change Act in June 2019 in response to the Committee on Climate Change's report 'Net Zero – The UK's contribution to stopping global warming' (May 2019).

- We have delivered a comprehensive and efficient set of physical site security upgrades at all relevant sites as identified by the Centre for the Protection of National Infrastructure (CPNI).

- We are playing an increasing role in supporting third parties such as community energy projects and local authorities as they look for solutions to their energy needs and, in the case of local authorities, seek to act on their climate emergency declarations.

Our focus on putting customers first has brought significant success. It has also helped us meet our outputs under our regulatory framework, which we are on track to deliver for the full eight years. Our efforts have been recognised across the board with:

- A 'RoSPA Gold' Award for the sixth year in a row, resulting in our achieving 'Gold Medal Status' (which is only awarded after five consecutive Gold Awards). We are currently the only network to hold this achievement.

- The RoSPA Oil & Gas Sector Award for industry-leading health and safety performance.

- Accreditations for performance in Occupational Health and Safety (IS045001), Asset Management (IS055001), and the Environment (ISO14001).

- Awards for our Freedom Project including the Network Awards 'Gamechanger Award', and 'Best Collaborative Project' and 'Best Emerging Cross-Vector Technology' in the Energy Innovation Awards.

- We won the IGEM customer service award, alongside our partners Morrison's Utility Services, in recognition of our Customer Service Officers and the proactive approach taken to communicating and safeguarding customers, especially those in vulnerable circumstances.

We are proud of all of these achievements as we continually seek to further improve the service we provide to customers.

Andrew Hopkins
Director of Asset Management, Health, Safety & Environment

# 1. Executive summary

## 1.1 Context

This document contains our annual and peak demand and supply forecasts. These forecasts have been developed in conjunction with National Grid UK Transmission (UKT) and through our own modelling and analysis.

We are required to publish this annual statement in accordance with Standard Special Condition D3 of our Gas Transporters Licence and Section 4.1 of the Uniform Network Code Transportation Principal Document.

Our forecasting methodology has encompassed the results of our Regional FES innovation project, as well as the final results of our collaborative GDN Gas Demand Forecasting project. Improved forecasting techniques include new approaches for forecasting flexible gas generation using electricity market information.

## 1.2 Demand and supply outlook

As a result of our modelling our peak demand is now forecast to increase by 11% in the next 10 years.

We have continued to work with our biomethane customers who have sites that they wish to connect to our network. We have already connected 19 biomethane sites delivering green gas into our network and although we have not connected any further sites this year, we do have a further 7 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.

Research[2] 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 to allow the biomethane site to take priority over our adjacent natural gas 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.

Our OptiNet project, a collaboration with Cadent, is looking to investigate how using compression and other new technologies in parallel might alleviate such constraints and increase entry capacity.

[2] https://www.smarternetworks.org/project/nia_nggd0093

## 1.3 Industry developments

The UK is committed to legally binding obligations to eradicate the UK's net contribution to climate change by 2050. The UK Government's June 2019 decision provided much greater certainty about the timeframes our sector has to deliver a zero carbon energy system.

We are fully committed to achieving these targets, and believe that the gas network can contribute to this. Our business plan, which we will publish in December, will 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. Our network will be able to support the required quantities of green gas, eliminating the need to use fossil fuels. We will have the flexibility to support flexible generation and transport, which in turn, supports the decarbonisation of the electricity and transport sectors.

It is widely acknowledged that whole system solutions that optimise energy flows across gas and electricity transmission and distribution networks will play a major part in facilitating the delivery of a sustainable energy solution for the UK. Increased integration of gas and electricity networks will result in changes on one network having the potential to impact another.

These impacts have been taken into account in the forecasting models and research that we have undertaken this year.

- For example, through our GDN Gas Demand Forecasting project we are already developing models that forecast the impact of electric vehicle charging on gas generation requirements.

- Our Freedom project, a collaborative project with Western Power Distribution, has shown how use of hybrid gas and electric heating systems in homes can significantly reduce costs and carbon whilst avoiding significant and unnecessary investment on the electricity distribution networks to meet peak heat demand. The full report is now available on our website: Project Freedom Final Report.

- Our Green City Vision has assessed more broadly the interactions between gas and electricity networks and has determined feasible solutions for decarbonisation in a real location. This project has engaged local stakeholders to develop decarbonisation scenarios that will be further developed through use of our Pathfinder 2050 model and the more recent update of Pathfinder 2050, the Pathfinder Plus model. The new model includes a range of new functionality including significant improvements to the way in which economic parameters such as levelised costs can be forecast for the specific scenario being analysed.

### 1.4 Investment implications

Our stakeholders have told us that maintaining a safe, reliable gas supply is a key priority. We adopt innovative techniques to ensure efficient investment in network health through use of monetised risk models, and have fed this analysis into our business planning processes.

Going forward we anticipate new requirements for compression, storage and smart control to accommodate increasing demands for flexible gas usage and injection from our customers.

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

Data from our Regional FES indicates that blended hydrogen will be injected by 2027 in Wales and by 2030 in the south west of England. We also anticipate significant use of pure hydrogen to support industry in South Wales from 2030 which would then offer opportunities for use in other cities along the M4 to Bristol during GD4.

### 1.5 Innovation

Innovation is part of our DNA. It has helped us deliver benefits that go far beyond financial benefits to encompass safety, customer experience, value and reliability.

From our engagement we know that investing in innovation and working collaboratively with the wider industry to support national strategic energy challenges is an important priority to our stakeholders.

We therefore very much welcome the recent decision by Ofgem to retain the Network Innovation Allowance (NIA). This funding will be used in GD2 to support projects that will deliver customer benefits and provide the lowest cost pathway to heat carbonisation. It will also build on our excellent record of research, demonstration and engagement in GD1

In preparing our business plan, and having discussed our proposals with wide-ranging stakeholders, we have determined our innovation focus areas for the 2020s. These areas build on the ENA's Gas Network Innovation Strategy (March 2018). They are centred on the steps needed to deliver a net zero ready network by 2035, providing more from our current network to the homes and businesses that rely on us in their daily lives. Our network facilitates secure and resilient energy for heat, power and transport and enabling cleaner, greener energy is central to our ambition.

# 2. The UK gas network


David Smith - ENA

In 2019, the UK became the first major economy to commit to a 'net zero' greenhouse gas emissions target for 2050. The transition to meet that goal will touch every corner of our economy and our energy system, and our gas networks are no exception. While we know the fuel mix will be different in 2050, we don't know exactly what it will look like – but gaseous fuels and the gas networks which deliver them have a vital role to play in the transition and the decarbonised energy system.

The UK's gas network is one of the best developed in the world, providing safe, secure, affordable energy to homes and businesses across the country. The flexibility that gas provides across the system has never been more important. 40% of UK electricity was generated from gas in 2018, ten percentage points higher than the generation share in 2015 as it replaces coal and balances intermittent renewables. New research this year demonstrated the role of gas 'linepack' storage across the energy system: over a five-year period the average hourly linepack available was around 4,400GWh, and the highest three hour drawdown from the Gas Distribution Networks (164 GWh) dwarfs the highest equivalent figure from pumped electrical storage (7.9GWh). As we decarbonise, we need to ensure that our future energy system can provide those attributes – and an increasing body of evidence suggests that decarbonised gasses (biogas, bio-SNG and hydrogen) will play a vital role in a deliverable, low cost pathway to net zero.

The gas networks are developing their vision for the role of gas in delivering deep emissions reductions through the Gas Decarbonisation Pathways Project. In the short term, biomethane connections are increasing the volume of 'green gas' in the network. This increase in connections to lower pressure tiers is starting to change the way distribution networks are operated, and may require further changes in future to move gas around the system and allow biomethane producers to inject their gas even during times of low demand. In the longer term, our pathways to net zero will include higher volumes of biomethane, alongside blended and dedicated hydrogen networks and smart technology such as hybrid heating systems.

The 'whole system' implications of decarbonisation are increasingly well understood. The decarbonisation of electricity generation has already had significant impacts, with increasing demand for flexible generation plants connected to the distribution network and dozens more in build or have accepted connection agreements. Growing use of electric vehicle recharging may exacerbate this impact further. Other new demands such as CHP engines for energy users such as hospitals and district heating schemes are also providing new peak requirements and – in some cases – additional overall demand.

Longer term government policy direction is not clear, even within the 'net zero' vision. This is particularly the case for harder sectors to decarbonise, such as industry and home heating. That is likely to change over the coming years – a new Heat Policy Roadmap is expected in 2020 – but the precise mix of technologies is still likely to remain unclear for some time to come. For now, the medium term demands for gas will remain significant given the role it plays across the energy system, and our Gas Decarbonisation Pathways envisage ‘low regrets’ steps towards decarbonisation such as ongoing funding for new biomethane production plants.

The evidence for the longer term role that gas can play in a decarbonised system is becoming clearer, partly through some of the network innovation projects referenced below. Compared to alternative ways of reducing greenhouse gas emissions, for example, attempting to completely electrify heat and transport, evolving our gas supply chain towards a low carbon future is more affordable and secure, and will help deliver our emission goals with less disruption. Investing in the continued development of our gas network also makes a wide economic contribution to the country while its innovations and capacity play a crucial role in the UK’s integrated energy system.

Between now and 2032, the Gas Distribution Networks are continuing to invest in the Iron Mains Risk Reduction Programme. This work is mandated by HSE to improve safety, while reducing direct emissions of methane, a potent greenhouse gas. By the end of the programme, the distribution networks will be substantially constituted of polyethylene (PE) pipes, which are capable of carrying a wider range of gasses including low-carbon hydrogen. As these pipes also require significantly lower maintenance than existing materials, they will deliver a low cost, low carbon network which can continue to play a central role in our energy system.

# 3. Industry developments

## 3.1 Key messages

- We are seeing a 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.
- The UK Government's June 2019 decision has provided much greater certainty about the timeframes our sector has to deliver a zero carbon energy system.
- Our underground gas network is safe, secure and resilient – whatever the weather, and as part of an integrated energy network, it can continue to power homes, businesses and industry long into the future.

## 3.2 Key industry developments

There have been a number of key industry developments to note since the 2018 update:

- A report by the Committee on Climate Change in February 2019 (UK Housing: Fit for the future?) which led to an announcement in the Government's Spring Statement of a Future Homes Standard that proposes that gas would not be allowed in new homes from 2025. The Government is currently consulting on this issue.
- In May, the Committee on Climate Change (CCC) released its publication 'Net Zero – The UK's contribution to stopping global warming'. In this report, the CCC responded to a request from the governments of the UK, Wales and Scotland and recommended a new emissions target for the UK of net zero greenhouse gases by 2050 (the net zero target).
- In June, the UK and Scottish Governments introduced legislation to implement this target.
- The Welsh Government accepted a lower target – to cut carbon emissions by 95% by 2050 – due to the importance of the farming industry to rural communities in Wales (although it has said that it has ambitions to go further and reach net zero).
- In August, Ofgem's letter entitled 'RIIO-2 response to Committee on Climate Change's Net Zero Report' provided further clarity on the approach Ofgem expected us to adopt towards scenarios and forecasting for the purposes of our investment planning and business plans.
- As part of this we were asked to carefully reconsider the opportunity for undertaking anticipatory investments and to include them in our business plan where they supported net zero pathways.

- The National Transmission system and the industry UNC panel will be implementing changes to the model that underpins National Transmission exit charges to Networks (UNC Modification 678). Ofgem is the ultimate decision maker and a number of alternative proposals are under consideration by Ofgem. A decision on this is not expected before the end of 2019 and the implementation date should Ofgem decide to direct implementation of one of the alternatives is also not clear at present. Implementation is likely to have a significant impact on NTS exit capacity charges across Great Britain.

Our network planning and work to develop our business plan for 2021-26 has taken account of these important developments.

### 3.3 Gas as an essential component of future energy policy

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 much more closely integrated, and are interacting in more complex and dynamic ways. Our demand data, for example, clearly shows the increase in the use of flexible generation at times when renewable generation decreases because of weather conditions.

- New types of customers, with different requirements and behaviours, are having a significant impact on the use of 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 continue to inject during periods of hot weather (when demand is low). We also anticipate having to implement smarter systems to manage changes in network flows to support gas and electric vehicle charging.

- Peak demand is increasing and is set to increase by 11% over the next ten years as a result of the new requirements detailed above. In some areas investment in our network will be required so that we can continue to provide a reliable and safe supply of gas. This will be necessary in spite of a reduction in annual gas demand because our customers will be using gas in different ways.

- Gas generators are making use of the cheap form of storage provided by our network, enabling them to offer 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 are able to compete in the services they provide for national grid electricity balancing. This benefits electricity customers.

- There is increased recognition that while many technological solutions have great potential, at present there is no single technology that will work at scale for consumers and 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 CCC. It was also supported by our own Green City Vision project, in collaboration with SSEN and UKPN.

The forecasts detailed in this document represent our central forecasts, and they take into account current policy and customer trends.

### 3.4 Distribution network entry and storage

We recognise and support the increasing interest in distribution network (DN) entry and storage, including for gas from a number of sources such as anaerobic digesters and synthesis gas. We are also anticipating an increasing use of hydrogen in our network. Gas from non-fossil sources contributes to achieving the UK Government's climate change targets. In 2013 networks introduced a change to their transportation charging methodology to better reflect the use of the system by Shippers injecting gas at DN entry points.

Connections for entry and storage to our network will be provided in accordance with our licence obligations and our first biomethane DN entry site went live in 2013.

Key issues for gas entry include gas quality, odorisation, flow weighted average calorific value (CV) and the capacity available on the system.

Further details on current gas quality specifications can be found in Appendix A6.3.1 and further information on our connections process for DN entry is available at the following location: Distributed Gas Connections Guide

We have connected 19 biomethane sites since 2013 but current uncertainty around the Renewable Heat Incentive has had a significant impact on connection of biomethane sites this year, with none being connected since our last Long Term Development Statement was published. We do, however, have a further seven accepted enquiries.

We are already experiencing entry capacity issues in parts of our network and have had issues with green gas sites being backed out at periods of low demand, usually on summer evenings. We proactively reconfigure local pressure settings to allow the biomethane sites to take priority over our adjacent natural gas 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. Our OptiNet project is looking to increase entry capacity in a specific part of a gas network by using compression and other new technologies. Developing solutions to these issues will become increasingly important to support the UK in its ambition to become net zero. We describe our vision to make our network net zero ready below.

## 3.5 Our net zero ready vision

Our business plan will set out in full detail our ambitious vision to support the UK's decarbonisation targets and become a net zero ready network by 2035. Our plan represents a pathway that is both credible and achievable. It assumes:

- an even greater penetration of green gas in our local distribution zones;
- a significant use of hydrogen post 2035 in the UK's largest cities and for big industry – in our region the cities are expected to be Swansea, Cardiff, Newport and Bristol;
- the use of renewable electricity to decarbonise heat using hybrid heating technology in homes and businesses across our region – as trialled in our Freedom project;
- reduced demand for gas as customers adopt more efficient and flexible systems and continue to make improvements to the insulation of their homes and businesses;
- a move to electric cars among consumers and to hydrogen or green gas to fuel heavy goods vehicles, buses and trains;
- the use of renewable electricity, supported by wind, solar, marine and a small fleet of nuclear power stations, to power the UK and keep the lights on.

The vision is based on our extensive research and stakeholder engagement to consider the future of energy. It is founded on a broadly defined whole systems approach, working together to keep bills low, maintain reliability and minimise householder disruption.

# 4. Demand

## 4.1 Key messages

- Peak demands are forecast to increase over the next ten years.
- We have connected another three flexible generation sites since we last published our long term development statement and anticipate continued growth of new connections associated with flexible generation.
- Despite some uncertainty around the use of gas in new homes from 2025 we forecast that new connections will continue to outweigh efficiency reductions in all LDZs at peak until that time.
- We have booked additional NTS capacity in order to meet our revised forecasts.
- Additional investment in storage and smart network control may be required in the longer term to support ramp-up-rates and the intermittency of flexible generation, as well as predicted increases in the number of customers using gas vehicles.
- We are leading a number of innovation projects to better forecast our customers' changing requirements and to develop optimal ways to configure our networks to meet them.
- Our industry-leading Pathfinder model has allowed us and others to model different energy scenarios in a real way, thereby enabling us to design optimal options to decarbonise the future. This year we have enhanced the economic model and added some further functionality in a new version, Pathfinder Plus.

## 4.2 Forecasting approach

In last year's long term development statement we talked about how our customers' requirements and use of our network are changing as we see the growth of renewable energy supplies in the UK. We also set out how we were developing our long term forecasting and modelling capability to ensure that we can continue to develop reliable and efficient networks. The two key models we discussed were:

- 2050 Energy Pathfinder, which assesses how different future energy mixes would work in practice, providing hourly information over a year period; and
- a separate investment model which uses projections of gas supply and demand to provide high-level indications of the network investment that would be required to support them.

This year we have continued to develop our thinking in a number of ways:

#### 4.2.1 Innovation projects:

We are working on several innovation projects that are helping provide further clarity on how our future customers are likely to want to use our network for gas usage or gas injection. We are also developing new and innovative ways to optimise our network so that it can respond to this wider range of requirements.

Many of our projects are carried out with other gas and electricity network partners and further details on the relevant projects are provided in Appendix 4: Our future of energy research.

#### 4.2.2 Stakeholder engagement:

This year we have engaged with a wide range of stakeholders from both within and outside the industry to support both our ongoing business as usual processes and as part of our engagement to inform our GD2 business plan (2021-26). We also continue to act as a leading partner in debates around the future of energy – influencing and informing and listening at national, regional and local levels.

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 our future of energy research.

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.

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 active members of the Welsh Government's Energy and Environment sector panel, and chair or participate in many other groups including the Institute of Welsh Affairs' project Re-energising Wales.

Other highlights include holding 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. As part of our engagement programme this year we also carried out regional workshops in Exeter, Bristol, Cardiff and Llandudno as part of our Regional FES project.

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 general terms while customers want bills to remain affordable, they are supportive of the contribution we can make to decarbonisation.

There is also the 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.

## 4.3 Demand summary

This section describes the key forecast assumptions and drivers that are used in our current processes to generate the ten-year forecast demand for each of the three LDZs within our distribution network.

The chapter includes the headline outcomes as well as information about how current forecasts relate to those we have published previously.

Further information, including the detailed numerical tables, is provided in Appendix 2.

Our gas demand forecast levels in the current price control period from 2013 to 2021 are underpinned by our belief that natural gas will continue to play a significant role in the UK energy market beyond 2030. This is consistent with current statements made by the Department of Energy and Climate Change and supported by detailed analysis commissioned by WWU and other GDNs.

To summarise:

- Peak (daily) demand is expected to increase by 11% in the next 10 years.
- Annual demand is not expected to change over the 10-year horizon.

During the next ten years, our view is that peak day demand in our network will increase from 2019/20 out to 2028/29 for all LDZs. This is primarily due to new connections of domestic customers and smaller loads, along with flexible generation which will off-set reductions we anticipate as a result of efficiency improvements, including improvements to insulation.

The forecasts within this document take account of national data and assumptions from a number of sources including National Grid's FES scenarios and our own forecasting models. Last year we led a collaborative GDN project on demand forecasting with Delta-EE which recognised that in future our networks will need to support new load types and behaviours; the project was completed in late 2018.

This year we have continued our forecasting research through our Regional FES project. This project was completed with our partners Regen and looked at forecasting at sub-LDZ level. The project uses a methodology that Western Power Distribution (WPD) has previously used. We aim that in later projects we will be able to use the outcomes as the basis for producing joint GDN/DNO scenarios for the parts of our regions where our networks have the same geography.

### 4.3.1 Composite weather variables

Due to the temperature sensitivity of the domestic load band, LDZ forecasts of annual demand are based on an assumed average weather condition. The demand models adjust from actual to average weather conditions using factors known as composite weather variables (CWVs). The CWVs are derived from temperature and wind speed data to optimise the correlation between demand and weather.

To comply with the Uniform Network Code we are obliged to review the definition and seasonal normal basis of all CWVs, at least once every five years.

From 1 October 2015 Xoserve published revised seasonal normal composite weather variables (SNCWV) for use going forward. This includes a revised shortened weather history than was previously used. We have considered the impact of these revisions in this current iteration of our long term development statement.

For more information on the change to the EP2 method and its impacts on the demand forecasting process please see Appendix 1.

### 4.3.2 Capacity management

We annually assess the level of capacity that is required to operate the network in a safe and secure manner and to comply with the obligation to meet 1 in 20 demand conditions. There are a variety of ways in which capacity requirements can be managed. In the event that a capacity constraint occurs on our network our main options would be to:

- proceed with the network investment that is described in Chapter 6; or
- interrupt key sites through bilateral interruption contracts with customers.

In the event that interruption is not available there may also be a requirement to increase our bookings of capacity from the National Transmission System.

We have participated in the annual auction for interruption processed by Xoserve on behalf of the gas networks in the past two years. In 2018 we invited offers for any level of interruption, for any number of days and in any location. There were no offers from any of our customers and there are no longer any interruptible customers connected to our network. This year we considered the parts of our network where interruption would offer the most benefit and we then contacted all of the sites that were eligible before the interruption auction to ask them if this would be of interest. In spite of this direct engagement, however, there were still no offers from any of our customers.

This year we have made further increases in our bookings for capacity from the National Transmission System going forward.

#### 4.3.3 LDZ peak forecasts

This section provides the latest gas demand forecasts through to 2028/29. More detailed information is provided in Appendix 2, which includes forecasts by load band for both peak and annual demand on a year-by-year basis.

In this year's forecasts we are continuing to project significant increases in our peak demands over the next ten years. This is because of generation requirements having a significant impact at peak.

Most of our current investment decisions are based on days when our network is under the most stress (that is, on a peak day). It is for this reason that our recent forecasting work has focussed on a process for forecasting peak days directly, rather than deriving them from annual projections of gas demand as we have done in the past.

Annual demand forecasts are still of interest as these will influence other processes including measuring carbon savings through lower use of fossil gas because of either lower demands or increasing supplies of green gas.

#### 4.3.4 Peak day forecasting process

Last year's process for peak day projections included demand information that had not been used in previous processes. For this year's forecasts we have continued to use the revised process for flexible generation that is set out in bullet 2 below. However, there were no new examples of severe weather to enable us to repeat the cold day analysis so the work in point 1 could not be repeated and is still the best example we have of real demands during very cold weather.

1. During the severe weather at the end of February and beginning of March 2018 we were able to validate our assumptions of peak day demand which in the last few years had not included any examples of temperatures anywhere near those used to calculate our peak days. During this period of cold weather, due to issues with supplies to the National Transmission System, a Gas Deficit Warning was issued by National Grid. Gas prices increased rapidly as a result and the consequence was reduced demand for sites that were influenced by daily gas pricing. In our analysis we can clearly see the pricing impact that resulted in zones with a higher proportion of large loads having their demands reduced due to these separate issues on the networks. We have taken this into account during our review.

2. We have responded to the on-going requirement to connect flexible generation onto our network by improving both our understanding of the electricity networks and the way we use data that is publicly available. In this year's process we have mapped information from the National Grid's Market Electricity Capacity Register against sites that are either connected or have enquiries in process on our network. This robust process has allowed us to determine which enquiries to include in our projections. The process also provided us with information about sites that we were not yet aware of that may approach us for capacity.

#### 4.3.5 Peak day forecasting results

The 2019 peak demand forecast for the network is 497 GWh/d. We project that this will increase to 553 GWh/d by 2028/29, which represents an 11% increase.

The increase is attributed to the continued growth of domestics and of power generation seen on our network since 2013. We have included:

- loads that have accepted connection offers from us in 2018/19;
- sites that have capacity via the electricity capacity register in 2020/21 (T-1); and
- sites that have capacity via the electricity capacity register in 2023/24 (T-4).

For years after 2024 we have assumed similar levels of flexible generation growth in the South West and Wales North. However, constraints on WPD's network mean that we have not included new power generation in Wales South until 2026.

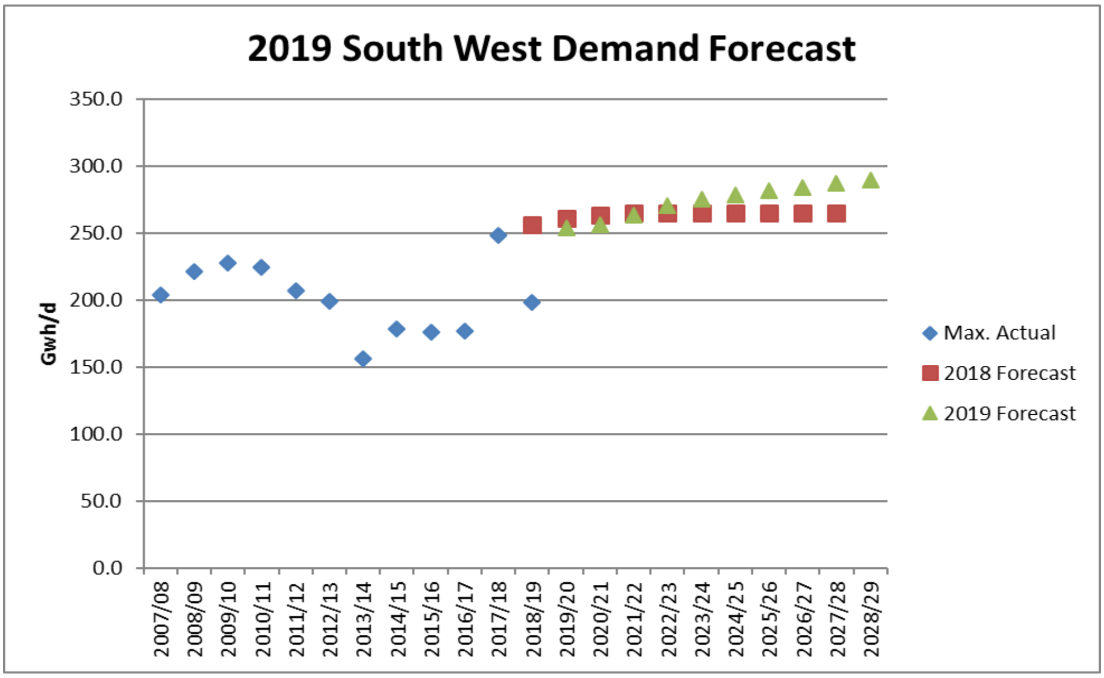
Further information on the WPD constraint is available in Appendix 2.

South West:

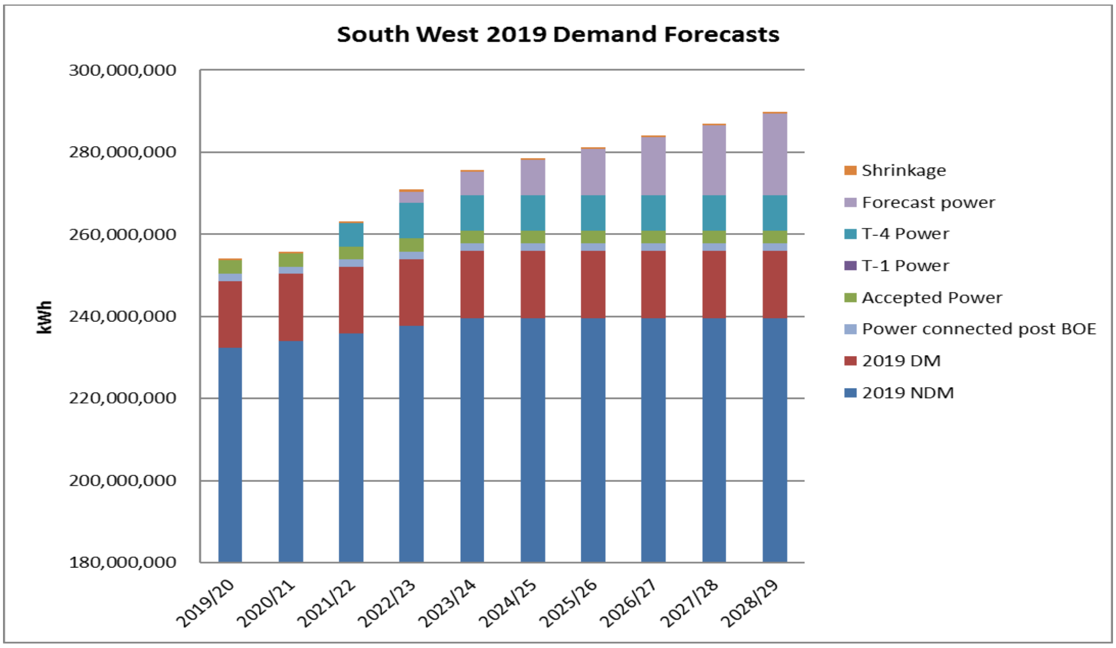
The 2019 peak demand forecast for the South West is 254 GWh/d. This is projected to increase to 290 GWh/d by 2028/29, which represents a 14% increase. The increase is due to domestic and power generation growth which has not been offset by reductions in other load bands, as shown in the graph below.

The maximum demand for 2018/19 was 198.3 Gwh/d, which was experienced on 1 February 2019.

Graph 1: Comparison of current and previous forecasts vs actual maximum flow



Graph 2: 2019 Demand forecast by load type

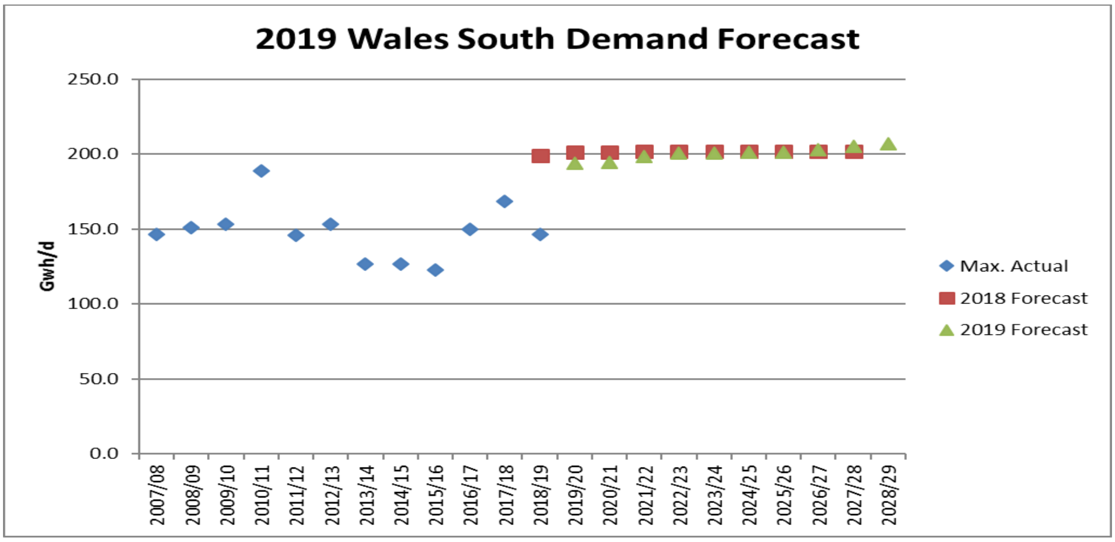



## Wales South:

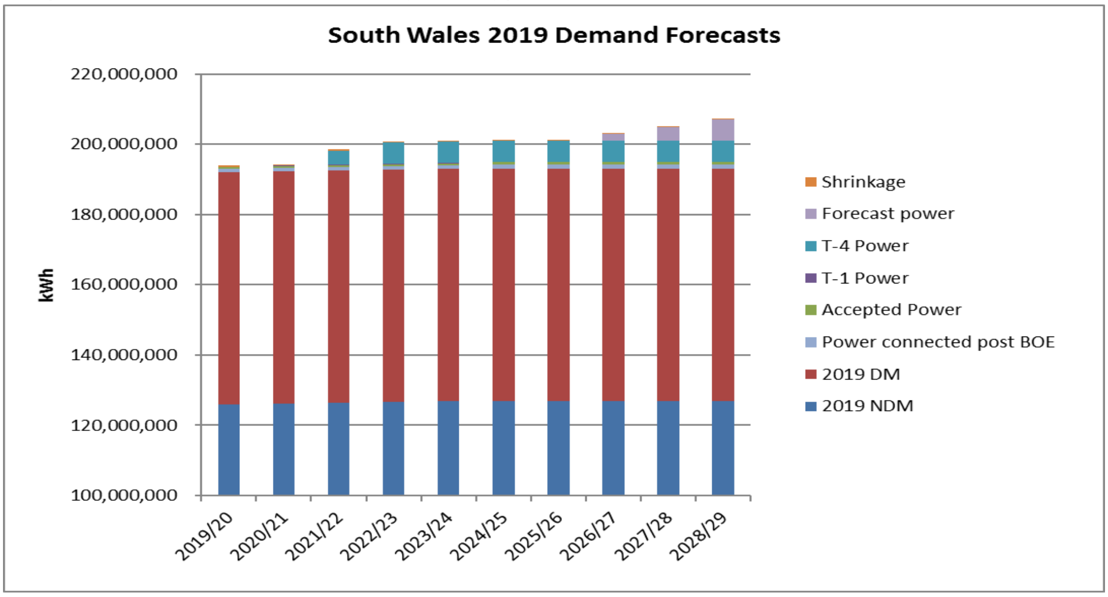
The 2019 peak demand forecast for Wales South is 194 GWh/d. This is a reduction from last year's forecast following the closure of one of our older power stations. This is projected to increase to 207 GWh/d by 2028/29, which represents a 7% increase.

The maximum demand for 2018/19 was 146.7 GWh/d, which was experienced on 1 February 2019.

Graph 3: Comparison of current and previous forecasts vs actual maximum flow




Graph 4: 2019 Demand forecast by load type

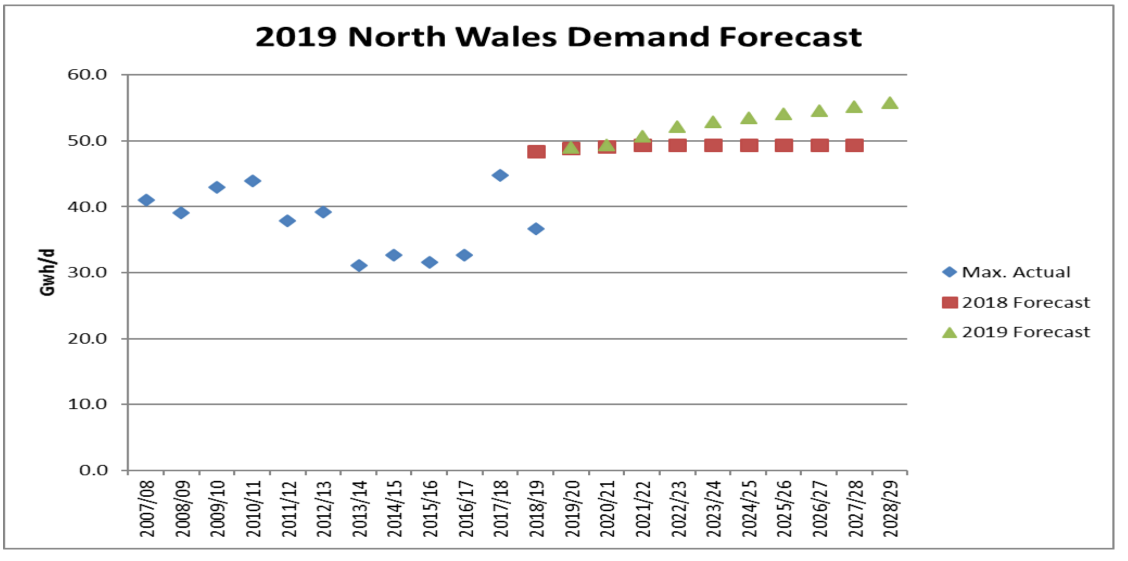


## Wales North:

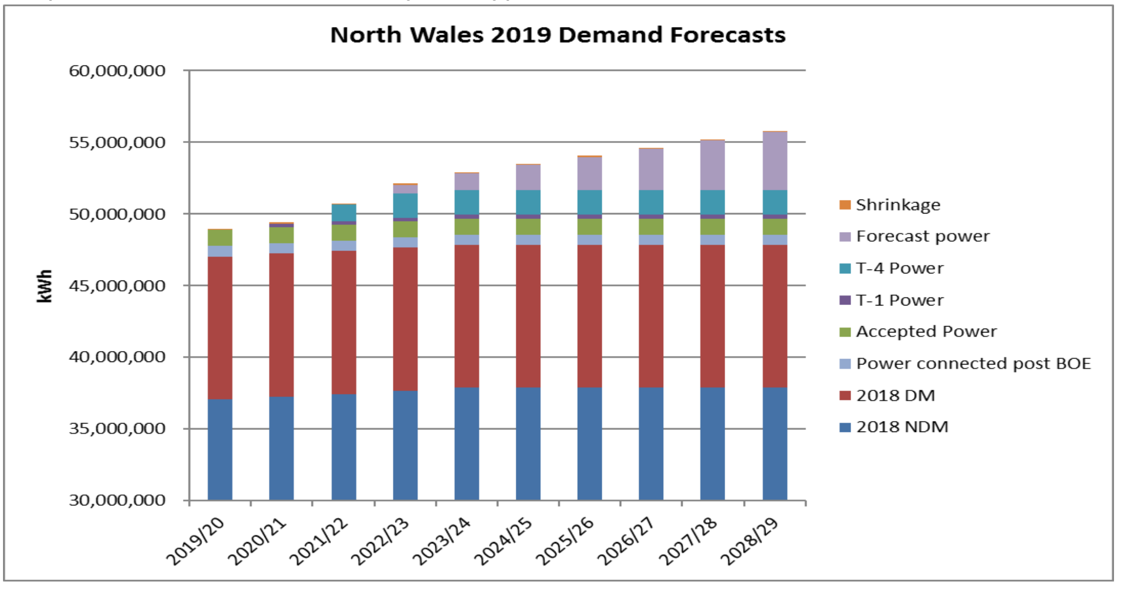
The 2019 peak demand forecast for Wales North is 49 GWh/d. This is projected to increase to 56 GWh/d by 2028/29, which represents a 14% change. The increase is mostly the result of increases in power generation.

The maximum demand for 2018/19 was 36.6 Gwh/d, which was experienced on 31 January 2019.

Graph 5: Comparison of current and previous forecasts vs actual maximum flow



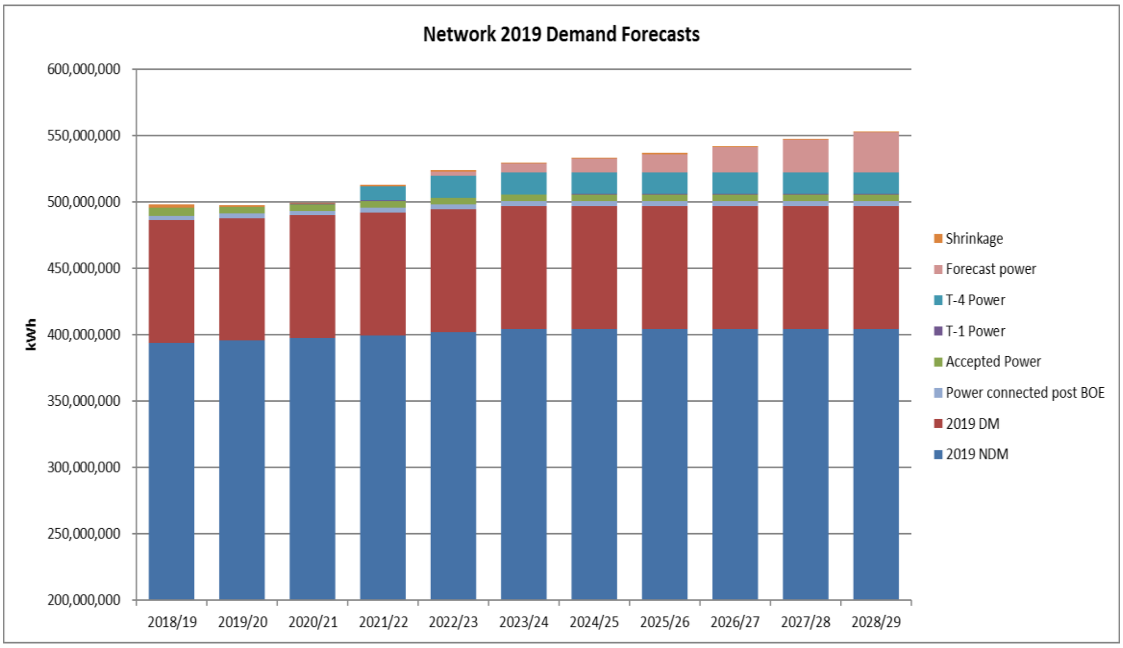

Graph 6: 2019 Demand forecast by load type



### WWU network:

The graph below shows the data for the network considered as a whole for all three of our LDZs.

Graph 7: Whole network




### 4.3.6 Future projections:

In recent years we have updated our processes and developed new models to consider the impacts of improved boiler efficiency and home insulation on residential peak demand. We have also taken account of available information from public sources and stakeholder engagement to assess the impact of flexible generation at specific locations in our network.

This year we have completed additional research to provide further certainty for other loads on our networks as follows:

**Green City Vision**

We led this collaborative project with SSEN, UKPN and our partners Progressive Energy. In this project we are working with other stakeholder to develop a 2050 low carbon scenario for Swindon, taking into account the impacts on carbon reduction and costs. Our Pathfinder model was used to assess a number of decarbonisation scenarios as well as their impact on hourly flows through the network. This in turn allows us to fully understand and assess capacity requirements.

The learning from this project will inform our net zero vision (as outlined in section 3.5)

**Regional FES**

We undertook our Regional FES project with Regen. The project took learning from the gas demand forecasting project described above and used that along with regional strategies and information from stakeholders such as local authorities, to develop granular forecasts at a sub-LDZ level for the first time.

This project's outputs included demands for a number of load types, scenarios and for each year up to 2035. Further information is available in Appendix 4: Our future of energy research.

#### 4.3.7 Annual gas demand

There are a number of processes that rely on annual gas demand which detail the total quantity of gas we expect to transport through our network in any given year. Going forward these will be increasingly important for determining the carbon emissions associated with the use of fossil gas, as well as for determining any reductions that are a result of green gas displacing current sources.

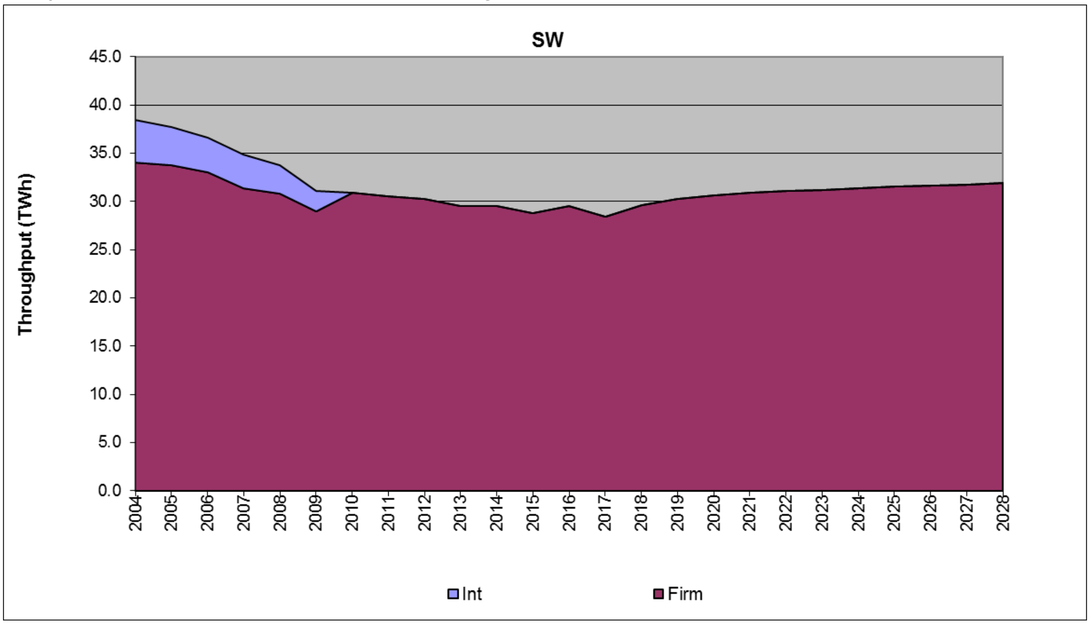
The seasonal profile of annual demand will also be important if we assume that green gas will continue to be injected into our network at similar rates throughout the year. This is because there may be a requirement for seasonal storage, which is currently not available in our network.

While our analysis of peak demand shows increases in the short term, we agree with the more general view that annual gas demand may reduce – although current policies have not been successful in delivering this. This reduction would be a result of general building and appliance efficiency improvements and a decrease in load factors as some gas generation is displaced with other sources, including renewables on sunny and windy days. Our forecasts are detailed below.

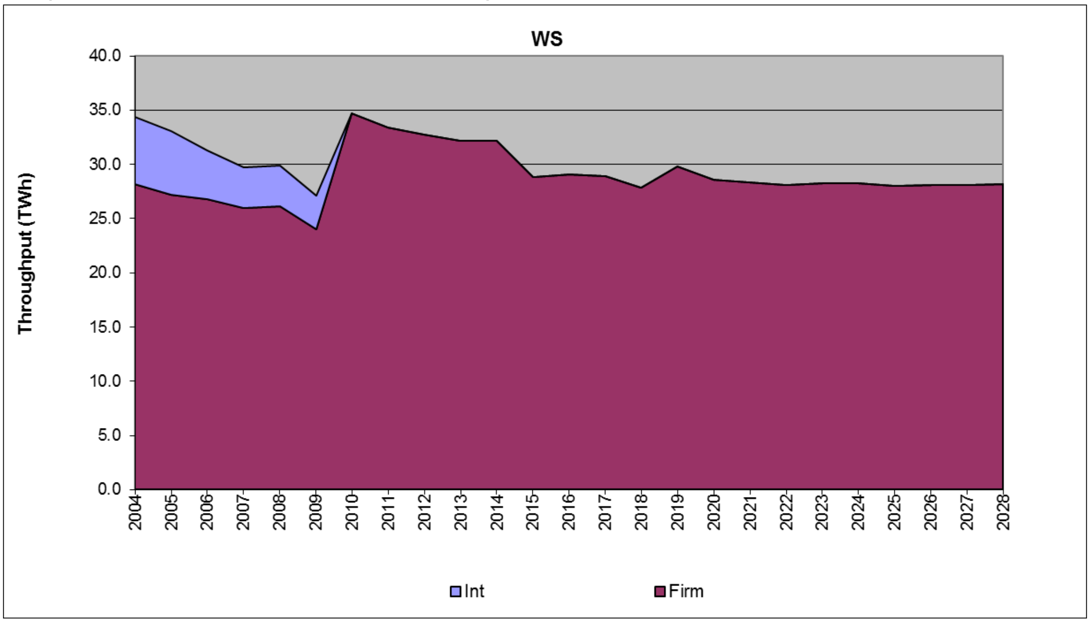
In the South West and North Wales LDZs the majority of the demand is from domestic energy users, whereas in Wales South the demand is more evenly spread between domestic and large industrial users. Throughput in North Wales is significantly less than it is in the South West and in Wales South.

## South West

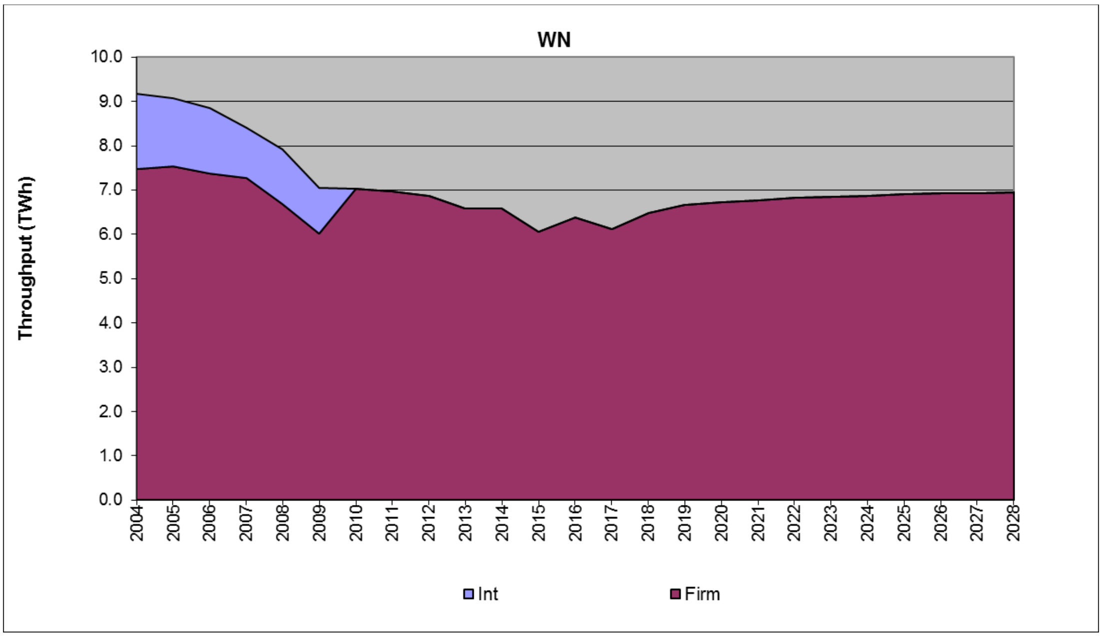
Graph 7:  Historical and forecast annual gas demand for South West LDZ




Graph 8:  Historical and forecast annual gas demand for Wales South LDZ



Graph 9: Historical and forecast annual gas demand for Wales North LDZ



# 5. Supply

## 5.1 Key messages

- We have already connected 19 biomethane sites to our network which have capacity to meet the needs of more than 130,000 customer homes.
- We have increased NTS capacity bookings in most areas this year in response to increased peak demand forecasts across the region.
- We are due to be the first network to accept synthesis gas into our network.
- We are supporting significant industry work to update industry standards around gas quality so that networks can transport a wider range of gases safely and in doing so support decarbonisation.
- We are leading innovation projects to forecast how gas supplies might change in the longer term and how we can maximise entry capacity on our networks including for hydrogen.

## 5.2 Overview

We develop the local transmission and distribution systems to meet our customers' requirements. In turn, National Grid Transmission (NGT) will develop the national transmission system (NTS) in line with supply and demand forecasts and this is then detailed within their development statement. NG Gas Ten Year Statement

Our supply is mainly brought into the network from the NTS via the 17 offtake sites; in addition we have 19 biomethane supplies. As biomethane feeds are subject to customers' requirements, we do not assume they will be flowing at peak and we therefore book sufficient NTS capacity to meet peak day demand requirements.

General principles of operation are that supply is delivered to distribution networks at a steady rate for each gasday and that storage within those networks is used to retain it until it is required at specific times of that day by our demand customers. We store gas within our network of pipes in the form of 'linepack' and also in High Pressure Storage Vessels (or bullets). In total we have 52.5 GWh storage available in linepack and 5.2 GWh storage available in bullets.

### 5.3 Distributed gas

#### 5.3.1 Green gas

We believe in a future integrated energy network and have introduced distributed gas entry standards to support the connection of distributed biomethane gas. Injecting gas into the distribution network directly helps to achieve climate change targets (reducing reliance on fossil fuels) as well as improving the security of supply.

During our consultation processes in 2019 we have increased our stakeholder engagement through our Regional FES project. We also carried out other specific stakeholder events to support the production of our GD2 business plan and to test our proposals to support decarbonisation plans for the UK.

Based on 21 engagements with more than 21,000 stakeholders, it is clear that our commitment is viewed as the right thing to do to help reduce emissions across the UK. There is clear stakeholder interest and approval for projects, such as Freedom, that support this commitment. We are therefore now recommending steps that would roll this work out, striving towards industry-wide decarbonisation. Based on this feedback and government support, we are committing to deliver a net zero ready network by 2035.

Projected annual green gas production volumes vary between different national energy scenarios, depending on the policy measures that are assumed to be in place. Scenarios for 2030 vary from a ‘failure’ or no increase scenario, to the highest prediction of 120 TWh a year – which is equivalent to more than a thousand ‘biomethane to grid’ plants across the UK.

As we anticipated in last year’s long-term statement, our Gas Demand Forecasting Phase 2 and Green City Vision projects provided evidence that significant amounts of green gas injection will be required in order for the UK to meet its carbon reduction targets in the heat and transport sectors.

At the same time, most reports now recommend the continued use of the gas network, including reports from the CCC and National Grid’s Future Energy Scenarios. Other bodies such as the Institution of Mechanical Engineers (2018) recognise the value of both hydrogen and hybrids, with a recommendation that investment in the gas network should continue.

More recently, DNVGL, in its 2019 energy transition Outlook (September 2019) concluded as follows: “Our Outlook gives a clear message: there is no single pathway to a decarbonised energy mix. A combination of energy sources (primarily gas and variable renewables) must work together to provide the quickest route to a secure supply of affordable, decarbonised energy in the lead-up to mid-century. Gas will increasingly complement variable renewables, meeting demand in peak periods such as winter in colder climates.”

Our proposed use of biomethane was supported by the Renewable Energy Association (REA) in its report published on 5 September 2019. According to the report, bioenergy, which currently represents 7.4% of the UK’s primary energy supply mix, must play a “crucial” role in decarbonisation as sectors such as transport and heavy industry rely increasingly on electrified technologies and systems. These challenges in increased electricity demand, the REA notes, will be compounded by the phase-out of coal generation plants and the so-called “nuclear gap”.

According to the REA report, the most cost-effective and low-carbon way in which to approach these interlinked issues is to double bioenergy deployment through to 2032, adding 117 TWh. It states: “Bioenergy is the backbone of the renewables revolution providing all-important dispatchable power and the most advanced solution to meeting the demands of heat and transport.”

#### 5.3.2 Coal bed methane

We have not received any enquiries for significant quantities of other distributed gas injection in the form of coal bed methane in the past year. As a result in the short term we are not proposing any investment. However, the challenges of connecting coal bed methane would be similar to those caused by green gas entry.

#### 5.3.3 Hydrogen

In 2018 we undertook analysis on the likely methods of converting Bristol and Cardiff to 100% hydrogen in the longer term. Following the increase in ambition for UK decarbonisation and new information from our stakeholders received as part of our Regional FES process we anticipate that blended hydrogen will be injected by 2027 in Wales and by 2030 in the south west of England. We also anticipate significant use of pure hydrogen to support industry in South Wales from 2030 which would then offer opportunities for use in other cities along the M4 to Bristol during GD4.

### 5.4 Capacity impacts of distributed gas

The principles of gas distribution are challenged by increasing distributed gas entry. Where this occurs at lower pressure tiers and in less populated areas we will need to introduce new technology including compression to move this gas to the areas where our customers need it.

Where the proportion of distributed gas increases further, it may also be necessary for seasonal storage to be provided so that gas produced in the summer can be stored for use in the winter. To maximise the capacity that can be made available with current technology and following the introduction of new technology, smarter control systems will be needed to provide dynamic pressure setting changes based on flows of gas into and out of key sites.

We are continuing work our innovation project OptiNet with Cadent and our partners Passiv to look at innovative ways to make capacity available in a part of our network that is currently unable to accept enquiries we have received for green gas injection. Further information is available in Appendix 4: Our future of energy research.

We recognise that new commercial and regulatory frameworks will be required to make sure that associated costs are dealt with appropriately. We will include proposals for this in our GD2 submission later this year.

### 5.5 NTS supplies

To ensure that we can meet our 1:20 licence condition it is essential that we have booked sufficient capacity from the NTS to meet our peak day demands. While we consider the availability of distributed gas in the locality, this is not currently treated as a firm supply and is not used as a means to off-set our NTS capacity.

Included in our RIIO framework is an incentive to book NTS capacity efficiently at the lowest cost. However, current arrangements mean that increases to our enduring capacity bookings result in us being 'locked in' to capacity for four years under User Commitment arrangements. This can result in us having more capacity than we need – either in specific locations or in some cases at an LDZ or network level.

In 2017 we raised this issue in our response to the NTS' Exit Capacity Release Methodology consultation: WWU Response and in 2018 we raised UNC Modification 671 to propose changes to the way NTS Exit Capacity is made available. This modification was withdrawn following a requirement in Ofgem's sector specific methodology decision document (May 2019) for NTS to review system capacity access arrangements.

Figure 1 provides details of the current physical and commercial capacity through our NTS Offtake sites:

| Subsystem Name | Offtake Location | Capacity kWh/h | Capacity KWh/d | 2019/20 Capacity Bookings kWh/d |
|---|---|---|---|---|
| | **LDZ:- SW** | | | |
| **Northern** | **Wiltshire (1)** | 1,322,569 | 31,741,667 | 27,391,725 |
| | **Gloucestershire (1)** | 1,254,861 | 30,116,667 | 21,293,234 |
| | **Bristol (1)** | 2,632,500 | 63,180,000 | 48,850,575 |
| **Central** | **Bristol (2)** | 1,625,000 | 39,000,000 | 22,688,355 |
| | **Somerset** | 1,895,833 | 45,500,000 | 28,968,678 |
| **Southern** | **Exeter (1)** | 677,083 | 16,250,000 | 14,000,883 |
| | **Plymouth** | 3,250,000 | 78,000,000 | 40,420,636 |
| **Other** | **Exeter (2)** | 1,318,056 | 31,633,333 | 19,128,874 |
| | **Gloucestershire (2)** | 487,500 | 11,700,000 | 7,417,140 |
| **Pressure Controlled** | **Devon** | 379,167 | 9,100,000 | 4,830,571 |
| | **Herefordshire** | 270,833 | 6,500,000 | 4,023,357 |
| | **Wiltshire (2)** | 230,660 | 5,535,833 | 2,299,463 |
| | **Worcestershire** | 410,764 | 9,858,333 | 5,584,329 |
| | | | | |
| | **LDZ:- WS** | | | |
| **South Wales** | **Cardiff** | 4,702,118 | 112,850,833 | 91,369,207 |
| | **Swansea** | 2,545,833 | 61,100,000 | 40,231,974 |
| | **Newport** | 3,423,333 | 82,160,000 | 75,404,154 |
| | | | | |
| | **LDZ:- WN** | | | |
| **North Wales** | **Wrexham** | 2,708,333 | 65,000,000 | 49,258,990 |
| **Assumned CV 39.2** | | | | |

# 6. Investment in the distribution network

## 6.1 Key messages

- Our stakeholders have told us that maintaining a safe, reliable gas supply is a key priority and that they support initiatives to encourage more green gas to enter the network.
- We are adopting new techniques to ensure efficient investment in network health through use of monetised risk models.
- We anticipate increasing requirements for compression, storage and smart control in the future to accommodate increasing demands for flexible gas usage and injection from our customers.

## 6.2 Distribution network

We manage the operation and maintenance of the Local transmission system and below 7 Bar distribution networks in three LDZs: South West, Wales South and Wales North.

We will continue to develop and invest in our networks in order to operate a safe and efficient network and to meet current and future customers' requirements and operating behaviours. We are certificated to asset management standard ISO55001 and we plan investment in line with the principles of the standard.

In 2019 we have carried out significant stakeholder engagement:

- Based on 12 engagement events including over 21,000 stakeholders we have gathered consistent feedback that safety and reliability of service are of paramount importance and that we have broad support for our continued efforts to improve our mains replacement programme. Based on this feedback we are committing to significantly reduce the safety risk for over half a million people living in the vicinity of an ageing metallic gas main, by continuing to invest in our mains replacement programme.

- Based on 13 engagement events, including over 2,400 stakeholders, we are seen as playing a central role in creating a sustainable energy future. Customers would like us to incorporate their views in the development of initiatives to achieve this ambition. 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.

### 6.3 Network management

To better understand the reliability and condition of our assets and to understand how this will change over time with different investment scenarios, we have used Condition Based Risk Management (CBRM) models to date. These decision support tools help us to plan, justify and target future investment to maintain the current high level of safety and reliability of the gas supply network. The established methodologies have been developed further across the industry through the Network Output Measures (NOMs) methodology work. We have recently invested in both systems and people to further enhance our assessment of asset health, consequence and risk and our investment strategies to manage this. We have purchased and embedded an asset investment optimisation tool (AIM) and employed a number of data scientists to ensure that we get the most out of this investment in new systems. Our GD2 plans have been derived using these new skills and tools.

For pipelines, we have implemented an ‘as low as reasonably practicable’ (ALARP) methodology in assessing the options that are available to us to identify the most cost-effective way to minimise societal risk, specifically targeting high consequence areas.

To manage pipelines in this way requires high-quality data and analytics. To support this we have digitised our entire high pressure pipe network (2,364km) into short sections so that we can better assess the consequences of any failure. We previously had 199 pipeline routes. This has now become 10,785 pipeline sections. This took a team of four staff 18 months to deliver and has resulted in a very detailed assessment of risk according to the people, property and infrastructure in the vicinity of each pipeline section.

This will achieve the greatest risk reduction for the minimum expenditure in preference to wholesale replacement of pipelines.

### 6.4 Investment

We will continue to invest for reinforcement and new connections consistent with the peak day demand forecast in this document. We will continue to invest in the replacement of our transportation network assets, primarily for the renewal of mains and services within our distribution system. This includes expenditure associated with the three-tier approach initiated by the HSE for metallic mains replacement under the iron risk removal programme. This is our 30-year gas mains replacement programme (from 2000) which requires all iron mains within 30 metres of a building to be replaced. From 2013 to 2021 we will replace around 3,360km of metallic gas mains, at an annual cost of £70 million.

In future years further non-demand driven investment may be required as we start to investigate other requirements such as hydrogen injection, blending services and compression.

Through our OptiNet project we are investigating ways to optimise our network through a combination of storage, compression and smarter pressure control. Further information is available in Appendix 4: Our future of energy research.

## 6.5 Hydrogen impacts on our repex programme

In 2018 we participated in Project H21, a project of strategic modelling in major urban centres. The analysis looked at the likely methods of converting Bristol and Cardiff to 100% hydrogen in the longer term. Our investment plan for mains replacement is designed to be a no regrets enabler for hydrogen and will keep us on track to deliver hydrogen networks in the future.

# 7. Innovation

## 7.1 Key messages

- Since the start of the current gas network price controls in 2013, the networks have delivered over 400 innovation projects.
- For today's customers, our innovations have helped us deliver outstanding levels of customer service: reducing the disruption from our essential work while making us more efficient and cost-effective and our network more resilient.
- For tomorrow's customers, our research projects and partnerships make sure we play our part in delivering reliable energy at affordable costs for customers, while helping the UK meet its decarbonisation targets.

## 7.2 GDN innovation


In March 2020, the gas networks will set out their latest vision for network innovation projects and priorities. The latest Gas Networks Innovation Strategy will build on the inaugural version from 2018[3], reviewing progress and setting future priorities.

Network innovation projects help deliver increased efficiency and value for money, and develop the new technologies and approaches needed for decarbonisation. The Gas Networks coordinate to share learning and ensure that projects are delivering industry goals. You can find out more information about individual projects at the Smarter Networks Portal, https://www.smarternetworks.org/.

We work closely with colleagues from the Electricity Networks and the wider energy industry to deliver innovation. The Gas Network Innovation Strategy was published alongside an equivalent Electricity Network Innovation Strategy, and the 2020 Strategies will feature enhanced analysis of cross vector challenges and opportunities.

Input from wider industry is crucial to shape our Innovation Strategies. We consult widely during their development, and encourage third parties to participate directly in innovation projects and present new ideas to network operators. You can find out more or submit your proposals via https://www.nicollaborationportal.org/.

3 http://www.energynetworks.org/assets/files/Gas%20Network%20Innovation%20Strategy%20Final%202018.pdf

## 7.3 WWU innovation summary

We have invested in more than 250 business improvement and innovation projects since 2013, representing a total investment of £19.8m. Our innovation has delivered the following value:

- Improvements in safety, reliability and customer service.
- Providing real evidence of the way in which the gas network plays a critical enabling role in achieving net zero.
- A framework to roll-out out proven innovation – 78 projects embedded through our innovation programme have delivered overall cost savings or costs avoided to the value of c£10m. These costs savings will continue into GD2.

We welcome the recent decision to retain the Network Innovation Allowance (NIA).

## 7.4 WWU innovation strategy

Our strategy is simple. We innovate to make sure we can deliver the highest possible levels of safety, reliability and service for today and tomorrow's customers. These challenges can be summarised as:

- Delivering a smart, reliable, low cost and low carbon network to meet the future energy needs of our customers;
- Supporting customer needs and expectations in a changing environment;
- Effectively managing an ageing infrastructure to keep the gas flowing to our customers' homes and businesses;
- Continuing to review, develop and demonstrate technological advances to keep our colleagues and customers safe while delivering value for money.

### 7.4.1 Innovation for customers today

For today's customers, our innovations have helped us deliver outstanding levels of customer service: reducing the disruption from our essential work while making us more efficient and cost-effective and our network more resilient.

We put our customers first, and target innovation to deliver value for money and real results for our customers. Our values have helped innovation thrive, with 80 NIA projects started since 2013/14.

Not all of our projects have been successful but we have learnt from each and this has helped us deliver for our customers in the long term. We have used the incentive funding to pursue a number of solutions to real problems including:

- Setting out to develop a network approved steel cutting tool that allows rapid access to inserted PE pipe in our mains. This advanced equipment is now commercially available and saves us time and money and reduces disruption for customers as a result of our work.

- A cross-sector, pioneering project to establish a standard, network-wide framework from drone use that could revolutionise the way we monitor and maintain our assets.

The ‘Above and Beyond’ project is looking at how drones could transform the way energy networks perform vital inspections and aims to shape the future for drone applications.

#### 7.4.2 Innovation for customers of tomorrow

For tomorrow’s customers, our research projects and partnerships make sure we play our part in delivering reliable energy at affordable costs for customers, while helping the UK meet its decarbonisation targets.

With more than 80% of heat and power demand at peak times currently met by the gas network, we are planning for the future – to make sure we continue to deliver reliable energy at affordable costs for customers, while helping the UK meet its decarbonisation targets.

There has been a marked increase in the number of research and demonstration projects in the energy futures space since 2013. In 2013/14 we had just one project in this category – but today more than 46% of our NIA funding has been committed to innovating for the customers of tomorrow.

Our research has told us that the full electrification of heat comes at an excessive cost. Alongside our partners, we are committed to delivering an energy future that addresses the UK energy trilemma: providing consumers with affordable, secure, and low carbon energy. Some of the research made possible by the incentive funding is detailed in Appendix 4: Our future of energy research.

### 7.5 Our team

#### 7.5.1 Governance and delivery

We have been committed to innovation since day one. This is led from the top by our leaders who believe that investing appropriate commitment and resources into innovation will help us improve our performance year on year. Our innovation team ensures that innovation is delivered at pace and that benefits are recorded and shared across all relevant parts of the business. With a small innovation team supported by a large delivery team – the business – our innovation is driven by our five business priorities which reflect the stakeholder outputs we deliver, as well as making sure we meet the needs and expectations of all our customers and stakeholders today and in the future.

#### 7.5.2 Collaboration and sharing

Collaboration is central to delivering our business innovation strategy. We are proud that two-thirds of our NIA project portfolio since 2013 has been delivered in collaboration with one or more other network licensees. We are now working with more partners than ever before. Since 2013, we have formed relationships with more than 350 organisations such as suppliers, academia and businesses of all sizes. We continue to facilitate collaborative innovation within the energy sector alongside our own contractors and other utility companies.

Our project partners are always ready to rise to our challenges and make our innovation programme a success. Working with partners is important to help us deliver innovation with tangible benefits for our customers and the industry.

We launch our problems and challenges through a call for innovation process, using a variety of methods which include our collaboration partners the Energy Innovation Centre. This open and transparent process generates interest and action from businesses large and small who produce efficient competitive solutions to problems – helping us deliver value for money to our customers.

We share our project successes and learning experiences with other networks and industry in the UK, as well as other organisations further afield. One example where this approach has benefited a wider market is the Ductile Iron mains cutting tool (NIA_ WWU_013), which we designed and developed alongside Steve Vick International. It has not only been bought by the other UK networks, it has also reached gas networks in the United States of America and Australia.

Our colleagues are fully engaged in challenging and shaping our future too. We have a voluntary team of innovation champions who endorse our innovation strategy and advocate the continual growth and development of an innovative culture. They work closely with our innovation team supporting the implementation of solutions designed to deliver for our customers. We are proud that a significant source of innovation is from our colleagues – more than 40% of ideas come from our own colleagues.

We focus on innovation to drive business efficiency and make the best use of our available resources to target problems through engagement with external organisations. We share our challenges by launching calls for innovation on specific problems, publishing our industry challenges and taking opportunities to communicate these challenges at events and workshops.

## 7.6 Looking ahead

Innovation is core to our business strategy. We rely on innovation to drive efficiency, while delivering against all our business priorities and output targets and we will continue to do this in the future. Our strategy will stay the same: innovating for customers today and tomorrow, with an innovation portfolio split between projects that develop solutions to solve today's problems and those that plan for the UK energy system of the future.

There are a growing number of successful projects that have been developed across and beyond the industry that we want to adopt and we will be embracing these projects, working closely with other networks to implement their successful projects in our network where appropriate. We will build on our drive to fully embed our projects to business as usual, making use of our innovation champions to promote, roll out, communicate and support people as they respond to the changes.

Guided by the publication of the Gas Network Innovation Strategy, we will use innovation funding to build on and keep pace with the critical changes brought about by a changing energy system.

# Appendix 1: Process methodology

### A1.1 Introduction

Demand forecasts have been developed using the methodology defined within Uniform Network Code OAD Section H, for more information refer to Joint Office OAD Section H.

### A1.2 Demand forecasts for Wales & West Utilities planning

Models have been built for each load band that relates weather correct demand to economic variables using established econometric techniques. For large loads local information is used where available, for example information on new loads or known future changes in demand.

Forecasts are produced for annual demand and peak day demand. Different models and techniques are used for these two purposes. The forecasts of peak day demand is a forecast of demand under extreme conditions and therefore uses statistical distributions designed to model extreme values. Peak day modelling uses the full historical weather from 1928/29 through to present. The weather data is used in conjunction with seasonal normal demand and a simulation technique to produce a 1 in 20 peak demand for each LDZ. This can then be applied to the previously forecast annual demands to produce peak daily demand across the ten-year forecast period.

### A1.3 NDM profiling and Composite Weather Variable

Demand Estimation parameters are calculated based on SNCWV. From 1st October 2015 Xoserve have published revised SNCWV for use going forward. This includes a revised shortened weather history than was previously used. We have considered the impact of these revisions in this current iteration of our Long Term Development Statement.

### A1.4 Supply

NG own and maintain the NTS which supplies our network through 17 offtakes. Exit Capacity bookings at these offtakes are made by us as per the arrangements in Uniform Network Code and further information regarding the release of capacity by NTS is described at the following location; National Grid Exit Capacity

Where available, Biomethane sites are also providing gas injection directly into our network. Whilst the number of sites are few and in the absence of historic data, we do not consider that these volumes can be assumed to be available at peak, with no commitment from these suppliers to provide flat capacity and as such bookings for equivalent NTS capacity are also made to ensure security of supply. However, as the number of sites increases this will be reviewed.

## A1.5 LTS planning

We use a forecast of demand to model system flow patterns and produce capacity plans that take account of anticipated changes in system load and within-day demand profiles.

The options available to relieve LTS capacity constraints include:

- Uprating pipeline operating pressures.
- Constructing new pipelines or storage.
- Constructing new supplies (offtakes from the NTS), regulators and control systems.
- DN Entry when available and secure.
- Offering customer interruption via the interruption capacity auctions

As well as planning to ensure that LTS pipelines are designed to the correct size to meet peak flows, there is a requirement to plan to meet the variation in demand over a 24-hour period. Diurnal storage is used to satisfy these variations and consists of gas held in linepack and high-pressure vessels.

### A1.5.1 Below 7 Bar distribution planning

The lower pressure tier distribution system is designed to meet expected gas flows in any six-minute period assuming reasonable diversity of demand. Lower tier reinforcement planning is based on LDZ peak demand forecasts, adjusted to take account of the characteristics of specific networks.

Network analysis is carried out using a suite of planning tools with the results being validated against a comprehensive set of actual pressure recordings. The planned networks are then used to assess future system performance to predict reinforcement requirements and the effects of additional loads. Reinforcement options are then identified priced and programmed for completion before any potential constraint causes difficulties within the Network. Reinforcement is usually carried out by installing a new main or by taking a new offtake point from a higher-pressure tier. In general, the reinforcement project is of such a size that the work can be completed and operational before the following winter.

## A1.6 Investment procedures and project management

All investment projects must comply with our Investment Procedures, which set out the broad principles that should be followed when evaluating high value investment or divestment projects. Governance is carried out by our Committee structure.

The investment procedures define the methodology to be followed for undertaking individual investments and cover the following stages:

- Project Planning
- Financial Appraisal
- Project Approval
- Project Monitoring
- Project Completion

Primarily the purpose of investment is to maintain the safe supply of gas to the customer. Projects are either mandatory or discretionary investments and are considered on the basis of:

i) Maintenance of security of supply,
ii) Financial & commercial impact, and
iii) Mandatory requirements such as legal or HSE obligations.

All investment proposals fully account for the technical, safety, environmental and financial aspects.

The successful management of major investment projects is central to our business objectives. Our project management strategy involves:

- Determining the level of financial commitment.
- Monitoring and controlling the progress of the project to ensure that financial and technical performance targets are achieved.
- Post Completion Reviews and Post Investment Appraisals to ensure compliance and capture lessons learnt.

Our management of investment projects is designed to ensure that they are delivered on time, to the appropriate quality standards at minimum cost. The project management process in particular makes use of professional consultants and specialist contractors, all of whom are appointed subject to competitive tender.

# Appendix 2: Gas demand & supply volume forecasts

## A2.1 Demand

NB: Volumes are estimated using CWV derived on the EP2 basis implemented in 2016. Figures may not sum due to rounding.

Figure A2.1 – Forecast 1 in 20 Peak Day Firm Demand (GWh per day).

| LDZ | 2019/20 | 2020/21 | 2021/22 | 2022/23 | 2023/24 | 2024/25 | 2025/26 | 2026/27 | 2027/28 | 2028/29 |
|---|---|---|---|---|---|---|---|---|---|---|
| South West | 254 | 256 | 263 | 271 | 276 | 278 | 281 | 284 | 287 | 290 |
| Wales North | 49 | 49 | 51 | 52 | 53 | 53 | 54 | 55 | 55 | 56 |
| Wales South | 194 | 194 | 198 | 201 | 201 | 201 | 201 | 203 | 205 | 207 |
| | | | | | | | | | | |
| Network Total | 497 | 499 | 512 | 524 | 530 | 533 | 537 | 542 | 547 | 553 |

Figure A2.2 – South West LDZ Forecast Annual Demand Table – Split by Load Categories (TWh).

| Calendar Year | 2019 | 2020 | 2021 | 2022 | 2023 | 2024 | 2025 | 2026 | 2027 | 2028 |
|---|---|---|---|---|---|---|---|---|---|---|
| 0 - 73.2 MWh | 20.17 | 20.14 | 20.11 | 20.09 | 20.07 | 20.06 | 20.06 | 20.07 | 20.07 | 20.08 |
| 73.2 - 732 MWh | 3.14 | 3.32 | 3.44 | 3.52 | 3.59 | 3.64 | 3.65 | 3.67 | 3.72 | 3.75 |
| >732 MWh | 3.85 | 3.98 | 4.10 | 4.26 | 4.31 | 4.39 | 4.49 | 4.56 | 4.61 | 4.65 |
| NDM Consumption | 27.16 | 27.43 | 27.65 | 27.87 | 27.96 | 28.09 | 28.20 | 28.30 | 28.39 | 28.48 |
| DM Firm Consumption | 3.07 | 3.15 | 3.21 | 3.19 | 3.21 | 3.26 | 3.32 | 3.35 | 3.38 | 3.40 |
| Total LDZ Consumption | 30.23 | 30.59 | 30.86 | 31.07 | 31.18 | 31.35 | 31.52 | 31.66 | 31.77 | 31.88 |
| Total Shrinkage | 0.26 | 0.27 | 0.27 | 0.27 | 0.27 | 0.27 | 0.28 | 0.28 | 0.28 | 0.28 |
| Total Throughput | 30.48 | 30.86 | 31.13 | 31.33 | 31.45 | 31.62 | 31.80 | 31.94 | 32.04 | 32.16 |
| | | | | | | | | | | |
| Gas Supply Year | 2019/20 | 2020/21 | 2021/22 | 2022/23 | 2023/24 | 2024/25 | 2025/26 | 2026/27 | 2027/28 | 2028/29 |
| Total Throughput | 30.79 | 31.02 | 31.30 | 31.39 | 31.63 | 31.69 | 31.91 | 32.01 | 32.16 | 32.23 |

Figure A2.3 – South West LDZ Forecast Annual Demand Graph – Split by Load Categories (TWh).

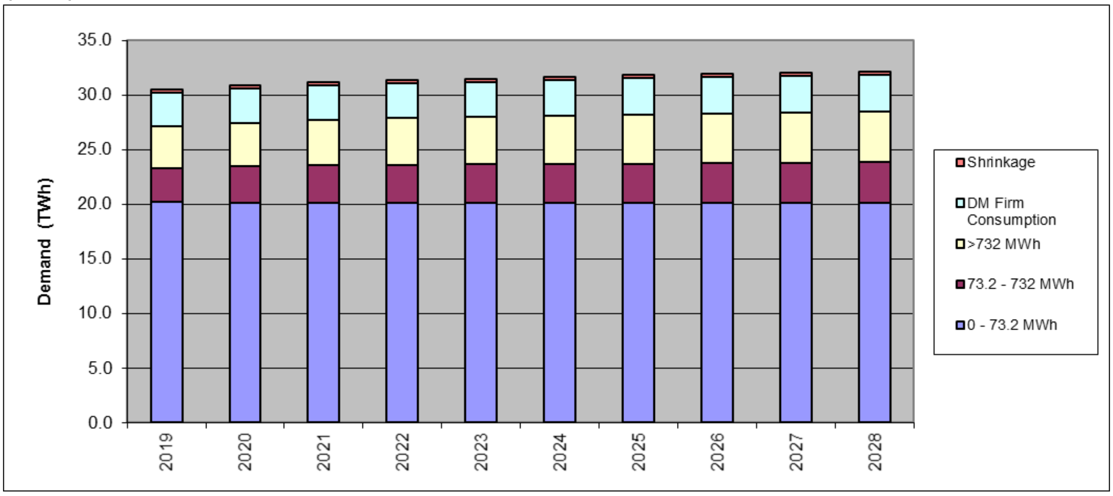


Figure A2.4 – Wales South LDZ Forecast Annual Demand Table – Split by Load Categories (TWh).

| Calendar Year | 2019 | 2020 | 2021 | 2022 | 2023 | 2024 | 2025 | 2026 | 2027 | 2028 |
|---|---|---|---|---|---|---|---|---|---|---|
| (a) 0 - 73.2 MWh | 12.16 | 12.14 | 12.12 | 12.11 | 12.09 | 12.09 | 12.09 | 12.09 | 12.09 | 12.10 |
| (b) 73.2 - 732 MWh | 1.63 | 1.73 | 1.83 | 1.85 | 1.87 | 1.87 | 1.86 | 1.88 | 1.91 | 1.92 |
| >732 MWh | 2.54 | 2.63 | 2.71 | 2.82 | 2.85 | 2.90 | 2.97 | 3.02 | 3.04 | 3.07 |
| NDM Consumption | 16.33 | 16.50 | 16.67 | 16.77 | 16.81 | 16.86 | 16.92 | 16.99 | 17.05 | 17.10 |
| DM Firm Consumption | 13.44 | 12.05 | 11.68 | 11.29 | 11.47 | 11.38 | 11.11 | 11.08 | 11.04 | 11.09 |
| Total LDZ Consumption | 29.77 | 28.55 | 28.35 | 28.06 | 28.29 | 28.24 | 28.03 | 28.07 | 28.09 | 28.18 |
| Total Shrinkage | 0.17 | 0.19 | 0.19 | 0.18 | 0.19 | 0.21 | 0.22 | 0.22 | 0.22 | 0.22 |
| Total Throughput | 29.94 | 28.74 | 28.54 | 28.25 | 28.48 | 28.45 | 28.25 | 28.29 | 28.31 | 28.41 |

| Gas Supply Year | 2019/20 | 2020/21 | 2021/22 | 2022/23 | 2023/24 | 2024/25 | 2025/26 | 2026/27 | 2027/28 | 2028/29 |
|---|---|---|---|---|---|---|---|---|---|---|
| Total Throughput | 29.88 | 28.55 | 28.48 | 28.28 | 28.57 | 28.35 | 28.25 | 28.30 | 28.38 | 28.35 |

Figure A2.5 – Wales South LDZ Forecast Annual Demand Graph – Split by Load Categories (TWh).

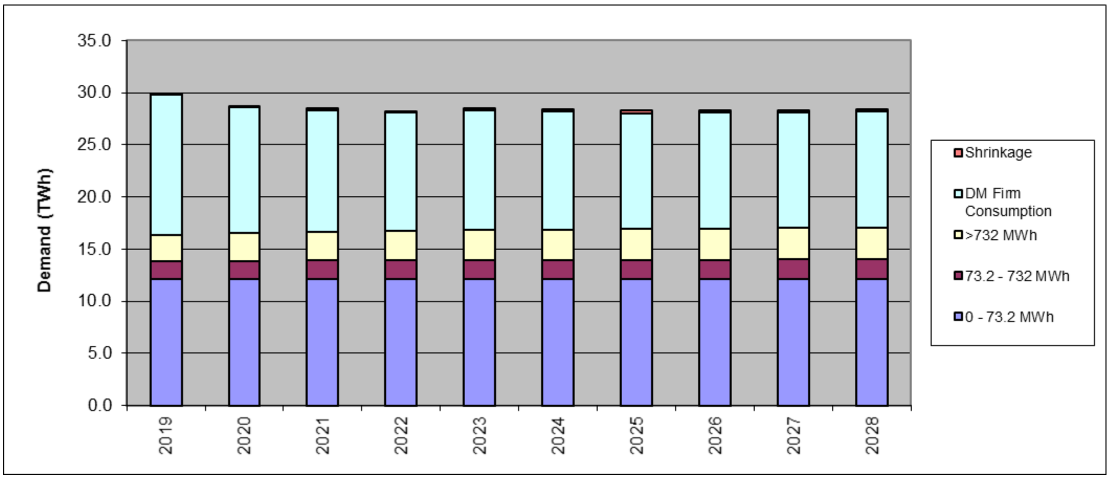
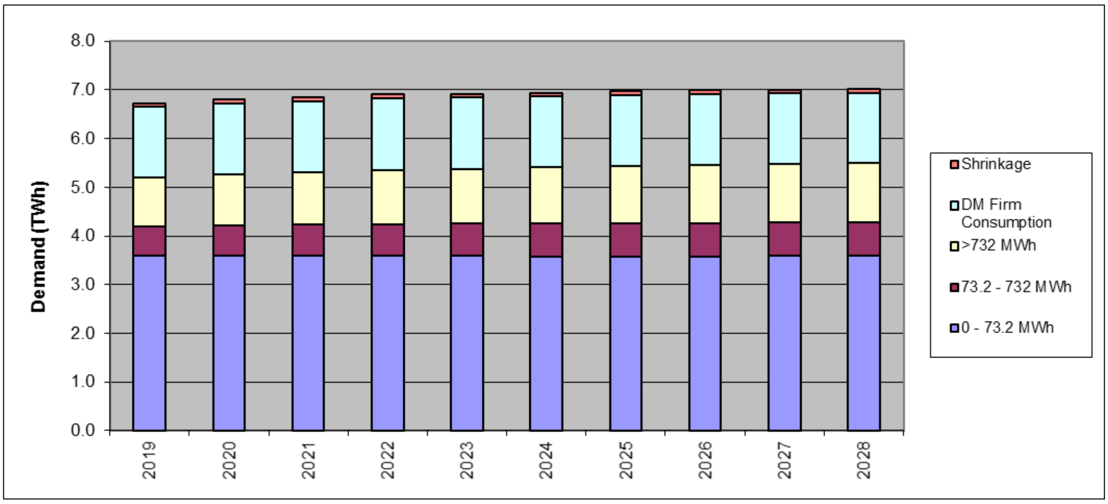


Figure A2.6 – Wales North LDZ Forecast Annual Demand Table – Split by Load Categories (TWh).

| Calendar Year | 2019 | 2020 | 2021 | 2022 | 2023 | 2024 | 2025 | 2026 | 2027 | 2028 |
|---|---|---|---|---|---|---|---|---|---|---|
| (a) 0 - 73.2 MWh | 3.60 | 3.60 | 3.59 | 3.59 | 3.58 | 3.58 | 3.58 | 3.58 | 3.58 | 3.59 |
| (b) 73.2 - 732 MWh | 0.60 | 0.62 | 0.64 | 0.66 | 0.66 | 0.67 | 0.68 | 0.68 | 0.69 | 0.69 |
| >732 MWh | 1.01 | 1.04 | 1.07 | 1.12 | 1.13 | 1.15 | 1.18 | 1.20 | 1.21 | 1.22 |
| NDM Consumption | 5.21 | 5.26 | 5.30 | 5.36 | 5.38 | 5.41 | 5.44 | 5.46 | 5.48 | 5.50 |
| DM Firm Consumption | 1.45 | 1.47 | 1.47 | 1.47 | 1.46 | 1.46 | 1.46 | 1.46 | 1.45 | 1.44 |
| Total LDZ Consumption | 6.66 | 6.73 | 6.77 | 6.83 | 6.84 | 6.87 | 6.90 | 6.92 | 6.93 | 6.94 |
| Total Shrinkage | 0.07 | 0.07 | 0.07 | 0.07 | 0.07 | 0.08 | 0.08 | 0.08 | 0.08 | 0.08 |
| Total Throughput | 6.72 | 6.80 | 6.85 | 6.91 | 6.92 | 6.94 | 6.98 | 7.00 | 7.00 | 7.02 |

| Gas Supply Year | 2019/20 | 2020/21 | 2021/22 | 2022/23 | 2023/24 | 2024/25 | 2025/26 | 2026/27 | 2027/28 | 2028/29 |
|---|---|---|---|---|---|---|---|---|---|---|
| Total Throughput | 6.78 | 6.82 | 6.90 | 6.91 | 6.94 | 6.96 | 6.99 | 7.00 | 7.02 | 7.02 |

Figure A2.7 – Wales North LDZ Forecast Annual Demand Graph – Split by Load Categories (TWh).




## A2.2 Western Power constraint information

WPD-South-Wales-St
atement-of-Works-U

# Appendix 3: Actual flows 2018

## A3.1 Annual flows

As forecasts are made without knowledge of what weather conditions will prevail into the future they are made at seasonal normal temperatures. In order to compare actual throughput with forecast values the impact of weather needs to be removed from the figures. This is known as weather corrected demand.

The Network Code requires a revision to seasonal normal values every five years and as such the basic seasonal normal temperatures were revised during 2015/16 and implemented on the 1st October for gas years 2016/17 onwards.

Figure A3.1 – South West LDZ Annual Demand 2018 (TWh)

| | 2018 Actual Demand | Weather Corrected Demand | 2018 Forecast Demand |
|---|---|---|---|
| 0 – 73 MWh | 19.30 | 18.63 | 18.59 |
| 73 – 732 MWh | 2.93 | 2.86 | 2.73 |
| > 732 MWh Firm | 7.34 | 7.22 | 7.87 |
| Interruptible | 0.00 | 0.00 | 0.00 |
| Total Consumption | 29.57 | 28.70 | 29.20 |
| Unidentified Gas | 0.92 | 0.92 | 0.00 |
| Shrinkage | 0.21 | 0.21 | 0.27 |
| Total Throughput | 30.69 | 29.82 | 29.46 |

Figure A3.2 – Wales South LDZ Annual Demand 2018 (TWh)

| | 2018 Actual Demand | Weather Corrected Demand | 2018 Forecast Demand |
|---|---|---|---|
| 0 – 73 MWh | 11.64 | 11.53 | 11.79 |
| 73 – 732 MWh | 1.36 | 1.34 | 1.49 |
| > 732 MWh Firm | 14.88 | 14.84 | 2.42 |
| Interruptible | 0.00 | 0.00 | 0.00 |
| Total Consumption | 27.88 | 27.72 | 28.40 |
| Unidentified Gas | 0.61 | 0.61 | 0.00 |
| Shrinkage | 0.10 | 0.10 | 0.19 |
| Total Throughput | 28.58 | 28.43 | 28.59 |

Figure A3.3 – Wales North LDZ Annual Demand 2018 (TWh)

| | 2018 Actual Demand | Weather Corrected Demand | 2018 Forecast Demand |
|---|---|---|---|
| 0 – 73 MWh | 3.36 | 3.32 | 3.34 |
| 73 – 732 MWh | 0.51 | 0.51 | 0.55 |
| > 732 MWh Firm | 2.62 | 2.61 | 0.88 |
| Interruptible | 0.00 | 0.00 | 0.00 |
| Total Consumption | 6.49 | 6.43 | 6.19 |
| Unidentified Gas | 0.28 | 0.28 | 0.00 |
| Shrinkage | 0.05 | 0.05 | 0.07 |
| Total Throughput | 6.81 | 6.76 | 6.26 |

The weather corrected demand gives the expected level of demand for 2018 had the weather been at its seasonal normal value. As can be seen in the tables above the Actual Demand in 2018 was very similar to the Seasonal Normal in the Wales South and South West areas but higher in Wales North.

## A3.2 Maximum and peak flows

In 2019 our most severe weather occurred in all LDZ on the between the 31st January and 2nd February. The maximum firm demand for the whole network this gas year occurred on the 1st February and was 34.98 mcm. This was significantly lower than the peak demand of 2018 during on the 1st March when extreme weather led to demands of 42.57 mcm.

The maximum and minimum for the LDZs are shown in the following table.

Figure A3.4 – LDZ Peak and Minimum Flows (GWh)

| **LDZ** | **Maximum Day 01/02/2019** | **1 in 20 Forecast peak 2018/19** | **Minimum Day 30/07/2019** |
|---|---|---|---|
| **Wales South** | 147 | 197 | 27 |
| **LDZ** | **Maximum Day 31/01/2019** | **1 in 20 Forecast peak 2018/19** | **Minimum Day 25/08/2019** |
| **Wales North** | 37 | 48 | 8 |
| **LDZ** | **Maximum Day 01/02/2019** | **1 in 20 Forecast peak 2018/19** | **Minimum Day 25/08/2019** |
| **South West** | 199 | 252 | 25 |

# Appendix 4: Our future of energy research

## A4.1 Introduction

This appendix provides further information about the research that we have undertaken into the future of energy.

The future of gas debate is critical in deciding future investment policy and asset lifespans. As such, it has an impact on investment decisions and will impact on future negotiations for funding allowances within regulatory timelines.

We have completed a number of projects with a number of different approaches to help us understand how our customers will want to use our network in the future. These have ranged from desktop analysis to live trials. Where possible we have sought input from stakeholders to inform our approach and the projects' outcomes.

## A4.2 Projects summary:

| Overview of our research projects | | | | | | |
|---|---|---|---|---|---|---|
| **Project** | **Stakeholder engagement** | **Network collaboration** | **Modelling/ analysis** | **Live trial** | **Project summary** | **Key findings/output** |
| Bridgend Study (2015) | | | ✓ | | Work to explore willingness to pay considering the likely payback period that would encourage investment in new heating technology. | 80% of households would be unable or unwilling to pay to transition to a heat network. |
| Cornwall Energy Island (2016) | ✓ | | ✓ | | Modelling and analysis of proposals put forward by the Energy Island group using renewable generation. | Improved understanding of storage requirements and costs associated with electrification scenarios. |
| 2050 Energy Pathfinder (2016/18) | | | ✓ | | Creation of a high resolution whole energy model to assess how future energy mixes would work in practice. | Development of a whole system model which is used extensively within WWU and by external projects under licence. |
| Freedom (2017/18) | ✓ | ✓ | ✓ | ✓ | Installation of air source heat pumps alongside gas boilers in 75 homes along with smart functionality to optimise both appliances. | Hybrid heating systems can be used to optimise use of electricity and gas resulting in reductions in cost and CO2. |
| Gas demand forecast project (2017/18) | | ✓ | ✓ | | Development of long-term projections for gas supply and demand changes by individual load types to feed our planning processes. | Significant change to energy usage is only likely as a result of significant incentive or deterrent. |
| Regional FES (2018/19) | ✓ | | ✓ | | Production of regional forecasts based on the NG 2018 future energy scenarios framework. | Forecasts in a format that can be combined with similar forecasts produced for WPD. |
| KESS – advanced research into anaerobic digestion | | | ✓ | ✓ | Academic research aimed at making biogas production more in line with gas network supply and demand profiles | Two projects have been progressed; one to provide variable output from an AD; the other to produce higher chain alkanes to enable biogas CV matching to existing network levels. |
| Green City Vision (2018/19) | ✓ | ✓ | ✓ | | Case study demonstrating whole system thinking using Pathfinder to determine feasible solutions for decarbonisation in a real location, Swindon. | Detailed whole network analysis will be essential to ensure that effective decarbonisation strategies are implemented. |
| Optinet (2018/19) | | ✓ | | ✓ | Assessing the potential for lower investment solutions including compression solutions to be used to improve network capacity. | In progress. |
| Consumer economics of hybrid heating | ✓ | | ✓ | | To create an economic calculator for consumers to evaluate hybrid heating systems | A series of case studies have been assessed and a calculator being made available for consumers to use. |

## Bridgend consumers' willingness and ability to pay (2015)

This project was carried out to determine the certainty of long-term gas use. The approach taken was to evaluate the viability of alternative heat sources, specifically in relation to:

- cost (including cost per tonne of carbon saved);
- reliability (intermittency);
- availability: and
- willingness and ability to pay for decarbonisation investment.

The networks area of Bridgend was chosen for this evaluation because the installation of heat networks in the area was being proposed.

Our principal learning from this project was that home energy policies in 2015 that had been set up by the Government are unlikely to lead to change that will solve the energy trilemma. In 2015 policies were weighted towards carbon reduction and do not give equivalent weight to affordability.

Due to the high cost of full electrification, use of the current gas infrastructure could potentially avoid billions of pounds in investment in the electricity system. It would also ensure a continued, reliable supply, particularly during winter months when energy and heat are at their highest requirement.

The transition to a low carbon future will ultimately result in higher energy costs to the consumer. Therefore, a significant issue in moving to a low carbon energy future is the consumer's willingness to pay these costs. It is important for the industry to understand the benefits of a low carbon future, and to be able to communicate them to consumers.

When the costs and benefits are properly understood, pricing and incentive mechanisms will enable consumers to make a rational choice. Based on the research that has been carried out to date, however, around 50% of consumers would need a very high incentive and 30% of consumers could not switch to a low carbon energy future – irrespective of the incentive offered. Key findings from this project were that:

- electric heat pumps increase emissions and cost compared with gas;
- cost is the key factor that influences consumer switching behaviour; and
- green gases such as biomethane require lower investment than other renewables.

As a result of this project we identified the need to continue to develop evidence to inform models and a vision for electricity and gas networks. This led on to other projects that are detailed in this section.

## Cornwall Energy Island (2016)

This unique independent research project set out to understand how the ample renewable energy resources could meet the County of Cornwall's ambition to be 'carbon neutral' or better, while at the same time maximising the economic and social opportunities of low carbon technologies. These were principally renewable electricity.

The Cornwall project allowed us to look at single-vector networks, notably one without support of a gas network.

It took a 'bottom up' approach to consider the impact on energy for end consumers in individual dwellings in Cornwall. Different potential scenarios to supply energy were compared, including solar, wind, marine, geothermal, and a combination of these options in a multi-option energy supply strategy. The use of low carbon gas was not considered in the scenarios.

The project provided the project sponsors with a typical view of what it would take to deliver a low carbon county via an electrification route.

No such study had previously been undertaken in GB and examples of this type are critical in deciding future investment policy for network operators, suppliers and policy makers.

The project allowed us to consider appropriate whole life cost decisions in connection with gas asset investment in Cornwall; the operating period of that asset is a key factor within the appraisal. If the project was successful, future investment in the gas network may not have been worthwhile.

During this project the first iteration of our Energy Pathfinder model was developed, see below, which provided an easily configurable decision support tool to repeat similar scenario assessments for other communities and regions.

The project concluded that a mix of 25% solar; 50% wind and 25% geothermal could support the energy needs of Cornwall, but the costs (especially for storage) were excessive and could not be justified. We concluded that investing in the gas network was still worthwhile.

## Freedom (Flexible Residential Energy Efficiency Demand Optimisation and Management) 2017

Freedom was an industry first cross-sector collaboration project involving the installation of hybrid heating systems in 75 residential properties in Bridgend, South Wales.

Working alongside Western Power Distribution and Passiv Systems the project simulated a roll out of hybrid heating systems in a demand-side response market to demonstrate and articulate the potential consumer cost, carbon emissions and energy system security benefits from large-scale deployment.

It gave a first insight into balancing the interests of the consumer, supplier and network operations. A hybrid heating system combines an electricity powered air source heat pump with a conventional gas boiler. A smart control panel enabled switching between the two heat sources driven by the cost – supporting the decarbonisation of heat in an affordable way, with limited cost to the customer and requiring limited behaviour change.

Key outcomes of this project were that it:

- Demonstrated the ability of the hybrid heating system to switch between gas and electric load to provide fuel arbitrage and highly flexible demand response services;
- Demonstrated the consumer, network, carbon and energy system benefits of deployment of hybrid heating systems with an aggregated demand response control system;
- Provided insights into the means of balancing the interests of the consumer, supplier, distribution and transmission network when seeking to derive value from the demand flexibility.

Freedom was followed by FreeNonDom, a feasibility study to assess smart hybrid heating systems in commercial buildings. The project concluded that similar benefits could be accrued for space heating in small commercial units.

A follow-on project is now underway to investigate the application of hybrid heating in buildings in the flexible whole system scenario of the future. The project will:

- Explore new comfort-as-a-service business models;
- Integrate other flexible home appliances to further develop 'Smart Living' within the hybrid energy management system;
- Identify opportunities for technology innovation to support supply chain cost optimisation.

### Pathfinder 2017-19

Our holistic 2050 Energy Pathfinder model determines the feasibility of alternative solutions across all energy vectors in an integrated way. It accommodates the demands of energy distributors, system planners and regulators by seamlessly incorporating heat, power and transport demand with electricity and green gas generation, while integrating interconnection and storage vectors.

Our simulator is already implemented within our business, and has been used by other third-party stakeholders to measure future energy systems along the road to 2050 and beyond. The Pathfinder is the first of its kind – the simulator models future energy supply and demand scenarios, using renewable, low carbon and traditional generation capacity, assessing the best mix based on local resource availability. It has shown how biomethane, BioSNG and hydrogen blends can be used to store energy for use in heat.

Pathfinder was used for the Green City Vision project, a unique collaborative study that assessed low-cost, technically feasible solutions to deliver a city of the future. The project is described in more detail below.

Following the use of Pathfinder in our Green City Vision project we are now developing an enhanced version – Pathfinder Plus – which will be delivered at the end of 2019. Pathfinder Plus will build on the existing model and include significant new economic modelling to enable robust comparison of customer costs for each scenario. Some minor changes will also be included such as the provision of additional functionality for demand-site response activities and grid inertia assessment. Pathfinder Plus will be offered for use as part of our contribution to Local Area Energy Plans and has been offered to other networks to develop such plans across the whole country.

### KESS, academic research

Flexible methane production – technical feasibility is currently being conducted with good results – linking particularly well with animal slurries and sewage sludge (both 'decentralised resources', as well as recovery of ammonia and phosphate). A financial assessment is to follow and the project will end in December 2019. The University reports that ideally more work would continue but funding is not readily available at this stage.

Higher alkane production - the University has managed to produce ethane and butane from $H_2$ and $CO_2$ as a feedstock, at a concentration that needs to be measured better but combined =<4-5% on a mixture with methane. The University needs to evaluate the metabolic pathways now and increase these concentrations, and be selective about which product they produce.

The University is also progressing well in the conversions of $H_2$ and $CO_2$ into $CH_4$ and would aim to go to a larger demo as soon as possible. It is establishing a spin-off company to support the commercialisation activities.

### Gas Demand Forecast Project (2017/18)

Scenarios being developed across the UK energy industry highlight significant uncertainty in the quantity and types of energy that are likely to be used in the future.

A consistent message is that future gas customer usage patterns will be increasingly difficult to predict and will require the gas networks to provide greater flexibility in response to more variable customer demands.

We developed an in-house investment decision support tool that allows us to assess the impact of changing customer requirements on our network, when considering maximum load, minimum load and likely hourly profiles. Good input data on the long-term volume and characteristics of different load types, which are required for the model have been difficult to obtain, especially at a local level.

This project, which was undertaken in collaboration with all gas distribution networks, provided us with a holistic view and impact assessment allowing us to better predict future requirements for the gas network. This work will support the UK’s strategic aim to enable the use of smart technologies that will help decarbonise energy over the next 30 years.

A key benefit of the project is that it will ensure that future investment on the network is spent wisely. It will also provide savings to customers by providing better long-term planning information.

We have used the project's output in developing our business plan and have also fed the information from the project into work undertaken by networks to develop a consistent view of the future.

A number of new innovation projects are using the output of this project and others to develop more granular forecasting models (for example at hourly and individual consumer level).

### Regional FES (2018/19)

The purpose of the Regional FES project is to develop and trial a new gas demand forecasting methodology to create a set of regional and sub-regional growth scenarios for gas and heat from a 2018 baseline out to 2035. The intention is that these growth scenarios, backed by extensive analysis and stakeholder engagement, will create a dataset and evidence case to help us and other stakeholders to understand the future requirements and usage of the gas network.

We are also creating the forecasts in formats that should enable us to combine the outputs with similar work carried out by the DNOs in our network so that we can eventually produce a single suite of energy forecasts for gas and electricity combined – a prototype Distribution FES.

The project is being delivered in three phases:

- The first phase, which was completed in February 2019, developed the project scope, methodology and approach.
- Phase 2, which was completed at the end of May, created a set of regional future energy scenarios for gas and heat for the south west of England.
- Phase 3, which Regen began in June, will be to develop a similar set of scenario projections for the gas distribution network in Wales. We have received an early set of draft results during August.

The project has used and adapted the four National Grid FES 2018 energy scenarios with the addition of a fifth, Hybrid Accelerator, scenario which has been developed in conjunction with WWU and regional stakeholders. Use of these national scenarios has provided a common framework and an overarching set of assumptions, while the regional scenarios have themselves been developed through a bottom-up process of data gathering, energy system analysis and stakeholder engagement for the specific regions (South West and Wales).

A key part of the project methodology has been to engage with regional and local stakeholders through workshops in Exeter, Bristol, Cardiff and Llandudno. These workshops influenced the assumptions in the modelling; for example at the Cardiff event there was significant discussion around projections for the use of hydrogen in Wales, which the group felt were higher than our initial assumptions.

## Green City Vision (2018/19)

The purpose of the Green City Vision project was to create the initial evidence base to better understand system decarbonisation within the context of an integrated gas-electricity system. A number of decarbonisation strategies have been applied to a reference scenario to understand the requirements of any given strategy to decarbonise regions with respect to the UK's Climate Change Act 2008 with carbon emissions reduction target of 80% relative to 1990 by 2050. It is proposed to use Regional FES to update this to Net Zero (Climate Change Act 2019).

The objective of the Green City Vision project was to view decarbonisation strategies from a more holistic perspective, by understanding the implications of any given strategy on the gas and electricity systems and by focusing on the interface between the two. By integrating both supply-based and demand-based solutions across both networks, the outcome of Green City Vision project is to understand an optimum solution for decarbonisation, with feasibility level investment implications to achieve such a solution.

The main outcomes from the analysis undertaken were as follows:

- The scenarios modelled indicated that continued operation of both the gas and the electricity network will provide the least disruptive pathway to compliance – as evidenced from the necessary investment implications and changes that resulted from the single-vector electrification and green gas scenarios.

- All decarbonisation vectors have a role to play. However, to achieve a given level of carbon emissions reductions, 'top down' supply-driven strategies were determined to be more deliverable than 'bottom up' demand-driven strategies. An example of such deliverability is where, in a 2050 energy system, a 10 MW biomethane plant would yield the same decarbonisation as 8000 ASHPs, and would require 45% less subsidy to incentivise the same decarbonising output, at current support prices.

- The expected adoption of electric vehicles (minimum 90% of cars and vans by 2050) alone will require investment to facilitate a resulting compound peak electricity demand growth rate of 5% for each five-year ED RIIO period until 2050. The delivery of further decarbonisation will therefore be made more achievable by leveraging the gas network to achieve compliance, given that a full electrification compliance scenario yielded an 11% compound peak demand growth rate each five-year ED RIIO period until 2050.

- The decarbonisation of heat is a necessary condition for compliance given that current Swindon heat emissions are 15% greater than the 2050 total emissions target. Focusing on low-carbon gas, supported by efficiency improvements and hybrid heat pumps, followed by other measures, is seen as the least disruptive pathway to compliance, given the advantages of leveraging the gas network and the deliverability advantages of supply-driven strategies over demand-driven strategies.

- Integrated demand forecasting between the gas and electricity network will be essential in ensuring reliable supply to the collective energy system. This is particularly the case in relation to gas network diurnal storage – as flexible capacity for electric vehicle charging will dominate gas demand in the summer months, where generation requirements will be determined by the availability of intermittent renewable electricity.

- Consumer choice will play a major role in achieving compliance, given that maximising energy efficiency to the technical upper limit could reduce overall emissions by 28% and that optimising electric vehicle charging patterns could reduce additional peak demand by up to 15%. Therefore, incentivisation of consumer investment will be an important factor in determining the ultimate compliance pathway.

- Based on the scenarios modelled, the average reduction in both annual and peak gas demand by 2050 was 35%, relative to current operation. This is in line with an average reduction of 32% across the National Grid future energy scenarios by 2050.

- The main investment focus for the gas network within the Swindon area should be: facilitation of at least 80 MW of biomethane capacity, as well as investment to reduce opex and ensure a low-cost operation in a reduced utilisation environment.

- Based on the scenarios modelled, the average increase in annual and peak electricity demand by 2050 was 50% and 45% respectively, relative to current operation.

- Annual average electricity generation inertia is forecast to reduce from 70% to 50% by 2050. This is broadly in line with the 2018 National Grid future energy scenarios which on average yield 40% inertia by 2050. The minimum-inertia hour calculated from the scenarios modelled was 20%.

- The main investment focus for the electricity network within the Swindon area should be: regional investment to facilitate a minimum compound peak growth rate of 5% each five-year RIIO period, as well as investment to accommodate a much more dynamic system given that the average increase in peak demand change rates was found to be 60%.

### Optinet (2018/19)

The growth of distributed gas generation, principally in the form of biomethane production, brings with it many technical, economic and regulatory challenges. The most significant issue we are facing currently is that sufficient network capacity is not available in low demand periods and new biomethane connections may not be able to connect into the network or may be constrained off during the periods of low demand. Project Optinet is looking at ways to mitigate this issue.

The impacts of the new types of exit connections onto the distribution systems have to be considered in parallel with the challenges of entry.

Electricity flexible generation plants, which ramp up quickly and usually operate over the peak energy periods, are connecting onto the distribution networks in large numbers. This sudden demand on the distribution networks could cause the pressure in the network to rise and drop in an unpredictable manner as they are called on to balance intermittent renewable electricity generation.

Combining the impact of both green gas entry and power generation supply places unprecedented challenges on the operation of the network. Balancing these requirements and adapting to constant changes in the ways our customers wish to use our network can only be achieved by deploying new optimisation methods and technologies.

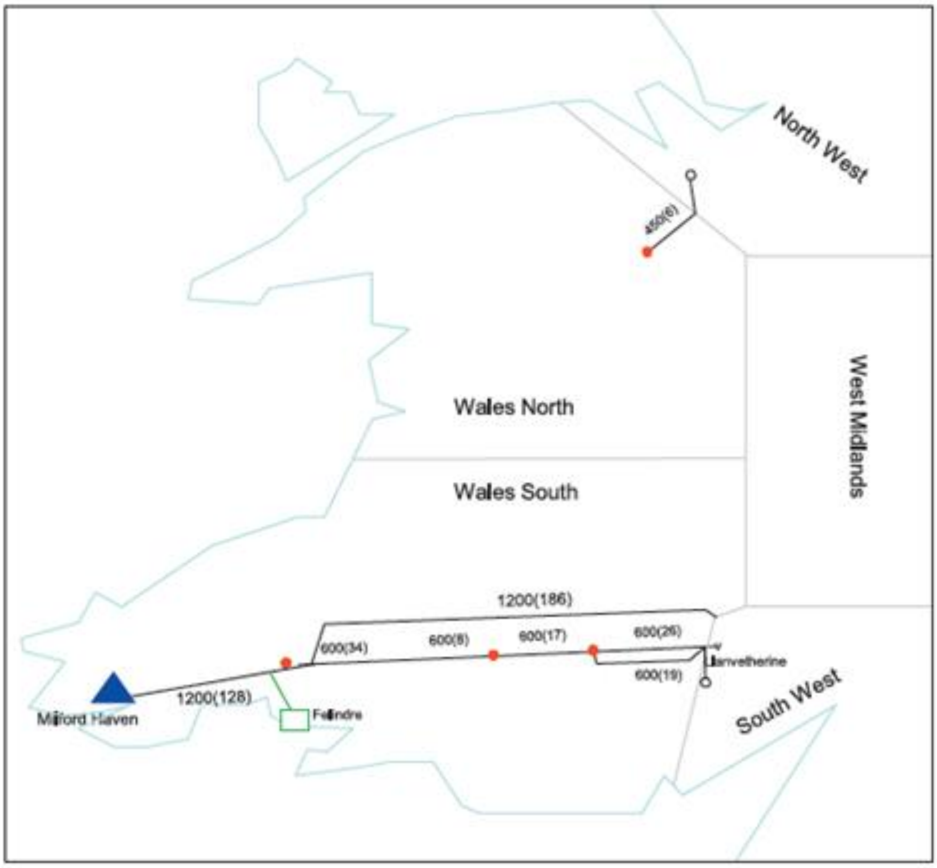
The project will review a number of solutions to create capacity in the network to allow additional biomethane plants or other distributed gas generation to connect and flow – even during periods of low demand. This will maximise the opportunity to decarbonise the gas network and support the energy system transition. The main solutions that are being investigated through the project are as follows:

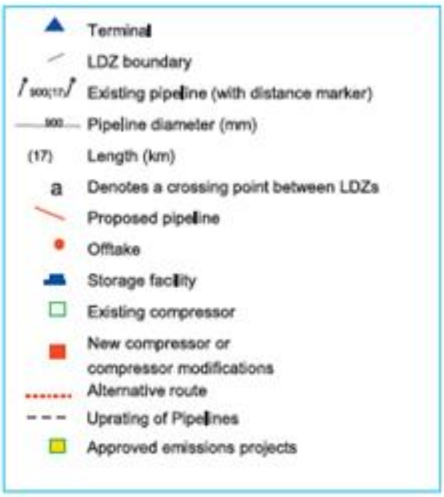
- Smart pressure control of the network
- Compression from the lower pressure tiers to higher pressure tiers
- Storage solutions

The project hopes to demonstrate the ability to implement solutions that enable the wider connection of green and distributed gases into the network and to use them in tandem. This will provide a cost-efficient and reliable way to manage green gas injection while supporting the requirements of new demands such as the increase in flexible power generation or gas for transport.

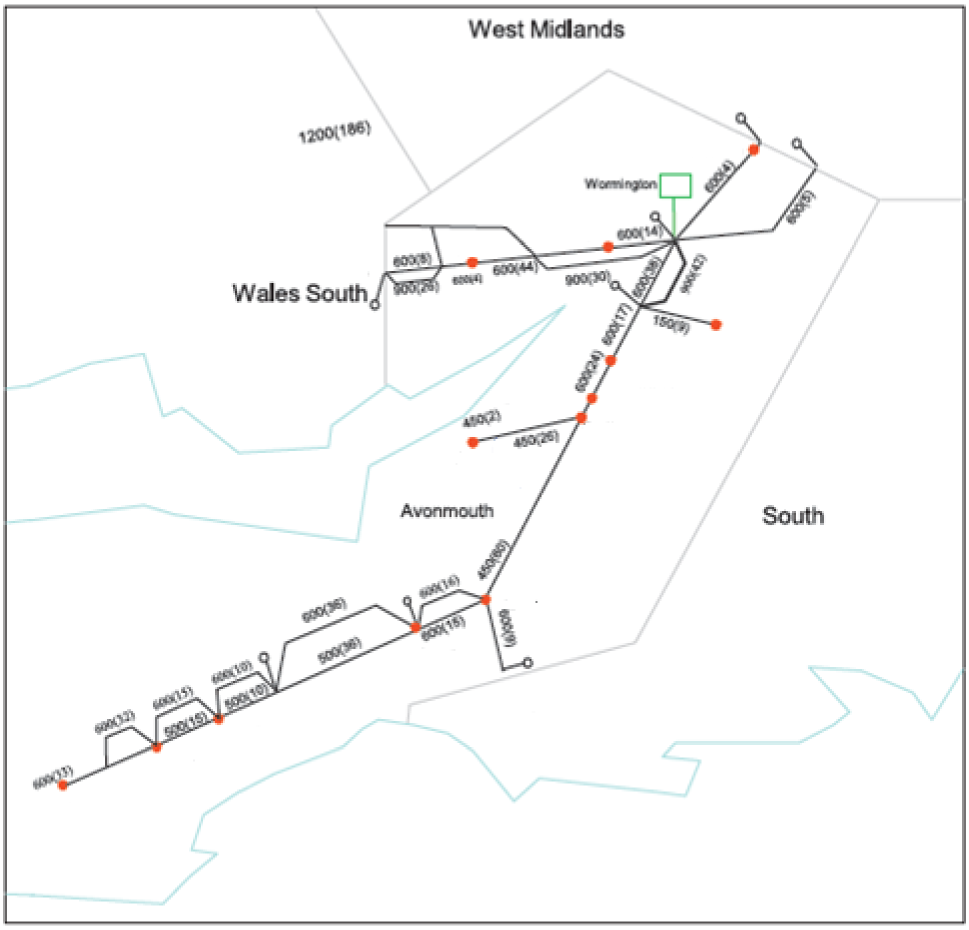
# Appendix 5 : The gas transportation system

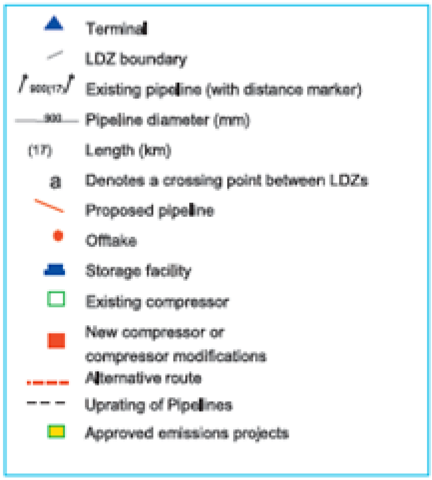
## A5.1 Wales North and Wales South (WN & WS) NTS

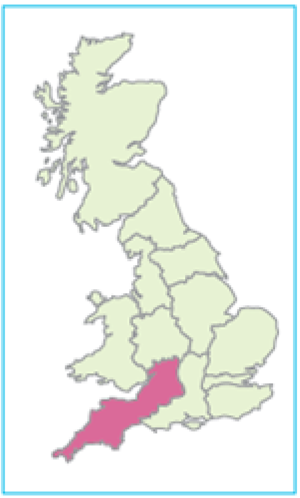


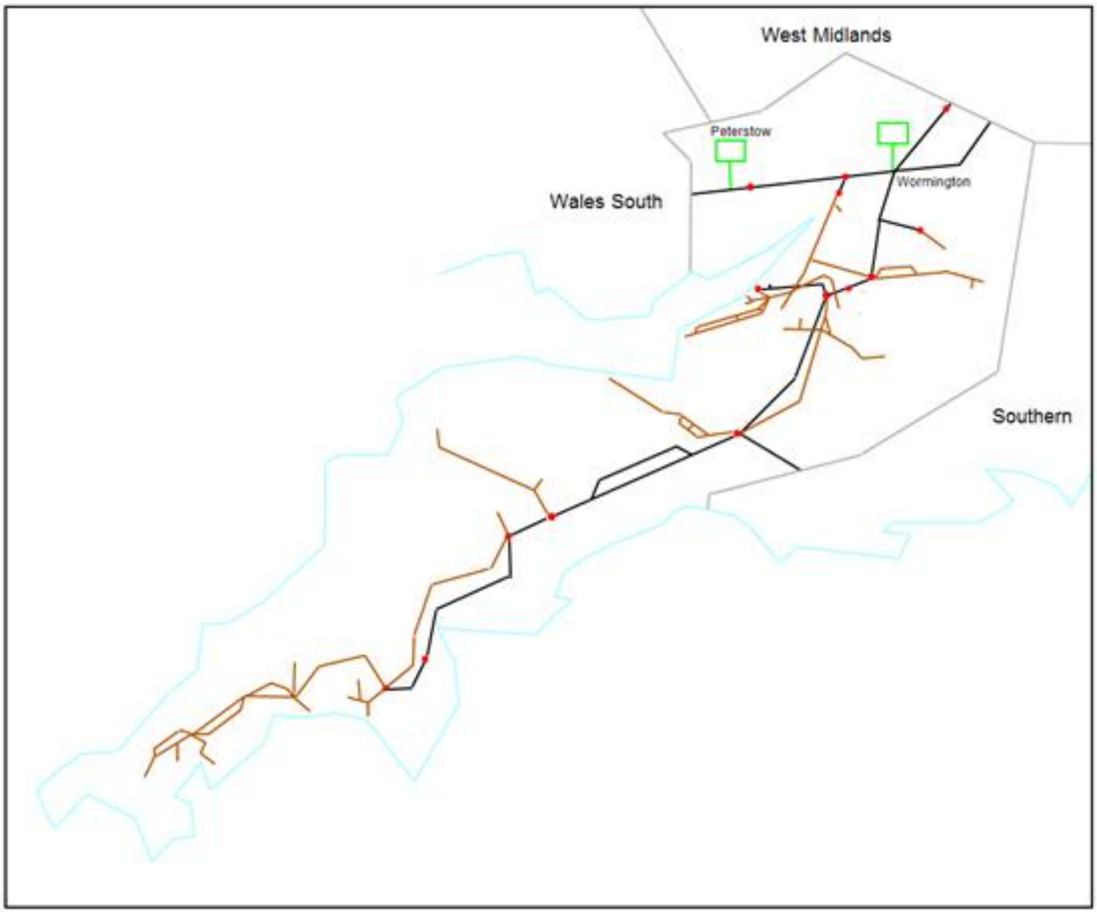

## A5.2 South West (SW) NTS

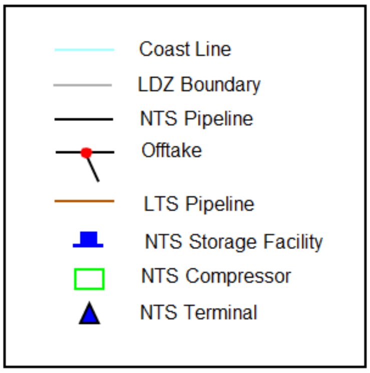


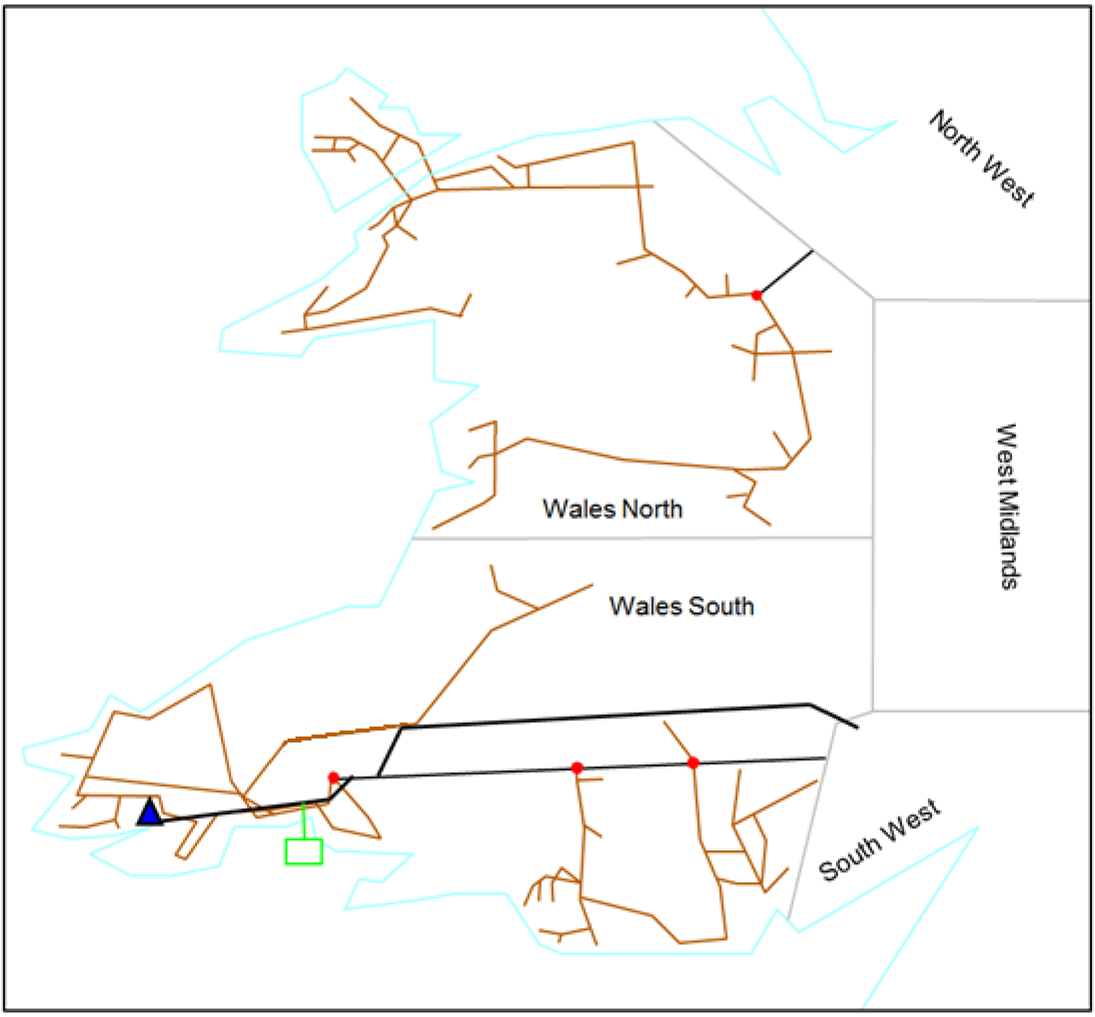



### A5.3 South West (SW) LDZ - LTS

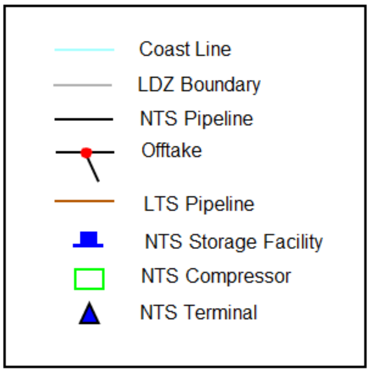


## A5.4 Wales North and Wales South (WN & WS) LTS




## A5.5 Code LDZ Maps



# Appendix 6: Connections to WWU's system

## A6.1 Introduction

We offer connection services in line with our Gas Act obligations. System entry connections conditions are detailed in Section A6.3 below.

Our exit connections allow gas to be taken from our system to premises (a 'Supply Point') or to Connected System Exit Points (CSEPs). There are several types of connected system including:

- A pipeline system operated by another gas transporter.
- Any other non-WWU pipeline transporting gas to premises consuming more than 2,196 MWh per annum.

Please note that in addition to new pipes being termed connections, any requirement to increase the quantity of gas delivered to or taken from the system is also treated as a new connection.

## A6.2 General information regarding connections

Our connection charging policy for all categories of connection is set out in the publication 'Standard Condition 4B of the Gas Transporter Licence – Statement of Principles and Methods to be used to determine charges for Gas Distribution Connections Services', which is supported by our Connections and Other Distribution Services Charges Document. Both documents can be downloaded from our web site (www.wwutilities.co.uk).

Additional information relating to the connection process, including contact details, can also be found on the website. It should be noted that any person wishing to connect to our system, or requiring increased flow should contact us as early as possible to ensure that requirements can be met on time, particularly if system reinforcement is required.

## A6.3 Information for system entry connections

We require a Network Entry Agreement or Connection Agreement with the respective operator to establish, among other things, the gas quality specification, the physical location of the delivery point and the standards to be used for both gas quality and the measurement of flow.

### A6.3.1 Network entry quality specification

For any new entry connection to our system, the connecting party should notify us as soon as possible as to the likely gas composition. We will then determine whether the gas can be accepted, taking into account our existing statutory and contractual obligations. Our ability to accept gas supplies into the system is affected by, among other things, the composition of the new gas, the location of the system entry point, volumes entered and the quality and volumes of gas already being transported within the system. In assessing the acceptability of any proposed new gas supply, we will take account of:

- Our ability to continue to meet statutory obligations (including, but not limited to, the Gas Safety (Management) Regulations 1996 (GS(M)R)).

- The implications of the proposed gas composition on system running costs.
- Our ability to continue to meet our contractual obligations.

For indicative purposes, the specification set out below is usually acceptable for most locations and encompasses but is not limited to the statutory requirements set out in the GS(M)R.

1. Hydrogen Sulphide
    - Not more than 5mg/m3
2. Total Sulphur
    - Not more than 50mg/m3
3. Hydrogen
    - Not more than 0.1% (molar)
4. Oxygen
    - Not more than 1% (molar) - HSE has now issued a class exemption to GS(M)R to allow network conveyance of gas with an oxygen content <= 1% (molar) at pressures up to 38 barg
5. Hydrocarbon Dewpoint
    - Not more than -2°C at any pressure up to 85barg
6. Water Dewpoint
    - Not more than -10°C at 85barg
7. Wobbe Number (real gross dry)
    - The Wobbe Number shall be in the range 47.20 to 51.41MJ/m3
8. Incomplete Combustion Factor (ICF)
    - Not more than 0.48
9. Soot Index (SI)
    - Not more than 0.60
10. Gross Calorific Value (real gross dry)
    - The Gross Calorific Value (real gross dry) shall be in the range 36.9 to 42.3MJ/m3, in compliance with the Wobbe Number, ICF and SI limits described above. Subject to gas entry location and volumes, we may set a target for the Calorific Value within this range
11. Inerts
    - Not more than 7.0% (molar) subject to
    - Carbon Dioxide: not more than 2.0% (molar). Please note that there is a proposal by NG to modify the UNC to a limit of 2.5% (as mentioned above the limit is indirectly limited by the GS(M)R)
12. Contaminants
    - The gas shall not contain solid, liquid or gaseous material that may interfere with the integrity or operation of pipes or any gas appliance within the meaning of regulation 2(1) of the Gas Safety (Installation and Use) Regulations 1998 that a consumer could reasonably be expected to operate
13. Organo Halides
    - Not more than 1.5 mg/m3
14. Radioactivity
    - Not more than 5 Becquerels/g

15. Odour
- Gas delivered shall have no odour that might contravene the statutory obligation not to transmit or distribute any gas at a pressure below 7 barg, which does not possess a distinctive and characteristic odour

16. Pressure
- The delivery pressure shall be the pressure required to deliver natural gas at the Delivery Point into our Entry Facility at any time taking into account the back pressure of our System at the Delivery Point as the same shall vary from time to time
- The entry pressure shall not exceed the Maximum Operating Pressure at the Delivery Point

17. Delivery Temperature
- Between 1°C and 38°C

18. Siloxanes
- Tests for siloxanes and the determination of safe limits are subject to ongoing work.

  The limits and testing regime will be updated as industry best practice develops

Please note that the Incomplete Combustion Factor (ICF) and Soot Index (SI) have the meanings assigned to them in Schedule 3 of the GS(M)R. In addition, where limits on gas quality parameters are equal to those stated in GS(M)R (Hydrogen Sulphide, Total Sulphur, Hydrogen, Wobbe Number, Soot Index and Incomplete Combustion Factor), we may require an operational tolerance to be included within an agreement to ensure compliance with the GS(M)R.

Due to continuous changes being made to the system, any undertaking made by us on gas quality prior to signing an agreement will normally only be indicative.

### A6.4 Additional information specific to system exit connections

Any person can contact us to request a connection, whether they are a shipper, operator, developer or consumer. However, gas can only be taken where the Supply Point so created has been confirmed by a shipper, in accordance with the Uniform Network Code.

#### A6.4.1 Offtake pressures - distribution network connections

Gas will normally be made available to consumers at a pressure that is compatible with a regulated metering pressure of 2 mbar. Information on the design and operating pressures of distribution pipes can be obtained by contacting us.

#### A6.4.2 Self-lay pipes or systems

In accordance with Section 10(6) of the Gas Act, and subject to the principles set out in the published Licence Condition 4B Statement, and the terms and conditions of the contract between us and the customer in respect of the proposed connection, where a party wishes to lay their own service pipe to premises expected to consume 2,196 MWh per annum or less, ownership of the pipe will vest in us once the connection to the our system has been made.

Where the connection is for a self-laid pipe to premises with an expected consumption of more than 2,196 MWh per annum or the connection is to a pipe in our system which is not a relevant main, these pipes do not automatically belong to us. However, subject to the principles set out in the published Licence Condition 4B Statement and the relevant contractual terms and conditions, we may take ownership of pipes to such premises.

Parties considering laying a pipe that will either vest in us or is intended to come into our ownership should refer to the published Licence Condition 4B Statement and make contact prior to the planning phase of any project.

#### A6.4.3 Reasonable demands for capacity

Operating under the Gas Act 1986 (as amended 1995), we have an obligation to develop and maintain an efficient and economical pipeline system and, subject to that, to comply with any reasonable request to connect premises, provided that it is economic to do so. However, in many instances, specific system reinforcement may be required to maintain system pressures for the winter period after connecting a new supply or demand. Details of how we charge for reinforcement and the basis on which contributions may be required can be found in the published Licence Condition 4B Statement. Please note that dependent on scale, reinforcement projects may have significant planning, resource and construction lead-times and that as much notice as possible should be given. In particular, we will typically require two to four years' notice of any project requiring the construction of high pressure pipelines or plant, although in certain circumstances, project lead-times may exceed this period.

# Appendix 7: Gas transporter licence

### A7.1 Overview

Our Gas Transporter (GT) Licence arrangements include a number of incentives, which are there to incentivise the networks to focus on specific outputs valued by Stakeholders. We have an Exit Capacity Incentive which is there to encourage us to minimise our Flat Capacity bookings with the NTS. In the longer term, if we can reduce our flat capacity requirements from the NTS, the NTS may be able to avoid additional investments and therefore minimise costs to gas users.

### A7.2 Distribution Network Exit Incentive

Following a robust and transparent price control review process we have been given baseline volume capacity allowances. Each October we agree with the NTS our flat capacity requirements for the gas year ahead (Oct to Sept). Each year, our booking requirements then are compared to the upfront volume allowances and if we are able to book less than the allowances we can earn additional revenues but if we have to book more than the baseline up front allowances we will have revenue deducted. The incentive is symmetrical and does not have any caps or collars. Any gains or losses are shared with gas consumers.

For further details on our incentives please refer to our Gas Transporter licence and the Ofgem website.

# Appendix 8: Glossary

**Annual Quantity (AQ)**

The AQ of a supply point is its annual consumption over a 365-day year, under conditions of average weather.

**Bar**

The unit of pressure that is approximately equal to atmospheric pressure (0.987 standard atmospheres). Where bar is suffixed with the letter g, such as in barg or mbarg, the pressure being referred to is gauge pressure, i.e. relative to atmospheric pressure. One millibar (mbar) equals 0.001 bar.

**Calorific Value (CV)**

The ratio of energy to volume measured in Mega Joules per cubic meter ($MJ/m^3$), which for a gas is measured and expressed under standard conditions of temperature and pressure.

**Climate Change Levy (CCL)**

Government tax on the use of energy within industry, commerce and the public sector in order to encourage energy efficient schemes and use of renewable energy sources. CCL is part of the government's Climate Change Programme (CCP).

**Composite Weather Variable (CWV)**

A single measure of weather for each LDZ, incorporating the effects of both temperature and wind speed. A separate composite weather variable is defined for each LDZ.

**Combined Cycle Gas Turbine (CCGT)**

A Combined Cycle Gas Turbine is a unit whereby electricity is generated by a gas powered turbine and also a second turbine. The hot exhaust gases expelled from the first turbine are fed into the heat exchanger to generate steam, which powers the second turbine.

**Combined Heat and Power (CHP)**

The simultaneous generation of electricity and heat for use within buildings or processes, by recovery of the heat produced in the power generation process.

**Connected System Exit Point (CSEP)**

This is a connection to a more complex facility than a single supply point. For example a connection to a pipeline system operated by another Gas Transporter.

**Cubic Metre ($m^3$)**

The unit of volume, expressed under standard conditions of temperature and pressure, approximately equal to 35.37 cubic feet. One million cubic metres (mcm) are equal to $10^6$ cubic metres, one billion cubic metres (bcm) equals $10^9$ cubic metres.

**Daily Metered Supply Point**

A supply point fitted with equipment, for example a datalogger, which enables meter readings to be taken on a daily basis. Further classified as SDMC, DMA, DMC or VLDMC according to annual consumption.

**Datalogger**

An electronic device that automatically records, stores and transmits meter readings (such transmission usually being via PSTN lines).

**Distribution Network or Independent Distribution Network (iDN)**

An independent gas transporter responsible for the operation and maintenance of the LTS and <7barg DNs within a defined geographical boundary.

**Distribution System**

A Network of mains operating at three pressure tiers: intermediate (2 to 7barg), medium (75mbarg to 2barg) and low (less than 75mbarg).

**Diurnal Storage**

Gas stored for the purpose of meeting, among other things, within day variations in demand. Gas can be stored in special installations, such as bullets and gasholders, or in the form of Linepack within transmission, i.e. >7barg, pipeline systems.

**Exit Zone**

A geographical area (within an LDZ) that consists of one or more Offtakes that, on a peak day, receive gas from the same NTS pipeline.

**Formula Year**

A twelve-month period commencing 1st April, predominantly used for regulatory and financial purposes.

**Gas Transporter (GT)**

Formerly Public Gas Transporter (PGT). GTs, such as WWU, are licensed by the Gas and Electricity Markets Authority to transport gas to consumers.

**Gas Supply Year**

A twelve-month period commencing 1st October, also referred to as a Gas Year.

**Interconnector**

A pipeline transporting gas to another country. The Irish interconnector transports gas across the Irish Sea to both the Republic of Ireland and Northern Ireland. The Continental Interconnector transports gas between Bacton and Zeebrugge. The Continental Interconnector is capable of flowing gas in either direction.

**Interruptible Service**

A service where the transporter can interrupt the flow of gas to the supply point in return for lower transportation charges.

**Kilowatt hour (kWh)**

A unit of energy used by the gas industry. Approximately equal to 0.0341 therms. One Megawatt hour (MWh) equals $10^3$ kWh, one Gigawatt hour (GWh) equals $10^6$ kWh, and one Terawatt hour (TWh) equals $10^9$ kWh.

**Linepack**

The volume of gas stored within the National or Local Transmission System at any time.

**Liquefied Natural Gas (LNG)**

Gas stored in liquid form.

**Load Duration Curve (1 in 50 Severe)**

The 1 in 50, or severe, load duration curve is that curve which, in a long series of years, with connected load held at the levels appropriate to the year in question, would be such that the volume of demand above any given demand threshold (represented by the area under the curve and above the threshold) would be exceeded in one out of fifty years.

**Load Duration Curve (Average)**

The average load duration curve is that curve which, in a long series of winters, with connected load held at the levels appropriate to the year in question, the average volume of demand above any given threshold, is represented by the area under the curve and above the threshold.

**Local Distribution Zone (LDZ)**

A geographic area supplied by one or more Offtakes from the NTS. Consists of LTS and distribution system pipelines.

**Local Transmission System (LTS)**

A pipeline system operating at >7barg that transports gas from Offtakes to distribution systems. Some large users may take their gas direct from the LTS.

**National Transmission System (NTS)**

A high-pressure system consisting of terminals, compressor stations, pipeline systems and offtakes. Designed to operate at pressures up to 85 bar. NTS pipelines transport gas from terminals to Offtakes.

**Non-Daily Metered (NDM)**

A meter that is read monthly or at longer intervals. For the purposes of daily balancing, the consumption is apportioned, using an agreed formula, and for supply points consuming more than 73.2MWh pa, reconciled individually when the meter is read.

**Odorisation**

The process by which the distinctive odour is added to gas supplies to make it easier to detect leaks. WWU provide odorisation at Offtakes.

**Office of Gas and Electricity Markets (Ofgem)**

The regulatory agency responsible for regulating the UK's gas and electricity markets.

**Offtake**

An installation defining the boundary between NTS and WWU Network or a very large consumer. The offtake installation includes equipment for metering, pressure regulation, etc.

**Own Use Gas (OUG)**

Gas used by us to operate the transportation system. Includes gas used for heating and venting.

**Price Control Review (PCR)**

Ofgem's periodic review of our allowed returns, the current PCR runs for the period 2013/14 to 2020/21

**Peak Day Demand (1 in 20 Peak Demand)**

The 1 in 20 peak day demand is the level of demand that, in a long series of winters, with connected load held at the levels appropriate to the winter in question, would be exceeded in one out of 20 winters, with each winter counted only once.

**Seasonal Normal Composite Weather Variable (SNCWV)**

The seasonal normal value of the CWV for a LDZ on a day is the smoothed average of the values of the applicable CWV for that day in a significant number of previous years.

**Shipper or Uniform Network Code Registered User (System User)**

A company with a Shipper Licence that is able to buy gas from a producer, sell it to a supplier and employ a GT to transport gas to consumers.

**Shrinkage**

Gas that is input to the system but is not delivered to consumers or injected into storage. It is either Own Use Gas or Unaccounted for Gas.

**Supplier**

A company with a Supplier's Licence contracts with a shipper to buy gas, which is then sold to consumers. A supplier may also be licensed as a shipper.

**Supply Hourly Quantity (SHQ)**

The maximum hourly consumption at a supply point.

**Supply Offtake Quantity (SOQ)**

The maximum daily consumption at a supply point.

**Supply Point**

A group of one or more meters at a site.

**Therm**

An imperial unit of energy. Largely replaced by the metric equivalent: the kilowatt hour (kWh). 1 therm equals 29.3071 kWh.

**Transporting Britain's Energy (TBE)**

NG's annual industry-wide consultation process encompassing their Ten Year Statement, targeted questionnaires, individual company and industry meetings, feedback on responses and investment scenarios.

**Unaccounted for Gas (UAG)**

Gas lost during transportation. Includes leakage, theft and losses due to the method of calculating the Calorific Value (Flow Weighted Average CV cap is set at 1 $MJ/m^3$ above the lowest CV).

**UKCS**

United Kingdom Continental Shelf

**Uniform Network Code (UNC)**

The document that defines the arrangements between WWU, NG, the other DNs and System Users.

# Appendix 9: Conversion Matrix

To convert from the units on the left hand side to the units across the top multiply by the values in the table.

Note
All volume to energy conversions assumes a CV of 39 $MJ/m^3$.

| To: Multiply | GWh | mcm | Million therms | Thousand toe |
|---|---|---|---|---|
| **GWh** | 1 | 0.092 | 0.034 | 0.086 |
| **mcm** | 10.833 | 1 | 0.370 | 0.932 |
| **Million Therms** | 29.307 | 2.710 | 1 | 2.520 |
| **Thousand toe** | 11.630 | 1.073 | 0.397 | 1 |

All conversions are to 3 decimal places and therefore may not include the full conversion factor.
GWh = GigaWatt Hours
mcm = Million Cubic Metres
Thousand toe = Thousand Tonne of Oil Equivalent